FGF Studies in Small Business and Entrepreneurship

Elisabeth S.C. Berger
Andreas Kuckertz *Editors*

Complexity in Entrepreneurship, Innovation and Technology Research

Applications of Emergent and Neglected Methods

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ISSN 2364-6918 ISSN 2364-6926 (electronic)
FGF Studies in Small Business and Entrepreneurship
ISBN 978-3-319-27106-4 ISBN 978-3-319-27108-8 (eBook)
DOI 10.1007/978-3-319-27108-8

Library of Congress Control Number: 2016931356

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG Switzerland

About the FGF Studies in Small Business and Entrepreneurship

Understanding entrepreneurship and entrepreneurial phenomena in new ventures, small businesses, and established corporations is of crucial importance for entrepreneurs, corporate managers, and policy makers alike. Since its inception in 1987, the *Förderkreis Gründungsforschung e.V. (FGF)* has strongly supported the development of research on these important topics and is today the largest and leading association of entrepreneurship and innovation scholars in Germany, Austria, Switzerland, and Liechtenstein. Today, the *FGF* provides an established platform for the exchange of ideas and new results from entrepreneurship research and related phenomena such as innovation, small and medium-sized enterprises (SMEs), and family businesses. One important medium for the exchange of knowledge is the book series "*FGF Studies in Small Business and Entrepreneurship*."

The aim of this peer-reviewed book series is to showcase exceptional scholarly work in small business, innovation, and entrepreneurship research. The book series has an interdisciplinary focus and includes works from management, finance, innovation, marketing, economics, sociology, psychology, and related areas reflecting the breadth of different approaches to small business and entrepreneurship research. Volumes in the series may include

- research monographs,
- edited volumes, and
- handbooks or quick reference books.

The book series *FGF Studies in Small Business and Entrepreneurship* acknowledges that small business and entrepreneurship phenomena occur at various levels of analysis and hence the series is concerned with a plethora of levels including the analysis of individuals, organizations, networks, economies, and societies. Through this, the book series serves as a vehicle to help academics, professionals, researchers, and policy makers, working in the fields of small business and entrepreneurship, to disseminate and obtain high-quality knowledge.

Proposals for new titles in the series are extremely welcome and should be addressed to one of the two editors-in-chief.

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The Challenge of Dealing with Complexity in Entrepreneurship, Innovation and Technology Research: An Introduction

Elisabeth S.C. Berger and Andreas Kuckertz

Abstract Complex systems seem to be all around us and the world, economies and businesses apparently become more complex every day. This is especially true for phenomena in entrepreneurship, innovation and technology research. This introductory chapter elaborates our understanding of complexity and explores the interdependencies in entrepreneurship, innovation and technology research with regard to complexity. When studying complexity it is essential to apply research methods that consider the non-linearity, dynamics and interrelatedness inherent in complexity. However, appropriate methods are frequently neglected or not yet established among the plethora of available research methods. This volume adds to the visibility of the application of emergent and neglected methods in the context of complexity in entrepreneurship, innovation and technology research. Finally, the chapter provides an overview of the contributions in this book.

Keywords Complexity • Entrepreneurship • Innovation • Research methods • Technology

1 Defining Complexity

Complexity, complex systems, complex theory or science of complexity are terms which have a long history. However, there appears to be neither a consistent definition or a well described science or theory. In this book, we take the perspective of the broadest possible understanding of complexity originating from the Latin word *plectere*, which refers to parts of a system being entwined (Mitchell, 2009). Those large number of parts might be in itself simple, but are irreducibly interlinked to each other and thus create what is referred to as a complex system that is "more

"Fools ignore complexity. Pragmatists suffer it. Some can avoid it. Geniuses remove it." Alan J. Perlis (1982)

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_1

than the sum of its parts" (Simon, 1962, p. 468). According to Lichtenstein (2000), four assumptions characterize such complex systems:

1. Dynamics—Complex systems are dynamic and constantly changing.
2. Irreducibility of elements—Due to the entwined nature of the elements, it is insufficient to focus on the effects of the single elements as the system as such cannot be reduced to them.
3. Interdependencies—The causality in complex systems cannot be described by linear models, as the causality is interdependent.
4. Non-proportionality—The effect of an antecedent or input factor is not proportional to the strength of that antecedent. Due to the non- or disproportionality, small inputs might have a large impact, whereas large inputs might hardly change the outcome.

Based on this characterization, complex systems seem to be all around us and the world, economies and businesses are only becoming more complex, as many reports attempting to measure the increasing degree of complexity in economies and businesses show (Hausmann et al., 2011; MediaMind Research, 2013). Especially since more and more interactions involve the internet, which is a complex system in itself, some even argue we are in fact dealing with sets of complex systems (Park, 2005). In sum, it appears to be inevitable for researchers to acknowledge and study complexity. Likewise a large part of social science including management science has consequently embraced the so-called "complexity turn" (Urry, 2005). This is also true for practitioners given that growing complexity increases the need for control to a more than proportionate amount, which is a key challenge in management.

2 Complexity and Interdependencies in Entrepreneurship, Innovation and Technology Research

The thematic focus of this edited volume is primarily on entrepreneurship. Yet, entrepreneurship as a fairly new field has many interfaces with neighboring disciplines, which is especially true for innovation and technology. All three fields naturally interlock (Kollmann, Kuckertz, & Stöckmann, 2010). As Mitchell (2009, p. xii) points out, when we seek to study complexity "lines between disciplines begin to blur". Therefore, we do not seek to create an unnatural separation by focusing on complexity in entrepreneurship research alone, but rather embrace the blurred lines to innovation and technology research. However, even this extended focus might appear as a fuzzy demarcation. Therefore, concepts, insights and methods discussed in this volume will surely not only touch on the three disciplines separately but also create parallels with them and possibly be an inspiration for other disciplines.

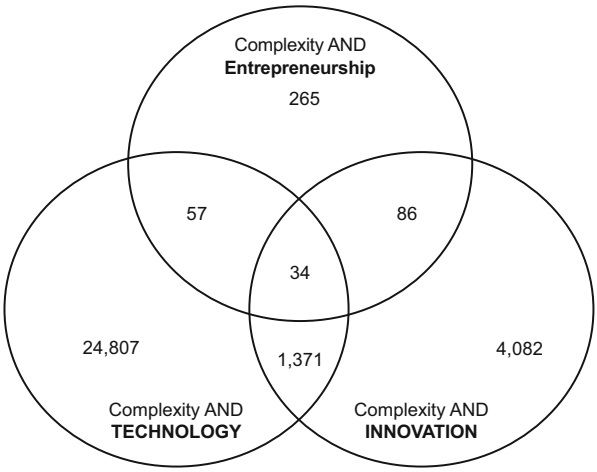

Fig. 1 Number of publications for search terms on *Web of Science*™

In order to show how the research domains of entrepreneurship, innovation and technology research are actually intertwined, we analyzed the number of publications appearing in the *Web of Science*™ *Core Collection*[1] applying the following search terms:

- Complexity AND Entrepreneurship
- Complexity AND Innovation
- Complexity AND Technology
- Complexity AND Entrepreneurship AND Innovation
- Complexity AND Entrepreneurship AND Technology
- Complexity AND Innovation AND Technology
- Complexity AND Entrepreneurship AND Innovation AND Technology

The results of this analysis are depicted in the Venn diagram in Fig. 1. Note that the size of each circle is not adjusted for the magnitude of the respective domain.

The link between complexity and technology appears to be very pronounced resulting in 24,807 publications since 1972. The number of publications has dramatically increased since the 1990s and reflects how complexity science has borrowed from technology research and vice versa in their development. In innovation research, there have been 4082 publications since 1979 which can be attributed to the interface of complexity and innovation. Whereas in the 1980s and 1990s only a few manuscripts were published, the number has picked up significantly since the 2000s.

The theoretical relevance of complexity in innovation research is stressed in a recent paper by Poutanen, Soliman, and Ståhle (2016, in press). The authors provide a literature review showing how researchers in innovation are increasingly adapting

[1] As per September 2015.

a complexity approach to study the innovation process and how this approach helps to understand the interactions of actors involved in the innovation process a lot better. Furthermore, the authors call for moving from a linear understanding of innovation processes to embracing complexity by accepting non-linear, dynamic and interrelated causality.

Complexity and entrepreneurship has led to 265 publications since 1992, most of them appearing after 2005. The seminal work by McKelvey (2004) has contributed strongly to the growing attention of complexity by entrepreneurship scholars.[2] In this study the author lays out how entrepreneurship is a naturally complex system, as it focuses not on equilibrium but rather on creating order. Accordingly, it is appropriate if not necessary to study entrepreneurial phenomena applying complexity science.

However, while this analysis might give a rough idea of how popular or how closely related complexity and those three research areas are, comparing absolute numbers of publications only provides limited insights for two reasons. Firstly, the research areas are in different stages with regard to age and maturity, which leads to naturally more publications in technology research as the oldest discipline among those three. Secondly, the number of publications might not necessarily reflect the interest in complexity but also the ability or inability to study complex systems.

Yet, a strong link is evident when focusing on the intersection of publications, which relate to complexity and entrepreneurship and innovation or technology. 32 % of the complexity and entrepreneurship publications are also in the area of innovation, the same is true for 22 % of the intersection with technology research. These results reinforce Mitchell's argument (2009) of blurred lines between disciplines with regard to complexity and emphasize the suitability of including innovation and technology research when studying complexity in entrepreneurship.

3 The Need for New Research Methods

Research needs to contemplate the interplay between the studied phenomenon, the considered theory and the methods employed and align those three areas. This is especially crucial when studying complex phenomena as the underlying assumptions such as non-linearity and dynamics are not in accordance with the most common research methods. Despite an increasing degree of complexity in strategic management, for instance, the application of linear models is still the most prevalent research approach (Shook, Ketchen, Cycyota, & Crockett, 2003). However, research which seeks to study the interlink between complexity theory and entre-

[2] 23 of the 233 articles published since 2005 which address the interface of entrepreneurship and complexity have cited McKelvey (2004).

preneurship, innovation and/or technology research, needs to acknowledge the implications of complexity theory in the entire research design. In consequence, new methods need to follow new theory (Ketchen, Boyd, & Bergh, 2008). By doing so, applying new or neglected methods also exhibits the potential of fostering the development of new methods (Van Maanen, Sørensen, & Mitchell, 2007).

Yet, the application of new methods and getting those past the review process and published can be a challenging endeavor for several reasons. We refer to emergent methods as research methods, which are not yet well established, hence cookbook like instructions are likely not to be available yet. Instead, researchers applying new methods need to be flexible, open for changes, sometimes creative and willing to take some risk. Researchers frequently develop new methods from modifications of existing ones, thus going to the edge and exploring the borders of established methods is another quality needed to apply and develop new methods. New methods are going to drive scholars out of their comfort zone and possibly raise justified questions concerning validity and reliability. However, this is only one part of the story of emergent methods, the other half involves the review process and hence the gatekeepers to publications. Reviewers might likewise have a tendency to disapprove of new methods, simply because they are not familiar with them. This is even a greater challenge for reviewers, if the new method is not related to conventional linear models, such as methods which capture complexity (Hesse-Biber & Leavy, 2010). Even if this might cause a lot of frustration on the researcher's side, in early stages of a method researchers are thus forced to spend large sections on explaining the methods and appropriateness for the research design. Another approach might be to run linear analysis and to emphasize how the results fail to mirror the interactions in place.

Following this argumentation, we refer to neglected research methods as those, which might have been developed a while ago, but are still not fully developed or applied frequently. Nevertheless, the neglected methods could exhibit the potential to capture complexity appropriately but might need to be further developed to become established. However, that does not mean that their negligence is justified.

A study by Kuckertz and Mandl (2013) explores the current and potentially future methods in entrepreneurship research. Accordingly, regression analysis is rated as the most fundamental method in entrepreneurship research scholars should be familiar with, but is inappropriate for studying complex systems. The methods entrepreneurship researchers are currently interested in lists structural equation models, case study analysis, network analysis, action research and experimental designs as the top five. Some of those are indeed appropriate to study complex phenomenon and hence this list offers cause for encouragement, that we will find a broader variety of methods being applied and also more studies which embrace complexity with appropriate methods. As Shook et al. (2003) point out, in order for future researchers to apply methods which are capable of accounting non-linearity, dynamics and interrelated causality this also needs to be taught to doctoral students and requires reviewers to be open-minded and favorable towards the application of new methods.

4 Goals and Structure of this Volume

This volume aims at providing a forum for the discussion of emergent and neglected methods in the context of complexity in entrepreneurship, innovation and technology research and also at developing to be a standard reference in the rising field of the application and advancement of those methods. We hope that this volume adds to the visibility of those useful methods and also acts as an encouragement for other researchers and other disciplines to engage more into complexity and apply appropriate research methods to do so.

In order to assemble a rich, vibrant and multi-faceted collection of studies applying methods able to capture complexity and bringing together diverse perspectives, this volume comprises different theoretical concepts and methods. To ensure high standard contributions, all chapters went through a rigorous double-blind review process. The edited volume consists of 21 chapters arranged in four parts: (I) Methodological and Conceptual Discussion, (II) Qualitative Methods, (III) Configurational Methods, and (IV) Semantic Methods.

Part I of this book focuses on the methodological and conceptual discussion around complexity in entrepreneurship, innovation and technology research. The first chapter by Najmaei "Using Mixed-Methods Designs to Capture the Essence of Complexity in the Entrepreneurship Research" might be viewed as an extension to this introduction as it expands on the review of complexity theory. Furthermore, the author argues for the application of mixed methods in order to capture complexity in entrepreneurship research. Mühlenhoff follows Najmaei's line of argumentation in chapter "Applying Mixed Methods in Entrepreneurship to Address the Complex Interplay of Structure and Agency in Networks" by stressing the relevance of integrating qualitative and quantitative approaches when studying complex entrepreneurial networks. The third chapter by Schlaile and Ehrenberger titled "Complexity, Cultural Evolution, and the Discovery and Creation of (Social) Entrepreneurial Opportunities" studies the phenomenon of social entrepreneurship and explores the extent to which a memetic perspective might be appropriate to understand this complex system. The following three chapters focus on the conceptualization of complex systems in entrepreneurship. Liening, Geiger, Kriedel, and Wagner (chapter "Complexity and Entrepreneurship: Modeling the Process of Entrepreneurship Education with the Theory of Synergetics") suggest that the complex process of entrepreneurial education, which is known to be a very vibrant field (Kuckertz, 2013), might be well modelled by applying theory of synergetics, a complexity theory of self-organization. In chapter "Computer Simulation Studies of the Entrepreneurial Market Process" Keyhani elaborates the strengths of applying computer simulations to complex entrepreneurial phenomena by reviewing three recent studies. In the subsequent chapter "Analyzing Complex Organizational Arguments with Logical Model Building" Péli makes a case for applying logical model building in order to analyze complex organizational arguments as this method allows researchers to draw exact conclusions from complex arguments.

In Part II we turn to the application of emergent and neglected research methods and present a wide spectrum of studies applying qualitative research methods to capture complexity in entrepreneurship, innovation and technology research. In an introductory chapter to this part of the book Wenzel, Senf, and Koch (chapter "Exploring Complex Phenomena with Qualitative Research Methods: An Examination of Strategic Innovation Trajectories in Haute Cuisine") provide guidance to scholars by arguing for the application of qualitative methods to discuss complexity and by introducing an analytical approach to scrutinize complex phenomena based on qualitative data. Lastly, the authors illustrate the advantages of the analytical approach by providing an exemplary application. Chapter "Effectuation and the Think-aloud Method for Investigating Entrepreneurial Decision Making" by Frigotto discusses the complex phenomenon of entrepreneurial decision making from an effectuation perspective by showing the potential of the thinking-aloud method in an illustrative study. In the subsequent chapter titled "Applying Factorial Surveys for Analyzing Complex, Morally Challenging and Sensitive Topics in Entrepreneurship Research" Dickel and Graeff make a case for disentangling effects of interrelated variables by applying factorial survey in the context of entrepreneurial ethics. To do so, the authors review the methodological approaches taken previously in entrepreneurship ethics and illustrate the advantages of factorial surveys by providing a sample vignette study. Felden, Fischer, Graffius, and Marwede illustrate in the tenth chapter ("Illustrating Complexity in the Brand Management of Family Firms") complexity in entrepreneurship by merging two research areas, namely family research and brand management, which are usually studied unconnectedly. The authors show how the more complex consideration of the phenomenon can provide new insights to theory and for practitioners. In chapter "A Systematic Approach to Business Modeling Based on the Value Delivery Modeling Language", Metzger, Kraemer, and Terzidis illustrate the application of Value Delivery Architecture Modeling, a new approach to deal with the challenges associated with studying complex value creation networks. Action research is the only example of a neglected qualitative research method. However, Schultz, Mietzner, and Hartmann argue that this method is indeed appropriate to analyze complex systems in entrepreneurship in chapter "Action Research as a Viable Methodology in Entrepreneurship Research".

Part III embraces studies applying configurational methods, mainly qualitative comparative analysis (QCA), but also cluster analysis to study complexity in entrepreneurship. Again as an introduction to this part of the volume, Berger (chapter "Is Qualitative Comparative Analysis an Emerging Method?") provides an analysis of the maturity of QCA applications in business and management research by conducting a structured literature review and a bibliometric analysis (see Kuckertz, Berger, & Mpeqa, 2016, in press, or Kuckertz, Berger, & Allmendinger, 2015, for recent applications). In chapter "The Complex Determinants of Financial Results in a Lean Transformation Process: the Case of Italian SMEs", Camuffo and Gerli give an example of applying QCA to explore the

complex determinants of financial results in a lean transformation process, when applying OLS did not lead to satisfactory results to answer the research question. Roig-Tierno, Mas-Tur, and Ribeiro-Navarrete illustrate in chapter "Young Innovative Companies and Access to Subsidies" the strength of QCA to study complexity by comparing the results of a previous regression analysis to the configurations that result from a QCA. In the subsequent chapter "Applying QCA and Cross-impact Analysis to the Study on ICT Adoption and use by Croatian SMEs", Ceric and Krivokapic-Skoko show with an empirical example how QCA can be developed further towards in-depth case analysis by identifying potential areas of alignment with cross-case analysis. Szklarczyk and colleagues (chapter "Configurational Analysis in the Evaluation of Complex Public Programs") demonstrate the dynamics of emergent methods as they employ qualitative comparative analysis as a starting point to develop a new approach for data analysis in the area of knowledge transfer. In chapter "Entrepreneurial Orientation and the Handling of Complexity in Small and Medium Enterprise Research", Braun and Steger apply another configurational method, namely cluster analysis to explore entrepreneurial orientation in small and medium-sized enterprises.

The final part of this edited volume draws to the application of semantic analysis to study complex phenomena. Kuckertz and Mandl (chapter "Capturing the Complexity and Ambiguity of Academic Fields") apply content analysis in order to disentangle two research areas, which are strongly intertwined and offer definitions of small business research, entrepreneurship and their shared interface. Grønning looks in chapter "What do Organizations Think are Their Risks and Uncertainties? Risk Self-assessments within Securities Reports as a new Source for Entrepreneurship, Innovation and Technology Research" at the step of data collection in the research process in entrepreneurship, innovation and technology research and introduces securities reports submitted to the authorities as a new kind of source for relevant information and provides suggestions how the security reports might be used in future studies. In the final chapter ("Complexity of Textual Data in Entrepreneurship and Innovation Research"), Schuelke-Leech and Barry explain the sources of complexity associated with text in entrepreneurship and innovation research. In order to deal with the complexity of texts and produce a nuanced view, the authors apply text data analytics using corpus and computational linguistics.

Taken together, these 21 chapters form a rich, vibrant and multi-faceted volume discussing and applying methods to capture complexity in entrepreneurship, innovation and technology research. We thank all authors for their excellent contribution, and are also indebted to all of them who have acted as reviewers. Additional reviews were provided by Rene Mauer, Patrick Roehm and Christian Walter. Prashanth Mahagaonkar at Springer impressed us with his incredible support. Furthermore, we are more than thankful to Sven Jagusch for his effort regarding the layout of this edited volume.

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Part I
Methodological and Conceptual Discussion

Using Mixed-Methods Designs to Capture the Essence of Complexity in the Entrepreneurship Research: An Introductory Essay and a Research Agenda

Arash Najmaei

Abstract Although entrepreneurships is recognized as a complex field, existing research does not pay enough attention to capturing the essence of its complexity. I argue that mixed methods designs offer a solid foundation for bridging this gap. To build my argument, I review the key assumptions and dimensions that make entrepreneurship a complex scientific field, discuss the structure of complexity and compare and contrast different research paradigms in terms of their ability to capture complexity. I will then show that mixed methods designs based on the pragmatic paradigm are philosophically better suited than mono-method designs to capture complex phenomena in entrepreneurship. The paper concludes with an integrative framework to guide research and practice along this direction and discusses the implications of this view for studying complexity in entrepreneurship.

Keywords Complexity theory • Mixed-methods design • Pragmatism

1 Introduction

Entrepreneurship research is the "scholarly examination of how, by whom, and with what effects opportunities to create future goods and services are discovered, evaluated, and exploited" (Shane & Venkataraman, 2000, p. 218). Entrepreneurship involves various forms of activities embedded in social systems that take place across different levels and are performed by a single person or a team of individuals within established or new firms (McMullen & Shepherd, 2006). Hence, it represents a system of interdependent factors whose understanding is riddled with complexity.

Dismantling complexity requires the ability to decipher interactions among components of a system (Simon, 1962). Traditional attempts to explain complex phenomena have been either to explore underlying mechanisms or processes via

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_2

interpretive qualitative approaches based on the logic of inductive reasoning or to examine the direction and significance of causal relationships between a set of variables via quantitative methods based on the deductive logic.

Both approaches would generate incomplete insights that, at best, offer a partial picture of the reality of entrepreneurship. Take for example studies on the nature of entrepreneurial opportunities (Dimov, 2011; Patzelt & Shepherd, 2011). Entrepreneurial opportunities are complex entities whose formation and exploitation depend on numerous contextual, cognitive and structural factors (Wood & McKelvie, 2015). Qualitative methods can shed light on the processes involved in the formation and exploitation of opportunities. Quantitative methods can, on the other hand, illuminate causal relationships that explain or predict formation and/or exploitability of opportunities. Such mono-methodical approaches are informative but incapable of producing outputs that are both exploratory—as in the qualitative methods (Neergaard & Ulhøi, 2007)—and descriptive or predictive—as in the quantitative methods (Mingers, 2006). Therefore, it is not surprising to see that entrepreneurship is gradually passing the point where we simply examine its inherent complexity by adopting mono-methodical mindsets. In sum, mon-methods research cannot fully capture complexity in entrepreneurial phenomena for at least two reasons: (1) it is based on a set of limited assumptions about the reality of the phenomenon of interest. (2) It is constrained by a set of methods that either generate context-specific inductively derived facts or result in generalizable less context-relevant deductively-produced results among a limited number of factors. Supporting this view, Anderson (1999) argues that, "simple boxes-and-arrows causal models are inadequate for modeling systems with complex interconnections and feedback loops, even when nonlinear relations between dependent and in-dependent variables are introduced by means of exponents, logarithms, or interaction terms" (p. 216).

In light of the above, the key thesis of this chapter is to revisit the methodological side of entrepreneurship by endorsing the idea that mixed-methods designs (MMDs) open new doors to explore different aspects of complexity in entrepreneurship. MMDs adopt a pluralistic and pragmatic view in which qualitative and quantitative data and methods can be combined to create meta-inferences to paint a more complete picture of complex realities (Creswell & Clark, 2007). Because MMDs take many forms from concurrent and sequential, and from qualitative or quantitative dominant (Creswell, Clark, Gutmann, & Hanson, 2007), they afford a great deal of flexibility to the researcher whose primary goal is to draw a more complete picture of the complexity surrounding entrepreneurial phenomena.

The remainder of this chapter is organized as follows. First, an overview of the entrepreneurship research with a specific attention to its dimensions and evolutionary path into a complex multidisciplinary field will be provided. Then, the mono-methodical view will be discussed and its inadequacy and shortcomings for studying complexity in entrepreneurship will be illuminated. Next, I will argue that the preponderance of mono-methods research has largely been caused by an overreliance on traditional philosophical assumptions that are now shifting towards a pragmatic mixed-methods worldview which is more apt to capture complex realities. Subsequently, the role of mixed methods research in complexity science

will be briefly reviewed and an agenda and a guiding framework for future research on the complexity of entrepreneurship using MMD will be proposed.

I hope this chapter will help entrepreneurship scholars escape from the mono-methodical straitjacket in order to tackle the complexity of entrepreneurship by generating a richer and more complete understanding of by who, why, how, when, and under what conditions various entrepreneurial activities are carried out.

2 Entrepreneurship and Complexity: An Overview

2.1 History of the Entrepreneurship as a Field of Scientific Inquiry

The scientific field of entrepreneurship is an expansive body of literature formed around three concepts of "entrepreneurship," referring broadly to the set of activities carried out by an entrepreneur or a field that studies, "entrepreneur(s)" as the agent (individually or in teams) who perform these activities and "entrepreneurial," as the qualifying characteristics or attributes that capture the essence of these activities. Entrepreneurship has its roots in economics. In fact, the notion of entrepreneurship is as old as economics itself (Cole, 1946; Soltow, 1968). The contemporary literature attributes the current understanding of entrepreneurship to the works of Schumpeter (1934), Kirzner (1973), and Knight (1921). It is to be noted that many others including McClelland (1965) and Gartner (1988) have also made impressive contributions to the field of entrepreneurship (see Landström, 2007 for a comprehensive review),[1] however, consistent with McMullen and Shepherd (2006) I focus on Schumpeter, Kirzner and Knight as pioneers of the theory of entrepreneurship and entrepreneurial activities.

Knight famously conceptualized entrepreneurs as bearers of uncertainty. He distinguished risk from uncertainty by defining uncertainty as incalculable risk. According to Knight, individuals who tolerate uncertainty in hope of gains are entrepreneurs who define and change markets. Schumpeter, on the other hand, was interested in the new theory of capitalism and economic prosperity based on the processes of change and innovation. He proposed that economic wealth is not created by capital accumulation; rather it is generated by innovative activities that use capital in new ways. He called these new ways "new combinations" (Schumpeter, 1934, p. 377) and famously proposed the idea that entrepreneurs drives markets by creating new configurations of asset and destructing the old ones—the process that is famously known as creative destruction. He also distinguished between five types of innovations: new products, new methods of production, new sources of supply, exploitation of new markets, and new ways to organize

[1] I thank an anonymous reviewer for this point.

business or new business models. Accordingly five forms of Schumpeterian entrepreneur can form in markets each requiring a complex configuration of assets.

Schumpeterian ideas were further developed by Austrian economists and most notably Kirzner (1973). According to Kirzner, entrepreneurship is all about discovering and exploiting previously unexploited opportunities by using new combinations of resources. Therefore, Kirzner (1973) shifts the focus of attention from new combinations to opportunities and advocates the study of entrepreneurship as a process rather than an outcome (innovation in Schumpeter's view) (Foss, Klein, Kor, & Mahoney, 2008). According to this view, some individuals have some behavioral or personal elements that enable them to be alert to opportunities and thus they can be called "entrepreneurs." He further assumed that the actions of entrepreneurs lead to a better allocation of resources. By analogy, entrepreneurship leads to better allocation of resources in a market economy (Kirzner, 1973), making entrepreneurship the most important force in today's markets.

Since these classical works, the study of entrepreneurs and entrepreneurship has undergone a metamorphosis (Shane, 2000). The contemporary model of entrepreneurship represents a growing multidisciplinary field that centers on opportunities, risks, innovation and management of complex actions to allocate resources to all sorts of value-creating activities. Therefore one of the most striking challenges faced by students of entrepreneurship is to map the boundaries of the expansive realm of entrepreneurship (Foss et al., 2008; Shane, 2000). In an attempt to define boundaries of this field Shane and Venkataraman (2000) defined entrepreneurship as "the scholarly examination of how, by whom, and with what effects opportunities to create future goods and services are discovered, evaluated, and exploited." (p. 218). This definition is reductionist in that it reduces the domain of entrepreneurship to the nexus of two phenomena: the presence of lucrative opportunities and the presence of enterprising individuals who act alone, in teams or on behalf of small or large organizations to exploit those opportunities. Entrepreneurial opportunities are, hence, the most fundamental component of entrepreneurial activities (Dimov, 2011).

Opportunities in this sense are those situations in which new goods, services, raw materials, and organization methods can be introduced and sold at greater than their cost of production (Casson, 1982). Opportunities arise either in an idiosyncratic manner as a result of errors and omissions of others that cause surpluses and shortages (Casson, 1982), or are the result of technological, political, regulatory, socio-demographic, perceptual, and other unexpected changes in the environment (Korsgaard, Berglund, Thrane, & Blenker, 2015; Patzelt & Shepherd, 2011). Consequently, entrepreneurship involves the study of numerous interacting factors including sources of opportunities; the processes of discovery, evaluation, and exploitation of opportunities; and the set of individuals, the team of corporate actions and social, economic and regulatory factors and conditions that enable or inhibit formation, discovery, evaluation, and exploitation of opportunities (Shane & Venkataraman, 2000). Further, opportunities and associated gains exist in different contexts. For instance, it is already well known that if entrepreneurship is to exploit opportunities for social and environmental gains rather than commercial it becomes

social or sustainable entrepreneurship (Patzelt & Shepherd, 2011). If it is to make better use of political and public resources for the benefit of the society it then becomes political or public entrepreneurship (Lewis, 1988).

In light of the above, it is obvious that entrepreneurship involves various factors at different levels form individuals to socio-environmental and economic into political and regulatory ones. Similarly, as a scientific field it has numerous foci ranging from identification of factors that link entrepreneurs to opportunities, to types of opportunities, types of gains and mechanisms that enable or prohibit these processes. The next section shows that such phenomena and associated fields are complex systems. Accordingly, my thesis is that, entrepreneurship in all its glory as both a multifaceted phenomenon and as a scientific field of inquiry can be best viewed through the lens of complexity.

2.2 Complex Systems and the Science of Complexity

The term 'complexity' comes from the Latin word 'complecti' that translates to grasp, comprehend, embrace (Israel, 2005). Complexity connotes the opposite of simplicity. That is, the world is fundamentally simple and the purpose of any scientific inquiry is to explain it in terms of simple constituent elements (Israel, 2005). To understand the importance of this positioning we need to look at two perspectives that dominate the way scientists look at the world. Let's consider the world around us and phenomena within it as open systems of factors that interact with each other and with their surroundings. Holism is a viewpoint that stresses the behavior of the whole system and seeks explanation in the identification of the simplest explanatory principles (Malansona, 1999). On the contrary, reductionism seeks explanation through the isolation of parts and examination of interactions between pairs of parts (Malansona, 1999).

Although both views are informative they create, at best, only an incomplete understanding of the behavior of a system. Reductionism does not lead to simple principles for the general behavior of a system and holism cannot distinguish among alternative configurations of the building blocks of a system (Malansona, 1999; Stacey, 1995). Thus, both views ideally offer complementary insights into the behaviors of complex systems (Fontana & Ballati, 1999). Furthermore, both views are inherently concerned with the equilibrium or a tendency towards stability, predictability and regularity (Stacey, 1995). That is an unrealistic and over simplistic assumption because many physical, behavioral and social systems are dynamic and largely unpredictable because they are complex. Herbert Simon (1962) defines a complex systems as:

> ....made up of a large number of parts that interact in a non-simple way. In such systems, the whole is more than the sum of the parts, not in an ultimate, metaphysical sense, but in the important pragmatic sense that, given the properties of the parts and the laws of their interaction, it is not a trivial matter to infer the properties of the whole. (p. 468)

In the language of complexity, "an in-principle reductionist may be at the same time a pragmatic holist" (Simon, 1962, p. 468). Therefore, when dealing with complex systems scientific inquiries are to be guided by the science of complexity[2] (Anderson, 1999). The science of complexity is the science of complex systems. It aspires to explain how simple processes and interactions derived from reductionism can combine to generate complex holistic systems that interact and coevolve with their surrounding environments (Malansona, 1999). The more complex a system becomes the less knowable it gets (Perrow, 1967).

2.3 General Attributes of Complex Systems

The science of complexity makes four important predictions. First, complex systems are usually hierarchical. This is, composed of "of interrelated subsystems, each of the latter being, in turn, hierarchic in structure until we reach some lowest level of elementary subsystem"(Simon, 1962, p. 468). Second, hierarchical systems not only are easier to study and decompose but also can evolve more efficiently and quickly than non-hierarchical systems of comparable size, making them more interesting for evolutionary investigations (Anderson, 1999; Perrow, 1967; Simon, 1962; Stacey, 1995). Thirdly, looking at hierarchies in complex systems, we realize that in general, interactions among elements within subsystems are more intense and frequent than those of between subsystems make them easier to decompose. This attribute is known as near-decomposability (Simon, 1962) and implies that in the "short-run the behavior of each of the component subsystems is

[2] Interest in studying systems is not new. The holism-reductionism view emerged after WWII which was then completed by Cybernetics and the general system theory (GST). Cybernetics is the study of closed linear feedback loops between a system and the environment [see for example Ashby, R. (1956). *An introduction to cybernetics*. London, United Kingdom: Chapman and Hall] and general system theory is a more complete theory of general systems such as open, close, simple and relatively complex systems in which the linearity assumption between feedback loops and the environments is relaxed [see for example von Bertalanffy, L. (1968). *General system Theory: Foundations, development, applications*. New York, NY: George Braziller]. Ecology theory also addresses the conflict between holism and reductionism by looking at hierarchies in systems but is limited only to middle-number systems those in which component are too many to represent individually and too few to capture statistically in causal models [see Malansona, G. P. (1999). Considering complexity. *Annals of the Association of American Geographers*, *89*(4), 746–753]. So complexity theory represents the most appropriate lens to look at complex systems. Another interesting point is the main difference between normal science (Descartesean scientific method), complexity theory and chaos theory. Normal science explains how complex effects can be understood from simple laws by breaking systems into components and examines them independently using competing theories and add them together in linear fashions to get to the system behavior. Chaos theory, however, stresses the importance of nonlinear relationships and explains how simple laws can have complicated, unpredictable and radically big consequences for the system and the environment. Finally, Complexity theory also subscribes to the nonlinearity of cause and affects and describes how complex causes can produce simple effects.

approximately independent of the short run behavior of the other components and in the long run, the behavior of any one of the components depends in only an aggregate way on the behavior of the other components" (p. 474). Finally, through hierarchies and decomposability complex systems become easier to describe, model and comprehend. The best summary of these four has been stated by Herbert Simon:

> One path to the construction of a nontrivial theory of complex systems is by way of a theory of hierarchy. Empirically, a large proportion of the complex systems we observe in nature exhibit hierarchic structure. On theoretical grounds we could expect complex systems to be hierarchies in a world in which complexity had to evolve from simplicity. In their dynamics, hierarchies have a property, near decomposability, that greatly simplifies their behavior. Near decomposability also simplifies the description of a complex system and makes it easier to understand how the information needed for the development or reproduction of the system can be stored in reasonable compass. (Simon, 1962, pp. 481–482)

The importance of understanding complex systems is reflected in the fact that complex systems are ubiquitous and their ubiquity directly influences entrepreneurship; "...business firms, governments, universities all have a clearly visible parts-within-parts structure" (Simon, 1962, p. 468). In this chapter I focus on social and behavioral systems that are studied in entrepreneurship. These include ventures, business organizations, and individuals who act entrepreneurially alone or in collaboration with each other in the form of venture teams, markets and industries.

2.4 Elements of Complex Systems in Social Sciences

In social and behavioral settings complex systems are generally characterized by four key elements: (1) agents with schemata, (2) self-organizing networks sustained by importing energy, (3) coevolution to the edge of chaos, and (4) system evolution based on recombination (Anderson, 1999).

Agents refer to individuals whose actions define dynamics of systems. Collections of actions shape activity systems that determine how individuals behave relative to each other in social settings. As Anderson (1999) describes, each agents' behavior is defined by a schema that is a cognitive model, framework or a set of assumptions and beliefs that represents its perception of the environment and acts as an information filtering and processing devise to make sense of the surrounding conditions. Different agents may develop and use different schemas given variations in their history, worldviews and personality. In complex systems, schemas can be seen as lower order elements that influence higher order behaviors of agents which partake in the process of spontaneous change in the system and sub-systems (Choi, Dooley, & Rungtusanatham, 2001).

Another fundamental element of complex systems is networks of positive feedback loops. A feedback loop is a circular arrangement of causally connected elements in which each element affects the next, until the last feeds back into the first element, thus completing the loop (Walby, 2003). Feedback loops enhance or

hamper changes that occur in a system. Agents are connected to one another through networks of feedback loops (Anderson, 1999). That is, they observe and act on information acquired form their local connections. Because of these connections behaviors of any agent depends on and influences that of others in a system. In addition, because, no single agent determines the collective behavior of the system, complex systems have an inherent tendency to develop and maintain a self-organizing state of feedback networks (Mitleton-Kelly, 2003). Complex systems involve loops of positive feedback. That is, those that enhance or facilitate changes in the system and lead the system towards disequilibrium (Anderson, 1999). This mechanism is, for example, are manifested in the observation that behaviors of managers of a firm based on the feedback from customers lead to new strategies that change the direction of the firm which in turn affects markets, industries and other businesses in the firm's ecosystem.

The third element of complex systems is their evolution at the edge of chaos. Agents coevolve with one another (Anderson, 1999). Each agent strives to improve its fitness with the environment but the outcome of these attempts depends on the behaviors of other agents (Mitleton-Kelly, 2003). As a result, the adaptive state of each agent constantly changes, causing complex systems to go through temporary equilibrium in the short term or constant disequilibrium in the long term. Consequently, complex systems lie at the edge of chaos (Anderson, 1999; Simon, 1962). Order at the edge of chaos reflects the notion that a complex system possesses an emergent nature that enables it to be productive (Choi et al., 2001). Simple or uncomplex systems are very submissive and stable whereas too complicated systems are chaotic. However, complex systems are positioned between stability and chaos. Hence behaviors of complex organizations are neither definitively predictable nor completely unpredictable (Smith & Humphries, 2004). Some chaos prevents systems from being completely unpredictable and little order makes it productive and functional (Smith & Humphries, 2004).

Finally, evolution of complex systems is a function of reconfigurations of agents. That is, the process of entry, exit, formation of new agents and/or formation of new connections between agents. This process creates internal dynamics that lead the system towards its evolutionary fitness (Anderson, 1999; Choi et al., 2001). Even new subsystems or levels of hierarchies may form as "the linkages between agents may evolve over time, shifting the pattern of interconnections, the strength of each connection, and its sign or functional form" (Anderson, 1999, p. 220). Building on this understanding, in what follows I will discuss the importance of complexity in entrepreneurship.

2.5 Complexity in Entrepreneurship

The argument put forward in this section is composed of two interrelated parts. First, entrepreneurial phenomena are inherently complex and many issues in entrepreneurship are embedded in complex systems. Second, the science of complexity

as discussed in the previous section offers a robust theoretical ground upon which to advance both theoretical and empirical frontiers of entrepreneurship.

To understand the complex nature of entrepreneurship, let's consider the case of an entrepreneur who establishes a small venture in a market. A large number of inter-connected factors influence dynamics of this phenomenon from the recognition of the opportunity to the acquisition of various resources to the initial launch of the business and enticing customers to pay for the product and service and adjusting the offerings if necessary to sustain the revenue. The entrepreneur in this case has undeniably a set of relationships with others in the market and industry. This may include friends, family members, colleagues and authorities, whose feedback affects the entire entrepreneurial processes and activities listed above. In addition, the entrepreneur's mental picture of the business, his/her perception of the market, customers, depth and breadth of his/her relationships and his/her skills, knowledge and experience collectively form a schema that acts as an information-filtering and processing device shaping his/her actions. With this picture in mind, social-cultural, economic and political factors are very influential yet out of his/her control. These forces affect the whole market and industry where the entrepreneur is running his/her business. Technological advances and fluctuations in customers' preferences also create a situation where constant adjustments to value offerings and business models lead the entrepreneur and the market as a whole to the edge of chaos.

This simple example illustrates how a basic entrepreneurial phenomenon is in fact a complex one embedded in a complex system of interacting elements distributed across levels. A similar logic can be applied to almost any other entrepreneurial activity from the development of a new product/service, to the design and execution of social and political innovations. Thus, it is not surprising to see that the relevance of complexity to the field of entrepreneurship has long been recognized by scholars. McKelvey (2004), for instance, states that:

> ...unlike traditional scientists, who conduct research under conditions of equilibrium, complexity scientists focus on the study of order creation. Since creation of new economic order in the form of new firms is what entrepreneurs do, complexity science makes much more sense as the preferred kind of science for entrepreneurial research. (p. 314)

Despite this recognition, surprisingly very few have tapped into the power of complexity science for entrepreneurship research. For instance, Lichtenstein, Carter, Dooley, and Gartner (2007) use complexity theory to show when (1) the rate of start-up activities is high, (2) start-up activities are spread out over time, and (3) start-up activities are concentrated later rather than earlier over time, start-up activities will lead to the emergence of new firms. Similarly, Goldstein, Haz, and Silberstang (2008) highlight the contribution of complexity to the social entrepreneurship literature and Schindehutte and Morris (2009) argue that complexity offers better explanations for five key themes of strategic entrepreneurship (exploration–exploitation, opportunity, newness, micro-macro interaction, and dynamics).

In this sprit, I posit that although complexity is at the heart of entrepreneurship, capturing the essence of this complexity is perhaps one of the most fruitful yet

underemphasized tasks of researchers in the field of entrepreneurship. I will not engage in a conceptual nor will I offer a theoretical discussion of this issue. Rather I depart from this literature and shall focus on the methodological side of capturing the essence of complexity in entrepreneurship in hope of stimulating more focused research on this topic.

My thesis is that because many aspects of entrepreneurship are inherently complex they cannot be completely explained with current causal models nor can be described through context-specific exploratory accounts (Schindehutte & Morris, 2009). Therefore, a mixed-methods approach is better suited to capture the complexity of entrepreneurship. Building on this ground, the next section looks at two dominant research paradigms namely: positivism and interpretivism, highlights their shortcomings with respect to the study of complex phenomena and advocates the use of an emerging paradigm known as pragmatism as an alternative for studying complexity in entrepreneurship.

3 Research on Complexity in Entrepreneurship: Mono-Method Versus Mixed Methods Designs

Kuhn (1970) defines science as the constellation of elements such as facts, theories, and methods collected on a set of related phenomena in a particular field of interest (p. 1). Consequently, "scientific development becomes the piecemeal process by which these items have been added, singly and in combination, to the ever growing stockpile that constitutes scientific technique and knowledge" (pp. 1–2). According to Karl Popper (1959) any scientific field has to be falsifiable. That is, its core assumptions and facts should be testable and falsified if necessary by application of sound reasoning and sets of logical methods.[3]

Science advances through research and research is carried out when an appropriate set of research methods is used to generate new knowledge. Research methodology is different from research methods and research design. I shall distinguish them as follows. Methodology is knowledge of methods. That is, a knowledge base, a set of agreed-upon principles and assumptions that guides the choice of research methods. Research methods are standard tools, techniques and approaches used by researchers to collect, analyze and interpret data, whereas research design is the way these methods are combined and joined in a meaningful and purposeful fashion to fulfill research goals or address research questions.

In any scientific discipline there are a number of paradigms that not only show the most appropriate way to link methodology to methods but also guide the entire research design and conduct of the research. Appropriate applications of these paradigms ensures falsifiability of findings and facilitates the progressive accumulation of evidence within a domain of study (Popper, 1959). Kuhn (1970) defines a

[3] I thank an anonymous reviewer for this point.

paradigm as "some accepted examples of actual scientific practice—examples which include law, theory, application, and instrumentation together—provide models from which spring particular coherent traditions of scientific research" (p. 11). A paradigm is also a cognitive framework with "an entire constellation of beliefs, values, techniques and so on, shared by a given [scientific] community" in which "universally recognized scientific achievements . . . for a time provide model problems and solutions to a community of practitioners" (Kuhn, 1962, p. 175). In other words, a paradigm is seen as a temporary theoretical framework and a structure of thought that provides a particular vision of reality. It guides the way we perceive, think and act during our daily researching activities.

A paradigm dictates what is considered rational and relevant. It guides our expectations by telling us what we are expected to see and where to look to see it. Therefore, adoption of a paradigm is both eye-opening and blinding. It is as guiding as limiting. The extent to which researchers agree on a paradigm determines its maturity (Kuhn, 1970). Furthermore, sharing a paradigm by researchers ensues methodological consistency to examine falsifiability of findings (Popper, 1959).

Two paradigms have dominated social sciences: interpretivism and positivism. These two subscribe to two different research designs and promote conflicting sets of research methods. Interpretivism assumes that reality is subjective and constructed through interpretations of the researcher. Hence, there could be various pictures of the same reality. As a result, interpretive research encompasses inductive reasoning and collection of qualitative context-specific data in their natural setting (Ketokivi & Mantere, 2010). It also seeks to explore and explain processes through narratives and rich explanations (Creswell, 2007). Techniques and approaches such as hermeneutics, ethnography, case-study and grounded theory are based on this paradigm. Thus, qualitative entrepreneurship research is predominantly interpretive. As intuitively appealing and powerful as it sounds, qualitative research is incapable of testing causal relations and fails to make generalizable inferences about the population under study. Therefore it cannot be used in examining various aspects of complexity such as cause-and-effects in feedback loops and also direction and intensity of relationships among components of decomposable systems and subsystems.

In contrast, the positivism paradigm advocates objectivity of the reality and assumes that reality is independent of the interpretations of the researcher (Creswell, 2007). Consequently, it offers standard quantitative methods mostly based on deductive reasoning in which inferential, descriptive, experimental and simulative techniques are used to examine and test causal and other forms of relationships among a limited number of variables. Quantitative hypo-deductive research in entrepreneurship is based on this paradigm. Positivism has its own limitations. Most importantly, positivist methods cannot take too many variables into account at once and are unable of providing rich context-specific explanations for dynamics of inter and intra components within and between systems. Table 1 offers a summary of these two mono-methodical paradigms with respect to their

Table 1 Dominant mono-methodical paradigms

	Research paradigms	
Assumptions	Interpretivism	Positivism
Reality	Subjective	Objective
Research design	Qualitative	Quantitative
Data collection methods	Interviews, qualitative observations, textual, audio, visual data	Surveys, quantitative observations, numerical methods
Data analysis methods	Coding, narrative, case studies, phenomenology, ethnography, grounded theory	Quantitative descriptive, inferential (e.g., Chi-square, ANOVA, correlation, regression), simulations, experimental
Form of inference	Rich context-specific explanations of processes, mechanisms and dynamics	General cause-and-effect, direction and significance of association (linear, non-linear) among a limited number of variables
Application in complexity research	Exploring dynamism of sus-systems, exploring how behaviors emerges in specific contexts	Examination of causal relationships between elements within and between hierarchical sub-systems, examining the emergence of fit between the system and its environment
Limitations for complexity research	Incapable of measuring the direction and intensity of relationships among elements	Incapable of capturing dynamic interactions, limited to associations among a small number of variables

Adopted partly from Creswell (2007) and Ketokivi and Mantere (2010)

ability to inform and enable research on the complexity of entrepreneurial phenomena.

As the foregoing discussion suggests, neither positivism nor interpretivism is capable of generating a complete picture of complex systems. Heidegger (1996) argues that each paradigm opens up and closes down a world. Because what we observe is conditioned and mediated by our paradigm (Kuhn, 1970), neither of these paradigms is suitable for grasping the essence of complexity.

The above argument challenges the suitability of mono-methodical paradigms for capturing the essence of complexity in entrepreneurship. More specifically, "differences in the use and the conclusions of interpretive and positivist work have led purists in both camps to assert that these two systems of inference cannot be combined" (Lin, 1998, p. 163). That said, there is a growing recognition that a multi-paradigmatic view in social sciences would enable researchers to mitigate this effect (Scherer, 1998; Watkins-Mathys & Lowe, 2005). In line with this trend, I argue for the value of a more-liberating and less-rigid paradigm, a paradigm that permits combination of inductive (i.e., qualitative) and deductive (i.e., quantitative) methods to grasp the essence of complexity in entrepreneurship in a more meaningful and complete fashion.

3.1 Pragmatic Paradigm and Mixed-Methods Design

Pragmatism is an emerging paradigm that allows the use of both inductive and deductive reasonings through various combinations of qualitative and quantitative data (Creswell, 2008). Pragmatism shares the same root with the terms 'practice' and 'practical'. They all come from 'pragma', a Greek word meaning action (McCaslin, 2008). Pragmatism, is, hence, a philosophical paradigm that views reality as provisional rather than absolute and fixed (Jacobs, 2010). In pragmatism focus is placed on application—'what works'—rather than methods, allowing the researchers to use all approaches from a pluralistic view to understand the problem at hand (Creswell, 2013). Pragmatism does not see the world as an absolute unity permitting researchers to look to many approaches to collecting and analyzing data in contrary to subscribing to only one way as in mono-method approaches (e.g. quantitative or qualitative) (Creswell, 2013). In pragmatic research, truth about the subject under study is what works at the time. More specifically, the truth is not based on a strict dualism between the mind and reality. It is completely independent of the mind as in positivist tradition nor is it constructed by the mind as in the interpretivist tradition. Hence, pragmatic investigations can use both quantitative and qualitative data to provide the best understanding of the research problem. In addition, pragmatism advocates the view that research always occurs in social, historical, political, and other contexts that require multiple worldviews and different assumptions to understand (Creswell, 2013). Therefore, adoption of pragmatism as a research paradigm enables multi methods or mixed methods designs. That is, a purposeful combination of qualitative and quantitative data and techniques to create a more complete picture of the reality. These features make pragmatism and by implication mixed methods research suitable for studying complex issues and phenomena.[4]

Adoption of a mixed-methods approach enables researchers to combine qualitative and quantitative data in different orders and ways. The sequence and importance of qualitative and quantitative data and the stage at which they are integrated lead to a number of standard designs for mixed methods research. Creswell, Clark, Gutmann, and Hanson (2003) proposed the following typology of mixed-methods research (Table 2).

Mixed methods give researchers more flexibility in the choice of data, designs and methods. Hence, mixed-methods researchers can investigate multifaceted phenomenon, address more complicated questions and tackle a broader range of issues by synthesizing inductive and deductive logics. Tashakkori and Teddlie

[4] Design paradigm is also used in the design of mixed methods research but it is not a philosophical paradigm. Other philosophical paradigms that enable mixed methods research include emancipatory paradigm and critical realism [see Venkatesh, Brown, and Bala (2013), for a review]. We focus on pragmatism because it has been argued to be the dominant and main paradigm for mixed methods research (Creswell, 2007).

Table 2 Mixed methods designs (Creswell et al., 2003)

Design	Implementation	Priority	Stage of integration	Theoretical perspective
Sequential explanatory	Quantitative followed by qualitative	Usually quantitative	Interpretation phase	May be present
Sequential exploratory	Qualitative followed by quantitative	Usually qualitative	Interpretation phase	May be present
Sequential transformative	Either quantitative followed by qualitative or qualitative followed by quantitative	Usually quantitative	Interpretation phase	Definitely present (i.e., conceptual framework, advocacy, empowerment)
Concurrent triangulation	Concurrent collection of quantitative and qualitative data	Preferably equal	Interpretation phase or analysis phase	May be present
Concurrent nested	Concurrent collection of quantitative and qualitative data	Preferably equal	Analysis phase	May be present
Concurrent transformative	Concurrent collection of quantitative and qualitative data	Preferably equal	Usually analysis phase; can be during interpretation phase	Definitely present (i.e., conceptual framework advocacy, empowerment)

(2008) list seven major goals that can be pursued by mixed-methods research as summarized in Table 3.

Drawing on this introduction into the pragmatic paradigm and mixed-methods research, I will discuss how entrepreneurship researchers can use different types of mixed methods to investigate various aspects of complexity in entrepreneurial phenomena.

4 Mixed Methods and Complexity in Entrepreneurship: A Research Agenda and a Guiding Framework

> . . .no single truth is ever sufficient because the world in complex. Any truth separated from its complementary truth, is a half truth. . . (Pascal quoted in Myers, 2000, p. 74)

In this section I briefly explain how mixed methods research can help entrepreneurship researchers better investigate different aspects of complexity in entrepreneurial phenomena. To do so, I review key aspects and elements of complex systems and exemplify some potential ways in which mixed methods designs can be used to explore and explain them in entrepreneurship.

Table 3 Purposes of research methods designs (Tashakkori & Teddlie, 2008)

Purpose	Description	Example
Complementarity	A complementary view of the phenomenon and/or relationships is developed by combining the findings	A qualitative study was used to gain additional insights on the findings from a quantitative study
Completeness	A more complete picture is obtained by mixing methods. The full picture is more complete than the parts created by each method	The qualitative data and results provided rich explanations of the findings from the quantitative data and analysis
Developmental	Question or hypothesis for one method emerge from the other in a sequential form	A qualitative study was used to develop constructs and hypotheses and a quantitative study was conducted to test the hypotheses
Expansion	Understanding obtained by one method is expanded and explained by the other	The findings from one study (e.g., quantitative) were expanded or elaborated by examining the findings from a different study (e.g., qualitative)
Corroboration/ confirmation	The credibility of inferences from one method is assessed by the other	A qualitative study was conducted to confirm the findings from a quantitative study
Compensation	Weaknesses of one meth are compensated for by the other	The qualitative analysis compensated for the small sample size in the quantitative study
Diversity	Divergent pictures of the same phenomenon are obtained, compared and contrasted	Qualitative and quantitative studies were conducted to compare perceptions of a phenomenon of interest by two different types of participants

4.1 Mixed Methods, Hierarchies and Decomposability

Mixed methods research brings about an enhanced capacity to explore dynamics of hierarchical systems and relationships between elements of systems and nested sub-systems simultaneously in one project. Designs such as sequential explanatory, sequential exploratory and concurrent nested (Table 2) are suitable for such investigations. For example, sequential exploratory design can help researchers explore boundaries of hierarchical systems in an organization which is undergoing a major business model renewal (an entrepreneurial phenomenon), key inter- and intra-system mechanisms across levels including management team's dynamics, multifunctional operational teams and forces at the supply chain level such as contracts with suppliers, supply chain risks, demand fluctuation, etc. can all be explored through qualitative methods. Then, quantiative methods such as DEA (data envelopment analysis) can be employed to establish the significance of associations between sets of components including teams' commitment, leadership styles, operational effectiveness and efficiency and how these forces affect each other across levels. In the language of mixed methods design such a research can be

classified as complementary or completing type (Table 3). Both types can generate a more complete and realistic explanation for the complex phenomenon of interest than traditional mono-methodical approaches (either qualitative or quantitative).

Given this example, mixed-methods research can create interesting insights into the dynamics of hierarchical decomposable systems in entrepreneurship. Some complex issues that would benefit from this approach are business models and their transformation, new business model and product development projects in multinational corporations, public entrepreneurship involving new rules and regulations in the public sector, and dynamics of new venture creation by migrant entrepreneurs.

Ubiquity of hierarchical decomposable systems in entrepreneurship points to two general directions for future research: (1) research designed to show how mixed methods designs help us better understand boundaries of sub-systems and delineate interactions between subsystems in entrepreneurial phenomena. (2) Research aimed at showing how mixed methods designs can advance our understanding of decomposability of various systems surrounding entrepreneurial phenomena in social and business settings.

4.2 Mixed Methods and Agents with Schemas

Agents in entrepreneurship exist in many forms. They can be individuals or teams of entrepreneurs working privately to establish and grow a business or be executives of publicly listed firms whose job is to boost innovativeness, creativity and growth prospects of their business in domestic or international markets. Other types of agents can be angel investors, venture capitalists and even authorities whose actions and decisions affect the way entrepreneurs pursue they dreams. Agent populate complex systems and their actions shape behaviors of systems and sub-systems. Every agent has a mental picture of its task environment and develops a set of assumptions about his/her tasks. Social interactions provide agents with information that help them adjust or reinforce these assumptions which in turn affect their subsequent behaviors and actions of other agents with whom they interact in the business ecosystem.

Take for example the case of a scientist who intends to commercialize his patented invention. His plan may involve a fund-raising phase through angel investors and venture capitalists. This plan is based on an action plan that is guided by an evaluation of his relationships with friends, family members and colleagues as well as suitable venture capitalists in the industry. On the other hand, these investors may develop different perceptions of both the entrepreneurial potential and drive of the scientist and marketability of his technology. These similarities and differences in schemas directly affect the entire entrepreneurial process. In general, dynamics of networks, flow of information among agents and changes in markets and technological side of the industry cause these agents to constantly adjust their

schemas in favor or against the technology. The question is how these agents with schemas can be effectively studied.

Mixed methods design enable researchers to capture these dynamics. Qualitative methods are suitable for exploring unmeasurable, unobservable aspects of mental models, schemas and cognition such as cognitive frames, assumptions, and cognitive maps that shape schemas and quantitative methods are suitable for measuring associations between aspects of perceptions, attitudes, beliefs and assumptions to explain how schemas and subsequent actions are related among a set of agents. Sequential or concurrent combinations of these methods in a complementary or developmental fashion enable researchers to generate better explanations as to why, when, how and under what conditions schemas affect the way agents interact and communicate toward entrepreneurial goals.

There are still many unexplored territories and unaddressed questions about the dynamics of shared mental models and collective cognition in entrepreneurial teams (Klotz, Hmieleski, Bradley, & Busenitz, 2014), networks and eco-systems (Isenberg, 2010) that can be addressed by mixed methods research. In sum, future research can tap into the power of mixed methods to explore and explain how mental models and cognitive underpinning of agents in a complex system affect formation and success of entrepreneurial initiatives.

4.3 Mixed Methods and Networks of Positive Feedback Loops

Because entrepreneurs coevolve with markets, their behaviors are organized by positive feedback loops (McKelvey, 2004). These loops are "deviation-amplifying" mechanisms that facilitate changes in markets (Anderson, 1999; McKelvey, 2004). A key feature of systems with networks of positive feedback is that they involve unpredictable emergent patterns. Some examples of such patterns in entrepreneurship are innovations that bread new innovations, disruptive technologies that result in new disruptive responses, emergence of new markets and new business models and collaborative and co-opetitive activities that create new markets, new offerings and new chains of entrepreneurial initiatives.

A fundamental aspect of positive feedback loops is that they are usually nonlinear and involve complex processes (McKelvey, 2004). So, neither quantitative methods nor qualitative ones are solely capable of explaining them. Exploring complex systems are not just about understanding dynamics of interdependencies among factors across levels. More important is to explore why and how interdependencies spawn new phenomena (Buchanan, 2004). Mixed methods designs, in particular, sequential with complementary and developmental goals are valuable tools in the hand of researchers to explore and examine formation and mechanisms of positive feedback loops and emergent dynamics of systems in entrepreneurship.

4.4 Mixed Methods and Order at the Edge of Chaos

As previously discussed, order at the edge of chaos suggests that complex systems are not completely unpredictable and are, to some predictable extent, productive and functional. Therefore complex systems are not entirely understandable by positivist approaches, neither are they completely understood by interpretive methods.[5] Today's markets are perfect examples of such conditions. Constant shifts in consumers' preferences and continuous waves of technological advances and disruptive innovations drive markets to the edge of chaos. Under these circumstances lie opportunities as well as risks that facilitate or hinder entrepreneurship. Exploring dynamics of forces that underpin markets and examining approaches taken by entrepreneurs to take advantage of market imperfections are at the core of entrepreneurship (Mahoney & Qian, 2013).

Mixed methods designs are in particular suitable for such investigations. Qualitative data can provide rich and context-specific explanations about forces that drive a system to the edge of chaos and quantitative data can be analyzed to examine associations that give order to such a system. Take for example, continuous business model innovations in high-tech industries. Fast-moving markets and technological innovations create opportunities for both established firms and new entrants. Entrepreneurs either develop new business models or adjust their current business models in response to new disruptive technologies or to tap into new markets. These mechanisms drive the market away from equilibrium towards the edge of chaos where market trends are not completely chaotic and unpredictable but are moving fast at an understandable pace and direction (Brown & Eisenhardt, 1997). Qualitative research such as case studies and thematic analyses are strong tools to explore and describe boundaries and conditions of such movements but are also incapable of making general meaningful conclusions about causal relationships among forces that drive markets towards disequilibrium and different factors that are employed by entrepreneurs to take advantage of chaos. Mixed methods designs, therefore, help researchers address a combination of questions such as: (1) what factors do drive an entrepreneurial system towards chaos? How do entrepreneurs succeed at chaos? And what attributes and characteristics define success at the edge of chaos? among others to develop more compelling accounts for entrepreneurial phenomena at the edge of chaos.

4.5 Mixed Methods and Evolution by Recombination

Schumpeter (1934) argued that entrepreneurship is essentially a function of creative recombination of resources by innovative individuals. In addition, markets and industries evolve through the entry, exist and growth of firms that are established,

[5] I thank an anonymous reviewer for this point.

managed and led by entrepreneurs. Therefore, recombination of resources and firms through entrepreneurial talents, skills and abilities lies at the heart of evolutionary processes in entrepreneurship. Exploring how agents, firms and resources are recombined is an undeniably complex issue that can be better understood when exploratory and explanatory techniques are mixed. Therefore, future research can benefit from mixed methods designs to find how, when and under what conditions recombination of resources at individual, organizational or inter-organizational levels take place in complex entrepreneurial systems.

4.6 Towards an Organizing Framework

As the previous section delineates, applications of both mixed-methods and complexity theory are incipient in entrepreneurship research. Thus, a synthesis of them holds even a greater potential to advance entrepreneurship. In line with this fact, the foregoing discussion is, at best, a short and suggestive list of some fruitful directions for future research. Researchers who are willing to take this path need an organizing framework or a roadmap not only to choose the right mixed methods design for directing their research along suggested paths but also to explore new directions that address novel and more fine-grained questions aimed at enriching the complexity domain in the entrepreneurship literature.

Taken together, I believe that, the application of mixed methods research and the choice of the right mixed methods design to capture complexity of entrepreneurial phenomena involves four phases:

1. Identification of a complex topic. That is, an entrepreneurial phenomenon involving a large number of interconnected elements or agents with schema whose actions and networks of feedback loops shape dynamics of the phenomenon under investigation.
2. Specification of systems and subsystems that constitute the totality of the phenomenon under study.
3. The choice of the right combination of qualitative and quantitative data and methods. In this phase, researchers should justify why mixed methods designs are superior to mono-methodical ones and what the main objective of their research is and why it cannot be achieved using a qualitative or quantitative method alone. As explained earlier, a mixed-methods design can be to complement, complete, develop, expand, corroborate or illuminate diverse aspects of a phenomenon.
4. The last phase is to specify the most appropriate design based on the objective of the research. This step involves two choices: the choice of the sequence and the priority of qualitative and quantitative data in order to leverage the power of both methods to maximize the payoff of mixing them in the project. By integrating

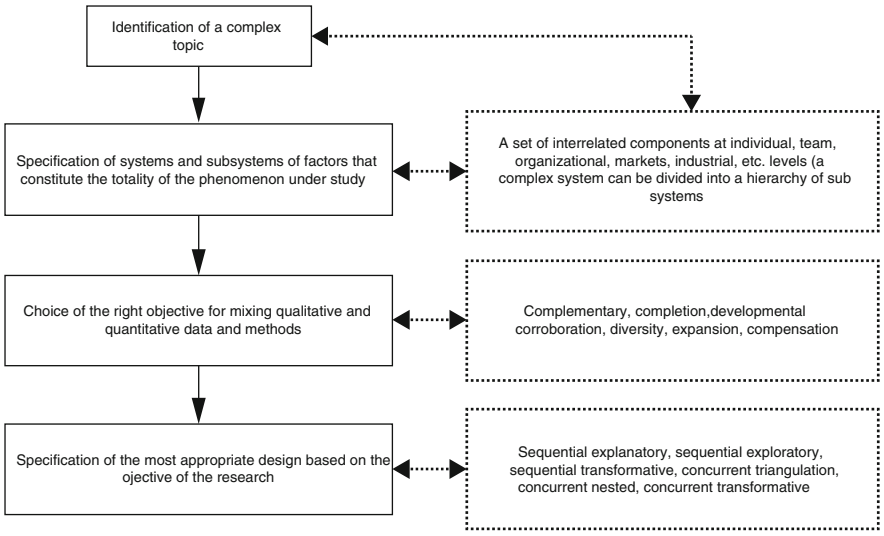

Fig. 1 An organizing framework for the application of mixed methods designs in the complexity research in entrepreneurship

these four into a framework researchers can plan and conduct mixed methods research more confidently to study complex issues in entrepreneurship. Figure 1 illustrates a schematic view of this framework.

4.7 Final Thoughts on the Framework[6]

Although the above framework highlights the potential of mixed methods research for studying complex phenomena in entrepreneurship and helps researchers design more effective research in this direction, it is prudent to discuss two of the key challenges faced by researchers when using this framework. First, as a methodology involving incompatible data and divergent analytical methods, assumptions and tools, mixed-methods designs are more resource-consuming than mono-method ones. Thus, mixed-methods is not as simple as it sounds. Mixed-methods researchers require more resources, a more carefully laid out plan, luxury of time and a wider range of research skills to conduct their research (Creswell, 2007). This is amplified by the fact that collection of qualitative and quantitative data for entrepreneurial research in one project is a challenge on its own (see Short, Ketchen, Combs, & Ireland, 2010 for a list of challenges in entrepreneurship research). Second, although mixed-methods designs afford flexible design choices and are gaining momentum in entrepreneurship (see Molina-Azorín, López-

[6] I thank an anonymous reviewer for suggesting to add this section.

Gamero, Pereira-Moliner, & Pertusa-Ortega, 2012 for a review), the complex side of entrepreneurship seems to be overlooked by mixed-methods researchers. A reason could be the fact that complex phenomena tend to have blurred boundaries (Simon, 1962). Hence, the key challenge here is not the identification of a complex phenomenon rather the specification of its boundaries. This issue should be addressed before making any choice about the type of the mixed methods design and its features. Absence of established norms for studying complexity in entrepreneurship is perhaps the main barrier in this regard. Therefore, researchers interested in using this framework are encouraged to carefully demarcate their topic of interest and clarify its theoretical and conceptual boundary by properly contextualizing it in the context (Welter, 2011) or the broader complex system in which it is taking place or embedded. Then they should assess the availability of resources and skills required by a fitting mixed-methods design. Despite these challenges I believe that the future of complexity research in entrepreneurship will be shaped by a stream of cumulative research that taps into the benefits of multiple methods.

5 Conclusion

Entrepreneurship is a complex field of research and entrepreneurial phenomena are inherently complex. Furthermore, complex systems are ubiquitous in entrepreneurship. This paper showed that traditional mono-methodical approaches based on the positivist or interpretivist paradigms offer, at best, incomplete ways to capture the essence of complexity in entrepreneurship. It further suggested that mixed methods designs are, in particular, suitable for exploring and explaining complexity in entrepreneurship because they benefit form advantages of both paradigms. Subsequently, a suggestive list of research directions and an organizing framework for designing mixed-methods research to study complexity in entrepreneurship were proposed. It is my hope that the arguments made here will motivate future research directed toward a more carefully designed use of mixed methods for studying a vast galaxy of complex issues in the entrepreneurship universe.

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Applying Mixed Methods in Entrepreneurship to Address the Complex Interplay of Structure and Agency in Networks: A Focus on the Contribution of Qualitative Approaches

Judith Mühlenhoff

Abstract Networks define a key entity in entrepreneurship and have spurred an enormous amount of research. Nonetheless, research lacks studies on entrepreneurial contexts and opportunities. This is due to the common separation of research on networks between the macro-level of structure, conducted by quantitative methods, and the micro-level of agency, conducted by qualitative methods. Mixed methods provide ways to bridge this separation of structure and agency and grasp the complexity of entrepreneurial action from a multidimensional perspective. Hence, mixed methods are crucial for conducting studies to answer urgent questions of the research field and inform theory building. This chapter guides researchers in applying mixed methods of network research in entrepreneurship. It gives an overview of different research designs with several examples and recommendations. The chapter focuses on the integration of qualitative approaches into mixed methods because first of all, they have been neglected and training is required, and secondly, qualitative approaches show promise to address current gaps in entrepreneurship research.

Keywords Entrepreneurship • Mixed methods • Networks • Qualitative methods • Study design

1 Introduction

Following a recent literature review (Busenitz, Plummer, Klotz, Shahzad, & Rhoads, 2014), papers that belong to the most emergent research areas of entrepreneurship deal with the environment or contexts of entrepreneurship and its opportunities. Their authors acknowledge the embeddedness of entrepreneurial processes

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_3

in dynamic socio-cultural contexts—what McKeever termed "the social turn of entrepreneurial research" (McKeever, Jack, & Anderson, 2014, p. 454). This view accounts for entrepreneurship happening in an open system and the complex interdependence between individuals (agency), like entrepreneurs, and their environment (structure). Nevertheless, scholars note that entrepreneurship research lacks studies that apply this view due to missing methodological implementation. Their call gains momentum for qualitative and mixed methods to address the complexity of entrepreneurship (Gartner & Birley, 2002; Hoang & Antoncic, 2003; Hoang & Yi, 2015; Jack, 2010; Jennings, Greenwood, Lounsbury, & Suddaby, 2013; Molina-Azorín, López-Gamero, Pereira-Moliner, & Pertusa-Ortega, 2012; Slotte-Kock & Coviello, 2010).

Social networks play an important role with a dramatically increasing body of literature to understand the contexts and opportunities of entrepreneurs. They are now established as a focal entity of analysis in entrepreneurship (Jack, 2010). Economic action is embedded in social interactions and shaped by relationships, which also provide access to required resources and opportunities.

A huge body of literature in entrepreneurship analyzes the structure of networks and causal factors, such as the effects of networks on entrepreneurial outcomes. Such a structural view in entrepreneurship in particular considers a macro view from outside networks. This structural research builds on tools of numerical social network analysis and causal factors.

Acknowledging the complexity of social worlds, a growing number of network researchers turn towards a qualitative methodological approach—non-numerical social network analysis. They criticize numerical methods for leaving out the culture and social world of meanings and narrowing the view on causal factors in an abstract and formal matter (Crossley, 2010a; Fuhse & Mützel, 2011). On the other hand, qualitative approaches seek to understand and explore the content, quality, and meaning of relationships: The context and nature of interactions, the practices, and how networks matter, come into play—what is going on within a network (Jack, 2010; Weishaar, Amos, & Collin, 2015). In this regard, qualitative approaches account for an agency and micro view on entrepreneurship from the inside of networks.

If we want to tackle the complexity of networks in entrepreneurship, we should acknowledge both views—those of structure (macro) and agency (micro). Therefore, mixed methods offer a silver bullet to integrate both views in research (Edwards, 2010; Fuhse & Mützel, 2011; Jack, 2010).

Combining both views enhances the generalizability and explanatory power of network studies. According to Molina-Azorín et al. (2012), another advantage of mixed methods lies in the chance to generate and verify a theory in one study and explore outcomes and processes. Mixed methods can also provide better inferences and provide diverging views, which help to modify conceptual frameworks.

Nevertheless, mixed methods are rare. The biggest barrier in conducting mixed methods refers to the absence of training and skills (Bryman, 2007; Molina-Azorín et al., 2012). Thus, this chapter will introduce the diverse practices and latest developments in mixed methods network research from different disciplines, especially sociology. The chapter will focus on integrating the neglected qualitative

approaches into mixed methods network-based research in entrepreneurship due to their potential for future studies. As noted, qualitative approaches have been disregarded in network research and in entrepreneurship—even within mixed methods (Bryman, 2007; Giddings, 2006; Hesse-Biber, Rodriguez, & Frost, 2015; Johnson, Onwuegbuzie, & Turner, 2007). Therefore, although mixed methods target to combine qualitative and quantitative methods, this chapter concentrates on contributing to the need for skills in qualitative methods within mixed methods. Hence, discussions of quantitative methods or theoretical underpinnings are out of scope. The chapter will provide various examples and recommendations of applying mixed methods in network research, but cannot account for an extensive literature review of the field.

First, the chapter gives an overview on why network approaches matter in entrepreneurship and which research gaps exist. Then, it presents qualitative approaches of network research and their contribution for studying entrepreneurship. Next, the article guides researchers in evaluating and choosing from the different study designs for mixed methods research in entrepreneurship with several examples. The chapter ends with recommendations and a discussion of the application of mixed methods for network studies in entrepreneurship research.

2 Relevance and Gaps of Network Approaches in Entrepreneurship

In entrepreneurship we are experiencing a "dramatic increase" of literature about networks, making networks a key element of the research (Jack, 2010). With the predominant quantitative/numerical studies, a lot of research addresses the evolution, growth, alliances, and performance of enterprises as well as their financing and the social capital of the entrepreneur [see Jack (2010) and Hoang and Yi (2015) for an overview]. But network research in entrepreneurship still shows promise to uncover untapped fields and neglected questions.

As mentioned above, research on contextualization and opportunities belongs to the most emergent topics in entrepreneurship (Busenitz et al., 2014). Based on the prevalent definition by Shane and Venkataraman (2000), the field of entrepreneurship is described as the discovery, evaluation, and exploitation of opportunities. A decade later, in a reflection about this seminal paper and the following research, Shane still notices a lack of studies on the sources of opportunities and their exploration to understand the different distributions of opportunities throughout space and time (Shane, 2012).

Studying social networks promises to contribute to findings on opportunities in entrepreneurship: Social networks have an effect on opportunity identification in terms of information access and the valuation of opportunities (Shane, 2012). Networks also play an important role in providing access to the resources for opportunities (Jack, 2010), for example by the size of the network, its diversity

(Hoang & Antoncic, 2003), or the kind of ties (weak, strong) a network consists of (Jack, 2010).

Shane (2012) and Shane and Venkataraman (2000) as well as several further scholars, acknowledge entrepreneurship as a process (Hoang & Antoncic, 2003; Hoang & Yi, 2015; Molina-Azorín et al., 2012; Sarason, Dean, & Dillard, 2006; Slotte-Kock & Coviello, 2010). However, research on processes remains a gap in entrepreneurship (Jack, 2010; van Burg & Romme, 2014; Zahra, 2007), especially when it comes to the identification of opportunities and the outcomes of such processes (Shane, 2012).

A central claim of Shane and Venkataraman (2000) was to bring together the view of individuals and the view of opportunities and see them as nexus in entrepreneurship. In this regard, following Alvarez and Barney (2007), as well as Klein (2008) and Shane (2012) recognizes that entrepreneurs also create opportunities. These opportunities are not objective and not independent of the individual.

In a recent review of the field of network-based research in entrepreneurship, Hoang and Yi (2015) especially encourage future research to examine the interrelatedness between the structural and the relational constructs of networks, for which the latter includes a network's content and governance.

What Hoang and Yi (2015) notice and what Shane describes with the nexus of opportunities and the individual points to a classic discussion within sociology—that of structure and agency, respectively culture. Opportunities belong to the structure of entrepreneurship and the individual, that is the acting entrepreneur, stands for the agent (Sarason et al., 2006).

In sociology, scholars emphasize either structure (macro level) or agency (micro level), thus seeing either structure or the agent as the dominant force in society. However, a growing group of scholars calls for an integrating view, acknowledging that both levels, that of structure and that of agency, are interdependent. We have to look at both levels and how these are interrelated to grasp the complexity of social reality. Social structure concurrently enables and constrains an agent.

Giddens (1984) stands as a prominent scholar of this thinking with his structuration theory. Sarason et al. (2006) and Jack (2010) apply structuration theory to entrepreneurship and claim that research would benefit from overcoming one-sided views of either structure or agency.

Similar to structuration, a group of sociologists introduced the relational approach to overcome the dualism of structure and agency/culture (Emirbayer & Goodwin, 1994; Fuhse, 2015[1]; Mützel, 2009). Relational sociology is based on social network research and introduced the notion of culture into social network analysis. Mützel (2009) recognizes economics as a very fruitful area for deploying relational sociology. Tatli, Vassilopoulou, Özbilgin, Forson, and Slutskaya (2014) promotes applying relational sociology in entrepreneurship with the agenda to bridge distant research streams of agency and structure, resp. qualitative and

[1] Relational sociology captures different theoretical streams and is no homogeneous concept. Empirical applications are still emerging and developing [for an overview see Fuhse (2015)].

quantitative research. Following this, entrepreneurial phenomena are "produced by irreducibly intersubjective meanings, relational properties, and interdependent patterns and processes" (Tatli et al., 2014, p. 616).

Researchers, who call for structuration and relational sociology, emphasize that these lead to a bigger picture and better understanding due to the integration of different multilayered facets (Jack, 2010; Sarason et al., 2006; Tatli et al., 2014). These approaches take into account the complex dynamics between the levels of structure and agency/culture as well as between relationships and multiple actions of a network. As a result, structuration and relational sociology enable researchers to better tackle complexity in entrepreneurship. These approaches help to shed light on the nexus of opportunities and the individual (entrepreneur); and they help to tap into the different contexts regarding the exploration of sources for opportunities. Network research shows promise for methodological applications of a structuration/relational sociology approach because it is able to bridge the micro perspective of agency with the macro perspective of structure (Crossley, 2010a). This bridging calls for applying mixed method approaches in network research. Qualitative methods are rather associated with inquiries about the micro level and agency (inside-view) while quantitative methods rather address the macro level and structure of a network (outside-view). An integrative mixed methods approach empowers researchers to overcome a one-dimensional view on networks.

However, mono-method quantitative studies have dominated research on networks and entrepreneurship. Accordingly, a growing number of scholars are calling to integrate qualitative methods in network-based research in entrepreneurship and point to mixed methods study designs to account for different and/or complementing views (Gartner & Birley, 2002; Hoang & Antoncic, 2003; Hoang & Yi, 2015; Jack, 2010; Jennings et al., 2013; Molina-Azorín et al., 2012; Slotte-Kock & Coviello, 2010).

Therefore, I will first introduce qualitative approaches to network research and show how they contribute to entrepreneurship research, especially how they address the previously discussed gaps of context, process, and resources/opportunities.

3 Qualitative Approaches to Network Studies in Entrepreneurship Research

In this section, I describe the overall contribution of qualitative approaches in network studies tied to their methodological and epistemological backgrounds. Then, I show the relevance of qualitative approaches for research on networks in entrepreneurship and finally present fields of application with examples.

3.1 Contribution of Qualitative Approaches in Network Studies

Quantitative network analysis tells us a lot about the "how much" and "how many" of a network and yield to a better comprehension of a network through its structure. But drawing on the same methods like in physics or biology, such numerical analysis neglects socio-cultural factors. Qualitative approaches towards studying networks contribute especially to the comprehension of "why and how" (e.g., McKeever et al., 2014). This entails the qualitative parts of a network, its contexts and how people make sense of what is going on in a network (Crossley, 2010a; Hollstein, 2006). Quantitative, formal methods simplify relationships, e.g., as existing or not existing, resp. directed or un-directed, to fit them into an adjacency matrix for mathematical calculation. On the other hand, qualitative methods allow for detail and complexity. Like for ties, they convey their inherent meaning or content, such as a story, which sometimes is important to know "if we are to comprehend, explain or predict their effect," (Crossley, 2010a, p. 10). Otherwise, even the same structural figuration of ties, e.g., the strength of a relationship measured by frequency of interaction, might lead to different effects. The underlying quality of a relationship, based on trust, affinity, shared content, etc. probably explains more than strength measured by frequency of interaction. In this regard, the dominant quantitative network analysis risks a narrowed, atomistic view on networks and individuals; whereas open qualitative methods help to explore and understand the network and its actors in depth and breadth.

If we lack prior knowledge of a network and its context, the standard procedures of formal network analysis risk validity errors: A priori definition and limitation may exclude explanatory and contextual factors, thus misguiding measuring of the right data. For example, the researcher's definition of the content of a relation differs from the respondent due to another understanding of what to regard as friendship tie or important flow of information (Wald, 2014). Another problem can arise from implicit assumptions, which are often made about the motivation for or positive impacts of networking (Jack, 2010; Wald, 2014).

As stated, if we want to grasp a fuller and complex picture of a network, we need to consider its environment and contextual conditions, especially its social and cultural context. This accounts for entrepreneurial practices and processes embedded in socio-cultural contexts and social networks imprinted with culture (Jack, 2010; McKeever et al., 2014; Slotte-Kock & Coviello, 2010). As relational sociology notes, "network structure is always intertwined with cultural forms," (Fuhse, 2015, p. 22). For example, political or cultural developments in the environment of entrepreneurs and organizations influence decisions. Embedded norms and practices or international differences impact entrepreneurial action. For example, to include the social-cultural context would go beyond an equation of nation with culture (e.g., the USA and "individualism") and explore the meaning and operation of culture in the country context (Jennings et al., 2013). These cultural factors entail practices, meanings, and discourses (Mützel, 2009). We better understand the

content and what is going on in a network, if we understand how these cultural factors affect actions and relations in a network and vice versa. Meanings mediate what information flows through a network; they are attached to particular relationships and communities (Crossley, 2010a; Weishaar et al., 2015). For example, someone shares information about a new record label only with people who like the same music. The same taste of music, often supported by a corresponding fashion style, enfolds the meaning.

Furthermore, something like information flow is mediated by the history and quality of social relations. Dividing tie strength into weak and strong does not grasp the multiple dimensions of tie strength, e.g., time spent, the emotional intensity, or the degree of reciprocity between individuals (Kim & Aldrich, 2005). Therefore, we should collect in-depth information on relationships and interpret the role and position of actors (Weishaar et al., 2015).

3.2 Relevance of Qualitative Approaches to Networks Studies in Entrepreneurship

Interest in studying networks in entrepreneurship is driven by the crucial role of networks in providing access to the resources of opportunities. The networks of an entrepreneur offer various, important resources throughout all phases of a firm's evolution. For example, they might help in recruiting personnel or reaching out to investors. Furthermore, they provide knowledge and information and thus prove highly relevant for the discovery and creation of opportunities. A central field of inquiry about entrepreneurial processes is start-up formation, covering opportunity discovery and the exploration and exploitation of opportunities. Edwards (2010), while referring to MØnsted (1995), notes that quantitative methods of network research are not appropriate for describing and analyzing in depth such dynamic processes. This applies particularly to the emergence of new structures because very weak or emerging ties often play a crucial role in provoking change, but quantitative methods struggle to record these ties and the change (Edwards, 2010; MØnsted, 1995). Qualitative methods and longitudinal research help us to close the gap on how networks develop over time and what this process consists of (Jack, 2010).

While notable research exists on the discovery, exploitation, and consequences of opportunities, the field of entrepreneurship still lacks insights on the source and nature of opportunities (McMullen, Plummer, & Acs, 2007; Shane, 2012). By going beyond reducing networks to resources (as in structural analysis), we encompass the qualities of certain resources and their opportunities. These insights could answer how the sources find their way into the market or why there are more opportunities in some place and time (McMullen et al., 2007; Shane, 2012). Accordingly, we improve our understanding about what types of networks bring a

competitive advantage to entrepreneurs (Bhagavatula, Elfring, van Tilburg, & van de Bunt, 2010).

As demonstrated, qualitative network approaches offer an inside-view of networks, provide depth and context. They contribute remarkably in bridging gaps in entrepreneurship research, e.g., the sources of opportunities or processes. Following the summaries of Stegbauer and Häussling (2010) and Hollstein (2006, 2011), qualitative approaches are of particular relevance in the following six areas of application in network research:

- The exploration of networks, which also helps in knowledge generation of a field prior to a quantitative study
- Network practices, which entails the concrete interaction and communication patterns in context
- Network orientation and assessments, which includes the interpretation and orientation of action by actors
- Network effects, which tell us about why networks matter
- Network dynamics, which covers process and change in networks
- Validation of network data (from standardized research), field access

4 Fields of Application and Examples of Qualitative Network Approaches

The following section introduces qualitative approaches to networks research. What becomes immediately apparent: "The definitive" qualitative network analysis does not exist and one can even doubt to term it a research field on its own because there are no established stand-alone methods with the exception of network maps (Diaz-Bone, 2008; Straus, 2006). In line with Hollstein (2011), I link qualitative approaches in network research with the common ground of an interpretivist research paradigm (resp. a narrative or constructivist paradigm). Different to the dominant positivist paradigm, an interpretivist methodology focuses on understanding the meaning of a social reality that is constructed by the actors. This leads to special attention towards contextuality to understand the subjective meaning of actors and their dynamic social reality. Thus, research follows an inductive and iterative path.

Corresponding with the broad range of methods applicable to retrieve data and different theoretical/conceptual approaches towards networks, the potential sources of qualitative data are diverse. If the goal of the study is related to network practices and effects, the study design will require data on actually existing relations. If the study deals with e.g., network orientations and assessments, the researcher needs to collect data on the perception of relations by the actors (Hollstein, 2011).

Interviews represent the prevalent method to obtain qualitative data in network research, frequently integrated in ethnographic study designs or case studies. The widespread case studies on firms in entrepreneurship research often combine

different data sources (data triangulation). Besides interviews with actors, secondary data like documents or data from observations provide a fuller picture beyond individual statements. How explorative a study design is and how much the researcher already knows about the inquiry guides how open and how standardized the chosen methods will be.

For example, McGrath and O'Toole (2013) integrated 19 semi-structured interviews and secondary data "to illustrate the complexity of network capability development" (McGrath & O'Toole, 2013, p. 1141), using the example of all Irish micro-brewing companies. They detected moderating and context variables, which inhibit or engage network capability development. Their data collection and analysis was guided by previously developed themes, so was partly standardized.

In a study by Jack and Anderson (2002), seven established entrepreneurs were selected from a rural remote area for analyzing "the effects of embeddedness on the entrepreneurial process". The data collection lasted over 3 years to observe a process. The chosen entrepreneurs were interviewed in an open, ethnographic way and rich, secondary data was collected on the background and history of the entrepreneur and his firm. The authors drew on Giddens' theory of structuration and used grounded theory oriented data analysis to come up with a grounded model on the embeddedness of entrepreneurs.

Both examples are rather concerned with the conditions, premises, and antecedents of network development and structure. To analyze networks per se in a qualitative matter, the use of network maps and circles provide promising opportunities and gain momentum (Schönhuth, Gamper, Kronenwett, & Stark, 2014). Usually, they represent egocentric networks in a visual way, but may picture a whole network as well. The actor (ego) is positioned in the center of concentric circles (Kahn & Antonucci, 1980) and describes his or her relations. This data collection process can be performed on a totally open basis (free cards with drawing and open interview) or with a high degree of standardization. For the latter, researchers use so called "name generators". This instrument has been established in formal network analysis for a long time (Heath, Fuller, & Johnston, 2009) and consists of questions on e.g., people important to a central actor. Additionally, "name interpreters" (Heath et al., 2009) about the nature of relations, pre-defined categories (e.g., "family"), or non-human nodes (e.g., objects, events, places) can depict the network of an ego in further dimensions. Pies of the network circles, different colors, etc. mark these categories, making a complex network easier to grasp.

Network maps thus give a more holistic and detailed view of networks (Tubaro, Casilli, & Mounier, 2014). They enable the tracking of the contexts of origin of a network and its underlying indirect and implicit influences (Heath et al., 2009; Schönhuth et al., 2014). Likewise, participants can more easily reflect on their network while it is mapped in front of them. They can change the structure of the network throughout this process, thus helping to improve validation (Schönhuth et al., 2014). Network maps also trigger narratives by participants, which often yield rich contextual data. Participants stay longer motivated or even experience excitement (e.g., Coviello, 2005), compared to an open or semi-standardized

interview as well as solely filling out or answering surveys. Furthermore, developments in software (e.g., VennMaker or EgoNet) and hardware (e.g., touch screens) facilitate the elicitation of networks compared to the classic "paper and pencil" method (Hollstein, Pfeffer, & Behrmann, 2014). Tubaro et al. (2014) describes a web-based application of network maps. Although this may miss insights from face-to-face interviews, it can reach more people and demonstrates the future potential and field of application of visual methods in network research.

Coviello (2005) used qualitative data collection by network map to analyze the development of a family-owned business network over time. Within inductive, iterative in-depth interviews with the three founders/owners, she traced back the overall network evolution of this small enterprise over a four-year period in retrospect. The data collection and analysis was based on case research procedures and previous models of network development. The author did not just analyze the data in a qualitative way, but also in a quantitative way, which I will go into in the next chapter. The study revealed various results on different levels, e.g., that the network of the enterprise changed from an identity-based network to a more calculative network.

Qualitative approaches to network research offer a broad range of ways to collect and analyze data, combined in various ways. The nature of qualitative research also allows for a flexible adaptation of data collection. However, it is important that the researcher knows her general methodological background and is clear about the goal of the study (e.g., exploration versus explanation). Furthermore, it is important that the researcher reflects on possible guiding models and theories to decide about the degree of standardization of the applied methods.

Of course, qualitative approaches in network research are subject to the same disadvantages as qualitative approaches in general: Small sample size, flexibility, and the reconstruction of subjective meaning miss the representativity and generalizability of findings in a statistical sense. Qualitative network studies risk replicating the "messiness of the social world" (Weishaar et al., 2015) and thus fall short of a clearer picture.

As stated previously, qualitative approaches recognize in particular the micro, respectively the inside or agency view of networks. To allow for an integrated view of the micro and macro level of a network and make its complexity graspable, I will discuss the application of mixed methods in the next section.

5 Mixed Methods for Network Studies in Entrepreneurship Research

This section explains the advantages of mixed methods in entrepreneurship research when studying networks. It will focus on how to apply mixed methods and guide through the various ways of conducting mixed methods, ending with advice for research designs.

Following the previously introduced structuration and a relational sociology approach towards networks, the micro and macro level, that is agency and structure, are interdependent. To understand the processes and complexity of entrepreneurial action within a network, we cannot think one level without the other.

Mixed methods promise to take account of the inside (micro) and outside (macro) view on networks, thus shed light on the nexus of both entrepreneur and opportunities. The next section will introduce mixed methods in network research, provide an overview of different mixed methods research designs and guide researchers in entrepreneurship in conducting their own.

5.1 Mixed Methods and Their Contribution to Network Studies

Mixed methods in network studies address the integration of multiple views and research approaches by spreading beyond the levels of agency and structure. Although some state a whole "movement" has emerged around mixed methods in social science (Bernard, 2014), entrepreneurship research in general counted only about 11 % of papers using mixed methods between 2000 and 2009 (Molina-Azorín et al., 2012).

Mixed methods research can be defined as a "synthesis based on qualitative and quantitative research" (Johnson et al., 2007, p. 129). While combining methods is nothing new, the growing interest in mixed methods spurred a lot of discussion and fostered an institutionalization of the field with the development of its own research paradigm. Although some scholars reject the compatibility of qualitative methodologies like interpretivism with quantitative methodologies like positivism, most call to overcome these boundaries. The majority refers to pragmatism as the leading paradigm of mixed methods. Pragmatism puts the research questions into the center to guide the choice of methods. Researchers see methods as tools and combine them according to what best fits the needs and goals of the research (Hesse-Biber et al., 2015; Johnson & Onwuegbuzie, 2004; Onwuegbuzie & Leech, 2005). Meanwhile, scholars have criticized a delinking of pragmatism in mixed methods from its original philosophical origins, turning it into a "practical pragmatism" of "what works" (Greene & Hall, 2010; Hesse-Biber et al., 2015).

As an alternative, but equal framework to pragmatism, the dialectic approach (Greene & Hall, 2010; Hesse-Biber et al., 2015) links mixed methods more strongly to philosophical paradigms. The dialectic approach aims to traverse between different paradigms in a constant, spiraling conversation (Hesse-Biber et al., 2015). It does not aim to overcome different methodologies or to focus on convergence, but rather to seek new insights, surprises, and also dissonances (Greene & Hall, 2010). The overall goal of a dialectic approach in mixed methods studies calls for a strong reflection by the researcher on the links to theories, methodologies, values, etc., as well as her own standpoint within the research.

The core idea of mixed methods is that the strength of a single method or approach outweighs the weakness of another and thus leads to better validation. However, mixed methods do not target a simple, quick mix of "both worlds" of qualitative and quantitative methods (Giddings, 2006). Mixed methods study designs ask for a purposeful choice of methods to increase knowledge with a constant reflection of the researcher's questions and methodology. Therefore, a highly integrated or equal mix of qualitative and quantitative methods does not have to be the only or best way to conduct mixed methods research. Mixed methods designs can also be driven from a stronger qualitative methodology (qualitative dominant mixed methods) or quantitative methodology (quantitative dominant) (Hesse-Biber et al., 2015; Johnson et al., 2007).

In network analysis, the formal-structural analysis (e.g., density, centrality) will provide a picture of the networks' structure in a glimpse, while qualitative methods add detail and depth to the structural analysis. Qualitative parts of a study can problematize or even correct biases from structural network analysis (Crossley, 2010b), e.g., by questioning a priori definitions or limitations through explorative interviews, which yield into the development of a survey. Results from a quantitative study may point to outliers in data, leading to promising cases for in-depth research. The interplay of different research strategies allows for increasing validity of measurement and inferences or the corroboration of findings (Johnson et al., 2007; Miles & Huberman, 1994; Molina-Azorín et al., 2012; Wald, 2014).

Applying different research strategies can initiate theory development and lead to the discovery of new research questions through more breadth and range of inquiry (Molina-Azorín et al., 2012). If a researcher discusses the quantitative results of her study, qualitative insights, for instance from in-depth interviews, contribute to the discussion of results, e.g., through a better understanding of underlying motivations of actors. By combining qualitative and quantitative approaches, researchers even have the chance to generate and verify theory in the same study (Molina-Azorín et al., 2012; Wald, 2014). If the results from different methods do not lead to corroboration or verification, this challenges the researchers to come up with new, more complex explanations and might spur completely new thinking and theory (Miles & Huberman, 1994).

Hollstein (2014, p. 11) describes three conditions that define mixed methods network research:

- Studies contain qualitative (textual) and quantitative (numerical) data
- Analysis used both strategies of qualitative/interpretivist (meanings, contexts, etc.) and quantitative/mathematical (network structure) approaches
- Integration of data or strategies of analysis at least at one stage of the research process

Wald (2014, p. 84) works out when it is best to use mixed methods in network research when confronted with the following study design issues:

- Research question: highly complex, partly clear-cut and partly open
- Objectives: confirmatory and exploratory

- Research field/phenomenon:
  - Well-structured elements and unstructured elements
  - Existing, but incomplete prior knowledge of field
  - Subjective meanings and frameworks of relevance of the actors differ significantly and/or are unstable
- Networks: no clear delineation of the system

Wald (2014) adds that complexity not only refers to the first point on the list, the research questions. Complexity also manifests through the different questions a researcher wants to answer, or through analyzing a complex set of possible relations. Furthermore, complexity refers to the purpose of the study as a complex study tries to answer confirmatory and exploratory objectives.

Before the chapter moves on towards the application of mixed methods research, Fig. 1 condenses the various concepts and categories introduced here. It shows how

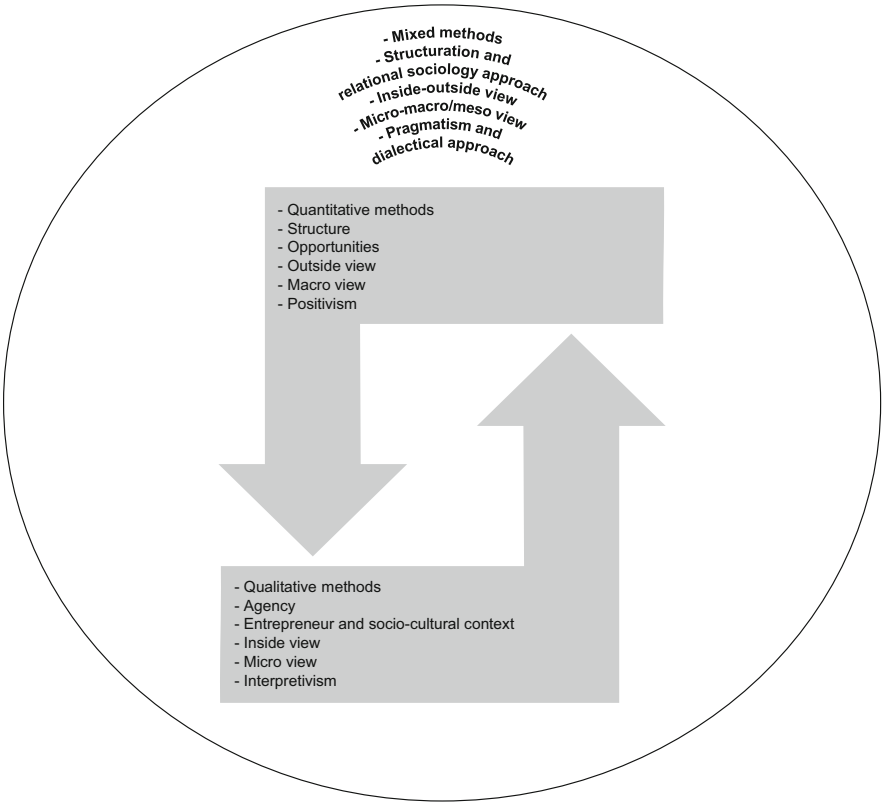

Fig. 1 Integrated approaches to address the complex interplay of structure and agency in entrepreneurship research

mixed methods "overarch" qualitative and quantitative approaches to tackle the complex interplay of structure and agency.

5.2 *Application and Examples of Mixed Methods Research in Network Studies*

Many ways exist to combine different research approaches for a better understanding of networks, thus to grasp their complexity. The field is evolving rapidly, has already produced an astonishing variety of implementations, and still leaves a lot of creative space for future research (Creswell, 2015; Straus, 2006).

Edwards (2010) distinguishes between three generally different ways of conducting mixed approaches in network studies. This is based on the data at the start—qualitative or quantitative—and to what extent both data types are combined at the phases of data collection and analysis. She comes up with a type of study, in which qualitative approaches inform quantitative social network analysis or vice versa. A second type of study integrates qualitative and quantitative approaches at both data collection and analysis phases. And a third type of study mixes qualitative data collection with mixed-methods data analysis.

Hollstein (2014) depicts similar differentiations, but proposes five different ways of mixing methods in network studies, which will be described below and in Table 1. Her taxonomy is based on the classifications of Teddlie and Tashakkori (2006), Tashakkori and Teddlie (2009), Creswell and Plano Clark (2003), Creswell and Plano Clark (2007), and Greene, Caracelli, and Graham (1989).

Following this summary of Hollstein (2014), criteria for the description and classification of mixed methods consist of:

- What the study combines—be it the number of strands or phases included
- Differences in implementation
- The use of an identical or non-identical sample
- The chosen stage of mixing methods within a study
- The overall goal of mixing methods (e.g., corroboration or focus on exploring a field)

The author then introduces the following five research designs: Sequential design, embedded, parallel, conversion, and fully integrated design (see Table 1). The research design types have no clear-cut boundary and different designs may partly be combined. Even the distinction between qualitative and quantitative data can be blurred (Wald, 2014). This relates to the big advantage of qualitative data over quantitative data: Qualitative data, such as interviews, relatively easy convert into quantitative data ("quantitizing") while the other way round ("qualitizing") makes sense only rarely.

Table 1 Mixed methods designs in network research [based on Hollstein (2014) and Miles and Huberman (1994)]

Type of research design	Advantages	Disadvantages
Sequential design a) QUAL → QUANT b) QUANT → QUAL	Easier to implement	Limits ability to make adjustments at later stages, takes longer
Embedded design a) QUAL — (QUANT) → Mainly QUAL b) QUANT — (QUAL) → Mainly QUANT	Less demanding and costly	Mostly limited to narrowly focused research questions and well-defined boundaries
Parallel design QUAL → QUAL → QUAL QUANT → QUANT → QUANT	Useful for triangulating data and checking for complementarity, usually takes less time	Considerable expertise needed for applying different approaches simultaneously
Fully integrated design QUAL → QUAL & QUANT → QUAL & QUANT QUANT →	Most integration of qual and quant depicts complexity for the best, good for studying processes	Demanding for researcher in terms of complexity and coordination
Conversion design a) QUAL, QUANT → QUANT b) QUAL, QUANT → QUAL & QUANT	Suited for various secondary data, saves time in data collection	(a) quasi-mixed method that lacks true combination, narrowed results (b) using one sample data for qual and quant analysis enhances validity

5.2.1 Sequential Design

The sequential design (Hollstein, 2014) corresponds with Edwards (2010) description of studies where one approach informs the other. When starting with a qualitative, exploratory approach (version a in Table 1), e.g., open interviews or a qualitative analysis of documents help to explore and understand the research field. In network studies, researchers enhance the reliability of their quantitative evaluation of networks through qualitative pre-studies, where interviews inform the design of questionnaires.

When starting research with a quantitative, explanatory approach (version b in Table 1), that is, formal network analysis, the results give an overview of the research field and point to critical issues. In this way, the results guide the researchers in choosing participants for in-depth interviews, e.g., the central actors of a network (e.g., Kolleck & Bormann, 2014).

The sequential design is easy to implement, but limits the possibilities of changes to the study. Following a sequential design also takes longer because the second part of the study (and respectively the third, etc.) cannot start before the first has ended.

For example, Human and Provan (1997) conducted a case-based study using explorative, qualitative research logic on small-firm networks from the wood products industry. However, they used questionnaire data and descriptive statistics to validate data patterns from the previous qualitative research phase with open interviews. In this way, they discovered four types of network exchange in the qualitative first round. Sociometric data around these four types as well as further descriptive data was then obtained through the questionnaires in the quantitative research phase two. By using the network analysis program UCINET, the authors plotted a network graph and analyzed the sociometric data. In the end, they came up with a proposed model of SME network structure and outcomes with testable propositions.

To study an ambiguous network of cross-community youth leaders in Belfast, Smith (2015) used a three-step design of first qualitative, then quantitative, and finally again qualitative data collection, respectively analysis (qual → QUANT → qual). First, she had to specify the boundary and parameters of the network because the network itself was quite ambiguous and difficult to access. Therefore, she collected field notes and developed a network instrument in an ethnographic way within 8 months. She conducted over 90 informal and exploratory conversations and obtained external information sources on boundary specifications related to, e.g., time period, place, or actor attributes. In the second phase, she ran a survey with 59 participants, which was developed along the reoccurring themes from phase one. The analysis with the program UCINet incorporated more than 25 network measures. From this analysis composite indexes identified 9 interview partners with different network positions for the third, qualitative phase. This last phase focused on variables that were previously identified for their explanatory contribution from the survey results and extended the network findings. An integrated analysis was achieved through exploration and comparisons of both interview and network data within the same matrices.

5.2.2 Embedded Design

In embedded (or nested) research design, one research approach dominates the whole study. A quantitative part enriches a qualitative study (version a), but the results remain mostly qualitative or vice versa with a qualitative part enhancing a quantitative study (version b). Embedded designs usually are less demanding, but often limited to narrow research questions and a well-defined research field.

Chell and Baines (2000) integrated open questions in interviews with multiple-choice questionnaires about the networking behavior of microbusinesses. The results were merely analyzed and discussed in a quantitative matter, establishing typologies and simple statistical connections.

5.2.3 Parallel Design

In a parallel design, qualitative and quantitative research strands take place independently from each other, often at the same time. Interim results can inform the other strand, but usually the analysis of the strands happens separately. The design of the study is not built on a continuous exchange between both strands. Nevertheless, the researcher compares the results of both strands. Therefore, parallel designs in particular check the complementary of results and provide a comprehensive understanding rather than to a convergence of findings. They allow exploratory and confirmatory research questions to be addressed. However, such research designs ask for substantial knowledge in applying qualitative and quantitative approaches at the same time.

Bernardi, Keim, and Klärner (2014) implemented a parallel study design when investigating network effects on fertility decisions and intentions, by analyzing egocentric networks of men and women. They used one sample of interview partners and conducted semi-structured interviews together with a socio-demographic questionnaire, network grids (for collection of an ego's alteri—that are his or her connections), and the evaluation of concentric circles (network maps). This mixed data collection provided direct qualitative and quantitative data. Additionally, qualitative data was quantified for the overall analysis of structural data. Additionally, the authors interviewed a subsample of relevant members of an ego's social network (his or her alteri), which partly was difficult to access, but yielded further information from another perspective.

5.2.4 Fully Integrated Design

A fully integrated research design, as the name indicates, exhibits a high degree of integration between qualitative and quantitative approaches. Qualitative and quantitative approaches relate to each other at several points. Their analyses are interwoven and inform the next phase of research. The design takes full account of both parallel and sequential research designs, but has to manage this accordingly. Thus, this design is quite challenging for the researcher. However, with the constant and interactive integration of different approaches, it depicts complexity in a superior way, compared to the previously introduced designs. The integration of the sequential design makes it perfect for longitudinal studies, such as network processes.

Avenarius and Johnson (2014) deployed this approach in a study on "adaptation to new legal procedures in rural China", which took place over 3 years. This multi-step and multi-stage research design was not planned straight ahead, but modified dynamically, in accordance with the findings. It included five data-collection instruments from ethnographic observation to semi-structured and structured interviews. Some instruments were used continuously over two or three of the 3 years. Quantitative and qualitative analyses were conducted on data from every data-collection and informed the next stages as well as the different approaches at

several times. Furthermore, the integration of different methods and crossover analyses yielded comprehensive inferences. It allowed an understanding of social structures and social cognition—"the meaning of social relationships in the context of rural Chinese culture" (Avenarius & Johnson, 2014, p. 198).

5.2.5 Conversion Design

This research design incorporates the quantitizing strategy (respectively the qualitizing strategy) by converting qualitative data into quantitative data for analysis. A simple conversion design only takes account of one style of analysis: Qualitative data that have been transferred into quantitative data are only analyzed in a quantitative way. Thus, Hollstein (2014) regards simple conversion designs (version a in Table 1) not as "typical" mixed methods design. The qualitative information is lost for the results, but may have been helpful during data collection, e.g., to avoid misunderstanding through a misguiding survey, which allows for no check backs by research participants. "True" mixed conversion designs (version b in Table 1) analyze in a qualitative and quantitative way. They often involve a few, alternating rounds of data collection and analysis.

Both versions save time and are able to encompass a range of secondary data such as emails or other documents. This opens space to use a variety of already existing qualitative data for a structural analysis, which is promoted by the relational sociology approach of network studies (see above). The data in such studies often rather describe cultural or conceptual networks or models than actual networks of interaction (Edwards, 2010).

Weishaar et al. (2015) used secondary data such as drafts and websites to convert these textual into relational data in a study on European policy networks. A plagiarism detection software tool helped to detect relationships/collaborations between actors based on similar documents. From these data, the researchers plotted a network, which informed the sample for in-depth interviews. These led to validation as well as contradiction of previous interpretations, revealing what was not stated in the publicly available documents.

A promising application of network studies with conversion design lies in Qualitative Comparative Analysis (QCA), which entails a mixed method in its own (Hollstein & Wagemann, 2014). QCA performs "alternate rounds of qualitative analyses involving the reconstruction of individual cases, on the one hand, and quantitative analyses on the other" (Hollstein, 2014, p. 17). QCA supports especially studies of medium-sized samples to understand network effects and to develop typologies.

Hollstein and Wagemann (2014) made use of QCA in a network study on the conditions of successful labor market transitions of young adults with low or no educational qualifications. Qualitative and quantitative approaches towards the analysis of secondary data were merged to systematically compare cases and explain individual behavior.

Coviello (2005), as described in the previous section, used qualitative data and network maps in studying the process of network building of a small business. The qualitative data was converted into quantitative measures, such as betweenness centrality or frequencies. This informed the generation of "frames for the analysis of the origins and outcomes of network processes" (Coviello, 2005, p. 51), for which the author drew on a theory-based concept from literature. Furthermore, the data provided a reconstruction of the evolution of individual egocentric networks and the resulting changing power structure in the firm.

5.3 *Applying Mixed Methods in Network Studies: Advice and Disadvantages*

Mixed methods in network research open a huge, fruitful space for analyzing the role of networks in various fields of entrepreneurship research. They are capable of integrating questions that address the structure as well as the content, context, and agency of networks.

Compared to a single research approach, mixed methods have the potential to increase the overall validity of a study. Fully integrated research designs in particular show promise in taking full account of this and allowing for the complexity of a given phenomenon to be grasped most fully. Using the same sample throughout the study in general can enhance validity and positively affects generalizability (Wald, 2014).

Even when starting with quantitative data collection, it might make sense to collect some qualitative data (documents, interviews) to gain knowledge of the research field. This can lead to an increased reliability via an optimized survey questionnaire.

Reliability will also be enhanced if researchers check network maps with participants a second time or even multiple times (Edwards, 2010, see Coviello, 2005). In this way, participants can point to missing, inaccurate, or forgotten data.

Egocentric networks provide rich understanding of a network, especially with the various possibilities of integrating visual material such as network maps and applying more or less standardized data collection to a study's need. Nevertheless, it takes a lot of time to conduct the research and the generalizability of the results is limited. Complete egocentric network analysis needs to gather all alter-alter relations (not just the friends but "friends of friends") to make advanced statistical inferences on the structure of an overall network (Diaz-Bone, 2008). In bigger networks, it is unfeasible to collect all alter-alter relations as these usually grow exponentially. This points to a basic problem of network research—that of boundary setting (Laumann, Marsden, & Prensky, 1992). When approaching a very ambiguous network, the problem of setting the limit of the studied network can be decreased by intensive exploratory research in advance (see Smith, 2015). A lot of studies seem to address the issue of network boundary setting by deliberately

choosing small networks and readily comprehensible settings like SMEs (Coviello, 2005), or rural areas (Avenarius & Johnson, 2014; Jack, 2010).

A similar strategy might apply when dealing with the difficulties of longitudinal studies. Studying processes and the evolution of networks is an important, but often neglected perspective due to the time constraints of data collection. Focusing on small networks might enhance retrospective interviews on events. However, recall bias of participants is an issue not to be ignored. Using network maps within multiple, iterative network maps will help research participants to remember information regarding processes. Furthermore, implementing multiple name-generators can enhance the risk of incomplete data collection (Elfring & Hulsink, 2007).

Turning to affiliate membership data (e.g., event-based), or documents like emails, resolves the problem of relying on collecting network data by interviews and egocentric network evaluation. This saves a lot of time and bypasses further issues. Nevertheless, this kind of data is not suitable for all research questions and may miss the depth of interactive, dynamic interviews.

Bernardi et al. (2014), whose parallel study design was introduced previously, point to four explicit challenges of mixed methods research they encountered in their study: Research philosophies, sampling, data management, and under-exploitation of data.

Highly integrated mixed methods studies ask for skills of both qualitative and quantitative research. Thus, and for enhancing triangulation through researchers, teams with several members often conduct mixed methods studies. Following Bernardi et al. (2014) the different paradigm backgrounds of the team members (either positivist or interpretivist views) can lead to different interests for which enough time for negotiations should be accounted.

For the sampling, the team agreed upon a feasible compromise combining a qualitative sampling strategy with a quantitative strategy by setting a limited amount of respondents with certain representative characteristics.

The different data types require refined data management because textual and numerical data are stored in different formats and programs. This can lead to the same information being stored in both data sets, but in different software and formats. The editing of the data while keeping track of them becomes especially difficult.

Finally, the huge amount of data, notably the quantity of text derived from what may be a relatively high number of interviews, risks an under-exploration of data. Due to time constraints etc., data analysis needs to focus and may miss further, interesting results.

To decide for or against conducting mixed methods research and facing the challenges, Wald (2014) suggests the following: The researcher should evaluate the availability of the resources, such as the time, costs, skills, and willingness of researchers. The optimal proportion and integration of qualitative and quantitative instruments depends on the individual case, guided by the research questions and goals. Similar to Bernardi et al. (2014) on paradigms, Wald (2014, p. 73) suggests

that all team members take care to specify and "reveal their (implicit) interpretation schemes and their pre-structuring of the research object and problem".

The integration of qualitative and quantitative approaches usually requires much work and time. But, mixed methods can overcome the weaknesses of a single approach. Nevertheless, reducing the weaknesses of single approaches comes with the new price of the challenges discussed earlier.

6 Conclusion

Understanding entrepreneurship embedded within its environment and exploring opportunities of entrepreneurship are the most dynamic areas for research in the field currently. Network research contributes to this development in various ways, e.g., by shedding light on the access to information. The research on networks has mostly been driven by mathematical, quantitative structural analysis, coming from an outside and macro view on networks. With qualitative approaches to studying networks, researchers rather address an inside and micro view on networks with a focus on the interactions of individuals. But both levels of networks, micro and macro, resp. inside and outside, or agency and structure, are interrelated. Acknowledging this interdependence accounts for the complexity of entrepreneurial action. Relational sociology and the concept of structuration guide us in combining both levels. They help us to address the research of networks methodologically: Pragmatism and a dialectical stance call for the integration of qualitative methods and quantitative methods.

Mixed methods of integrated qualitative and quantitative approaches address the interplay between agency and structure at its best. In this way, mixed methods enable us to grasp the complexity of entrepreneurial action better than single approaches. They integrate the overall picture of a network's structure with a detailed in-depth view on what is going on in a network. This provides both an inside- and outside-view of networks, yet acknowledging that the outside and inside view are basically versions of the same (Edwards, 2010).

Various instruments and ways to conduct mixed methods enable tailored research designs such as a sequential, embedded, parallel, fully integrated, or conversion design. Qualitative approaches have been neglected and can provide a valuable contribution to future research, especially in studying processes in networks or the sources of opportunities. Researchers can contribute to a greater understanding of entrepreneurial phenomena and current research gaps if they integrate qualitative approaches in mixed methods to a greater extent. Network maps or QCA as well as conversion designs sound promising to open space for a further development of methods.

However, conducting mixed methods is still demanding and not an all-purpose tool (Wald, 2014). Studies should be planned deliberately and thoroughly within a conceptual framework determining the range and functions of methods (Häussling, 2014), but stay open for unplanned learning or even discrepant results. The latter

tends to happen with mixed methods design rather than with a mono method design. Nevertheless, if we want to grasp the complexity of the social world, embracing contradictions can help us to discover new perspectives and understanding of a phenomenon. For example, a contradictory finding may dissolve into the acknowledging of both "x" as well as "y" and yield new conceptual models or theory.

Acknowledging this "both/and" perspective, accepting converging and diverging findings (Johnson, 2015) entails the greatest opportunities as well as challenges in mixed methods. What is holding us back in making full use of these opportunities is not the incommensurability of methods or methodologies, but the constraints of researchers—be it a lack of time, skills, or open-mindedness. Researchers will become more aware of the possibilities and limitations of different methods and methodologies through supporting the teaching and spread of mixed methods skills. Thus, mono method studies can benefit from mixed methods training, too.

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Complexity, Cultural Evolution, and the Discovery and Creation of (Social) Entrepreneurial Opportunities: Exploring a Memetic Approach

Michael P. Schlaile and Marcus Ehrenberger

Abstract The central contribution of this chapter consists in exploring the implications of a memetic perspective for dealing with complexity in (social) entrepreneurship. The line of argument can basically be divided into four aspects. First, it is argued that memes, especially their mental representations, can be conceptualized in the context of (cultural) schemata that have an impact on the perception and discovery of entrepreneurial opportunities. Second, a memetic view of creativity also suggests that opportunity creation strongly depends on memes. Third, viewing social entrepreneurship as a meme(plex) allows us to compare it with related concepts. Moreover, we argue that by focusing on the properties of social entrepreneurial opportunities we can get to the core of the social entrepreneurial process. In this chapter, we are focusing on social entrepreneurial opportunities that can be understood as the intersection of the set of 'opportunities to solve a societal problem' and the set of 'profitable business opportunities'. This conception represents the vantage point for the fourth part of this contribution, where we argue that, in order to facilitate the propagation of the social entrepreneurship meme within (for-profit) organizations, a systematic analysis of the firm's social network as well as its memeplex is advisable.

Keywords Memes • Schemata • (Social) Entrepreneurial opportunities • Social entrepreneurship • Social innovation

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_4

1 Introduction

This conceptual contribution aims to fathom the theoretical and application-oriented potential of a memetic perspective for (social) entrepreneurship. The overall goal of the chapter can therefore be seen in the development of a fruitful conceptual synthesis that ultimately yields a research framework, which in turn facilitates developing reasonable research questions, testable hypotheses, or viable starting points for further work. As Richard Barrett has recently stated,

> "every year, almost without exception, every sector of business becomes more complex. Along with this increase in complexity, we are also experiencing an increase in uncertainty" (Barrett, 2014, p. xvii).

One of the factors that contribute to this rising complexity and uncertainty in an increasingly globalized (business) world can be found in cultural evolution, as culture and business are closely intertwined and may often be seen as actually inseparable or coevolving fields. Despite this connection, the business literature commonly (with a few welcome exceptions) does not seem to realize the benefits of integrating insights from literature on cultural evolution. The elements that drive cultural evolution have often been called memes (for an overview see Heylighen & Chielens, 2009; von Bülow, 2013).[1] For some authors, memes are adaptive cultural entities that can be seen as elements of meme complexes or memeplexes (e.g., Blackmore, 1999a, 1999b; Speel, 1999), whereby culture itself may be construed as a complex (adaptive) system of memes (see also Schlaile, 2013, on a related note). It is thus plausible to assume that a focus on memes may help to shed light on some of the issues concerning complexity and uncertainty in a business context. One vivid example of a complex phenomenon in the business world can be seen in entrepreneurship in general[2] and in social entrepreneurship in particular. In this context, we can observe that the environment of and conditions for entrepreneurship and innovation have fundamentally changed over the last decades (e.g., Johannessen & Olsen, 2010). Acceleration of technological change, actors' increasing interconnectedness and interdependence—e.g., through globalization or open innovation (Chesbrough, 2003)—and division of labor, to name but a few, also led to a growing degree of complexity innovators have to deal with (see also Fichter, 2012).

Moreover, in the course of our chapter, we aim to illustrate that *social entrepreneurship* (SES) can be conceived as a meme(plex). By focusing on the properties of social entrepreneurial opportunities (SEOs), we will be able to reduce terminological uncertainty and move beyond SES as an umbrella term for various,

[1] At this juncture, it should be sufficient to point to the definition of a meme in the *Oxford Dictionaries*: "An element of a culture or system of behaviour passed from one individual to another by imitation or other non-genetic means." http://www.oxforddictionaries.com/definition/english/meme. For a readily accessible introduction to memetics also cf. http://www.practicalmemetics.com/index.php/memetics-101.html.

[2] Hence, for example, McKelvey (2004) explicitly proposes a complexity science approach to study entrepreneurship.

often contradictory, notions. Thereby, our contribution argues that SES can be more than just a prolific buzzword. Hence, in this chapter, we primarily focus on a special type of SES that draws upon the social innovation school of thought (e.g., Dees & Anderson, 2006; Defourny & Nyssens, 2014) as well as the social business (e.g., Yunus, 2007) approach. Despite the fact that social innovation is often contrasted with business innovation (e.g., Pol & Ville, 2009), the two spheres frequently "overlap and intertwine" (Fuglsang, 2008, p. 7). Consequently, in the context of (social) entrepreneurship, a strictly isolated treatment of social innovation would not be feasible in any case.

The theses or lines of argument we will put forth are, thus, arranged as follows. At the outset, we will argue that memes—especially their mental representations—can be conceptualized in the context of (cultural) schemata that have an impact on the perception and discovery of entrepreneurial opportunities. Based on a short review of the memetic aspects of creativity, we will also establish a link to opportunity creation. We will then present a memetic view on SES that is also supported with case examples. Furthermore, we suggest that a memetic perspective on SES is useful to shed light on the definitional debate of SES and to reveal connections to related concepts. In this chapter, we are focusing on a notion of SEO that represents a way to solve societal problems by means of a profitable business model. Within such opportunities, the 'social case' and the 'business case' are integrated and facilitate the simultaneous generation of social and economic value. Under the assumption that SES in the sense presented here does indeed represent a highly attractive field of operation for traditional for-profit organizations, we will additionally present managerial implications that may help raise awareness of SEOs in order to contribute towards the solution of a societal problem on the one hand, and on the other hand improve the competitiveness of the organization itself. Our concluding remarks will then be presented and supplemented with a summarizing illustration.

2 Memes and (Cultural) Schemata

Since their first introduction by Richard Dawkins (1976), memes have drawn a lot of attention and found their way into publications from a variety of fields (e.g., Aunger, 2000, 2002; Blackmore, 1999a, 1999b, 2001; Blute, 2010; Breitenstein, 2002; Brodie, 1996; Costa, 2010; Dennett, 1991, 1995, 2001, 2002; Distin, 2005; Gers, 2008; Leigh, 2010; Lynch, 1996; Patzelt, 2015a, 2015b; Pyper, 1998; Shennan, 2002; Shifman, 2013, 2014; Spitzberg, 2014; to name but a few). The idea that there is a second *replicator*—aside from genes—that drives cultural evolution,[3] by means of a process which may be called imitation (e.g., Blackmore,

[3] See also Wilkins and Hull (2014) on the notion of replication and replicators or Hodgson and Knudsen (2010) on "generative replication and the evolution of complexity".

1999a, 1999b, 2001; Dawkins, 1976, 1999), has important implications for example with respect to human agency and the identification of (ultimate) beneficiaries. The so-called *meme's-eye view* on human and cultural evolution has been explicated—on the basis of Dawkins (1976)—by Blackmore (1999a, 2000, 2010), Dennett (1995, chapter 12), Shennan (2012, pp. 235ff.) and many others. According to this perspective, when looking at a specific cultural trait, habit, or tradition, the question of purpose or utility *for humans* is subordinate to the question of what helps *the meme* survive and propagate successfully in that context (see also Dennett, 2011). At this point, it is important to note that the idea of culture as some kind of independent entity has neither been introduced by memeticists nor is it a new concept. The German ethnologist Leo Frobenius has already written, for example, that his basic tenet was to

> "understand culture as an organism independent from its human carriers [and] every cultural form as a living entity on its own … First of all: cultures are not brought forth by human will, culture rather lives 'on' humans" (Frobenius, 1921, p. 3 f., own translation).

Similar phrasing can also be found in Oswald Spengler's works: "*Cultures are organisms*, and world-history is their collective biography" (Spengler, 1926, p. 104; italics in original). It is evident that although this relationship between humans and culture may often be a symbiotic one, we can also find many cases of 'parasitic' memes (see also Csikszentmihalyi, 1994, p. 162), which may give rise to the notion of "viruses of the mind" (Brodie, 1996; Dawkins, 1993), or a cultural "programming of the mind" (e.g., Hofstede, 2001, p. 1; or Hofstede, Hofstede, & Minkov, 2010, p. 6). Moreover, there can be aspects of culture that are neither beneficial nor detrimental to their human carriers, which has, for example, been framed by Freeman Dyson (2004) in the following way:

> "Junk DNA is DNA that does us no good and no harm, merely taking a free ride in our cells and taking advantage of our efficient replicative apparatus. … It is easy to find in human culture the analogue of junk DNA. Junk culture is replicated together with memes, just as junk DNA is replicated together with genes" (Dyson, 2004, p. 90).

However, we should be careful not to take the meme-gene-analogies too seriously and it can, therefore, be summarized in the words of Lee Cronk:

> "Memes are in some ways similar to genes, but they are also sometimes similar to viruses. Like viruses and other pathogens, memes are passed from person to person and may not necessarily be helpful to the people who catch them" (Cronk, 1999, p. xii).

It is important to note that there have already been several attempts to utilize memetics in other disciplines, for example, in order to explain the (cultural) evolution of firms (Weeks & Galunic, 2003), the evolution of patented technology (Bedau, 2013) and trademarks (Johnson, 2013), with respect to marketing (e.g., Marsden, 1998, 2002; or Williams, 2000, 2002, 2004), and in organizational contexts (e.g., Kappelhoff, 2012; Price, 1995, 2009, 2012; or Shepherd & McKelvey, 2009). Others have applied memes to innovation strategy (e.g., Pech, 2003; or Voelpel, Leibold, & Streb, 2005) or mergers and acquisitions (Vos &

Kelleher, 2001). Nevertheless, what Richard Pech stated more than a decade ago is still valid, namely that

> "... the business literature has only scratched the surface of memetic theory's potential ..." (Pech, 2003, p. 113).

One of the reasons for the reluctance to make use of memetics in a business context may be the ambiguity with respect to the 'locus' of the meme. In other words, while some authors focus on cognitive aspects, others concentrate on (imitable) behavior or other elements of culture and this may create the impression that, according to Jameson Gill,

> "on each occasion memes are couched in terms which suit the message of the thesis rather than a consensus of what might constitute a putatively real entity" (Gill, 2012, p. 326).

From the beginning, not just for terminological reasons, memetics has struggled to survive as an academic field of research. Discussions and critical arguments pro and contra memes can, for example, be found in Aunger (2000), Mesoudi, Whiten, and Laland (2006), including commentaries, chapter 8.3 in Godfrey-Smith (2009), the debate between Blackmore (2010) and Wimsatt (2010), the German monograph by Müller (2010), or more recently in Gill (2012), Lord (2012), von Bülow (2013), and references therein. It is neither the goal nor within the scope of this chapter to repeat or even resolve those ongoing issues, but we acknowledge that we have to clarify the positioning of our approach carefully.

The age-old debate between dualism and monism is also (to some extent) reflected in the memetic literature. Some authors would like to engage in a strictly materialistic view of memes and argue for an 'intracranial' location of memes as some kind of neural substrate (e.g., Aunger, 2002; Cloak, 2015; Delius, 1991; Wickler, 2006; see also the suggestion by Tyler, 2011, for a related terminological differentiation between *intracranial* and *intercranial* memetics). Others argue for a differentiation similar to the genotype-phenotype juxtaposition in genetics which may then be reflected in the distinction between "i-culture" and "m-culture" (Cloak, 1975), "i-memes" and "e-memes" (McNamara, 2011), or "copying-the-instructions" and "copying-the-product" (Blackmore, 1999a), and, even more general, between replicators and vehicles or interactors (e.g., Hull, 1982, 1988a, 1988b; see also Speel, 1998, on a related note).[4] It would be presumptuous to argue that we can find a solution to this philosophical problem here; therefore we will just build upon an existing categorization that seems useful and logically consistent within the context of our approach. First of all, we are in opposition of a strictly 'neurological'

[4] However, Sue Blackmore's distinction can be regarded as a differentiation on yet another level than the others cited above. "In fact, it is an attempt to diffuse aspects of these arguments completely. In ... [Blackmore's] view, there are two completely different kinds of system. Those that copy-the-instruction (most of biology) do have a replicator/interactor (or vehicle) distinction but those that copy the product do not. Hence ... [, the] soup example in *The Meme Machine* [(Blackmore, 1999a)]—if you watch the cook and try to emulate her [, then] the process is low fidelity and no such distinction can be made. If you use a written recipe [, then] it can" (S. Blackmore, personal communication, July 14, 2015).

view of memes and follow Daniel Dennett, who, in the course of his TED talk on *Dangerous memes,* explained:

> "What's a meme made of? What are bits made of . . .? Not silicon. They're made of information, and can be carried in any physical medium" (Dennett, 2007; see also Dennett, 2003, p. 176, in this regard).

In our opinion, this substrate neutrality does in turn not imply that (tacit) cultural ideas and (material) artifacts are to be treated as the exact same thing, although material culture may still be regarded as the "reification of human ideas in a solid medium" (D'Andrade, 1986, p. 22, as cited in Cole & Packer, 2011, p. 135). Hence, although the dichotomy mentioned above might rather be seen as two poles of a continuum (see also Fuchs, 2001, in this regard), we will even go one step further and make a case for a trichotomy, or three-dimensional view on memes (see Fig. 1). Note that a similar division has already been proposed by Franz Wegener (2009), who likewise distinguished between three types of memes. To a certain extent,

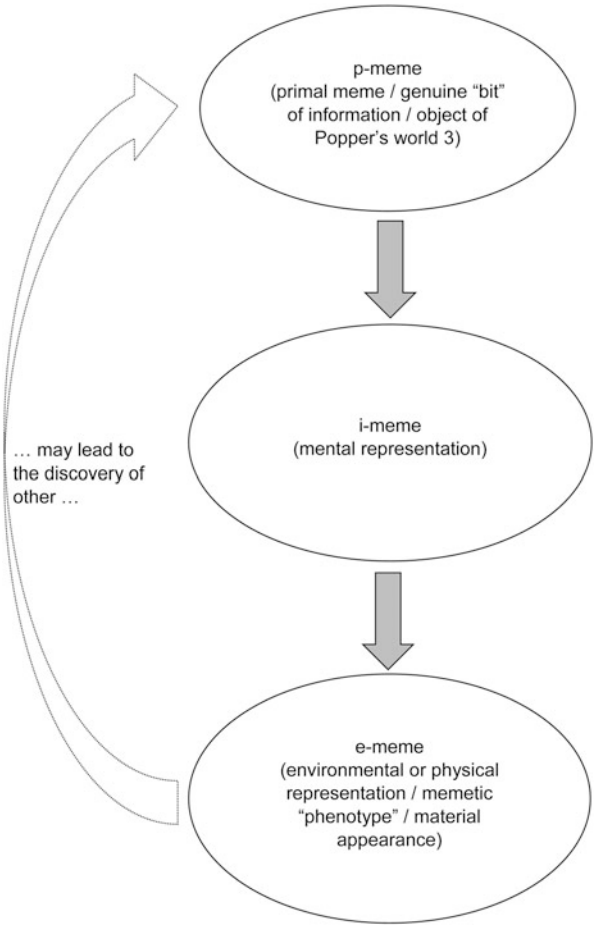

Fig. 1 P-I-E dimensions of memes

these aspects can also be found in Edgar Schein's three levels of organizational culture (e.g., Schein, 2004), and another distinctive overlap evidently exists with respect to Karl Popper's three worlds (e.g., Popper, 1972).

Here, we can see that the first category is *p-memes* or primal memes. Those are basically the objects of Popper's world 3, i.e., genuine information. The second type is *i-memes*. These are *mental representations* of a meme. We will elaborate on this dimension further below as it will be of particular importance in the remaining part of the chapter. However, for the sake of completeness, the third dimension has to be explained as well. The dimension of *e-memes* is rather straightforward as it depicts the environmental or physical representation, i.e., the material appearance, of a meme in terms of an observable (imitable) product, process, behavior, codified knowledge, and the like (also cf. the concept of an e-meme in McNamara, 2011, or the related notion of *gMeme* in Wegener, 2009). With the help of e-memes (e.g., memes represented in tools or books), there may then also arise the possibility of discovering other, previously unknown ('new') p-memes.

As stated above, we will hereafter primarily concentrate on i-memes, i.e., mental representations of a meme. This should, however, not imply that p-memes and e-memes are considered to be less important dimensions. First of all, mental representations can in general be described as (individual) mental concepts that may, for example, comprise beliefs, attitudes, impressions, stereotypes, and the like (e.g., Smith & Queller, 2003; or Flechsig, 2006, chapter 4). While several types of mental representations can be found in the literature, Elliot Smith and Sarah Queller (2003) have concentrated on reviewing four of them, namely *associative networks*, *exemplars*, *distributed representations*, and *schemata*. With respect to the topic of this chapter, we are convinced that the most fruitful insights can be gained from focusing on the latter. This will immediately be apparent as soon as we take a look at the respective definition and see the striking overlaps with central memetic aspects: According to Smith and Queller (2003, p. 114), a *schema* can be defined as a "structured unit of knowledge about some object or concept." Furthermore, schemata are considered to be "independent entities ... [and they] affect the interpretation of perceptual stimuli" (Smith & Queller, 2003, p. 114). According to Karl-Heinz Flechsig,

> "schemata serve not only the selection, filtering, and interpretation of incoming information but also the retention and organization of knowledge in the human brain" (Flechsig, 2006, p. 24, own translation).

In this respect, a central aspect has been enunciated by Paul DiMaggio as follows: "*People are more likely to perceive information that is germane to existing schemata*" (DiMaggio, 1997, p. 269; italics in original). Moreover, Flechsig states that "schemata evolve, adapt, change, and communicate with each other" (Flechsig, 2006, p. 24, own translation). In the context of complexity, Nobel laureate Murray Gell-Mann even mentions *selection pressures* on the competition among schemata (Gell-Mann, 1997) and states:

> "In the case of societal evolution, the schemata consist of laws, customs, myths, traditions, and so forth. The pieces of such a schema are often called 'memes'" (Gell-Mann, 1997, p. 5).

It can now be summarized with reference to Flechsig (1998, 2006) as well as Quinn and Holland (1987) that, firstly, schemata help transform information into knowledge (or p-memes into i-memes) and facilitate the systematic search for 'suitable' information (as models *of* the world) and, secondly, they can serve as behavioral instructions and/or heuristics (in terms of models *for* the world). At this point, it is important to note that not every i-meme may be (part of) a schema and, vice versa, not every schema is the mental representation of a meme. This may especially be the case when the personal schemata in question have been acquired through *individual learning* (e.g., operant conditioning or trial and error). However, we can clearly assert that the construction and confirmation of *cultural schemata*, i.e., schemata that are shared by a certain group of people and, thus, have been acquired through *social learning*, will be heavily influenced by the memes that are already present within that group's culture. In Flechsig's terms:

> "the acquisition of new and previously unfamiliar schemata always occurs on the basis of already existing schemata that have been formed in the course of one's own enculturation" (Flechsig, 2006, p. 35, own translation).

These cultural schemata can then serve as culture-dependent models *of* the world as well as culture-dependent models *for* the world as a result of shared i-memes. The processes involved in propagating these schema-relevant i-memes may then in turn be linked to Dan Sperber's "*epidemiology of representations*" (Sperber, 1996, pp. 25 ff.).[5]

Bearing the overall topic of our chapter in mind, we can now use these insights to conclude that—by means of (cultural) schemata—the perception and discovery of *entrepreneurial opportunities* (EOs) will be highly dependent on memes. This theoretical implication builds upon the *discovery perspective* on EO (e.g., Alvarez, 2005; Alvarez & Barney, 2007; Alvarez, Barney, & Anderson, 2013; Sarasvathy, Dew, Velamuri, & Venkataraman, 2010). With reference to *Austrian economics* (e.g., Hayek, 1945; Menger, 1871; von Mises, 1998; and especially Kirzner, 1973, 1979, 2009), the *traits approach* (for an overview see Brockhaus, 1982; Brockhaus & Horwitz, 2002), and *critical realism* (see also Alvarez & Barney, 2010), the discovery perspective builds on a comprehensive theoretical, epistemological, and empirical background. Without going into detail, we want to sketch three assumptions underlying the discovery approach which are relevant for our contribution (see also Alvarez, 2005; Alvarez & Barney, 2007):

(i) Ontologically, an EO is conceptualized as an objectively existing phenomenon, i.e., it exists independently from individual and collective actors (Kirzner, 1973; Shane & Venkataraman, 2000).

[5] In this way, we can also argue that cultural schemata may be listed among the factors contributing to homophily in social networks.

(ii) An EO is based on "competitive imperfection resulting from misalignment in prices in two or more markets" (Alvarez et al., 2013, p. 304). The causes of this misalignment in prices are exogenous shocks (e.g., via technological change) in existing markets or industries that lead to a heterogeneous distribution of information (Shane, 2003). The entrepreneurial task is to discover an asset that can be bought in one market for a lower price and sold in another market for a higher price. For this kind of economic action, which is termed arbitrage (Kirzner, 2009), the entrepreneur needs special knowledge and competence which leads us to the next point.

(iii) There are ex ante differences between entrepreneurs and non-entrepreneurs concerning cognitive, psychological, and other individual factors, which constitute the ability to discover and exploit EOs. Kirzner condensed these factors that are responsible for the ability to be aware of EOs in the concept of "entrepreneurial alertness" (Kirzner, 1973, p. 67). Entrepreneurial alertness allows an entrepreneur to discover and exploit an EO before other economic actors can do so.

With reference to our memetic perspective, we can infer that if an objective EO may or may not be discovered depends on whether or not the information concerning this opportunity is compatible with the (potential) entrepreneur's i-memes. Another way to phrase this—especially with an eye to complexity science—would be to take up Sperber's notion of "cultural attractors" (Sperber, 1996, pp. 106 ff.). When we think of all EOs in a space of possibilities, probabilities of discovery will tend to cluster around the positions of the attractors (e.g., cultural schemata) in this space which may also lead to culturally biased opportunity exploitation (see also Acerbi & Mesoudi, 2015, p. 487 on the idea of a "cultural attractor" and non-random (biased) transformation during cultural transmission).

3 Memes and Creativity

The role of creativity in entrepreneurship has often been considered to be a central one, especially when it comes to the link between creativity and opportunity (e.g., Alvarez & Barney, 2007; Endres & Woods, 2007; Fillis & Rentschler, 2010; Hansen, Lumpkin, & Hills, 2011; Hills, Shrader, & Lumpkin, 1999; Lumpkin, Hills, & Shrader, 2004; Sarasvathy et al., 2010; Wood & McKinley, 2010).

At this point, it is important to note that, aside from the aforementioned *discovery* perspective, there exists another point of view that focuses on the *creation* of EO (for an overview see Alvarez, 2005; Alvarez & Barney, 2007, 2010; Alvarez et al., 2013).[6]

[6] Note that Sarasvathy et al. (2010) view opportunity recognition as a third perspective. However, in our chapter, we tend to follow Alvarez et al. (2013, endnote 1) by regarding opportunity recognition as a special case of discovery.

This creation approach is based on *social constructivism* (e.g., Berger & Luckmann, 1967), *enactment* theory (Weick, 1979), *evolutionary theories* of entrepreneurship (e.g., Aldrich & Ruef, 2006; Nelson & Winter, 1982), and *evolutionary realism* (Campbell, 1960, 1974; see also Dopfer & Potts, 2004).

As we did in the previous section, we will briefly condense some of the assumptions relevant to our topic:

(i) At the beginning of the creation process, ontologically the EO is a socially constructed phenomenon, which does not exist independently from human perception and action (Aldrich & Kenworthy, 1999). The entrepreneurs try to test their assumptions concerning their subjective opportunity ideas on the market, potential customers, and other stakeholders throughout an iterative trial and error process and draw conclusions from it (Wood & McKinley, 2010). In this sense, the exploited EO does not exist until it is created in an active creation process by an (economic) actor.

(ii) In contrast to the discovery perspective, the source of an EO is not an exogenous shock to existing markets and industries but rather endogenous activities of an economic actor, namely the entrepreneur or an entrepreneurial firm. The central elements of these activities are creativity and variation (e.g., Sarasvathy, 2001; Sarasvathy et al., 2010).

(iii) From a creation theory perspective of EO, ex ante differences between entrepreneurs and non-entrepreneurs are unnecessary to explain why some people form and exploit EOs while others do not. Quite contrary, it could be argued that differences between entrepreneurs and non-entrepreneurs are not the source for forming and exploiting an EO but rather the result (Hayward, Shepherd, & Griffin, 2006).

Despite the fact that several contributions (e.g., Endres & Woods, 2007; Hansen et al., 2011; Hills et al., 1999; Lumpkin et al., 2004; Lumpkin & Lichtenstein, 2005) explicitly draw upon the works of Mihaly Csikszentmihalyi (1996) on creativity, none of them seems to take into consideration what that author has written on memes (e.g., Csikszentmihalyi, 1994) or the memetic aspects of creativity. For example, with respect to the role of culture and domains in the creative process, Csikszentmihalyi (1988) has stated that

> "we might conclude that creativity is one of the aspects of evolution . . . [and] we could say that a domain is a system of related memes that change through time, and what changes them is the process of creativity" (Csikszentmihalyi, 1988, p. 333 with reference to Csikszentmihalyi & Massimini, 1985).

In Csikszentmihalyi (1996) we can also find several references to memes (e.g., already on page 7), and even more detailed elaborations (e.g., on the role of memes in storing and accessing information) can be found in Csikszentmihalyi (1999). There, it is also stated that "how available memes are also bears on the rate of creativity" (Csikszentmihalyi, 1999, p. 317). While many of these statements are also supported by Darwinian accounts of creativity (e.g., Simonton, 1999), other scholars have questioned the explanatory value of Darwinism and memetics for the

study of creativity (e.g., Kronfeldner, 2011, esp. chapter 3). However, for the purpose of our chapter, we tend to follow Susan Blackmore (2007), who claimed that "the true creative power behind human imagination is memetic evolution" (Blackmore, 2007, p. 76) and that basically "human creativity emerges from the human capacity to store, vary, and select memes" (Blackmore, 2010, p. 269, with reference to Blackmore, 2007). We can now clearly discern the implications of this view on creativity with respect to EOs: In addition to the inferences we have already drawn at the end of the previous section (with respect to schemata and opportunity discovery), it can be argued that opportunities (esp. creation but also discovery/recognition) may be influenced by memes in an additional way, namely via *creativity*.

4 The Meme(plex) of Social Entrepreneurship

A memeplex, also called (coadapted) meme complex, can be defined as a group or network of (usually) reciprocally supportive memes that can replicate more successfully when they are aggregated than on their own (see also Speel, 1999). Examples of memeplexes include chain letters, languages, religions, scientific theories, political ideologies, etc. (e.g., Blackmore, 1999b). The goal of this section is to apply memetic reasoning at a rather metatheoretical level in order to delineate a social entrepreneurship (SES) memeplex by comparison with conceptually related ones.

For several decades SES and related topics like *social innovation* and *social enterprise* have been gaining in importance in the political, societal and academic discussion (e.g., Dacin, Dacin, & Tracey, 2011; Lundström, Zhou, von Friedrichs, & Sundin, 2014; Smith, Gonin, & Besharov, 2013; Volkmann, Tokarski, & Ernst, 2012). Even though in the meantime different schools of thought (or memeplexes) have emerged, the definitional issues around the topic have not been solved, yet (e.g., Certo & Miller, 2008; Choi & Majumdar, 2014; Dacin et al., 2011; Mair & Marti, 2006; Martin & Osberg, 2007; Nicholls, 2010; Petrella & Richez-Battesti, 2014; Short, Moss, & Lumpkin, 2009). As Roger Martin and Sally Osberg have stated, SES is "an immense tent into which all manners of socially beneficial activities fit" (Martin & Osberg, 2007, p. 30). There are fundamental differences between the schools of thought concerning the form (e.g., legal structure, financing structure, policies and procedures for the allocation of profits) and the process (e.g., the relevance of innovation, of management, and of earned income strategies) of SES which lead to the fact that the entire field lacks clear boundaries (Hoogendoorn, Pennings, & Thurik, 2010; Mair & Marti, 2006; Newbert & Hill, 2014).

Against this background, the following section suggests focusing on the properties of *social entrepreneurial opportunities* (SEOs) as they can be seen as key elements for differentiating the various schools of thoughts.

With the focus centered on the process of SES, the relevance of social innovation and its disruptive impact, the theoretical conception of SES depicted in this chapter is mainly based on the social innovation school of thought (Dees & Anderson, 2006; Defourny & Nyssens, 2014; Hoogendoorn et al., 2010). Concerning the organizational and financing structure as well as the relevance of viable business models, it also shows reference points to the *social business* approach (Yunus, 2007, 2011).

We define SES in general as an entrepreneurial process that contains the discovery and/or creation and exploitation of specific EOs. Henceforth, we will refer to these specific opportunities as SEOs and argue that the properties of these SEOs differ in the various schools of thought in the SES definitional debate (for an overview see Hoogendoorn et al., 2010; Dees & Anderson, 2006; Defourny & Nyssens, 2014). In general, an SEO is contextually oriented toward a societal problem. Following this understanding, a specific criterion of SES and a distinction from classical (commercial) entrepreneurship is the context targeted by the entrepreneurial process: the focus lies on pressing societal problems that are neglected by existing institutions (market failure, public sector failure, third sector failure) and have positive external effects (Santos, 2012). With regard to the identification of a societal problem, we are following a pragmatic approach (see Beckmann, Zeyen, & Krzeminska, 2014), i.e., we assume that the problem is determined by means of a social discourse. The UN-Millenium Goals[7] are exemplary for this kind of societal problems. It is important to note, however, that not all kinds of societal problems may be solved via SES, as understood in our contribution. In many cases (e.g., environmental catastrophes) other methods like philanthropic donations or publicly subsidized programs are more adequate solutions (Yunus, 2011). Another major difference between classical (commercial) EOs and SEOs are the special normative demands concerning their exploitation. In the context of SEOs, social legitimacy will be assessed by other societal actors (e.g., social impact investors) depending on normative compatibility with (moral) values (which in turn depend on cultural evolution).

A major difference exists between the schools of thought with regard to the relevance of innovation. With reference to the social innovation approach (Dees & Anderson, 2006; Defourny & Nyssens, 2014; Hoogendoorn et al., 2010), SES is based on a business model that contains an innovative aspect, or more explicitly a social innovation (for an overview see Rüede & Lurtz, 2012; or Osburg & Schmidpeter, 2013). A social innovation is defined as

> "a novel solution to a social problem that is more effective, efficient, sustainable, or just than existing solutions and for which the value created accrues primarily to society as a whole rather than private individuals" (Phills, Deiglmeier, & Miller, 2008, p. 36).

[7] Cf. http://www.un.org/millenniumgoals/.

In the sense of *creative destruction* (Schumpeter, 1994), a social innovation leads to disruptive change of existing institutions and resource allocation. At this point, it is also important to note that, according to a study by KEA (2009) for the European Commission, "culture-based creativity plays a key role in generating social innovation" (KEA, 2009, p. 6). With an eye toward the previous section, we can clearly see that, thereby, social innovation will also be influenced by memes—via culture-based creativity—as they are the constituent entities of culture and have also been found to have an important relationship with creativity in general. Put differently, when looking at the definition of a social innovation cited above (Phills et al., 2008), it is also plausible to assume that what is considered a social problem as well as how the problem will be solved (e.g., what is conceived as *justice*) varies depending on culture and creativity and, thus, on memes.

Another major difference exists between the schools of thought with regard to the potential profitability of the societal problem (Dees & Anderson, 2006; Defourny & Nyssens, 2014; Hoogendoorn et al., 2010). With reference to the social business approach (Yunus, 2007, 2011), we are focusing on economic organizations (for-profit organizations) as agents of the social entrepreneurial process. In accordance with Niklas Luhmann's systems theory (Luhmann, 1995, 2012, 2013), economic organizations follow the *guiding difference* "revenue/expense" which in the long run needs to be positive in order to ensure a going concern. Accordingly, one financial objective of a social entrepreneurial organization is to at least cover its cost. As we have already mentioned above, this objective finds its correspondence in the properties of the SEO. Consequently, these properties are reflected in the construction of the business model (Yunus, Moingeon, & Lehmann-Ortega, 2010). Philanthropic donations or public subsidies are not favored because the organization aims to protect its financial and operative independence to ensure its longevity (Yunus, 2007, 2011). In this sense, SES focuses on societal problems that represent—to a certain extent—a business opportunity. Profitability is mandatory for a financially sustainable business model, but profit is not an end in itself. Instead, it is seen as a means to an end. Consequently, SES is not about profit maximization and an SEO can be pictured as the *intersection* of two sets, namely a social case (opportunities to solve a societal problem) and a business case (profitable business opportunities) as depicted in Fig. 2. Here, we can also see that in this intersection there can be found EOs that contribute more to the solution of a societal problem but are only on the verge of profitability (X'), and others that will be more (economically) profitable but contribute less to the solution of a societal problem (X^*).

The Grameen Bank (financial service), Arogya Parivar (health care), and Hindustan Unilever Limited (nourishment and hygiene products) serve as vivid examples for this type of SES: The Grameen Bank runs an innovative business model that offers microcredit to the poorest of the poor (see also Yunus, 2003). With an average repayment rate above commercial banks (Hudon & Sandberg, 2013, p. 573), this social innovation confounds the assumption of the traditional banking industry, namely that only people with material collateral are regarded as creditworthy. As of 2012 more than 200 million poor people worldwide, mostly poor

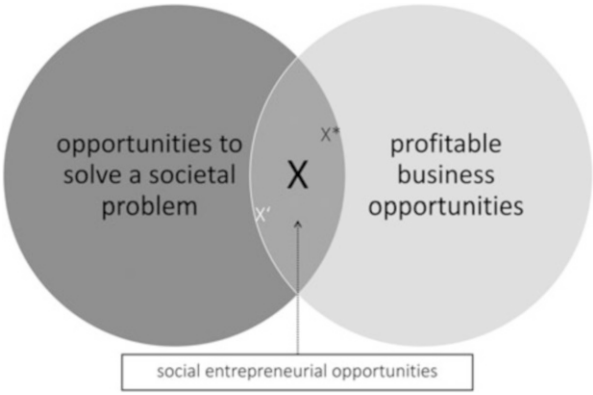

Fig. 2 Social entrepreneurial opportunities as intersection between social case and business case

women, had received a microloan from microcredit institutions (Reed, 2014; see also Hudon & Ashta, 2013) that offered them a foundation for their own entrepreneurial activities and provided a proactive way out of poverty. By assuming that on average each borrower is part of a five-person household, one could estimate its effect on global poverty reduction. This social innovation has spread widely: After an annual global growth rate of approximately 30 %, the microfinance sector encompassed more than 10,000 institutions in 2011 (Hudon & Ashta, 2013, p. 277). According to one of the largest data sets available, the average interest rates charged by microfinance institutions range from about 32 to 35 % per annum (Hudon & Ashta, 2013, p. 279). These relatively high interest rates are deemed necessary in order to cover the high transaction costs of the business model. Following the principles of social business, the profit is used to pay back the investment amount and to reinvest into the organization (Yunus, 2007, 2011). With Arogya Parivar and the Hindustan Unilever Limited two multinational corporations (Novartis and Unilever) demonstrate that poor people who live on less than 11 U.S. dollars per day can be reached by innovative products and business models and represent an attractive business field. Both companies have accessed profitable new markets (business case) by offering affordable products and services as well as jobs to people that were excluded before (social case). Novartis' Arogya Parivar offers medicine and medical services to the poorest of the poor in India. The initiative broke even after 31 months and covered 42 million poor people in 33,000 villages across 10 states in India (Fürst, 2014, p. 18). In addition to that, Arogya Parivar has developed education and qualification programs for medical employees and physicians that improved the local health care (Novartis, 2013). Arogya Parivar is expanding to other countries like Kenya, Indonesia and Vietnam and represents an enormous growth market for Novartis. Hindustan Unilever Limited reached more than 57 million Indians with nourishment and hygiene products in 2013 (Unilever, 2013). With the connected "Project Shakti", Unilever also developed a local distribution network which offers jobs to 110,000 poor people (as of 2013), mostly women (Unilever, 2013).

The business models of these examples illustrate how a social case and a business case can be integrated. From the perspective of value creation, this interrelation could be described as a simultaneous creation of social value and economic value (e.g., Porter & Kramer, 2011). On the one hand, society benefits, because a neglected societal problem is solved, positive external effects are generated, and the common good is enhanced (i.e., social case or social value). On the other hand, the business organization benefits as it generates profitable product, service, and business model innovations, gains access to new markets, and increases its competitiveness (i.e., business case or economic value) (e.g., Osburg, 2014, p. 113). Those two aspects (social case and business case or social value and economic value) are not to be understood as dichotomous opponents, i.e., there is no trade-off in their interrelation (Porter & Kramer, 2011). From the social entrepreneurial perspective we are building on, a societal problem is seen as a special opportunity for an economic organization. It is exactly this social entrepreneurial mindset—i.e., the awareness that specific societal problems are also (profitable) business opportunities—that represents the meme we are focusing on.

At this point, it is important to note that this meme cannot exclusively be found in SES. The meme has, for example, (more or less modified) equivalents within the *bottom of the pyramid* approach (Prahalad, 2004; Prahalad & Hammond, 2002), the *creating shared value* approach (Porter & Kramer, 2011), the *strategic CSR* approach (Jamali, 2007; Porter & Kramer, 2006), the *responsible (research and) innovation* approach (von Schomberg, 2013; see also Stilgoe, Owen, & Macnaghten, 2013), the *sustainable entrepreneurship* approach (Weidinger, Fischler, & Schmidpeter, 2014), to name but a few. One core aspect of all these concepts is the idea that there is an opportunity to solve societal problems by using a financially sustainable business model and thereby simultaneously creating social value and financial value (see Table 1). Thus, they can all be located within the intersection of business case and social case.

Developing and processing a viable business model that works in the respective intersection is a difficult (social) entrepreneurial and managerial challenge. Potential consequences for a company that leaves this set by changing its social entrepreneurial business model towards more of a business case orientation can be studied in the case of a Mexican microfinance institution. The Banco Compartamos was under massive public pressure because its stakeholders recognized a mission drift towards the business case. In 2007 the Banco Compartamos implemented a secondary offering that led to a tremendously profitable transaction for existing shareholders[8] (Ashta & Hudon, 2012). Due to the fact that the institution had charged relatively high interest rates from its customers (Hudon & Ashta, 2013), the stakeholders blamed the bank for rich investors profiting on the back of the poor (Ashta & Hudon, 2012; Hudon & Ashta, 2013). The whole case has then led to an enormous loss of trust in the concept of microcredit as a whole.

[8] "They received $470 million (12 times the book value and a multiple of 261 times their paid-in capital!). This puts them in the top 1.7 % of venture capital investments, earning returns of more than 100 times the paid-in capital" (Ashta & Hudon, 2012, p. 335).

Table 1 Examples of variants of the "social entrepreneurship meme"

Concept/Approach	Verbalization ('e-meme') of SES meme
Bottom of the pyramid	"By stimulating commerce and development at the bottom of the economic pyramid, MNCs could radically improve the lives of billions of people and help bring into being a more stable, less dangerous world. . . . In fact, many innovative companies—entrepreneurial outfits and large, established enterprises alike—are already serving the world's poor in ways that generate strong revenues, lead to greater operating efficiencies, and uncover new sources of innovation." (Prahalad & Hammond, 2002, p. 4)
Creating shared value	"The concept of shared value can be defined as policies and operating practices that enhance the competitiveness of a company while simultaneously advancing the economic and social condition in the communities in which it operates." (Porter & Kramer, 2011, p. 66) "Businesses create shared value when they can make a profit—create economic value—while simultaneously meeting important social needs or important social goals like improving environmental performance, reducing problems of health, improving nutrition, reducing disability, improving safety, and helping people save for retirement. The basic idea of shared value is that there are many opportunities in meeting these societal needs to actually create economic value in the process." (Porter & Driver, 2012, p. 423)
Strategic CSR	"Each company can identify the particular set of societal problems that it is best equipped to help resolve and from which it can gain the greatest competitive benefit." (Porter & Kramer, 2006, p. 92) "It is through strategic CSR that the company will make the most significant social impact and reap the greatest business benefits." (Porter & Kramer, 2006, p. 85) "Strategic CSR . . . is strategic philanthropy aimed at achieving strategic business goals while also promoting societal welfare. The company strives in this respect to identify activities and deeds that are believed to be good for business as well as for society." (Jamali, 2007, p. 7)
Responsible (Research and) innovation	"Responsible Research and Innovation is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)." (von Schomberg, 2013, p. 63)
Sustainable entrepreneurship	"Sustainable Entrepreneurship will not only be a key driver for our common sustainable future but also for business success. Sustainable Entrepreneurship is a progressive management approach to generate new products

(continued)

Table 1 (continued)

Concept/Approach	Verbalization ('e-meme') of SES meme
	and services, management systems, markets and organisational processes that increase the social as well as the environmental value of business activities." (Schmidpeter & Weidinger, 2014, p. 2)
Drucker's "New meaning of corporate social responsibility"	"The proper 'social responsibility' of business is to tame the dragon, that is to turn a social problem into economic opportunity and economic benefit, into productive capacity, into human competence, into well-paid jobs, and into wealth." (Drucker, 1984, p. 62)

5 Managerial Implications

One of the central insights from our prior deliberations has been that the (social) entrepreneurial process strongly depends on memes. As we consider the SES meme itself to be a primarily symbiotic meme that can be useful for us as humans, we argue for supporting the propagation of that specific meme within (traditional) for-profit organizations in order to create an intraorganizational awareness of SEOs in terms of *social intrapreneurship* (e.g., Kistruck & Beamish, 2010; Light, 2008) or *corporate social entrepreneurship* (e.g., Austin & Reficco, 2009). First of all, we have to note that ignoring the increasingly widely spread SES meme may even be detrimental for business organizations as this could jeopardize their *social license* (e.g., Yates & Horvath, 2013) or, as Richard Pech has stated it,

> "ignoring the power and influence of memes can lead to the failure of even the most stable and seemingly prosperous of firms" (Pech, 2003, p. 113).

In this regard, Pech (2003, p. 113) has also stated that

> "entrepreneurs and managers have the power to conceive and shape appropriate memes for their markets, their products, and their work milieu."

We do not share this 'top-down optimism' completely, as we are also aware that—with respect to the meme's-eye view presented above—memes may evolve in a direction that is unforeseeable or uncontrollable for entrepreneurs and managers. However, knowing the memetic 'ecosystem' of a firm (e.g., its corporate culture or memeplex) should definitely be useful when it comes to identifying memes that may help or hinder the spread of the respective meme (in our case the SES meme). Examples of factors that should help spread the SES meme include the intraorganizational presence of related meme(plexe)s (e.g., the ones depicted in Table 1), whereas a widespread prevalence of rival memes (e.g., in the traditional schema that there is always a trade-off between social and economic benefits) can be expected to be disadvantageous.

One systematic managerial approach may then look as follows. To start with, two levels of analysis should first be differentiated: (1) *Social network analysis* of the corporation, and (2) *analysis of the memeplex* of the firm. The social network analysis should then, for example, help to identify hubs, opinion leaders, or intraorganizational clusters that have a positive effect on the spread of the respective meme (see Heylighen & Chielens, 2009, p. 3214, on the role of hubs). Due to the fact that memetic transmission (in terms of (informal) information flow) may not necessarily coincide with the formal organization chart, network analysis may help reveal those agents that exhibit the potential for being opinion leaders and, in our case, facilitating social intrapreneurship. The second level of analysis (i.e., the memeplex analysis) may then be conducted in order to identify helpful (or symbiotic) memes, rival (or toxic) memes, or ambiguous memes (e.g., what Dyson, 2004, has called "junk culture"). The analysis should also be supplemented with computer simulations (e.g., modeling the epidemiology of a meme within the firm network captured in step (1))[9] and related approaches such as "meme mapping" (e.g., Karafiath, 2014, p. 20; Karafiath & Brewer n.d., p. 11; for a different meme mapping approach cf. Paull, 2009), "memetic engineering" (Pech & Slade, 2004), the "management of meme evolution" (Taillard & Giscoppa, 2013, p. 65), or the so-called "innovation meme" process suggested by Voelpel et al. (2005).

Moreover, an important aspect that should not be neglected with respect to memetics in an organizational context is that constraints on the transmission of the meme may accrue from boundaries in social network size as a result of the limited information processing capability of the human brain (e.g., Dunbar, 2011; see also Schlaile, 2012, pp. 94 ff., with reference to Dunbar, 1993, 1998).

6 Conclusion and Outlook

The approach we have decided to take in the course of our conceptual contribution can be summarized in the following way. First, we have proposed a three-dimensional ("p-i-e") view on memes. By focusing on i-memes and cultural

[9] Note that there already exists a simulation model with so-called kenes, which "represent the aggregate knowledge of an organisation" (Ahrweiler, Pyka, & Gilbert, 2014, p. 2). These kenes (as the individual knowledge base of an agent in the model) contain "a number of 'units of knowledge'" (Ahrweiler et al., 2014, p. 2) and it can, therefore, be argued that there appears to be a conceptual relationship between kenes, memes, and the notion of schemata presented above, especially since Nigel Gilbert, who first coined the notion of 'kenes' also explicitly mentions the intentional similarity to 'genes' (Gilbert, 1997). Consequently, it may be rewarding to have a closer look at the relationship between memes, kenes, and schemata in subsequent works in order to evaluate if it proves feasible to integrate findings from the "Simulating Knowledge Dynamics in Innovation Networks (SKIN)" model (Gilbert, Ahrweiler, & Pyka, 2014) with implications from (organizational) memetics (or vice versa).

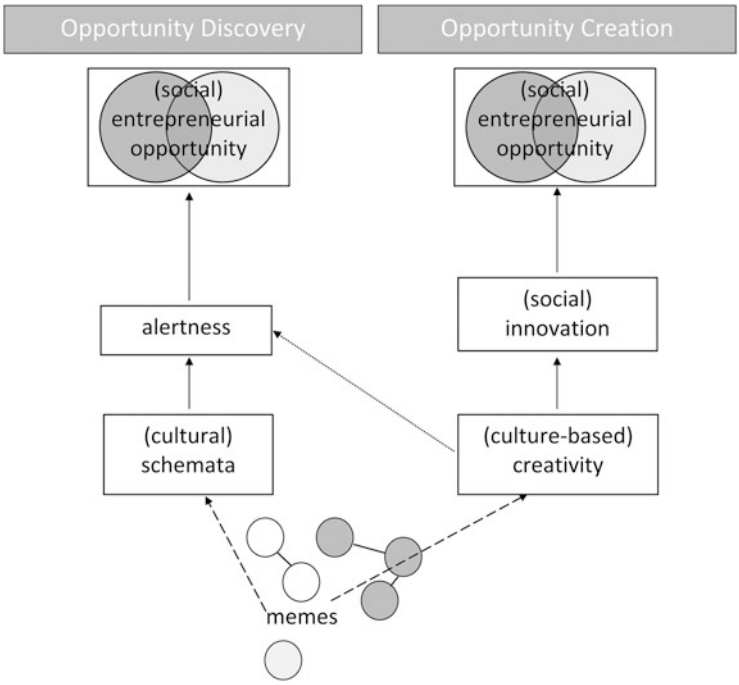

Fig. 3 Depiction of potential memetic influences on (social) entrepreneurial opportunities

schemata, we could then infer from the respective literature that the perception of information with respect to EOs (or "alertness") seems to depend on compatibility with memes that are already present. Moreover, by reviewing memetic aspects of creativity, we have deduced another link between opportunity and memes. Second, we have proposed to view SES as a meme(plex) and argued that, by focusing on the properties of the EO, we can identify similarities to and differences from related approaches.

Figure 3 summarizes central aspects of this chapter. Here, we can also see that according to the literature, (culture-based) creativity apparently plays a role in both perspectives (discovery/creation) of (S)EO.[10] However, it clearly depends on the individual case if we can delineate the boundaries between both opportunity perspectives more unequivocally.

At the center of our understanding lies what we have called the SES meme, which—as we have asserted—can also be found in other approaches (e.g., the ones presented in Table 1). This SES meme reflects the core idea that there are specific

[10] According to David Hansen, Thomas Lumpkin, and Gerald Hills, "a number of authors have described the opportunity recognition process either as being influenced by creativity or more specifically as a creative process in-and-of itself" (Hansen et al., 2011, p. 517). This influence is depicted by the dotted arrow from (culture-based) creativity to alertness in Fig. 3, since, as we have noted in footnote 6, we tend to regard opportunity recognition as a special case of discovery.

opportunities—which we have termed SEO—that are represented by the intersection of the set containing opportunities to solve a societal problem and the set containing profitable business opportunities.

However, it is also important to remember that not all societal problems can be solved by means of SES and, therefore, the limitations of this specific type of entrepreneurship should be seriously taken into consideration. Several societal problems that may not be solvable (or can even be aggravated) by means of a business approach have, for example, been elucidated by Michael Sandel (2012).

As a last step, we have considered managerial implications in order to spread the SES meme in (for-profit) organizations and, thereby, increasing the potential for social intrapreneurship and corporate social entrepreneurship. In this respect, two layers of analysis have been suggested, namely a social network analysis and an analysis of the memeplex of the firm. These suggestions also represent a starting point for further application-oriented empirical work in this direction, especially with respect to the second level of analysis.

Due to the fact that our inferences and deductions are thus far primarily based on conflating memetic literature with (social) entrepreneurship literature, further scientific inquiries building upon the aspects presented within the course of this chapter are advised. In this regard, a number of approaches are conceivable, ranging from ('traditional') qualitative, quantitative, and experimental studies to ('more unorthodox') simulation models or configurational (comparative) methods. Examples of research questions and hypotheses for future work may include: *What is the (exact) relationship between memes, schemata and the perception and discovery of EOs?* Or: *How can the relationship between memes and creativity in entrepreneurship be substantiated?* Or: *Do cultural schemata sufficiently explain the relationship between i-memes and discovery of EOs (*e.g., *controlling for the effects of associative networks)?* Or: *Does a higher fecundity (or longevity or copying-fidelity) of memes lead to more social innovation?* Or in terms of hypotheses: Null hypothesis H_0: *Memes have no significant influence on the discovery of EOs*; H_1: *(Only those) i-memes corresponding to cultural schemata that are compatible with the opportunity-related information have a positive influence on opportunity perception and discovery;* H_2*: Opportunity creation depends on the 'mutation rate' of memes;* and the like. Apart from this, the conception of SEO as a set (the intersection of 'opportunities to solve a societal problem' and 'profitable business opportunities') should facilitate further analyses of (S)EOs by means of established set-theoretic methods such as (fuzzy-set) *qualitative comparative analysis* and related approaches (e.g., Ragin, 2000, 2008, 2014; Rihoux & Ragin, 2009; Schneider & Wagemann, 2012).

Acknowledgments We have benefited from presenting earlier versions of this chapter at the *18th Annual Interdisciplinary Entrepreneurship Conference (G-Forum)*, November 13–14, 2014 in Oldenburg, Germany, and the *European Academy of Management (EURAM) Annual Conference*, June 17–20, 2015 at Kozminski University in Warsaw, Poland. We are grateful for helpful questions, criticism, and suggestions from participants of both events. Special thanks to Elisabeth Berger, Sue Blackmore, Anna Comacchio, Jameson Gill, Ilfryn Price, and four anonymous reviewers (two for EURAM, two for this book) for their valuable comments. Moreover, we

would like to thank Nicholas Terry for voluntarily pointing out a couple of spelling and punctuation errors. All remaining confusion and mistakes are exclusively our own.

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Complexity and Entrepreneurship: Modeling the Process of Entrepreneurship Education with the Theory of Synergetics

Andreas Liening, Jan-Martin Geiger, Ronald Kriedel, and Waldemar Wagner

Abstract Both entrepreneurial and educational processes are often characterized by a high degree of dynamics and uncertainty. The assumption that similar initial conditions cause similar results does not apply to these properties. Based on the current state of the art of entrepreneurship, the underlying assumption of this elaboration is that entrepreneurship can be learned. One issue concerning this field of research is that, to date, it has not succeeded in obtaining a deep level of insight into the actual process of entrepreneurship education without reducing its complexity. The concern of this theoretical elaboration is to draw closer to this 'black box' by applying the Theory of Synergetics, a complexity theory of self-organization. First, the central concepts of entrepreneurship and their meaning for the development of an entrepreneurial mindset are given. Then, we present an overview of educational topics and introduce the conception of complexity and its consequences for entrepreneurship education. Finally, entrepreneurship education is displayed as a self-organized process by using the Theory of Synergetics. The results offer new insights, explanatory concepts and opportunities for further research.

Keywords Complexity • Entrepreneurship education • Synergetics

1 Introduction

Research in entrepreneurship education (EE) has become important over recent years, especially the question of how to model the process and the impact of EE programs (Bae, Qian, Miao, & Fiet, 2014; Duval-Couetil, 2013; Griffiths, Kickul, Bacq, & Terjesen, 2012; Vesper & Gartner, 1997). In the early days of EE research, there was an underlying conviction that the entrepreneurship process was linear and

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_5

divided into stages (Levie & Lichtenstein, 2010; Sarasvathy, 2001). Entrepreneurship is differentiated in stages such as the phases of idea generation, planning, starting, establishing and growing (Volkmann & Tokarski, 2006). This conviction concerning a linear process in which each stage builds on previous stages neglects the fact that entrepreneurial processes in particular are highly uncertain and occur in a complex and dynamic environment (Lichtenstein, Carter, Dooley, & Gartner, 2007; Mason, 2006; Read, Dew, Sarasvathy, Song, & Wiltbank, 2009; Sarasvathy, 2008). Coping with this unpredictable and unstable environment is a crucial success factor for entrepreneurs in entrepreneurial processes. Hence, EE programs have to consider and address these aspects.

To design an entrepreneurial education setting, it is important to pay attention to didactical questions (Fayolle, 2013). For instance, which contents should be provided and by which methodology should they be conveyed. Hence, it is essential to provide a substantive understanding of the facets of entrepreneurship and what characterizes them as complex.

In addition to the didactical level but just as important is the underlying assumption concerning what education means and how the process of learning works. There is a wide range of existing learning theories that offer explanations. Behavioral approaches are based on the idea that an individual learns because she/he expects a positive outcome or is able to avoid negative consequences (Skinner, 1970). Social-cognitive theories are based on the idea that individuals compare and adapt their conceptions with the environment (Bandura, 1977). Learning theories allow an insight into why and how learning works, although considering them might be helpful at the conception of EE programs. Despite the full range of learning theories in the literature, all approaches have one thing in common: education is apparently anything but static and occurs in a continuous process. This situation complicates an examination of the 'black box' of EE. An illustration of the EE process would be a first helpful step to identify at which learning point a participant in an EE-program is, whether she/he has already created an entrepreneurial mindset, another unanticipated mindset or no new mindset at all. It would also help to decompose an EE process into its elements and phases to examine them. Furthermore, it would enable analyzing dependencies for a sound understanding and recognizing the possibilities of intervention.

The following chapter contains an approach to modeling the EE process that focuses on the complexity of the entrepreneurial process. Within the scope of this aim, the fundamental theoretical framework of the considered research fields of entrepreneurship, education, and complexity are derived from the literature to develop a common insight. Finally, in the last section, these aspects are combined by modeling EE as a Synergetics process with the intention of offering a new perspective in EE research.

2 The Triad of Entrepreneurship, Education and Complexity

2.1 Entrepreneurship

Over the last decade, entrepreneurship has been recognized as a main success factor for economic wealth and sustainability. To date, however, there is still no uniform definition of what exactly entrepreneurship, and an entrepreneur, is.

Shane and Venkataraman (2000, p. 218) define entrepreneurship "as the scholarly examination of how, by whom, and with what effects opportunities to create future goods and services are discovered, evaluated, and exploited." Alvarez (2005) names the combination of the individual and the opportunity the individual-opportunity-nexus, which defines the heart of entrepreneurship. It is important for what follows that the individual plays an important role in the entrepreneurial process and that entrepreneurship can be taught (Kuratko, 2005).

However, especially when the educational process is the focus, it is important to understand what is meant by entrepreneurship because only through a thorough understanding of the meaning of the topic can an adequate didactical process be designed. Thus, at least two main obstacles should be taken into account when grasping a sound understanding of entrepreneurship. On one hand, there is the dilution of the meaning of entrepreneurship. It has become a 'fad or trend' that everything 'is' entrepreneurial, e.g., entrepreneurial finance, entrepreneurial marketing, and entrepreneurial management (Kuratko, 2005). Although people tend to name these subjects as entrepreneurial, the content of the subjects remains (often) the same. However, without adopting the entrepreneurial tools and methods to the subjects (Zahra & Wright, 2011), the offered subject toolbox fails to actually broaden the perspective to the domain of entrepreneurship. Without understanding, for example, effectuation, business models and lean start-up processes, it is impossible to align these topics to the subjects. In addition, studies on entrepreneurship in recent years have delivered new insights. The focus on the obtainable and available resources in the emerging theories in entrepreneurship, as opposed to the focus on the outcome of an entrepreneurial process, is an especially remarkable difference between the old and the emerging theories in entrepreneurship (Fisher, 2012). Moreover, the emerging theories (such as effectuation and bricolage) acknowledge the uncertainty and complexity of an entrepreneurial process, which stands in contrast to the focus on predicting and planning (Alvarez, 2005; Baker & Nelson, 2005; Sarasvathy, 2001). These findings construct the basis for what follows below.

In an entrepreneurial process, the responsible person has to address uncertainty (Sarasvathy, 2001) and an unpredictable future (Dew, Read, Sarasvathy, & Wiltbank, 2009; Read et al., 2009). It is impossible for the entrepreneur to plan or predict many steps beforehand. Given that basic management tools are based on predictions and forecasts, these might work for an intrapreneurial process in which the company is equipped with facts and figures about their customers. For an entrepreneurial process, however, new methods and understandings are needed

(Brettel, Mauer, Engelen, & Küpper, 2012; Dew et al., 2009). As opposed to the effectual approach, which focuses on the initial situation and acknowledges the unpredictability of an entrepreneurial process, Sarasvathy (2001) names the focus on prediction and forecasting the causal approach. Moreover, because an entrepreneurial process is unpredictable, the probability of making mistakes and encountering failure is very high. Therefore, we have to acknowledge that not only success but also failure belongs to entrepreneurship. The only important aspect when addressing failure is 'successfully dealing' with failure. Equating entrepreneurial performance with company performance is a common mistake. By doing so, we overlook the importance of failure and risk management (Sarasvathy, 2008). An entrepreneur's decision to stop an entrepreneurial process may mean success because the ratio of uncertainty to resource expenditure is no longer justifiable (Sarasvathy, 2008). These examples show that entrepreneurship needs its own methods and understandings. Different authors underpin this view and state that entrepreneurship is its own discipline and therefore needs its own methods and frameworks (Kuratko, Morris, & Schindehutte, 2015; Sarasvathy & Venkataraman, 2011). Especially to address uncertainty and risk management, usable methods remain lacking and must be implemented within an education process.

Moreover, different authors conclude that entrepreneurship is a nonlinear and complex process (Sarasvathy, 2001; Swanson & Zhang, 2011) and that EE has to address these characteristics in the educational process (Rasmussen, Mosey, & Wright, 2011; Read, Sarasvathy, Dew, & Ohlsson, 2010). Mäkimurto-Koivumaa and Puhakka (2013) take up on this understanding and propose a new entrepreneurial mindset. An entrepreneurial mindset is the ability to "sense, act, and mobilize under uncertain conditions" (Haynie, Shepherd, Mosakowski, & Earley, 2010, p. 217). Mäkimurto-Koivumaa and Puhakka (2013) argue that the entrepreneurial mindset should also promote flexibility, creativity, and continuous innovation, in addition to the ability to be dynamic, self-regulating and flexible in uncertain tasks (Haynie et al., 2010).

Whether people are able to handle a high degree of uncertainty, complexity and dynamics within the field of entrepreneurship depends on their mindset. With her concept of effectuation, Sarasvathy (2001) underpins that successful entrepreneurs follow the same principles (which address the ability to handle complexity and uncertainty) and understand the entrepreneurial process as an iterative and recurring process without a given goal (Sarasvathy, 2008). She contrasts the effectual approach to the causal approach (linear process), which is only helpful in a secure environment and a predictable future. As previously noted, an entrepreneurial process is not predictable but is rather complex and uncertain (Dew et al., 2009; Grichnik & Gassmann, 2013). Because companies often use a causal approach for 'entrepreneurial' issues and processes, they might fail in continuous innovation processes. The fact that a person is able to apply the right concept in complex and dynamic situations shows her/his ability to conceive of an entrepreneurial process as dynamic and complex.

There are several methods, tools and approaches that can be regarded as fundamental in composing an entrepreneurial mindset. One example is the effectual

approach (Sarasvathy, 2001). Through an empirical research project with successful entrepreneurs, Sarasvathy finds that entrepreneurial expertise follows five underlying principles:

- *The bird-in-hand principle: Entrepreneurs are means-driven instead of goal-driven. They start with their means, which can be cognitive or material resources.*
- *The affordable-loss principle: Before starting a process, entrepreneurs define what they are willing to invest, which entails not only financial aspects but also time and effort.*
- *The crazy-quilt principle: Entrepreneurs negotiate with their stakeholders throughout the entire entrepreneurial process. They do not stick to their first idea. Rather, they search for opportunities to get the most out of their resources.*
- *The lemonade principle: Instead of trying to avoid contingencies, entrepreneurs acknowledge them. Thus, surprises are viewed as opportunities to leverage the idea.*
- *The pilot-in-the-plane principle: Entrepreneurs keep the process under control. They rely on facts that they are able to use to control the entrepreneurial process as the prime driver instead of exploiting and relying on external factors such as technology or socio-economic trends* (Sarasvathy, 2008).

These five principles can be regarded as the basis of the effectual approach, which accepts that an entrepreneurial process is dynamic and complex, as opposed to the causal approach, which presents the entrepreneurial process as linear.

In addition to the effectual approach (Uncertainty, Unpredictability → Effectuation) (Sarasvathy, 2001, 2008), the following concepts and methods (learning parameters) constitute an entrepreneurial mindset, acknowledge complexity and dynamics and the entrepreneurs' thinking and behavior:

- *Iterative and feedback processes → Lean-Start-Up* (Maurya, 2012; Ries, 2011)
- *Business Model → Business Model Canvas* (Osterwalder & Pigneur, 2011)
- *Customer Focus → Value Proposition Canvas, Customer Development Process* (Blank & Dorf, 2012; Osterwalder, Pigneur, Bernarda, & Smith, 2014)
- *Differentiation Strategy → Blue Ocean* (Kim & Mauborgne, 2005)

This listing is by no means exhaustive, but it offers good insight into the basic concepts and understandings that a person should be aware of when she/he starts an entrepreneurial process. Start-ups often have to use these methods and tools because of fewer resources, which may be a reason why start-ups often tend to be better innovators.

As noted above, these approaches are identified as adequate concepts in entrepreneurship research. The difficulty, now, consists of integrating them into the mindset of possible entrepreneurs. Individuals often have a specific perception concerning how things work: If they are convinced that creating and following a business plan is the best practice in becoming an entrepreneur, then this idea will order all activities in their founding process. The challenge is to arrange an addition to or a change in the ordering concepts of would-be-entrepreneurs to allow them to

reflect on their thinking and behavior from new perspectives such as those noted above.

To approach the challenge of integrating such concepts into an entrepreneurial mindset, educational issues concerning the didactical level and the importance of learning theories in the entrepreneurial context are introduced in detail below.

2.2 Education

Entrepreneurship education can be defined as "any pedagogical programme or process of education for entrepreneurial attitudes and skills", and it is not limited to the immediate creation of new businesses (Fayolle, Gailly, & Lassas-Clerc, 2006, p. 702). One central educational issue concerns the understanding of learning. Rigg and O'Dwyer (2012) argue that the literature on EE pays little attention to learning theories. As noted above, behavioral approaches assume that individuals are more likely to learn if they can gain positive or avoid negative consequences (Skinner, 1970). The implication is that entrepreneurial learning occurs because individuals expect that participating will lead to a change in their mindset from which they will benefit. Although this assumption is reasonable, it says more about the motivation to participate in an educational program. The actual learning process, however, is neglected in a 'black box'. The social cognitive learning theory of Bandura (1977) assumes that individuals observe the behavior of a person whose performance is perceived as successful. The observed behavior is processed in cognitive schemes and then retrieved in relevant situations. Accordingly, entrepreneurial thinking and action is the result of an observation of a model. On one hand, this view underlines the importance of best practices; on the other hand, it neglects that cognitive entrepreneurship-related schemes can also be developed without observing a model, for example, by reflecting on one's own actions.

Focusing on the cognitive approach makes it possible to understand how such a reflection process works. It is possible to deduce that individuals have cognitive schemes that influence how situations will be interpreted. According to Piaget (1976), this phenomenon is described as assimilation; existing schemes order the individual's perception. During a learning process, a contradiction between the existing scheme and subjective perception occurs, and the scheme is replaced. This process is strongly controlled by the learning arrangement; nevertheless the constitution of new schemes is self-organized and, according to Piaget (1976), described as accommodation. This process is included within the process of the Theory of Synergetics, which is presented in section "Synergetics and Entrepreneurship Education". For both educators and learners, it may be worth knowing at which point the conceptual change occurs.

Another educational dimension concerns the didactical level. The EE literature pays a considerable amount of attention to contents, methods or expected outcomes such as skills, attitudes and entrepreneurial intentions (Duval-Couetil, 2013; Rushing, 1990; Vanevenhoven & Liguori, 2013). However, in addition to the dimensions

of 'what?' (content) and 'for which results?' (expected outcome), according to Fayolle (2013), it is also important to raise further didactical questions, such as 'for whom?' (participants and which needs they might have) and 'why?' (pursued goals). The research on EE methods, especially their applicability and effectiveness, has already been introduced in economic education (for instance Miller & Rebelein, 2012). In the construction of an EE program, is it also important to distinguish between short-term and long-term goals. One perspective may be to foster an entrepreneurial culture (Kuratko, Hoskinson, & Wheeler, 2014), whereas another perspective may be to underline the importance of integrating concepts of sustainability (Lourenço, Jones, & Jayawarna, 2013). In this context, Nandan and London (2013) classify EE as an interdisciplinary learning arrangement that may support the development of corporate social responsibility and social entrepreneurship. They emphasize the role of 'leaders' and 'team players' as social change agents, in addition to their innovative and multidimensional approaches, their critical thinking, and their problem-solving skills.

In addition to learning theories and the didactical level, it is important to reflect on the underlying assumption of what exactly education means. When do we refer to a person as being educated? At first glance, one may regard a person as educated if a certain knowledge or competence is acquired. Despite such an outcome-oriented understanding, one may adopt a more human-centered perspective of education: A person who assumes responsibility for her/himself and for others can be described as educated. Following Frank, Korunka, Lueger, and Mugler (2005, p. 260), "the education system is a key area where it is possible to intervene and present entrepreneurship as a viable alternative to dependent employment." In this context, education means providing choices and opportunities rather than simply defining individuals as entrepreneurs or non-entrepreneurs. It does not matter whether one accepts responsibility as an entrepreneur, manager, employee, bureaucrat or even consumer. If we are 'educated', we play many roles in our everyday lives and comprehensively meet the necessary requirements. The specific facets that one has to be aware of to be regarded as educated are strongly dependent on the ethical framework in which one lives (Wight, 2012).

One of the central traits of education is that it occurs voluntarily and is self-organized and that learning arrangements only act as a catalyst for individuals. Although it is possible to obligate individuals to act in a certain manner, it is impossible to force individuals to become educated. This remark is most likely the largest common ground of the perspectives offered in this chapter: A certain degree of freedom is necessary to break out of rigid structures and follow up an undetermined way. What complexity in this context means and what complexity is in general will be introduced in the following section.

2.3 Complexity

In recent years, there have been profound changes in the economic environment, leading to a world of increasing complexity (Wallner, 1999). As a consequence, many traditional economic explanatory models have increasingly lost their persuasiveness because the linearity condition, on which most of the traditional models rely, has become increasingly unrealistic. For example, the long-since proven microeconomic partial analysis of markets is only a viable method provided that no interdependencies exist between single markets. With regard to entrepreneurship, Gartner (1995) criticizes a consisting deterministic view that strengthens the belief in feasibility. This perspective assumes a mechanistic worldview that fits with causational approaches and the idea that the same initial conditions will lead to the same results.

As suggested by numerous traditional models, the economic development of the system as a whole and in specific domains such as the entrepreneurial sector is not always characterized by fluent transitions (Liening, 2013). For instance, it is not reasonable to explain self-organizing processes such as a founding process by using linear views (Sarasvathy, 2001). Therefore, Nijkamp and Poot (1993) assert the following: "Our economic world is highly dynamic and exhibits a wide variety of fluctuating patterns. This causes a sharp contrast with our current economic toolbox, which is largely filled with linear and comparative static instruments" (Nijkamp & Poot, 1993, p. 25). Consequently, when examining economic theory, one can say that the assumptions of mainstream economics are changing completely. This claim especially holds true for the dynamic and innovation-driven field of entrepreneurship.

To model complex developments based on realistic scenarios, one must utilize traditional exogenic dysfunctions or random variables. Eventually, abnormal and non-continuous developments are analyzed through the use of methods that seem to be applicable only to linear and lineal conditions or continuous processes, respectively. For a long period of time, economics was subordinate to the influence of a mechanistic worldview that, for example, applied models whose trajectories[1] tended towards equilibrium and seemed to be predictable and tangible through the assistance of partial analyses. However, the economic reality is often much more difficult and complex than suggested and can only be modeled by non-linear system models (Liening, 1999). In this context, however, what does complexity mean?

[1] A trajectory is the development line of a dynamic system. It depicts the course that begins from a certain starting point and is conducted by a system in the course of its dynamical development in the phase space. Here, the phase space is a space spanned by the time-variant variable of a dynamical system. If the trajectory moves in an 'attractive' dynamical state, it is referred to as an attractor, which is a subset of a phase space. There are four types of attractors: Fixed point, limit-cycle, limit-tori, and chaotic (also called 'strange') strange attractors (Strunk & Schiepek, 2006).

First, it is important to distinguish the meaning of simple and complicated, random and complex. Addressing a simple problem means that the situation or the system is constructed in linear causal relationships and that all relevant elements of the system are known (Strunk & Schiepek, 2014). Transferring this notion to an entrepreneurial context leads to the assumption that, if the entrepreneur starts a project, every partner is known, the customers are identified and the return on investment is predictable. A complicated case, for instance, is a clockwork that consists of a huge number of individual parts, including gearwheels, small wheels, springs and so on. Although the mechanics of the clockwork look somewhat confusing, all parts are determined to run in a specific sequential order. Moving one of the parts has a predictable effect on the hands of the clock. Thus, a clockwork cannot be described as complex, simple or random. It is complicated (Strunk & Schiepek, 2006). Transferred to an entrepreneurial context, this notion implies that founding a company is challenging because one has to know all aspects of the process and their effects on the other parts. However, founding a company would be nevertheless calculable and predictable. With the right instruments and methods, the founding process and the return on investment can be foreseen. It must be noted that the differentiation between simple and complicated is merely based on the quantity of effort that a person has to expend within the entrepreneurial process.

By contrast, every roll of the dice can be understood as a random operation. The solution set in this example is well known: A number between one and six. It is also possible to assign probabilities to each solution, but the concrete realization cannot be determined. Thus, rolling the dice is definitely not complicated or complex. It is random. Applied to an individual entrepreneurial task, the implication is that it does not matter which methods, tools or efforts an entrepreneur uses and invests. The final result is not linked to her/his activities and is under no circumstances predictable.

Finally, raising a child may be explained as a complex task. There are thousands of books, information centers and parents out there, but no one is able to predict the 'result' of the parenting process or provide the one piece of correct advice. There are empirical values and methods that have worked, but the fact that they have worked for one child does not imply that they will work for another. Moreover, it is impossible to define 'will work' because every family, culture and environment has different expectations of parenting. Thus, this process is neither simple nor complicated or random. Transferred to the field of entrepreneurship, the outcome of a funding process cannot be estimated, even when the same tools and methods, which other entrepreneurs have successfully used before, are applied. The smallest deviations in the initial conditions may lead to a completely different result.

The last presentation sets the basis for the modeling of the entrepreneurial process in the following section. Thus, the engagement with nonlinear, complex systems may play a decisive role in the search for an expansion of the 'economic toolbox'. On the basis of these ideas, it is possible to represent a wide range of economic behavioral patterns and explanatory approaches.

The next section introduces the Theory of Synergetics, a concept that originates from the field of physics, to describe self-organization processes. Synergetics has already been successfully applied to the field of behavioral therapy to examine how cognitive behavioral patterns are formed by a process of self-organization (Mackinger, 2013; Strunk & Schiepek, 2006).

3 Theory of Synergetics

A broad field of theories addresses complex systems, e.g., the Theory of Thermodynamics, Fractal Geometry, Catastrophe Theory, Chaos Theory, and the Theory of Synergetics. Although these approaches seem to differ greatly from each other, they are all primarily concerned with questions related to the origination and analysis of complex order patterns (Liening, 2014). Following several authors who state that entrepreneurship is a complex and highly uncertain process (Lichtenstein et al., 2007; Schindehutte & Morris, 2009), the authors apply the Theory of Synergetics to the field of entrepreneurship.

Synergetics[2] is an interdisciplinary approach that allows the self-organization of complex systems. It "[...] describes a self-organized order establishment within systems through the behavior of system components. It refers to systems that are characterized by openness, dynamics, and complexity"[3] (Schiepek, Manteufel, Strunk, & Reicherts, 1997, p. 122). The physicist Hermann Haken established this theory in 1969. He was the first researcher to show that the existence of laser light can be explained by self-organization phenomena (Haken, 1977). Haken himself states:

> The basic idea, which the Synergetics copied from nature, is easily outlined. In order to imprint a structure on an object or to incorporate it with functions we usually use the working hypothesis of a sculptor, who carefully chisels smallest fragments out of a block of marble to create, for instance, a head. These steps require planning and control effort. Following the example of nature, Synergetics contrasts the organization and detailed control of a system to another principle: namely, self-organization. Here, the system, which is constructed of many parts, is given only a few framework conditions and finds its structures and in particular its functions on its own. (Haken, 2006, p. 17)

The term self-organization "[...] means that these systems evolve their structures by themselves, without any specific external intervention" (Haken, 1982, p. 66). When new structures arise through the interaction of the distinct parts of the system, one can also speak in terms of emergence if the newly created quality of

[2] Although the term Synergetics is often used synonymously with the Theory of Self-Organisation, it is in fact only a part of a larger group of interrelated theories that unify and constitute self-organisation theory. The other theories are Dissipate Structure Theory, Catastrophe Theory, Super-Cycle Theory, Fractal Theory and Chaos Theory (Fei & XiaoHang, 2010).

[3] Translated by the authors.

the emerging structure cannot be reduced to its original parts[4] (Liening, 1999). Self-organization theories have already been applied in entrepreneurship research to identify the relevant interdependencies during an entrepreneurship process (Lichtenstein, 2000; Lichtenstein et al., 2007).

For a deeper understanding of the Theory of Synergetics, some concepts, processes and terms have to be introduced and explained. A prerequisite for the self-organization process is that the system is an open multi-component system that allows energy to flow through it. A self-organizing system can only exist if there is a certain given energy supply, similar to how the sun enables the growth of plants but its energy is unable to control the form of the growing plant. In short: Only open systems induce self-organized evolutionary structures; the other systems expire eventually. In this context, one may also speak in terms of control parameters that symbolize an unspecific natural control, while they are also specific insofar as not every system reacts to every available control parameter (Manteufel & Schiepek, 1994). Finally, the control parameters do not determine the order structure, but by controlling the intensity of the energy supply, they are able to influence the behavior of system elements on the micro level. In a process of self-organization, system elements construct a pattern that is observable at the macro level in the form of an order parameter. The order parameter then enslaves the micro level and forces the elements into the coherent behavior that led to the order parameter in the first place. On the other hand, there is an interplay between the order parameters and the control parameters. It is possible that once-established patterns—e.g., a bird swarm formation—might destabilize when the intensity of the control parameter—e.g., the wind—changes. By changing the control parameter and, thus, changing the energy supply, the system elements become stimulated and eventually stop the coherent behavior, which leads to a disorganization of the system and dissolution of the order parameter, leaving the system in a critical state in which it is highly sensitive to external perturbations. Instantly, new order parameters emerge and compete against each other until one order parameter dominates the others and again forces the system elements into a certain coherent behavior. From this behavior, new behavioral structures can occur. However, a forecast of which possible behaviors will be established as the new order parameter is nearly impossible, especially when considering that the smallest random perturbations ('noise') in a destabilized system can determine which of the competing order parameters will dominate the others. Such a change of the macroscopic patterns induced by the variation in the control parameter is called 'phase transition' (Haken, 1975). Figure 1 shows the general concept of Synergetics:

The macroscopic and the microscopic levels are relative because the macroscopic level may be a subsystem in a microscopic level of a superordinate system. On the other hand, the elements of the relative microscopic level may be the

[4] Please note that not necessarily every emergent process is already a process of self-organization. Instead, both phenomena emphasize different properties of a system and can exist in isolation from one another. For an elaborate differentiation of both phenomena, see De Wolf and Holvoet (2004).

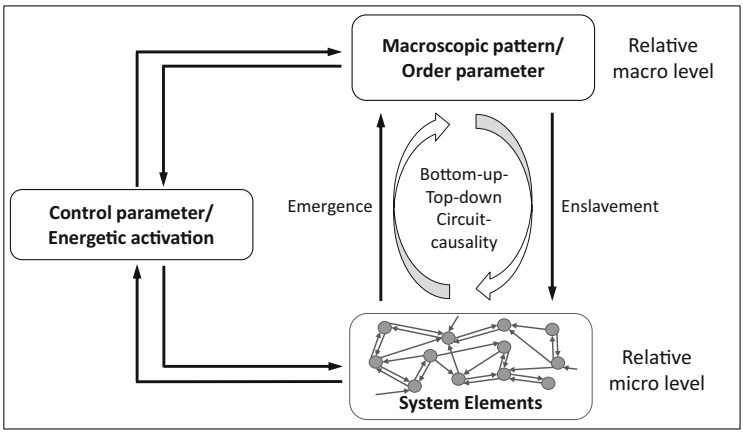

Fig. 1 Model of synergetics (Strunk & Schiepek, 2006)

smallest elements in the examined system, but every element can also function as a subsystem with its own macroscopic and microscopic level. Therefore, it is important to define the elements that constitute the system prior to interpreting the system.

In the following section, we consider an individual learner to be a system in which the system elements of the microscopic level are her/his knowledge, values, experiences etc. These elements represent the constitution of the individual, which is the origin of the self-organizing process that leads to the emergence of a macroscopic pattern.

However, a simple transfer of the general Theory of Synergetics to the field of EE may lack information. Although the system elements that have been modeled in the natural sciences (e.g., the atoms of a laser crystal) are somewhat simple in their structure and the system itself is highly segregated from its surrounding environment, the considered systems in EE are far more complex and interact with their environment to a higher extent. Therefore, Fig. 2 displays the extended model of Haken and Schiepek (2010), in combination with Eckert, Schiepek, and Herse (2005) which considers the influence of the environment and internal and external system constraints:

The environment represents the area surrounding the system and is highly dynamical because it consists of various self-organizing systems that all interact with the individual system. These systems may include, for example, other individuals or the general surrounding (media etc.) of the individual and the government. On one hand, it is able to send stimulating signals to system elements. The environment stimulates the individual's system elements in specific ways, but it can also provide control parameters, set by the dynamic conditions of the environment, which can activate system elements and induce the emergence of an order parameter or a new macroscopic pattern. On the other hand, the environment can be chosen/influenced by the order parameter to a certain extent. Moreover, the

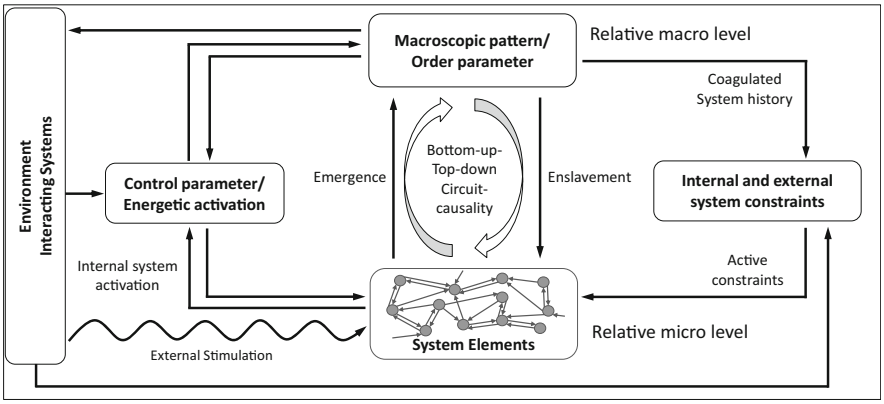

Fig. 2 Extended model of synergetics (Haken & Schiepek, 2010)

environment provides the external system constraints, which have a regulative effect on the behavior of the system elements. In the case of an individual, these external constraints may be other systems and their order parameters, including, for example, family settings and the financial base, which may restrict the individual from participating in entrepreneurship programs.

In addition to the external system, there are internal constraints, which are mainly based on the order parameters and macroscopic patterns that have been constructed in the past. As soon as an order parameter emerges, it effectively changes the entire system and affects the probability of which order parameters will emerge in the future. In particular, it increases the probability of the emergence of an order parameter with nearly identical characteristics. One can also speak in terms of a coagulated system history, given that all previously emerged order parameters are memorized by the system and, therefore, set its internal constraints, which again set the context for the creation of new order parameters. The internal constraints are able to influence the functionality and interdependence of the system elements and set the system framework.

Just as an individual is able to change her/his environment, she/he can also indirectly change the external constraints. However, these constraints change more slowly in relation to the order parameter, which in turn changes more slowly than the system elements. Finally, it must be noted that the only part of the Synergetics model in which an external person (e.g., an educator) is able to intervene is the control parameter. All other parts are not directly influenceable. As a final adjustment to the basic Synergetic model (Fig. 1), the term 'enslavement' is changed to 'synchronization' in the extended model (Fig. 2). The term 'enslavement' provokes misleading associations in a human context. Therefore, in the following, the term 'synchronization' is used, based on the recommendation by Eckert et al. (2005).

At present, Synergetics has been explained as a theory that offers an explanatory approach to self-organization. In the following section, the system (microscopic level) is viewed as the individual and her/his knowledge, values, experiences etc., thus, the constitution of an individual person.

4 Synergetics and Entrepreneurship Education

After implementing a sound understanding of the underlying theories of entrepreneurship, complexity, education and Synergetics, these theories are now combined, and an EE Synergetics model is presented and visualized. Through the Synergetics Entrepreneurship Education (SEE) model, new insights concerning the field of EE, especially concerning the understanding of how EE works and how an EE process should be designed, may be derived (compare Fig. 3). The construction of cognitive structures is one of the results of an educational process (see "Complexity") and can be explained by the Theory of Synergetics. As noted in section "Theory of Synergetics", the Theory of Synergetics differentiates between control parameters, order parameters, the macroscopic system level, the microscopic system level, the environment and system constraints. Modeling the EE process based on this theory, the educational process starts with an external activation that is realized through entrepreneurial learning parameters (control parameter). This impulse ignites an undirected change process in the EE participant (microscopic level), which (in the best case) leads to the emergence of new entrepreneurial cognitive structures within the individual (macroscopic level). It is important to consider that the control parameter initiates an unspecific process within the individual. Thus, it is impossible to foresee the 'outcome' at the macroscopic level and which cognitive pattern, such as an entrepreneurial mindset (order parameter), will emerge within the individual. The only method—based on the Theory of Synergetics—of influencing the emergence process is the careful configuration of the control parameter. In the case of EE, the aim is to increase the likelihood of the emergence of an entrepreneurial mindset (order parameter) within the individual by setting up the proper entrepreneurial learning parameters. For a deeper understanding, each part of the SEE (compare Fig. 3) is explained in detail in the following section.

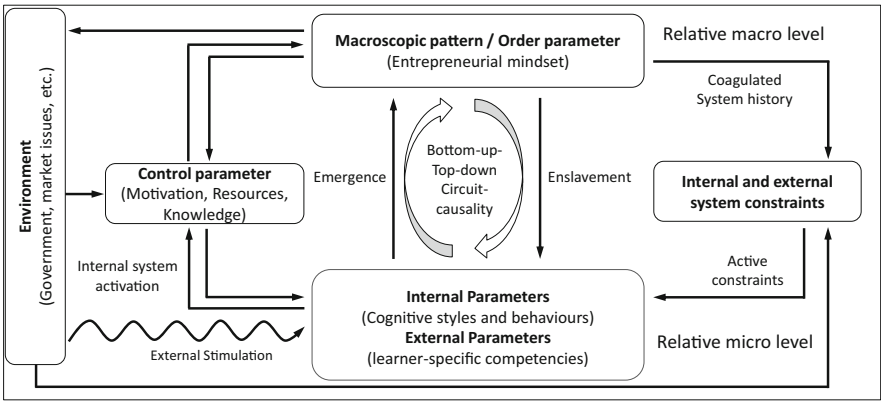

Fig. 3 Entrepreneurship education process displayed as a synergetics process (SEE)

4.1 Control Parameters

Control parameters can be individual and group-specific, but as explained above, the focus here lies on the individual person. In the case of EE, the entrepreneurial learning parameters (control parameters) may aim to address different aspects such as the knowledge, motivation or resources of the individual.

4.1.1 Control Parameters for Knowledge

To provide the individual with knowledge, different learning arrangements can be chosen. First, there are normal classroom sessions, web-based arrangements, blended learning settings or self-study. Furthermore, the option of a coach or mentorship is possible. Through the different learning arrangements (with different methods such as teacher-centered education, self-study, presentations by the learner etc.), the individual is approached on different cognitive levels. Hence, the individual reflects on the topic (in our case, entrepreneurship) from different viewpoints. Therefore, the relevance of the content itself is reduced, and the content review of the individual leads to a personal analysis and evaluation. Thus, for the individual, the emergence of her/his own understanding of the field of entrepreneurship becomes possible. Through a comprehensively designed learning arrangement that acknowledges all facets of the subject with the possibility for the individual to use different viewpoints, an entrepreneurial mindset can emerge. Understanding entrepreneurship as a dynamic and complex process, the learning arrangement should concentrate on the methods listed in section "Entrepreneurship". Because it is not possible to directly determine which outcome the learning parameters (control parameter) will evoke, it is even more crucial to choose the parameters as carefully as possible. Without using methods (such as those listed in section "Entrepreneurship") that foster the understanding of complexity and dynamics, the opportunity for an entrepreneurial mindset to emerge is impossible.

4.1.2 Control Parameters for Motivation

The motivation of the individual can be fostered through speeches by people who have already founded a company (de Dios & Montero, 2003). Through their experiences (successful or otherwise), the individual obtains first-hand information about the field of entrepreneurship, and the theoretical content becomes vivid. Moreover, in addition to the first-hand information, the individual has the opportunity to ask questions and start conversations. Other motivational aspects can be addressed by the reward of credits or prizes for successfully participating in an EE program. These tools do not necessarily result in a better learning outcome, but through the achievement of a higher goal, a deeper involvement with the topic occurs.

4.1.3 Control Parameters for Resources

Through the availability of resources such as rooms (for meetings or co-working activities), money (for testing and producing products as in the minimum viable product approach) or consulting (to obtain advice for her/his own idea), the individual has lower entry barriers to attempt to start entrepreneurial processes.

These three areas are examples of aspects that can be addressed through the control parameters of the SEE model. In this section, the focus is on the aspect of knowledge. The proposed learning parameters in section "Entrepreneurship" mainly address the knowledge aspect, which functions as an activation point to start the emergence process of an entrepreneurial mindset (order parameter). Nevertheless, through a combination of learning parameters (control parameter), e.g., the theoretical, motivational and guiding resources noted above, the individual receives broader stimuli (microscopic level) concerning entrepreneurship, and the enduring emergence of a new order parameter is more likely to occur.

4.2 The Microscopic Level

In the SEE model, the microscopic level represents the individual, the system with its elements. Two aspects must be taken into account on the microscopic level: On one hand, the foreknowledge, experiences and cultural aspects of the individual and, on the other hand, the learning and cognitive styles, which refer to how the individual approaches new knowledge, experiences and cultural aspects. Every individual has different cognitive styles and cognitive habits[5]. Thus, the control parameters have to consider that every individual has different initial situations. Especially in an educational process, it is important to know to what extent learning groups are homogenous or heterogeneous. With this knowledge, the learning parameters can be chosen in a manner that considers the homogeneity or heterogeneity.

4.3 Macroscopic Level/Order Parameter

On the macroscopic level, the aim of the EE process is for an entrepreneurial mindset to emerge within the individual. Through the control parameter, the individual's constitution, on the microscopic level, changes. New information and experiences affect the old macroscopic pattern. Depending on how strong the old pattern is, new patterns emerge through the self-organization process and compete against each other until one pattern wins and dominates the other patterns. The

[5] Compare, for example, Riding and Rayner (1998).

implication is that new knowledge, experiences or resources will be viewed with the understanding of the new pattern. Although the resulting dominant pattern/mindset cannot exactly be foreseen, the proper use of the learning parameters (control parameters) and external stimuli should increase the probability of the emergence of an entrepreneurial mindset, which becomes visible through the entrepreneurial actions and applications of the individual in different contexts.

The order parameter 'entrepreneurial mindset' can be regarded as the 'gate' to the field of entrepreneurship. With an entrepreneurial mindset, a person understands the foundations of entrepreneurship theory and knows how to act entrepreneurially. For other people, the mindset becomes visible when the person uses methods and tools such as the lean-start-up approach or effectuation principles (compare section "Entrepreneurship"). When the entrepreneurial mindset is the active order parameter, all new actions are synchronized through this parameter. There is not only the *one* entrepreneurial mindset. There can be endless manifestations of the entrepreneurial mindset that can emerge as an order parameter. Through carefully designed control parameters, there is a higher probability of an entrepreneurial mindset that considers the complexity and dynamics of an entrepreneurial process.

4.4 Constraints

There are two types of constraints, internal constraints and external constraints, which influence the individual's system elements. Internal constraints are composed of the coagulated system history. During a phase transition, patterns that have emerged once in the past are more likely to reemerge than other patterns. Therefore, old patterns, such as a linear understanding of a founding process, which have already been learned by the individual, compete with new patterns that have emerged due to the influence of the actual control parameters on the microscopic level. Moreover, external constraints[6] such as low credits for entrepreneurial classes, reduced reputation, bad marks or a high demand on employees in the market have an effect on the system elements at the microscopic level (individual). Thus, the control parameters and the constraints affect the microscopic level.

Internal constraints and external constraints, such as legal regulations, facilities, interaction processes, and the architecture of the building, are difficult to change. However, over the long term they can be influenced by the individual's order parameters. With regard to internal constraints, the implication is that, due to newly emerged patterns, a broader range of patterns (and a more suitable pattern) is available, and therefore, historically coagulated patterns become less important. There are also external constraints that can change due to the long-term effects of

[6] Furthermore, external constraints may be classified into physical (such as financial ressources) and non-physical (such as cultural characteristics) elements.

the entrepreneurial mindset. If, for example, entrepreneurs with an entrepreneurial mindset have a high reputation in society, then more people will want to become entrepreneurs as well. Therefore, the demand for entrepreneurial classes increases. As a consequence, external constraints such as the number of offered entrepreneurial classes rises because of the higher level of government funding.

4.5 Environment

The environment contains several aspects. All aspects have in common that the individual cannot directly influence them. Over time, the aspects are able to change, but change is not a direct process and is especially not directly influenceable by the individual in the SEE process which depicts the main difference to the constraints. The environmental aspects (in the short term) must be taken into account and must be taken for granted.

Examples of environmental aspects may include the government, family, friends, organizations, and legal regulations. In general, the environment represents all parts that are not within the system of the individual (microscopic level) and do not belong to the control parameter of the SEE but have an indirect or direct effect on the microscopic level.

4.6 The Process

After explaining the different parts of the SEE process, the final comprehensive flow of the model is explained. First, it is crucial to realize that the only part in which educators may intervene within the SEE process is the control parameter. The implication is that there is no opportunity to forecast which pattern and order parameter will emerge on the relative macro level (compare section "Theory of Synergetics"). Every individual has different initial situations (knowledge, motivation and experiences); therefore, it is important to deliver a broad range of entrepreneurial learning parameters (control parameters) that offer the individual the opportunity to challenge her/his prior acquired knowledge, motivation and experiences, which represent the individual on the micro level and are the basis for the emergence of an order parameter on the macro level. By challenging the actual order parameter within the individual through affecting the micro level, old patterns lose their influence over time, and suddenly, a new pattern, in the actual case of SEE, an entrepreneurial mindset, emerges.

However, given the coagulated system history (old patterns within the individual), it is more likely that, through the persistence of the system, new knowledge, motivation and experiences will be evaluated by the individual through the old, previously learned patterns. For example, a person who already has an understanding of entrepreneurship, an understanding that is composed of business plans

instead of business models, predictions instead of control and market research instead of lean-start-up, is more likely to use her/his old pattern instead of new patterns. Given the coagulated system history, the chosen entrepreneurial learning parameters (control parameter) have to be enduring and must address as many of the individual's aspects as possible to initiate the emergence of a new mindset.

5 Conclusion

The aim of this theoretical elaboration is to model and present an entrepreneurial education process without reducing its complexity but rather acknowledging it. It is obvious that the provided model depends on the underlying assumption of what entrepreneurship is, but its definition greatly varies in the literature. The same holds true with regard to the understanding of education and complexity, which one has to be aware of when applying this SEE model. Another specific attribute of the SEE model is the system theory perspective. However, by considering the mentioned aspects it is possible to broaden the theoretical perspective on the EE process.

Regardless of these circumstances, the model offers new opportunities on different levels:

First, it makes it possible to model EE as a process. As shown above, the effects from EE may differ depending on the structure of the internal and external parameters of the individual. The model acknowledges this fact by regarding the conceptual change on the macroscopic level.

Second, the SEE model takes an interdisciplinary approach. Discussing EE means considering didactical dimensions and the traits of education, whereas discussing entrepreneurship as a complex process requires an illustration of complexity and the resulting consequences.

Finally, throughout the SEE model, it is possible to separately contemplate the elements of the EE process. Synergetics offers an approach to understand the elements of the educational setting (control parameter), which functions as an impulse for individual and self-organized learning. It underpins why it is so important to design the educational setting with great care. Moreover, it enables a separate reflection on order parameters, the microscopic level, the macroscopic level and constraints without neglecting the system and its dependencies as a whole. However, it is important to note that there is not always a distinct separation of the parameters and elements of the system, and therefore, there is still room for discussion concerning the right classification, especially in the case of the differentiation of control parameters and environmental effects.

The potential for further research exists, for instance, in the phase transition of the order parameters. It would be helpful for both the learner and the educator to know at which point in the conceptual change process the individual is currently situated.

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Computer Simulation Studies of the Entrepreneurial Market Process

Mohammad Keyhani

Abstract This chapter reviews a line of research that studies several different theoretical questions in entrepreneurship through novel applications of computer simulation. All of the simulation studies reviewed are based on a shared game-theoretical modeling framework that allows a high level of integration with existing theories. What made these simulations unique was their firm grounding in the theory of the entrepreneurial market process from Austrian economics, and the lack of previous simulation studies in the entrepreneurship field. The focus is on how and why the cooperative game theory framework was chosen, the justification and process of applying the simulation method and the lessons learned from doing so. The aim is to provide entrepreneurship scholars with a better understanding of where and why computer simulation may add something of value to their research as a tool for the analysis of complex systems. The reviewed studies involve artificial economies with a small number of agents, demonstrating that the emergence of complex macro patterns from micro behaviors does not require large numbers of agents.

Keywords Austrian economics • Computational modeling • Cooperative game theory • Disequilibrium • Market process

1 Introduction: Simulation as a Method for the Study of Complex Social Systems

When faced with the task of analyzing complex social systems, it is often useful—if not inevitable—to analyze a model of the system instead of the system itself. Traditionally, mathematical models either abstract away from the detailed components of the system or assume that the system as a whole can be analyzed by studying the behavior of individual parts separately (López-Paredes, Edmonds, & Klugl, 2012). But complex systems often exhibit behaviors that are not analytically

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_6

tractable with mathematical or closed-form modeling and involve interactions among components such that studying partitions of the system independently is useless (Edmonds, 2005). Computer simulations allow us to move beyond analytical tractability and study systems that cannot easily be modeled with equations. Compared to other methods, simulation is particularly powerful in the study of complex phenomena involving interactions, dynamics, feedback loops, tipping points, and the emergence of complex macro patterns from simple micro behaviors (Miller & Page, 2007). It is a powerful methodological tool that can shed light on a variety of research questions, often in unique ways compared to other methodologies (Harrison, Lin, Carroll, & Carley, 2007).

In addition to resolving the tractability issue, simulations allow us to better represent the causal mechanisms of the modeled system, thus producing explanatory insights into why certain inputs lead to observed outputs, which is perhaps the central aim of complexity science. Epstein (1999) considers the ability of computational models to explain how patterns are generated to be their key feature, encapsulated in the motto "if you didn't grow it, you didn't explain its emergence" (Epstein, 1999, p. 43). Management scholars have recognized this explanatory strength of computational modeling early on. Cyert and Grunberg (1963, p. 310) argued that computational modeling allows us to go beyond Friedman's (1953) predictionism (i.e., explanation is not necessary as long as prediction is achieved) and "gain explanatory value for our models as well as predictive ability." Because of this explanatory power, simulation is particularly useful for theory building (Davis, Eisenhardt, & Bingham, 2007) when dealing with complex phenomena (Axelrod, 1990; Epstein & Axtell, 1996).

Although simulation technology has been available to scholars for several decades, social science researchers have mainly begun to use the method since around the early 1990s (López-Paredes et al., 2012). It is a young methodology compared to many more established methods and many disciplines are still in the phase of figuring out the best practices for applying simulation methods in their research (Edmonds, 2005). Among the more famous simulation studies in the social sciences are Schelling's (1971) segregation model, Forrester's (1969, 1971, 1973) system dynamics studies, Axelrod's (1984) studies of the evolution of cooperation in repeated games introducing Anotol Rapoport's tit-for-tat strategy, Epstein and Axtell's (1996) "sugarscape" model based on the NK fitness landscape modeling framework, and March's (1991) study of the trade-offs between exploration and exploitation.

Due to its strength in modeling dynamics, bounded rationality, heterogeneous and interactive agents, as well as disequilibrium phenomena, computer simulation has been heralded as particularly well suited to strategy and entrepreneurship research (Axtell, 2007; Page & Ryall, 1998). However, looking at the simulation studies published to date, one gets the picture that simulation as a methodology of theory building is gaining a foothold in the broader strategic management discipline (Almirall & Casadesus-Masanell, 2010; Gavetti & Levinthal, 2000; Lazer & Friedman, 2007; Levinthal, 1997; Levinthal & Posen, 2007; Rivkin, 2000; Rivkin & Siggelkow, 2003; Siggelkow & Rivkin, 2005), while being largely neglected in

the particular area of entrepreneurship research (Crawford, 2009; Yang & Chandra, 2013). This chapter reviews three studies by the author that are among the early efforts in the entrepreneurship field to tackle the complexity of entrepreneurship with the methodological tool of computer simulation.

2 Searching for a Modeling Framework

When I set out to model entrepreneurship in an economy, the logical starting point was the traditional model of a Walrasian economy that is the basis of neoclassical economics and its fundamental theorems (Debreu, 1959). This model of an economy is in fact the basis for much of modern strategy theory, including theories based on Industrial Organization (IO) economics, and the Resource-Based View (RBV). It basically consists of a supply side made up of a set of producers with production functions and a demand side made up of a set of consumers with utility functions, and the relative quantities and qualities of supply and demand determine the equilibrium price at which the aggregate welfare of the market participants is maximized. Equilibrium price is derived mathematically, and not through any actual process of market participants interacting with each other. When a process is suggested for how equilibrium is derived, it is commonly a fictional process involving market participants taking prices from an imaginary auctioneer.

Given the static equilibrium focus of the neoclassical framework, when attempting to model entrepreneurship as a disequilibrium phenomenon involving the creation and discovery of opportunities in a dynamic market process (Chiles, Bluedorn, & Gupta, 2007; Littlechild, 1982, 1986), it seems that the traditional Walrasian modeling approach may not provide the right toolbox. At the same time, moving to a completely new toolbox would hinder the prospect of cumulative knowledge development and comparability with previous findings and theory.

In an important paper, Makowski and Ostroy (2001) suggest that it may be possible to revisit Walrasian equilibrium theory and extend this theory to include what they call the ‘creativity of the market’. Their idea of what exactly ‘the creativity of the market’ entails is particularly interesting to strategy theorists, since it encompasses both opportunistic behavior and entrepreneurial behavior. This has certainly never been achieved before and would constitute a major advance in strategy and entrepreneurship theory. In their exposition of how such a framework may be arrived at, Makowski and Ostroy (2001) present their arguments using elements of Cooperative Game Theory (CGT), and inspired Lippman and Rumelt (2003a) to recommend this toolbox to strategy researchers.

3 Game Theory and the Value Capture Model

For many years most of the works published within the field of strategic management itself have at best taken inspiration from the game theory toolbox, and have mostly left the task of directly engaging with the modeling work to the economists. The barrier to such engagement was not only that learning the mathematical jargon and toolbox would require extensive investment for those not trained in mathematical economics, but also that the returns to such investment did not seem promising: many strategy scholars have been skeptical of the merits of trying to capture complex real world strategic problems within a straightjacket of simplifying assumptions required to render them analyzable with formal tools. The wave of work inspired by Makowski and Ostroy (2001) has focused on cooperative game theory in particular, which is more flexible and less complex, and thus easier and more intuitive to understand.

Today, a body of research has accumulated around the application of CGT to strategy that is well integrated and is enabling cumulative knowledge development in an unprecedented manner in the field (Adegbesan, 2009; Adner & Zemsky, 2006; Brandenburger & Stuart, 2007; Chatain, 2010; Chatain & Zemsky, 2007; Keyhani, Lévesque, & Madhok, 2015; MacDonald & Ryall, 2004; Ryall & Sorenson, 2007). Referring to this body of work as the Value Capture Model (VCM), Ryall (2013) hails it as a new approach to strategy theorizing. Gans and Ryall (2015) provide a review of this work, demonstrating how it generates important theoretical insights that previous theories may have been blind to.

Interestingly, given that one of the main intentions of Makowski and Ostroy (2001) was to enable the formal analysis of entrepreneurship, the wave of CGT research in strategy (i.e., the value capture model) initially inspired by their paper has had little or no spillover to entrepreneurship research. To be sure, a major cause for this lack of adoption of CGT among entrepreneurship researchers is that traditional CGT has a relatively objectivist and static equilibrium-based approach, seemingly running counter to the subjectivism and dynamism principles of Austrian economics. Nevertheless, even before Makowski and Ostroy, other researchers had suggested that CGT can fruitfully be used to model the entrepreneurial market process (Foss, 2000; Reid, 1993). More specifically, Foss pointed to the early work of (Littlechild, 1979a, b; Littlechild & Owen, 1980) who made initial inroads into modeling both subjectivism and the dynamics of the market process using a CGT framework, but whose work has remained largely under-appreciated since. An overview of this model is provided in the appendix to this chapter. As important a contribution as it is, the Littlechild model is still an analytical one aiming for a closed-form mathematical analysis of the market process. In the next section we discuss how adding the element of simulation will allow us to better capture the dynamic nature of the market process.

4 A Cooperative Game Simulation Approach to the Market Process

Can the CGT framework truly provide an integrated framework within which both the traditional equilibrium-based theories of strategy, and the disequilibrium-based processes of opportunity creation and discovery can be modeled? In this section, I outline why I think the answer to this question is, at least to some extent affirmative.

Within the CGT framework the structure of the economy is modeled with a characteristic function, which simply assigns a value to every possible coalition or grouping of players, and equilibrium is modeled with a notion known as the core of a cooperative game which simply refers to any profit distribution from which no player or coalition of players has incentive to deviate. As Moulin (2002, p. 77) points out: "The fundamental economic example of a cooperative game is the pure exchange economy à la Arrow-Debreu (e.g., Debreu, 1959). Every agent owns certain resources (a certain bundle of private goods) and they freely engage in trade by pairs or in any other coalition (i.e., subgroup) of agents."

It is possible to add dynamics to the CGT framework. In particular we add two dynamics from ideas in the Austrian school of thought on the function of entrepreneurship in an economy. The first dynamic is that of discovery which is the process of taking the economy towards equilibrium by discovering and exploiting existing opportunities (Kirzner, 1997). We incorporate this into the characteristic function framework using simulation by allowing a player to identify excess (non-exploited value) in a coalition, and form that coalition if it is not already formed. The excess value is divided among the members of this coalition and added to their previous payoffs. Research modeling the process of coalition formation in a characteristic function until equilibrium is reached has been previously published using either closed-form models (Arnold & Schwalbe, 2002; Hart & Kurz, 1983; Konishi & Ray, 2003) or computer simulation (Chavez, 2004; Dworman, Kimbrough, & Laing, 1995; Klusch & Gerber, 2002). Littlechild (1979a, b) and Reid (1993) both suggest that entrepreneurship can be modeled as the discovery and exploitation of excess in a characteristic function game.

The second dynamic is that of creation which is the process of taking the economy away from equilibrium by creating new opportunities also known as innovations (Schumpeter, 1934). We incorporate this dynamic into our model using simulation by allowing a player to increase its added value (i.e., marginal contribution) to all possible coalitions including that player. This effectively changes the characteristic function similar to research on repeated n-person cooperative games in which the characteristic function is allowed to change over time (Filar & Petrosjan, 2000). Afuah (2009, p. 291) suggests that innovation can be modeled as the act of increasing marginal contribution in a characteristic function. Other research also suggests similar modeling representations of innovation in terms of increased added value in cooperative games (Adner & Zemsky, 2006; Chatain, 2010; Chatain & Zemsky, 2007; Grahovac & Miller, 2009).

Having described the background and basic structure of the modeling framework, I now proceed to outline some of the research questions explored and insights that have been generated using this simulation framework. The studies reviewed here are either published or works in progress, and complete details of the models can be found in the original studies. Unless specified otherwise, in these studies an economy is simulated with a default of four agents with varying degrees of discovery and creation capabilities (i.e., the probability that they will perform each of these actions as described above in any given time period). The discovery algorithm works in such a way that the best opportunity in terms of excess value per capita is discovered but not necessarily fully exploited.

5 Implementation of Simulation Framework

There are three major types of simulation: agent-based simulation, system dynamics, and discrete-events simulation (Borshchev & Filippov, 2004; Dooley, 2002), with the latter being the most established form. Discrete event models involve the definition of a state of the system composed of a series of parameters at any given time (Law & Kelton, 2000). In the studies reviewed here, the state was defined jointly by the game theoretical framework's parameters: the characteristic function, coalition structure, and profit distribution at any point in time. Time flows in discrete steps, and the state may change in each step, triggered by discovery or creation events. Although some software packages exist specifically for simulation studies, more general software is also capable of running simulation experiments. We used MATLAB because of its strength in working with mathematical constructs such as matrices, vectors and functions.

6 Study 1: The Returns to Creation and Discovery

In Keyhani et al. (2015), the main goal was to study the link between performance and entrepreneurial capabilities of creation and discovery. The imputation of value to its sources has always been a crucial issue in strategic management (Lippman & Rumelt, 2003b; Winter, 1987). Winter (1987, p. 165) argues that "a proper economic valuation of a collection of resources is one that precisely accounts for the returns the resources make possible." The argument can be broadened to include both resources and actions. The cooperative game simulation framework allows us to distinguish between the value that can be attributed to actions of creation and discovery, and the value that can be attributed to structural conditions. Note that in the static Walrasian and CGT models, only rents attributed to structural conditions can be identified, whereas adding the dynamics of action creates a level of complexity that is not easily amenable to closed-form analysis. What's more, in the real world it is not easy to distinguish returns to action from returns to structure, because

of the interaction of feedback loops: action changes structure and structure enables or constrains action. In a computer simulation however, the experimenter can control the starting conditions, and thus choose a starting structure (i.e., characteristic function) that gives no player any structural advantage over others. Hence, all performance differentials can be attributed to differences in entrepreneurial capabilities, even though they are influenced by feedback loops along the way.

We found several simple but not trivial effects that produced interesting interactions: creation capabilities of different players complement each other, creation and discovery capabilities complement each other (for a single player or among different players), discovery capabilities of different players substitute each other, the performance advantages of creation and discovery are relative to market size, and opportunities saturate over time if forces of discovery outweigh forces of creation in the economy, in which case returns to marginal increases in discovery capability are zero unless accompanied by enough increases in forces of creation in the economy. Because discoverers are substitutes with each other but complements to creators, competition among them is devastating for them and hugely beneficial to creators.

7 Study 2: Equilibration and Disequilibration Effects of Creation and Discovery

In Keyhani and Lévesque (2015, in press) the main goal was to study the functional role of entrepreneurial action in the economy, which has been a topic of widespread debate and disagreement within various schools of thought. The traditional neoclassical framework tends to see equilibrium as the default and only state in which analysis takes place, thus not leaving much room for dynamics and by extension the entrepreneur as the driver of such dynamics. In contrast, the Austrian school views the economy not as a state but as a process, the dynamics of which is driven by the entrepreneur. In the Schumpeterian view the entrepreneur moves the economy by disequilibrating it, while in the Kirznerian view the movement is equilibration. Most entrepreneurship scholars today attribute disequilibration to the creation of new opportunities and equilibration to the discovery of existing opportunities, respectively (Alvarez & Barney, 2007; Venkataraman, 1997). The cooperative game simulation framework allows us to formally analyze and refine these theoretical propositions.

Our results verify the basic propositions in the sense that individual acts of creation are found to be mostly disequilibrating, and individual acts of discovery are found to be mostly equilibrating. But more interesting results go beyond our intuitive understanding and demonstrate the power of simulation in shedding light on complex phenomena. We found that various combinations of creation and discovery capabilities at the micro level can produce a variety of patterns at the macro level. Depending on the relative strength and combination of creation and

discovery forces, an aggregate equilibrating or disequilibrating effect or a punctuated equilibrium pattern may arise. Furthermore, in punctuated patterns the fluctuations may not converge around equilibrium, but a constant level of disequilibrium. Even more interesting was the ability of the simulations to uncover boundary conditions to the basic propositions under study. For example, Kirznerian discoverers may in some cases be motivated to *prevent* equilibration and may succeed in doing so if there are not enough other discoverers in the market. As for creation, we find that the extent to which an innovation of a given value is disequilibrating depends on the relative value of that innovation compared to the size of the market.

8 Study 3: The Returns to Bargaining Ability in the Kirznerian Market Process

While in the previous two studies the focus is on the effects of creation and discovery as the main forms of entrepreneurial action, In Keyhani and Lévesque (2014) we invite focus on a third type of action that influences performance, i.e., bargaining. Whenever value is discovered in an economy, it must be exploited by the coalition capable of producing it. But then the issue arises as to how any exploited value will be divided among the members of that coalition, especially if each member can argue that the value would not be possible without their participation. Adegbesan (2009) points out that the elements of bargaining power determining the split of a pie of value that goes to one party over another in an exchange are relative to the other party. He identifies three main elements: (a) the complementarity (or synergy) generated by the exchange relative to other options available to the counterpart, (b) the relative scarcity of the agent's offering compared to other options available to the counterpart, and (c) the relative bargaining ability of the agent compared to that of the counterpart. While complementarity and scarcity are structural elements of the market accounted for in the static cooperative game theory framework, Adegbesan's third element (i.e., bargaining ability) refers to the portion of value appropriation undetermined by the structure of the market that has to be determined through action. Thus again we arrive at an element of dynamics that can be analyzed with the cooperative game simulation framework. In this study we remove the capability of creation in order to reduce the noise in the economy and isolate the effect of bargaining ability on performance in a Kirznerian discovery process.

In our model $b = (b_1, b_2, \ldots, b_n)$ is the bargaining ability vector. When player i is bargaining within a coalition T, the *relative* bargaining ability of player i is:

$$\frac{b_i}{\sum_{j \in T} b_j} \tag{1}$$

Note that the relative bargaining ability of all players sums to 1 and each player's bargaining ability corresponds to the fraction of the pie of value being negotiated that would be appropriated by that player. Mathematically, it can be observed that in the simplest case if a group of players were involved in a single round negotiation over the split of a pie, the returns to increased bargaining ability of one player relative to others would be increasing with a concave functional form. But when we allow a dynamic market process involving multiple negotiations, in which players can enter and leave coalitions at will, more complex patterns emerge. For one thing, we would expect that if one player has such high bargaining ability that she is getting a very large share of the four-player pie, that the other three players may have incentive to disband and form a three-player coalition on their own. For the case of four players operating with 100 % exploitation efficiency (i.e., all the value discovered is always fully exploited), a simple calculation reveals this threshold to be $b^* = 1.5$. Indeed, we see this dynamic as illustrated in Fig. 1a. There is a big fall after the $b^* = 1.5$ tipping point in the performance of the superior bargainer relative to other players.

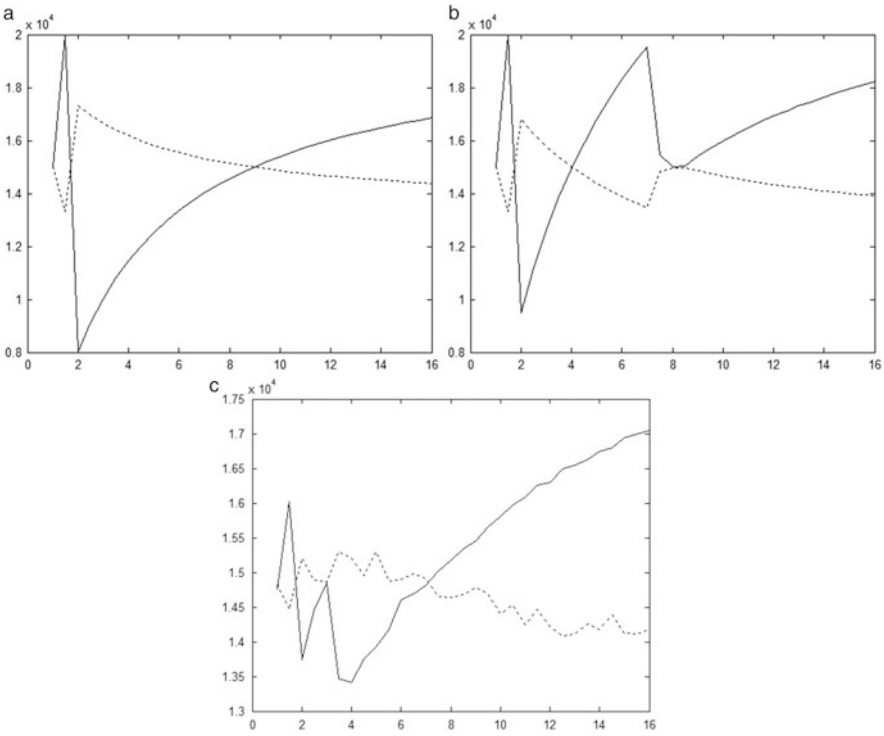

Fig. 1 Returns to increased bargaining ability of one player (*solid line*) relative to others (*dotted line*) in a 4-player game. The *vertical axis* represents cumulative performance after 2000 periods of a game. The *horizontal axis* represents the relative bargaining ability of the focal player, where the bargaining ability of all other players is set at 1. Each point on the graph represents the average of 800 trials. (**a**) all players have 100 % exploitation efficiency and use the best discovery algorithm, (**b**) all players have 70 % exploitation efficiency and use the best discovery algorithm, (**c**) all players have 100 % exploitation efficiency and use the random discovery algorithm

As we introduce further bounded rationality in the form of imperfections in the ability of players to discover and exploit opportunities, more complex patterns begin to emerge. First, we reduce exploitation efficiency to 70 % such that coalitions can only exploit 70 % of the value that has been discovered they can produce. Then we see as illustrated in Fig. 1b that even after one big fall, there is room for another. But even that could have been predicted mathematically. The most interesting pattern arises when we change the discovery algorithm from best discovery to random discovery, such that in each instance of discovery, one opportunity with positive excess is randomly discovered from the available opportunities in the economy. This simulation experiment is illustrated in Fig. 1c. Even though exploitation efficiency is set at 100 %, we still observe more than one big fall.

9 Lessons Learned from Studying the Entrepreneurial Market Process with Simulation

The above studies all use a similar cooperative game simulation framework and each has been reported in detail elsewhere. In this section I will look back on the overall research program to date, and outline some of the most important lessons learned about the strengths and weaknesses of the simulation approach in studying the complexity of entrepreneurship.

9.1 Strengths of the Simulation Approach

My main takeaway has been that simulation is indeed a useful methodology for theory building in entrepreneurship research, not as a substitute for other methods, but as a complement (Page & Ryall, 1998). Simulations lead to the emergence of new theoretical insights, beyond what we can arrive at with either narrative argument, closed-form modeling, or empirical measurement. Study 3 reviewed above illustrates all three relative advantages:

(a) Narrative argument: Study 3 investigates the interplay between two opposing forces that influence the relationship between relative bargaining ability and performance. On the one hand, you get a larger share of the pie in each negotiation, and on the other hand, you could be excluded by other players. In most theoretical and empirical studies in the management field, the propositions are based on narrative argumentation, and typically handle a situation of opposing forces with a balance-is-best type hypothesis, expecting to measure an inverted U shaped relationship with data. Figure 1 shows that the interaction of opposing forces can produce more complex patterns than an inverted U shape.

(b) Closed-form modeling: Study 3 demonstrates that closed-form modeling can only go so far in predicting the relationship of interest. When the parameters involved become too many and too complex or involve random events on which future events depend, closed-form analytical modeling typically reaches its limits. In Study 3 we were able the outcome of more simple experiments but when a random discovery algorithm was introduced, new insight was gained beyond what could have been easily obtained analytically. Simulation maintains the precision advantages of modeling yet allows us to impose fewer assumptions and less information requirements on players and to incorporate a higher level of complexity and indeterminateness than purely analytical models would allow (Harrison et al., 2007). Imposing less structure on the model also makes it simpler and easier to understand.

(c) Empirical measurement: Computer simulation experiments give the experimenter God-like capabilities in terms of experiment design and measurement compared to what could be achieved in empirical studies. The experimenter is typically unlimited (or much less limited) compared to empirical studies in terms of the number of trials, granularity of measurement, control of possible confounding factors, error-free data, span of parameter space studied, time horizon, determination and consistency of experimental environment, and manipulation of focal variables. For example, Fig. 2 illustrates what would have happened if we were limited in the detail of our measure of bargaining ability. We may have reached very different conclusions about the relationship under investigation. As another example, consider how in all the studies we are able to set initial structural conditions in specific ways that would be impossible to find in the real world or at best difficult to re-create in an experiment with human subjects.

The fact that the cooperative game model has agents as its main unit of analysis, means that any macro patterns we observe at the economy level are derived from the micro behavior of these agents. This is not only in line with the Austrian economics principle of methodological individualism (White, 1984), but is also in line with recent efforts in management theory to develop theory with micro-foundations (Abell, Felin, & Foss, 2008; Felin & Foss, 2005; Foss, 2011; Foss & Lindenberg, 2013) and multi-level theory building (Hitt, Beamish, Jackson, & Mathieu, 2007; Klein, Tosi, & Cannella, 1999). Proponents of the micro-foundational approach argue that organizations are comprised of individuals and that the more aggregate concepts such as structure, capabilities, routines, culture and institutions that have dominated strategic management discourse need to be more strongly grounded in an understanding of the individuals that shape them and bring them about with their choices, abilities, goals and expectations (Felin & Foss, 2005). Both cooperative game theory (Lippman & Rumelt, 2003a, b) and simulation methods (Abell et al., 2008) have been suggested as viable tools to advance the micro-foundations agenda, and the studies reviewed in this chapter have illustrated how this can be done in practice. Future research could extent to analysis to multi-level modeling in both higher and lower levels, for example by modeling firms

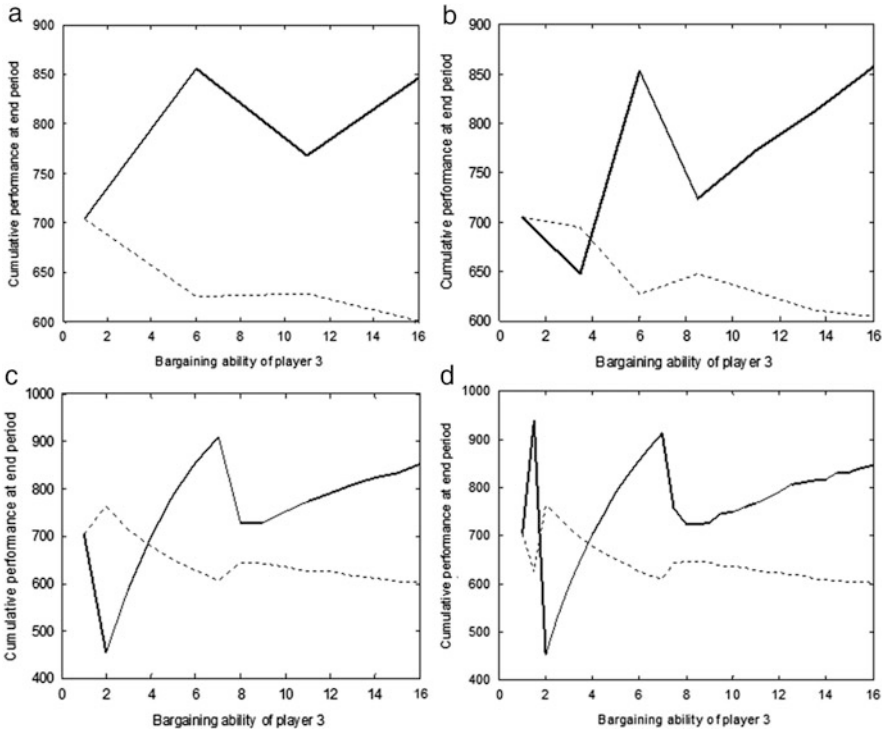

Fig. 2 Re-production of Fig. 1b this time for a 100 period game and measured with varying levels of granularity. Only at a granularity of 0.5 (Fig. 2d) or higher does the full picture emerge. (**a**) Focal player's relative bargaining ability increased with increments of 5 (1, 6, 11, 16). (**b**) Focal player's relative bargaining ability increased with increments of 2.5. (**c**) Focal player's relative bargaining ability increased with increments of 1. (**d**) Focal player's relative bargaining ability increased with increments of 0.5

composed of agents, or by modeling the decision making process inside the agents' minds (e.g., Vancouver, Weinhardt, & Schmidt, 2010).

Another strength of the simulation method I have experienced first-hand in conducting the above reviewed studies, is the ability to track the emergence of complex patterns. In other words, it is not only the complex patterns that simulation reveals, but also the causal process that produces them. If you can grow a pattern on a computer, you can explain its emergence (Epstein, 1999). For example, although the mathematically predictable patterns in Figs. 1a and 1b point to the exclusion phenomenon as the reason for the big falls in the emerged patterns, we can track the simulation process in order to check whether or not the same reason is behind the big falls in Fig. 1c. All we have to do is implement a counter in the algorithm to count the number of times a player gets excluded in each trial. Doing so reveals a direct connection between the average number of exclusions and performance, where the points of the big falls correspond to increments in this average.

9.2 Weaknesses of the Simulation Approach

Mathematical models and simulations are often touted for their transparency and power to clarify (Adner, Pólos, Ryall, & Sorenson, 2009; Kreps, 1990) due to their clear-cut approach in deriving logical consequences of given assumptions step by step. But on the flip side, this same approach leaves them vulnerable to the criticism of being 'trivial'. The fact is that most mathematical results can indeed be accused of being trivial, because it follows directly from the given assumptions and axioms. That is precisely the mathematical method. It is simply the nature of the deductive method of formal logic. The true value of the deductive method derives from its ability to arrive at findings that are formally trivial—indeed necessary given the assumptions—but more complex than what is cognitively trivial to the human mind. In other words, formal logic allows the human mind to understand the necessary consequences of a given set of assumptions by tracing the path from the assumptions to the conclusions step by step. The difference between simulation and purely mathematical analysis is that simulation puts the power of deduction on steroids, to the extent that deduction can be done so fast and so numerously that the results of numerous deductions themselves become data for induction. This is why simulation can be considered a hybrid form of deductive and inductive reasoning (Miller & Page, 2007). This is, for example, what we are doing when we produce Fig. 1c in which every point on the graph is the outcome of an 800 trial, 2000 period simulation (deductive step), and then attempt to theorize by looking at the pattern of simulation results put together in one graph (inductive step).

Nevertheless simulation as a method has its limits. Page and Ryall (1998) outline a number of common limitations which more or less apply to the studies reviewed in this chapter. First, they point out that computer simulations can be vulnerable to small changes in the value of a parameter (e.g., butterfly effects). However, we have conducted a number of robustness checks and parameter manipulations and fortunately our results do not show any problematic butterfly effects. But this problem could possibly arise if additional levels of complexity are added to our models. In one instance, we did find that changing the detail of measurement produced awkwardly different results (Fig. 2), but we were able to overcome the problem by studying a more detailed span of the parameter space.

Second, they point out that different computational methods may yield different results. Indeed we saw an important change when we changed the discovery algorithm from best discovery to random discovery in Figs. 1a and 1c. But we have not checked other potential discovery algorithms, for example using some sort of neural network, genetic algorithm, etc. to drive discovery.

Third, they argue that including too many variables in a simulation model may cloud causal relationships, and suggest that researchers should begin with simple baseline models and build up complexity step by step. We have done our best to follow this recommendation and so have hopefully avoided this common pitfall of simulation studies.

Fourth, Page and Ryall (1998) point out that computer capacities are still severely limited. Almost two decades after their writing, Fig. 1c which studied an

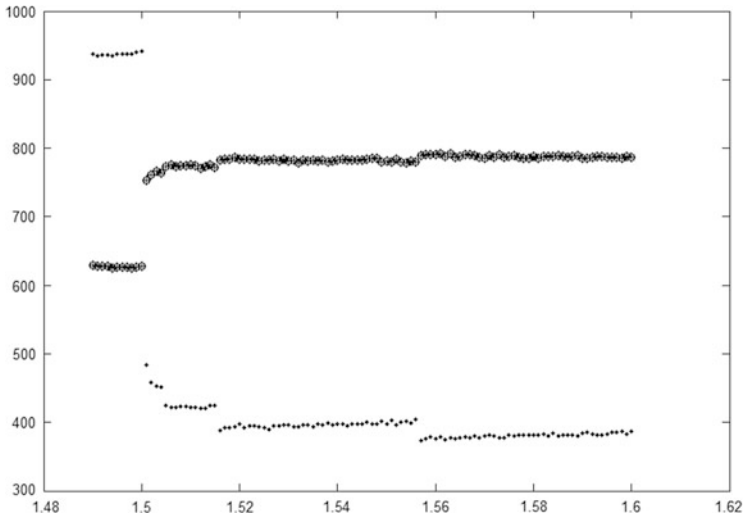

Fig. 3 The simulation of Fig. 2d zoomed in on the range between 1.49 and 1.6 illustrates noise possibly created by number truncation. The *thin line plots* the performance of the focal player whose bargaining ability is manipulated (*horizontal axis*) and the *thick line plots* the performance of everyone else whose bargaining ability is set constant at 1

economy of only four players using simulations on a top-of-the-line 2014 model computer, took roughly eight hours to produce. Obviously, adding more players or more levels of complexity to the model will not be easy, especially when the experimenter needs to manipulate multiple variables to explore a wide range of the parameter space.

Finally, an important weakness pointed out by Page and Ryall (1998) lies in the memory systems used by computers to store numbers. Since the memory allocated to each number is finite, computers have no choice but to truncate numbers beyond a certain decimal point, and such truncation may result in noise, or even worse, misleading patterns observed in simulation results. To illustrate, observe what happens when we zoom in very closely on the first big fall in Fig. 2d in Fig. 3. We see that there seem to be a number of small falls in the range of bargaining ability between 1.5 and 1.6. Since our tracking system shows no change in the average number of exclusions the player experiences in that range, I believe these falls are noise generated by number truncation.

10 Conclusion: Austrian-Flavored Simulations

Reflecting on why Schumpeter's dynamic analysis approach to economics failed to take over the mainstream of the field, Mathews (2006, p. 16) points out that "one reason is no doubt the fact that tools for disequilibrium analysis were not available

at the time that Schumpeter was writing; these tools have become available only much more recently, with computer-based modeling and the analysis of complex systems and emergent phenomena." The studies reviewed in this chapter illustrates how the new tools Mathews refers to can shed light on our understanding of entrepreneurship.

While previous studies of simulated or 'artificial' economies exist (e.g., Epstein & Axtell, 1996), I am not aware of any systematic research effort to simulate economies specifically rooted in the theory of the market process put forward by Austrian Economics, even though the Austrian school of thought is increasingly referred to as the intellectual foundation for modern theories of strategy. Such references are made in the literatures on competitive dynamics (Chen, 1996; Chen & Miller, 2012), resource management (Sirmon, Gove, & Hitt, 2008; Sirmon, Hitt, & Ireland, 2007), dynamic capabilities and asset orchestration (Helfat, 2007; Sirmon, Hitt, Ireland, & Gilbert, 2011), as well as entrepreneurship (Alvarez & Barney, 2007; Klein, 2008; Shane & Venkataraman, 2000).

Austrian economists themselves have been resistant to applying simulation methods due to the tradition's long-standing criticism of formal modeling. Gloria-Palermo (2002) warns that a resistance to these new tools of formal analysis among Austrians is presently unjustified and calls for such research to be conducted.

In fact, I believe that it is not only simulation that can contribute to Austrian economics, but that Austrian economics can contribute something to simulation studies. The basic methodological principles of Austrian economics, (i.e., subjectivism, dynamism, and methodological individualism), if applied correctly to simulation studies, could result in a special kind of Austrian-flavored simulations. I believe the studies reviewed in this chapter begin to show what this Austrian flavor could look like, but the full taste will come only to those with the patience and perseverance to continue this line of work.

Appendix: Overview of the Littlechild Model

While the use of cooperative game theory has proliferated in the strategic management field in recent years, the entrepreneurship field has not seen such activity. One particular contribution that has remained underappreciated in the literature (Foss, 2000) is Littlechild's (1979b) paper titled 'An entrepreneurial theory of games' that aims to take a step in capturing some elements of the entrepreneurial market process as described in the Austrian school of economics within the characteristic function game framework. In this appendix, we take a closer look at this paper's model, and consider how it may serve as a basis for further research. The paper is a mix of informal narrative accompanied by some formal modeling. While the formal modeling does not cover all of the subjectivism and process dynamics discussed in the narrative, it does provide a basic framework that may be built on.

Littlechild (1979b) starts the formal description of the model as follows (p. 155):

> Let (N, v) be a game in characteristic function form where $N = \{1, 2, \ldots, n\}$ is the set of players. Let $M = \{1, 2, \ldots, m\}$, where $m < n$, be the subset of players who choose an active role, i.e., the entrepreneurs. Define an artificial entrepreneur (player 0) permanently offering the value $v(\{j\})$ to any player j cashing-in alone.

Active players are those who may propose offers to other players. Their behavior in looking for opportunities and proposing offers in order to exploit them justifies their labeling as entrepreneurs in the Austrian sense. The remaining $n - m$ players are passive, meaning that they may only accept or reject offers proposed to them, and do not actively seek opportunities or propose offers to others. Non-zero values for single-player coalitions are not necessary, as the game can be zero-normalized. However, having these non-zero values helps in the intuitive understanding of why a player may choose not to form any coalitions with others. Littlechild continues (p. 155):

> At the beginning of each period t, where $t = 0, 1, \ldots$, let $S_i(t)$ denote the set of players already committed to entrepreneur i and $A(t)$ the set of as-yet uncommitted players. These sets are disjoint but collectively exhaust the set of all players. That is, the collection $\{S_0(t), S_1(t), \ldots, S_m(t), A(t)\}$ forms a partition of N.

The sets of committed and uncommitted players are updated by

$$S_i(t+1) = S_i(t) \cup B_i(t), \tag{2}$$

$$A(t+1) = A(t) - \bigcup_{i=0}^{m} B_i(t). \tag{3}$$

Thus we are presented with a concise algorithm to model the game as it is played out through time. The outcome of the game is (p. 157):

> A partition of players into coalitions $\{S_0, S_1, \ldots, S_m\}$, where $S_i = S_i(T)$, and a payoff vector $\{x_1, x_2, \ldots, x_n\}$ which distributes the value of each coalition amongst its members so that

$$A(t+1) = A(t) - \bigcup_{i=0}^{m} B_i(t). \tag{4}$$

$$\sum_{j \in S_i} x_j = v(S_i) \tag{5}$$

The requirement that the S_i sets form a partition of N, implies that no two entrepreneurs may deal with each other. When the game starts at $t = 0$ no passive player has decided to cash in alone ($S_0(0) = \phi$), entrepreneurs have no one but themselves in their coalitions ($S_i(0) = \{i\}, \forall i \in M$), and so all passive players are still on the market ($A(0) = N \backslash M$). The game is completed at any point $t = T$ when $A(T) = \phi$. Littlechild then begins to go beyond the pure framework of the characteristic function game by explicitly describing a model of the market process (pp. 155–156):

> At the beginning of each period, each entrepreneur offers a price for each uncommitted player, and each uncommitted player sets a reservation price. The uncommitted player is

signed up by whichever entrepreneur offers the highest price for him, provided this price exceeds his reservation price; otherwise he remains uncommitted. Formally, let $p_j^i(t)$ be entrepreneur i's offer to player j, defined for $i = 0, 1, \ldots, m$ and $j \in A(t)$, where $p_j^0(t) = \boldsymbol{v}(\{i\})$, and let $r_j(t)$ be player j's reservation price, for $j \in A(t)$. Let $B_i(t)$ be the set of players acquired by entrepreneur i as a result of the bidding in period t, so that $B_i(t) = \left\{ j \in A(t) : p_j^i(t) \geq p_j^k(t), k \neq i, \text{ and } p_j^i(t) \geq r_j(t) \right\}$. In case of a tie in bidding, allocate the player arbitrarily to one of the maximum bidders, so that the sets $B_i(t)$ are disjoint.

And payoffs are distributed as follows (p. 157):

Each passive player gets the amount which he accepted on joining a coalition, and the entrepreneur's payoff is determined by the balance remaining, so that

$$x_i \equiv v(S_i) - \sum_{\substack{j \in S_i \\ j \neq i}} x_j \quad \text{for } i = 1, \ldots, m. \tag{6}$$

Although Littlechild does not run a dynamic simulation of the game, the only remaining elements needed to actually run the game are the strategies of the players. The strategies of active players consist of who to offer to, how much to offer them, and how to revise these in each new period, while the strategies of passive players consist of how to set reservation prices and how to revise them in each new period until an offer is accepted. Littlechild does not determine any particular way for the passive agents to set reservation prices, stating only that if they eventually start decreasing their reservation prices by at least a fixed minimum amount in each period, the game is guaranteed to end in finite time. As for the entrepreneur's strategy, Littlechild suggests that if the entrepreneur had a guess for the price it would take to attract each passive player, then the following method could be used for choosing who to offer to, and how much to offer them (p. 156):

Let $\widehat{p}_j^i(t)$ be the price which entrepreneur i believes it necessary to bid to secure j's signature, where $\widehat{p}_j^0(t) \equiv v(\{j\})$. Let $D_i(t)$ be the set of additional signatures desired by i. By definition $D_0(t) \equiv A(t)$, and for $i = 1, \ldots, m$ obtain $D_i(t)$ as the solution to the optimisation problem

$$\max_{D_i(t)} v(S_i(t) \cup D_i(t)) - \sum_{j \in D_i(t)} \widehat{p}_j i(t) \tag{7}$$

$$\text{subject to } D_i(t) \subseteq A(t). \tag{8}$$

. . .Finally, set

$$p_j^i(t) = \begin{cases} \widehat{p}_j i(t) & for \quad j \in D_i(t) \\ 0 & for \quad j \in A(t) - D_i(t). \end{cases} \tag{9}$$

Littlechild does not determine any particular way by which entrepreneurs may arrive at their guesses or revise them, although some suggestions are implied in that paper's narrative arguments. Note that there is no cost to making an offer, and no limit on the number of offers an entrepreneur can make in each period.

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Analyzing Complex Organizational Arguments with Logical Model Building

Gábor Péli

Abstract This chapter demonstrates the application of a qualitative formal method, logical formalization, to organization and management theory. Organizational arguments are usually phrased out in some natural language in the first place. After separating the premises (facts, definitions) of a natural language argument from its conclusions (predictions), this preprocessed text is translated into a logical language. Then, experimentation can begin if the logical formulae standing for the verbal premises imply the putative conclusions as formal theorems. If not, what kind of modifications can make these outcomes follow? What other theorems are implied from the same argument core? A substantial advantage of using symbolic logic over many branches of applied mathematics is that logical models can quite closely map the intended meaning of assertive sentences, while the deduction of conclusions can proceed with the rigor of mathematical proofs. The examples highlight how different logical languages, different dialects, can be used to the idiosyncrasies of the subject. The proof and the translation process from natural language statements to logical models are supported by user-friendly theorem-prover softwares. The appliers of the method need not be logic experts; what they need are analytical skills, sharp eyes at formula evaluation, and some stamina. The promise of using symbolic logic is combining the flexibility of qualitative reasoning with exactness in drawing conclusions from complex arguments. The chapter is to show how and in which extent logical formalization can fulfill this promise.

Keywords Deductive reasoning • Logical model • Organization science

1 Introduction

Complexity research in organizational domains used to study systems with many interacting components, for example, multitudes of firms competing in a market characterized by multidimensional customer tastes (García-Díaz & van Witteloostuijn, 2011). There are contexts, however, in which complexity does not

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_7

stem from the large number of components, but rather from the sophisticated relations between them. The constituents analyzed in this chapter are statements on organizational issues that may form complex structures, theoretical arguments. The method I am going to describe, logical formalization, is to tame this complexity by rendering argumentations transparent and open to logical testing. Formal methods are oftentimes identified with quantitative methods operating with numbers and parameters standing for numbers. Though quantitative methods are also formal, not all formal methods are quantitative. Qualitative formal models establish relations between their objects typically without reference to quantities. As a result, these models can oftentimes stay closer to the natural language argumentation, while still having the deductive rigor of formal methods. For example, qualitative simulation, a non-mainstream branch within simulation studies, arrives at its results with reference to tendencies that may or may not override each other (Kuipers, 2001).

Logical modeling methods form another branch of qualitative formal methods designed to analyze and support reasoning. For example, Cinà and Endriss (2015) provided a model for Arrow's famous impossibility theorem on preference aggregation by using a modal logic of social choice functions (see more on modal logics in Sect. 5.3). Logical formalization, the focal topic of this chapter, is a modeling method aiming at representing, testing, and further developing natural language argumentations, theories and theory fragments with formal logic. Although it has been mainly used to organizational models, its application is not bound to organizational phenomena. It can be applied whenever researchers (analysts, decision-makers, acting agents) identify information based on which they intend to make inferences, predictions concerning their subject domain. Logical formalization starts with some concisely phrased out arguments in natural language (e.g., in English), for example, describing the functioning of an organization, or collectives of organizations. This involves a meticulous translation process of the natural language argumentation into theory premises and conclusions spelled out with formal logical sentences. When this translation is done, efforts can be made to derive the predictions of the subject theory as syntactic consequences, theorems, of the established premise set. This premise set may also be extended to see what sort of new conclusions would follow from a somewhat enriched organizational argument. A smartly formulated symbolic logic model can map natural language arguments with good fidelity. Hence the promise of logical formalization is providing a tool for qualitative organizational reasoning with which arguments can be transposed into formulae in a transparent manner and the ramifications of the theory can be tested with the deductive rigor we used to have in mathematics. Proving theorems from a premise set may seem a highly non-trivial task for the non-logician reader. Fortunately, this deduction phase can be performed by the support of powerful theorem provers like the online available, user-friendly *Prover9* (Prover9 & Mace4, 2009). These softwares can tell if a syntactic string, standing for the formalized premises of a theory, supports another string, a candidate theorem of the theory. Theorem provers are also powerful interactive tools at the formalization phase. But the logical translation of our theoretical arguments is certainly not

Table 1 Syntactic basics of FOL

Logical connectives, in order of their decreasing binding strength.[a] $\neg$ (negation), $\wedge$ ('and'), $\vee$ (inclusive 'or'), $\rightarrow$ (implication, 'if . . . then'), $\leftrightarrow$ (bi-implication, 'if and only if').
Operators. $\forall$ (universal quantifier, 'for all')[b], $\exists$ (existential quantifier, 'there exists')
Rules for constructing well-formed formulae (*wff*) 1. A predicate name P followed by a (maybe empty) list of variables—such as $P(x,y)$, where x and y are variables—is a *wff*. From these, further *wff*-s can be constructed by the following rules: 2. If A and B are *wff*-s, then so are $\neg A$, $A \wedge B$, $A \vee B$, $A \rightarrow B$, and $A \leftrightarrow B$. 3. If x is a variable and some $C(x)$ is a *wff*, then so are $\forall x[C(x)]$ and $\exists x\,[C(x)]$. 4. Only formulae obtained by 1–3 are *wff*-s.

[a]For example, $A \wedge B \vee C$ is equivalent to $(A \wedge B) \vee C$ as 'and' binds stronger than 'or'. The binding strength order can be overruled by using parentheses.
[b]Universal quantification at the outmost left position of formulae can be left out by convention.

automated; rather, it requires genuine analytical work. Still, theorem provers can give immediate feedback during the model specification process, letting to better see the consequences of alternative ways of logical translation.

The rest of this chapter is organized around two modules. The first, composed of parts 2–3, introduces and discusses logic applications within organization and management studies. Particularly, part 2 gives an overview on logical formalization applications in organizational domains. Part 3 surveys the problems of a computational application, automated theorem generation from a theory formalized in logic. The second module is more about the technical aspects of the formalization process. Part 4 gives examples, hints and practical advice concerning the implementation of logical model building. Part 5 is about choosing specific logical languages tuned to the specificities of the theory domain. Part 6 briefly concludes. Table 1 summarizes some syntactic basics of first-order logic (FOL). Most logical formalizations use FOL, or they use logical systems that are extensions of FOL (see Sects. 5.2–5.4). Teaching hands-on formalization techniques is clearly beyond the scope of this chapter. The practical introduction of the method will take place in a learning-by-doing manner, with ample helping comments. The interested reader may learn more about the logic basics from excellent textbooks like Gamut (1991). The reader can also learn a lot about technical implementation from the increasing bulk of logical formalization papers, many of which are cited in this chapter; all these pieces are on organizational topics and had been typically published in social science journals.

2 Application Domains

Contemporary organization science encompasses a broad variety of methodologies from which some are labeled as qualitative/informal, while others as formal. The arguments for and against these approaches might be summarized as follows. Informal research is performed in natural languages (e.g., in English), which are

flexible tools to reflect the idiosyncrasies of scientific contexts. The focal concepts of the theory may have a historically developed halo of interpretations, well understood by the scholars of the field. This richness and multiplicity of meanings may allow pursuing multiple future directions as scientific knowledge develops. But a trivial disadvantage of conceptual ambiguity is that it makes clear-cut communication difficult. When communicating their arguments, researchers have to devote a big deal of work just clarifying which meaning aspects of the verbally described concepts they are going to apply. And this is still based on the overly optimistic assumption that users clearly see which aspects of their core concepts they actually do apply at a particular argument. Logical formalization turned out to be a great help to have a clearer picture in these respects. Still, many may feel this disambiguating property a disadvantage, saying that logical models 'nail' natural language theories on the crux of rigid formulae. Doing so, they deprive the argument from a variety of potential meanings, associations, so closing down future development scenarios for good. But these critics overlook that logical models can be changed when the formal suit they bring about turn out to be too tight for the phenomena under investigation. The reconceptualization of an organizational argument requires about the same conceptual fine-wiring whether it is spelled out by formulae or by grammatically put natural language sentences. The difference in efforts between the two approaches comes at the level of technical implementation (see in Sect. 4).

In which phase of theorizing should formal model specification step in? The development of scientific arguments is far from being fully rational (Lakatos, 1976). In the early phase of theory building, researchers heavily rely on pictures and visualizations, without respect if their domain belongs to natural or social sciences. When some strong intuitive understanding has already been developed about the subject may come the model specification in natural language. In order to communicate these understandings, researchers translate these insights into some grammatical form, still in natural language. Converting an intuitive mental model into grammatically correct strings of verbal expressions is a substantial formalization process itself. This verbal formalization is crude and truncating; it forces subtle, intuitive concepts with a rich halo of potential interpretations into the *Procrustean bed* of natural language expressions. Replacing 'natural language expressions' for 'formulae' in the previous sentence, we just get how protagonists of informal methods denounce formal modeling. Casting theoretical insights into the mold of grammatical terminology is a substantial first formalization phase. Translating these verbalized insights into a symbolic logic model adds a secondary layer of formalization to the first, helping the further clarification of concepts and their relations, and so opening new possibilities for testing.

With a dose of simplification, the basic idea behind logical formalization can be recapitulated as follows. Take an organizational argument in your subject domain spelled out in natural language. Identify the core concepts in the text. Some concepts with a meaning considered straightforward and consensually understood you label as the primitives and keep them undefined. For other concepts, you spell out the meaning aspects they encompass, concisely as possible, so arriving to a set

of explicit definitions and meaning postulates of your theory still expressed in natural language. You also describe the relevant relations between the concepts and explain, in assertive sentences, how these relations lead to the putative conclusions. This natural language preprocessing is called the *rational reconstruction* of the verbal theory. Next may come the translation of this reconstruction into logical formulae, the definitions and assumptions forming the premises while the conclusions being the candidate theorems. If a candidate theorem does not follow from the set of logical premises, which is usual at the beginning, then a quest can begin to modify the premises. New information, new constraints, have to be fed in, until the formal premise set (tested against contradictions) becomes strong enough to support the theory's conclusions as theorems.

Since the above-described idea of logical formalization is quite straightforward, the question may arise that why had not this method become established in science long time ago, let's say, since the dawn of logical positivism in the early twentieth century. The logical formalization approach I describe in this chapter roots back to the applied logic project at the *Center for Computer Science in Organization and Management* (*CCSOM*), a research unit of the University of Amsterdam in the early 1990s. Several authors cited in this chapter earned their Ph.D.-s from their research performed in this team. The success of logical modeling at *CCSOM* was dependent on a number of factors. One was that the formalization could already proceed with the support of theorem prover softwares. This had a substantial disciplining effect on model building; researchers could immediately control the consequences of premise modifications on their putative theorems. The team was a mix of social scientists and mathematicians; some team members earned degrees in social and natural sciences both. But maybe most important condition was that the head of the team, organizational scientist Michael Masuch, coupled his inherent interest in logic applications with heavy-weight managerial skills. The results had to be presented in markets of picky social scientists. Publishing in reputed and visible organizational journals was essential to garner a necessary critical mass of interest from reputed and capable representatives of organization theory. The dominant view on the role of logical formalization has been somewhat altered since the outset. These roles included the logical representation of extant organization theories, theory development and integration with the support of symbolic logic, and the derivation of new results from these model cores with computational means. Below, I survey the first two tasks, delegating the more extensive discussion of automated theorem generation to part 3.

At the outset of the logical project at *CCSOM*, the main idea was representing well-established organizational theories, or parts of them, in symbolic logic in order to reproduce their core conclusions from a premise set deemed to be realistic. Although the chosen verbal theories (like Thompson, 1967) had been nicely developed, the job of representing them in logic turned out to require way more than theory reconstruction and subsequent logical translation. The process included the search for additional premises, sometimes coming outside from the subject theory, with which in place the putative conclusions did follow. Theorem proving is based on giving sufficient conditions: the model builder has to patch up the

information gaps in the arguments, so making the premise set strong enough to support the purported theorems. A logical model can well detect the lack of sufficient information in the premises. However, the method does not tell what the good solutions to the problem are. 'Logic cannot replace intuition' is a basic maxim to keep in mind. The logical reconstruction of theories is heavy theory building *per se*.

Logical formalization is also a tool of new theory development. This task has become the mainstream application domain of the method within organization science in the past decade (Hannan, Pólos, & Carroll, 2007). Logic can also be applied in parallel with data-driven empirical theory testing, for clarifying hypothesized connections between concepts, applying these insights at operationalizations, and proceeding with empirical justification accordingly. The empirical research of Kuilman, Vermeulen, and Li (2009) studied the chances of proto-organizations with such logic support. Bruggeman, Grunow, Leenders, Vermeulen, and Kuilman (2012) found empirical evidence that a modest niche overlap between organizations may even have a positive impact on their performance, possibly improving their constitutive legitimation. Consecutively, they applied non-monotonic logic (see Sect. 5.4) to align their finding with the mainstream understanding that niche overlap harms organizations by fueling the competition.

A third application domain is theory development by establishing links between inherently related domains within organization science. Theory *unification* proceeds by showing that two or more phenomena, earlier deemed to be different, are the manifestations of the same concept in different contexts. Famous examples are Maxwell's electromagnetic theory pointing out that electricity and magnetisms are different facets of one phenomenon, and Einstein's general relativity theory, based on the measurements of Loránd Eötvös demonstrating that bodies' inertial and gravitational masses are proportional to each other. No similarly deep formal unifications had been taking place in the social sciences up till now. Logical formalization, however, proved to be an extremely useful tool at the somewhat more modest, but still important, task of theory *integration*. This involves that disparate domains are brought into a common conceptual frame so that the joint framework reproduces the main conclusions of the component theories. As a surplus, theory integration may also allow deriving new predictions on the interplay between the constituent elements of the integrated parts. In their comprehensive book '*The logic of organization theory*', Hannan et al. (2007) integrated various parts of organizational ecology. Péli and Bruggeman (2007) suggested a common logical frame for alternative interpretations of temporal niche theory and for the first movers *versus* efficient producer dilemma (Hannan & Freeman, 1989; Péli & Masuch, 1997). Later, Péli (2009) suggested a common logical framework that reconciled contradicting predictions of organizational inertia theory (Hannan & Freeman, 1984) and the Red Queen adaptation theory of organizational populations (Barnett, 2008). Hsu, Hannan, and Pólos (2011) integrated a focal problem of organization science, identity-based form emergence, into a joint model with typecasting theory. The logical representations of Le Mens, Hannan, and Pólos eliminated contradicting predictions between different theory phases concerning

the age dependence of organizational hazard rates (2011), organizational obsolescence (2015a) and inertia (2015b).

3 Automated Theorem Generation

Another goal of the logic project at *CCSOM* was to derive new theorems from established formal theory cores in an automated manner. While representing extant theory parts with logic has led to a cascade of papers, this second goal could only be materialized in some initial publications (Kamps, 2000; Kamps & Masuch, 1997). A well-working theorem generator could really be a hit: you properly formalize a theory, an argument or a managerial decision scheme in logic and deduce, automatically, the relevant consequences following from this core. We have to keep in mind, however, that derivations make explicit the information already contained in the premises. Even an automated theorem generator could not tell, for example, the best contingent decisions for managers unless the interactions between these contingencies had already been fed into the model. Still, an automated machinery that explores the consequences of constraints in a premise set could be of huge theoretical and practical importance.

Some believe that this automated theorem generation approach is dead end, because softwares cannot discriminate between relevant and trivial, or even meaningless, consequences. But why could not researchers pick up the relevant theorems from the heap of derived syntactic junk by hand, just as miners search for diamonds in the debris? Experiences with theorem generation had shown that, literally, megabytes of new theorems can be deduced even from relatively simple premise sets, even after the trivial junk filters had been applied. I agree with skeptics that specifying, even partially, what we mean under an interesting new theorem is quite difficult and also context dependent. Still, I would not exclude the possibility of gradually teaching theorem-generating machineries to filter out more and more of the irrelevant conclusions. Note that all arguments in the current part 3 apply to first-order logic (FOL) models for which good theorem prover softwares exist. Theorem provers are concerned with syntax, while users are interested in meaning. This difference may be responsible for the fact that the provers would not find some relevant consequences while deriving many irrelevant ones. The first problem can be caused by some background knowledge, trivial for the user, which had not been put into the premise set. For example, not specifying the transitivity of inequality $(x > y \wedge y > z \rightarrow x > z)$ as a premise might occasionally block the derivation of otherwise following consequences. This sort of necessary but taken-for-granted information can be gradually fed into the models as experience accumulates. Handling the problem of deriving unwanted theorems is more difficult, because the solution hinges upon informing the prover about the semantic issue of relevance. Experience shows that it can be much easier to specify aspects not relevant in a given organizational context than telling the computational machinery what relevant is. Below, I survey some of these filtering possibilities.

A big deal of syntactic junk implied by the premises can be eliminated relatively easily. Concatenating two theorems, i.e., connecting them with an 'and' ($\wedge$) would yield trivial new theorems. Appending an arbitrary A to an extant theorem with an 'or' ($\vee$) connective yields trivial conclusions as well. Another junk removal task is filtering out *vacuously true* consequences. A sentence with an 'if . . .then' structure is vacuously true when its antecedent (i.e., what comes left from the '$\rightarrow$' sign) can never be the case. Kamps (2000, p. 117) demonstrates vacuously true statements with the following example, based on the premises from an earlier logical rendering on organizational inertia theory (Péli, Bruggeman, Masuch, & Ó Nualláin, 1994):

$$\neg(Reorg\_free(x, t_1, t_2) \wedge Reorg(x, t_1, t_2)) \tag{1}$$

$$Reorg\_free(x, t_1, t_2) \wedge Reorg(x, t_1, t_2) \rightarrow A \tag{2}$$

Here, (1) expresses that no x can be under reorganization and be reorganization free during the same period between t_1 and t_2. With this premise in place, the antecedent of (2) can never be satisfied; consequently A will trivially hold. A somewhat more difficult junk removal task is filtering out *non-intended models* (Kamps, 2000). Here the problem is, again, that some meaning aspects of the verbal theory had been left out from the formal machinery. For example, if all agents in the theory are organizations, then a predicate stating that x is an organization, $O(x)$, might be superfluous. For example, formalizers may simply keep in mind, or even make it a convention, that variable x always stands for organizations (Hannan et al., 2007). This economic and reasonable choice, however, might cause a problem at automated theorem proving, because a model generator that had not been informed about this convention might instantiate all objects of the formal theory into x, possibly deriving many weird theorems. Non-intended models occur because the formal coat designed for the verbal theory is somewhat loose, which may give rise for bizarre interpretations. Fortunately, non-intended models can also be gradually eliminated with careful formalization. Weaker versions of existing theorems should be filtered out as well. Let's assume that Thompson's well-known statement that organizations have technical core (1967; Kamps & Pólos, 1999) is a deduced as a theorem:

$$\forall x[O(x) \rightarrow TC(x)] \tag{3}$$

Where $O(x)$ and $TC(x)$ predicate, respectively, that x is an organization and x has a technical core. Then, the statement

$$\forall x[O(x) \wedge Friday \rightarrow TC(x)] \tag{4}$$

meaning, let's say, that organizations on Fridays have technical core is also a theorem.

Let's assume that the trivially redundant consequences discussed above have already been filtered out. Thus the theorems derived by the theorem-generator software are novel (unless researchers had already found them by hand) and pertain

to possible contexts within the theory under investigation. Even then, many of the derived conclusions might be obvious. Assume, for example, that we can derive that the winner x of the competition in market M is a bank, $Winner(x, M) \rightarrow Bank(x)$. Then, we can also derive the meaningful but modestly interesting outcome that the winner is an organization, $Winner(x, M) \rightarrow O(x)$, provided, of course, that the model had been informed that banks are instances of organizations, $Bank(x) \rightarrow O(x)$. Note however that aiming at filtering out all redundant consequences would be throwing out the baby with the bath water. Derivations explore the information content of the premises. So theorems are *per se* redundant. The question is if these syntactically redundant conclusions are novel for the researchers. If yes, then the conclusion is booked as trivial; if not, then the conclusion may be 'interesting'. Humans normally cannot fully foresee the consequences of constraint sets. If they could, mathematics would be superfluous since its task is the exploration of the consequences of the axioms. So teaching a theorem-generator to relevance would include the highly context-dependent task of informing it about humans' mental capabilities in identifying consequences ensuing from contexts humans perceive as complex. Performing this task might look hopeless in general. But narrowing down the giant set of consequences of a formal theory drastically can still be a possibility. It is an intriguing question if social science theories, arguments about organizations, or logically built up decision-making schemes could be extended with that kind of tools to explore unforeseen consequences.

4 Hints and Tricks for Model Building

Getting practice in logical formalization requires relatively little logic knowledge but considerable theoretical effort. The process of formalization will be demonstrated on examples using first-order logic (FOL), a system with relatively simple syntax and good expressive power. Although model building in more advanced logics (see part 5) require some additional knowledge, their formalization basics are similar on many accounts to those applied at FOL-based renderings. This part does not provide a detailed manual. The methodological paper of Bruggeman and Vermeulen (2002) gives many good insights about the basics of logical formalization in FOL. The interested reader can also learn a lot about technical solutions from the extending reservoir of published organizational pieces presented with logic.

What is essential for the start is learning the syntactic components of FOL and to learn writing syntactically *well-formed formulae*. The basics concerning these two are summarized in Table 1. The natural language analogue of a well-formed formula is a grammatically correct sentence. For example, the FOL-sentence $\forall x [O(x) \rightarrow Green(x)]$ is syntactically well-formed. If we assign the respective meanings to the O and $Green$ predicates of being an organization and being green, then we may possibly find the obtaining sentence meaningless, while under other interpretations, like with O meaning olive, it might be seen meaningful. As mentioned before, the reader can get a more extensive, user-friendly discussion on FOL

basics from Gamut (1991) or from some other introductory textbooks. Note, however, that these books teach much more than might be needed to start to build your own logical model in your domain of interest. Below come some guidelines, distilled from practice and teaching, how logical formalization may proceed.

The first advice is: begin with your conclusions. This may sound counterintuitive. Mathematical proofs normally begin with the premises, then enlist the primitives, the definitions and the connections (assumptions) between them, and conclude finally with the derived theorem. But in practice, it goes in the other way around as has been demonstrated in the celebrated epistemic piece of Imre Lakatos, *Proofs and refutations* (1976). Researchers usually know, intuitively, what their main points are and look for suitable premises that imply these as conclusions. So first state your candidate theorem with a concise assertive sentence, typically (but not always) in an 'if . . . then' form. Translating your conclusions into logical sentences, you may define predicates of different arities, like the zero-place *Friday* predicate and the one-place $O(x)$ and $TC(x)$ predicates in formula (4). One-place predicates are about properties telling that the object instantiated to x belongs to a certain group, i.e., to the group of objects having that particular property. Two-place (three-place, etc.) predicates state that a binary (tertiary, etc.) relation holds between the objects instantiated to the variable slots. For example, $C(x, y)$ indicates a competitive relation between x and y, provided that C is interpreted as 'competes'.

Starter formalizers can have the same paralyzing feeling that novice language learners experience: 'I have the words, but I don't know how to make a sentence of them'. The general rule is that if the target could be expressed with an assertive natural language sentence, then it can be also expressed with a logical statement. A trivial formalization solution is naming the whole sentence with a string, let's say, with A. Clearly, we usually need more sophisticated formulae that also represent the structure of the argument. Here applies a very useful second formalization advice: if you do not know what it is, or how it works, then name it.[1] For example, you want to formalize the consideration that extant industries have member organizations. This may be represented by an implication between two items. Let I stand for an extant industry and HMO for the state of affairs of having member organizations. Then

$$I \rightarrow HMO \tag{5}$$

can be a first formalization attempt for the verbal statement. But (5) is too rudimentary in the sense that the fact that HMO applies to I does not appear in it. A better solution would be making one-place predicates from the zero-place predicates of (5).

[1] This statement has been first stated as a *Murphy law*. Interestingly, some Murphy laws concerning science have substantial epistemic relevance. The scientific process is oftentimes well facilitated by this naming rule, think of the development of the atom concept since the Greeks. Using variables for the unknown in equations also follows this name-giving heuristics.

$$\forall x[I(x) \rightarrow HMO(x)] \tag{6}$$

This logical sentence states that 'for all x, if x is an extant industry, then x has a member organization'. The square brackets mark the scope along which the universal quantification $\forall$ applies. At a later phase of model building, the need may arise to refer to the member organizations of particular industries directly, necessitating the introduction of some new predicates, for example $O(x)$ positing that x is an organization and $HM(y, x)$ to claim that object y has x as its member. Then, we can make the syntactically more sophisticated statement

$$\forall y[I(y) \rightarrow \exists x[O(x) \wedge HM(y, x)]], \tag{7}$$

which reads: 'for all y, if y is an extant industry, then there exists an x, such that x is an organization and y has x as its member'. As you can see, correctly 'reading' a formula by instantiating the logical and vocabulary symbols into it gives a grammatically well-formed, though maybe somewhat clumsy, natural language sentence. The same holds, in general, for all well-formed formulae. So with proper instantiation, one can always check if a formula carries the meaning the formalizer aimed assigning to it. Note also that there are two quantifications in (7). The existential quantification $\exists$, claiming the existence of a member organization x, has been embedded into the scope of the universal quantification $\forall$ over variable y. The respective scopes of the two quantifications are indicated by the two pairs of square brackets.

The level of sophistication of a logical model may depend on the complexity of the target. Beyond this, it also depends on the theoretical depth the model builder aims to reach. Which facts do we want to explain via more elementary facts and which facts do we take for granted? The strategy of beginning with the candidate conclusion and then searching for supporting premises allows getting layer by layer deeper in the context of the subject theory (Péli & Masuch, 1997, p. 316). Non-trivial premises may be explained by simpler ones. What had been an assumption of a main theorem at the beginning may become a theorem itself at a subsequent formalization phase. Some premises of this second theorem might also be derived from even simpler considerations. The formalization process can so proceed through layers of intermediate theorems (lemmas or lemmata). Figure 1 displays the lemma structure of a FOL-formalization on how economic inequality impacts upon growth (Gomez & Bosman, 2014).

This regressive process of in-depth model building need not continue until the level of mathematical axioms is ultimately reached. The rule of thumb is that lemmatization may stop when the formal model 'leaves' the domain of the subject theory behind. The sign of approaching this point is that the new premises we introduce are rather from other disciplines than organization science: mathematical or philosophical ideas, psychological considerations begin to dominate the explanations. The suitable lemma-depth depends on the purpose for which the model has been made. Lemmatization helps making the formalization stepwise, splitting the problem to many smaller ones. This enhances process efficiency, just as in the

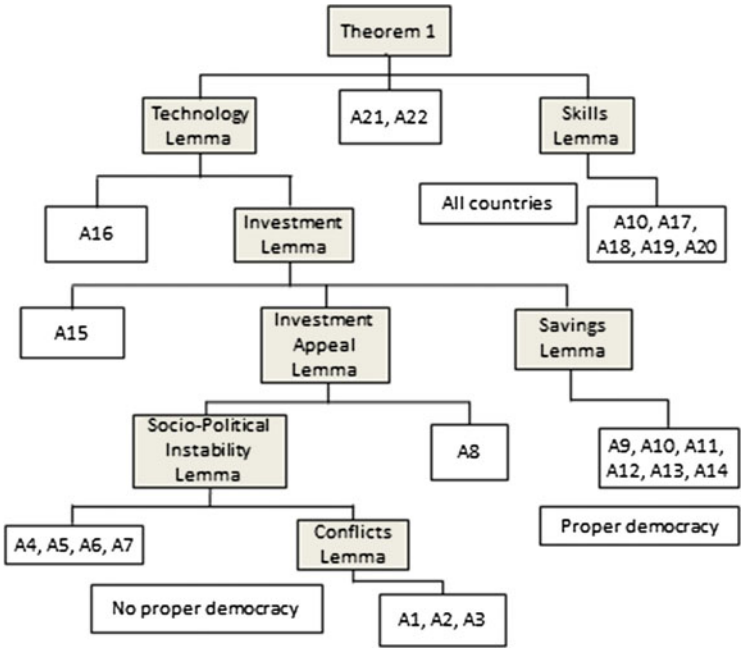

Fig. 1 The lemma structure of a logical model of inequality effects on economic growth. A# stands for Assumption #. *Source*: Logical formalization assignment of research master students, Thomas Gomez and Susan Bosman (2014)

parable of Herbert A. Simon (1969) on the two watchmakers, Tempus and Hora, choosing for respective holistic and compartmentalized assembly strategies. Thus the third advice is: lemmatize!

5 Applying Different Logical Systems

5.1 Going Beyond or Staying with First-Order Logic?

A substantial part of logical models apply standard first-order logic as basic formalization tool. FOL couples technical simplicity with considerable expressive power (Gamut, 1991). Another reason for using FOL is that most theorem provers take FOL as input. The capabilities and limitations of FOL can be best tested by 'going until the wall', that is, using this relatively simple system as far as it is possible. Research experience at the *CCSOM* project revealed that this wall had been gradually shifting further away as the formalization capabilities of the research team increased. What was believed to be a shortcoming of the system turned out to be a shortcoming of skills. Teaching experience also suggest that acquiring logical formalization skills should begin with FOL and that novice users

should preferably stay with FOL for some time before applying more advanced logical tools. As composer and reformer of twentieth century music Béla Bartók has once written, those who want perform well modern music must first acquire absolutely solid basics in classical music. An analogue statement may hold for logic applications. Those who start immediately with some more advanced logical system, possibly tailor-made to the organizational task at hand, may book some rapid initial progress. Still they will most likely have lingering problems at coping with logical formulae with a somewhat complicated syntax. For sure, FOL has its inherent limitations; so proceeding with advanced logical tools can have a positive payoff beyond a point. Below, I briefly address applications of three possible extensions of FOL, second-order logics, modal logics and non-monotonic logics.

5.2 Second-Order Logics

While in FOL logical quantifiers ($\forall$, $\exists$) can only be applied to variables, second-order logics allow for quantifications over predicates as well. For example, if P stands for a set of possible properties, then the second-order sentence $\forall P$, $\forall x$ [$P(x) \vee \neg P(x)$] would express that for all P and for all x, P either holds or not. This sentence puts forward the epistemic consideration that the objects of our universe do, or do not, have a certain property. A disadvantage of theories represented with second-order logic is, however, that they are not finitely (but only recursively) axiomatizable, meaning that their theorems cannot be deduced from a finite set of axioms (Gamut, 1991). For example, Peano arithmetic, the set of axioms characterizing natural numbers requires second-order logic, because it generates each natural number larger than 0 from its predecessor recursively, with mathematical induction. Since natural numbers are essential in most non-trivial theories, it was a kind of surprise that second-order constructs could be well circumvented in many logical models on organizations. The next example demonstrates how certain aspects of Peano arithmetic can be fit into a FOL framework. Table 2 displays the premises on arithmetic operations applied at theorem-proving by Péli and Schenk (2015) in their piece on managerial beliefs. Premises A.7 and A.9–11 are about properties of multiplication and division with two particular natural numbers, 2 and 4. For example, A.7 and A.10 characterize what multiplication with the numbers 2 and 4, respectively, means. In Peano arithmetic, multiplication with a natural number n is defined by induction:

$$\forall n \forall x [n^* x = (n-1)^* x + x]. \tag{8}$$

(8) is not a FOL formula, because $\forall$ is applied to n, which here stands for an arbitrarily chosen positive natural number. The four ad hoc premises on multiplication and division in Table 2 circumvent generating numbers with induction, so circumventing moving to second-order logic.

Table 2 FOL premises on arithmetic operations (Péli & Schenk, 2015, Table A1)

A1. $x + min(x) = 0$
A2. $x > y \leftrightarrow x + min(y) > 0$
A3. $x + min(y) > 0 \leftrightarrow 0 > y + min(x)$
A4. $x + 0 = x$
A5. $x + y = y + x$ Addition is commutative.
A6. $(x + y) + z = x + (y + z)$ Addition is associative.
A7. $x + x = 2 * x$
A8. $x > y \rightarrow x + z > y + z$
A9. $0 > x \rightarrow 0 > x / 2$
A10. $(x + x) + (x + x) = 4 * x$
A11. $(4 * x) / 4 = x$

Instead of characterizing all properties of multiplication/division, which would require second-order logic, some premises express concrete properties of these operations that we need at the derivation. This ad hoc solution allows staying in the first-order framework

5.3 Modal Logics

Modal logics extend FOL, or other logical systems, with *modal operators*. These operators add modalities to statements on their status like 'it is necessary that', 'it is possible that' (Blackburn, de Rijke, & Venema, 2001; Gamut, 1991; Pólos, Hannan, & Hsu, 2010). In their work on typecasting and legitimation processes at new organizational form emergence, Hsu et al. (2011) introduced modal operators for *perception* and *default* in order to make distinction between contexts when an agent x perceives (correctly or not) if some state of affairs is the case and when x considers this state of affairs to hold by default. Let $\mathbf{P}_x$ and $\mathbf{D}_x$ respectively denote the perception and default modal operators, with φ standing for the sentence 'managers act rationally'. Then $\mathbf{P}_x\varphi$ expresses that x perceives managers acting rationally while $\mathbf{D}_x\varphi$ expresses that x takes for granted that managers act rationally.

Certain logical systems make distinction between *knowledge* and *belief*, with the latter allowing for cases when agents incorrectly believe some state of affairs to hold. For example, Péli and Schenk (2015) applied the respective **K** and **B** modal operators to reflect false beliefs concerning impacts of managerial actions. False beliefs may lead to undesirable outcomes like flock behavior concerning mergers and acquisitions (M&A). The authors started with formalizing some prevailing managerial considerations, oftentimes also taught by undergraduate business textbooks, to track possible consequences occurring when decision-makers adopt these considerations. Managers are oftentimes seen as captains steering their ship (adapting their organization) in the ever-changing oceans of environmental conditions. Managerial idleness is believed to be bad, which leads to losing adaptive stance. These considerations are approximated by the sentence

$$\mathbf{B}\{Firm(x) \wedge \neg Opts(x) \rightarrow \neg Fit(x)\} \tag{9}$$

stating that that managers *believe* that if x is a firm and x does not opt for adaptation (joining the M&A bandwagon in this case), then x cannot be fit. Another textbook example is *benchmarking*, the belief that the fidel imitation of 'good practices' is beneficial for the organization. This is expressed by the statement that managers *believe* that if y properly imitates the M&A move of first-mover firm x, then y will share x's putative fitness:

$$\mathbf{B}\{Firm(x) \wedge Firm(y) \wedge Imitates(y,x) \wedge Fit(x) \rightarrow Fit(y)\} \tag{10}$$

Finally, the managers in this model also believe that the *fi* fitness benefit of a successfully implemented M&A exceeds the *rc* reorganization process costs the implementation involves.

$$\mathbf{B}\{fi > rc\} \tag{11}$$

The authors also assumed that beyond sharing these three beliefs, managers behave perfectly rationally, pursuing actions ensuing from such mixtures of correct and potentially false beliefs systematically. With these and similar considerations in place, the model implies that, after rationally calculating the expected benefits for each outcome believed to occur, decision-makers will opt for M&A, even before getting to know if the M&A trial of their first-mover competitor succeeds or not.

Beliefs can contradict to facts. So using a belief operator has the advantage that a sentence stating that agents believe something false does not cause a contradiction with the facts opposing this belief. Statements (9, 10 and 11) posit what managers—possibly incorrectly—believe. The reader might have the impression at this point that using modal operators in this managerial example allowed for representing a context that could not have been formally represented in standard first-order logic. Indeed, if for example statement (9) is deprived from its **B** operator, then we get a FOL statement contradicting to observations that some organizations not opting for an adaptive path can still be fit. But we can well eliminate this, and similar, contradictions from the FOL-version by making two separate premise sets, one for the facts and another for the beliefs. Then we can derive the theorems on facts and beliefs separately from the respective premise sets (Péli & Schenk, 2015). But the explicit reference to beliefs and knowledge would disappear from that FOL model version; this distinction could then only be preserved in the non-formalized background knowledge. The choice of the logical system is oftentimes driven by a trade-off between user convenience and investment efforts into learning, or developing, some new modeling tool, an observation that recurs in the next section as well.

5.4 Non-monotonic Logics

Classic first-order logic (FOL) is called *monotonic* in the sense that once a statement is found true, it holds true whatever other new information is added to a FOL

model. To better see what this property means, consider again sentence (3) stating that organizations have a technical core, $\forall x\,[O(x) \rightarrow TC(x)]$. Let this statement hold in respect of a particular object a. Let's also assume that some new piece of information pops up expressed by sentence A. The monotonicity property of FOL means that then

$$O(a) \wedge A \rightarrow TC(a) \tag{12}$$

will also hold, whatever this new statement A would mean. Why? A may or may not contradict to the $O(a)$ statement. Let's begin with the first case. If the state of affairs that a is an organization holds without constraints, then a is also an organization on Fridays as formulated in (4), so here identifying A with the *Friday* predicate. This new information does not invalidate the old. Clearly, the interesting cases are rather those when some new information contradicts to extant knowledge. Let now assume that A means that a is not an organization: $A \leftrightarrow \neg O(a)$, yielding $O(a) \wedge \neg O(a) \rightarrow TC(a)$ by instantiation to (12). This statement will also hold true; recall the discussion on vacuously true statements in part 3.

FOL has the 'explosive' property that a single contradiction makes all its statements true (Gamut, 1991). This has given rise to efforts to develop logical systems that can somehow absorb contradictions, without making any statement trivially true. *Non-monotonic logics* (NMLs) abandon the above-discussed monotonicity property of FOL, so allowing that new pieces of information update the old. There are also other logical systems aiming at taming the highly unwanted consequences of contradictions, like *paraconsistent logics* (da Costa, Krause, & Bueno, 2007). My survey stays with NMLs because of the increasing number of organizational representations using this type of logic (Bruggeman et al., 2012; Hannan et al., 2007; Hsu et al., 2011; Kuilman et al., 2009; Le Mens et al., 2011, 2015a, 2015b). These works all use the NML system proposed by László Pólos (Pólos, 1995; Pólos & Hannan, 2004), extending the fundamental work of Veltman (1996). All forthcoming discussions pertain to this version of NML. The reader finds an intuitively motivated introduction to the organizational applications of this system in Hannan et al. (2007) upon which the descriptions below also draw.

Let the two-element list of FOL quantifiers ($\forall$, $\exists$) be extended with two others, *normally* ($\mathfrak{N}$) and *presumably* ($\mathfrak{P}$). Premises that are generic statements with ad hoc or systematic exceptions get a *normally* quantifier while theorems deduced from premises some of which tagged with *normally* get a *presumably* ($\mathfrak{P}$) quantifier instead of $\forall$. For example, there might be some atypical organizations without a technical core, think of those proto-organizations that though had already been registered but had not yet actually been built up (Kuilman et al., 2009). This fact can be expressed in FOL by stating that some proto-organizations (PO) have no technical core

$$\exists x[PO(x) \wedge \neg TC(x)] \tag{13}$$

We may also say that this state of affairs is *normally* the case when a proto-organization is in a very early age of its assembly process (*New*).

$$\mathfrak{N}x\,[PO(x) \wedge New(x) \rightarrow \neg TC(x)] \tag{14}$$

But we still want to keep the general rule that organizations *normally* do have a technical core.

$$\mathfrak{N}x\,[O(x) \rightarrow TC(x)] \tag{15}$$

Let's add that proto-organizations are *all* instances of organizations:

$$\forall x[PO(x) \rightarrow O(x)] \tag{16}$$

Now, the existence of any new proto-organization would create a contradiction in FOL, i.e., were (14) and (15) spelled out with universal quantifier ∀. This is because this proto-organization should then have a technical core because of being an organization (15), while it could not have a technical core because of being new (14). But this need not happen in a non-monotonic framework. How does NML absorb the contradiction? The general idea is investigating if a *specificity ordering* applies between the contradicting statements: Is one a special case of the other? In the current example, this is the case: proto-organizations are instances of organizations (16). Then, the rule is that the more specific piece of information updates the other. So in the present case, we would conclude that *presumably* new proto-organizations have no technical core[2]:

$$\mathfrak{P}x\,[PO(x) \wedge New(x) \rightarrow \neg TC(x)] \tag{17}$$

An important feature of the NML-based system is that the more generic statement (15) can also be sustained without running into a contradiction. It is in line with

[2] The practice of formalization in NML revealed the occasional need for *ad hoc* simplifying assumptions to derive certain conclusions. These *auxiliary assumptions* have oftentimes nothing to do with the 'normal' state of affairs and so they are no parts of the theory under investigation. Their role is rather to "link the causal stories and meta-considerations, on the one side, and desired theorems, on the other side" (Hannan et al., 2007, p. 129). To discriminate these assumptions from the rule-like premises with a *normally* quantifier, the authors introduced an *assumedly* quantifier. The role of *assumedly* is in some aspects similar to (though certainly not the same as) the *ceteris paribus* clauses in arguments that freeze the impact of certain variables, so that the effect of interest can make its influence free from interferences of other effects. For example, Hannan et al. (2007) apply the auxiliary assumption that units within an organization initiate architectural change with the same probability (p. 247), a condition that certainly does not occur normally. But besides their technical usefulness, auxiliary assumptions raise non-trivial theoretical problems. For example, if a theorem is derived relying on auxiliary premises acknowledged to be possibly non-realistic, then why would its statement deserve the *presumably* status? I delegate the detailed analysis of such issues to later research.

intuition that well-established generic statements should not necessarily be discarded because of the appearance of some counterexamples. As mentioned before, even a single pair of contradictory statements renders all sentences true in FOL representations. Non-monotonic logics defuse this explosive consequence of contradictions; they can handle knowledge updates and offer a book keeping of contexts that tells when the main rule applies and when it is updated by some particular exception.

But what if no specificity ordering applies between contradicting statements? Consider a hypothetic case when managers are normally rational, while addicted players are normally not.

$$\mathfrak{N}x\,[Manager(x) \rightarrow Rational(x)] \tag{18}$$

$$\mathfrak{N}x\,[Addict\_Player(x) \rightarrow \neg Rational(x)] \tag{19}$$

Since neither managers form a subset of addicted players nor *vice versa*, there is no specificity ordering between (18) and (19). Now consider an agent a who is a manager and also addicted to stock exchange gambling or to bidding games concerning acquisitions (Schenk, 2005). The NML version has no prediction concerning the rationality of a, with a good reason. This is not a weakness of NML, but a consequence of incomplete knowledge on the relative importance of the two states of affairs under investigation. If information is missing from a theory, it is not the task of the logical tool, but of the scientist, to generate it.

The knowledge updating property of non-monotonic logics can make them suitable tools for representing theories under development. Note however that the fact that NMLs can absorb contradictions does not mean that FOL-based models, not having this property, are irreparably crashed by the occurrence of a single contradiction. In FOL, the impact of conflicting statements is handled by restricting some formulae in a way that eliminates the contradiction. For example, the conflict between the FOL-versions of (18) and (19), i.e., when $\forall$ replaces the *normally* quantifier in them, can be resolved by restricting the antecedent of (18) with the negation of the condition in (19) responsible for the counterexample:

$$\forall x[Manager(x) \wedge \neg Addict\_Player(x) \rightarrow Rational(x)] \tag{20}$$

According to (20), now managers are rational, provided that they are not play-addicts. This sort of *ad hoc* problem elimination was named *monster barring* by Lakatos (1976). An important difference between the contradiction handling of NML and FOL is that the NML representation absorbs the contradiction by also maintaining the generic rule that managers are normally rational (18) even if some particular managers are not. But this piece of information would not be part of the FOL representation of the theory; it could only be kept in background knowledge.

Contradictions between older and newer theory phases or between different parts of the same broader theory may come upfront repeatedly as theories develop. In case of larger systemizing works (cf. Hannan et al., 2007), it can be quite convenient that established formulae need not be modified when some knew knowledge

updates the old. Using NML can spare the continuous re-wiring of the machinery by constraining old formulae as indicated in the FOL example above (20). Still, it is important to point out a frequent misunderstanding concerning the capabilities of NML. Many social scientists abhor the over-generalizations formal modeling methodologies may bring about; therefore, the NML feature that its generic statements allow for counterexamples might be quite appealing to them. But for the laymen, this feature might also give the incorrect impression that NML somehow solves the information problems posed by counterexamples. This is not the case. Counterexamples normally pop up by new knowledge inflow and necessitate additional research to find out how they interact with the rest of the theory. Since logical systems do not generate new information, using NML does not spare this additional research either. Rather, it is a convenient tool for accommodating the new information when theoretical knowledge is updated.

6 Concluding Remarks

I have been teaching logical formalization techniques in the multidisciplinary economics master program of Utrecht University since a number of years. After getting some introductory lectures on the basics, students prepare a logical formalization in first-order logic on a theory fragment chosen by them. During an about 2 month long time frame given for the assignment, they have to come up with a rational reconstruction and subsequent logical translation, proving a number of theorems. Their theorems are oftentimes far from being trivial. The students proceed with the lemmatization as described in part 4, typically ending up with a lemma structure of 3–5 layers depth (cf. Fig. 1). Many of the formalization tips described in this chapter come from the tutoring experience of these projects. For example, I perceived a radical quality improvement of the final logical models after instructing students to perform the logical formalization, from its very beginning, with the use of the *Prover9* theorem prover. *Prover9* was also a great help to learn how to write well-formed formulae. Formalization trials and tests of these trials could proceed in parallel, providing immediate feedback, and maybe more importantly, teaching that the formal coat of the target argument can be, and should be, changed as model building proceeds and our ideas on the subject improve. The method can be learned and can be taught efficiently, beyond students to capable organizational scholars and practitioners as well.

Logical formalization can be applied to analyze contexts when the intention is making inference in order to predict or explain outcomes from certain facts serving as premises. Specifying a logical model, or a series of subsequent models as our understanding improves, can supplement our domain knowledge with a clear-cut inference structure. At the current state of affairs, such endeavor would most likely require help from someone already familiar with logical formalization. This constraint, however, is not specific to the logic method; it is a recurrent feature of yet non-mainstream methodologies. Multivariate regression is now a standard tool for

business scholars, although its application typically required expert help a couple of decades ago. It is difficult to tell if logical formalization, and other applications of logic, will have a carrier similar to that of multivariate analysis (some definitely claim that they will). I recommend these methods for researchers and practitioners who already have substantial information and good intuitive understanding on complex organizational contexts, but want deeper, systematic knowledge on expected outcomes and on how events possibly unfold. Intense domain knowledge is a precondition because logical formalization is not information generating tool, but rather, a way of organizing information.

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Part II
Qualitative Methods

Exploring Complex Phenomena with Qualitative Research Methods: An Examination of Strategic Innovation Trajectories in Haute Cuisine

Matthias Wenzel, Ninja Natalie Senf, and Jochen Koch

Abstract Whereas qualitative research methods have become increasingly popular in the broader social sciences, they remain less prominent in entrepreneurship, innovation, and technology research. In the face of increased complexity of empirical phenomena in these fields of research, we make the case for qualitative research methods as one valuable methodological option for researchers to gain a better understanding of complex phenomena. By unbundling the challenges that the empirical examination of complex phenomena imposes on researchers, we outline that qualitative research methods are particularly well-suited to cope with these challenges. To shed more light on how researchers may use qualitative data to draw theoretical inferences, we propose an analytical approach for the examination of complex phenomena that systematically discloses the inner logic of these phenomena in a step-wise process. In a case study of strategic innovation trajectories in haute cuisine restaurants, we illustrate how researchers may apply this analytical procedure 'in practice.' Our illustrative analysis indicates that, despite the severe challenges that researchers face when exploring complex phenomena, the proposed analytical procedure provides a practical and helpful guide for researchers to gain a better theoretical understanding of complex phenomena based on qualitative data.

Keywords Analytical technique • Complex phenomena • Haute cuisine • Methodological challenges • Qualitative research

> Our generalizations often display a mind-numbing banality and an inexplicable readiness to reduce the field to a set of unexamined, turgid, hypothetical thrusts designed to render organizations systematic. (Van Maanen, 1995, p. 139)

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_8

1 Introduction

Coping with complexity has long been a central concern for scholars of the social sciences. Whereas natural scientists rely on laws of nature to explore relationships between variables in formulaic expressions, social scientists continue to struggle with the challenges that arise from methodologically grasping the complex patterns of social interactions (Prasad & Prasad, 2002; Van Maanen, 2015). Although scholars in all social sciences seek suitable answers to the questions of how to cope with, and methodologically grasp, the complexity of social life, scholars in entrepreneurship, innovation, and technology research seem to be even more urged to find appropriate answers (Short, Ketchen, Combs, & Ireland, 2010): in contemporary environments, entrepreneurs can engage with an even larger network of stakeholders to gather resources for their business ideas (Sarasvathy, 2001; Zolin, Kuckertz, & Kautonen, 2011), draw on ever more sophisticated technologies to discover or create new business opportunities (Alvarez & Barney, 2007; Sirén, Kothamäki, & Kuckertz, 2012), and accelerate the clock speed of technological change by launching innovations even more rapidly (Kuckertz, Kothamäki, & Droege gen. Körber, 2010; Teece, 2012).

The extant literature on entrepreneurship, innovation, and technology predominantly encounters the complexity of social interactions by employing sets of simplifying assumptions that enable the systematic empirical examination of cause–effect relationships (Leitch, Hill, & Harrison, 2010). In the quest for more rigorous research, scholars have invested considerable efforts in improving the measurement of examined phenomena (Hibbert, Sillince, Diefenbach, & Cunliffe, 2014) and constricting the research results to larger sets of boundary conditions (Alvesson & Sandberg, 2014). Although the applied methodologies have become ever more sophisticated and have contributed to more rigorous examinations in entrepreneurship, innovation, and technology research, the continued reliance on simplifying assumptions has promoted "variable and measurement-driven" (Van Maanen, 2015, p. 35) research results that cannot capture the complexity of social interactions (Cunliffe, 2010). Accordingly, scholars increasingly raise concerns about the cumulative body of empirical research that is "somewhat simplistic, ahistorical, decontextualized, reductionist, aphilosophical, and nonreflexive" (Prasad & Prasad, 2002, p. 5; see also Hibbert et al., 2014; Leitch et al., 2010; Pratt, 2008).

In the face of these concerns, the purpose of this chapter is to contribute to the ongoing debate about how to examine complex phenomena in entrepreneurship, innovation, and technology research in three ways. First, this chapter aims to offer qualitative research as one viable methodological option to cope with, capture, and better understand complex phenomena in entrepreneurship, innovation, and technology research. Qualitative research methods refer to a set of techniques to collect and analyze non-quantitative data to examine social phenomena (Pratt, 2008). Social scientists have long applied qualitative research methods across many fields and disciplines (Van Maanen, 2015). Along with the increasing number of unique

and much-cited contributions, qualitative research has entered the mainstream of most fields and disciplines of social science (Hoon, 2013). However, despite its large potentials, qualitative research is still located at the periphery of entrepreneurship, innovation, and technology research (Leitch et al., 2010; Short et al., 2010). To make the case for qualitative research methods to examine complex phenomena in entrepreneurship, innovation, and technology research, we draw on von Foerster's (1985, 1993, 2003) distinction between 'trivial' and 'non-trivial machines' to unbundle the challenges of exploring complex phenomena and show that qualitative research methods are well-suited to cope with these challenges.

Second, this chapter aims to propose an analytical approach for the examination of complex phenomena using qualitative research methods. Whereas qualitative research methods have often been criticized for insufficient prescriptive advice on how researchers can draw theoretical inferences from qualitative data (Klag & Langley, 2013), we offer a systematic approach for the qualitative examination of complex phenomena. This analytical approach hinges upon the identified challenges of empirically examining complex phenomena and provides guidance on how to gain a better understanding of these phenomena.

Third, this chapter aims to illustrate how researchers may apply the proposed analytical approach 'in practice.' In particular, we examine the evolution of strategic trajectories in haute cuisine restaurants and how and why they are shaped by different ways to innovate. Using the proposed analytical approach, we explore different strategic trajectories and associated innovation approaches as well as their underlying mechanisms. The illustrative analysis of the cases indicates that, although the empirical examination of complex phenomena imposes severe challenges on researchers, the proposed analytical approach provides a practical and helpful means for the systematic examination of complex phenomena based on qualitative data.

The remainder of the paper is organized as follows. First, we unbundle the challenges that are associated with empirically examining complex phenomena. Second, we argue that qualitative research methods are well-suited to unpack the complexity of empirical phenomena and propose a procedure that allows researchers to do so. Third, we illustrate the use of the proposed analytical approach by examining the strategic development and innovation activities in haute cuisine restaurants. Forth, we conclude this chapter by discussing our conceptual and empirical considerations.

2 Key Challenges of Examining Complex Phenomena

An empirical phenomenon can be described as complex when the number of its elements is larger than the number of elements that an observer is able to connect with one another (Luhmann, 1995). This definition of complexity relates to other definitions in the previous literature (e.g., Anderson, 1999; Levy, 1994; McKelvey, 1999) and suggests that complexity does not exist without an observer that has

limited combinative capacities (Weick, 1995). Accordingly, complex phenomena impose challenges on researchers as one group of observers that aim to draw inferences about causal relationships. To illustrate and clarify the challenges of empirically examining complex phenomena, we rely on von Foerster's (1985, 1993, 2003) distinction between trivial and non-trivial machines (Antonacopoulou & Tsoukas, 2002; Hendry & Seidl, 2003; Koch, 2011).

A *trivial machine* refers to an unambiguous and invariant relationship between input (stimulus, cause) and output (response, effect). Because this relationship is permanently fixed, it is deterministic in that it reliably transforms the same input to the same output. Furthermore, because this relationship does not change over time, it is independent from past transformations and predictable for future transformations. Therefore, observers may interpretatively reconstruct the mechanism that transforms input to output by tracking the output that the machine produces for different inputs.

Non-trivial machines differ from trivial machines in that self-organized processes take place; i.e., non-trivial machines recursively change their 'inner state,' i.e. the mechanism that determines the rules of how input is transformed to output. Its changes depend on prior inner states. Therefore, transformations from input to output depend on previous transformations. Furthermore, because of these self-organized processes, non-trivial machines do not necessarily produce output that observers would expect for certain inputs. Thus, predictions of output for certain inputs are practically impossible.

Von Foerster (1993) was one of the first to denote that researchers primarily treat complex phenomena as if they were trivial machines; i.e., they tend to reduce empirical complexity by employing sets of simplifying assumptions that enable the systematic empirical examination of cause–effect relationships. Recent works have highlighted that von Foerster's objection still seems to apply to the social sciences in general (Van Maanen, 2015) and entrepreneurship, innovation, and technology research in particular (Leitch et al., 2010; Short et al., 2010; see Black, Carlile, & Repenning, 2004; Danneels, 2007, Leitch, McMullan, & Harrison, 2013, for notable exceptions).

By introducing the distinction between trivial and non-trivial machines, von Foerster (2003) clarifies that treating social phenomena as trivial machines does not enable researchers to grasp their empirical 'reality.' Therefore, the scholar proposes to resist treating complex phenomena as trivial machines and, instead, acknowledge complex phenomena as non-trivial machines. Yet, the empirical examination of non-trivial machines does not remain without serious challenges. Thus, from von Foerster's distinction, we can derive four key challenges of examining complex phenomena:

Lack of Control To reconstruct the transformational mechanism of trivial machines, researchers may collect information on the output it produces when they feed it with different inputs. Once researchers are aware of the transformational mechanism, they are able to control the trivial machine; i.e., they can produce predictable output by manipulating the input. In contrast, the output of non-trivial

machines is inherently unpredictable. The lacking predictability of non-trivial machines suggests that researchers are hardly able to manipulate complex phenomena in a deliberate way. This characteristic of non-trivial machines indicates that researchers lack control over complex phenomena (Weick, 1995). Therefore, thoroughly examining complex phenomena does not seem possible by manipulating inputs and tracking produced output.

Non-linear Dynamics Trivial machines are static in that they reliably reproduce output for certain inputs over time. In contrast, non-trivial machines change their internal mechanisms over time. This characteristic of non-trivial machines suggests that selective observations at specific points in time have only limited power to help researchers unpack complex phenomena. Instead, it seems that researchers are required to reconstruct the development of complex phenomena over time (Rothmann, Wenzel, & Wagner, 2014; Weick, Sutcliffe, & Obstfeld, 2005). In addition, the recursive change of inner states of non-trivial machines indicates that researchers face non-linear change whose scope of possible outcomes exceeds researchers' abilities to construct linear cause–effect relationships (Sydow, Schreyögg, & Koch, 2009). Therefore, theorizing complex phenomena seems to require process-based instead of determinant-driven inferences.

Context Dependence A key characteristic of trivial machines is that they provide reliable performance independent of time and space. Therefore, observers can expect reliable results from trivial machines independent of the context in which they operate. In contrast, the inner state of non-trivial machines also changes depending on the inputs that they transform. Consequently, the operations of non-trivial machines—at least partially—depend on their context. This issue indicates that complex phenomena are embedded in a context and can hardly be understood without putting them into perspective (Vaara & Durand, 2012; Wenzel, Rothmann, & Koch, 2014). In fact, researchers who examine a complex phenomenon may even struggle with clearly distinguishing it from its context (Phillips & Hardy, 2002).

Observing the Invisible Researchers may analytically reconstruct the inner logic of a trivial machine by observing the output it produces for certain inputs. Such "first-order observations" (Schreyögg & Kliesch-Eberl, 2007, p. 927) hardly seem applicable for the empirical examination of complex phenomena. Because the prediction of the output of non-trivial machines exceeds an observer's combinative capacities, unpacking complex phenomena by tracking inputs and outputs "amount [s] to the blind spot of any first-order observer" (Schreyögg & Kliesch-Eberl, 2007, p. 927); i.e., the transformational mechanism becomes invisible as a 'black box.'

While these key challenges of empirically examining complex phenomena address different aspects, they share that the traditional approach of *observing* input and output to collect data on trivial machines and to interpretively assign cause–effect relationships seem hardly applicable for the examination of complex phenomena. Therefore, von Foerster (2003) proposes the use of methods that help researchers *understand* the 'eigenvalue' of complex phenomena, i.e., the inner logic

to which complex systems recursively refer when they act. Thus, instead of leaving the 'black box' closed by reconstructing the transformational mechanism based on observed input–output relationships, the scholar proposes to 'open the black box.' The scholar's proposition follows the insight that, despite the lacking predictability of produced output, a non-trivial machine itself observes and enacts a complex environment of potential inputs from the background of its inner logic (von Foerster, 1984, 1991; see also Luhmann, 1995). Thus, understanding the inner logic of non-trivial machines requires researchers to conduct "second-order observation[s], i.e., an observation of first-order observers" (Schreyögg & Kliesch-Eberl, 2007, p. 927; Sydow et al., 2009). In the following, we propose that qualitative research methods are well-suited to conduct second-order observations and, with that, to address the key challenges of examining complex phenomena described above.

3 Using Qualitative Research Methods to Examine Complex Phenomena

Qualitative studies can take on many forms, such as case studies (Yin, 2014), grounded theory approaches (Glaser & Strauss, 1967), discourse analyses (Phillips & Hardy, 2002), and ethnographic approaches (Van Maanen, 1979) (see also Neergard & Ulhøi, 2008, for a comprehensive overview). They have in common that they rely on a set of techniques to collect and analyze non-quantitative data for the examination of social phenomena (Pratt, 2008). These data help researchers draw theoretical inferences from analyses of a small number of unique and/or extreme cases in which the phenomenon of interest is particularly salient (Eisenhardt, 1989; Siggelkow, 2007; Strauss, 1987).

As qualitative studies rely on a small number of selected cases, the purpose of qualitative research is not to develop theoretical insights that are generalizable to a large statistical population. Instead, the purpose of qualitative research is to gain an *in-depth understanding* of social phenomena to draw theoretical inferences that are *analytically generalizable* (Eisenhardt, 1989; Yin, 2014). To clarify the difference between statistical and analytical generalization, it is important to acknowledge that both refer to different levels of inferences (Yin, 2014). Statistical generalization relies on the sample logic and allows inferences from a smaller sample to a bigger population. In contrast, qualitative studies rely on theoretical abstraction as the key instrument to achieve analytical generalization, i.e., to infer from the empirical findings to theoretical conclusions. Therefore, qualitative researchers develop a generalized argumentation that is grounded in, but abstracted from, the data (Yin, 2014). In doing so, the theoretical results become logically transferrable to different empirical settings (Lincoln & Guba, 1985).

With this general aim, qualitative research is well-suited to provide an in-depth understanding of complex phenomena. Instead of reducing complex phenomena to

trivial machines, i.e., linear and stable input–output relations, qualitative research embraces the ambiguity and 'messiness' of complex phenomena by "moving from a shapeless data spaghetti toward some kind of theoretical understanding" (Langley, 1999, p. 694). In this way, qualitative methods help researchers open the black box of complex phenomena by gaining an in-depth understanding of the inner logic (Langley, Smallman, Tsoukas, & Van de Ven, 2013). In particular, the following key characteristics of qualitative research indicate its suitability for gaining an understanding of complex phenomena.

Lack of Control over the Studied Phenomenon While other research methods rely on manipulations of the studied phenomenon, qualitative researchers engage with the phenomenon to gain an understanding of it (Gioia, Corley, & Hamilton, 2013). In doing so, qualitative research is suitable for the examination of phenomena that researchers can hardly control (Yin, 2014). Thus, once we accept complex phenomena as non-trivial machines that are uncontrollable (Weick, 1995), qualitative research becomes a methodological approach that is particularly suitable for the empirical examination of complex phenomena.

Longitudinal Research Designs As the inner logic of non-trivial machines changes over time in non-linear ways (Sydow et al., 2009), gaining an understanding of complex phenomena requires researchers to track the development of these phenomena over time (Rothmann et al., 2014; Weick et al., 2005). Thus, the examination of complex phenomena requires researchers to employ longitudinal research designs. Although qualitative studies may also employ cross-sectional designs (Eisenhardt, 1989), a key strength of qualitative research is that it enables researchers to focus on a small number of cases to accurately reconstruct their development over time or even to experience their development in real-time (Gioia et al., 2013; Langley, 1999; Yin, 2014).

Giving Consideration to the Context Avoiding the reduction of complex phenomena to trivial machines also means that qualitative researchers acknowledge that these phenomena are embedded in, and are inseparable from, their context (Vaara & Durand, 2012; Wenzel et al., 2014). Accordingly, giving consideration to the context is an essential part of gaining an understanding of complex phenomena through qualitative research (Eisenhardt & Graebner, 2007). In fact, the determination of how the examined cases differentiate themselves from, and enact, their context is essential for the reconstruction of their inner logic (Koch, 2008, 2011; Schreyögg & Kliesch-Eberl, 2007).

Rich Data The use of rich qualitative data enables qualitative researchers to gain in-depth insights into examined phenomena (Eisenhardt, 1989; Geertz, 1973). By collecting and triangulating data from various sources, qualitative research captures a variety of perspectives on examined phenomena (Van de Ven, 2007). Furthermore, qualitative research offers a broad range of functionally equivalent techniques that scholars can use to analyze and better understand phenomena from different theoretical and empirical angles (Eisenhardt, 1989; Langley, 1999; Yin, 2014). This high level of methodological complexity enables researchers to

understand especially complex phenomena (Easterby-Smith, Golden-Biddle, & Locke, 2008; Leitch et al., 2010).

With these characteristics, qualitative research addresses the challenges of examining complex phenomena and, therefore, becomes an attractive methodological approach for entrepreneurship, innovation, and technology research in the face of increased empirical complexity (Short et al., 2010; Wenzel, Wagner, Wagner, & Koch, 2015). Especially giving consideration to the context and triangulating rich qualitative data from different sources enable researchers to understand how the examined cases interpret the environment and themselves; i.e., researchers can reconstruct a set of basic assumptions that guide the cases' actions (Schreyögg & Kliesch-Eberl, 2007). While qualitative research methods have long been criticized for a lack of prescriptive detail on qualitative researchers can develop theoretical inferences from qualitative data (Klag & Langley, 2013), we propose to use qualitative research methods to reconstruct the basic assumptions in a systematic four-step process (Koch, 2008, 2011), from

- *Action*: what the cases 'do'/do not 'do'
- *Talk*: what the cases 'say'/do not 'say'
- *Reflection*: how the cases justify what they 'do'/'say', to
- *Basic assumptions*: in which premises action, talk, and reflection are embedded.

Whereas Koch (2008, 2011) used this analytical framework to analyze organizational paths, we argue that this four-step process provides a systematic framework for reconstructing the basic assumptions—i.e., the inner logic—of all kinds of complex, i.e., 'non-trivial,' phenomena through qualitative research. Using this analytical procedure, researchers become 'second-order observers' of complex phenomena: by identifying consistencies and inconsistencies within and between these levels, especially action and talk (Brunsson, 1989), researchers gain an understanding of how the analyzed cases interpret and enact environments that they also perceive as complex (Luhmann, 1995). In the following section, we illustrate how researchers may apply this analytical procedure 'in practice'.

4 An Examination of Strategic Innovation Trajectories in Haute Cuisine

4.1 Strategic Innovation Trajectories in Haute Cuisine as a Complex Phenomenon

Remaining competitive in turbulent environments requires organizations to continuously work on their strategic development. As entrepreneurial creativity and innovativeness have become recognized as crucial factors for assuring long-term survival and sustained competitive advantage, they have gained increased importance (Lampel, Lant, & Shamsie, 2000; Ottenbacher & Harrington, 2007a). This is

especially true in cultural and creative industries such as the haute cuisine: being a highly institutionalized field that is shaped by the external evaluations and expectations of leading gourmet guides, such as the Guide Michelin and the Gault Millau, restaurants in haute cuisine are constantly confronted with the need to innovate in order to remain competitive and maintain or improve their rating (Bouty & Gomez, 2013; Di Stefano, King, & Verona, 2014, 2015; Durand, Rao, & Monin, 2007; Fauchart & von Hippel, 2008). As creativity and innovativeness have evolved into being the key criteria for evaluation by the guides, the question of how haute cuisine restaurants develop over time in a strategic way is therefore closely related to their innovative activities (Ottenbacher & Harrington, 2007a). Therefore, the aim of our study is to gain a better understanding of the strategic trajectories, i.e., the development of product–market concepts (Burgelman, 2002), in haute cuisine and to examine how and why they are shaped by different ways to innovate. In fact, this interplay is a matter of complexity in that it exceeds researchers' calculative capacities to reliably predict input–output relationships (e.g., Weick, 1995) for the following reasons:

Lack of Control Innovation in haute cuisine finds its expression mainly through the dishes that are presented to the guests. These dishes are the output of an underlying innovation process that appears to be complex in nature (Stierand, Dörfler, & MacBryde, 2009). This process is based on creative leaps that are hard to predict based on mere observations of actions. Because it combines inputs in an extraordinary and surprising new way to assure the fulfillment of external expectations, predicting and controlling the output on behalf of the researcher is hardly possible (Ottenbacher & Harrington, 2007a; Senf, Koch, & Rothmann, 2014). It actually is the very essence of innovation to create results that differ in a certain degree from what has been known before and, thus, represent a blend of past and present (Messeni Petruzzelli & Savino, 2014).

Non-linear Dynamics Culinary innovation is a dynamic phenomenon that changes directions because of a multitude of partially contradictory factors (Bouty & Gomez, 2010; Svejenova, Planellas, & Vives, 2010), such as a plastic and dynamic institutional frame that does not lead to isomorphic (i.e., predictable) behavior (Senf et al., 2014). Therefore, predicting the strategic development of selected restaurants in haute cuisine from a single point of observation is nearly impossible. Instead, following the processes over a period of time not only helps us to understand their strategic unfolding but also to explain potential *differences* in the observed trajectories (Di Stefano et al., 2014). Only then can a contribution to the general understanding of the interplay between innovative activities and strategic development in haute cuisine be made.

Context Dependence The potential for, and outcome of, innovation processes in haute cuisine are highly dependent on the resources available and the people involved. Outcomes can differ depending on underlying motives of the chef de cuisine (Bouty & Gomez, 2010), the knowledge base and the teamwork (Bouty & Gomez, 2013), the products, tacit skills in creative thinking, and sources of

inspiration (Ottenbacher & Harrington, 2007b). Additionally, the expectations of the environment as observed by the restaurants can take a stake in considerations (Senf et al., 2014). Thus, in order to find the underlying causes for potential differences, a closer consideration of the respective context is necessary.

Observing the Invisible An understanding for the causes of the strategic trajectories cannot be generated with an outside view on the restaurants, but requires a look inside. Therefore, merely observing and comparing the output of the process over several cases would not suffice in order to understand the actual development process that we are interested in. The reason for that is that it would not help us understand *how* and *why* certain options are chosen over another and how inputs are combined. Thus, analyzing the strategic trajectories of haute cuisine restaurants and how they are shaped by those ongoing innovative activities requires us to open the black box and uncover the underlying processes.

4.2 Data

To deal with the complexity of the phenomenon at hand, we chose a qualitative case study approach to answer our research question (Yin, 2014). The data stems from a larger research project on the strategic development of haute cuisine restaurants that the second and third author of this paper cooperatively collected over a period of 2.5 years. We mainly relied on three data sources: interviews, documents, and participant observation. These data served as a means to get a deeper understanding of the matter and to view it from different angles to ensure data triangulation (Yin, 2014). We purposively focused our data collection on one specific geographical region, as cuisine is still a "regional phenomenon" (Durand et al., 2007, p. 416). In this way, we were also able to ensure the exposure to the same institutional context as well as economic conditions. Because of the duration of the study, we could observe innovation processes in real-time and link their outcomes to the resulting strategic trajectories of the respective organizations (Langley et al., 2013).

We selected the focal cases in a two-step procedure: after a pre-study with industry experts and critics, which served for our access to the field and the reconstruction of the institutional context (Senf et al., 2014), we contacted the relevant restaurants in the selected region for an initial interview. Out of the sample of 11 haute cuisine restaurants, we selected three distinct cases with apparent differences in their innovation process and strategic trajectory for the particular research question at hand. We repeatedly interviewed the chefs of these restaurants and intensely observed them in their innovation process by attending team meeting and brainstorming sessions, test cooking, and dinners. Additionally, we collected secondary data in form of their menus, newspaper articles, and critiques. Overall, for the in-depth analysis of the three cases, we drew on 17.5 h of interviews, 30 h of observation, and 590 pages of documentary material. These data complemented the other data gathered in interviews with industry experts and critics (21 h) as well as

with other restaurants (23.5 h of interviews plus 22 h of observation). We recorded and subsequently transcribed all interviews for further analysis. We analyzed the data with the help of the computer-aided coding software *Atlas.ti*. The software served as a means to construct a case-study database to increase reliability (Yin, 2014) and to structure the data into selected coding categories, which enabled us to develop and compare emerging themes.

To analyze the data, we developed four coding categories that closely followed the proposed analytical approach and paid particular attention to *action*, *talk*, *reflection*, and *basic assumptions* (see also Wenzel, in press).

- *Action*: Refers to observable decisions and actions taken within the innovation process, from the initial generation of ideas until the implementation of a dish on the menu. We particularly looked at the amount and the frequency of changes and what remained constant.
- *Talk*: Refers to what the cases 'say' about their innovative activities and their importance within the strategic development of the restaurant. Here we particularly looked at to which degree the cases talk about innovation as a central element of the daily and long-term business.
- *Reflection*: Refers to how the cases justify what they 'do'/'say' with regard to their innovation process and strategic trajectory. Here we also looked at how consciously aware the cases were of the consequences of their action/talk and in what way those were taken into consideration.
- *Basic assumptions*: Refers to the underlying premises into which action, talk, and reflection are embedded. Here, we looked at the reasons that explained the observable behavior, talk, and reflection and which referred to the interaction with the environment, i.e., the customers (and critics), as they are the target of strategic action.

We coded the data across all cases by following the proposed step-wise process; i.e., we sequentially searched for instances in our data that described the cases' actions, talk, and reflection. Although the underlying basic assumptions emerge from the researchers' interpretation as a result of cycling through action, talk, and reflection, we also coded representative instances in our data that matched with our interpretation of the basic assumptions. Because our interpretation of the underlying basic assumptions evolved over time as our coding progressed, we re-coded the data with regard to the basic assumptions several times until the coded instances gained coherence with the upper level, i.e., coded instances on the reflection of the analyzed cases. By comparing and contrasting the cases along the coded dimensions in a tabular format (Langley, 1999), we identified notable differences between the cases (see Table 1). These patterns helped us discern three different strategic trajectories that evolved over time and observe their causes and consequences.

Table 1 Exploring strategic innovation trajectories in haute cuisine along the four-step process

	Case A	Case B	Case C
Action	Minor changes to a small amount of dishes while keeping the rest of the menu constant for a long period of time Every 4–6 months	Regular changes to selected amount of dishes leading to a smooth transition to a new menu over time Every 3 months	Radical changes to all dishes on the menu with no repetition of the past Every 2–3 months
Talk	The aim is to find the perfect product and the perfect way to present it and to achieve the same high quality in that endeavor every night. Innovation is only necessary to adjust to seasonal changes in products.	The aim is to continuously work on the improvement of existing dishes while also testing new ideas once a week. A continual process needs to be installed in order to avoid stagnation and boredom.	The aim is to completely reinvent oneself on a regular basis and to surprise the guests with drastically new inventions, although accomplishing such changes is a constant struggle.
Reflection	On having found 'perfect recipes' that need not to be changed, on the majority of regulars, on having the best product quality ("the product is the star"), on continuity	On wanting to bridge past, present, and future, on enjoying the evolution of a dish, on not needing to change the whole menu at once	On the necessity of change, on the rising problems with being associated as very innovative, on the impossibility to change the concept despite problems
Basic assumptions	The guests come for signature dishes and want to know in advance what they can order. Continuity and reliability are the keys to success.	Continuously improving dishes as well as keeping the balance between old and new inventions is the perfect mixture.	Constant and radical change is what the guests expect and what constitutes the competitive advantage.

4.3 Findings

The trajectories that emerged based on the underlying processes differ with regard to their temporal orientation (Nadkarni & Chen, 2014; Shipp, Edwards, & Lambert, 2009), which seemed to influence the openness for new innovations. The cases all have in common that the trajectories were not planned as such but rather result from emergent (Mintzberg & Waters, 1985; Mirabeau & Maguire, 2014) and collateral effects (Sydow et al., 2009) of the chosen innovative actions that formed a certain strategic profile over time (Senf et al., 2014). In turn, this profile serves as a reference point for guests and critics alike and, at the same time, frames the innovation process through seemingly required conformity and through being closely attached to the basic assumptions.

4.3.1 Trajectory A: Past-Oriented

The strategic trajectory of Case A is shaped by a backward-looking focus with a strong emphasis on past achievements on which strategic actions are based. Due to the basic assumption that value is created through finding outstanding products and presenting them in *the* perfect way, preserving what has been found is more central than creating something new. Therefore, the scope for innovation is tightly constrained and 'signature dishes' take up most of the space on the menu. The restaurant kept the signature dishes constant and only—if at all—slightly adjusted these to fit the season. Hence, instead of moving forward, the restaurant's focus is on recreating the past. While this orientation leads to high stability and reliability for guests and critics as to what to expect, innovation only plays a minor role. However, the consequences of such a trajectory are not negative *per se*, as they are dependent upon the evaluation of the environment. In Case A, the more traditionally oriented Guide Michelin still values the high quality dishes alongside a very classical setting and has not reduced its rating—as opposed to the Gault Millau, which places a stronger emphasis on innovativeness and novelty (Senf et al., 2014). Yet, the trajectory might become problematic as soon as the external expectations do not reward the past-orientation any longer. Whether the restaurant would then be able (and willing) to change its current strategic behavior is questionable and points to the dangers of a potential lock-in (Sydow et al., 2009).

4.3.2 Trajectory B: Past-Present-Future-Oriented

As opposed to Case A, Case B has managed to keep a well-balanced portfolio of existing dishes and new inventions that bridge time and connect past, present, and future. Through continuously working on the existing dishes, they never evolve into classical signature dishes that are set in stone. Rather, they serve as *one* possible point of departure for the innovation process, in which they are re-arranged, improved, altered, and presented in a revised but related way. This approach ensures some kind of continuity for the guests, as they are able to observe and experience the evolution of an idea over time and re-try it in varying shapes and shades. The *other* future-oriented avenue for moving forward is the continual effort to innovate and develop ideas *independent* of what has existed before. Through this effort, the restaurant manages to present a balanced blend. This balanced portfolio enables the restaurant both to keep the trajectory open enough for innovations and to remain recognizable over time. This delicate balance resonates with the basic assumptions and the profile that have emerged.

4.3.3 Trajectory C: Future-Oriented

For Case C, the past is seemingly non-existent and the present is only a transition to the future. Accordingly, the focus is never on recreation but on default radical innovation. The detachment from the past (and present) becomes apparent in the imperative *not* to refer to anything that has been done before. As this approach excludes avenues for innovation that Case C has walked on before, this orientation toward the future leads to a (perceived) restricted scope of innovative ideas that can be selected. Furthermore, the attached creative profile does not seem to allow a divergence from the chosen path of conducting default radical innovation—at least not in a visible way. As such, the strategic trajectory of Case C can be considered equally restricting as the trajectory of Case A, although in the opposite way. Despite being seemingly open as compared to Case A, Case C is trapped in a different form of lock-in—one caused by the force to be *creative* and *new* at any costs. Here, the strict orientation toward the future along with a neglect of the past sets strict boundaries to the space of creations as to which innovative ideas *can*, and which ideas *cannot*, be included.

5 Discussion and Conclusion

The purpose of this chapter was (1) to make the case for qualitative methods as one valuable methodological approach to gain a better understanding of complex phenomena in entrepreneurship, innovation, and technology research, (2) to propose a systematic analytical approach with which researchers are able to unpack complex phenomena based on qualitative data, and (3) to illustrate how this analytical approach enables researchers to gain a better understanding of complex phenomena by applying it to the qualitative exploration of strategic innovation trajectories in haute cuisine. In the following, we discuss our conceptual and empirical considerations along these lines.

5.1 Making the Case for Qualitative Methods in Entrepreneurship, Innovation, and Technology Research

Whereas qualitative research methods have become increasingly popular in the broader social sciences (Hoon, 2013), they still remain underrepresented in entrepreneurship, innovation, and technology research (Leitch et al., 2010; Short et al., 2010). Given that empirical phenomena in these fields of research have largely become highly complex (Alvarez & Barney, 2007; Kuckertz, Kothamäki, & Droege gen. Körber, 2010; Sarasvathy, 2001; Sirén et al., 2012; Zolin et al., 2011), we

argue that qualitative research methods are one attractive methodological option to grasp the complexity of empirical phenomena in entrepreneurship, innovation, and technology research.

For this purpose, we relied on von Foerster's (1985, 1993, 2003) distinction between trivial and non-trivial machines to unbundle the challenges of examining complex phenomena and showed that qualitative research are well-suited to cope with these challenges. Whereas prior works have emphasized this distinction as a valuable approach to gain a better understanding of the challenges of empirically examining complex phenomena (Antonacopoulou & Tsoukas, 2002; Hendry & Seidl, 2003; Koch, 2011), we offer a more nuanced understanding of the challenges that are involved with examining complex phenomena. These nuances help us disclose, clarify, and better understand the suitability of qualitative research methods to gain in-depth insights into complex phenomena.

Although the identified challenges of examining complex phenomena point to the use of qualitative research methods, we denote that qualitative approaches are not universally applicable for all research aims: whereas qualitative methods help researchers gain an in-*depth* theoretical understanding of complex phenomena by finding answers to questions of 'how' and 'why,' other research methods may be more appropriate when the research aim is to generate theoretical insights that are generalizable to a *broad* statistical population (Eisenhardt, 1989; Yin, 2014). Yet, by emphasizing the potentials of qualitative methods for this distinct class of research aims in the face of complex phenomena, the paper may provide a step forward to establish a legitimate position of qualitative methods as one among other valuable methodological approaches in the mainstream of entrepreneurship, innovation, and technology research.

5.2 *Proposing a Systematic Analytical Approach to Explore Complex Phenomena Based on Qualitative Data*

Besides making the case for qualitative methods to explore complex phenomena in entrepreneurship, innovation, and technology research, we also proposed an analytical approach with which researchers may gain a better understanding of complex phenomena using qualitative data. In particular, we proposed to reconstruct the inner logic of complex phenomena by relying on a four-step process from actions, talk, reflection, to basic assumptions (Koch, 2008, 2011).

Qualitative research methods have long been criticized for their imprecision with regard to the process of how researchers can generate theoretical inferences from qualitative data (Klag & Langley, 2013). By unbundling the challenges that the examination of complex phenomena impose on researchers, we emphasized that gaining a theoretical understanding of complex phenomena requires researchers to focus on the reconstruction of the inner logic of these phenomena, i.e., the underlying basic assumptions. Accordingly, the proposed analytical approach guides

researchers toward the underlying basic assumptions in a step-wise process. Thus, it offers a systematic way of gaining a better understanding of all kinds of complex phenomena that can be described as non-trivial machines.

Although the proposed approach provides a more precise description of the analytical process from qualitative data to theoretical inferences, it leaves a remaining range of variety with regard to the generation of research results. As Langley (1999, p. 691) denoted, "no [qualitative] analysis strategy will produce theory without an uncodifiable creative leap, however small." Accordingly, even the systematization of the analytical process for the examination of complex phenomena requires researchers to creatively engage with the gathered data—which is a core strength of qualitative research (Klag & Langley, 2013). For this purpose, the proposed systematic approach provides a broad epistemological access to qualitative data and, at the same time, reduces the complexity of analyzing qualitative data by directing researchers' ontological attention toward reconstructing the underlying basic assumptions. In this way, the proposed analytical approach constitutes a practical tool for researchers to engage with qualitative data in order to gain a better understanding of complex phenomena; it complements other strategies for analyzing qualitative data (Langley, 1999) and, as shown in the empirical section of this paper, may be used jointly with existing analysis strategies to develop theoretical inferences.

5.3 Illustrating the Use of the Analytical Approach in the Haute Cuisine Context

To illustrate how researchers may use the proposed analytical approach in practice, we applied this approach in a case study of strategic innovation trajectories of haute cuisine restaurants. In particular, we were interested in the evolution of strategic trajectories in haute cuisine restaurants and in how and why these trajectories are shaped by different ways to innovate.

Using the proposed analytical approach, we found three shapes of strategic innovation trajectories on the action level: strategic persistence with little innovative efforts, continuous strategic evolution with a carefully balanced portfolio of (slightly modifying) existing and new products, and radical strategic renewal with massive innovative efforts. By reconstructing the basic assumptions of the cases, we found that these trajectories seemed to be inspired by different temporal orientations: whereas strategic persistence seems to be guided by the belief that the organization's success relies on reproducing past excellence, radical strategic renewal seems to result from enacting the belief that success requires the generation of future novelty. Both trajectories exhibit a form of path dependence (Sydow et al., 2009): whereas strategic persistence results from a constrained scope for innovative activities due to commitments to past successes, radical strategic renewal is narrowly bound to innovative activities that generate future novelty. Only continuous

strategic evolution seems to escape the traps of path dependence. Our analysis indicates that, in contrast to a vectorial orientation toward the past or future, this strategic innovation trajectory is guided by a multi-directional orientation toward the past, present, and future in which success is believed to result from both reliably reproducing existing ideas and, at the same time, continuously developing innovative ideas that gradually advance the overall portfolio.

The illustrative analysis of the cases indicates that, although the empirical examination of complex phenomena imposes severe challenges on researchers, "all this can [...] happen because these systems operate recursively" (von Foerster, 2003, p. 313); i.e., the analyzed organizations enacted their own basic assumptions that constitute the underlying logic of seemingly unpredictable change. Therefore, reconstructing these basic assumptions enables researchers to gain a better understanding of the inner logic of complex phenomena, such as strategic innovation trajectories, and to draw theoretical inferences about how and why they occur. We hope that the illustrative application of the proposed analytical procedure inspires the use of qualitative methods in entrepreneurship, innovation, and technology research in future empirical inquiries.

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Effectuation and the Think-Aloud Method for Investigating Entrepreneurial Decision Making

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Abstract Research on effectuation has the opportunity to advance from an intermediate development stage along two main directions. First, effectuation exists as an alternative to classical models for testing hypotheses; and second, effectuation has introduced a grounded approach that envisions new theoretical elements and further theories. In this chapter, I discuss the potential effectuation has for both theory testing and theory building. I present the methods from which effectuation theory emerged, namely the think-aloud method, and their protocols and content analysis. I offer hints for the implementation of such methods and provide an illustration from a related research project. I also discuss sample size and elicitation tool construction. I conclude with limitations of the effectuation approach to research.

Keywords Effectuation • Entrepreneurial decision making • Think-aloud method

1 Introduction

Understanding the decisions of entrepreneurs has traditionally been a challenge for scholars of both decision making and entrepreneurship. The fact that entrepreneurs typically assume huge risks and take decisions within settings that are largely ill-structured and indefinite, poses significant problems for classical models. To address these problems, scholars have a) attributed to entrepreneurs an extreme risk propensity, which earned them the image of the fool gamblers (Foss & Klein, 2012), and b) reduced entrepreneurial indefinite-decision settings to the subset of 'relevant' settings according to an ex-post perspective. While this approach can build on the plethora of studies and advancements made within the classical decision-making models, such richness is achieved through a simplification of the peculiarities of entrepreneurial decision making. Some studies have offered a genuinely different perspective called effectuation (Dew, Read, Sarasvathy, & Wiltbank, 2009; Sarasvathy, 2001, 2008; Sarasvathy, Simon, & Lave, 1998). This

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_9

neologism emphasizes that entrepreneurs focus on the set of *possible* alternatives, rather than on the indefinite set of *desired* goals as in classical models, and effectuation theory pinpoints the process of shaping and crafting entrepreneurial ventures rather than a process of assessing them. Effectuation has been able to speak both to theory and practice, as proven by the diverse events hosted at academic conferences and its adoption at entrepreneurial education initiatives, indicating that the theory mirrors real phenomena.

While effectuation still needs theoretical refinements and further empirical validation (Arend, Sarooghi, & Burkemper, 2015), it provides great opportunities to understand the original structure and process of entrepreneurial choice in at least two different ways. First, effectuation has become an alternative perspective to mainstream axiomatic classical models of decision making. It is another reference model against which empirical data can be matched and hypotheses can be tested. This is especially relevant given that empirical evidence is often controversial and does not always seem to consistently support classical decision models. Second, effectuation is an empirically grounded theory of entrepreneurial decision making that has been developed through peculiar methods, such as the think-aloud method. These methods are seldom adopted in the broader literature on entrepreneurial decision making; however, they have the potential to further develop the theory on entrepreneurial decision making, as shown by the innovativeness of effectuation theory. Studying effectuation provides the opportunity to understand these methods better, which may allow to expand our theories and understanding of entrepreneurial decision making even over and above effectuation itself.

Trying to move on from an intermediate stage of evolution in which the model is being validated (this stage has been recorded in 2012 by Perry, Chandler, Gaylen, & Markova), this chapter focuses on the two high-potential roles effectuation can have in the next research on entrepreneurial decision making. Effectuation can be used as 1) an alternative to classical models for testing hypotheses and 2) a grounded approach to entrepreneurial decision making and a mix of methods that support the identification of new theoretical elements or even further theories.

As an illustration of both roles, this chapter will refer to the research I conducted with Della Valle from 2013 to 2015, in which we replicated the experiments by Sarasvathy. This allows for learning the original methods and for identifying some hints in their implementation that will be reported later. We tested the effectuation model with a different sample, providing an extension of the available evidence. Then, we tested the role of gender within the effectuation model. The results of this part are published (Della Valle & Frigotto, 2015). Finally, we tried to expand the theory with new categories and variables.

This chapter will devote more room to methods adopted for the formulation of the effectuation theory, which is a topic seldom covered in the literature. I will present the methods and provide some hints for adopting them in research. Furthermore, I will discuss how such methods allow for addressing the complexity of natural entrepreneurial decision making and reflect upon how their adoption would deepen our current understanding.

In Sect. 2, I position effectuation theory with respect to classical models of entrepreneurial decision making. In Sect. 3, I review the literature on effectuation and show the potential of effectuation for future research. In Sect. 4, I discuss in depth the methods to conduct research with an effectuation approach, as well as its validity and its advantages. In doing so, I refer to my empirical research on effectuation and gender as an illustration. Finally, in Sect. 5, I mention the limits of the effectuation approach.

2 The Need for a Grounded Theory of Entrepreneurial Decision Making

The mainstream perspective on entrepreneurial decision making builds on neoclassical models grounded in the foundations defined à la von Neumann and Morgenstern (1944), and Savage (1954). They provide decision criteria that enable the achievement of goals through a selection of given alternatives, where choice derives from the ability to foresee consequences in uncertain futures, i.e. to map causally related alternatives into consequences with some degree of probability.

Despite being largely adopted to model entrepreneurial decision making, such theories fail to represent the ontological state in which entrepreneurs typically make their decisions and act. They assume a pre-defined structure of decision problems, which is typically missing in entrepreneurial decision problems. Entrepreneurs who build new and innovative ventures deal with decision situations that are ill-defined and beyond their predictive knowledge. In fact, entrepreneurs create businesses that did not exist beforehand and shape the conditions of their success, rather than selecting them among a set of given conditions. In the decision-making language, this means that they take decisions in settings that are largely ill-structured and indefinite, and that the definition of the decision setting is part of the entrepreneurial decision-making ability. To describe this condition, it is useful to refer to Gilboa and Schmeidler's (1995) refinement of Knight's (1921) distinction between risk and uncertainty through the introduction of a third category labelled *ignorance*. *Risk* relates to a situation in which probabilities are given; *uncertainty* relates to cases in which states are naturally defined, but the translation into probabilities is not; *ignorance* refers to situations in which states are neither naturally given nor can be easily constructed (Gilboa & Schmeidler, 1995, p. 622). Adopting such distinctions, the entrepreneurial decision-making typically takes place in a condition of ignorance.

Effectuation scholars (Dew et al., 2009; Sarasvathy, 2008; Sarasvathy et al., 1998) started to develop their theory from observing how ignorance is structured, i.e. how decisions are taken in a setting that is inconclusive if genuinely considered within traditional models. This concerns the ancestral problem that classical models have relegated outside their focus, i.e. the construction of alternatives and states of the world.

Effectuation conceives entrepreneurship as a science of the artificial ruled by five principles (Sarasvathy, 2003; Simon, 1996). Such principles were derived from the observation of entrepreneurs' behavior during simulations concerning the start-up of a new venture (Sarasvathy, 2001). First, entrepreneurs consider their own means and define what goals they can achieve accordingly, while in models, goals are set first and means are searched to reach them. Second, entrepreneurs establish what they can afford to lose at each step of their venture creation, rather than defining a targeted return and then trying to limit the associated risk. Third, entrepreneurs share their ideas in trying to commit others into the development of the project, rather than seeing others as competitors and rivals. In fact, if the project is nor realized, there is no competition nor rivalry based on it. Fourth, rather than putting effort in predicting the future, entrepreneurs try to focus on the smaller reality they can influence through their action. Fifth, entrepreneurs leverage contingencies and surprises rather than minimizing or avoiding them. Such principles build a process that is highly feedback and contingency driven. Such interactions progressively define more precise means, and they do not cease until new markets, products, and firms are actually realized and working.

Research on effectuation has experienced an intermediate stage of development (Edmondson & McManus, 2007; Perry et al., 2012). Observed heuristics have been conceptualized into theoretical constructs, which have been refined, and validation is being conducted. Early empirical contributions on effectuation investigated how entrepreneurs think about new businesses and take some of the typical decisions to start an enterprise (Dew et al., 2009; Dew, Read, Sarasvathy, & Wiltbank, 2008; Sarasvathy et al., 1998; Sarasvathy & Dew, 2005). Some field studies have also been conducted (Sarasvathy & Kotha, 2001), as well as validation studies (Brettel, Mauer, Engelen, & Küpper, 2012; Chandler, DeTienne, McKelvie, & Mumford, 2011; Harms & Schiele, 2012; Werhahn, Mauer, Flatten, & Brettel, 2015; Wiltbank, Read, Dew, & Sarasvathy, 2009). And while still more research is needed to expand the effectuation theory both conceptually and empirically (Arend et al., 2015), effectuation is also being adopted as a framework where further hypotheses can be assessed (role 1). As an example, Blauth, Mauer, and Brettel (2014) studied the relationship between effectuation, causation and creativity; Engel, Dimitrova, Khapova, and Elfring (2014) tested entrepreneurial self-efficacy with effectuation; Murnieks, Haynie, Wiltbank, and Harting (2011) analyzed dyads of entrepreneurs and venture capitalists displaying effectual or causal orientations, Zhang and Cueto (2014) tested the biases of overconfidence and illusion of control in 123 nascent entrepreneurs, contrasting an effectuation and causation framework. We will mention the Della Valle and Frigotto (2015) study that examined the role of gender on entrepreneurial decision making within an effectuation framework. This area of research is interesting and promising because classical models have shown limits in matching real behavior. The availability of a different model to test hypotheses will enrich our understanding of observed decision making.

The study and replication of effectuation founding research suggests also another potential role. Effectuation has brought to the field of entrepreneurial decision making as an approach and a mix of methods, namely the grounded

approach (Glaser & Strauss, 1967) and the think-aloud method (Ericsson & Simon, 1993). This can lead to modifying extant models or even developing new ones, as Sarasvathy (2008) did with effectuation (role 2). The next section will illustrate this latter potential, in particular.

3 Effectuation and Its Methods: A Legacy and a Potential

Besides the content of the theories, effectuation and classical models differ on several fundamental aspects. To start with, they derive from a different approach to research and to theory building. Classical models have a strong axiomatic foundation; effectuation is inductive and is grounded in the observation of behavior. Note that their stance on empirical evidence is different: in classical models, evidence might confirm or disconfirm theories; in effectuation, evidence is used to build theories. In the classical perspective, the behavior expected by models is often assumed as the baseline in decision making, because it is the product of rationality. In fact, disconfirming evidence has seldom led to the reformulation of models, but has largely been interpreted as human mistakes of fallible minds (Frigotto, Rossi, Trento, & Zaninotto, 2014). Furthermore, in classical models, typically the observed behavior is understood only as revealing consistency or inconsistency to an already formulated model. This approach builds on a strong and robust structure against which data can easily be recorded, providing clear results. However, it also consists of a rigid structure, which constraints interpretation of results and hinders the emergence of alternative models. Conversely, effectuation was constructed as a theory that *represents* observed behavior because its definition derives from the collected evidence. As such, the replication of effectuation research supports the development of further fresh contributions to the literature on entrepreneurial decision making. Therefore, effectuation provides a grounded approach to produce theoretical reflections, or whole theories, that derive from the empirical evidence.

Different approaches also affect the methods and tools used to do the research. Decision making has largely been empirically observed through the experimental method aimed at eliciting a very specific behavior in a controlled setting. Typically, elicitation tools concern a choice or a set of choices among given alternatives. The experimental literature is debating whether experimental design and elicitation tools affect behaviors observed in the lab as a reaction to contrasting evidence addressing the same research questions. This would mean that experimental design is not neutral and may be related to the words used to describe the setting, the context of the whole experiment, the sequence, or other aspects. In such cases, the experimental design would not just measure behavior but would influence it in a non-controlled manner. In addition, the debate addresses whether observed behaviors in the lab would appear in the same way in natural settings, and this reflects on the artificial nature of simulated situations. In contrast, effectuation involves a design and set of elicitation tools that are closer to natural settings and actual decisions than in typical experiments. It provides (continuing the list from the last

paragraph): a method to elicit observed behavior, i.e. the think-aloud method, which does not capture just the outcome of thought but addresses the whole process of decision making; and defines a setting for eliciting behaviors that is highly realistic despite being simulated, because the decision maker receives a set of situation problems and is free to decide how to address and structure their solution, including what information to use to evaluate them.

4 Methods for Effectuation Research: A Discussion and an Illustration

4.1 Presenting the Scope and Aim of the Illustrative Study

In the following Section, I will describe the methods Sarasvathy (2001, 2008) adopted to produce her theory, and I will report methodological practices that support their validity. I will also exemplify a hypothesis test study adopting effectuation as a reference model. I will refer to the research project I conducted with Nives Della Valle (Della Valle & Frigotto, 2015). For each research design decision or implementation step, I will describe the motivation for the choices we made. Through this illustration, I provide the reader a detailed presentation of the effectuation approach and methods, which may lead to an impactful research on entrepreneurial decision making, namely in testing hypotheses and in theory building.

For this research project, we took the original setting defined by Sarasvathy for her seminal study (2008) and replicated the grounded approach with a different sample: students at the Department of Economics and Management and start-uppers at a local accelerator, with equal number of men and women. Through this replication, we became familiar with the methods, and we developed expertise in their implementation. As a result, we were able to identify two original concepts that were not overlapped with previous effectuation research. Then, we tested some hypotheses on the role of gender in effectual decision making. In fact, the literature on the topic did not converge to clear support or rejection of hypotheses formulated within the classical model of decision making. We tried to settle such controversial evidence by changing the investigation methods and framework. We i) elicited decision makers' behaviors adopting the thinking aloud method within ii) a simulated natural entrepreneurial setting. Then, iii) we conducted a protocol and content analysis of verbalizations to extract theoretical constructs from empirical evidence. Finally, iv) we matched them against the available effectuation constructs and measured the differences introduced by gender.

4.2 The Think-Aloud Method

Sarasvathy (2008) adopted the think-aloud method for her research on effectuation. The think-aloud method is widely used in psychology (Wertheimer, 2012) and has also been adopted to study different thinking processes and to study expertise in terms of processes, such as reading and language learning or problem solving in nursing and engineering (e.g. Funkesson, Anbäcken, & Ek, 2007; Sainsbury, 2003; see Lundgrén-Laine & Salanterä, 2010 or Koro-Ljungberg, Douglas, Therriault, Malcolm, & McNeill, 2013 for an overview).

The think-aloud method has typically been associated with protocol analysis for studying decision making in an information perspective approach, where the model developed by Newell and Simon (1972) is the reference point (Lundgrén-Laine & Salanterä, 2010). While the two methods are often combined, they are distinct and address different research design elements. The think-aloud method requires decision makers to give immediate verbal expression to thoughts while they are performing a task. The protocol analysis concerns the analysis of such elicited material, and addresses "the "step-by-step" progression of a person's problem-solving ability" (Lundgrén-Laine & Salanterä, 2010, p. 566). As such, protocol analysis defines what is observed by thinking aloud because it provides a theoretical interpretation for observation. Conversely, the think-aloud method alone does not embed any specific theory on the meaning of the empirics. Section 4.6 will provide a further discussion on protocol analysis and other methods for data analysis and interpretation.

The think-aloud method displays several advantages (Koro-Ljungberg et al., 2013). It allows the observer to collect vivid, unfiltered accounts that are also less linearized and rationalized compared to an ex-post account produced, for instance, in an interview. It generates data that are unfiltered and unprocessed. In fact, after initial moments of embarrassment, subjects performing their tasks are less focused on adjusting their responses or to confirming social expectations. Such data is richer, as it may convey values, beliefs, and assumptions. It is also less linear and reflects the typical back-and-forth transitioning between present experience, memories, and reflections, and naturally articulations of thought do not take the form of coherent narratives. Furthermore, when subjects verbalize thoughts, they share the alternatives they considered, how they assessed them, how they built them, as well as hesitations, inconclusive reasoning, and other forms of 'not-knowing' (Koro-Ljungberg et al., 2013, p. 737).

The observer records both verbalizations and performances during a think-aloud session. In other words, participants are asked both to perform a task and to provide a description of the cognitive process that they go through while performing it. This allows for collecting data both on introspection and on observable behavior (Ericsson & Simon, 1993). When participants do this simultaneously (concurrent think-aloud), data display a closer correspondence between introspection and observable behavior, which heavily reduces filtering and linearization. However, retrospective think-aloud is also possible, and it takes place when the moments of performance

and of introspection are separated. Participants are videotaped when they perform their task. Later, they watch their actions and verbalize their thoughts. This technique is especially useful when participants might use a foreign language for verbalization, for example within a multicultural study. In fact, the distinction of moments does not absorb cognitive load with the use of a non-first language (Lundgrén-Laine & Salanterä, 2010).

Scholars have argued that the think-aloud method does not influence the process of thought if some conditions are respected (Ericsson & Simon, 1993; Fonteyn, Kuipers, & Grobe, 1993). They are: i) the investigation does not address introspective capacity but verbalizations of a process of thoughts that is related to some task performance, i.e. the so-called *inner speech*; ii) questions asked along the task performance take the form of 'how' but never of 'why'; iii) responses occur within 5–10 seconds from the consideration of the problem; therefore, there is no time for elaborations.

4.3 The Sample Size

Nielsen (1994) showed that through a relatively small number of participants, it is possible to provide rich and extensive data for analysis. Some scholars have suggested as small samples, such as five, in order to achieve stable results, while others have criticized such reduced size but have stressed that more important than the sample size, for a think-aloud research, are the characteristics of the participants, particularly in terms of verbalization skills (Lundgrén-Laine & Salanterä, 2010). As a reference, the original study by Sarasvathy involved 27 responders. For our study, we considered a sample of 20 individuals as large enough for our research. Given our interest on gender, we selected to have two groups of a similar number of men and women. Ten participants were international students attending a master's program at the Department of Economics and Management at the University of Trento. The other 10 participants were working to establish start-ups in high technology within an entrepreneurship accelerator.

Such small samples are normal in the expertise literature; however, they are meager if compared to the standards in the entrepreneurship literature. However, in think-aloud studies, which are more diffused in the expertise literature, the unit of analysis is the semantic chunk and not the subject. As Dew et al. (2009) state: "Each subject therefore provides a large number of analyzable units of data rich enough to make comparisons of decent statistical power" (p. 300). For example, our database consists of 968 relevant chunks for our research.

4.4 The Elicitation Tool

Sarasvathy's (2008) elicitation tool consists of a written text asking the subject to play the role of a start-upper and to address some problems concerning the starting of a new venture. First, a description of the research setting, i.e. the start-up of a new venture, introduces the document. Then, the product is described and questions are asked that concern the typical decisions an entrepreneur would need to make. They are simple but might imply very broad answers. For example, they range from marketing choices such as 'Which market segment/segments will you sell your product to?' or 'How will you sell to your selected market segment/segments?' (Sarasvathy, 2008, p. 313) to HR decisions; situations are often described so that the subject can enter the simulated situation more realistically, for example:

> You are now in the eighth year of your company. You are doing very well surpassing growth targets and building reliable market share. Your sales are $30 million and you project a growth rate of at least 50 percent per year for the next three years. Your board's advice is to hire professional management to run the company so you can focus on issues of new growth and new strategic initiatives. Assuming you have already developed a short list of three high potential candidates to interview for the position of COO, how would you prepare for the interview? List questions you would ask, techniques you would use, and critical issues you would take into account in hiring this person. (Sarasvathy, 2008, p. 318).

We intervened in the original text by modifying the description of problems only where they needed to be updated with contextual details from the current business world. The problems were previously tested with expert entrepreneurs by Sarasvathy herself, who considered them realistic by capturing all the main issues concerning a start-up phase. Our responders assessed them similarly. While the elicitation instrument took the form of a written description of problems, research in other empirical fields has shown that video-based vignettes could also be adopted (Anderson-Lister & Treharne, 2014).

Both with written descriptions or visual representations of a situation, it is important to remember that only specific tasks can be elicited and fruitfully combined with the think-aloud method (Ericsson & Simon, 1993). For example, to ask to perform a start-up without further requests and details on the setting is too general and does not produce a useful thinking path for the purpose of studying the actual decision-making process. In fact, it would be more likely to stimulate reasoning that relies on abstract concepts and normative principles, because it is incapable of embedding the respondent into a specific situation he would need to address.

4.5 Preparation of Observers and Implementation

We trained observers on the method and especially on how to stimulate the participants along the problem-solving task. We shared the conditions of validity

Table 1 Practical tips for observers

Do	Don't
• Ask to read directions aloud, including tables! • Ask to give verbal expression to those thoughts that spontaneously emerge during the solution, with no concern of their consistency or correctness. • Elicit responses within less than 5–10 seconds. • Keep a journal on respondent's reactions and attitude to problems. • In general, talk as little as possible.	• Do not ask why. • Do not allow long response latencies (without words).

I mentioned in Sect. 4.2 in practical terms with some general indications (Table 1). Observers were also instructed not to interact with participants other than for reminding them to keep talking if they remained silent for more than a few seconds. Instructions were written, and participants were asked to read them aloud. This was made to build on an extensive set of instructions, as they strongly affect the level of verbalization that could be provided (Lundgrén-Laine & Salanterä, 2010). Responders had a presentation on the method that explained we wanted them to verbalize their 'inner speech' (Ericsson & Simon, 1993) and, in particular, that they did not have to be concerned with the consistency or the correctness of their thoughts. We considered it an indirect form of the literature's recommended training (Lundgrén-Laine & Salanterä, 2010). However, small problem-solving tasks can also be assigned to allow responders to practice with the method. A diary of the experiment was also maintained to note the responder's attitude, tone of voice, and other aspects revealing how the responder reacted to the questions in general. Verbalizations were recorded and accurately transcribed.

4.6 Protocol and Content Analysis

There are several methods that can be used to analyze think-aloud data. In the information processing tradition (Ericsson & Simon, 1993), protocol analysis has typically been used for that purpose. However, many diverse adaptations and interpretations of such analysis have been produced in various studies. For this reason, protocol analysis and content analysis have often been overlapped and confused. As Lundgrén-Laine and Salanterä (2010) note, scholars have highlighted a difference between content analysis techniques and protocol analysis (Corbin & Strauss, 2007; Ericsson & Simon, 1993; Miles & Huberman, 1994). In fact, content analysis allows for making interpretations and synthetizing the phenomena under observation by capturing direct or indirect meanings. Protocol analysis, however, is focused on a specific topic among the broader interpretation task pursued by content analysis; it aims at describing the thinking path of the decision maker and his decision-making process. Furthermore, protocol analysis envisages codification under a fixed set of three different codes, revealing the different elaboration

processes they require. Content analysis instead deploys along an open list of coding, which may capture contents, structures, effort in production, etc., and defines a method for further elaboration into constructs and categories that build a theory. Some contributions (Charters, 2003; Koro-Ljungberg et al., 2013) push for a broader qualitative stance on think-aloud data, which follows the content analysis approach. Following the Sarasvathy study (2008), we also adopted a content analysis approach devoted to extracting theoretical constructs from empirical evidence, with no constraints on the concepts and the process elements.

We encoded verbalizations into the NVivo 10 software for qualitative analysis following a grounded approach in two stages (Bryman, 2012). First, we performed a line-by-line coding, where semantic chunks of verbalized thoughts were categorized under codes that represented meaning and that were labeled thereafter. Semantic chunks were identified with a sentence, a sentence piece, or some words that reflect a specific meaning in the decision-making verbalization. An open coding characterized this first phase. We did not search for a pre-defined set of codes derived from theories nor from the effectuation theory. This allowed us to capture meanings that directly emerged from the empirical material and that had not been found in previous grounded research on effectuation. In the second phase, we conceptualized such meanings and confronted our empirically derived coding with concepts Sarasvathy (2008) had identified within the effectuation model.

4.7 Hypothesis Testing: The Role of Gender in the Effectual Framework

The choice of our research question was motivated from the observation that there is controversial evidence on the role of gender in decision making. Such evidence has mainly been provided within the framework offered by classical models of choice. Scholars have shown that gender mediates risk attitudes when decisions are taken in specific contexts (Dohmen, Falk, Huffman, & Sunde, 2006; Dohmen et al., 2011; Fehr-Duda, De Gennaro, & Schubert, 2006; Jianakoplos & Bernasek 1998; Powell & Ansic, 1997), but risk attitudes are unaffected by gender when decisions are framed in terms of gains (Agnew, Anderson, Gerlach, & Szykman, 2008; Schubert, Brown, Gysler, & Brachinger, 1999) and when probability distributions can be enacted (Bergheim, 2014; Voorhoeve, Binmore, & Stewart, 2012). Furthermore, the literature on entrepreneurship highlighted peculiarities of entrepreneurial decision making that are not mirrored in classical models of decision.

The literature showed that women display a stronger perception of negative outcomes than men. The interpretation has been that women fear to lose in a stronger way (Fujita, Diener, & Sandvik, 1991), but also that when the possibility of loss is presented as affordable, they are more inclined to choose it (Caliendo, Fossen, & Kritikos, 2009). This made us expect that women would display an effectual 'affordable loss' behavior more than men, but our data did not support

such a hypothesis. Surprisingly enough, our data showed a positive correlation between the knowledge of several languages and affordable loss, especially for women (0.7142), while age and affordable loss is more positively related for men (0.3202). We found a stronger relationship between age, knowledge of languages, and effectuation decision criteria taken together, both for men and women. Our analysis shows that in order to adopt the effectual decisional criteria, women need to be older and to know several languages. They also need to be endowed with a richer and more diverse set of information than men. This connects to previous studies claiming that gender difference in the perception of negative consequences is related to different access to information (Slovic, 1997). However, future research may want to consider the structure and richness of the arguments built to address the problems. Here, studies on the different reasoning of men and women may provide some background on the elements and aspects to observe. For this kind of research, the think-aloud method would be adequate once again.

5 Potential Versus Criticalities of the Effectuation Approach

In this chapter, we introduced effectuation as an approach that may greatly contribute to the research on entrepreneurship. Effectuation is a less consolidated theoretical model compared to classical models of decision making (Arend et al., 2015) and is also less adopted both for hypothesis testing and for theory building. However, it displays a high potential in providing different explanations to controversial evidence. Furthermore, it builds on a set of methods that differ to the typical methods adopted in laboratory experiments to observe behavior of the decision makers. Effectuation provides 1) an alternative model for testing hypotheses and 2) a grounded approach to entrepreneurial decision making, which envisions the identification of new theoretical elements or even further theories. While contributions on hypotheses testing are slowly cumulating, the potential of the effectuation approach and its methods has not been largely adopted. However, contributions deriving from such an approach may be highly innovative for the entrepreneurial decision-making field, as it has been for effectuation.

Besides such important advantages, it is necessary to mention that effectuation is a research approach that requires extensive effort and time in data collection. Verbalizations are elicited and recorded one individual at a time. In contrast, experimental data can be gathered on several respondents at the same time. Verbalizations have to be transcribed before they build a data set, while computer-aided experiments provide complete datasets as soon as the experiment is finished. Furthermore, data appear in the form of transcribed verbalizations that totally lack structure and meaning, while experimental data typically already represent variables' intensity. In addition, there is no immediate identification of variables involved nor of different values for these variables. These are severe

elements, particularly if compared to the time needed and the form assumed by data collected in the experimental laboratory. This major effort is compensated by a smaller sample size, which is related to the fact that the typical unit of analysis is the semantic chunk (Dew et al., 2009).

Effectuation builds on strong methodological bases, i.e. the think-aloud method and the protocol and content analysis method, which convey internal and external validity. As Charters (2003, p. 75) states: "Ericsson and Simon (1980) gave think-aloud research respectability among social scientists by arguing that researcher inferences about the meaning of think-aloud utterances are as objective as behaviorist inferences about the purpose of visible actions and can be quantified with equal validity". As such, it provides an interesting research approach that may broaden our understanding of entrepreneurial decision making.

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Applying Factorial Surveys for Analyzing Complex, Morally Challenging and Sensitive Topics in Entrepreneurship Research: The Case of Entrepreneurial Ethics

Petra Dickel and Peter Graeff

Abstract This chapter aims at showing the benefits of using vignette based factorial surveys for examining complex and sensitive topics in entrepreneurship, innovation and technology research. The example of research on entrepreneurial ethics is used to illustrate potential methodological problems. A literature review on entrepreneurial ethics shows that factorial surveys have rarely been applied despite its benefits with respect to disentangling the effects of interrelated variables and reduction of social desirability. As the rare reception might be due to lack of knowledge in how to design and carry out such studies, a guideline is provided in how to set up and conduct a factorial survey.

Keywords Business ethics • Corruption • Entrepreneurship • Factorial survey • Vignette study

1 Introduction

Consider the following situation: a technology startup has developed a new influenza vaccine. For conducting the ultimate tests some highly specialized labor equipment is necessary which is only located in an African research facility. When the founders started to plan the tests, they learned that they have to bribe one of the local authorities in order to get the permission to enter all the necessary chemicals for conducting the tests. According to local experts, there is a 10 % risk that the bribing is being discovered by the U.S. Securities and Exchange Commis-

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_10

sion (SEC). If so, the firm will face—according to the SEC standards—a fine of $2,500,000. Pre-clinical studies imply, however, an 80 % chance that the tests will confirm the vaccine's medical effectiveness. Then, the firm could expect profits up to $5,000,000. According to expectations by medical experts, the vaccine will decrease the death rate due to influenza by 0.5 %.

If you were the startup founder, how strong is your willingness to bribe the local authorities? Please answer on a scale ranging from 0 (no willingness) to 5 (maximum willingness).

The realization of innovative ideas might sometimes involve ethical challenges which occur due to situational constraints or due to certain business interests. Business decisions entailing entrepreneurship and innovation are complex and affected by the interplay of the founders or managers, the characteristics of the firm and its environment (Gartner, 1985). Complexity means that a multiplicity of factors exists that are more or less interwoven with each other. In order to set up and develop their venture, entrepreneurs have to make decisions based on factors that are ambiguous and can often not precisely be assessed. In research, this poses a challenge because the interconnectedness implies that it is hard to discriminate amongst the variety of factors. Accordingly, the difficulty to disentangle the effects of independent variables on the dependent variables may yield inefficient and inaccurate decisions.

A typical example of research that is characterized by complexity is (entrepreneurial) ethics. Ethical decision-making is usually determined by various factors and entail that people gauge what *can* and what *should* be done. Conflicts arising from the partly contrary notions of righteousness, social ramifications of business activities and economic profit-making have become key issues in entrepreneurship research (Hannafey, 2003; Morris, Schindehutte, Walton, & Allen, 2002). In order to understand and analyze the ethical dimensions of entrepreneurship it is, however, necessary to measure the impact of norms and motivational reasons for decision-making.

Operationalizing, measuring and observing ethically suspect intentions, attitudes, and behaviors are a demanding endeavor (Trevino, 1992). When measuring complex and highly sensitive topics, discrepancies are likely to occur between the reality and the subjective, sometimes purposely distorted, statements of respondents. The mechanisms of dealing with and resolving moral dilemmas are ambiguous and multifaceted phenomena which involve "a web of filters which are used in an inter-connected way" (Vyakarnam, Bailey, Myers, & Burnett, 1997, p. 1625) and are thus difficult to investigate.

Past research mostly adopted an item-based measurement of the various aspects of entrepreneurs' ethical intentions, attitudes, and behaviors (e.g. Ahmad & Ramayah, 2012; Khan, Tang, & Zhu, 2013; Tang, Khan, & Zhu, 2012; Tonoyan, Strohmeyer, Habib, & Perlitz, 2010), which poses the risk of oversimplifying the complex phenomena. Some researchers used case vignettes to account for the complexity involved in the topic (e.g. Bucar, Glas, & Hisrich, 2003; Longenecker, McKinney, & Moore, 1988). Case vignettes are hypothetical narrative descriptions of persons, objects or situations, which respondents are asked to evaluate. An

advancement of case vignettes are their application within factorial surveys which combine the advantages of surveys and experiments.[1] In a factorial survey, the dimensions (independent variables) within a vignette that are relevant for the study are randomly varied by the researcher. Thereby, the factorial survey is characterized by central elements of experiments in that the factors presented to the respondents are both controlled by the researcher and randomly assigned. Vignette based factorial surveys allow to disentangle the effects of complex cause-effect relationships and provide a higher realism than surveys based on single items or item batteries. Accordingly, factorial surveys can be considered as an effective tool for analyzing complex issues, in particular because they are proven instruments to gain an understanding of the principles and the decisive factors when people make judgments (Aguinis & Bradley, 2014).

In business research, many topics are subject to interrelated factors and/or sensitive issues (e.g. ethical behavior, narcissism, impression management, leadership, motivation, trust) and thus would benefit from adopting a factorial survey design. Nonetheless, the method has rarely been applied in entrepreneurship, innovation and technology research. Critics may point out that even if factorial surveys present a situation of decision, experiencing the same situation in real life might be different. We argue that vignette based factorial surveys enable to proximate experimental settings in these research fields, which are otherwise hardly amenable to real experimental testing due to the complex and realistic conditions and at the same time reduce measurement errors that may, for example, arise from social desirability. The chapter outlines the advantages and challenges of factorial surveys with regard to the investigation of complex topics. We use the context of entrepreneurial ethics to discuss the challenges involved with measuring interconnected and sensitive variables. A literature overview on entrepreneurial ethics research serves to demonstrate the limits of previous methodological approaches and to suggest how factorial surveys can be used to reduce some of the specific methodological problems. Subsequently, a guideline for adopting and implementing factorial surveys in entrepreneurial ethics research is given. The sample vignette from the beginning of this chapter serves as a means to illustrative some of the aspects that need to be considered when setting up a vignette based factorial survey. We conclude with recommendation for the general applicability of the method in entrepreneurship, innovation, and technology research.

[1] Aguinis and Bradley (2014) distinguish between two types of experimental vignette methodologies: (a) paper people studies in which vignettes are presented to respondents who then are asked to make explicit decisions, judgments and choices and (b) conjoint analyses and policy capturing studies in which participants are asked to make decisions between scenarios to assess implicit processes. In this chapter, we focus on factorial surveys that explicitly address processes and outcome, that is, what Aguinis and Bradley (2014) refer to as paper people studies.

2 Ethical Decision-Making in Entrepreneurship

Ethics commonly refers to the distinction between right and wrong and deals with moral judgments and norms (Morris et al., 2002). Widespread corporate malpractices and scandals have led to an increased interest in ethical conduct in business contexts both on the practitioner and academic side (see Craft, 2013; O'Fallon & Butterfield, 2005). In a new venture context, though, research on ethics[2] is still in its infancy (Harris, Sapienza, & Bowie, 2009).

Khan et al. define entrepreneurs' ethically suspect behaviors as "...those acts of omission or commission, by individuals acting in their entrepreneurial roles, which violate socially constructed normative, regulatory, and/or legal structures, on behalf of firm goals" (Khan et al., 2013, p. 638). Examples of such behaviors are inflating revenues by questionable accounting methods, bribing officials or giving inappropriate rewards to deciders in stakeholder firms. Liabilities of newness and pressures inherent in setting up a new venture may increase the chance that entrepreneurs engage in ethically questionable business practices to succeed against all odds (Bucar & Hisrich, 2001).

Entrepreneurs have to deal with unique ethical challenges that arise from their vulnerability to external forces, operational and financial pressures, lack of reputation and often overdependence on a limited range of products or services (Hannafey, 2003; Morris et al., 2002). Ethical dilemmas could arise from changing relationships with other individuals during the founding process, for example, when lending money from family members or friends is involved (Dees & Starr, 1992). Furthermore, the necessity to convince key stakeholders, such as customers and investors, may lead to a higher degree of impression management, over optimism and overenthusiasm that could limit entrepreneurs' ability in ethical judgment-making (Dees & Starr, 1992; Hannafey, 2003). Making ethical compromises, particularly in times of financial stress, can mean the difference between firm survival and failure (Morris et al., 2002). Moreover, ethical conduct in entrepreneurial firms may pay off less than pure profit orientation regardless of the ethical implications. Bhide and Stevenson (1990) argue that bad behavior often involves little penalty while good behavior is often not rewarded and sometimes even penalized. Thus, the adherence to ethical standards may neither be realistic nor feasible for entrepreneurs and could even negatively affect firm performance. Lack of capital and limited liquidity imply that entrepreneurs need to make decisions that, in case of failure, can endanger the very survival of the firm. With no clear guideline and a high degree of grey areas of what is considered right and wrong, entrepreneurs typically must rely on their own judgments. As entrepreneurs have to

[2] Research on the intersection of entrepreneurship and ethics can be divided into (1) entrepreneurship and society, that discusses the implications of entrepreneurial actions for economic development and social wellbeing, and (2) entrepreneurial ethics, that analyzes the moral attitudes and challenges of the individual entrepreneurs and their organizations (Hannafey, 2003). The focus of this chapter is on the latter, that is, entrepreneurial ethics.

deal with the every present risk of failure much more than established firms (Stinchcombe, 1965), these decisions frequently involve the dilemma between the desire to be ethical and the need to make profits and to survive (Robinson, Davidsson, Mescht, & Court, 2007).

Also, entrepreneurs possess unique personality traits that could affect their attitudes and behaviors with respect to ethical issues. While entrepreneurs generally have a positive image and are admired for their innovative forces, many are "perceived as willing to do almost anything to succeed" (Hannafey, 2003, p. 99). A rule-breaking attitude and non-conformist behavior are sometimes even considered synonymous to core entrepreneurial traits such as innovativeness and creativity (Kuratko & Goldsby, 2004). Thus, compared to other groups, entrepreneurs might be more prone to circumstances that require dealing with (and breaking of) existing social norms that potentially hinder their innovative forces.

3 Methodological Approaches in Entrepreneurial Ethics Research

Although a growing body has addressed ethical decision-making in entrepreneurship research, empirical evidence is still rare and sometimes even contradictory. Controversial findings exist, for example, whether entrepreneurs display higher or lower ethical standards than other individuals. Bucar et al. (2003) find partial support that entrepreneurs exhibit slightly higher levels of ethical attitudes than managers, while Longenecker et al. (1988) show that entrepreneurs reveal higher ethical values with regard to ensuring peoples' health but are less concerned with other ethical challenges, such as tax declaration, using inside information or collusive bidding. Among others, inconclusive findings might derive from samples based on different industries and countries. However, methodological issues could also play a role and distort results. Conducting ethic-related research in general, and in entrepreneurship in particular, is a difficult endeavor due to the social desirability and complexity involved (Hannafey, 2003; Trevino, 1992).

Methodological problems can arise from nonresponse and lack of valid data (McNeeley, 2012; O'Fallon & Butterfield, 2005). In entrepreneurship, obtaining an adequate number of key informants is a difficult task that affects entrepreneurship research in general. First of all, there are various views on what constitutes an entrepreneur and a new venture respectively (Hannafey, 2003). Second, entrepreneurs are often unwilling to devote too much of their precious time and decline to participate in surveys (Teal & Carroll, 1999). Third, a general hesitation exists with respect to the participation in ethic-related studies (Hannafey, 2003). Potential respondents may opt out of a survey, if it covers sensitive information. This obviously is the case for questions on unethical behavior that, if admitted by the respondents, could damage one's reputation and, in the worst case, even result in legal sanctions (Tracy & Fox, 1981).

Concerning the validity of data, measurement errors can arise from cognitive biases, that is systematic errors in judgment and decision-making which can be due to cognitive limitations, motivational factors, and/or adaptations to natural environments (Tversky & Kahneman, 1974). First, unethical behavior occurs relatively infrequently (Trevino, 1992), which implies potential recall biases on behalf of the respondents. Furthermore, persons with a history of unethical behavior will probably attempt to conceal it. Social desirability is particularly prevalent if the questions refer to very private information. As unethical behavior is typically considered morally wrong in a society, respondents may be reluctant to admit to such behaviors. Thus, self-reported data on ethical issues involves the risk that individuals portray themselves as more ethical than they actually are (Bucar et al., 2003). Respondent may purposefully misreport to present themselves in a better light, to avoid embarrassment and to prevent potential repercussions (Pridemore, Damphousse, & Moore, 2005; Trevino, 1992). Moreover, the use of standard item scales precludes to separately examine the effects of each independent variable, that is, do not allow to isolate the effects of explanatory variables on the explained variable.

To alleviate some of the measurement problems, particularly with respect to the validity of data, the use of case vignettes is the dominant methodology in ethical decision-making literature in business research (O'Fallon & Butterfield, 2005). Case vignettes are hypothetical narrative descriptions of objects or situations. Respondents are asked to evaluate each vignette with specific criteria (e.g. fair–unfair). The respondents give their assessment on a realistic bundle of information, that is, case vignettes account for the connectedness of independent variables. In entrepreneurship research, however, most researchers adopted an item-based measurement of various aspects of ethical intentions, attitudes, and behaviors while only a few studies included case vignettes or similar story-based techniques to account for the complexity and potential biases involved in measuring entrepreneurial ethics (see Table 1).

Although case vignettes enable to give a more realistic picture of the factors under investigation than item-based indicators, the relevant factors in the bundle do not vary from each other, which preclude a separate examination of the effects of each independent factor. Potential solutions to overcome the incurred methodological problems are vignette based factorial surveys. The method combines an experimental design within a survey and thereby not only enables to reduce social desirability but also to disentangle interconnected explanatory variables (Rossi & Anderson, 1982).

Aguinis and Bradley (2014) reviewed articles that were published between 1994 and 2013 in 30 major management related journals on the prevalence and use of experimental vignettes methodologies (which include both paper people studies and conjoint analyses/policy capturing methods[3]). The authors conclude that these methods are "clearly not a very popular methodological approach" (Aguinis &

[3] See footnote 1.

Table 1 Measurement of ethics-related variables in entrepreneurship research

Article	Research focus[a]	Data	Ethics-related measures		
			Rating scales	Case vignettes	Other
Khan et al. (2013)	Relation between dynamism, social capital, firm performance and entrepreneurs' *ethically suspect behaviors*	158 entrepreneurs	x		
Obschonka, Andersson, Silbereisen, and Sverke (2013)	Effect and gender differences of *rule breaking attitude and behavior* in adolescence on entrepreneurial status in adulthood	294 males, 370 females	x		x[b]
Ahmad and Ramayah (2012)	Prevalence of *ethical and socially responsible business practices* in ventures and their impact on performance	212 SME founder-owners	x		
Tang et al. (2012)	Impact of entrepreneurs' *ethically suspect behaviors* on effective information acquisition	139 entrepreneurs	x		
Tonoyan et al. (2010)	Impact of formal and informal institutions on *corrupt behavior* of entrepreneurs in transition and mature markets	2576 entrepreneurs and small firm owners	x		
Zhang and Arvey (2009)	Association among *rule-breaking behavior* in adolescence, risk propensity and entrepreneurial status	60 entrepreneurs and 105 managers	x		
Bryant (2009)	*Moral awareness* of entrepreneurs particularly with respect to social cognition aspect of self-regulation	30 founder-managers			x[c]
Bucar et al. (2003)	Differences in *ethical attitudes* between entrepreneurs and managers across different cultures	408 entrepreneurs and 210 managers in 3 countries	x	x	x[d]
Morris et al. (2002)	Prevalence of *ethical dilemmas* during venture development	227 CEOs or owners of small firms	x	x	x[d]
Teal and Carroll (1999)	Differences of entrepreneurs to non-entrepreneurs with regard to *moral reasoning skills*	26 entrepreneurs, 243 managers and 1149 adults	x		x[e]

(continued)

Table 1 (continued)

Article	Research focus[a]	Data	Ethics-related measures		
			Rating scales	Case vignettes	Other
Clarke and Aram (1997)	Culture specific differences of *ethical orientations*, among others with respect to *entrepreneurial dilemmas*	339 students in 2 countries	x		
Longenecker et al. (1988)	Differences of *ethical values and ethical business decisions* of entrepreneurs and non-entrepreneurs	158 entrepreneurs and 1866 non-entrepreneurs	x	x	

[a]Ethics-related variables are displayed in italic
[b]Official records (e.g. police records)
[c]Coded interview data
[d]Binary items
[e]Defining Issues Test

Bradley, 2014, p. 355). Our review supports this finding and shows that factorial surveys can be considered as a method only very rarely applied in entrepreneurial ethics. Reasons for the reluctance in using factorial surveys might be due to lack of knowledge in how to design and carry out such studies as well as lack of confidence in using experimental methods due to potential practical and logistical challenges involved (Aguinis & Bradley, 2014). To reduce potential doubts and fears of applying factorial surveys, the next section introduces the methodology in detail and offers a guideline how to plan and implement it in entrepreneurship research.

4 The Vignette Based Factorial Survey

The factorial survey originates from Rossi (1979) and Rossi and Anderson (1982) who investigated social judgments of households. Since then, it has been broadly employed in various disciplines such as sociology, medicine, law and psychology (Mutz, 2011). The method applies an experimental design within a survey. Survey participants are asked to respond to vignettes, which are "[. . .] carefully constructed description of a person, object, or situation, representing a systematic combination of characteristics" (Atzmueller & Steiner, 2010, p. 128).

Such characteristics contain factors (dimensions or independent variables) that are relevant for the study. The level of each of the dimensions is randomly varied by the researcher. Thereby, the factorial survey is characterized by central elements of experiments in that the factors presented to the respondents are both controlled by the researcher and randomly assigned (Auspurg, Hinz, & Liebig, 2009; Rossi & Anderson, 1982). By combining experimental settings with survey designs,

factorial surveys apply varying treatments to the respondents and allow straightforward conclusions about variations in the dependent variable because the randomization process cancels the influence of unobserved variables out. The construction of vignettes and their factorial designs presupposes that the researcher selects the relevant independent variables (factors) which may be hypothetically able to explain the dependent variable. Such factors refer either to theoretical ideas or to research hypotheses.

Consider the example from the beginning. The description of this situation provides information to the readers which are suspected to drive the ultimate decision about a corrupt transaction within an entrepreneurial setting. For generating such a vignette, one might refer to theoretical foundations such as the subjective expected utility model (Sattler, Graeff, & Willen, 2013) or studies which apply theoretical ideas about factors which influence corrupt behavior (Graeff, Sattler, Mehlkop, & Sauer, 2013). The vignette situation suggests an economic setting in which costs and benefits are relevant factors when deciding about bribing. Corruption is modelled here as a function of the costs or fine (C) when the corruption is discovered, the detection probability (p) and the benefits (B) if the corruption is successful:

$$\text{Corruption} = f\left(C,\ p,\ B_p,\ B_s,\ q\right) \tag{1}$$

The ethical decision is incorporated explicitly by adding a social benefit (B_s) to the firm profit (B_p). Since corruption is considered as a crime, it might involve itself an ethical issue. This could be outweighed by the opportunity to improve public health by decreasing the death rate due to influenza. The social and the firm benefits occur in the example with a probability of q (probability of benefits). In the example, the decision to bribe the local authorities is also assumed to depending on the fine/costs (C) and the probability by which the corruption is detected (p). The crucial information are varied across the factors (see Table 2).

Suppose the hypothesis is that entrepreneurs are more prone to justify their decisions to bribing by picking up self-justifying arguments. If so, the provision of public goods such as the social benefit B_s is tested whether it increases the likelihood of deciding to engage in corruption. In a factorial survey, factor B_s could—as an example—be varied by steps such as from 0.5 % to 1.5 %.[4]

Depending on the sample design and the sample size, one could also vary other factors such as costs or the detection probability. Each factor or dimension should

[4] Beside the aspects mentioned in the paper, considerations about the variation of factor levels can also regard practical issues for setting up the vignette such as that an odd number of levels might involve bigger difficulties to create sets of vignettes which are presented to a single respondent (so called decks or blocks). For the sake of simplicity and presentation, we refer in our example to an odd number of levels. In this regard one may also consider the argument that vignettes with the same number of factor levels allow in the analysis to approximately compare their regression coefficients. Research applications may adjust the number of levels according their needs.

Table 2 Suggestions for variation of levels and vignette text across factors

Vignette		
According to local experts, there is a p% risk that the bribing is being discovered by the U.S. Securities and Exchange Commission (SEC). If so, the firm will face—according to the SEC standards—a fine of $C. Pre-clinical studies imply, however, a q% chance that the tests will confirm the vaccine's medical effectiveness. Then, the firm could expect profits up to $$B_p$. According to expectations by medical experts, the vaccine will decrease the death rate due to influenza by B_s%.		
Dimension/factor	Level	Vignette text
Cost/fine (C)	1	$1,500,00
	2	$2,000,00
	3	$2,500,00
Benefit/profit (B_p)	1	$3,000,000
	2	$5,000,000
	3	$7,000,000
Social benefit (B_s)	1	0.5 %
	2	1.0 %
	3	1.5 %
Risk (p)	1	5 %
	2	10 %
	3	15 %
Probability of benefits (q)	1	70 %
	2	80 %
	3	90 %

be varied in order to test the hypotheses. Suggestions for the variation of each factor are provided in Table 2.

When setting up the factors and their levels, it is crucial that specific combinations of factor levels do not become unrealistic and may spoil the whole vignette. Consider a detection probability of 100 %. If the corruption is being unveiled for sure, it is highly unlikely that a respondent would be willing to engage in the bribing.

All factor combinations constitute the vignette universe which increases in size when the number of factors and their levels are increased. The vignette universe in our example consists of five factors or dimensions, each with three levels. This results in $3^5 = 243$ vignettes. Each vignette must be plausible and must provide clear information for evaluating the dependent variable. The number of factor levels should reflect the requirements for testing the hypotheses. If one assumes simple categorical differences, two levels would suffice. For ordinal (or simple linear) effects, one might refer to three or four levels as we suggested in Table 2. Testing more complex, e.g. non-linear effects might involve more levels per factors. When setting up the levels, one should bear in mind that smaller numbers of levels lead to leaner and more efficient vignette samples.

In the usual survey mode, respondents randomly receive several vignettes out of the vignette universe. By this, a variation of responses per respondent (within-

subjects) is gained. Moreover, there is also variation between respondents (between-subjects) if the same vignette is rated by different respondents. Concerning the number of vignettes per respondent, Auspurg and Hinz state (2015, pp. 48–49): "If only one respondent rates a single vignette, this vignette or experimental condition is completely confounded with the respondent's personal characteristics. Hence, several respondents should rate each single vignette [...]. We recommend allocating at least five different respondents to each vignette [...]." How many vignettes a respondent should evaluate is also a question of the sample size (of respondents) and, moreover, a question of the efficiency of the design (see Duelmer, 2007). If the vignette universe is too large to be applied, one could either draw random samples of vignettes or could use a fraction of the universe. In order to estimate the parameters, an efficient fractional design (e.g. the d-efficient design) seems to be superior over random samples as efficient designs regard for criteria such as orthogonality of factors and an equal frequency of levels (Auspurg & Hinz, 2015, p. 28).

The dependent variable in such a survey is usually measured as a response (such as a rating score). In the example, the willingness to engage into corruption is measured as an indicator for behavioral intention (Ajzen, 1991). Since most ethical topics also involve sensitive issues, it might be an advantage that the measured response is not a respondents' statement about past behavior or the prevalence rate. Moreover, it might be easier for study participants to reveal a behavioral intention than to actually act if ethically challenging behavior is considered which might be an advantage compared to experimental game settings. Obviously, the measured response—at best a behavioral intention—should not be taken as a real behavior.

A factorial survey is particularly beneficial when sensitive topics are addressed (Aguinis & Bradley, 2014) and in situations that involve moral and ethical dilemmas as it decreases the participants' reluctance to answer (Aviram, 2012). In comparison to surveys with single items or item batteries, the vignette based methodology provides a more realistic setting and reduces problems from social desirability biases as their purpose is less obvious to the respondents (Weinberg, Freese, & McElthattan, 2014). In particular for ethical and sensitive topics, empirical studies support the suggestion that factorial surveys reduce the social desirability bias and trigger more honest answers (Auspurg, Hinz, Saucer, & Liebig 2014).

Suitably designed factorial surveys might also be able to overcome some difficulties of convenience samples (Mutz, 2011) due to their experimental designs. The randomization of vignettes allows for ceteris paribus comparisons of factors that drive the decisions about ethical challenges. For entrepreneurship research, this method also mitigates the aforementioned problems in getting "large" samples. Due to the experimental notion, factorial surveys with vignettes particularly focus on obtaining internal validity rather than obtaining generalizability. The scrutinizing of causality between explanatory and explained variables does not require—depending on the design—a large sample of respondents but rather a sufficiently large number of vignettes. The fractionalization of the vignette universe is usually

applied to relatively small subsamples of the respondents' sample which should answer to a specific set of vignettes (Jasso, 2006).

Moreover, factorial surveys are useful for research questions, in which correlations among explanatory variables exist. The researcher needs, however, to specify the causal relationships between the variables (Aguinis & Bradley, 2014). The random assignment of the levels of the independent variables ensures that the factors are independent of each other and allows that the effects of independent variables on the dependent variables can be isolated from each other.

Summing up, factorial vignette surveys are an effective method for measuring complex issues and are suitable for investigating social phenomena that are otherwise difficult to examine (Ludwick et al., 2004). Factorial surveys preserve internal validity because of the random assignment of the levels of the independent variables. This random assignment ensures that the factors are independent of each other. The experimental variation of the factor levels dimension allows to separately examining the influence of explanatory variables, which are in reality correlated with each other to some degree. Put in other words, the experimental setting enables to isolate the effects of explanatory variables on the explained variable.

For scrutinizing decisional mechanisms, internal validity is more crucial than external validity. The degree of external validity depends on the sample feature to reflect the population heterogeneity sufficiently and usually demands a large random sample from the population. However, if one wants to generalize results to be valid also for the population, even convenience samples may be able to preserve external validity as recent factorial survey studies imply (Weinberg et al., 2014).

5 Application of Vignette Based Factorial Surveys

Concerning the application of vignette based factorial surveys in order to analyze complex issues in entrepreneurship, innovation and technology research, several aspects need to be considered, which are briefly summarized in this section (see Aguinis & Bradley, 2014; Auspurg & Hinz, 2015; Aviram, 2012). If applicable, the recommendations will be illustrated with our example of measuring unethical behavior that is described in the beginning.

(1) *Theoretical background*: Vignette based factorial surveys start with elucidating the theoretical background of the research question. Clear hypotheses are needed that suggest a causality structure of variables and are capable of being operationalized by specific factors or dimensions (see e.g. Zahra, 2007). To theoretically ground hypotheses on unethical behavior of entrepreneurs, researchers could, for example, draw on the Willis (1963) theory on nonconformity to argue for entrepreneur's predisposition to deviate from norms or studies which apply theoretical ideas about factors which influence corrupt behavior (Graeff et al., 2013).

(2) *Factorial survey mode*: Most factorial survey studies are conducted as paper-pencil or online-/computer-based surveys. Vignettes can be applied to respondents not only in written format but also by other media such as videos, pictures or audio elements (Hughes & Huby, 2002) as long as the randomization of treatment information is being warranted. An indirect benefit of including additional presentation types (besides the written form) is that with higher levels of participants' immersion, realism is also increased. Whatever form is used, researchers should take care that the respondents are able to handle the complexity and information included in the vignettes. The storyline should be easy to understand. The crucial information need to be easily remembered.

(3) *Specify the number and levels of dimensions*: The key is to identify all critical factors for the study that are to be manipulated in the factorial survey and not omit relevant variables. A clear recommendation on an "optimal" number of dimensions does not exist and mainly depend on the hypotheses that are to be tested. For simple categorical differences, two levels would suffice while more complex, for example, non-linear relationships would necessitate more levels per factors. In case of doubt better use more than fewer dimensions to reduce potential response biases. However, too many dimensions could result in information overload and fatigue of the respondents, so a careful consideration is required. One should also regard for the cognitive limitations of respondents and for the effect that study participants get bored if they respond too often to similar vignettes. Our example as shown in Table 2 used three factor levels in order to allow testing for simple linear relationships.

(4) *Draft and pretest the vignettes*: When the vignettes are constructed one should bear in mind that the factors could concern ethically challenging, sensitive behaviors. The presented situation should be realistic and the story told in the vignette must be coherent and believable in all combinations. A pretest is mandatory to assure clarity of wording. The variation of factors needs to be plausible and should, in particular, be capable of producing respondent variance substantially differing from zero. Also, length and perceived difficulty in responding to the vignette should be assessed in order to identify potential problems resulting from fatigue and cognitive limits with regard to information-processing that would ultimately lead to an increase in non-responses or invalid statements.

(5) *Sampling*: To avoid confounding the respondent's personality traits with the experimental condition, a vignette should be rated by several respondents. Auspurg and Hinz (2015) suggest as outlined above to use at least five different respondents for one vignette. If the vignette universe, that is the number of characteristics within the dimensions, is too large, fractionalized samples could be applied which maximize statistical efficiency. The sample size should be determined with regard to the factorial survey mode (either between- or within-subject or mixed modes) and the criteria of efficiency. Such decisions such as choosing the proper sample size and suitable experimental design or removing certain level combinations should be done in order to maximize the likelihood

that the parameters of interests are identified and in order to identify the theoretically proposed effects.

The example in the beginning was introduced in order to combine several variables of interest with a story that fits to the potential target group of respondents. Relatively long vignettes take more time to read the story which, in turn, increases surveying time the more vignettes are presented to each respondent. If one cannot refer to the complete vignette universe due to a low number of respondents, for instance, it is advantageous to apply a vignette design that obtains the maximum information for the variables/parameters of interest (Duelmer, 2007). Efficient designs allow measuring the postulated effects with the same statistical power than less efficient designs with a bigger number of vignettes or respondents. But since efficient designs also allow—ceteris paribus—applying more dimensions or variables than less efficient designs, efficient designs are usually preferred.

(6) *Data analysis*: The analysis of the factorial survey data aims first and foremost on the postulated effects of the independent variables on the outcome variable. Comparisons of means or variances are also possible but less frequently done. In most vignette based factorial surveys, respondents will rate several vignettes which implies a nested data structure: vignettes are nested within respondents. While pure between-subject designs would suit to ANOVA-type data analysis techniques, within-person designs involve clustered observations, which bias the estimation of standard errors (and significance levels) and require either a correction of the estimates or a statistical model that regards the hierarchical data structure (such as multi-level models).

The techniques for data analysis depend on the scale level one has applied for the dependent variables. Typically, metric dependent variables are used. They allow—in contrast to categorical variables (which would demand non-linear regression techniques)—linear regression techniques which are modeled by an additional error term that regards for the clustered observations. These models usually consist of two types of variables: the independent variables of interest (factors) and the sociodemographic variables which pertain to the respondents' characteristics. Typical analysis strategies lead to models which pinpoint individual thresholds (random intercept models) for the outcome variable or estimate, additionally, individual variations of slope terms (random slope models). The number of independent variables of interest in the model represents the number of dimensions a respondent has to consider simultaneously for each vignette.

For ethical decisions it is of particular interest how much a respondent would be willing to give up of one dimension in order to get more from others. Auspurg and Hinz (2015, p. 99) call it "cross-elasticity" and show how this trade-off between the variables can be determined. Based on the factorial survey method proposed by Rossi (1979), Jasso (2006) provides a framework for applying vignette-based factorial survey methods to measure beliefs and normative judgements. She shows that a proper collection of factorial survey data allows for the application of standard econometric techniques such as

regressions methods applying ordinary or generalized least squares estimators or seemingly unrelated regression estimates. Depending on the design becomes it necessary to consider the multilevel data structure, too.

(7) *Reporting of results*: Researchers should explicitly describe the process of designing and executing the vignette study. This includes the detailed description of the methodological preparation and the vignettes used and, if applicable, make additional presentation forms, such as video and audio files, publicly available. This transparent approach contributes to extending knowledge within the research community and facilitates replication of results.

6 Conclusion

There are several differences when ethical topics are considered by simple item-based surveys and vignette based factorial surveys. Scrutinizing ethical challenges with item-based surveys implies that respondents answer in a general manner referring to their person specific context. In contrast, vignettes suggest a context relevant for deciding and allow people to picture themselves in such situations. The responses of vignette based factorial surveys are not general statements but deliberated answers based on the challenging features of the specific context. Ethical decisions are usually determined by various factors and entail that people gauge what *can* and what *should* be done. Vignettes provide descriptions which resemble real situations that initiate gauging processes. By the experimental set up, these gauging processes are intentionally triggered by manipulating factor levels.

Beside the advantages of experimental settings, vignette based factorial surveys seem to deal more efficiently (than simple items surveys) with problems which usually occur when ethical and sensitive issues are concerned such as self-serving biases (Armacost, Hosseini, Morris, & Rehbein, 1991; Mutz, 2011).

For entrepreneurship research, this survey technique offers solutions for the aforementioned problems that "large samples" are difficult to achieve. Due to the experimental notion, factorial surveys with vignettes focus more on obtaining internal validity than on the capability of a study that their results can be generalized. The scrutinizing of causality between explanatory and explained variables does not require—depending on the design—a large sample of respondents but rather a sufficiently large number of vignettes. The fractionalization of the vignette universe is usually applied to relatively small subsamples of the respondents' sample which should answer to a specific set of vignettes (Jasso, 2006). Moreover, the general hesitation of entrepreneurs to participate into surveys with ethical issues stems probably from their experiences with surveys that apply general statements or single-item questions only. Since vignettes create situations for deciding, vignette based factorial surveys suit the expectations of entrepreneurs better and leave them more open to respond. And since the vignette situation allows a more serious questioning that does not attract the attention to a specific aspect only such as a

single-item question, social desirability biases are also reduced (Alexander & Becker, 1978).

Despite the mentioned benefits there are also potential drawbacks involved with conducting factorial surveys. Disadvantages mainly arise from the time involved in using factorial vignettes instead of traditional items in surveys which, particularly with a high number of dimensions, may lead to fatigue of the respondents. Furthermore, learning effects from the repetitive survey character and dissonant behavior due to implausible case scenarios can be the source of methodological errors (Auspurg et al., 2009). One has also to consider that vignette based factorial surveys are—until now—only rarely applied in entrepreneurship, innovation and technology research, despite the fact that it suggests itself as a method to deal with ethical or sensitive topics. Factorial surveys are not a substitute for surveys or interviews which determine motivational conditions, personality characteristics or skill levels. They should also not be taken as a means to pinpoint the prevalence rate of a certain action (e.g. deviant behavior and crime). The experimental factor variation is conducted in order to test their effects on the outcome variable. For gaining an assessment on the prevalence of a certain social phenomenon such as bribing, one would need to know how "... many people will be exposed to the treatment in the real world" (Auspurg & Hinz, 2015, p. 114).

Experiments are often criticized for improving internal validity at the expense of external validity, so that generalizability of results poses an issue (Argyris, 1975; Scandura & Williams, 2000). Factorial survey allow to simultaneously enhancing internal and external validity by combining an experimental design within a survey. Although the hypothetical setting of vignette based factorial surveys implies that respondents are emotionally detached from the situation in question, the realism of vignettes is higher than standard item batteries. Alternative methods, which allow tapping actual behavior and overcoming some limitations of factorial surveys are, for example, laboratory experiments, in basket exercises, and simulations (Trevino, 1992). However, other problems are involved with these methods, particularly with respect to associated time and efforts as well as reduced external validity.

Summing up, we agree with Hannafey who argues that due to the importance of entrepreneurship for the world's economy and human welfare, "carefully designed and well executed ethics research is needed to assist economic policymakers and individual entrepreneurs" (Hannafey, 2003, p. 100). With no clear guideline and a high degree of grey areas of what is considered right and wrong, entrepreneurs typically must rely on their own judgments. The identification of factors that determine whether and in which situations entrepreneurs cross the line of unethical behavior or stick to moral standards is an intriguing research area. By approximating experimental settings, factorial surveys enable to gain more realistic data on this complex, morally challenging topic and at the same time reduce measurement errors. In business research, several topics besides ethical decision-making focus on complex issues. Research on the 'dark' side of managers and entrepreneurs, such as CEO narcissism (e.g. Wales, Patel, & Lumpkin, 2013), would benefit from factorial surveys in order to reduce social desirability bias. Also, factorial surveys could enhance to disentangle the underlying causes of latent variables, such as

motivation (e.g. Carsrud & Braennback, 2011) and trust (e.g. Zahra, Yavuz, & Ucbasaran, 2006) which are based on interrelated factors and often unclear cause-effect relationships. So far, the factorial survey has been an underestimated and seldom used method in business research. This chapter showed that it provides a promising and feasible solution in overcoming existing methodological problems that are not only salient in ethics research, but generally concern the investigation of complex and sensitive topics in entrepreneurship, innovation and technology research.

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Illustrating Complexity in the Brand Management of Family Firms

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Abstract Family firms form the majority of enterprises in almost all national economies. While public corporations consist of the two components ownership and business, family firms have a third component: the family. In the past, brand management and family firms have been seen as two separate fields of research. This empirical study focuses on brand management of family firms, which can be seen as a complex interdisciplinary field of research. Taking the complexity into account, a model based on the brand identity model of Burmann, Halaszovich, and Hemmann (Identitätsbasierte Markenführung. Springer-Gabler, 2012) and qualitative interviews that were conducted with German family firm managers, is developed. This model, the so-called "markencloud", categorizes the different aspects of brand management in family firms and gives family firm owners additional hands-on information on their company's brand. The "markencloud" does not only illustrate complexity from a scientific point of view, it also works as a practitioners' tool to support a family firm's brand management.

Keywords Brand identity • Brand image • Brand management • Entrepreneurial family • Family firm

1 Introduction

Family firms work differently to non-family firms. This difference is particularly evident in small and medium-sized family-owned firms.

They make decisions differently (faster), as these do not have to go through different levels of management. This leads to more trust on the part of clients/suppliers, which gives family firms a competitive edge on the market (Cooper,

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_11

Upton, & Seaman, 2005; Upton, Teal, & Felan, 2001; Ward & Aronoff, 1991). In addition to financial goals, owners of family firms pursue non-financial goals which are termed "socio-emotional assets". These non-financial goals likewise lead to behavior different to that of non-family firms (Cennamo, Berrone, Cruz, & Gomez-Mejia, 2012; Gomez-Mejia, Haynes, Núñez-Nickel, Jacobson, & Moyano-Fuentes, 2007).

The differences between family and non-family firms also influence the brand and brand management of family firms. Family firms possess a substantial distinctive feature which differentiates their brand. This can be described as follows: "Knowing the roots of a person, place, or firm can help create interest and a bond. The same is true for a brand" (Aaker & Joachimsthaler, 2000, p. 249).

The scientific approach to brand management is wide-ranging. Research in this area has provided a wealth of enquiries, as well as important findings and ideas. One of the most widely accepted approaches is identity-based brand management (Meffert, Burmann, & Koers, 2005). In practice, too, a large number of publications support firms in managing their brand. The most important message to take from this: The brand is a central factor which can make a firm stand out from the competition (PricewaterhouseCoopers, 2006). However, this scientific understanding only applies to large firms. Although family firms form the majority of enterprises in almost all national economies, the characteristics of this group of enterprises with regard to brand management has thus far only undergone light research. This (also) relates to the fact that the brand management of family firms is a complex interdisciplinary field of research that is at the interface of several areas of research and disciplines:

- research in family firms, which is often shaped by sociological or legal factors,
- as well as distinctly commercial brand research.

Thus in the case of identity-based brand management in family firms, the factor of the entrepreneurial family should be considered alongside the tension between image and identity.

This article attempts to explore the characteristics of family firms in brand competition. In order to identify these characteristics, a literature review on both family firms and brand research is given. Based on this recent literature the relevant research questions are developed. These questions are answered by conducting interviews with German family firm owners. As a result of these interviews, the so-called "markencloud", a practitioners' tool for brand management in family firms, is developed.

In order to make the complex matter manageable for smaller enterprises which are low on resources, the tool should provide the decision-makers in family firms with recommendations on how to act, so that they can create and strengthen the brand of their firm. The content shall be analyzed qualitatively, forming the methodological basis for the investigation. The data sample selected consists of

11 enterprises from the metropolitan area of Berlin-Brandenburg.[1] The findings from qualitative, guideline-based interviews are systematically analyzed and form the basis of an application-oriented tool (markencloud). This tool helps the user to visualize an up-to-date self-perception of the brand and brand management of the family firm in question and to get recommendations for the development of the brand.

The tool is available to the public (www.markencloud.org) and can be used without having to register.

2 Current Stage of Research

Brand management in family firms is a complex topic. In order to ensure a coherent understanding of the terms chosen for this research, all essential terms are defined in the following passage. Moreover, the relevant literature is used for the development of research questions and the interview guidelines.

2.1 Family Firms and SMEs

Family firms do not only occur in different forms from a historical perspective, but even today this term covers a wide spectrum of very different businesses and structures. Elements such as ownership of the family, management by owners or the influence of the supervisory board occur in almost all definitions, while the distinction between family firms and non-family firms is drawn differently in each case. The predominant view of family firms presented by research can be summarized as follows:

- The property is either fully, predominantly or at least to a considerable extent in the hands of one or more families (Ramos, Man, Mustafa, & Ng, 2014).
- The family can actually exert a considerable amount of influence on the firm in relation to the company shares or the voting rights formed independently of these (Delmas & Gergaud, 2014).
- The family works actively within the firm, usually in the form of at least a shareholder-manager, sometimes also on the level of employees or at least in an active role of control on the advisory or supervisory board (von Andreae, 2007).
- The entrepreneurial family considers the business as a long-term, mostly intergenerational project and has already undergone a change in generation or at least intends to do so (Dyer & Whetten, 2006).

[1] Definition of the metropolitan area: https://www.statistik-berlin-brandenburg.de/regionales/rbs/metropolregion.asp?Kat=4201

- The two areas of life of "family", that is the more personal area of life, and "business", as an economically rational area, permeate each other and exert an ongoing influence on each other (von Andreae, 2007).

However, the characteristics which are necessary to categorize something as a "family firm/non-family firm" are open-ended. Thus some authors demand that the entrepreneurial family has an ownership of 100 %. The majority only requires 51 % of the votes, that is, the majority vote at a shareholders' meeting, while others only consider it necessary to have the blocking minority of 25 %, that is, the potential of a minority to prevent a certain decision at a vote (Felden & Hack, 2014).

Even the number of criteria which have to be fulfilled for this approach is open-ended: If property and management have to be in the hands of the same person, large and developed family firms which are run by a non-family manager would be left out. Nevertheless, even in these cases the entrepreneurial family possesses all power and responsibility, makes decisions on strategy and direction, employs the non-family managers and supervises them.

Finally, it should be decided what is meant by the term "family". A broader definition includes both the founders without any familial relation and the extended family with its various branches and in-laws. If the criterion of family is more narrowly defined, this would involve the parents and children who are involved.

Instead of using strict definitions which only allow the two results "is a family firm" and "is not a family firm", it is more sensible to use flexible definitions, such as "a more narrow definition of a family firm" and "a broader definition of a family firm". In the development of this thought an attempt is made to find precise gradations of the term "family firm". This distinction is made between

- firms run by the owners where property and management are in the hands of the same person,
- family-run firms where not all family members are running the firm,
- family-controlled firms where the family only influences the external management via a supervisory body and
- non-family-run family firms (von Andreae, 2007).

The answer to the question "What is a family firm?", however, cannot be answered unambiguously with the existing definitions.

In the interest of this research project, in a similar way to the explanation from the Institut für Mittelstandsforschung Bonn (SME research center),[2] the following definition shall be chosen:

Family firms are enterprises that

- are shaped by a person or a manageable group of related persons,
- actively controlled on the basis of their capital interest
- and mostly run by the family.

[2] The IfM Bonn classifies all enterprises as family firms if they have up to two natural persons or their family members who hold at least 50 % of the shares of an enterprise and if these natural persons are on the management board (see Haunschild & Wolter, 2010).

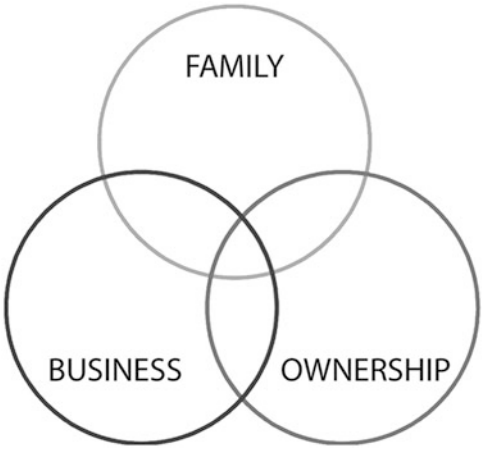

Fig. 1 The three circle model of the family firm by Gersick, Davis, McCollom Hampton, and Lansberg (1997, p. 6)

In terms of the classic business areas such as finance, controlling, HR management, but especially marketing, family firms are subject to different rules compared to public companies which form the focus of business management studies. As financial success simultaneously determines the wealth of the family, the family becomes the centrally active and formative factor. It also becomes evident that family firms work differently to purely public companies. This also applies to brand management, which is the focus of this article.

A central cause for these differences can be visualized as displayed in Fig. 1 with the so-called three circle model (Gersick et al., 1997, p. 6):

Each enterprise consists of two parts—an inner management part made up of the organizational structures and processes, the employees, market presence etc. and an ownership part, that is to a certain extent the passive side of the balance; the shareholders and external creditors of the firm.

Family firms are distinguished by a third part which also communicates with the two other parts: the family.

The parts each have their own communication logic: The management's logic is to make corporate decisions e.g. about hiring personnel. Communication on the level of the shareholders is closely oriented towards legal logic and leads to a strong formulation of communication. Thus the shareholder agreement defines what is permitted and what is forbidden. The family alone as a bond-oriented system predominantly uses communication to ensure that the family members in turn affirm their dedication.

Communication thus has a very different aim in each other of the three parts and is also perceived differently. Therefore family firms must always be aware that communication is about "interface management". This is because it often remains unclear which logic the communication concerned is using and more often than not it is precisely this that causes misinterpretation and disputes in the entrepreneurial families.

What is interesting for the creation of the brand is above all the influencing factor of the family. This can be incorporated purposefully into brand management. Thus Micelotta and Raynards discovered in a study in 2011 that family firms incorporate their family in various ways into brand management. The study identified three major strategies:

- Family Preservation Strategy: Here the focus is on the family. The fact that family and firm are inseparably connected to each other is highlighted at every opportunity. This strategy primarily aims to preserve the "family traditions".
- Family Enrichment Strategy: With this strategy the connection between family and firm is supposed to be presented, yet without wanting to preserve the traditions of the firm with all their might. On the contrary: Here the focus is on new, innovative products which are supposed to distinguish themselves from other products only with the help of the family.
- Family Subordination Strategy: No connection between family and firm is displayed to the outside world (Micelotta & Raynard, 2008).

Yet even when these strategies were identified, it could not be determined why the firms chose which strategy and why some make use of their status as a family firm and others do not (Zellweger, Kellermanns, Eddleston, & Memili, 2012).

This is primarily interesting in the context of Ward and Aronoff's work as stated in 1991 that family firms are able to achieve a certain competitive edge through their reputation as a family alone (Krappe & von Schlippe, 2010; Ward & Aronoff, 1991).

While large family firms have generally established a professional brand management and are using its tools widely, practical experience shows that this is often not the case for small and medium-sized family firms. Therefore it is small and medium-sized family firms that form the primary focus of this research project. The tool that has been developed is also targeted at SMEs in particular.

2.2 Brand

Generally the term brand can be understood as "a characteristic name and/or symbol" (Meffert et al., 2005, p. 6). The definition of a brand has gone through manifold forms during the process of research. Only a brief summary of the early stages of development shall be used for this research:

Until the mid-1990s, the dominant view about brands was that this was something that is shaped by perception from outside, therefore by the perception of the consumers, marketing intermediaries and competitors. In so doing the internal view of the brand which is shaped by the employees and the management was neglected. It is only with the identity-based approach which is now considered a valid paradigm (Meffert, Burmann, & Kirchgeorg, 2015) that the perspective has been widened and also encompasses internal stakeholders. This change is also evident in the works of notable researchers: Esch thus still defines brands in older publications as "images in the minds of the consumers which act as a form of identification and differentiation and influence the decision-making process" (Esch, 2005, p. 23). The

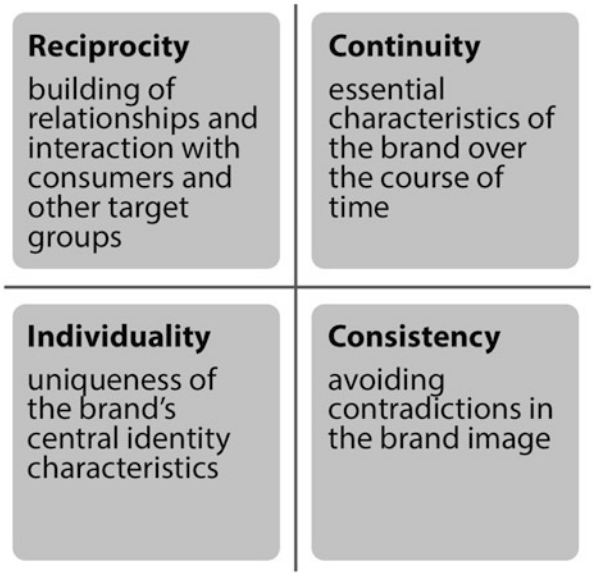

Fig. 2 Characteristics of brand identity according to Burmann et al. (2012, p. 36)

aim of brands is to create a relevant and equally unmistakable image—yet in this case only in the minds of the consumers. In order to take account of the increasing scientific and also practical relevance of the influence of employees and management, Esch (2012) expanded on his definition of brands and updated it to "images in the minds of the target groups which act as a form of identification and differentiation and influence the decision-making process" (Esch, 2012, p. 22).

In German-speaking areas, the team of authors led by Burmann is also relevant today alongside Esch when considering the brand scientifically. Based on the work of Meffert (1974), Burmann, Halaszovich, and Hemmann define the brand as a "bundle of benefits with specific characteristics which make sure that this certain bundle differentiates itself sustainably in the eyes of the relevant target groups in comparison with other bundles of benefit which fulfill the same basic needs" (Burmann, Halaszovich, & Hemmann, 2012, p. 28). This understanding of the brand is not limited to technical-functional characteristics of the branded goods, rather it is created through the actions of the employees and the management. These actions shape the self-image, identity of the brand and its fundamental components, the competence of the brand, and instill trust in the consumer. These in turn then give feedback from their outside perspective, the external image. With these interactions between external perspective (image) and internal perspective (identity), the current definition of the brand materializes out of the old views. Academic literature considers that the "traditional outside-in perspective of the brand [. . .] is being supplemented by an inside-out perspective" (Burmann et al., 2012, p. 28).

With this new aspect of brand identity, other features which had thus far received little attention are also becoming relevant for the academic study of brands. First of all, the term identity, which originates from psychology, is applied to brands. In relation to this, four characteristics (Fig. 2) are considered relevant for the formation of a strong and stable brand identity.

Reciprocity means that the brand identity is molded to consumers and other target groups through the building of relationships and interaction. A relationship that is stable over time is important for the formation of a stable brand identity.

- Continuity refers to the retention of the essential characteristics of the brand over the course of time. If the essential characteristics which describe the essence of a brand are lost, then the identity will cease to exist.
- Consistency in brand management is avoiding contradictions in the brand image and in the behavior of the employees of the enterprise
- Individuality and uniqueness of the brand's central identity characteristics in comparison with the competition form a strong brand identity.

As can be seen in Fig. 3, internal and external target groups have a reciprocal relation to each other. In this case, the brand identity is influenced by the expectations communicated by the clients.

A strong identity consciously adapts to external influences in moderation without giving itself up in the process. In order to be able to develop this strong identity, special skills and resources are important. In identity-based brand management, according to Burmann et al. (2012) these are:

(1) *Vision*: a wish realizable in the long term which will produce a brand on a timescale of 5–10 years
(2) *Competencies*: organizational skills typical of an enterprise to identify, refine and combine resources
(3) *Values*: core beliefs of the enterprise
(4) *Personality*: "character traits" of an enterprise or a product
(5) *Origin*: localization, company background and industry affiliation
(6) *Type of brand performance*: defining the bundle of benefits, primarily functional

These six skills and resources represent the constituents of the brand identity.

However, it is not only the brand components that are important for a comprehensive view of the complexity of the topic, rather it is also the markets which the enterprise is active in. This is significant as there are differences in B2C and B2B markets and especially in the target groups which have a considerable influence on the firm's brand management.

In B2C markets the customers are private end consumers. In contrast, in B2B markets the customers are professional buyers, for example from enterprises or organizations. Moreover, in B2B markets it is generally not one single person who makes the decision to buy, rather a collective which academics describe as a buying center (Bausback, 2007).

This results in differences in buying behavior. While the buying process in B2C markets is considerably influenced by emotional factors, the buying process in B2B markets is more rational and focuses heavily on objective criteria such as the quality of a product (Leek & Christodoulides, 2012). This is partially due to the fact that in B2B markets it is conventionally considered that there seems to be no room for emotional factors, which is why in the past constructing a brand for B2B markets

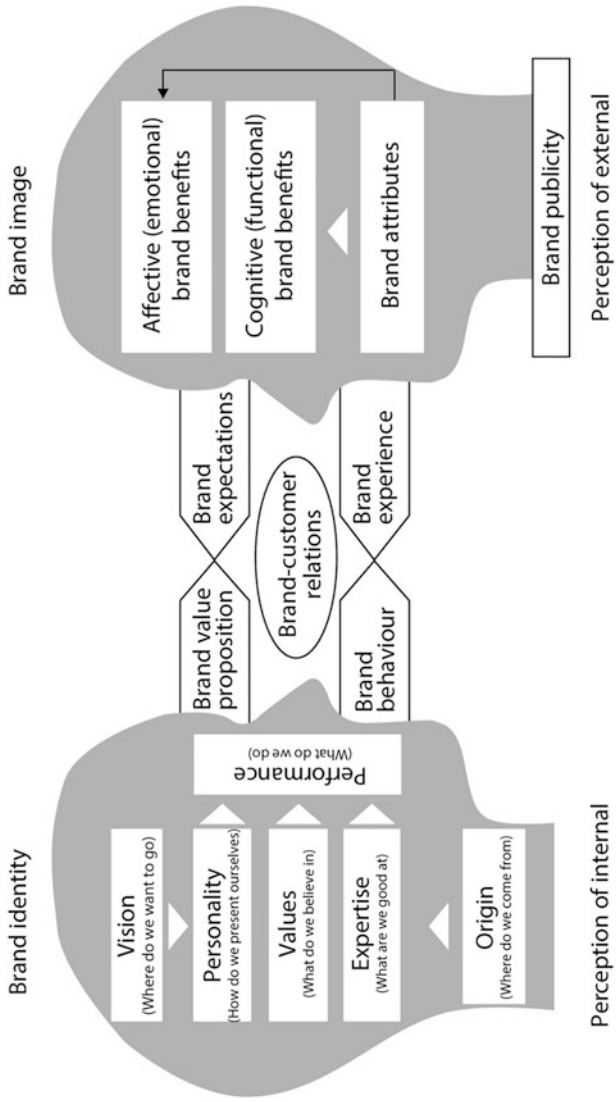

Fig. 3 Translated by the author from the identity-based brand management according to Meffert et al. (2005, p. 52)

was less attractive (Leek & Christodoulides, 2011). On the other hand this is due to the fact that quality still remains the central buying criterion in B2B markets (Bendixen, Bukasa, & Abratt, 2004).

The fact that emotional factors can still play an important role in B2B markets and that the brand therefore still has a reason to exist in B2B markets has only become evident in studies during the last few years (Bausback, 2007). Thus a study by Mudambi (2002) shows that attributes such as quality and product features do still play the largest role if it is buying decisions in B2B markets that are concerned. However, it is also clear in the study that reputation, corporate image and service quality are becoming more and more important. Particularly when making risky decisions, even professional buyers tend to purchase products of a specific brand as this reduces their subjective sense of taking a risk (Baumgarth, 2010).

There is one more difference in the interaction between enterprises and customers. In B2C markets, the contact between the sellers and end consumers is minimal. In most cases, sellers in B2C markets do not develop a close bond to their customer. In contrast however, it is mostly long-term relationships that develop between sellers and customers in B2B markets. Whether and how these relationships can be influenced by the development of a B2B brand in general and especially with family firms has not yet been sufficiently investigated (Leek & Christodoulides, 2012).

2.3 Brands and Family Firms

As explained above, the identity-oriented approach to brand management considers brand identity as a decisive factor in the long-lasting differentiation and authenticity of a brand. The characteristics "reciprocity, continuity, consistency and individuality" thus shape the character of the brand in the long term (Burmann et al., 2012, p. 86). A reliable, high level of quality in a product takes the "central position in the perception of a brand's consistency" (Schallehn, 2012, p. 49), because this then tells the consumers that this is consistent behavior on the part of the brand: It fulfills the value proposition at all brand touch points without contradictions (Burmann et al., 2012).

In order to construct an authentic brand that will have long-term success, enterprises should focus primarily on the two dimensions of "consistency" and "continuity" (Burmann et al., 2012). The authenticity of the brand, which is often equated with trustworthiness, also plays an important role in this. There is a demonstrably high correlation between authenticity and trust when it comes to brands: Trust is then the result of authenticity (Schallehn, 2012). The authenticity of a brand can, for example, be built on enhancing the brand with a "personality". This kind of emotionalization beyond pure utility reaches customers on an emotional level, they view the brand positively and form a long-term bond with it (Aaker, 2012). Both terms (trust and authenticity) are often associated with family firms. The reputation and the image of the firm and of the family also play an important

role in family firms (Danes, Stafford, Haynes, & Amarapurkar, 2009; Westhead, 2003; Zellweger, Nason, Nordqvist, & Brush, 2013).

Although it is therefore obvious that family firms differentiate themselves on the market through their own characteristics, their exact influence (on performance) continues to be unclear. What is equally unclear is why some firms clearly position themselves as family firms, communicate this and in so doing form a brand (e.g. in Germany Hipp and Oetker and in the U.S. Mars and Koch Industries), whereas other family firms hardly mention the role of the family in the business (Zellweger et al., 2012). It is true that in early publications the question of how family firms develop into their own brand is studied, however these do not consider the issue of brand management as it is discussed here (Krappe & von Schlippe, 2010).

2.4 Complexity in Brand Management of Family Firms

As has been made clear in the previous sections, brand management in family firms is a particularly complex issue, which is not only complex in terms of content (all the types of family firms, all the various family structures, complexity of brand management) but also because it lies at the intersection of various research disciplines. In the past, the areas of brand management and family firms were considered separately. If areas of research are combined, then research in complexity discusses "interdisciplinary sciences" (Schoeneberg, 2014, p. 14). The brand management of family firms can thus also be understood as an interdisciplinary area of research. There is an additional third factor: Due to globalization the world has become more connected and simultaneously more complex; this also affects the everyday challenges of family firms.

It is also the aim of research to explain complex real contexts by models and to use these to be able to deduce recommendations on how to act and to achieve a certain degree of predictability about standardizations. Thus the explanation of complexity occurs not only in the economic sciences, but also in almost all other areas of research.

> . . . in recent decades the limits of reductionism have become evident in phenomena where interactions are relevant. Since reductionism separates, it has to ignore interactions. If interactions are relevant, reductionism is not suitable for studying complex phenomena. (Gershenson, 2011, p. 1)

Particularly when various, independent areas of research which demonstrate a high momentum of their own and require interaction are combined, a simplified representation is not always possible in order to illustrate the big picture (Gershenson, 2011).

In traditional brand management, momentum occurs above all as a result of the interaction between the self-image and the external image of the brand. The self-image of the brand is defined by the brand identity and thus the employees play an active part in creating it. In contrast, the external image of the brand depends on the

subjective impressions of the customers (Schultheiss, 2011). However, this is not enough for a description of family firms, as a fundamental factor of this is not taken into account—the entrepreneurial family.

The momentum of the family firm results—as displayed in the three circle model (Fig. 1)—from the three influence factors of "business", "ownership" and "family". The latter can have various effects on the firm and thus help to shape the family firm to a considerable extent.

This study aims to do justice to this complexity and yet also tries to develop a practical solution that illustrates the complexity, which will support family firms in their brand management.

3 Research Questions

As part of the study two research questions were developed, whose answers not only provide new theoretical findings and form a basis for further research, but also can be used for practical recommendations on how to act and thus realize the desired reduction in complexity of the brand management of family firms:

1. What does brand identity mean in family firms?
2. How can complexity be illustrated in a family firm's brand management?

The first question is focused on how the identity of a brand in family firms is structured and formed. With the criteria which define the brand identity, this investigates which correlations, focal points and features occur in the interviews with the surveyed family firms. As the brand identity is composed of, among other things, elements such as values, origin and personality (Burmann et al., 2012), the particular effect on brand management in family firms shall be investigated with this question. An additional aim is to thus uncover findings on how brand management is practiced in family firms and who are the decision-makers in terms of brand management.

The second question investigates which tools and methods are already implemented in the enterprises' marketing strategies and what additional requirements small and medium-sized family firms have. This question also investigates which of the brand management methods that are implemented in the larger of the participating family firms can be adapted for small enterprises.

The tool that is developed as a part of this project is intended to show family entrepreneurs the state of affairs of their brand management and to serve as a foundation for their "family firm brand management".

4 Methodological Procedure

4.1 Qualitative Research

In this research project, a qualitative research approach has been chosen in order to be able to better comprehend the meaning of values in family firms. In comparison to a quantitative research model where the focus is on analyzing and explaining data, the qualitative approach makes it possible through personal interviews to understand the particular contexts, individual processes and special values in family firms in detail (Mayring, 2008). As the interviews mostly took place on site, it was additionally possible to gain insights into the structure of the enterprise, the personal atmosphere and the personality of the interviewee.

The research design can be divided into the following steps:

1. Preparatory work
2. Development of research questions
3. Development of interview-guidelines
4. Interviews with 11 family firm owners
5. Transcription of interviews
6. Initial coding process
7. Second coding process
8. Technical development of the "markencloud"
9. Implementing the research findings in the "markencloud"

The method of qualitatively analyzing content makes it possible to be able to describe passages, which are relevant for the research questions, from the interviews with items chosen for the study (Kuckartz, 2014). First of all in the qualitative analysis of content, categories are formed based on theory and are primarily oriented towards the items of the identity-based approach. These categories also take elements into consideration which appear to be appropriate for family firms according to academics. These are divided into three perspectives: on the one hand, the categories of brand identity and brand image from the identity-based approach and in addition the category of the entrepreneurial family which is significant for family firms. This three-part division of the perspectives is regarded as a theory-based expansion of the Meffert et al. (2005) model (cf. Fig. 3) on identity-based brand management by the entrepreneurial family category.

4.2 Guidelines for the Interviews

The interview guidelines were created by taking the core items from the identity-based approach of Burmann et al. (2012) into account alongside a comprehensive analysis of academic surveys. The questions asked were open-ended, thus giving the family firm managers the option for comprehensive answers.

The first section takes a general approach towards the brand of the enterprise. Only once an understanding of how the interviewee defines the term "brand" has been established does the interview continue with the rest of the questions from the guidelines. The second section inquires about the decision-making structures and paths of communication within the enterprise with regard to the brand. This is concerned both with internal communication as well as communication with external partners such as customers, suppliers and banks. Next the features of the brand management which are associated with the entrepreneurial family and the family firm are explored. This concerns itself with the family's influence not only on the firm's brand, but also on the values which are practiced within the enterprise and the family. In the next section the brand image, and therefore the brand consciousness of the various stakeholders, is investigated. As only the entrepreneurs themselves are questioned, all that can be obtained are suppositions and the estimations of the interviewees about the consciousness of the others with relation to the brand image.

In addition to the guidelines, the interviewees are asked to give personal information about themselves (position in the firm, age, time spent at the firm) and about the firm (number of employees, industry, information about the entrepreneurial family, generation of those managing the firm).

4.3 Sample of the Firms and Limitations

Eleven family firms from the metropolitan area of Berlin-Brandenburg were interviewed on the basis of these guidelines. The respective firms are chosen as they represent a broad sample concerning different criteria such as: sectors, number of employees, generation that currently manages the firm and the area (B2B/B2C). The interviewees, with the exception of one external manager, belong to the entrepreneurial family and manage the family firm from the first right through to the fourth generation of the family. All of the interview partners are CEOs and own a substantial number of shares of their family's company. In five family firms, there is more than one CEO in the management. Whenever possible, both CEOs were interviewed at the same time. One interview was conducted with both, the current CEO and his son, who is expected to take over the business within the next years. With the exception of one enterprise (publishing), the firms were owner-run small and medium-sized family firms. As of the end of 2014 all of these firms are in a position of solvency.[3] An overview is given in Table 1.

The focus of the qualitative interviews was on the sectors of manufacturing (four interviewed firms) and business-related services (three interviewed firms). These are followed by trade (two interviews) and personal services (two interviews). In addition to the firms mentioned, two further firms were interviewed as a pre-test. As

[3] According to the Dafne database. https://dafneneo.bvdep.com

Table 1 Overview of the firms interviewed

Sector	Employee[a]	Generation	Area
Metal processing	150	4	B2B
Communication	13	1	B2B
Logistics	36	3	B2B
Lab equipment	121	2	B2B
Communication	12	1	B2B
Cosmetics	130	4	B2B/B2C
Publishing	2,119	2	B2C
Architecture	10	1	B2B
Furniture	197	4	B2C
Surface treatment	37	2	B2B
Transport/travel	100	3	B2C

[a]The numbers of employees were obtained via a web search and the Dafne Database (2015) at: https://dafneneo.bvdep.com

the pre-tests were intended to test the survey and thereby to further develop the questions, these results are not included in the evaluation.

All interviews were conducted in 2013 and 2014. Apart from one interview, the interviews took place in the family firm itself. The interviews lasted 1 hour on average. When it comes to the limitations of this study, it can be said that, in terms of the interviewee's bias, the study would have further benefitted by interviewing more than just one person from each family firm. When developing the "markencloud", it has to be kept in mind, that the interviews only represent the view of the CEO. The views of other family members and/or employees, customers or other stakeholders would have given a broader perspective on the firm's brand management and could have helped to further validate the statements made by the CEOs.

4.4 Evaluation of the Interviews

The data is analyzed using MAXQDA[4] software. For a structure-building analysis of the content, thematic categories will first be deductively developed from the relevant literature and an initial coding process with categories will be performed (Kuckartz, 2014).

In order to develop a workable tool, the brand model of Burmann et al. (2012) with the two perspectives of identity and image is expanded with the perspective of the entrepreneurial family. These three perspectives serve as the main categories for the evaluation of the interviews. The thematic categories developed from the literature (subcategories) are then assigned each to one of these three main categories.

As part of the initial coding process, all texts are processed line by line in sequence. Appropriate passages are allocated to the processed codes. The category

[4] The program MAXQDA by VERBI GmbH has been used for categorization according to codes.

Table 2 Main categories and subcategories

Brand identity			
Stability	Consistency	Uniqueness	Brand interaction
History			
Performance			
Vision			
Brand image			
Market position	Recognition	Demarcation	Value
Tradition			
Functional benefits			
Emotional benefits			
Entrepreneurial family			
Members	Self-conception	Visibility	Family interaction
Origin			
Management			
Future			

of identity has the most search results at 284. In total, 112 passages were found and categorized in the image category. In the entrepreneurial family category, 277 search results were able to be categorized with codes. Next the passages, organized by main category, are put into a table (see Table 2).

Academic findings also enter into the three perspectives, for example the four characteristics of brand identity according to Burmann et al. (2012) can be found once again in the main category of brand identity.

For each of the 3 main categories it is possible to have 7 subcategories, so that a total of 21 terms have been developed, as displayed in Table 2.

The subcategories are each defined concisely in order to be able to better allocate the passages during the second coding process. For the formulations particular care was taken so that the definitions could be commonly understood and at the same were as precise as possible. This is particularly significant with regard to using the tool, which will also use these categories.

During the second coding process, 203 passages which were already identified in the first coding process are allocated to individual subcategories. Next, the passages are collected under each subcategory in the form of a table in order to be evaluated at the next stage.

It is precisely this conflation that allows statements for each subcategory to be generated which can then be used in the tool.

5 Results of the Interviews

When analyzing the interviews there are some passages which are coded in different contexts at a particularly frequent rate. The following representation and quotes from the interviews[5] shall illustrate some of the more frequent statements made by the entrepreneurs.

5.1 Brand Identity

The component "performance" can be found again and again in the coded passages on brand identity, as the interviewed family entrepreneurs see this as a decisive difference to competitors.

> I would think that the customers do not look at these soft facts, they are not that important to them. Instead, they ask themselves what the products are like. [. . .] The machines we built during the first decade of our company. [. . .] They are still in use and still working. Probably, for a lot of our customers, durable products are the first thing that comes to mind, when they think about our firm.

The questions about the decision-making processes behind the brand are answered very briefly by the entrepreneurs. Hardly any firm has strict processes or guidelines for this, rather it becomes clear that the entrepreneurs themselves, potentially after discussion with a few other persons, make the decisions.

> In a company like ours, marketing is always up to the boss.

What was also notable in the interviews is that there is no holistic understanding of the term "brand". Most commonly, in relation to the questions about the brand, the entrepreneur answered by linking the brand directly to the name of the firm. The firm's name is thus seen as one of the central components of the brand.

> I think that the brand will always have an important role in family firms, as I don't think that it would be possible to give up on the „original brand", as I like to call it. I don't think you could do that.

With the interviews it becomes clear that an essential aspect of brand management is communication with employees, customers and suppliers. All of the entrepreneurs were able to name features which their firms demonstrated in communication with third parties.

> We always try to figure out which employee fits best to which customer. With one employee, you might get along a bit better than with the other. If you see that, I'd say, then this certain employee is in charge of that customer.

[5] The interviews were conducted in German. The quotes are translated by the authors of this paper.

5.2 Brand Image

The peculiar thing about the statements on brand image is that in many cases the entrepreneurs could only give estimations as to how their firm is perceived from the outside. None of the interviewees promoted their brand image systematically e.g. through customer surveys.

> I think you have to take into account what kind of customer it is. The B2B customers that we have, I think they value and appreciate that we are a family firm.

From the point of view of the interviewees the brand image seems to be heavily influenced by the fact that these firms are family firms which are familiarly run by the entrepreneurs.

> If you can say you are a family firm, this title is, I suppose, is a positive brand. So it has a positive connotation and is distinguished from public companies, DAX companies and others.

5.3 Entrepreneurial Family

Statements on the future of the firm form a large part of the search results in the main category of entrepreneurial family. The particular characteristics of family firms which already stand out in the brand identity and brand image sections are also mentioned in relation to the family:

Thus it is emphasized in the interviews that the special relationship with customers and suppliers is closely related to the fact that the firm as a family firm is run with particular values.

> Because we are an owner-run company, I think that our customers put a lot of trust in us. I think that they say, this firm will probably go the extra mile for us.

It is not only the relationship with customers and suppliers that is extraordinary, but also the special behavior towards employees that is emphasized by all entrepreneurs. In this way behavior patterns which stress a familiar sense of togetherness (e.g. communal sport activities, cooking together on lunch breaks, excursions) can be seen in the firms.

> I think that it is important that we all see ourselves as one big family. For me, that means that I know my employees names, how many children they have, what problems they have, whether they have just been divorced etc. That you care about each other—just like in a real family.

Business succession is mentioned as one of the decisive factors. The interviewees particularly highlight communicating the succession to the outside world with regard to brand management.

> Sometimes, when I attend meetings together with my son, I realize that some customers are thinking „There seems to be a continuity.“ And that is important for us, because, my time in this company will sooner or later come to an end, that is inevitable.

6 Development of the "Markencloud"

In order to work on the second research question "How can complexity be illustrated in a family firm's brand management?", the "markencloud" is being developed as part of the research project.

The aims of the "markencloud" are:

- by means of an easy-to-understand survey
- to convey the state of affairs of the family firm's brand management
- and to display this clearly.
- An individual recommendation on how to act should also be deduced from this
- which highlights potential knowledge gaps and gives additional information and tips.

In order to make the "markencloud" as openly accessible as possible, an online tool was designed, which is available on its own website, www.markencloud.org, and is also integrated into the existing platform www.nachfolge-in-deutschland.de.

On the basis of the above mentioned requirements, a visual representation is chosen so that the topic can be conveyed in a way that is easy to understand yet corresponds to the complexity. First of all, 21 statements are generated from the passages on the above terms, 7 of each per main category (brand identity, brand image, entrepreneurial family). The quotations from the interviews are an important part in this procedure: First, they are used to generate a statement and second, they are shown in the individual evaluation, if they seem informative enough for other family firm owners. This procedure shall be described in an exemplary manner with the term "brand interaction" in Table 3:

Due to the large number of appropriate quotations, 63 more statements will be produced in the next stage so that there is a total of four statements per single term.

Table 3 Example representation of generating a statement

Term	Definition	Quote	Generated statement
Brand interaction	Interrelation between the firm and external parties such as customers and suppliers	"Just last week we had a team partner meeting, that is also a form of communication and is now the next topic. We have had this for eight years. I introduced this on my own. Before the children helped out. We have to keep up closer communication with our partners, I said. We have to tell them who we are and what we are doing. I then present a business report to everyone. Where do we stand, what is the position of *[firm's name]*?"	Our customers/suppliers/employees know exactly what they can expect from us

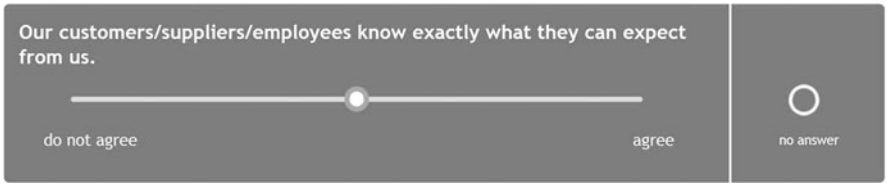

Fig. 4 Display of an exemplary question at the input screen for the brand tool

For this reason two versions of the tool have been developed: A basic version with 21 statements and a full version with 84 statements. Both versions work the same way. The full version allows the user to evaluate several statements per category and leads to a clearer picture of the family firm's band management. In that way, a more precise evaluation can be given in the end.

The statements are evaluated on a scale by the users of the "markencloud" in terms of the statements' meaning for the brand management of the certain firm in question. This is illustrated by Fig. 4.

The scale ranges from "fully agree" to "fully disagree" and is divided into six possible answers. Alternatively, the user can choose not to give an answer. The database does then automatically assign values from 7 (fully agree) to 1 (fully disagree) and 0 (no answer). In the basic version, this number is then used to generate an image of the current state of the brand. The result of the full version is calculated by the average points of each term, leaving out the questions not answered.

By weighing the statements from the three different perspectives (brand identity, brand image and entrepreneurial family), an image of the current state of affairs of the brand management of the firm in question is generated.

As the results of the input, the current state of affairs of the brand management of the firm in question is displayed as a clear diagram in the form of a so-called "three-part-cloud".

The different sizes of the terms in the individual evaluation in the cloud result from the given weightings of the statements. If a term is displayed as particularly large or particularly small, this allows initial conclusions to be drawn about the personal perception of the significance of each brand component in the firm. This can be seen in Fig. 5.

The textual evaluation, as shown in Fig. 6, is also generated from the evaluations of the statements and can be displayed beneath the cloud. The terms which the user has rated in a particularly strong way (i.e. 7 or 6 and 2 or 1 respectively) are displayed as individually generated recommendations on how to act with practical tips and hints. In addition to those practical hints, quotes from the interviews are displayed in order to illustrate how other family firms deal with a certain issue.

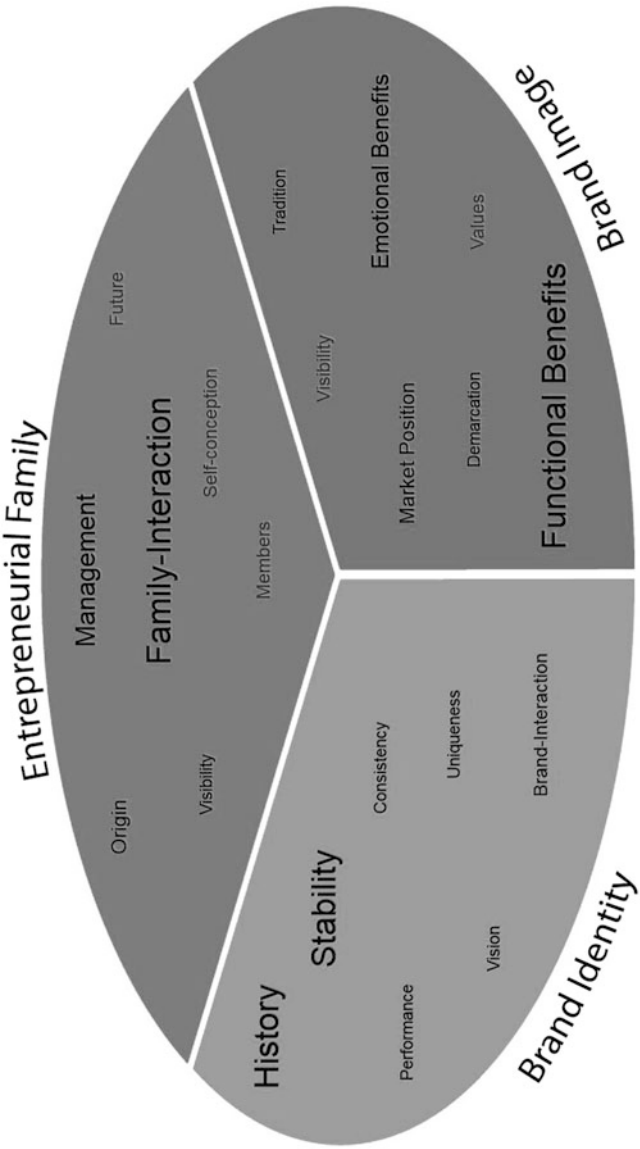

Fig. 5 Display of the evaluation screen (cloud) for the brand tool

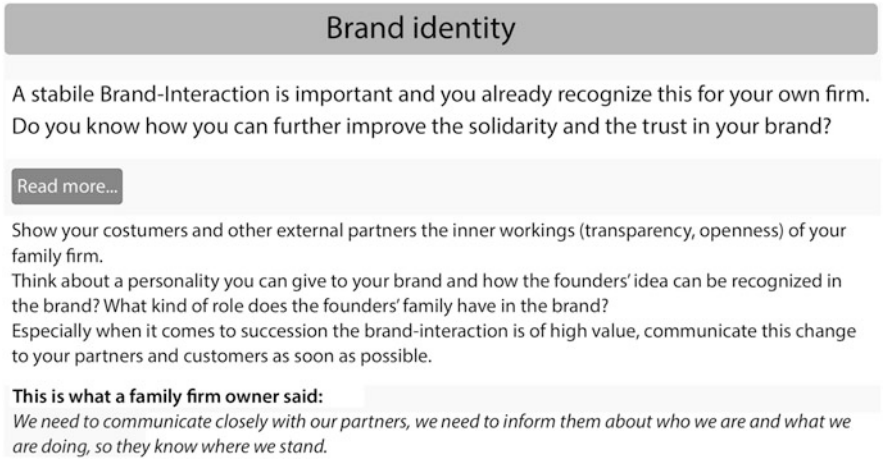

Fig. 6 Example of the suggestions in the "markencloud"

7 Discussing the Research Questions

7.1 What Does Brand Identity Mean in Family Firms?

When producing the guidelines for the interviews and the subsequent coding process, the brand identity is broken down into its individual components in a similar way to the model of identity-based brand management by Burmann et al. (2012) in order to be able to explore what the characteristics are for family firms for each term. During the interviews these terms (vision, personality, values, competencies, origin and performance) are queried. In doing so it becomes clear that the understanding of one's own firm and therefore also the brand identity are strongly connected to the fact of being a family firm.

The statements of the family firms make it clear that what shapes the brand identity are primarily values such as honesty and openness, as well as valuing long-term relations. It is important that all of the employees know these values, as then they help make all decisions about the brand and can act as a "compass" (Täubner, 2015).

Among the family firms interviewed, elements such as brand identity are conveyed through the entrepreneur inwards, to the employees. This usually happens unconsciously, in that family members and/or managerial staff set an example with the important values and attitudes desired for the brand identity. This is defined by academics as "brand citizen behavior" and is based on the experience that people learn attitudes and ways of behaving by observing others (Burmann et al., 2012).

The family firms interviewed have a vision of how the future of the firm and the brand should play out. This is not necessarily formulated in writing, rather it is partly embedded in the firm.

The family firms which have been active for several years or decades are conscious of their founding history. In many cases they also use this part of their brand identity in communication with the outside world. This may also lead to a stronger internal connection with employees and a more loyal bond of family members with the family firm. Especially concerning B2B markets, where the external perspective of a brand is somewhere limited to only a small amount of customers, the conscious communication of history and the family firm can be a strong tie to all stakeholders in the respective firm.

The family firms interviewed do not just make sure that new employees have the right qualification, they need to fit the enterprise, and share its values and its culture. Many describe the working atmosphere as very familiar and emphasize that the employees also get along well with each other and socialize outside of work. The brand identity is thus strengthened from the inside because the employees share the same values and feel at home in the culture of the enterprise (a good fit for the culture). Academics also describe this as "brand-oriented HR management" which helps to inwardly form a strong brand identity (Burmann et al., 2012). A study on B2B services also supports these results and shows that choosing the right employees, training employees in the brand values and heavily focusing on customers contribute to forming a strong brand identity (Coleman, De Chernatony, & Christodoulides, 2011).

The family enterprises interviewed cannot measure the worth of their brand in numbers. Some express this quality by describing it as their "life's work" or "life philosophy" or speak of a "family mark" that will be maintained in the event of succession.

7.2 How Can Complexity Be Illustrated in a Family Firm's Brand Management?

The evaluations of the interviews indicate that, especially in small family firms, brand management is professionalized only to a limited extent and that decisions about the brand are made on a case-by-case basis.

At the same time the close bond is not only very strong with the firm but also with the brand. This is particularly the case when the family name and the firm's name are the same. The brand is viewed by the interviewed entrepreneurs as an image, that is, the perspective with is directed at the customers, and less as something that is shaped by an identity and that can be created and honed by managerial staff.

The intention of the "markencloud" is to show the holistic picture of the respective brand in the individual family firm. Due to the complex intersection of multiple fields of research (as pointed out in the sections before), the mere reduction of brand management in family firms to some aspects might not be able to show the connections and dependencies.

The developed "markencloud" aims therefore to illustrate the complexity of the topic by providing family firm owners and possible internal or external successors with the three-part division of the perspectives, which were adapted from the brand model (Fig. 3). The illustration of the results of the "markencloud" further make a comprehensible and practical formulation to the brand elements for small and medium-sized family firms in B2B and B2C markets.

7.3 Implications for Further Research

With this study, the elements which distinguish brand management in family enterprises are systematically analyzed. In this way, the requirements for successful brand management are explored.

Future research could consider the following questions:

In the case of succession, which aspects of brand identity are of high importance for a successful handover? This seems interesting insofar as academics claim that "individuality" (Burmann et al., 2012) exerts a weaker influence compared to consistency, reciprocity and continuity. The current data cannot provide a conclusive statement on this.

How does the brand-customer-relation in family firms change by setting down (e.g. by means of a brand book) the brand management in writing, for instance due to the suggestions of the "markencloud"? As studies on brand management tell us, the stability of a brand's value proposition over time helps to build up trust.

How can the components of brand identity in family firms be actively created and be purposefully altered in times of radical changes in strategy? This question could be of particular interest to enterprises which cannot or do not want to pass the business down within the entrepreneurial family.

Are there systematic differences in views of the brand from the perspective of different stakeholders? The question of the brand and the brand management of a single firm cannot be conclusively answered by one person, not even by the entrepreneurs themselves. In many areas other persons such as chief employees, members of the entrepreneurial family or potential successors play an important role.

What findings can be deduced from the tool? For this purpose the anonymized data which is generated in each user group of the "markencloud" will be empirically analyzed and made available to the academic public.

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A Systematic Approach to Business Modeling Based on the Value Delivery Modeling Language

Joachim Metzger, Nicolai Kraemer, and Orestis Terzidis

Abstract Complex value creation networks have evolved as a substantial challenge for entrepreneurship in many industries. Value Delivery Architecture Modeling is a new approach to respond to this challenge by enabling people to understand the value creation network and by supporting the successful positioning of a company within this network. Consequently, Value Delivery Architecture Modeling allows for analyzing, evaluating and designing business models and their embeddedness in the value creation network. Value Delivery Architecture Modeling is based on the combination of the new business modeling language Value Delivery Modeling Language and semi-formal ontologies. The initial application of this new approach in the area of fast charging infrastructure in Germany shows promising results. The developed artifacts create an explicit frame of reference for the value creation network which can be useful in various situations. Value Delivery Architecture Modeling hereby addresses the understanding about the value network and enables the creation of novel value propositions.

Keywords Business model • Electric mobility • Ontology • Value creation networks • VDML

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_12

1 Introduction

Business modeling is no doubt considered as key activity of entrepreneurship. Typical approaches discussed in literature and applied in practice include the 'Business Model Canvas' (Osterwalder & Pigneur, 2010), the 'Business Model Navigator' (Gassmann, Frankenberger, & Csik, 2013) and the 'Business Model Cube' (Lindgren & Rassmussen, 2013). In one way or another, all approaches develop a model to describe the systemic arrangement of a venture, its key components and interactions.

Al-Debei and Avison (2010) performed a comprehensive literature review on the topic. In their conclusion, they state that a business model is primarily used for three functions: (1) as a conceptual tool of alignment of stakeholders, (2) as an interceding framework between strategy and business process models, and (3) as strategic-oriented knowledge capital that answers questions related to value creation.

With respect to value creation, it is important to realize that any venture is embedded in a complex and dynamic network of industry structures. Supply networks are composed of a variety of roles and a potentially large number of firms, sometimes from multiple interrelated industries. In their meta-analysis of success factors for startups, Song, Podoynitsyna, van der Bij, and Halman (2008) named the 'embeddedness in the supply chain' to be of prominent importance for the success of a new venture.

With this background, it becomes clear that business modeling must provide tools and methods to analyze, evaluate und design the position of a firm within its value creation network. In supply chain management literature, value creation networks have been characterized as highly complex due to (i) the combinatorics that is related to the network and (ii) due to the dynamic change that takes place in these networks (see e.g. Pathak, Day, Nair, Sawaya, & Kristal, 2007). Embedding the venture in a given or emerging value creation network therefore is one of the entrepreneurial challenges that directly relate to complexity and demand the right tools and thinking in order to make a venture successful.

The trigger for the following paper was a research project in the context of electric mobility in Germany. The goal was to analyze, evaluate, and redesign the business model for fast charging stations. Experts agree that the business case for the 'isolated' fast charging station is not profitable and that there is no 'viable business model' for the infrastructure alone. The situation is a key hurdle for the broader adoption of electro mobility: If nobody is willing to invest in fast charging stations, reach and ad-hoc mobility cannot be realized adequately, slowing down the adoption of electric vehicles.

Therefore the search for an adequate business model has been one of the major challenges for the last couple of years (Nationale Plattform Elektromobilität, 2014; Reinke, 2014). Applying the mainstream methods mentioned above (Gassmann et al., 2013; Lindgren & Rassmussen, 2013; Osterwalder & Pigneur, 2010) is possible, but does not create a clear picture of the value creation network. As the business case of the 'standalone' charging point is not positive, it is necessary to

think about bundling of products and services. Fast charging makes other, profitable products and services possible and should therefore be 'cross-subsidized' by them. In order to find out which bundles could make sense, it is of direct importance to clearly describe and depict the full value creation network.

Methodologically, we started with qualitative research in the form of expert interviews and made an in-depth content analysis. We were then looking for ways to depict the expert statements, in particular with respect to the value creation network of fast charging stations. In search for a tool to visualize the interview results, we considered to extend the Unified Modeling Language (UML) (Object Management Group, 2011) used in Software Engineering. At that point, we found out that a UML derivative had been published just recently that could serve our goals: the 'Value Delivery Modeling Language' (VDML) (Object Management Group, 2014, 2015).

With the tool, we visualized and compared the interview results. We realized the approach has the potential to create a common understanding among stakeholders on how the value creation network looks like and what roles come into play.

Beyond the project context, we consider that the approach is quite generic. Coming back to our remarks on the importance of what Song et al. called the 'embeddedness in the supply chain' (Song et al., 2008), we believe that the approach substantially helps to create a sound business concept. Based on VDML, we created the 'Value Delivery Architecture Model' (VDAM). The goal of this tool is to achieve a common vision and understanding among a group of people about the business model as part of a specific value creation network.

2 Background

In this section we will present the components, which were used in the development of VDAM. We based our tool on two existing approaches, the 'Value Delivery Modeling Language' (Object Management Group, 2014, 2015) and 'Ontologies' in Business Modeling (Osterwalder, 2004). These artifacts were combined to describe and depict value creation networks (Pathak et al., 2007) and the embeddedness in the supply chain (Song et al., 2008) of an innovative venture.

2.1 Value Delivery Modeling Language

VDML has its origins in Information Systems (IS) and is a UML-specified approach for business modeling. Its first beta version was released by the Object Management Group (OMG) in April 2014 (Object Management Group, 2014). It has been developed as a business modeling tool that intermediates between strategy and business processes.

One key function of VDML is to model value creation and value exchange on a strategic level. VDML also provides a link from strategy and business models to activities, roles and capabilities necessary to implement a business model. Thus, it provides a language for analysis, evaluation and design of business models with a link to a more operational level. The key notion of VDML is the creation and exchange of value.

VDML incorporates several types of diagrams that are included in the following views:

- Business Network View
- Activity Network View
- Organization Responsibility View
- Value Contribution View

In our proposed approach we use several of these diagrams to describe different aspects of business models (see Sect. 3.1). In addition, VDML supports several existing concepts of business modeling and business analysis approaches such as the 'Business Model Canvas' or 'Value Networks' (Object Management Group, 2014, 2015).

2.2 Ontology Building

In addition to a modeling language that visualizes value creation and value delivery, it is possible to create further transparency, clarity, and a common understanding between stakeholders by the use of ontologies. Ontologies are in widespread use in the area of Information Systems as explicit specifications of conceptualizations. They create a common understanding within a domain and simplify the buildup and sharing of knowledge. This contributes to an improved communication between people, organizations and machines, and thereby leads to an improved interoperability between systems (Ehrig & Studer, 2006; Mädche, Staab, & Studer, 2001).

Consequently, they are an important component to achieve the overall goal of this paper: to provide a tool that creates a common understanding among people on what their business model is or should be and how it is embedded in the value creation network.

For the design of ontologies, the following three guidelines have been described in the literature (Uschold & Gruninger, 1996):

- Clarity, in the sense of minimized ambiguity
- Coherence, in the sense of an internal consistency
- Extensibility of the designed ontology

Uschold & Grunninger's approach of ontology building includes the steps of capturing, coding, evaluation, and documentation. In the following, we will apply ontologies and VDML in the specific domain of electric mobility and demonstrate how their combination can help to create a clear understanding of the situation.

Overall, we deem VDML and semi-formal ontologies promising artifacts for reaching our goal of developing a new tool that focusses on a common understanding of value creation and delivery. These artifacts support the management of complexity and creation of a common understanding amongst stakeholders. Thereby, VDML offers a number of visualization methods that allow to describe and manage complex value creation and delivery. Ontologies, on the other hand, enable common understanding and improved communication amongst stakeholders, supporting collaborative efforts. The specific application of these artifacts in VDAM will be introduced in the following section.

3 Value Delivery Architecture Modeling

In order to describe and visualize collaborative value creation we combined the elements mentioned in the previous section (VDML and semi-formal ontologies) and developed a tool that we refer to as 'Value Delivery Architecture Modeling' (VDAM). Here, we use the term 'architecture' in analogy to its use in information system modeling and refer to the conceptual and functional partition of the value creation processes. As mentioned before, our goal is to develop an approach to create a common understanding among people on what their business model is and how it is embedded in the value creation network.

To this end, we describe and depict value creation and delivery processes in a domain or industry. This establishes a common ground for the analysis, evaluation, and design of business models. We will introduce the VDAM framework, including the process of developing the visualizing diagrams and the corresponding semi-formal ontology.

3.1 VDML Elements

VDML offers a number of views and diagrams to model and visualize value creation and delivery. In VDAM, we use a subset of these elements. The key diagram we use in our tool is the so-called 'Value Proposition Exchange Diagram' from VDML. This kind of diagram consists of three types of elements: Roles (R), Value Propositions (VP), and Connectors (C) (see Fig. 1). Here, 'Roles' are defined as abstract elements describing patterns of behavior or capabilities. 'Value Propositions' represent tangible and intangible values of deliverables. 'Connectors' represent the association that connects a 'Role' with a 'Value Proposition' or a 'Value Proposition' with a 'Role' (Object Management Group, 2014, 2015). (For simplicity of notation, we will drop the simple quote symbols '' in the following.) For the application within VDAM, we define that a Value Proposition Exchange Diagram can be described as a 3-tuple (R, VP, C), where

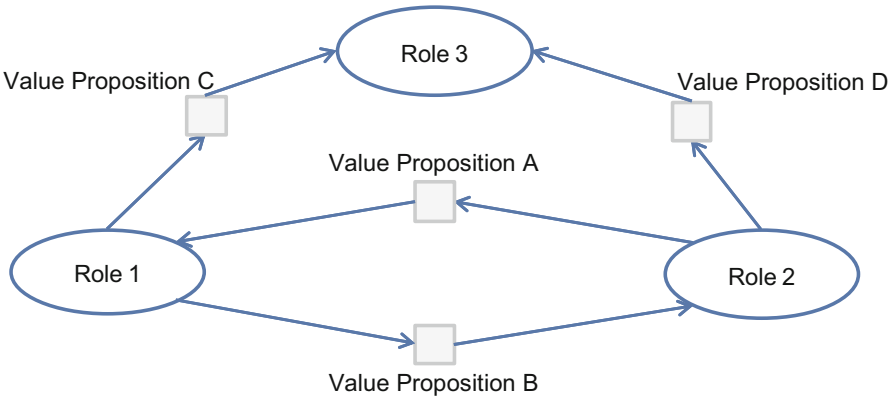

Fig. 1 Elements of a Value Proposition Exchange Diagram (Object Management Group, 2014, 2015) in VDAM

- R is a finite set of Roles
- VP is a finite set of Value Propositions
- R and VP are disjoint
- C: (R x VP) ∪ (VP x R) → ℕ is a multi-set of arcs

As a result, a specific Value Proposition can only be offered from one Role to one other Role. Additionally a specific Role can only offer one Value Proposition towards one other Role. Furthermore, since Roles and Value Propositions must not be identical, we define that Roles and Value Propositions cannot have the same names. These additional restrictions on the design of this key view aim to ensure comparability of Roles and Value Propositions due to a consistent level of abstraction. Following this approach, the resulting Value Proposition Exchange Diagram visualizes and describes the value delivery from a more strategic perspective.

In the following use case of electric mobility fast charging stations, we will focus on the Value Proposition Exchange Diagram. For reasons of completeness, we briefly mention three additional views that we consider important. Following the logic of VDML, these views can be derived from the Value Proposition Exchange Diagram by using additional information about value creation in a domain. The additional views allow for more informed decisions on if and how a new Business Model may be implemented. Without going into details, we consider the diagrams displayed in Fig. 2 as relevant and refer the reader to the VDML specification (Object Management Group, 2014, 2015) for further information:

- Network Activity Diagram
- Capability Management Diagram
- Measurement Dependency Graph

Network Activity Diagrams enable the design of key processes which are necessary to offer specific Value Propositions. The visualization can be used to identify critical steps in the value creation process and clarify responsibilities of

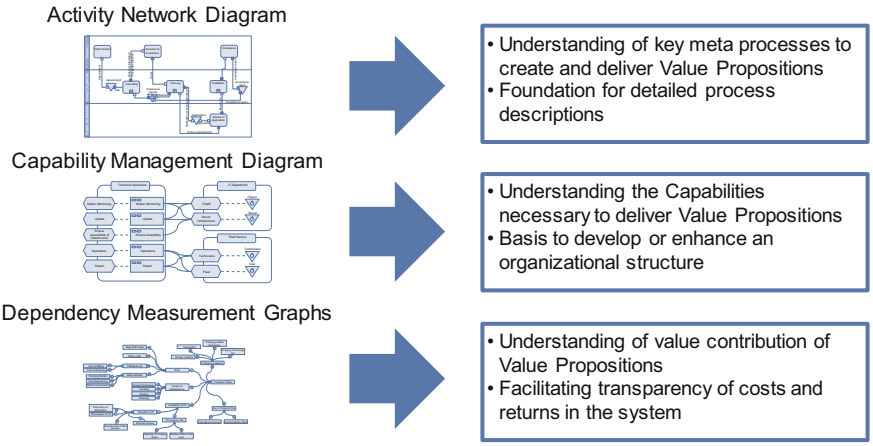

Fig. 2 Additional VDML views (Object Management Group, 2014, 2015) applicable in VDAM

partners and organizational units. Capability Management diagrams can be used to identify the necessary Capabilities and Resources for the delivery of a Value Proposition. Additionally, a gap analysis between existing and necessary Capabilities can be established and decisions towards partnerships or internal knowledge buildup can be made. By displaying organizational units and the allocated Capabilities, this type of diagram can also be used as input for the design of an organization to implement a specific Business Model. Measurement Dependency Graphs display the logic of value creation and value contribution.

The visualization of value creation and delivery between roles in a domain is a key enabler for the analysis, evaluation and design of business models, as it creates a visual language that enables stakeholders to come to a common understanding of the situation. It also helps to articulate and evaluate options and thereby leads to more informed decision on business models.

3.2 Ontology Building in VDAM

The graphical representations of VDML facilitate the understanding of relationships between Roles and their corresponding Value Propositions. The development of a domain ontology complements the approach and establishes a common language. The information captured in the ontology is directly related to the requirements of the VDML elements described above. Therefore, in addition to the elements Role and Value Proposition which are part of the Value Proposition Exchange Diagram, further elements such as Capability, Activity or Value have to be included in the ontology. These elements are necessary for the design of more detailed views. For the description of the ontology elements we used Osterwalder's

Table 1 Domain ontology element in VDAM based on Osterwalder (2004)

Name of element	VALUE PROPOSITION
Definition	VALUE PROPOSITION represents tangible or intangible VALUE offered by a ROLE towards another ROLE
Part Of	Product
Related To	ROLES CAPABILITIES VALUE
Set Of	VALUE PROPOSITION COMPONENTS
Cardinality	1 – n
Attributes	Name {abc} Description {abc} Example {abc} ValuePropositionComponents {abc} Target Role {Role} Value for Target Role {value} Offering Role {Role} Value for Offering Role {value} Activities {Activities} ~ Inherited Attributes from ValuePropositionComponents

Business Model Ontology approach. In Table 1, the approach is illustrated with the element 'Value Proposition'. Seven categories are specified: Name of the Element, Definition, Part of, Related to, Set of, Cardinality, and Attributes (Osterwalder, 2004).

Name and Definition are being used to specifically describe the elements and create a common understanding. The categories Part of, Related to, and Set of are being used to describe the semantic relationship of elements. Generally, elements can be decomposed into sub-elements to allow for different levels of granularity in analysis. For instance, an element 'Value Proposition' can be decomposed in several 'Value Proposition Components'. The cardinality defines the number of possible appearances of elements in the approach. By definition, the cardinality of the entities of Role and Value Proposition has to be one. The entities of other elements which are used in the more detailed diagrams can have other cardinalities. This enables reuse of these elements during the design process when deemed helpful. Finally the category Attributes defines what attributes have to be used to describe entities of an ontology element.

In summary, the use of Osterwalder's Business Model Ontology approach explicitly describes and defines the elements of the graphical representation in VDML diagrams. It can be applied on different levels of abstraction, e.g. for generic elements linked to VDML or for specific elements relevant in the industry or domain considered. The use of this semi-formal domain ontology in VDAM enables stakeholders to establish a common language thus reducing ambiguity through explicit definition and description.

3.3 Modeling of the Overall Value Creation and Delivery in a Domain

The VDAM approach starts with an abstraction from specific companies and their individual business models and distills a representation of the overall value creation network in an existing or emerging domain. This is accomplished by modeling abstract Roles, Value Propositions, and other elements introduced above. The resulting visualization and explicit description establishes a well-defined framework, which can become a solid foundation for analysis, evaluation, design and common opinion building. It helps to identify the role and value proposition of a venture and thereby position it strategically within the value creation network. It enables entrepreneurs to make an in-depth analysis of how to contribute to value creation and how to focus on core capabilities.

3.4 The Value Delivery Architecture Modeling Framework

As described above, the VDAM method makes use of VDML diagrams and the business model ontology to create a Value Delivery Architecture Model for a given domain. In Fig. 3, we depict the systematic approach, with typical steps and iterations. This process can be a considerable effort. We argue that this effort is time well spent, as it creates a foundation for key managerial decisions.

The process starts with gathering information about the domain or industry. This can be achieved in various ways reaching from expert interviews, industry reports and content analysis to sophisticated quantitative data analysis (Day, 1981). After processing and interpreting this information, it will be possible to draw a first version of the relevant diagrams. Modeling within VDAM implies the description of the value creation network using the Value Proposition Exchange Diagram. In addition, it is important to describe the results in the semi-formal ontology to ensure conceptual clarity and a common language.

The design of the diagrams and the development of the ontology is an iterative process. Developing additional diagram types makes use of the ontology that has emerged at that stage of the process. These diagrams in turn may create new questions and will trigger a process of additional empirical information gathering. The additional knowledge will be made explicit by including it in the ontology, which thereby is enriched and enhanced. In this way, the iterative ontology building and refinement process makes explicit use of the extensibility guideline for ontologies (Uschold & Gruninger, 1996).

The VDAM artifacts (VDML diagrams and the domain ontology) create an explicit frame of reference for the value creation network of a given domain. This is useful in various situations:

1) They help an entrepreneur or team to clearly position and align.

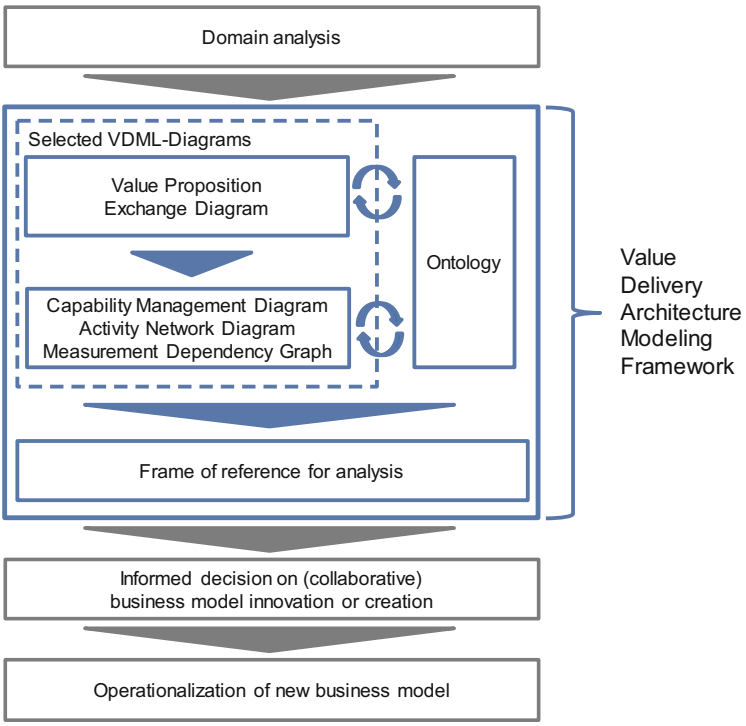

Fig. 3 VDAM approach based on VDML (Object Management Group, 2014, 2015) and semi-formal ontologies (Osterwalder, 2004)

2) They help to create a common understanding among stakeholders about value creation and delivery, thereby facilitating cross-company and cross-industry collaboration.
3) They help to analyze existing business models and create the basis for evaluating and (re-) designing these them.

Key questions of entrepreneurship and strategy definition are related to these topics. They include the own positioning in the value creation network, the identification of key capacities and resources, 'make or buy' decisions, competitor analysis, clarity about coopetition situations, the identification of key partnerships and more. VDAM can make a contribution to an informed decision making in these key questions of entrepreneurial management.

In the following section we will show this potential of VDAM on the case of fast charging infrastructure in Germany.

4 The Case of Fast Charging Infrastructure in Germany

As mentioned in the introduction, the trigger for our approach was a research project on business models of fast charging infrastructure for electric vehicles. In this context, we applied VDAM in the related domain, focusing on the Value Proposition Exchange Diagram. Thereby we visualized and explicitly described the value creation network of this specific domain from a more strategic perspective. In fact, the context of fast charging has some interesting aspects:

- Involvement of companies from diverse industry sectors, namely automotive, electro-technology, utilities and other services.
- Lack of a well-established value network and an ambiguous understanding of how value is created due to the novelty of this area.
- Deployment of heterogeneous technological standards and proprietary solutions, like CHAdeMO, Combined Charging System, and the Tesla system.
- Lack of a sound business case for the operation of fast charging infrastructure based only on electricity sales, due to high upfront investments and a limited willingness to pay (Nationale Plattform Elektromobilität, 2014; Reinke, 2014).

Altogether, this creates a very complex and uncertain environment not favorable to direct investments and entrepreneurial engagement.

Our research project was motivated by the question how to analyze the situation, how to create a conceptual framework and common understanding for the context and finally how to systematically create options for viable business models for fast charging stations. Methodologically, we performed the following steps:

1) Interviews with 17 domain experts and systematic content analysis,
2) Modeling of the experts' individual perspectives in VDML,
3) Creation of a consolidated frame of reference for the value creation network,
4) Positioning of companies in the frame of reference,
5) Analysis of value creation and existing business models.

Form a design science point of view, we have gone through the first steps to construct the VDAM artifact (Hevner, March, Park, & Ram, 2004). The validation of the artifact is still work in progress, but we want to report on the results we have obtained so far, as they are of general interest for advanced business modeling. In the following, we will describe the steps mentioned in some detail.

4.1 Interviews and Qualitative Data Analysis

Using qualitative research methods we interviewed 17 senior executives and top experts from companies representing the different industry sectors involved. We asked about their perspectives on this new domain of fast charging infrastructure and their companies' business models. All experts except one have direct

experience in electro mobility for 2 or more years. All of them show cross-company experience by participating in government funded research and demonstration projects and being part of the German National Electric Mobility Platform (Nationale Plattform Elektromobilität). The interviews were held face-to-face or via telephone during August and September 2014. The 17 interviews produced a record of approximately 16 hours, corresponding to a transcript of about 115,000 words. This empiric data was coded following Mayring and Brunner's iterative qualitative analysis approach (Mayring & Brunner, 2009), building the empiric basis for the modeling of the individual perspectives and the subsequent application of VDAM.

4.2 *Modeling of Experts' Individual Perspective*

Even though the experts all work in this emerging domain and were asked the same questions, the data reveals a highly heterogeneous understanding of how and by whom value is created. In particular, the experts were asked to name the key Roles and their corresponding Value Propositions in the area of fast charging infrastructures. In a first step, we visualized the experts' statements in the interviews, not yet applying the guidelines which we specify in the Value Proposition Exchange Diagram in VDAM. (Specific Roles and Value Propositions in the domain of fast charging infrastructure will be written in *italic*).

Figure 4 shows the view on the value creation network described by 4 of the 17 interviewed experts. Examples of the differences displayed in Fig. 4 are:

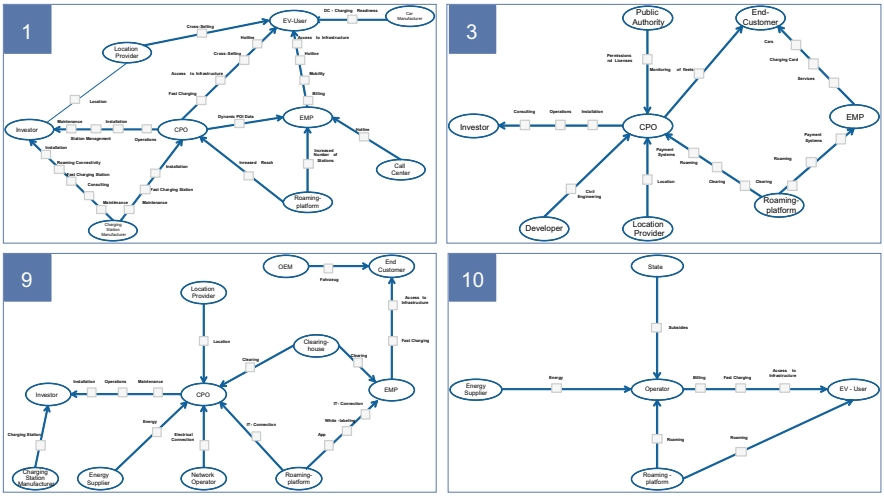

Fig. 4 Exemplary perspectives on the value creation network in the new domain of fast charging infrastructure in Germany

- The number of Roles in the value creation network ranges from 5 to 11 Roles.
- The number and nature of the Value Propositions exchanged by the Roles is highly heterogeneous.
- Experts assign different types of Value Propositions to the same Role and have different perceptions about which Role receives these Value Propositions.
- Even when experts described the same topics, the wording and terms of use were highly heterogeneous.

To some degree, these diverse perspectives may be intrinsic to the research design based on semi-structured interviews (Barriball & While, 1994; Burnard, 1991; Diefenbach, 2009). Another reason may be the different industry and personal backgrounds of the experts. In any case, four reoccurring phenomena can be observed which complicate the cross-company collaboration:

- Experts use different levels of abstraction when talking about Business Model, Roles and Value Propositions.
- Experts use patterns associated with their own company or other companies they have experienced.
- An unambiguous, common cross-company vocabulary is missing.
- Different experts do have a significantly different understanding of how value is created in the specific domain.

These results from the primary analysis show the need for a common conceptual framework which is fundamental for managing cross-company collaboration. The application of Value Delivery Architecture Modeling can substantially contribute to this.

4.3 Frame of Reference for the Value Creation Network

Applying the VDAM approach, we identified 21 different Roles and the corresponding Value Propositions that Actors (companies) can take on in the area of fast charging infrastructure. To derive these Roles and Value Propositions, we used the methods of abstraction (integration of Roles and Value Propositions) and structuring (creation of new Roles and Value Propositions) to fulfill the VDAM specific requirements for Value Delivery Exchange Diagrams. To minimize the potential of misunderstanding, we described all elements and their relationships in a semi-formal domain ontology, as described in Sect. 3. Thereby we developed an explicit frame of reference for the value creation network under consideration.

To illustrate the VDAM development process of a Value Delivery Exchange Diagram in more detail, we exemplify this process with one of these Roles, the so-called *Charge Point Operator* (*CPO*) Role. All experts mentioned the Role *CPO* but there were many different associations to what exactly this Role is supposed to do (Activities) and what Value Propositions this Role is offering or receiving. To

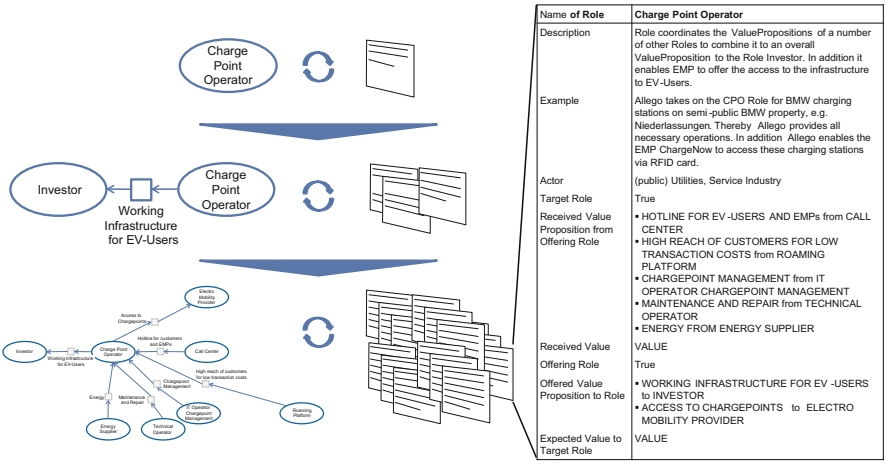

Fig. 5 Example of the iterative process of visualization and ontology building in VDAM

explicitly describe the Role, a first version of the ontology entity *CPO* was developed. In the iterative approach of analyzing expert opinions and defining and visualizing Roles and Value Propositions, the Value Proposition Exchange Diagram was constantly growing and changing. Simultaneously, the corresponding ontology element of the Role *CPO* became more detailed and other related ontology entities were described. Thus we created the desired unambiguous understanding of elements as well as the corresponding value creation and delivery (see Fig. 5). In the case of fast charging infrastructure it became evident that the Role *CPO* is mainly organizing the actual operations of charging infrastructure by coordinating several Roles as well as their Value Propositions and offering the result to the Role *Investor*. In addition, a second Value Proposition *Access to Charging Points* is offered to the *Electro Mobility Provider* Role.

In several iterations, we were able to map a consolidated view of the complex overall value creation network (see Fig. 6). This view includes 21 Roles and 29 Value Propositions. In the case of fast charging infrastructure it becomes apparent that even though the VDAM approach reduces heterogeneity resulting from disparate views, it also maps the actual complexity of the situation: the graph shows a considerable number of Roles and Value Propositions.

4.4 Positioning of Companies in the Frame of Reference

Using the Value Proposition Exchange Diagram as a frame of reference allows for an exact positioning of business models of companies. Fig. 7 demonstrates the general process of linking Roles to Actors (that is concrete firms) based on the expert statements. In the displayed case, the expert originally mentioned nine

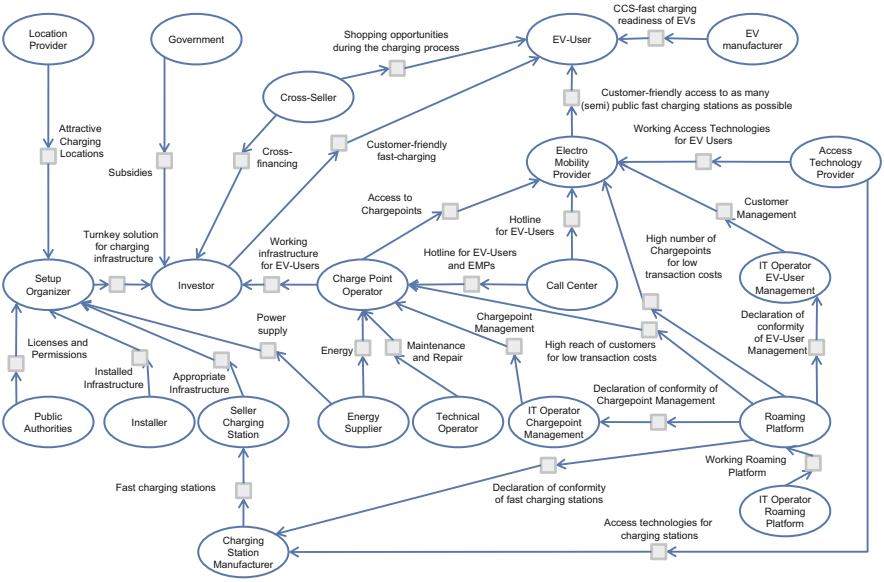

Fig. 6 Value Proposition Exchange Diagram of the fast charging infrastructure domain in Germany

Roles. In her perspective, her company occupies the roles EV Manufacturer, Charging Location Provider, Electro Mobility Provider, and Investor. After deriving the consolidated view, it is possible to allocate her perspective in that broader picture. Instead of filling four Roles as stated in her own description, the consolidated VDAM view shows that the company is in fact assuming six Roles.

Instead of three Roles which are filled by partners, there are four Roles. Additionally, in this specific case it becomes obvious that the expert described an oversimplified view on the value creation network. Therefore, a larger number of Roles offer Value Propositions to Roles which her company is assuming.

By following this approach of placing business model views of individual experts into the VDAM-referencing framework, a comparison of business models becomes possible. This can be used as foundation for various types of analysis. Additionally, understanding what Roles competitors, partners and other companies in the value network assume, allows for a more informed decision on partnerships. All these aspects are key to prepare informed decisions on if and how a new business model should be implemented or if the existing business model needs to be innovated.

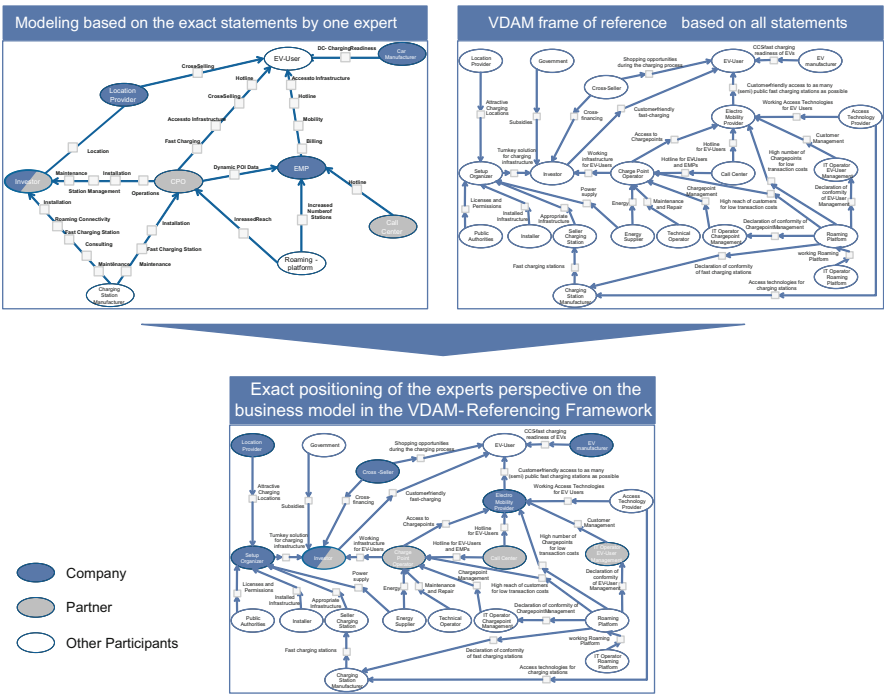

Fig. 7 Example of the positioning process of individual business models in the Value Proposition Exchange Diagram

4.5 Analysis of Value Creation and Existing Business Models

We used the Value Proposition Exchange Diagram to conduct four types of analysis based on the empiric data from the expert interviews. Two of these analyses are on the level of the overall value creation network and two are on the level of individual business models of companies:

- Analysis of Roles in the value creation network,
- Analysis of the competitiveness or complementarity of Roles,
- Analysis and comparison of companies with the same industry background,
- Analysis and comparison of all companies.

4.5.1 Analysis of Roles in the Value Creation Network

Analyzing the Roles in the value creation network displayed in the Value Proposition Exchange Diagram is conducted without taking the positioning of specific companies into consideration. By analyzing the Roles in the value creation network, the understanding about value creation in a domain can be deepened and

potentials for business model opportunities can be carved out. Looking at the Roles in the area of fast charging infrastructure in Germany several interesting facts about this emerging industry can be revealed:

Four Roles, namely *EV Manufacturer*, *Electro Mobility Provider*, *Investor*, and *Cross-Seller* have a direct Value Proposition for the Role *EV-User*, thereby occupying the B2C interface. Additionally, there are two Roles which can be placed into the public or governmental sector, namely *Public Authorities* which offers *Licenses and Permissions* to the Role *Setup Organizer* and *Government* which offers *Subsidies* to *Investor*.

In addition, a number of Roles with a high level of interrelatedness appear. These Roles are characterized by coordinating and thereby combining a high number of Value Propositions from other Roles to subsequently integrate them to one new Value Proposition. Therefore these Roles are acting as hubs, adding value to the complex network by system design.

Examples in the area of fast charging infrastructure are the *Setup Organizer*, *Charge Point Operator*, *Electro Mobility Provider*, and *Investor*. Two of these Roles have a major impact to facilitate the level of engagement by the *Investors* by coordinating a high number of Value Propositions of other Roles and offering a combined Value Proposition to the *Investor*. Other Roles like *EV Manufacturer*, *Charging Station Manufacturer* or *Energy Supplier* add value to the system by offering Value Propositions which are based on specific expertise and Capabilities from the respective industry types, namely automotive, electro-technology, and energy sector.

It is interesting to note that the level of granularity of the value creation network is not something absolute, but depends on the context. As an example, a car manufacturer is part of a very complex supply network that does not appear in our model. In contrast, the electric vehicle is considered as a whole. Depending on the business model in question, various levels of aggregation may make sense. In the context of fast charging stations, the interview statements of the experts determined the degree of granularity of the representation. In any case, VDAM has the flexibility to capture further details and extend the framework if needed.

4.5.2 Analysis of the Competitiveness or Complementarity of Roles

The positioning of the experts' companies in the frame of reference (Fig. 7) is necessary for this kind of analysis. One starting point is to look at the number of Roles assumed by a company as displayed in Fig. 8.

The Role assumed by most companies is *Seller of Charging Stations*. This is remarkable because only three of the interviewed experts stated that their company is actually providing charging infrastructure technology (Role *Charging Station Manufacturer*). This fact shows that the Role *Seller of Charging Stations* delivering to the Role *Setup Organizer* is appealing to companies from industries other than technology providers. It therefore shows a high degree of competition.

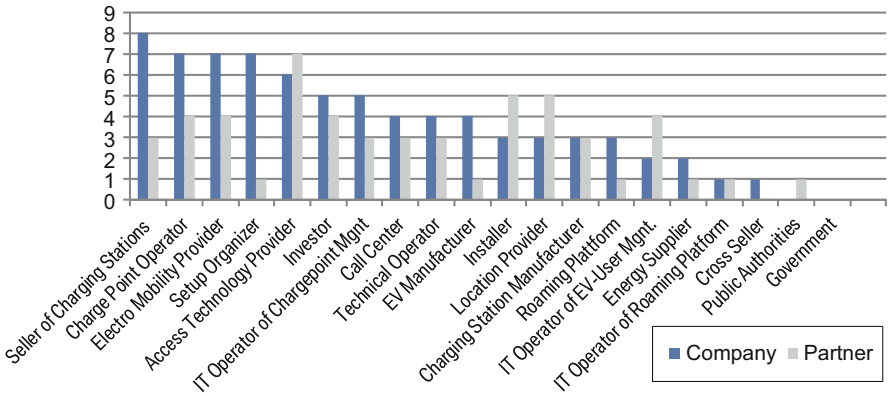

Fig. 8 Roles assumed by companies or Roles assumed by their respecting partners

The Roles *Charge Point Operator*, *Setup Organizer*, and *Electro Mobility Provider* rank second. This might be explained by the fact that these Roles are characterized with a high number of receiving Value Propositions. These Value Propositions are coordinated and combined to be offered as a single Value Proposition, or in the case of *CPO*, as two Value Propositions. Therefore we can conclude that coordinating Roles are appealing to Actors from different industries, too, and therefore reach a relatively high level of competitiveness.

Looking at the Roles which only few experts mentioned, it becomes apparent that only one expert stated that her company is filling in the Role *Cross Seller*. This is noteworthy because this is one of only four Roles that have a direct Value Proposition to *EV-User* and therefore is active in the B2C business. Analyzing the number of statements towards Roles that are assumed by partners of the companies, it becomes evident that the Role *Access Technology Provider* is of great importance to many Actors. This Role profits from the fact that its products and the corresponding Value Propositions build the technological interface which enables *EV-User* to authenticate at charging stations.

On the other hand, almost all experts did not name Roles from the public or governmental sector as partners. The fact that *EV-Manufacturer* did also just get mentioned by one expert is astonishing because the Value Proposition *CCS-readiness of EVs* is essential to the system as a whole.

Additionally, there are still some interoperability challenges between EVs and the infrastructure. Therefore the mentions of *EV-Manufacturers* were expected to be higher. Besides that, most Roles got mentioned as partners 3–5 times which supports the interrelatedness of roles and the complex value creation network in this domain.

4.5.3 Analysis and Comparison of the Positioning of Companies with the Same Industry Background

After describing ways to analyze the overall value creation network, we now focus on the positioning of individual companies. This analysis help in decision making processes about the entrepreneurial engagement of companies with specific industry backgrounds:

Six experts from five automotive companies took part in the study. Companies from this industry show very diverse levels of engagement in the new field of fast charging infrastructure. Interestingly, even the two experts from the same automotive company had different perceptions on which Roles are filled by their employer. Nonetheless, they agreed that their company assumes all Roles with direct contact to *EV-User*, thereby offering a holistic Value Proposition to this Role.

Other firms from the automotive industry show much less engagement in the area of fast charging infrastructure. Two experts stated that their company does not fill any Role in the value creation network at the moment, not even *EV Manufacturer* with the Value Proposition *CCS-fast charging readiness of EVs*. Based on the statements of the experts, two of the remaining three companies from the automotive industry act on a limited scale as *Investors*. One of the companies is active as *Access Technology Provider* due to the fact that the company implemented Power Line Communication as an authentication technology into their cars.

Looking at the companies from the energy sector it becomes apparent that all of them assume the Roles *Charge Point Operators* and *Setup Organizer*, thereby offering the two existing Value Propositions to *Investor*. But only two of the five companies do also act as *Investors* themselves. Besides that, four out of five companies are active as *Electro Mobility Provider*. Therefore, companies from the energy sector are highly active in three of the coordinating Roles mentioned above. Additionally, four out of five companies fill the Role *Seller of Charging Stations*.

Companies from the electro-technology area are active as *Charging Station Manufacturers*, *Technical Operators*, and *IT Operators for Charging Station Management*. Thereby they offer a holistic Value Proposition for fast charging stations. All of them fill the Role *Seller of Charging Stations*, but also have partners to support their own engagement in this Role. For all companies *Access Technology Provider* is another important partner. In general, electro-technology companies tend to focus on Roles close to their original industry and area of expertise and show only little engagement in other parts of the complex network.

The picture of the companies from the service industry is more diverse. Two of the three companies from the service industry are active in the Role *Roaming Platform* and closely related Roles, focusing on the B2B business. One of the two companies is acting as *Electro Mobility Provider* too, thereby expanding its reach towards the B2C business. The third company from this industry focuses on the Roles with access to *Investor*. This company is able to offer these highly complex Value Propositions *Turnkey Solutions of Charging Infrastructure* and *Working*

Infrastructure for EV-Users by having a widespread net of partners in all necessary Roles. Thereby this company needs the Capabilities 'Integration' and 'Coordination', as well as 'Project Management' to fulfill its Value Propositions.

4.5.4 Analysis and Comparison of the Positioning of All Companies

Shifting the analysis and comparison towards the specific positioning of all companies in the study, a number of additional observations can be made:

In general, primarily companies from the automotive and the energy sector compete for access to the *EV-User*. Especially the Role *Electro Mobility Provider* is of particular interest to companies from both industries. Other Roles with a relatively high degree of competition are the Roles with direct Value Propositions to the *Investor*. Mainly companies from the energy sector fill these Roles but there is competition from companies from other industries, e.g. Services, too. A Role with little competition is *Cross-Seller*. Even though this Role has a direct Value Proposition to *EV-User*, only one expert stated that her company fills this Role and no other expert mentioned this Role as a partner.

Even less attention is given to the public or governmental Roles as partner. This is a surprise due to the complexity of regulations for installing fast charging infrastructure and the general calling for subsidies as initial aid for the implementation of fast charging infrastructure in Germany. The willingness to act as *Investor* is relatively low. Only five of the experts stated that their company fills this Role, mostly with a relatively low level of engagement. All other companies simply want to participate in the market without bearing the risk of high investments.

In conclusion, the different types of analysis described enable to deepen the understanding on a number of aspects. Besides a clearer picture of the value creation network in the domain of fast charging infrastructure, it is possible to carve out indications about the competitiveness of different Roles. By looking at the specific positioning of companies active in the domain, conclusions towards current and future potential engagement of companies from certain industries could be drawn. All of these analyses support the decision making process of innovative enterprises or firms already active in the field.

5 Conclusion

The post-industrial economy can be characterized as a highly networked economy. Focusing on core competencies and creating adequate partnerships with other firms are key strategic activities in such contexts. We think that the well-known business modeling approaches do not fully account for the increasing importance of understanding the value creation network and the successful positioning of a firm within this network.

In order to fill this gap, we described the 'Value Delivery Architecture Model' approach to analyze, evaluate and design business models and their embeddedness in the value creation network. We have applied the method to the specific case of fast charging infrastructure for electric mobility in Germany and gave a first impression of the breadth and depth of analysis that the method makes possible.

We are well aware about some limitations of what we present. In developing VDAM, we are following a design science approach. In the paper, we have focused on the description of the artifact, and have provided some evidence for its usefulness.

The validation of the approach is still work in progress. In the case of fast charging stations, we still want to validate the consolidated VDAM view by presenting it to the experts and gathering their explicit feedback on the artifact. A successful application of VDAM in this case can also be considered a validation of the method. Further applications in entrepreneurial practice must be performed to gather further data, detect possibilities and limitations and develop the method further.

Nevertheless, we think the first results are very promising and are confident that Value Delivery Architecture Modeling is valuable to researchers and practitioners. VDAM is based on the new expressive business modeling language VDML and semi-formal ontologies. These artifacts create an explicit frame of reference for the value creation network of a given domain which can be useful in various situations. VDAM addresses one of the truly complex entrepreneurial tasks, namely understanding the value creation network and creating a novel value proposition that is relevant in that overall setting.

In our use case, we were able to visually document how heterogeneous the views of the different experts were. In an emerging market, this may be natural, but creating a common understanding or even defining the 'rules of the game' of value creation and delivery is one of the key success factors for entrepreneurial action. In creating a consolidated view of various expert statements, the VDAM approach is a key tool for business development in newly emerging value creation networks.

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Action Research as a Viable Methodology in Entrepreneurship Research

Christian Schultz, Dana Mietzner, and Frank Hartmann

Abstract Although the roots of action research trace back to the works of Kurt Lewin throughout the 1940s, there exists a great nescience concerning this methodology. This is largely due to a kind of Babylonian confusion where, depending on the literature stream, small differences result in new labeling and inconsistent usage of definitions across the methodological derivatives. However, the core action research approach has the potential to derive pioneering research results. In entrepreneurship research, the understanding of complex phenomenon through retrospective sense-making with self-reporting instruments has its inherent limitations. Action research through its real-time assessment by a researcher who is involved in the ongoing process and plans frequent learning circles, can result in superior research results. To reach this goal, the action researcher needs to follow specific rules and procedures in his or her research endeavor. The acquisition of individual social research skills is essential as they directly influence the results' quality.

Keywords Action research • Entrepreneurship research • Innovative methods • Research methodology

1 Introduction

In this chapter, we provide an overview of the general action research (AR) methodology and give advice to fellow researchers, especially PhD students, and young researchers new in the field of applying AR. Because of the lack of PhD students' experience in conducting and planning research, it is more likely that they make irrevocable methodological mistakes. Those faults might even compromise their research results and ruin their efforts, which consequently could lead to years of wasted research time. Besides of PhD students we are positive that this chapter is

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_13

a first step for every researcher who is not familiar with AR to explore if this methodology is suitable for his or her research project.

It is outside the scope of this short compendium to provide a full overview of AR applications in its various forms across the social science disciplines. Sophisticated scholars (e.g. Reason & Bradbury, 2008) make this effort with comprehensive book publications. We aim predominantly at pointing out the major mistakes in planning AR projects in the context of entrepreneurship research.

It is our strong conviction that there are numerous ways of following an AR approach efficiently and successfully. The empirical indicator for the numerous options a researcher has in that regard are the methodological derivatives that exist, e.g. action design research (Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011), innovation AR (Kaplan, 1998), canonical AR (Davison, Martinsons, & Kock, 2004) or normative AR (Babüroglu & Ravn, 1992).

Nevertheless, there are mistakes or "traps" the researcher might run into, which are critical to the perception of reliability and external validity of the research in the research community. Although these specific characteristics stem from the positivistic paradigm of science which is associated with quantitative methodologies, a responsible researcher will always try to measure the quality of the research results.

At the present time, AR methodology is rarely practiced in the areas of entrepreneurship research. A search in the Business Source Premier Database ebscohost brings only one article (Winkler, 2014) to our attention that targets an entrepreneurship topic, used AR and is published in a journal dedicated to entrepreneurship.

But AR is practiced outside the entrepreneurship realm. For an overview of 49 articles which use AR in top-tier management journals like AMJ and ASQ, see Zhang, Levenson, and Corssley (2015).

Molina-Azorín, López-Gamero, Pereira-Moliner, and Pertusa-Ortega (2012) identify an overall scarcity of non-quantitative or mixed-method research articles in the entrepreneurship area (see Table 1). Although, different opinion leaders in the field (Short, Ketchen, Combs, & Ireland, 2010; Zahra & Wright, 2011) stress the potential value of qualitative studies and mixed method research designs in the widely recognized leading journals of overall 742 published empirical articles, only 32.5 % (241/742, see Table 1) used a non-quantitative research design.

If this result is an indicator of the diffusion and reputation of quantitative methodologies, the acceptance of the positivistic paradigm in general, the scarcity of well-researched non-quantitative research studies or just the easy availability of processing power and statistical software, are ongoing discussions. The fact remains; non-quantitative papers are by far the minority of published papers in high-quality journals. Although the data in Table 1 covers only the period 2000–2009, we are sure that nothing fundamentally has changed in the general proportions of quantitative to qualitative research in high-quality journals.

We think that the reasons for neglecting non-quantitative methodologies in general are somewhat similar to the special case of AR. There are few codified protocols in place to deal with qualitative data (Short et al., 2010) and there are widespread misconceptions or ambiguities concerning non-quantitative methodologies.

Table 1 Types of entrepreneurship articles in JBV, ETP, ERD, AMJ and ASQ

Journal/ Time period	Total number of articles	Number of non-empirical articles	Empirical articles			
			Total number of empirical articles	Number of quantitative articles	Number of qualitative articles	Number of mixed articles
JBV 2000–2009	341	65	276	210	41	25
ETP 2000–2009	323	120	203	152	27	24
ERD 2000–2009	219	28	191	91	80	20
AMJ 2000–2009	46	0	46	35	4	7
ASQ 2000–2009	26	0	26	13	8	5
Total	955	213	742	501	160	81

Shorter and slightly changed version according to Molina-Azorín et al. (2012, p. 434)

But in our opinion, for entrepreneurship researchers to learn about AR and practice this approach is well worth the effort.

McKelvey (2004, p. 315) reasons that entrepreneurship is by definition an activity that focuses on new order creation and therefore complexity science is the adequate theoretical perspective for entrepreneurship research.

While other theoretical concepts which are used in entrepreneurship research e.g. evolutionary theory assume that there is some kind of equilibrium that allows the isolation of causation, complexity science recognizes that equilibrium is just one of many different conditions and most likely the current elements are far from being in equilibrium (McKelvey, 2004).

Schindehutte and Morris (2009) opine that the complexity lens offers better results for different key topics of strategic entrepreneurship e.g. exploration, opportunity or newness.

Recently, Bloodgood, Hornsby, Burkemper, and Sarooghi (2015) show that because of the interactions among different agents over time dynamic complexities emerge inside an organization. Through further coupling of subsystems, feedbacks, nonlinear reactions, adaptions and self-organization the system becomes even more complex. Consequently, Crawford and Kreiser (2015) propose the lens of complexity science to develop an integrative framework for corporate entrepreneurship.

In AR the research practitioners take active part in the research process and the study of change is the main interest of the AR methodology. We argue that AR as a research methodology has the inherent potential to discover the complexities and nonlinearities in different entrepreneurship areas and derive at relevant and helpful results.

In this contribution, we aim to start a discussion with fellow researchers about AR so they can make up their mind by themselves.

In a first step, we clarify the term AR and demonstrate its basic assumptions. Then we analyze the applicability of AR in the entrepreneurship domain in more detail.

In a third step, we present different established research strategies, which manifest in structured processes to conduct AR with high transparency and accuracy. This presentation enables us to give advice to researchers on the application of AR in their own research projects.

In the conclusion section, we sum up the main arguments and give some advice for future research endeavors.

To provide the reader with an easy to follow structure, we arranged the main text according to the following three questions:

1. What is Action Research?
2. Why Action Research in Entrepreneurship Research?
3. How to conduct Action Research?

In the last section, we provide further readings on the area of AR, which covers methodological issues and gives advice to would-be action researchers. Because of the lack of AR studies in the last 10 years, at least in the widely recognized leading publications of entrepreneurship research (e.g. ETP, JBV, Research Policy, International Journal of Entrepreneurship, Small Business Management, Small Business Economics, Journal of Business Economics) the main scientific discussion takes place in related research areas, especially management science (see MIS Quarterly since 2006).

2 What Is Action Research?

In order to answer this first question with the necessary depth, we give an overview of the early developments in AR and the common principles of this research methodology. In the end, we sum up specific recent developments in this research area.

2.1 The Origins

> The research needed for social practice can best be characterized as research for social management or social engineering. It is a type of action-research, a comparative research on conditions and effects of various forms of social action, and research leading to social action. Research that produces nothing but books will not suffice. (Lewin, 1958, pp. 202–203)

Since Kurt Lewin's paper entitled "Action Research and Minority Problems" (Lewin, 1946), a line of research has developed with the paramount intention of closing the so-called gap between scientific knowledge and social reality. AR in the

social sciences focuses predominantly on social practice. The central aim of AR is the increase of the practical effectiveness of research, with its subject matter being the widest range of social areas of activity.

Lewin's (1946) understanding of AR exemplifies two important aspects of "action." On the one hand, there is social action as the researched subject is changed in the present, on the other, it is a research approach that shall lead to new social action in the future. The research process is no longer a mere observation of external phenomena, but rather an active intervention in social practice. According to the methodology of AR, the subject matter of research is not only observed by the scientist, but rather the researcher intentionally influences the research subject in order to use the intervention for drawing conclusions on the research subject, the intervention and to change future outcomes.

These aims distinguish AR fundamentally from other methodological approaches e.g. grounded theory. The main purpose of grounded theory is to enable theory development from mostly qualitative empirical data. Grounded theory doesn't aim at active intervention to change the research subject. Consequently, the role of the researcher in AR is that of an active participant. In grounded theory the researcher is a more or less active observer.

According to Argyris, Putnam, and McLain-Smith (1982) significant elements in such an approach to research, which relate to specific social situations, are:

- It is a collaborative process between the researcher and the people in the studied social situation.
- The research is critical and reflective.
- The focus is on social practice.
- It is a process that explicitly relies on reflective learning.

The previous descriptions show that the duality of gaining knowledge and acting are always at the center of the AR approach. According to Checkland and Holwell (1998), who focus in particular on the validity of AR, the cycle in the action research process starts with a description of a specific coherent conceptual framework and a corresponding methodology in order to address a real problematic situation. Acting in the problematic situation allows for reflection on this involvement and its preconditions, which can lead on the one hand to new knowledge and, on the other, to new research subjects. The focal point lays on the process of gaining knowledge and less on the intended effect, i.e. the specific solution to the problem. According to Checkland and Holwell (1998), the systematic reflection in this research process also allows for the generalizability of the results, both in the specific case and with regard to other contexts (Checkland & Holwell, 1998, p. 16). Checkland & Holwell (2007) provide a chronological history of action research from Lewin (1946) to Dash (1997).

2.2 Constituting Elements of AR

There is agreement among AR proponents that the AR approach is characterized by a cyclical process, which starts with reflection on the problem and comprises planning the research design, implementing the design, collecting and analyzing evidence and subsequently reflecting (Riel, 2010). The cyclicality of the research approach speaks on the one hand for the fact that the results can be constantly improved over the course of the process. However, the question remains when such a process reaches saturation and when the researchers and the involved practitioners should exit the process.

Another important element in AR is its so-called collaborative approach. AR is understood as collaboration between researchers and social actors from the area of the subject matter. Collaboration includes the phase of general diagnosis of the problem and the formulation of an applicable theory and phase of implementing measures to solve the problem with subsequent evaluation. For Greenwood (1993, p. 176) participatory AR in the social sciences is method and process at the same time. However, the proponents of this approach also assume that participation cannot be fully imprinted on a research process and participatory AR is an emergent process that is located on a continuum between "expert research" and "participatory action research." The collaboration with actors from the field is a reason for the high quality expectations in regard to the new knowledge. In the handling of the problematic situation, experienced, professional actors gain access to the problematic situation through the researcher (Riel, 2010, p. 1). Coghlan, Coughlan and Brennan (2004) sum up the fundamental characteristics of AR (see Table 2).

Table 2 Main characteristics of action research (Coghlan et al., 2004)

No.	Characteristic of action research
1	Action researchers take action
	Action researchers are not merely observing something happening, they are actively working at making it happen
2	Action research always involves two goals: Solve a problem and contribute to science
	Not a clear distinction between theory and action
3	Action research is interactive
	Action research requires cooperation between the researchers and the client personnel and continuous adjustment to new information and new events
4	Action research aims at developing a holistic understanding during a project
5	Action research is fundamentally about change
	Action research is applicable to the understanding planning and implementation in groups, organizations and communities
6	Action research requires an understanding of the ethical framework, values and norms within which it is use in a particular context
7	Action research can include all types of gathering data methods
8	Action research requires pre-understanding of the corporate and organizational development

Professional actors have the appropriate context knowledge, knowledge about the history of the problematic situation, its structure and the involved stakeholders. Collaboration with researchers offers the opportunity to customize the research design to the problematic situation and improve it in the implementation process through reflection. The likelihood of developing adoptable solutions increases as a result.

At the same time, the difficulties connected with the orientation on practical problematic situations and the corresponding actors cannot be overlooked. A detailed approach makes future generalizations more difficult, and the ability of practitioners to collaborate in developing a research design varies tremendously. Areas such as municipal administrative action, which faces extremely complex social issues and in general the understanding between research and practice is not particularly close, should have some problems as a result.

At the moment, AR isn't practiced regularly in the entrepreneurship research community or even widely known. This is largely due to a kind of Babylonian confusion as recognized by Baskerville (1999, p. 6):

> The action research literature is rather imprecise in its basic terminology. The term "action research" is itself used, on the one hand, to refer both to a general class of methods in social enquiry, and on the other hand, to a specific sub-class of those methods as distinguished from "action science", "action learning", "participatory action research.

AR was intensively discussed in the course of a fundamental, societal, scientific and method-critical debate, but disappeared from the social science discourse almost entirely after a relatively short period of time after the 1970s (Unger, von Block, & Wright, 2007). The reasons were the commitment to social movements, a limited understanding of theory and practice as well as an underestimating of the role of theory formation in the research process (Nagel, 1983; Schneider, 1980). In particular, AR's claims to be a totally new research methodology and to intervene in social processes contributed to the fact that a large research community didn't establish, especially in the German context. Unger et al. (2007, p. 29) assume today that the criticism of action research in the 1970s is no longer entirely accurate. An improvement in the theoretical basis, a more differentiated methodological approach and greater theoretical depth in qualitative social research contributed to this new assessment.

3 Why Action Research in Entrepreneurship Research?

In this section we provide the reader with arguments for the application of AR in its research endeavor. This proceeding roots in our simple experience that in the double-blind review process the author needs to pay attention to explaining and describing the research methodology to the reviewers if a somewhat exotic or rather not very often used methodological approach is used.

We ranked the following arguments according to decreasing importance by our own weighing and are aware that other scholars might choose a different ranking or frame the arguments differently.

3.1 Entrepreneurship's Next Act

Zahra and Wright (2011) give different recommendations for "Entrepreneurship's next act" to overcome the entrepreneurship research growing pains.

In general they plea for a "reframing of the field, not simply relying on incremental research, filling known research gaps and voids." Preconditions for this aim is methodological rigor that takes into account the research context and the application of new and valid measurements (see Table 3). In the case of richer indicators the authors recommend a closer cooperation between the economic and psychology fields (Zahra & Wright, 2011, p. 69). Crook, Shook, Morris, and Madden (2010, pp. 203) analyze the quality of construct measurement in entrepreneurship research and give different suggestions for authors and editors alike to improve in this area.

Zahra and Wright (2011, pp. 76) give an overview of effective strategies for contextualizing. They advocate the usage of engaged scholarship, where researchers collaborate with practitioners. The main reason for this engagement is the development of new questions, which can initiate productive research agendas and enables the careful selection of research methods. Engaged scholarship only covers one part of the set of AR characteristics: collaboration. In our opinion, AR provides the researcher with a much deeper and more sophisticated research program.

Gummesson (2006) addresses additional strategies for improving research practices. He pleas to not only consider context but also context and persona.

3.2 Rising Recognition of the Value of AR

Through a survey of 196 members of the entrepreneurship research community, Kuckertz and Mandl (2013) rank action research as number four of ten reported methodological approaches researchers are currently interested in. Furthermore,

Table 3 Impact of contextualization on entrepreneurship research (Zahra & Wright, 2011, p. 73)

	Research practices	
Dimensions	Current	Contextualized
Treatment of context	Control for it	Is part of the story, sometimes it is the story
Role of researcher	Distant, detached	Heavily engaged
Scope (of propositions)	Broad	Bounded
Phenomenon	Defined a priori	Defined by context: Meaning and boundaries often evolve as research progresses
Questions	Relevance	Generalizability

action research is ranked seventh of out of ten reported methodologies when asked for methodological approaches that promise pioneering results.

A logical explanation in our opinion for this result lies mainly in the mentioned topics that are seen as high-potential areas of entrepreneurship research in the future. The first four ranks are, the entrepreneurial process, social entrepreneurship, entrepreneurial thought and action and the psychology of entrepreneurship. All of these topics deal with complex structures on the micro level, where the individual entrepreneur is the predominant research subject and its context must be taken into consideration to understand the actions correctly. As shown in the previous section, action research provides the rules and processes to the researcher to handle those challenges.

Other researchers, e.g. Zhang et al. (2015, p. 167) also recognize that AR seems to be naturally suited for any research question on young, fast-growing and entrepreneurial firms. When experts are increasingly aware of the potential of action research, there are likely to be less and less frictions in the review process.

Zhang et al. (2015, pp. 154–155) provide a table of 49 papers published in high-ranking publications, e.g. Academy of Management Journal, Administrative Science Quarterly or Organization Science, where action research was applied. None of the summarized publications can be directly linked to the entrepreneurship domain, which indicates a research gap in this domain that needs to be closed.

3.3 Innovative Combination of Three Modes of Entrepreneurship Research

Van Burg and Romme (2014) identify three modes of engaging in entrepreneurship research (see Table 4). According to these authors most entrepreneurship studies in leading journals are in the positivistic mode (see Table 1 for indication), where the focus is on hypotheses testing by the means of sophisticated statistical methods and the measure of internal validity. The narrative mode locates in the constructivist view of knowledge generation where the paradigm dictates that there is no analyzable objective, general knowledge, but reality with its items is constructed by the individual research objects. Then Geertz's (1973, p. 9) argument is well worth a look:

> What we call our data are really our own constructions of other people's constructions of what they and their compatriots are up to.

Table 4 Three modes of engaging in Entrepreneurship Research

	Positivist mode	Narrative mode	Design mode
Purpose	Understand entrepreneurship on the basis of consensual objectivity, uncovering general conditions and patterns from empirical data (cf. Aristotle's episteme)	Portray, understand and critically reflect on the values, experience and imagination of entrepreneurs (cf. Aristotle's phronesis)	Train, advise and help entrepreneurs and their stakeholders in their endeavor to create value and newness (cf. Aristotle's techne)
Role model	Natural sciences	Humanities and arts	Design and engineering disciplines
View of knowledge	Representational: knowledge represents the world as it is	Constructivist/ narrative: all knowledge arises from what entrepreneurs and their stake-holders think about the world	Pragmatic: knowledge is primarily developed to serve (creative) action by entrepreneurs and their stakeholders
Nature of thinking	Descriptive and analytic	Imaginative, critical and reflexive	Normative and synthetic
Research focus	Entrepreneurial phenomena as empirical objects (cf. facts). Description and explaining of these empirical objects in terms of general causal relationships among variables (hypotheses)	Entrepreneurial action and sense-making (in their broader contexts) as genuinely creative acts. Interpret and assess particular entrepreneurship narratives in their specific contexts	Entrepreneurial processes and outcomes as artifacts with descriptive as well as imperative (possibly ill-defined) properties Develop principles ("real helps" for entrepreneurs) by observing experienced entrepreneurs in action

Shorter version according to van Burg and Romme (2014, p. 371)

Typical methodological approaches as seen by van Burg and Romme (2014) are generally qualitative e.g. case studies and grounded theory development. The design mode follows the idea mainly postulated by Simon (1996) when he says that behaviors and outcomes are only artificial and human made.

Between the rather opposing views of positive and narrative (interpretist) mode there are also additional positions as the critical realist (Mingers, 2006), which is of growing importance in management science. This implies that the researchers need to overcome this artificial barrier through a thorough multidimensional analyses of the entrepreneur's action and her or his thoughts, e.g. through her or his diary (Sarasvathy & Venkataraman, 2011).

Van Burg and Romme (2014, p. 372) assert that "the overall discourse has subsequently developed into a research mode that focuses on how people construct tangible and intangible artifacts that embrace both positivistic and constructivist approaches."

In the opinion of van Burg and Romme (2014, p. 373):

> The future development of the field of entrepreneurship largely depends on efforts to combine and synthesize contributions from all three modes to be able to develop a body of evidence-based and actionable knowledge.

Earlier, Hindle (2004, p. 577) opines similarly, that entrepreneurship researchers need to practice more qualitative methodologies and distance from the positivistic paradigm to advance the knowledge base. AR is especially suited for the combination of the three modes of engaging in entrepreneurship research, as it can integrate different methods in a higher-ranking research program.

4 How to Conduct AR Research

> . . .the sciences have been enchanted by the myth that the assiduous application of rigorous method will yield sound fact—as if empirical methodology were some form of meat grinder from which truth could be turned out like so many sausages. (Gergen, 1985, p. 273, as cited in Mellor, 2001)

This quote exposes the fallacy some researchers fall into, when they think that by religiously following a research protocol, they will inevitably derive excellent results. So the following descriptions of research procedures shall provide a guiding structure in which the individual researchers can decide on operational research issues.

Baskerville and Lee (1999) present four processes in AR (typification, learning, generalizability, falsification) to derive general propositions. While typification and generalizability implicate an inductive procedure, where observations are reflected and subsequently incorporated into a theory, learning and falsification are deductive procedures, where existing theories are tested. In the perspective of Baskerville and Lee (1999), AR simply uses two epistemological processes subsequently, first an inductive and second a deductive procedure. This explanation should also somewhat silence the critics who are not in favor of AR and label the methodology "unscientific" (see previous paragraph).

Early, Susman and Evered (1978) define different phases to conduct an action research study after a proper research context with an established client-system infrastructure and where each phase leads to a different outcome (see Fig. 1).

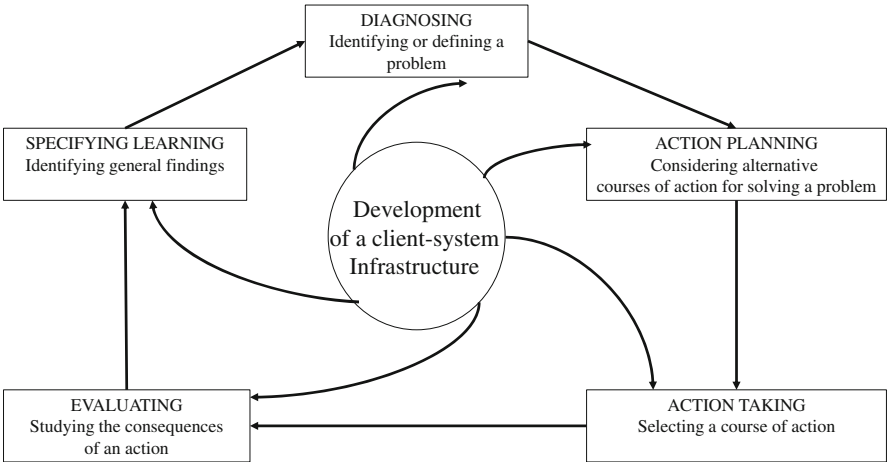

Fig. 1 The cyclical process of AR (Susman & Evered, 1978, p. 588)

Table 5 Options for integrating an action research orientation into traditional research programs (Zhang et al. 2015, p. 164)

Extent of integration	Integration examples
Light	• Researcher makes genuine effort at end of project to ensure the results can be fully understood and incorporated by organizations into decision making
	• Researcher uses the results of the dialogue about usefulness of research findings to alter future research programs to increase their perceived relevance by organizations
Medium	• Researcher works collaboratively with organizations to find mutual ground in formulating and executing a research agenda, while guiding the outcome toward topics the researcher identified ahead of time as relevant
	• Researcher includes as part of the research process regular feedback loops with the organization to maximize stakeholder engagement with and participation in the research process
	• Researcher makes some adjustments as needed in the research design to improve perceived usefulness of the research process to the organization and its stakeholders
Heavy	• Researcher and organization jointly identify and decide the domain for the research process, with equal input to the domain decisions
	• Primary, but not exclusive, importance in the research design process is given to the organization's ability to use the research results to drive effective decision-making
	• Research tools are adapted to ensure usability of the results, while maintaining scientific validity

This general process is still state-of the art in a general AR approach, for more details see the more recent publications by Baskerville (1999).

We are convinced that AR can be integrated in appropriate research programs. Zhang et al. (2015) give advice on how to reach that goal (see Table 5). Some "genuine" or rather very strict AR-researchers (Huang, 2010) would probably look very closely if a somewhat light or minimum integration of AR elements would qualify the research methodology as being a "real" AR methodology.

For PhD students who want to find out more about the state-of the art in research methodologies, especially AR, we recommend the following readings.

First of all, the "From the Editor Series" on how to publish in AMJ gives you a short overview of typical methodological issues, which are not exclusively important to publish in AMJ but are of overall importance to developing research articles. So this series provides some kind of a good introduction to research issues from where you can proceed to more detailed literature.

Regarding AR, we opine that the following four articles will help you to start to deepen your understanding of AR, which doesn't mean that you will not need to further your knowledge through additional literature.

1. Susman, G. I., & Evered, R. D. (1978). An assessment of the scientific merits of action research. *Administrative Science Quarterly*, *23*(4), 582–603.

   This is a real seminal paper that introduces most of the issues concerning AR that other researchers still occupy themselves with today, nearly four decades

later. For a young researcher it might be also really astonishing how the positivistic paradigm is criticized for its shortcomings, but when you look at the publication output today, nothing really has changed (see Table 1).

2. Mumford, E. (2001). Advice for an action researcher. *Information Technology and People*, *14*(1), 12–27.

   Mumford does exactly what the title of the paper promises in giving hands-on advice for research practitioners. Although her recommendations stem from the area of information technology, her practical insights and ways of connecting her research and consulting activities are valuable for researchers from other areas as well.

3. Cassell, C., & Johnson, P. (2006). Action research: Explaining the diversity. *Human Relations*, *59*(6), 783–814.

   Cassel and Johnson's paper is an essential read to make sense of the different labels of so-called AR-methodologies, which very well might confuse researchers (see also Sect. 1). The authors identify five different types of AR "families", which is a very realistic way to look at the overall issue.

4. Huang, H. B. (2010). What is good action research? Why the resurgent interest? *Action Research*, *8*(1), 93–109.

   In this paper, Huang who is editor of the journal Action Research, gives a firsthand overview what the reviewers in her journal look for in a good publication. Huang's views digress from the positions of other practitioners, e.g. regarding the role of collaboration and theory in AR. In a nutshell, her position is one of a rather non-diluted or strict action researcher who really emphasizes the action part in AR.

To gain knowledge about the latest developments in AR, the two journals, the "International Journal of Action Research" and "Action Research" are the publications to check on first.

In the style of Suddaby (2006), who described what grounded theory is not, and Huang (2010), we summarize important fallacies an aspiring researcher can fall into regarding the usage of AR (for additional comments on grounded theory see Greckhamer & Koro-Ljungberg 2005). What AR is not:

1. AR is not an excuse for sloppy data gathering or being clueless about what to do with the data.
2. AR requires a cyclical process of action taking and evaluating.
3. The quality of AR is assessable and is largely a function of the strictness of sticking to the cyclicality of the research process.
4. A constituting element of AR is collaboration and mixing with corporations and entrepreneurs. If there is none of these things truly taking place, it is not AR.
5. AR is also no excuse for not knowing the literature as high quality AR proceeds from the state-of-the-art of research results and then dedicates the process to explore the phenomenon innovatively. It is also quite impossible to practice AR without having some kind of knowledge on the subject, as practitioners will expect a certain level of expertise. Otherwise, they would feel that they would waste their time with the research project.

For an additional list of common misunderstandings and criticisms of AR, see a summary of DeLuca, Gallivan, and Kock (2008) (e.g. no recognition as a mainstream methodology, no valid research, lack of consistent research paradigm vocabulary, multiple forms of action research, no theoretical basis, not enough rigor etc.). The main problems from our point of view are addressed in this contribution.

5 Conclusion

In the beginning of this contribution, we outlined our aim to help researchers and especially PhD students to understand the foundations and content of AR. In our opinion, it is quite logical that research practice is an activity that benefits from training, just as nearly every other activity one performs we can think of. Predominantly speaking to the PhD students, we encourage you to practice research and start your learning curve rather sooner than later.

But keep two things in mind:

1. Your first tries will most likely not be the excellent research you might conduct after rounds and rounds of practice in the future.
2. The acquisition of research practice is not a linear process with clear stages but rather a messy self-organizing activity. For an honest report on the very nonlinear creation of a PhD thesis, see Mellor (2001).

These two notions shall also not be misunderstood for an excuse of being sloppy and superficial in your research, but to encourage you for early and open-minded research practice.

We are positive that the collaborative process with the research subject in AR is, at least for some researchers, a more rewarding experience than looking exclusively on spreadsheets to figure out indicators that support hypotheses that might or might not capture the underlying phenomenon properly. In this regard, AR might even be more fun, which is admittedly a rather unusual category in the scientific community.

By working closely with entrepreneurs and entrepreneurial firms, your research is very likely to be of relevance. Furthermore, your research results are transferred immediately into practice. Both traits improve the odds that your work becomes published in respected journals.

In our opinion, it is very likely that in the next couple of years, more and more entrepreneurship research papers, who apply action research as the methodology of choice will be published (see reasons outlined in Sect. 3). As researchers become educated about an innovative methodology, its publishing potential and its usefulness, they will strive to apply the method. Then it is clear that AR, because of its context relation, design approach and ability to dig deep into complex problems, is well suited for entrepreneurship research problems.

Areas with high potential, where action research can contribute, is social entrepreneurship as outlined by Gedajlovic, Honig, Moore, Payne, and Wright (2013), the growth decisions of technology start-ups (Zhang et al., 2015), action learning (Leitch, 2007) and technology transfer (Mietzner & Schultz, 2014). In general, we

see open avenues for AR to find attempts to answer research questions, which study the complex interrelations of different research levels simultaneously. For a good example see Greenman (2013), who focused on the role of culture on organizational decision-making.

To be able to publish in high-class journals, the researcher shall not only ask what questions might be of interest to the scientific community. It is paramount to invest in the quality of AR, which is most closely bound to the individual researcher itself. While in quantitative research the results are roughly speaking totally independent from the social research skills, it is the total opposite case in AR. The lack of social research skills of entrepreneurship researchers is the main obstacle to the diffusion of AR or other more qualitative methodologies, in our opinion.

We acknowledge that the active role of the researcher, the reflexive research process and the opportunity to use different modes of entrepreneurship research limits the capability of AR to develop theory.

Generally, we estimate the transition from a quantitative-oriented positivistic researcher to a sophisticated action researcher as challenging and definitely not easy. This gives PhD students and researchers a head start, who nurture the necessary skills early and become familiar with the AR methodology.

We recommend to all research personnel to occupy themselves with the philosophical underpinnings of their methodological approaches. In the long term, this will lead to a better understanding of the scientific method and consequently to superior research practices and research results.

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Part III
Configurational Methods

Is Qualitative Comparative Analysis an Emerging Method?—Structured Literature Review and Bibliometric Analysis of QCA Applications in Business and Management Research

Elisabeth S.C. Berger

Abstract Qualitative Comparative Analysis (QCA) is a powerful method originating in the fields of political science and sociology, where it is becoming a mainstream method. This article analyzes the state of QCA applications in business and management (B&M) research by conducting a structured literature review, which results in the identification of 96 studies between 1995 and 2015. Additionally, the knowledge basis of those articles is analyzed by means of a citations analysis. The 5,141 unique citations serve to also structure the research front using a bibliometric coupling analysis. The results point towards a somewhat deferred development of QCA in the discipline, which has recently undergone a quantum leap with regard to the number of publications as well as the advance of the method application. The current development is strongly determined by the originator of the method, Charles Ragin, and by the first studies applying QCA in business and management. Yet, the research front is only loosely connected, underlining that QCA remains at an early stage of adoption in business and management. The chapter gives three recommendations for future QCA studies and predicts a progressing profile formation of QCA in business and management research that can contribute to the adoption of configurational thinking within the discipline.

Keywords Bibliometric coupling • Citation analysis • Qualitative comparative analysis

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_14

1 Relevance of QCA in Business and Management and Research Objective

In political science and sociology, the twenty-fifth anniversary of Qualitative Comparative Analysis (QCA) was recently marked with a special issue of Political Research Quarterly presenting the advantages of the method and how it has developed in several articles (Rihoux & Marx, 2013). QCA is particularly celebrated for capturing high degrees of complexity as a set or outcome is explained by its subset(s), which can consist of combinations of different variables, in QCA more precisely referred to as conditions. Thereby, different paths can lead to the equifinal outcome, which are not necessarily the same configurations explaining the non-outcome. This characteristic is referred to as causal asymmetry (Ragin, 1987, 2000, 2008). Most researchers consider the seminal work by Charles Ragin, *The Comparative Method* (1987), to mark the beginning of the QCA era, and since its publication the method has gained in popularity, so that in the special issue, Rihoux, Álamos-Concha, Bol, Marx, and Rezsöhazy (2013) study the development of QCA applications since Ragin's introduction of it and conclude that QCA might be on the way to becoming a mainstream method. While this might be true for political science and sociology, QCA in B&M research is a younger phenomenon: the first application of QCA in that research stream appeared in 1995 by Romme, giving QCA a 20-year history in B&M research. Fiss (2007) shows that the notion of configurational thinking is inevitable and the approach fruitful also for B&M research. In recent years, a plethora of textbooks and articles providing step-by-step instructions on how to conduct QCA studies were published (e.g. Marx, Cambré, & Rihoux, 2013; Rihoux & Ragin, 2009; Schneider & Eggert, 2014; Schneider & Wagemann, 2012; Schulze-Bentrop, 2013). While reviews of QCA applications in general (Rihoux et al., 2013; Schulze-Bentrop, 2013), focusing on one type of QCA, such as fuzzy-set QCA (Mello, 2013), or on the application in one specific research area, such as the welfare state (Emmenegger, Kvist, & Skaaning, 2013) have been conducted and numerous calls for the application of the method in B&M exist (Greckhamer, Misangyi, Elms, & Lacey, 2008; Harms, Kraus, & Schwarz, 2009; Schneider & Eggert, 2014) and have resulted in a considerable number of publications, there remains little transparency on how QCA is applied in this discipline. Nevertheless, for both QCA experts and for novices to the method, it is relevant to understand how the application in the discipline has developed and what the state of the art of employing QCA in B&M studies is, in order to generate high-quality publications and to advance QCA applications.

The purpose of this study is to analyze the state of the application of QCA in B&M research. To achieve this objective, this chapter includes a structured literature review of applications in B&M research published between 1987 and 2015. This serves to identify the research front. The citations of the identified articles are also analyzed to reveal both the traditions and roots and the development of QCA applications in B&M research over the years. The approach also illuminates which are the most influential publications. In other words, the citation analysis aids the

identification of the knowledge base. In order to map the structure of the current research front, the technique of bibliometric coupling is applied, which is based on the citations of the articles and was therefore conducted subsequently. The article continues with the methodology section. The results of the analysis of 96 research articles, of the selected citations, and the results of bibliometric coupling are subsequently presented. The article ends with a summary of the discussion and a call for further innovative and high-quality applications of QCA in B&M research, which are aided by three recommendations for further QCA studies.

2 Methodology

Mapping the state of the QCA application in B&M research, involved conducting a structured literature review following Tranfield, Denyer, and Smart (2003), and as mentioned above, both a citations analysis and bibliometric coupling.

2.1 Identification of Research

To identify the relevant articles, the researcher and one other expert together determined four search strings to track QCA articles in several databases: Those search terms were *Qualitative Comparative Analysis*, *Boolean Comparative Analysis*, *Configurational Analysis,* and *Comparative Method*. The search term configurational analysis was included because QCA can be described as a configurational analysis, but other methods such as cluster analysis, can also be subsumed under this heading (Fiss, 2007). The search term comparative method also covers all studies citing Ragin's (1987) book *The Comparative Method*. However, the term could also identify all studies applying or mentioning *the constant comparative method,* mainly developed by Glaser and Strauss (1967), which is at the core of grounded theory and cannot be classified as QCA. The methods, however, are not completely alien to each other, therefore an adapted search term such as *comparative method AND NOT constant comparative* would have risked excluding articles mentioning both approaches.

The analysis is restricted to peer-reviewed journals in the English language. The time period examined starts with the seminal work by Ragin (1987). Some researchers argue that Ragin, Mayer, and Drass (1984) might be viewed as the first QCA study (Rihoux et al., 2013), however the authors also show no major QCA applications in the years to 1987. Other authors choose shorter time periods for a QCA overview (e.g. Schulze-Bentrop (2013) includes articles after 2000 or Mello (2013) includes articles from 2011 onwards) in order to improve comparability among the articles and the standard levels. However, this study deliberately includes all publications available online since 1987 until December 31, 2014 with the aim of showing the development of QCA applications in B&M research.

2.2 Selection of Articles

To select the articles, I followed a two-step procedure. The first step was to access the ISI web of knowledge journal citation report (JCR) and select all journals listed under the subject categories *business* and *management*. Ensuring a full-text search in the 240 identified peer-reviewed journals required the use of 35 different databases. When the researcher could not retrieve an article from a database, the authors of the articles were contacted directly to request the publication.

The second step involved accessing the compasss database,[1] which encompasses comparative studies, particularly QCA studies. According to Rihoux et al. (2013) this database provides a near exhaustive coverage of QCA articles. All papers in the category *applications in Business and Economics*, *Management & Organization* and in *other areas* were added if they were:

(a) not a duplicate of the articles already identified and
(b) published in a business or management journal[2] and
(c) written in English.

This second step resulted in the identification of a further 12 articles, adding up to an initial sample of 710 articles. To identify the relevant articles, inclusion and exclusion criteria were defined. The criterion for inclusion was the article being one primarily featuring empirical research. The exclusion criteria were accordingly an article being non-empirical, a non-research paper, and not applying QCA. As anticipated, the search string comparative method also produced many articles applying constant comparative methods, which were then also excluded. As suggested by Tranfield et al. (2003), I also applied a study quality assessment by excluding articles that did not disclose sufficient details of the QCA conducted.

Having distilled the final data set of 96 articles, two researchers reviewed the full-length articles independently and summarized the study design, key characteristics, and results using a structured data extraction form as suggested by Tranfield et al. (2003). The agreement percentage between the authors ranges between 0.9 and 1.0 and points to indicate an acceptable interrater reliability (Neuendorf, 2002). Discrepancies were resolved through discussion.

2.3 Citation Analysis

Citation analysis is based on the understanding of more frequently cited references wielding greater impact (Garfield, 1955). Instead of considering the citation counts

[1] Compasss database access: http://www.compasss.org/bibdata.htm

[2] Basis for this decision is a clear reference to Business or Management research in the aim and scope description of the journal especially compared to an economic focus, a precondition being that the journal is peer-reviewed and part of a journal database.

of a publication by any other scientific publication, such as *Google Scholar* citation counts, the focus is on the references cited by the previously identified QCA application articles. Hence in a next step, the data of the citations of the identified articles were extracted from several databases such as *ISI*, *Scopus*, and *EBSCO*. Additionally, the list of citations was complemented and verified by extracting the citations manually from the articles' bibliographies. Due to different data sources, it was necessary to perform substantial data cleansing as detailed by Zupic and Čater (2015). Following Harzing (2010), internal citations were not excluded, as they are mostly a justified acknowledgement of the researcher's prior work in the same field.

2.4 Bibliometric Coupling

In comparison to other citation analysis approaches, such as co-citation analysis, bibliometric coupling is not directed towards the past of a research field, but focuses on the research front and is hence suitable to identify present and prospective priorities in the academic field (Vogel & Güttel, 2013). According to Kessler (1963), two publications are bibliometrically coupled when they share at least one common reference. Hence, links are established by the authors of the identified articles, ergo the current research community (Zupic & Čater, 2015). On the basis of the list of citations, a matrix of bibliometric couples was created to enable the construction of a bibliometric network, where the strength of the links between two articles reflected the similarity of their bibliographies. For the visualization of the network, the open source network *gephi* (https://gephi.org) was applied.

3 Findings: The State of QCA Applications in B&M Research

3.1 (Why) Is QCA Applied in B&M Research?

The final sample of QCA applications in the B&M encompasses 96 articles. As is evident from Fig. 1, the number of publications has grown considerably, especially since 2009. The exact years of publication depend inter alia on the duration of review processes so do not matter, therefore Fig. 1 collates articles for several years and also differentiates between the type of QCA—crisp-set (csQCA) or fuzzy-set (fsQCA).[3] One single article applies both csQCA and fsQCA (Skaaning, 2007).[4] Although the considered time period starts in 1987, the first application in B&M

[3] Two multi-value QCA applications in 2015 are not separately disclosed, but added to the count of fsQCA articles.

[4] This article appears in the figures as an fsQCA application.

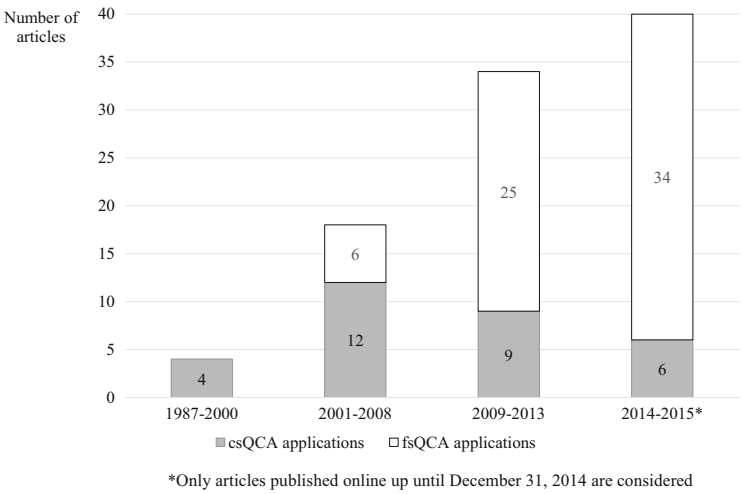

Fig. 1 Applications of QCA studies in B&M research 1987–2015

research was published in 1995 and only three more studies followed until the year 2000. From 2000 on, when another seminal work was published by Ragin (2000), the applications of QCA in B&M picked up, until in 2008, 22 QCA applications in B&M were published, the majority (73 %) being csQCA. However, a major increase can be observed from 2009 on, that is, after the publication of Ragin's (2008) and of Rihoux's and Ragin's (2009) seminal textbooks providing guidance on the methodology. Another influential publication for B&M research in this period was the article *A set-theoretic approach to organizational configurations* by Fiss in the *Academy of Management Review* (2007). The article emphasized the relevance of configurations in organizational studies and can be understood as an influential call to adopt the configurational approach in the discipline. Simultaneously, the introduction of the fuzzy-set variant of QCA seems to have increased the method's attractiveness and acceptance. To visualize how the number of publications have increased recently, Fig. 1 shows the articles published since 2014 separately, with the year of publication referring to printed issues. That the number of articles in 2014 and 2015 is already higher than in the five preceding years is remarkable, given that the 20 articles categorized as 2015 publications only include articles published online up until December 31, 2014 that will be printed in 2015. It seems inevitable that more will be published in the course of the year, and the trend for QCA publications in B&M research will progress.

Most authors (87 %) in our sample have only published one article. Three authors, namely Ruth V. Aguilera, Roberto García-Castro, and Na Ni have published (as first or co-author) three articles and could possibly be called experts in the application of QCA in B&M research. This is certainly true for Arch G. Woodside, who has published as many as nine articles as a first or co-author.

Table 1 Top five journals in B&M research publishing QCA studies

Ranking	Journal	No. of articles	Yearly output[a]
1.	Journal of Business Research	26	377
2.	Organization Studies	6	68
3.	Academy of Management Journal	5	72
4.	Journal of International Business Studies	5	67
5.	International Journal of Project Management	3	139

[a]Yearly output refers to number of articles published by the journal in sample year 2014

Furthermore, while Rihoux et al. (2013) reveals csQCA as the dominant type of QCA in a review of QCA applications across all disciplines until 2011, the dataset clearly shows a strong preference towards fsQCA in B&M research.

However, although there is a trend of more QCA publications, this is not the case across the entire discipline. Table 1 lists the five journals with the greatest number of published studies applying QCA. The *Journal of Business Research* (JBR) hosted the first article in this discipline (Romme, 1995) and has gone on to become the clear leader in publishing QCA studies. However, simply listing the number of QCA articles published by a journal is not as informative as knowing the proportion of QCA articles of the journal's total output, and accordingly, Table 1 also lists the yearly output of the journals for one exemplar year, 2014. This helps to put the 26 articles in the JBR into perspective, as the journal publishes more articles in total than some others. In 2014 for instance, 4.4 % of the articles in *Organization Studies* were applications in QCA, as were 2.8 % of those in the *Academy of Management Journal* (AMJ) and only 1.6 % in the JBR.[5] Accordingly, *Organization Studies* and the AMJ might be considered just as much an enabler of QCA studies as the JBR. The 96 articles identified appeared in only 50 different B&M journals, or in other words 20 % of the discipline's journals according to the *ISI JCR*.

However, a research trend should not be the reason why a method is applied, and there are good reasons why QCA is the most appropriate methodology in certain contexts. Most studies elaborate a plethora of QCA characteristics, and all studies give at least one specific reason for applying QCA in the particular setting of the study; four out of five journals give two or more study-specific reasons. In B&M the characteristic of QCA enabling the analysis of combinations of conditions or characteristics leading to an outcome, rather than analyzing net-effects, appears to be the most relevant, as in 80 % of the articles this is cited as one reason for choosing the method. This is in line with the arguments made by several researchers who want to encourage the application of QCA in the B&M field specifically (Greckhamer et al., 2008; Schneider & Eggert, 2014) and in research in general (Woodside, 2013). While those researchers present further advantages, the following arguments are all cited by around 30 % of the studies (multiple reasons are possible): causal asymmetry, equifinal configurations leading to the same outcome, the possibility of capturing a higher degree of

[5] In the Journal of international business studies the share was around 1.5 %, no QCA applications were published in the International Journal of Project Management in 2014.

complexity, and the appropriateness of the approach to analyze small sample sizes (this includes possible natural, limited diversity in the studies' context).

3.2 How is QCA Applied in B&M Research?

QCA can be used for a range of purposes from pure description, to hypothesis, or ideal type testing (Berg-Schlosser, de Meur, Rihoux, & Ragin, 2009; Kvist, 2007). In the studied QCA applications, the tendency to create hypotheses or propositions is increasing. Whereas in the period 2001–2008, only 29 % of the studies created hypotheses or propositions prior to the QCA, in the most recent period 2014–2015, this is true for 59 % of the studies. This development might point towards QCA in B&M research being increasingly applied as a holistic method covering all analytical questions, rather than being used only for descriptive purposes.

Over one in three studies (37 of 96) explicitly follow a multi-method approach to analyzing data either preceding or following the QCA, for instance to offer an alternative analysis of a phenomenon (e.g. Huang & Huarng, 2015). A considerable number of the studies (16 %) even argue for the application of QCA to be able to compare the results to other research methods. In comparison to Mello's (2013) findings of multi-method approaches being rare for fsQCA across disciplines, the B&M research appears to follow this approach more often. Some studies apply a multi-method approach as an integral part of the QCA, for instance to derive values for the conditions or outcome (e.g. Provan and Lemaire (2015) use network analysis to determine the outcome *positional embeddedness*). The findings are in line with the share of mixed methods across disciplines (Rihoux et al., 2013). In the B&M sample, the total number of multi-method approaches has increased, yet, when looking at the share of multi-method approaches relative to the number of studies published in a year, it is difficult to trace a pattern, as the share ranges inconsistently between 20 % and 56 % in 2007–2015. Therefore, on the basis of this review the conjecture of Rihoux et al. (2013) that QCA is maturing as a method, and therefore that stand-alone applications might be more frequently accepted by reviewers and editors, cannot be confirmed. Instead, whether a multi-method approach is applied might not only depend on the journal format or on the research context, but also on the study design in terms of sample size. Larger samples for instance might apply other forms of quantitative analysis such as regression analysis or factor analysis (e.g. Bijlsma & van de Bunt, 2003; Chang, Tseng, & Woodside, 2013). Smaller samples on the other hand could apply other qualitative methods, such as qualitative observations (Mol & Birkinshaw, 2014). In the setting of B&M studies, the category of 51–200 cases reveals the largest share (61 %) of multi-method approaches. Among them the majority of studies are at an organizational level of analysis.

Although, QCA was originally developed as a method enabling comparison even between few cases, the methodology has progressed and may be applied to (very) small, intermediate, or large sample sizes (Berg-Schlosser et al., 2009;

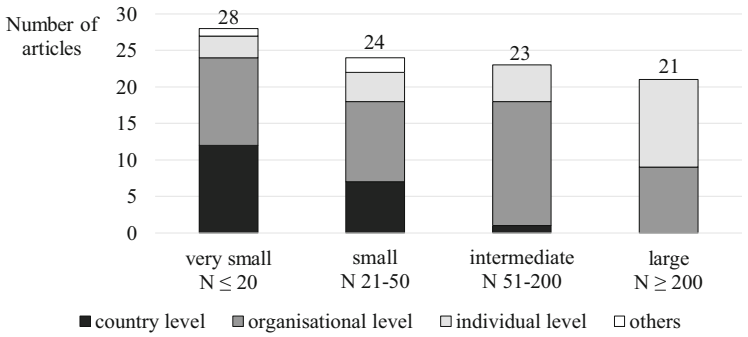

Fig. 2 Sample sizes and the level of analysis of QCA studies in B&M research

Ragin, 2008). In the B&M literature, the sample sizes range from three cases (Häge, 2007) to more than 6,000 cases (García-Castro & Aguilera, 2014; García-Castro & Casasola, 2011). Figure 2 shows the sample sizes of the 96 selected studies and underlines how, in B&M, QCA is applied for all sample sizes, yet more often with (very) small sample sizes. Over time, studies seem to use increasingly larger sample sizes (see Table 2).

As Fig. 2 also differentiates between the levels of analysis, two further observations are possible: Naturally, country-level analyses have rather smaller samples due to the limited number of countries in the world, this is also reflected in the studies at hand. Secondly, a large proportion of studies (49 out of 96) conduct the analysis at an organizational level, given that the focus is on B&M research it is rather surprising that the individual and organizational level do not make up an even larger share.

Although most studies can be assigned to an analytical level, tracing a pattern of the specific outcome that is analyzed is more challenging. The studied supersets range from ergonomic injuries (Marx & van Hootegem, 2007) through whistle-blowing behavior (Henik, 2015) to successful shaming for misbehavior (Stokke, 2007). Nevertheless, on the organizational level, two groups of outcomes are clearly identified: firm performance, and innovations. On the country level, performance in terms of growth and attractiveness creates the parameters for some of the outcomes. As a whole, researchers in B&M apply QCA to the defining set in strategic management research on performance, but also to a variety of other set-subset relations.

To better understand how QCA studies are conducted in B&M research, Table 2 offers an overview of the key characteristics of the studies. When different analysis or models within one article exist, the Table 2 considers the average for one article.

The upper part of Table 2 shows key characteristics of the study design in terms of number of cases, number of conditions, and the number of analyses conducted. All B&M QCA applications seem to follow the recommendation of keeping the number of conditions low, and on average the studies employ around six conditions to explain the outcome; slightly fewer for analysis on the country level and slightly more for individual-level analysis. No pattern concerning the number of employed

Table 2 Key characteristics of QCA studies in B&M research 1987–2015

	1987–2000			2001–2008			2009–2013			2014–2015		
	Mdn	Min	Max	Mdn	Min	Max	Mdn	Min	Max	Mdn	Min	Max
No. of cases	30.5	10	43	274	3	2841	364	6	6611	441	11	6592
No. of conditions	5.75	3	11	5.39	3	9	5.8	3	10	5.88	2	11
No. of analyses	3	1	5	3.17	1	8	2.18	1	9	3.76	1	20
Consistency cut-off	–	–	–	0.72	0.65	0.9	0.78	0.65	0.93	0.83	0.75	1
Frequency cut-off	–	–	–	8.25	1	30	2	1	6	3.3	1	27
Solution consistency	–	–	–	1	1	1	0.86	0.68	1	0.87	0.44	1
Solution coverage	–	–	–	0.58	0.55	0.6	0.61	0.22	0.97	0.49	0.02	0.86

Missing data are excluded
Mdn median, *Min* minimum, *Max* maximum

conditions and the number of cases, the use of primary or secondary data or the type of QCA is evident.

The number of analyses conducted varies across all years between one and as many as twenty. Whereas a single analysis indicates that the study does not analyze the outcome and the non-outcome, as is suggested as good practice by Schneider and Wagemann (2012), a large number of analyses imply the testing of different outcomes and possibly different models.

The lower part of Table 2 presents the summary of the quality measures for QCA: consistency (i.e. the degree to which the configurations are a subset of the outcome) and coverage (i.e. the proportion of the outcome explained by the solution configurations). As those measures were developed by Ragin in 2006, the first period naturally has no values either for the threshold requirements or for the reported solution consistency and coverage. Furthermore, in the second period, consistency and coverage were not determined, meaning the measures disclosed in the time periods 2009–2013 and 2014–2015 are more relevant. Both thresholds are within the recommended range, although a consistency cut-off of 0.65 is considered rather lax (Ragin, 2006, 2008). The results presented in the studies show a wide range of solution coverage (in 2009–2015 between 0.04 and 0.89), which emphasizes that not only empirically relevant results are presented. Quite the contrary, applying QCA can point to those configurations that might not be statistically relevant but may be theoretically so.

One strength of QCA lies in the calibration of measures, in other words, measures are transformed into concepts by assigning a membership, either in a binary form in the case of csQCA, or on the interval of 0 to 1 for fsQCA (Ragin, 2000, 2008). Among the selected studies, 17 % mentioned this as a reason for applying QCA in the specific research setting. The process of calibrating the data relies on theory and or case knowledge (Ragin, 2000, 2008). Disclosing the membership criteria and providing arguments for them (derived from theory and case knowledge, preferably external to the data) are therefore essential to understand the underlying assumptions and is considered good practice (Ragin, 2008; Schneider & Wagemann, 2012). The majority of QCA studies in the B&M field follow this recommendation. However, with regard to the time periods the disclosure of anchor points for calibration has declined from full consistency in the early period to three out of four articles in the most recent publications in 2014 and 2015. Specifying the reasons for the choice of calibration criteria is even less frequently done in the articles. This might point to a tendency of researchers applying QCA increasingly according to step-by-step instructions rather than having a deep understanding of the underlying assumptions of QCA. Across all years, the share of articles listing the anchor points as well as the reasons for choosing them, varies between 60 % and 75 %. As the number of QCA studies increases, researchers have more reference points when determining the membership criteria. By doing so the impression of arbitrary calibration can be reduced, which is often mentioned as a possible weakness of QCA (García-Castro & Casasola, 2011). But researchers can only take advantage of prior calibrations when prior studies disclose the criteria. In other words, if the quality of QCA applications in B&M research is to be improved, full disclosure of the calibration procedure will be essential and will also prevent

*Only articles published online up until December 31, 2014 are considered (*BN* Boolean Notation, *CP* Circle presentation, *TT* Truth table, *XY* XY plot, >1 = more than one presentation type employed)

Fig. 3 Proportion of studies using different modes for presenting the QCA results 1987–2015

blind, mechanical applications of QCA. If space is limited, online appendices can provide an appropriate option (Rihoux et al., 2013).

There are now several options available when presenting the results of a QCA. Figure 3 presents the chosen modes of presenting the results in relation to the total number of QCA applications in the time period under consideration. Given that QCA is based on Boolean algebra, it is perhaps not surprising that writing the results using Boolean algebra is apparently the most frequently adopted form of presentation in B&M research. However, this preference seems to be in decline. Disclosing the truth table to show the findings is a popular choice, yet whereas in the first period, two of four studies used the truth table, most recently less than 30 % of all studies chose this option. There are two forms of presentation of results that are gaining in popularity. One is the XY plot, which plots a case's membership in the outcome against the membership in the condition(s) and can be easily generated with the currently most popular fs/QCA software (Ragin, Drass, & Davey, 2006).[6] The second popular presentation mode is what Ragin and Fiss (2008) labelled a circle presentation. The form visualizes the results using filled and empty circles for the presence or absence of conditions, and in some studies the size of the circles further differentiates

[6] In the sample, 61 out of the 96 articles disclose which software program was used for the analysis, 85 % of those used fs/QCA (Ragin et al., 2006).

between core and peripheral conditions, which refers to the extent to which logical remainders were used for minimization (Fiss, 2011). Finally, Fig. 3 also shows the proportion of studies employing more than one presentation mode, an option that was growing until recently, but which now seems to be declining.

The use of Venn diagrams is another illustrative option, however, only around 6 % of the studies chose this mode (e.g. Freitas, Gonçalves, Cheng, & Muniz, 2013) and therefore it was omitted from the Fig. 3, as were other even rarer modes such as pattern presentations or path development diagrams. The reason for the low numbers of studies opting for Venn diagrams despite its suitability to visualize results, might be due to the fact that most software programs, which are used for QCA do not enable an automatic generation of Venn diagrams, Tosmana (Cronqvist, 2011) being a notable exception for csQCA results. In conclusion, Fig. 3 clearly shows a shift away from the traditional modes of presenting the results, as they are used in political and social science. Instead, B&M researchers seem to rely increasingly on presentation modes unique to their discipline. The growing preference for using only one presentation mode might point towards a maturing of the method in the discipline as one mode is adjudged sufficient to convey the results.

3.3 What Is the Knowledge Base of QCA Applications in B&M?

Extracting the citations of the 96 original articles, resulted in a list of 5,141 unique references, published between 1904 and 2014. Table 3 ranks the most often cited publications with at least 15 citations and shows the proportion of the 96 articles that refer to those publications. Furthermore, the Table 3 also shows the citation counts in Google Scholar.

Because Charles Ragin is considered the originator of QCA, it is not surprising that he authored or co-authored seven of the 12 most cited publications listed. All but one (Dai & Huang, 2015) of the 96 articles cite at least one Ragin publication. That Ragin's books from 2000 to 2008 are more relevant than the first book from 1987 might be due to the increasing application of fsQCA over csQCA in the B&M literature (see Fig. 1), which requires referencing Ragin's books published after 2000. Peer Fiss should also be designated an expert. His conceptual paper in 2007 and his application in the context of organizational typologies in 2011—the first empirical paper on the list—are cited by around 40 % of all publications.

Table 3 also shows that there is no bias towards older publications, as more recent publications such as Fiss (2011) or Woodside and Zhang (2013) are also frequently cited.

It is striking that the top three citations are all books, but that would not be unusual in other academic fields such as knowledge management (Walter & Ribiere, 2013).

Table 3 Ranking of most cited publications

Rank	Times cited in data set	Overall % in data set	Times cited in *Google Scholar*[a]	Reference	Type
1	57	59 %	2,529	Ragin (2000)	Book
2	55	57 %	1,106	Ragin (2008)	Book
3	49	51 %	5,820	Ragin (1987)	Book
4	38	40 %	470	Fiss (2007)	Article
5	37	39 %	289	Fiss (2011)	Article
6	27	28 %	376	Ragin (2006)	Article
7	26	27 %	105	Greckhamer et al. (2008)	Article
8	25	26 %	660	Rihoux and Ragin (2009)	Book
9	17	18 %	70	Schneider, Schulze-Bentrop, and Paunescu (2010)	Article
10	16	17 %	223	Ragin, Drass, and Davey (2006)	Software
11	15	16 %	80	Ragin and Fiss (2008)	Book
12	15	16 %	13	Woodside and Zhang (2013)	Article

[a]As at June 2015

Comparing the ranking of the cited publications with the number of citations in *Google Scholar* reveals that the relevance of these publications in the academic literature differs to the relevance in the B&M research. For instance, Greckhamer et al. (2008) with only 105 citations stands out and emphasizes how this publication has a great impact, not necessarily on the application of QCA across disciplines but certainly on the application of QCA in B&M research. Again, Ragin's first QCA book is more relevant in the academic community than the later publications according to the *Google Scholar* citation counts, possibly also because over all academic fields there have been significantly more csQCA studies (Rihoux et al., 2013), which was introduced in Ragin's *The Comparative Method* in 1987.

3.4 What is the Structure of the Research Front?

The bibliometric coupling analysis enables the structuring of the research front based on its reference to the knowledge base. The analysis results in a matrix of articles linked together by common citations. Among the 96 articles examined, 92 are connected by at least one common citation. The corresponding network is presented in Fig. 4.

The network is shown in the force atlas layout, which emphasizes the attraction between strongly linked nodes and accentuates dispersion between nodes, which repel each other based on their connections. Nodes represent the articles, their size relates to the number of other articles they are linked to, in other words the degree of

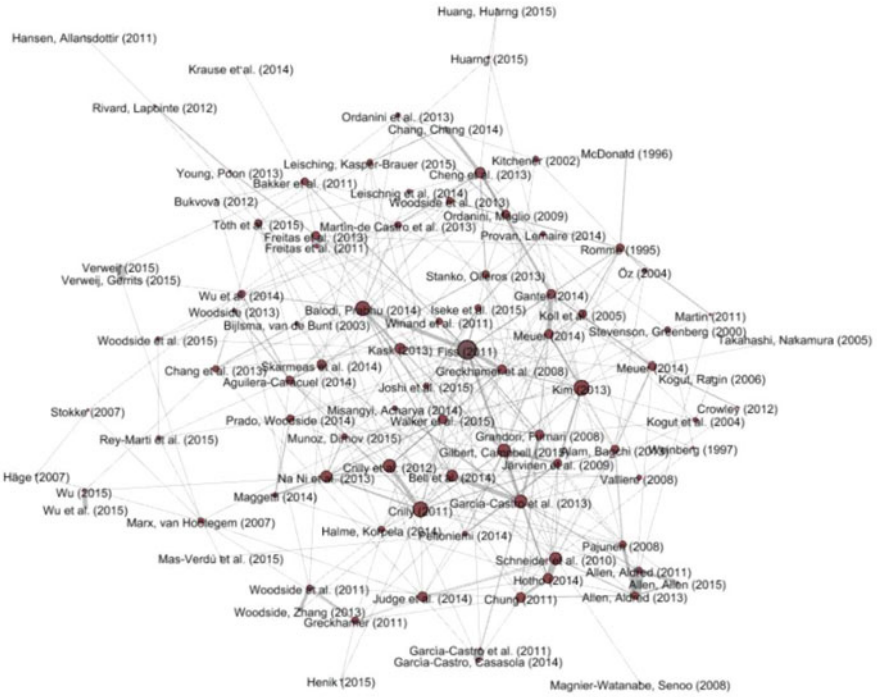

Fig. 4 Network of bibliometrically coupled articles

a node. Edges represent the links between the articles based on the similarity of their bibliographies. Stronger ties are presented by thicker lines. A list of the strongest links can be found in the appendix. There are 312 links between the articles ranging from one to 16, most of them (75 %) are only linked because of one shared reference. Yet, one common citation might be arbitrary, therefore only bibliography similarities composed of at least three citations (tie strength = 3) are considered. Vogel and Güttel (2013) argue for also setting a minimum level for the number of connections to other publications an article has, and suggest a degree of two, which was adopted here. The resulting network is presented in Fig. 5 and consists of 30 articles (nodes) and 20 connections between them (edges).

Due to the introduction of the thresholds for the degree and strength of ties, the visualization is focused on the articles with the greatest similarity, and the network becomes considerably less connected. This suggests that the research front in terms of topics is rather dispersed. There are ten components. Five of the components consist of only two articles, and it is striking that for each pair, at least one author is involved in both articles. The tendency of authors to include the same references, especially when applying the same method, is, however, insufficient to explain the strong bibliometric links. For instance Woodside has authored nine articles in the data set, but only two of them are bibliometrically coupled. The five pairs all apply the same type of QCA, share the same level of analysis, and very similar sample

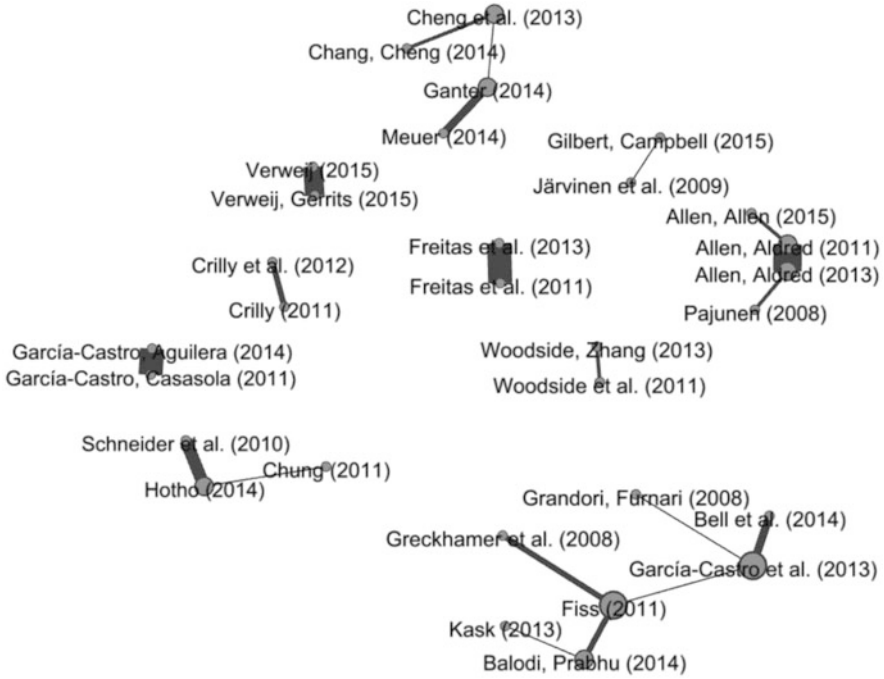

Fig. 5 Network of bibliometrically coupled articles with a strength of at least 3

sizes to the coupled article. With regard to content, this ranges from comparable research questions and outcomes (Verweij, 2015; Verweij & Gerrits, 2015) to only sharing a common considered concept as large as culture (Woodside, Hsu, & Marshall, 2011; Woodside & Zhang, 2013).

The largest component is that which has evolved around the frequently cited management studies of Fiss (2011) and Greckhamer et al. (2008). While sample sizes and type of QCA applied vary in these studies, all articles in this cluster approach organizational performance as a complex phenomenon, suited to analysis via a configurational approach, such as QCA. Accordingly, the seven articles in the cluster each focus on an organizational level.

In summary, the bibliometric coupling analysis shows that some authors already make use of past studies in QCA in B&M, whereas others tend to neglect the advances in this area. This might also be due to the fact that the field of QCA in B&M is still evolving. Accordingly, the structure of the research front is not yet sufficiently transparent to every researcher. This also indicates countless gaps for valuable QCA applications to different concepts and phenomena in B&M research. When future studies take past achievements (and hence studies) into consideration, this will strengthen the acceptance of QCA in B&M research and also lead to a more distinct map of the research front.

4 Implications and Conclusion

This review has aimed to shed light on the application of QCA in B&M research, in order to assess the maturity of QCA as a research method. The adoption of QCA in the B&M field initially progressed more slowly than it did in the fields where it originated, political science and sociology. QCA applications started off rather diffidently in the mid-1990s and the publications have only really picked up since 2007/2008, but there has been an almost explosive development since 2011. The structured literature review has shown, that the execution and documentation of QCA applications have gained in sophistication and acquired recognition within the discipline in recent years. Nevertheless, the review has also given rise to concern regarding the tendency of studies applying QCA like cookbook-instructions and thereby underestimate the power and requirements of the method (Hesse-Biber & Leavy, 2010). Furthermore, one might argue that QCA in B&M research is distancing itself from the original political science study designs and thereby gaining a unique profile, which is likely to find a place in the discipline's portfolio of standard methodologies in the future. To advance and clarify this profile, three recommendations for QCA applications in B&M studies should be considered by future research:

- having a strong case for choosing a configurational study design and a willingness to create innovative study designs, or to revisit research questions that are suited to a configurational approach,
- having methodologically sound and rigorous applications, including the full disclosure of thresholds and calibration criteria,
- having clear presentations of the results, to help B&M researchers unfamiliar with QCA to understand the particularities of the method, especially employing different visualization modes.

Adopting these recommendations would promote a detailed and configurational understanding of phenomena, help researchers not to fall for the illusion of blind, mechanical applications of QCA and might also be an inspiration for other disciplines.

The citation analysis above identified the most influential publications for the application of QCA in B&M research. Apart from the original methodology publications by Ragin (1987, 2000, 2008), applications of QCA in B&M such as Fiss (2011), Greckhamer et al. (2008) or Schneider et al. (2010) greatly influence academic fields. These publications could also constitute a good reading list for QCA novices in the B&M field. Yet, while the methodological basics of QCA might remain relatively constant in terms of their relevance, one sure sign that the application of QCA in B&M research is moving forward will be when the empirical studies are replaced by more recent ones, which take new paths in the application of QCA and thereby set new standards. The advances might be in identifying new topics to be tackled employing QCA or new methodologies and standards.

This bibliometric coupling analysis has connected studies based on the similarity of their bibliographies and shown that the research front is still looser than at first sight. There is one distinct cluster, which applies QCA on an organizational level and focuses on the outcome of performance. Naturally, this is one of the most pressing outcomes in the B&M area. However, many research questions and concepts in B&M research are truly configurational and applying QCA to those, can provide new insights. The bibliometric coupling analysis emphasizes the plethora of gaps regarding QCA applications in B&M research.

This literature review and bibliometric analysis structured both the research front and knowledge base and has shown how heterogeneous the studies are, but it has also pinpointed similarities between recent articles. Researchers conducting QCA studies in B&M should be aware of the development of this emerging research method and consider past studies and their shortcomings and advances in QCA in B&M more acutely, as doing so will improve the quality and acceptance of the studies in our field.

Acknowledgements The author is grateful to suggestions from participants of the Global Innovation and Knowledge Academy (GIKA) 2015 in Valencia, Spain. Two anonymous reviewers provided valuable insights and comments that helped improve this study.

Appendix

Table 4 List of weights between articles based on bibliometric coupling analysis (undirected)

Weight	Node1	Node2
16	Allen and Aldred (2011)	Allen and Aldred (2013)
14	Freitas et al. (2013)	Freitas, Gonçalves, Cheng, and Muniz (2011)
14	García-Castro and Casasola (2011)	García-Castro and Aguilera (2014)
12	Verweij and Gerrits (2015)	Verweij (2015)
9	Hotho (2014)	Schneider et al. (2010)
7	Bell, Filatotchev, and Aguilera (2014)	García-Castro, Aguilera, and Ariño (2013)
7	Wu, Wu, Lee, and Lee (2015)	Wu (2015)
7	Ganter and Hecker (2014)	Meuer (2014)
6	Fiss (2011)	Greckhamer et al. (2008)
6	Crilly, Zollo, and Hansen (2012)	Crilly (2011)
6	Balodi and Prabhu (2014)	Fiss (2011)
5	Woodside et al. (2011)	Woodside and Zhang (2013)
5	Chang and Cheng (2014)	Cheng, Chang, and Li (2013)
5	Allen and Aldred (2013)	Pajunen (2008)
5	Allen and Aldred (2011)	Allen and Allen (2015)

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The Complex Determinants of Financial Results in a Lean Transformation Process: The Case of Italian SMEs

Arnaldo Camuffo and Fabrizio Gerli

Abstract This study, by analyzing a sample composed of some of the best Italian small and medium-sized enterprises (SMEs) that are engaged in a lean effort, adopts a multi-method approach to investigate the complex relationship between the level of implementation of lean systems, the adoption of a set of "high involvement" management behaviors and a sustained financial performance, controlling for such variables as the duration of the "lean journey" and the size of the firm. Through fuzzy-set analysis, this study focuses on the process of financial value creation within a firm due to the lean transformation and on the multifaceted relation among its determinants. Our results corroborate the perspective of lean environments as complex and integrated sociotechnical systems, confirming that the configurational approach is the most appropriate to analyze them. From this study emerges that the best performing lean companies, according to the adopted financial criteria, are those that wholly embrace the lean philosophy, follow its principles and apply its tools for years. The role of the "high involvement" management behaviors appears to be essential, since they create an environment where the lean techniques and tools can be more effective.

Keywords Financial performance • Fuzzy-set analysis • Lean thinking • Lean transformation • Management behaviors

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DOI 10.1007/978-3-319-27108-8_15

1 Introduction

During the last two decades, as the principles and tools of lean thinking (Womack & Jones, 1996) were increasingly adopted by organizations in a variety of industries, research widely investigated the relationship between such adoption and the organizational performance. Several studies analyzed the effects on performance of lean practices' adoption, with particular focus on operational performance (Chandler & McEvoy, 2000; Hart & Schlesinger, 1991; Powell, 1995; Shah & Ward, 2003; Wood, 2004; Youndt, Snell, Dean, & Lepak, 1996). Instead, comparatively less research was conducted on if, to what extent and under which conditions the adoption of "lean" principles and tools leads to better and more sustainable financial performance. This research gap is obviously grounded in the difficulty to identify and isolate the differential contribution of lean implementation on a firm's financial performance. However, it also derives from the fact that research on the performance effects of the application of lean thinking practices has been traditionally segregated within the field of operations management where scholars have converged in conceptualizing lean systems as complex and integrated socio-technical systems composed by a set of complementary *production* practices and routines (Shah & Ward, 2003, 2007).

The adoption of lean thinking practices has been recently studied from broader, strategic and organizational perspectives, and interpreted as a process of organizational learning (Emiliani, Stec, Grasso, & Stodder, 2007; Rother, 2009), of knowledge transfer and diffusion (Liker & Franz, 2011; Liker & Hoseus, 2008; Liker & Meier, 2007), and as a dynamic capability (Anand, Ward, Tatikonda, & Schilling, 2009; Fujimoto, 1999).

As part of this trend, more emphasis has recently also been given to the role of management behaviors and leadership in lean environments as powerful determinants of the successful adoption of lean principles and tools (Found & Harvey, 2006; Lucey, Bateman, & Hines, 2005; Mann, 2005, 2009; Rother, 2009; Shook, 2008).

Spear and Bowen (1999) were the first to assert that lean tools and practices are effective only if applied in a lean environment in which managers use and teach them consistently. Since then, many other studies on Toyota and other companies adopting lean thinking principles and tools have showed the importance of managers' role in connecting people development and processes improvement to drive innovation, productivity and quality (Liker & Convis, 2012; Liker & Franz, 2011; Spear, 2004). Building on Ghoshal and Bartlett (1994), Womack (2011) recently elaborated on the role of management in lean environments describing it as the activity of constantly aligning processes and people to a common purpose. Similarly, Rother (2009), following Fujimoto's (1999) perspective on lean as an emergent management system made up of routines that shape organizational behaviors, conceives lean management systems as sets of routines and patterns of behaviors (kata) geared towards keeping organizations in a learning mode, avoiding bureaucratization and rigidity, allowing adaptation and change to pursue its goals in a changing environment.

However, despite all these studies underlying the importance of certain management behaviors as a condition for the successful adoption of lean practices in organizations, no one has hypothesized and tested if, to what extent and under which circumstances a given set of management behaviors might facilitate, support or complement the adoption of lean thinking principles and tools, thus driving better and sustainable financial performance.

This study, adopting a multi-method approach and building on previous research conducted by the authors, investigates the complex relationship between the level of implementation of lean systems, the adoption of a set of "high involvement" management behaviors and sustained financial performance, controlling for such variables as the duration of the "lean journey" and the size of the firm.

2 Theory and Research Constructs

As already mentioned, management behaviors in lean environments have been increasingly investigated by scholars interested in understanding the distinctive characteristics of lean management systems and in explaining what drives sustainable performance improvements over time.

Management behaviors play different roles according to the different stages of lean thinking principles and tools adoption. At the beginning of the lean transformation process they represent key enablers of the transformation process (De Menezes, Wood, & Gelade, 2010) but their importance is also significant when lean initiatives are at an advanced stage, when appropriate management behaviors might become a source of culture reinforcement and, hence, become complementary with increasingly better and more complete implementation of lean thinking principles and tools, and prevent regression to traditional habits (Mann, 2009). Existing studies on this topic approach this problem by contrasting a supposedly traditional style of management with a supposedly lean style of management (Mann, 2005; Womack, 2011; Womack, Jones, & Roos, 1990). More specifically, Womack (2008) identifies a set of differences between the two styles, by comparing the "modern management" approach and the "lean management" approach, which he described as follows: "By modern management I mean the set of interlocking ideas on management pioneered by Alfred Sloan at General Motors early in the twentieth century and progressively refined by many organizations across the world, perhaps most strikingly by General Electric in the 1980s and 1990s. And by lean management I mean a different set of interlocking ideas on management pioneered by Eiji Toyoda and his colleagues at Toyota in the 1950s and 1960s and spread across the world by Toyota's example in recent years" (Womack, 2008, p. 1).

According to this perspective, these two managerial styles present several differences, among them: the process of value creation (horizontal vs. vertical), the kind of managerial responsibility (over processes and cross-functional vs. vertical delegation), the problem solving approach (through the research of the root causes vs. by providing solutions and imposing decisions), the decision

making approach (decisions made at the point of value creation vs. decisions taken by analyzing data far from the point of value creation), the development of standards (by line managers and work teams vs. by staff with little interaction), the planning methods (Plan-Do-Check-Act approach vs. top-down approach), the managerial development process (through in-company gemba learning vs. formal/external development), and the knowledge sharing methods (managers as teachers and coaches vs. formal learning paths).

In order to understand how these managerial behaviors impact on the attainment of a successful organizational performance, it is necessary to study their effects in combination with the adoption of the lean practices and tools, according to a holistic and configuration-based approach.

For this reason, this study adopts a holistic perspective that takes into account not only the application of a set of "lean" practices, but also how these practices are integrated into a business philosophy that creates a learning organization which constantly strives for perfection. From this standpoint, lean management is viewed as an integrated and complex socio-technical system (Shah & Ward, 2007), or, alternatively, as a configuration.

Configurations have been defined by Meyer, Tsui, and Hinings (1993) as "any multidimensional constellation of conceptually distinct characteristics that commonly occur together". According to Shah and Ward (2007, p. 791) "lean production may be viewed as a configuration of practices/tools because the relationships among the elements of lean production are neither explicit nor precise in terms of linearity or causality. [...] From a theoretical standpoint, lean production is seen as a tightly coupled system where the constituent elements hold together in mutual dependence. It is the self-reinforcing effects of this kind of mutual dependence that contribute to the superior performance associated with lean production on the one hand and make it rare, valuable and difficult to imitate by competitors on the other hand". The same authors also suggested that lean production is better understood if studied with a configurational perspective because it helps to explain how a lean systems works, considering its underlying elements as a whole, not examining each of them separately.

Thus this configurational approach implies a different view on organizations, in which profiles (complex combination of causal conditions) rather than analytically independent variables are connected to performance (Delery & Doty, 1996; Fiss, 2007).

This study, adopting a multi-method approach, tests whether or not companies that embrace lean thinking, making it their vision, improve their financial performance at a faster pace and even constantly outperform their specific industry. By doing this, we try to understand the role of the lean practices and tools and of the "high involvement" management behaviors in determining an improvement in the firms' financial performance, according to the above mentioned configurational perspective.

Our research questions are the following: (1) Are the "high involvement" management behaviors depicted by the literature correlated with a higher financial performance? (2) Is there any configuration of variables that characterizes the companies that have obtained a particularly successful financial performance?

3 Data, Measures and Method

3.1 The Sample

To answer the research questions identified above this study analyses the same sample of firms examined by the authors in a previous research (Camuffo & Gerli, 2012). This sample is made up of 26 North Italian small and medium manufacturing enterprises. These firms have been selected among the ones that had already started a lean transformation process, picking the companies that were more seriously committed to adopt a lean system in the last years.

The sampled companies have been engaged in the lean transformation for a different number of years: 19 % of them are "early adopters", meaning that they have been implementing lean for more than 6 years; 46 % of them have been lean for 3 up to 5 years ("followers"); and 35 % of them are "late adopters" having started to implement lean in 2009 or 2010. Even if these firms are at different stage in their transformation process, they are successfully doing their lean journey, thus they can be considered a sample of "the best lean Italian SMEs" (Camuffo & Gerli, 2012).

Most of the firms in the sample (61 %) have sales revenues ranging from 10 euros to 50 million euros, while 35 % of the companies present sales revenues above 50 million euros and the remaining 4 % are small firms with sales ranging from 2 euros to 10 million euros. In addition, most of the firms (65 %) have a number of employees between 50 and 250, 31 % of them employs more than 250 people and only 4 % has less than 50 employees. These firms belong to many industrial sectors, such as mechanics, furniture, electronics, packaging, motor vehicles, domotics, child equipment, wine, laundry-home care, plastics, and industrial gases. Finally, about 35 % of them are part of a larger multinational group.

3.2 Independent Variables

The independent variables for this study are taken directly from Camuffo and Gerli (2012) and are: the Lean Advancement Score and the "High involvement" Management Behaviors.

The Lean Advancement Score (LAS) represents the degree of advancement in the lean transformation process. We measured it from an on-site assessment (an extensive "gemba walk") conducted by a sub-team of researchers on a set of 30 lean management systems characteristics. Researchers visited the main production plants of every firm and interviewed the personnel involved in the design, industrialization and production activities in order to have an insight on the technologies and the processes applied. Sub-teams' members' assessments were then compared to test their inter-rater reliability and converge on a univocal evaluation.

The 30 parameters of the assessment summarize the tools, routines, artifacts and practices that typically characterize a lean management system and are derived from the reviewed literature. These characteristics were grouped into seven clusters: (1) Just in Time Tools; (2) Continuous Improvement Tools; (3) Lean People Management; (4) Management Commitment; (5) Lean in Strategy; (6) Material Management; and (7) Supplier Management.

We computed the LAS as the average of the parameters' score, which ranges from 1 to 5, where 1 represents a low degree of advancement and 5 a high degree of advancement.

The Lean Advancement Score measure follows:

$$LAS = \frac{\sum_{i}^{n} V_i}{n} \tag{1}$$

where V_i is the value of advancement of lean item i, and n is the number of items.

The second independent variable was the degree of adoption of *"High involvement" Management Behaviors*, i.e. the behaviors the literature hypothesize to be consistent and complementary with lean thinking adoption. To measure it we considered 14 behaviors identified from the relevant literature on lean management and lean leadership. We started from the repertoire of lean management behaviors pioneered by Womack (2008, 2011) who lists a set of "lean management" behaviors contrasting them with "modern management" behaviors. Then we operationalized and integrated them with others (Liker, 2004; Liker & Hoseus, 2008; Ohno, 1988; Rother, 2009; Sato, 2008), and obtained the following "high involvement" behaviors: (1) Organizational horizontality; (2) Managerial responsibility; (3) Process-Based Evaluation; (4) Iterative Planning; (5) Managerial versatility; (6) Gemba-based management development; (7) Fact-based decision making; (8) Scientific method-based problem solving; (9) Standards development; (10) De-hierarchization; (11) Managerial reflexibility; (12) Teaching; (13) Open-mindedness; (14) Challenge.

Each behavior was then operationalized by defining a set of corresponding actions, which represent the presence or absence of application of each behavior. Some behaviors presented only two actions (one referable to the presence of that behavior, that is the coherence with a *lean* management approach, and another referable to the absence of that behavior, that is the coherence with a *modern* management approach). In order to offer a fine grained analytical scheme, for some behaviors in the list that presented a wider variety of adoption, we detailed a scale able to capture the different degree of application of these behaviors through a wider set of corresponding actions, according to the "just noticeable differences scales" (JNDS) approach, whose adoption in social sciences, and in particular in economics and psychology, has been widely acknowledged (Luce, 1956; Spencer & Spencer, 1993; Stevens & Stone, 1959).

Then to each action has been given a weight, from −1 to +1, depending on their coherence with the modern management or the lean management approach, where

−1 identifies actions completely consistent with the modern management approach and +1 actions completely consistent with the lean management approach. Intermediate behaviors were weighted in between −1 and +1.

To detect the degree of presence of these behaviors, a different sub-team of researchers (to avoid problems of endogeneity and single respondent bias) conducted a series of structured and standardized interviews with the top lean agent or the chief of the kaizen promotion office of each firm. The interview aimed at exploring the lean transformation process and some specific events in which the firm obtained significant results through the implementation of lean tools. The interview protocol largely drew upon the critical incident interview technique (Flanagan, 1954), where the attention of the interviewer is focused on gathering information on specific and real cases and events and not on the interviewee's opinions. The potential of the critical incident interview and of its developments, as an efficient substitute for direct observation of real events, has been recognized also in the process of analysis of organizational competencies and in the elicitation of tacit knowledge (Ambrosini & Bowman, 2001).

The overall presence of these "high involvement" behaviors (HIB) in the firm j has been measured as the weighted frequency of each behavior, as shown as follows.

$$HIBj = \sum_{i}^{n} F_i \tag{2}$$

Where:

F_i: Weighted frequency of behavior i;
n: Number of management behaviors.

The weighted frequency was calculated as follows:

$$F_{i,j} = \frac{\sum_{n} CB_{i,n} \bullet W_{i,n}}{\sum_{n} PB_{i,n}} \tag{3}$$

Where:

$F_{i,j}$: Frequency of management behavior i detected in the firm j;
$CB_{i,n}$: Coded Behaviors—number of times that the action n associated to behavior i was detected in the interview conducted in the firm j;
$W_{i,n}$: Weight associated to the action n (from −1 to +1 according to the consistency to a modern management approach or to a lean management approach) associated to behavior i;
$PB_{i,n}$: Potential Behaviors—the maximum number of weighted actions associated to behavior i detectable in the interview conducted in the firm j;
j: Analyzed firms (from 1 to 26);

i: Analyzed Behaviors (from 1 to 14);
n: Actions associated to that analyzed behavior.

3.3 Dependent Variables

As dependent variables we selected two financial metrics that are tightly linked to the internal processes and dimensions that are more directly affected by a lean transformation (Maskell & Baggaley, 2003), that is: (a) EBITDA (Earnings before interest, taxes, depreciation and amortization) Margin, which is a measure of the firm's profitability and is a proxy of the cash flow generated per Euro of sales; (b) ROIC (Return on invested capital), which is a profitability measure that takes into account the capital, the firm's cash flow generation and its operating and structural efficiency. They can be measured as follows:

$$\text{EBITDA Margin} = \text{EBITDA}/\text{Sales Revenue}\,(\%)$$
$$\text{ROIC} = \text{NOPAT}/\text{Net Invested Capital}\,(\%)$$

In order to be able to compare all the firms of the sample directly, since they operate in different industries, characterized by different trends and levels of profitability, we analyzed if each firm of the sample over/under-performed its industry according to the above profitability measures. To do this, we transformed each dependent variable into an index number which highlights the differential performance of each company compared with industry peers, by using the following formula:

$$D_{v,f,t} = \frac{X_{v,f,t} - m_{v,f,t}}{\left|m_{v,f,t}\right|} + 1 \tag{4}$$

Where:

$D_{v,f,t}$: Dependent Variable transformed into index number;
$X_{v,f,t}$: Value of the dependent variable v in the firm f in the year t;
$m_{v,f,t}$: Median value of the industry to which the firm f belongs, as regards the dependent variable v in the year t.

The underlying assumption is that, after controlling for industry peculiarities and trends, the differential performance of the analyzed firms should be reasonably attributed to their management system and, hence, to their "lean journey".

The median value of the industry was determined by identifying a panel of competitors for each firm of the sample. For the firms with sales revenues smaller than 30 million euros 20 competitors were selected, whereas for firms with sales revenues larger than 30 million euros 10 competitors were selected, due to the lower number of comparable firms of that size. The comparable firms were selected according to the following criteria: (a) same ATECO (national industry

classification category) code of the analyzed company; (b) Italian companies; (c) the closest 10/20 firms by sales revenues to the analyzed company.

Finally, for each of the analyzed firms and for each of the dependent variables transformed into an index number, we computed the variations over time in two ways:

1. As the percentage increase/decrease occurred comparing the situation at the beginning of the lean transformation to that in 2011 (the last year for which financial performance data were available). To avoid distortions due to particular events occurred in the first year of lean transformation, we considered as initial performance the average of the profitability measures of the first year of lean transformation and of the 2 years before.

$$\text{Lean Journey up to 2011} : LJ_{v,f,2011} = \frac{D_{v,f,2011} - D_{v,f,initial}}{\left|D_{v,f,initial}\right|} \tag{5}$$

Where:

$D_{v,f,2011}$: Value of the dependent variable v in the firm f in the year 2011;

$$D_{v,f,initial} = \frac{D_{v,f,t0} + D_{v,f,t0-1} + D_{v,f,t0-2}}{3} \tag{6}$$

$t0$: Year of beginning of the lean transformation.

2. As the average annual percentage increase/decrease in financial performance with respect to the initial situation.

$$\text{Average annual increase} : AI_{v,f} = \frac{\sum_{t} \frac{D_{v,f,t} - D_{v,f,initial}}{\left|D_{v,f,initial}\right|}}{t} \tag{7}$$

Where:

t: Years of lean transformation, starting from the next year of the beginning of the lean journey.

These two dependent variables capture different dimensions of the firms' financial performance. *LJ* measures the overall performance increase reached by each firm from the start of its process of lean transformation to 2011, whereas *AI* takes into account the financial value generated every year during the whole transformation, and for this reason considers also the variance occurred in the financial results during the whole process. At the same time, *LJ* might be influenced by particular events occurred in the last year of lean transformation, whereas *AI* might be influenced by the typical performance decrease that companies experience in the first years of lean transformation, and this might be particularly significant for those firms that have started their transformation only recently.

4 Research Method

Consistently with our theoretical framework, which considers the organization according to a holistic perspective and lean management as a configuration of practices and tools, where the relationships among the elements are not linear neither causal (Shah & Ward, 2007), our research tries to explore and validate this configurational vision by testing the relationships among the above defined variables, with the specific aim to test whether or not companies that embrace lean thinking can improve their performance and even outperform their specific industry.

In order to test the adequacy of the configurational perspective to our case, we started our analysis by exploring the relationships among independent and dependent variables, according to a traditional linear perspective, based on singular causation relations. Traditional OLS regression was used to test the model. The classic linear regression model considers each variable as competing in explaining variation in outcomes rather than showing how variables combine to create outcomes, since it focuses on the unique contribution of a variable while holding constant all the others (Fiss, 2007). For this reason, according to the adopted configurational theoretical framework, in our case this analysis should show unsatisfactory results in explaining the relation between dependent and independent variables. First of all, OLS analysis was applied to test the relationship between the independent variables (Lean Advancement Score and "High involvement" management behaviors) and the financial performance improvements achieved during the lean transformation journey, considering both the financial measures (EBITDA margin and ROIC) and both their indicators (LJ and AI). These models included two control variables: *Years of lean transformation* (a variable that measures the duration of the lean transformation journey and is supposed to be positively related to the financial performance improvements achieved by the firms during their lean transformation process) and *Size of the firm*, measured by the number of employees of the companies in the sample. These models were intended to test if the independent variables had separate and linear effects on the firms' financial performance and if these two variables contribute to explain the performance variability.

In addition, we further examined the role of the "High involvement" management behaviors. Our conceptual framework hypothesizes that they have a sort of bridging function between the lean tools and the lean principles, and that they contribute to the creation of an environment where the lean techniques and processes can be effectively applied (Mann, 2009). Consequently, from this perspective, they are expected to have an influence on the relation between the variable that measures the "hard" part of the lean systems (Lean Advancement Score) and the financial performance achieved by the companies during their transformation. Thus, we tested the hypothesis that the "High involvement" management behaviors act as a moderator variable with a positive effect on the relationship between the Lean Advancement Score and the financial performance.

Finally, consistently with a configurational perspective and a systemic view to lean management, we conducted a fuzzy set analysis (using the software fs/QCA), which is a set-theoretic method that makes it possible to analyze and evaluate different configurations characterized by causal complexity. The strength of this method is that, unlike traditional research methods, it considers observations as various kinds of cases and does not divide them into separate, analytically autonomous elements/variables (Fiss, 2011). So it helps to build different and sharp causal explanations and, with a holistic approach, allows to identify successful typologies/profiles that summarize the complex relationships between several characteristics (Fiss, 2011). In this research, this methodology has been used to compare various companies and simplify their complex nature on the basis of their commonalities. In addition, it is a case-oriented analysis technique, particularly recommended to study small samples, it takes into account interactive and nonlinear effects focusing on the joint distributions of the causal variables, and is based on the concept of equifinality, that is the belief that "a system can reach the same final state, from different initial conditions and by a variety of different paths" (Katz & Kahn, 1978, p. 30) and consequently that "two or more organizational configurations can be equally effective in achieving high performance" (Fiss, 2007, p. 1181). Moreover, this method allows to analyze the presence of causal asymmetry, namely the fact that the conditions/causes that lead to the presence of the outcome are often different from the ones that lead to its absence (Fiss, 2011). Summing up, it is possible to state the fs/QCA is useful "to explore evidence descriptively and configurationally, with an eye towards the different ways causally relevant conditions may combine to produce a given outcome" (Ragin, 2008, p. 141).

5 Findings

5.1 Descriptive Statistics and Performance Trends

Table 1 presents the descriptive statistics and the bivariate correlations between the analyzed variables for our sample. It is possible to note that some variables present a significant correlation: the Lean Advancement Score (LAS) is correlated to the High Involvement management behaviors (HIB), the duration of the lean journey is correlated to LAS, HIB and the size of the firm, and some financial performance variables are correlated each other. However, in spite of the strong correlation between some independent variables, this study does not suffer from problems of endogeneity: as explained above, the Lean Advancement Score and the High Involvement management behaviors have been evaluated independently by different sub-teams of researchers who used different sources and tools.

Table 1 Descriptive statistics

	Min	Max	Mean	Std. Dev.	1	2	3	4	5	6	7	8
Lean Advancement Score (LAS)	−1.5	3.53	2.44	0.476	1	0.660**	0.257	0.667**	−0.025	0.037	0.221	0.114
High Involvement Management Behaviors (HIB)	−57.1	663.3	245.10	198.161	0.660**	1	0.227	0.537**	−0.187	0.085	0.071	0.157
Size	39	3061	320.42	589.629	0.257	0.227	1	0.643**	0.243	0.145	0.273	0.118
Years	1	11	4.04	2.676	0.667**	0.537**	0.643**	1	0.280	0.407*	0.432*	0.389*
LJ2011 EBITDA	−2.03	1.98	0.16	0.791	−0.025	−0.187	0.243	0.280	1	0.616**	0.834**	0.395*
LJ2011 ROIC	−2.40	8.93	1.33	2.770	0.037	0.085	0.145	0.407*	0.616**	1	0.586**	0.805**
AI2011 EBITDA	−1.33	1.01	0.02	0.572	0.221	0.071	0.273	0.432*	0.834**	0.586**	1	0.550**
AI2011 ROIC	−3.18	5.70	0.88	2.295	0.114	0.157	0.118	0.389*	0.395*	0.805**	0.550**	1

*$p < 0.05$
**$p < 0.01$

5.2 *The Impact of Lean Tools and Behaviors on the Financial Performance*

In order to answer our research questions, we analyzed the impact of the adoption of lean tools and high involvement management behaviors on the financial performance of the firms. As explained in the method section, we started our analysis by testing this relation through linear regressions, with the purpose of verifying weather the lean tools and the management behaviors act separately and independently on the firms' performance improvements.

In the regression models we considered as dependent variable EBITDA Margin (Table 2) and ROIC (Table 3), both of them measured through the Lean Journey (LJ) and Average Annual Increase (AI) indicators. The two main independent variables are the Lean Advancement Score (LAS) and the High Involvement Management Behaviors (HIB). Some models also included two control variables: Years (the length of the lean transformation process) and Size (the number of employees of the sampled companies in 2011).

In addition, as explained above, we considered the particular role of the management behaviors, in terms of their potential influence on the relation between the tools and the performance. Consequently, we tested the hypothesis that the management behaviors act as a moderator variable with a positive effect on the relationship between the LAS and the dependent variables. In this case, the moderation effect is verified when the regression coefficient of variable LAS × HIB is positive and significant in the corresponding model.

Table 2 OLS results

	Dependent variable: LJ EBITDA			Dependent variable: AI EBITDA		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Std. Beta	Std. Beta	Std. Beta	Std. Beta	Std. Beta	Std. Beta
	(sig.)	(sig.)	(sig.)	(sig.)	(sig.)	(sig.)
LAS	0.283	0.008	−0.482	0.395	0.191	−0.218
	(0.327)	(0.979)	(0.237)	(0.116)	(0.491)	(0.550)
HIB	0.154	0.041	−1.652	0.287	0.204	−1.208
	(0.590)	(0.879)	(0.108)	(0.246)	(0.400)	(0.190)
LAS × HIB			2.160			1.801
			(0.090)			(0.117)
Size		0.188	0.341		0.112	0.240
		(0.487)	(0.212)		(0.643)	(0.330)
Years		0.447	0.256		0.341	0.182
		(0.221)	(0.471)		(0.294)	(0.572)
Adjusted R^2	0.073	0.227	0.318	0.324	0.377	0.435
F	1.829	2.542	2.957	6.039	4.177	4.231

Lean Journey (LJ) up 2011 and Average annual Increase (AI) as dependent variables (EBITDA). N = 22

Table 3 OLS results

	Dependent variable: LJ ROIC			Dependent variable: AI ROIC		
	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
	Std. Beta	Std. Beta	Std. Beta	Std. Beta	Std. Beta	Std. Beta
	(sig.)	(sig.)	(sig.)	(sig.)	(sig.)	(sig.)
LAS	0.185	−0.218	−0.355	0.150	−0.158	−0.400
	(0.504)	(0.449)	(0.386)	(0.608)	(0.635)	(0.398)
HIB	0.325	0.179	−0.295	0.229	0.119	−0.714
	(0.245)	(0.475)	(0.768)	(0.435)	(0.683)	(0.538)
LAS × HIB			0.605			1.062
			(0.625)			(0.459)
Size		−0.350	−0.307		−0.299	−0.224
		(0.173)	(0.266)		(0.312)	(0.477)
Years		0.878	0.825		0.684	0.590
		(0.016)	(0.032)		(0.091)	(0.165)
Adjusted R^2	0.137	0.328	0.297	0.028	0.088	0.064
F	2.669	3.559	2.771	1.303	1.504	1.288

Lean Journey up 2011 (ROIC) and Average annual Increase (ROIC) as dependent variables. N = 22

To make sure that the results were not distorted by few influent observations, the data homogeneity was checked. Four outlying observations were identified and excluded from the sample for this type of analysis. In particular two of them presented extremely high values for the year 2011, whereas the other two outliers presented extremely low values. The sample for this analysis was then reduced from 26 to 22 observations.

Our results show no significant variables in the regression models, except for the moderating variable LAS × HIB in model 3 and for the variable Years in models 8, 9 and 11 ($p < 0.10$). In these cases the significant variables present a positive sign, as expected. However, the adjusted R^2 is overall low. In model 6, which presents the highest R^2, the variable LAS × HIB shows a significance only slightly lower than 90 %. The failure of the models in explaining the variability of the dependent variables suggests that the analyzed variables LAS and HIB do not present independent effects on the firms' performances and that their impact cannot be observed through the additive approach typical of the OLS regressions. On the opposite, the result about the moderating variable means that the management behaviors seem to have a positive effect on the relation between the application of the lean tools and the firms' financial performances. Since the product of HIB and LAS is significant and positive, it means that they are mutually influenced and they present a combined effect (at least by analyzing the metric EBITDA margin) on the companies' performances. However, the moderating effect is not demonstrated for the metric ROIC. In addition, the variable Years must be taken into consideration, since it presents an impact on the financial performance in almost all the models which consider ROIC as the dependent variable.

These findings are only partially satisfactory: on the one side they suggest that the adoption of lean behaviors has a positive effect in achieving a higher financial performance in those companies that properly apply the lean techniques and that there is a

positive relationship between the management behaviors, the lean tools and the performance improvements obtained during the lean journey. This is consistent with the configurational approach and the systemic view to lean management, which requires the variables' effects to be analyzed holistically, as a whole, taking into account the synergetic effects and interactions between the variables (Shah & Ward, 2007). On the other side these results are mainly limited to one metric (EBITDA Margin) and present contradictory evidence about the role of the control variables. For this reason the next step of our analysis used the fuzzy set analysis as a tool to evaluate the role of different configurations of variables, instead of separate and autonomous variables.

5.3 A Configurational Analysis through fs/QCA

Consistently with a configurational perspective to the lean systems, we used the fuzzy set qualitative comparative analysis (fs/QCA) (Fiss, 2007, 2009, 2011; Ragin, 2000, 2006, 2008; Ragin & Fiss, 2008) to analyze our sample. It is a set-theoretic method that is particularly effective to study different configurations characterized by causal complexity and non-linear relationships (Fiss, 2007), where "variables found to be causally related in one configuration may be unrelated or even inversely related in another" (Meyer et al., 1993, p. 1178). Differently from traditional methods, it analyses asymmetric relationships and synergistic effects, accordingly with an equifinality perspective, where more organizational configurations may have the same impact on the firm's performance. Set-theoretic approaches are particularly appropriate for configurational theory since they conceptualize cases as combinations of attributes and highlight that these combinations give cases their unique nature (Fiss, 2007; Ragin, 1987, 2000). For these reasons, it is possible to conclude that the fs/QCA's advantage is "to explore evidence descriptively and configurationally, with an eye towards the different ways casually relevant conditions may combine to produce a given outcome" (Ragin, 2008, p. 141). In addition, it is a case-oriented technique, and for this reason it is particularly recommended to study small-*N* samples.

In our case, each configuration is represented by the different combinations of independent variables and controls. Using this type of analysis we tested one model where the conditions/variables were: Lean Advancement Score (LAS), High Involvement Management Behaviors (HIB), duration of the lean journey (Years) and number of employees (Size). These variables were considered related to the research outcome, represented by the financial performance improvements achieved during the lean transformation process.

Consequently, in this analysis, the hypothesis we tested regards which combination of elements of a configuration are sufficient conditions to obtain an outcome in terms of firms' financial outperformance. The underlying assumptions consider that, in order to obtain a better financial performance, a firm should have:

(a) implemented the lean tools and methods at an advanced stage (LAS);
(b) applied continuously the appropriate high involvement management behaviors (HIB);

(c) sustained lean transformation efforts for a long time (Years);
(d) reached an appropriate dimension to implement the lean tools and behaviors (Size).

In particular, the assumption about the duration of the lean journey comes from Mann (2009, p. 24) that highlights that "the longer an organization pursue Lean, the more opportunities for improvement it sees".

In order to apply the fs/QCA method, we followed these steps, by using the software fs/QCA version 2.5:

1. transformation of the variables into fuzzy sets through a calibration process;
2. construction of a Truth Table that includes the list of all possible configurations;
3. identification of the subset of configurations that lead to a higher outcome and are internally consistent;
4. identification of the solutions in terms of consistent configurations.

The first step of this analysis required to identify three thresholds, for each variable, that correspond to: full membership, full non-membership and the cross-over point, "the point of maximum ambiguity in the assessment of whether a case is more in or out of a set" (Ragin, 2000, p. 30). Membership is intended as the definition of the conditions under which one of the sampled firm can be considered as belonging to a given set (in our case, the outperforming firms). The definition of these thresholds makes it possible to calibrate the variables and obtain the fuzzy sets which range from 0 to 1. Although a set-theoretic analysis does not require the assumption that data are drawn from a given probability distribution and usually the calibration process is based on personal knowledge, we used standard distribution values for the calibration. For each variable, we identified the 20th, 50th and 80th percentiles as thresholds, where the 20th percentile is the threshold for full non-membership, the 80th percentile is the threshold for full membership and the 50th percentile represents the crossover point. The choice of using standard distribution values was made to avoid distortions due to subjective and arbitrary choices, since it is not possible to find any benchmark to refer to.

The second step was the construction of the truth table, which lists all the possible configurations that can be obtained by combining the causal conditions/variables. The number of all possible configurations is 2^k, where k is the number of causal conditions, that is 4 in our case. In addition, the truth table shows how many cases fall into any particular configuration (frequency) and their consistency, which "refers to the degree to which cases correspond to the set-theoretic relationships (i.e., configurations) expressed in a solution" (Fiss, 2011, p. 402).

The third step was conducted selecting the configurations, among those listed in the truth table, which presented at least one solution frequency (since the research is based on a small sample) and at least the lowest acceptable level of consistency, which Ragin (2000, 2006, 2008) recommended at the level of 75 %.

The final step consisted in the identification of the solutions. The truth table algorithm uses Boolean algebra and a process known as counterfactual analysis of causal conditions to identify complex, intermediate and parsimonious solutions. The complex solution lists all the configurations leading to the presence of the

outcome, whereas the intermediate and parsimonious solutions present other configurations, which derive from the ones listed in the complex solution, but include some simplifying assumptions. The configurations in the intermediate solution only include simplifying assumptions based on "easy counterfactual", whereas the configurations in the parsimonious solution include all simplifying assumptions regardless of whether they are based on "easy" or "difficult counterfactual" (Fiss, 2011). As explained by Fiss (2011), easy counterfactuals answer the question "Would adding another condition make a difference?" (Fiss, 2011, p. 403); difficult counterfactuals instead answer the question "Would removing a causal condition make a difference?" (Fiss, 2011, p. 403). Consequently, "core conditions" are defined as those that are part of both parsimonious and intermediate solutions, whereas "peripheral conditions" are those that only compose the intermediate solutions. Core elements are those for which the evidence indicates a strong causal relationship with the outcome, whereas peripheral elements are those for which the evidence for a causal relationship with the outcome is weaker (Fiss, 2011).

Table 4 shows the results for all the outcome variables considered in this research: LJ EBITDA, LJ ROIC, AI EBITDA, AI ROIC (one outlying firm was removed from the sample). The solutions table shows which elements of the configuration, marked with "Yes" are required to obtain the outcome; blank spaces in a solution indicate a "don't care" situation in which the causal condition may be either present or absent. The same table also reports, for each solution, the Consistency score and the Solution

Table 4 fs/QCA results

Solutions	LAS	HIB	SIZE	Years	Solution coverage	Solution consistency
Outcome: LJ EBITDA						
Complex	Yes	Yes	Yes	Yes	0.41	0.73
Parsimonious	Yes		Yes		0.49	0.68
Intermediate	Yes	Yes	Yes	Yes	0.41	0.73
Outcome: LJ ROIC						
Complex		Yes	Yes	Yes	0.46	0.76
Parsimonious a		Yes	Yes		0.53	0.69
Parsimonious b			Yes	Yes		
Intermediate		Yes	Yes	Yes	0.46	0.76
Outcome: AI EBITDA						
Complex	Yes	Yes	Yes	Yes	0.43	0.81
Parsimonious	Yes		Yes		0.52	0.75
Intermediate	Yes	Yes	Yes	Yes	0.43	0.81
Outcome: AI ROIC						
Complex		Yes	Yes	Yes	0.54	0.82
Parsimonious a		Yes	Yes		0.66	0.75
Parsimonious b			Yes	Yes		
Intermediate		Yes	Yes	Yes	0.54	0.82

N = 25

Blank spaces in a solution indicate a "don't care" situation in which the causal condition may be either present or absent

Coverage score. The consistency has been defined above, whereas the coverage of a solution represents the percentage of membership in the outcome that is accounted by the complete solution (Ragin, 2008).

Most of the solutions exhibit a high consistency degree and an acceptable overall coverage score, meaning that the chosen causal conditions explain well the companies' membership to the high performing groups. By accepting only the solutions with a consistency degree higher than 0.75, the performance variable which better explains the configuration of elements seems to be the average increase in EBITDA and ROIC. On the opposite, the LJ variable seems to offer less consistent results (this is probably due to the fact that the values of the LJ variable depend only on the financial performances of the year 2011 and do not consider what happened during the whole lean journey).

However, focusing on the valid solutions according to this consistency criterion, it is interesting to note that we obtain two kinds of configurations: the first one (outcome: AI Ebitda) includes all the considered variables (LAS, HIB, Years, Size), where LAS and Size can be considered as core variables and HIB and Years as peripheral. The second one (outcome: AI ROIC) includes HIB, Years and Size as core variables and does not consider LAS. Interestingly, none of the variables considered in our model has been explicitly excluded from the configurations, meaning that their contribution to the financial performance is confirmed.

In addition, all the complex and intermediate solutions are identical, and so no "easy counterfactuals" were applied. This is probably due to the low number of causal conditions we used and to the fact that the complex solutions included all or almost all the elements.

However, the identified solutions are consistent with the hypotheses of the model and with the configurational perspective of lean management. In fact, these results highlight the importance of all the elements we identified to obtain a higher financial performance. These solutions point out that the adoption, in a piecemeal fashion, of the techniques, tools and management practices typical of the lean management is not sufficient to achieve high performances, but has to be combined with the adoption of coherent management behaviors and with a constant application over time. The role of the size of the firm seems to emphasize the positive effect of a greater dimension on a correct and rigorous implementation of tools and behaviors, probably due to the impact of greater investments. Surprisingly, in the second analyzed solution, the role of tools and methods, represented by the LAS variable, appears even smaller. This may be a signal that even if a firm does not reach the highest level in terms of implementation of lean tools, it can effectively support its lean efforts through the adoption of coherent lean behaviors over an adequate period of time.

6 Discussion and Conclusions

Our results corroborate the perspective of lean environments as complex and integrated sociotechnical systems, confirming that the configurational approach is the most appropriate to analyze them. From this study emerges that the best

performing lean companies, according to the adopted financial criteria, are those that wholly embrace the lean philosophy, follow its principles and apply its tools for years. This result confirms what has been described in many studies: lean tools and principles cannot be implemented in a fragmentary manner (Lucey et al., 2005; Mann, 2005, 2009; Shah & Ward, 2003, 2007). Firms truly committed in pursuing a lean transformation need to embrace its philosophy completely and persist with this choice for years. This implies that the partial adoption of a lean system does not make sense because it does not guarantee any performance improvement.

The role of the "high involvement" management behaviors appears to be essential, as emerged from both our analysis (regression and fuzzy-set): the variable "high involvement" management behaviors resulted statistically significant as moderator in the regression analysis and was part of all the configurations leading to a high performance in the fuzzy-set analysis. Consequently, high involvement management behaviors create an environment where the lean techniques and tools can be more effective.

Our results also show that the firms that have been committed to the adoption of lean principles for a longer time tend to outperform their industry, improving their profitability ratios at a faster pace than that of their competitors. The importance of maintaining a lasting and strong commitment towards the lean principles throughout the whole lean journey is highlighted also by many other facts: the strong correlation of the variable Years with the other independent variables that measure the degree of implementation of a lean system and its related managerial behaviors, and the presence of the variable Years in the configurations leading to high performances identified with the fuzzy-set analysis. The most successful firms are the ones committed for 5 years or more in their transformation, namely the companies that did not give up the continuous improvement process after the first difficulties. As a matter of fact, the longer a company lean effort the higher its mastery of the lean techniques and tools. Moreover, a lasting commitment to the lean principles helps to reinforce the company culture.

This study also presents some strong managerial implications. Indeed, it underlines the importance of: (a) taking a serious and lasting commitment to change and keep investing in improving the processes throughout the whole lean journey, since lean investments start to repay after a couple of years. This issue has strong implications on the crucial role of the leaders who have to promote change in the companies, and on the peculiarities of small and medium-sized enterprises in terms of their attitude to change; (b) embracing completely the lean philosophy adopting not only the visible and hard tools and techniques, but giving particular attention to the invisible and soft part of the system: lean principles and management behaviors; (c) adopting the list of high involvement management behaviors as a guide, since they are behaviors that are the foundations of the lean management.

Finally, this study presents some limitations. First of all, it is based on a small sample that strongly limited the results of the traditional quantitative methods, which usually require far larger samples. Moreover, 35 % of the companies in the sample are late adopters, so for these companies it was impossible to study the evolution of their performance over a 5-year period. Consequently these data have

been used only to evaluate the performance in the first couple of years of lean transformation. In addition, this study takes into consideration the financial performances of a period of time characterized by the economic crisis and for this reason, even if the dependent variables of this study have been adjusted according to the industry dynamics, their value might have been biased. Furthermore, a couple of firms in the sample were harshly hit by the economic juncture and ended up in a company crisis. Future research should try to work with larger cross-national samples, studying the performance evolution over a longer period of time, and should focus on specific industries studying the dynamics of lean systems adoption and the performance trends of homogeneous groups of companies.

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Young Innovative Companies and Access to Subsidies

Norat Roig-Tierno, Alicia Mas-Tur, and Belén Ribeiro-Navarrete

Abstract Young innovative companies (YICs) are becoming increasingly prominent in the debate on industrial policy because of their role as drivers of industry and the economy. The aim of this research was to determine which variables associated with the entrepreneur and the creation of YICs enable access to public entrepreneurship policies. This analysis compared Mas-Tur and Simón-Moya's (2015) results (obtained using regression analysis) with results yielded by Qualitative Comparative Analysis (QCA). Using the QCA methodology, we identified causal configurations that lead companies to receive subsidies, or conversely, that lead companies not to receive subsidies. We thus observed differences in findings obtained using these two techniques.

Keywords Qualitative Comparative Analysis • Subsidies • Young innovative companies

1 Introduction

Young innovative companies (YICs) are becoming increasingly central to the debate on industrial policy because of their role as drivers of industry and the economy. Studies have shown that this type of company is fundamental in transforming industrial structure, contributing to economic growth, and spreading innovation within a territory (Schneider & Veugelers, 2010). Thus, scholars and

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_16

politicians are dedicating increasing attention to YICs (Mas-Tur & Ribeiro Soriano, 2014; Schneider & Veugelers, 2010). In fact, several EU Member States have implemented programs to establish, consolidate, and develop YICs (Veugelers, 2012).

The aim of this research was to determine which variables associated with the entrepreneur and the creation of YICs enable access to public entrepreneurship policies. This analysis compared Mas-Tur and Simón-Moya's (2015) results (obtained using regression analysis) with results yielded by Qualitative Comparative Analysis (QCA). Using QCA methodology, we identified causal configurations that lead companies to receive subsidies, or conversely, that lead companies not to receive subsidies. We thus observed differences in findings obtained using these two techniques. As per Woodside (2013), the present study yielded findings that explain the advantages of QCA with respect to traditional statistical methods (e.g., regression analysis and structural equation modeling).

We analyzed a group of YICs from the Region of Valencia in the southeast of Spain. This region is classified as a European region with a low absorptive capacity in terms of innovation (Azagra-Caro, 2011). Consistent with the *Global Entrepreneurship Monitor* (Bosma, Acs, Autio, Coduras, & Jonathan, 2008), the typical entrepreneur in the region is a man, aged approximately 40 years, with higher education but without entrepreneurial experience.

We selected the sample of firms using the definition of YICs found in the literature (Schneider & Veugelers, 2010). Firms were created after 2005 (i.e., they were less than 8 years old). Furthermore, the business model of all firms in the sample was based on innovation. We thus identified 189 YICs created between 2005 and 2008. According to data from the Valencian Institute for Small and Medium-Sized Industry (Instituto de la Pequeña y Mediana Industria Valenciana, IMPIVA), the sample covered practically the entire population of YICs in the region.

The chapter has the following structure. Section 2 discusses YICs and their relationship with a region's industry. It also examines access to subsidies by companies within a particular region. Section 3 describes our method and compares results obtained by Mas-Tur and Simón-Moya (2015) with results obtained using QCA. Finally, Sect. 4 presents conclusions, recommendations, and limitations of the study. It also discusses future research opportunities.

2 Theoretical Framework

2.1 YICs

According to the literature, innovation is a key component of entrepreneurship (Aldrich & Fiol, 1994; Braunerhjelm, 2011; Cuervo, Ribeiro, & Roig, 2007; Eckhardt & Shane, 2003; Leibenstein, 1968; Sternberg & Wennekers, 2005;

Wennekers & Thurik, 1999). Innovation not only is part of business activity, but also contributes to the ability to discover, assess, and exploit opportunities available to entrepreneurs (Shane & Venkataraman, 2000). Innovation exists in entrepreneurship from the outset. In other words, innovation arises from the moment the entrepreneur seeks gaps in the market to create new products, services, and production processes.

YICs play a key role in the entrepreneurship process. Owing to a combination of their age, size, and degree of innovation, YICs do not adapt innovations in their sector, but rather create new products, technologies, and markets. In other words, they make innovations based on R&D (Mas-Tur & Ribeiro Soriano, 2014; Mas-Tur & Simón-Moya, 2015; Schneider & Veugelers, 2010). This argument partly reflects Schumpeter's (1934, 1942) thesis, which states that small start-ups are based on the creative destruction of science and technology, whereas large, established companies base their processes on creative accumulation. Corporations stand out because of the accumulation of innovations, whereas smaller innovative companies are the source of long-term economic growth through constant innovation and the redefinition of sectors.

Nevertheless, the Global Entrepreneurship Monitor (GEM) does not consider innovation an intrinsic characteristic of entrepreneurship. Instead, the GEM defines entrepreneurs as 'adults in the process of setting up a business that will (mostly) own or currently own and manage an operating young business', without mentioning innovation. The GEM distinguishes between two types of entrepreneurs: opportunity entrepreneurs and necessity entrepreneurs. An opportunity entrepreneur is an individual who creates a business because it offers an exploitable market opportunity (Mas-Tur & Ribeiro Soriano, 2014; Mas-Tur & Simón-Moya, 2015; Reynolds, Camp, Bygrave, Autio, & Hay, 2001). Therefore, opportunity entrepreneurship is characterized by the entrepreneur's innovative capacity (Ho & Wong, 2007; Kelley, Bosma, & Amoros, 2010). In contrast, necessity entrepreneurs start businesses to avoid unemployment (El Harbi & Anderson, 2010; Reynolds et al., 2001); thus, such ventures are not based on the activity's innovation potential (Sternberg & Wennekers, 2005). Therefore, although innovation is not a key element of the GEM's general definition of an entrepreneur, it is a key component of the definition of an opportunity entrepreneur.

Several studies have shown that opportunity entrepreneurs are more likely to succeed than those who start businesses to avoid unemployment. The authors of most of these studies conclude that opportunity entrepreneurship is positively linked to performance (Reynolds et al., 2001; Van Praag, 2003). Moreover, this positive relationship is linked to the existence of innovation during business creation (Ho & Wong, 2007).

Innovation contributes not only to business performance, but also to economic well-being and wealth creation within a region or country (Braunerhjelm, 2011; Holcombe, 1998; Wennekers & Thurik, 1999).

As per research by Schneider and Veugelers (2010), YICs, which are fundamentally innovative enterprises, achieve better performance in innovation than other companies do, thereby introducing innovations to the market as a whole.

This type of company plays a key role in transforming industry and therefore contributes to economic growth and innovation within a territory (Azagra-Caro, 2011; Mas-Tur & Ribeiro Soriano, 2014; Mas-Tur & Simón-Moya, 2015). As a key to business success, innovation should be considered in the design of entrepreneurship policies.

2.2 Subsidies

This research examined public aids in the form of subsidies. As already explained, a major problem facing entrepreneurs is a lack of financing, above all when launching their businesses. Subsidies, as tools to promote entrepreneurship and business creation, began to appear at the end of World War II. The international conflict devastated many countries' economies, thus governments began seeking ways of rapidly reactivating the economy (Krueger & Tuncer, 1982).

The aim of subsidies for business creation remains the same now as it was then: using the value yielded by entrepreneurship to grow the economy. The rationale for using such policies to support new ventures is that the lack of capital markets for business financing creates a major barrier to entrepreneurship (Kerr & Nanda, 2011). Various EU Member States are establishing policies to overcome entry barriers that new firms face.

Nevertheless, there is notable controversy regarding the functionality, efficiency, and impact of public policies on business creation (Mas-Verdú, Baviera-Puig, & Martinez-Gomez, 2009). Some authors have questioned the validity of such measures, arguing that these policies can encourage inefficient projects (Pellegrino, Piva, & Vivarelli, 2011). In this vein, other authors (Aghion, 2011) have shown their aversion to entrepreneurship policies, arguing that they violate the principles of free competition.

On the contrary, certain scholars view entrepreneurship policies as drivers of entrepreneurship. Greenwald and Stiglitz (2006) drew upon the theory of the infant industry to present several reasons why newly created companies do not enjoy competitive equality with respect to established companies, citing high creation costs, liquidity problems during the initial stages, and low operating profits (Krueger & Tuncer, 1982).

In addition, Krueger and Tuncer (1982) argue that subsidies do not necessarily violate the principles of free competition because the entry of new companies in a sector increases competition and can thus actually encourage innovation. The rise in the number of companies in a sector promotes firms' competitiveness and increases the sectors' innovative potential by means of communication and knowledge transfer between firms (Prahalad & Hamel, 2006).

Therefore, suitably designed subsidy policies can reduce problems related to fostering businesses (Kirzner, 2011). Such policies should selectively stimulate efficient projects with greater likelihood of success. Therefore, when studying entrepreneurial and business characteristics related to benefitting from

entrepreneurship policies, it is important to emphasize aspects that positively affect firm performance.

Mas-Verdú et al. (2009) concluded that the effectiveness of public policies in this area largely depends on regional features in terms of productive systems. Among other factors, supportive policies may be a source of advantage for firms if administration of the policies is decentralized, in other words, if it takes place through the regionalization of policies on firm creation. These authors, and for instance, Schneider and Veugelers (2010) have highlighted the need for public policy analyses that consider the region where the beneficiary companies are based. In short, the existence of financing (internal and external) and innovation barriers facing YICs highlights the need for the analysis of public policies to adopt a territorial focus and to consider YICs' specific nature.

3 Method

As already noted, this chapter compares results from two methods (binary logistic regression and QCA). The first set of findings are taken from the research by Mas-Tur and Simón-Moya (2015). As Fig. 1 shows, the aim of this research was to identify significant differences in the probability of accessing subsidies in terms of factors related to characteristics of the entrepreneur (age and sex), items related to the company (sector and size), and business-related factors (degree of innovation and competition within the sector).

First, correlations were analyzed to explore relations between variables. Second, hypotheses were tested using *binary logistic regression* analysis. Third, moderating variables were included in the model to detect interactions. An independent variable may not influence the dependent variable directly but may instead exert an influence as a moderator of the relationship between independent and dependent variables. Moderating variables included the relationship between the independent variables (degree of innovation, age of the entrepreneur, sex of the entrepreneur, company size, sector, and competition in the sector) and the dependent variable (access to subsidies).

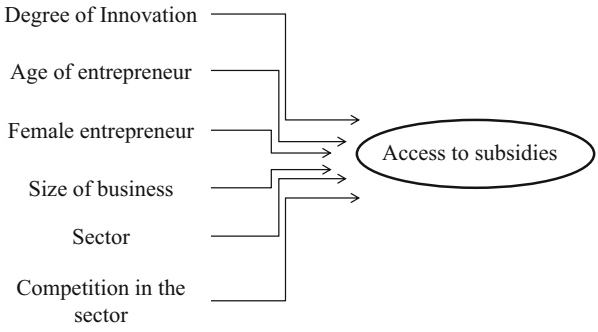

Fig. 1 Relationships proposed in the research by Mas-Tur and Simón-Moya (2015) between the independent and dependent variables

Findings can be summarized as follows:

1. The size of the company was positively associated with the likelihood of having greater access to subsidies. In other words, larger YICs were more likely to receive subsidies. Therefore, policymakers should consider this feature when designing and executing policies.
2. YICs managed by women were more likely to obtain subsidies than YICs run by men were.
3. The only significant moderating variable was the sex of the entrepreneur. Therefore, when the company was large and the founder was a woman, the probability of obtaining subsidies was lower than in the case of large enterprises in general or women in general. Therefore, the probability of obtaining a grant was lower than if the variables were observed independently. This finding shows how the effect of the interaction is not captured when considering just the two variables. This finding may be result of women's tendency to own small companies.
4. Age of the entrepreneur, sector, degree of innovation, and competition in the sector did not affect whether or not the YIC obtained subsidies. A higher degree of innovation did not increase the likelihood of obtaining subsidies. YICs are, by definition, innovative companies. Hence, policies seemingly do not discriminate between companies according to their innovation intensity.

Second, we performed a *QCA analysis* using the same independent and dependent variables.

QCA is based on set theory. Under set theory, it is assumed that the influence of certain elements in a specific result depends on how these elements are combined rather than on the levels of the individual elements per se (Ragin, 2008). QCA uses Boolean algebra to identify which combinations of properties can act as necessary or sufficient conditions for the outcome to occur (Fiss, 2007).

This is a qualitative and quantitative (or mixed) technique that is gaining in popularity among researchers, particularly in management (Fiss, 2007; Greckhamer, Misangyi, Elms, & Lacey, 2008) and innovation (Ordanini & Maglio, 2009) research. According to Berg-Schlosser, De Meur, Rihoux, and Ragin (2008), the QCA model is capable of meeting five objectives: (1) summarizing data, (2) checking data consistency, (3) testing hypotheses and existing theories, (4) analyzing basic assumptions, and (5) developing new theoretical arguments.

The specific requirements of QCA depend on the research question at hand—the selection of cases and variable specification—and the calibration of conditions (Ragin, 2000). QCA captures the idea of equifinality (Fiss, 2007). The application of QCA involves four sequential tasks (Fiss, 2011): (1) defining the property space, (2) developing measures to assess membership, (3) evaluating the coherence of the set-membership relationships, and (4) reducing the solution using logical reduction. In addition, when working with QCA methodology, performing analysis of negation of conditions is considered good practice (Legewie, 2013). Therefore, in this study, we analyzed not only causal configurations or recipes that lead to access to

subsidies for YICs, but also configurations that lead to the failure by YICs to access subsidies.

The QCA technique, developed by Charles Ragin (1987), originally drew upon Boolean logic to classify explanatory factors ('conditions') and a given phenomenon that is being explained ('outcome') into two groups. This method was later referred to as 'crisp-set' QCA (csQCA), and it consists of determining whether cases are 'fully in' {1} or 'fully outside' {0} a set. Later, however, Ragin developed an alternative 'fuzzy-set' technique (fsQCA). Unlike csQCA, fsQCA does not force-fit cases into one of only two categories, but instead allows the scaling of membership scores within the interval {0,1}. Hence, there are basically two QCA methods: crisp-set Qualitative Comparative Analysis (csQCA) and fuzzy-set Qualitative Comparative Analysis (fsQCA). For variables with binary values (0 or 1), csQCA is best suited. A value of 1 indicates the presence of a particular feature, and 0 its absence. For the variables that take ordinal or continuous values, fsQCA is more appropriate.

The analysis in this study was based on csQCA. QCA has traditionally been used with small or medium-sized data sets, although there is no limitation on the size of the data set that may be used with QCA (Woodside, 2012). In this study, we began with a sample of 189 YICs from the Region of Valencia. We then eliminated cases with missing or unreliable data to yield a sample of 157 YICs.

Following Ragin's (2008) recommendations, the first step to working with csQCA is to perform calibration. Calibration in csQCA consists of establishing degrees of membership to the group. In particular, levels range from 0 to 1, with 0 representing non-membership and 1 representing full membership (Ragin, 2008). We employed the method of direct calibration, as proposed by Ragin (2008), using the fsQCA 2.5 software (Ragin & Davey, 2014).

Table 1 presents the thresholds and descriptions of the conditions and outcome under study.

First, we performed an analysis of necessary conditions. For a condition to be necessary, consistency must be greater than 0.9 (Ragin, 2008). Table 2 shows that there are no necessary conditions that lead to access to subsidies for YICs. Nevertheless, for YICs to fail to access subsidies, gender is a necessary condition.

Next, we performed analysis of sufficient conditions. According to Ragin (2008), a condition is sufficient when consistency exceeds the consistency threshold of 0.75. The first step in performing the analysis of sufficient conditions is to compute the truth table (Ragin, 2008; Schneider & Wagemann, 2012). The truth table is the key element in QCA data analysis, the process of minimization, and the solutions yielded by QCA (Legewie, 2013). Table 3 shows the truth table for access to subsidies. Table 4, in contrast, shows the truth table for failure to access subsidies.

The exploratory analysis in Tables 3 and 4 identifies many configurations that lead to both access to subsidies and failure to access subsidies. From a 'logical' standpoint, this is impossible, but because we were working with survey data for a large sample, this type of inconsistency arose.

Table 1 Description and calibration

	Outcome/ Condition	Description	Calibration
Sub *(outcome)*	Subsidy	Captures whether the YIC has accessed subsidies from public institutions	1: Access to subsidies 0: Failure to access subsidies
Sec	Sector	Captures whether the main activity of the YIC is manufacturing or services (i.e., activities related to IT services, R&D, cultural services, engineering services, etc.)	1: Services sector 0: Manufacturing sector
Inn	Innovation	Because YICs are, by definition, innovative, this variable captures a YIC's degree of innovation. We distinguished between (i) technology-based firms—TBFs—(i.e., firms based on technology and specific knowledge); (ii) highly innovative firms (i.e., firms constantly developing or improving their products, services, or processes)	1: TBF 0: Others
Com	Competition	We used the following categories: (i) companies in sectors with few, identifiable competitors; (ii) companies in sectors with large yet unknown numbers of competitors	1: strong competition 0: little competition
Tam	Size	Captures the size of the company's staff	1–5 or more employees 0: fewer than 5 employees
Edad	Age	Captures whether the entrepreneur is older than 40. (This threshold was calculated by considering the mean age of the entrepreneurs in the region of Valencia	1: less than 40 years old 0: more than 40 years old
Gen	Gender	Reflects the entrepreneur's sex	1: Male 0: Female

Second, we analyzed the results of the solutions yielded from the minimization process. According to Ragin (2008), the three solutions are the complex, intermediate, and parsimonious solutions. In this study, we analyzed the parsimonious solution because it offers the simplest solution (Ragin, 2008). Tables 5 and 6 present the parsimonious solutions for *access to subsidies* and *failure to access subsidies*.

Results of QCA analysis imply that different conditions can contribute in the same way to explaining the outcome (Woodside & Zhang, 2013). Tables 5 and 6 show the results of this analysis.

Table 5 reveals 10 configurations that lead to access to subsidies. This shows that there is no unique path to accessing subsidies. Furthermore, all configurations are sufficient because the consistency exceeds the threshold of 0.75 proposed by Ragin (2008).

Table 2 Analysis of necessary conditions

Outcome variable	Sub		~Sub	
Conditions tested	Consistency	Coverage	Consistency	Coverage
cs_sector	0.608696	0.528302	0.769231	0.471698
~cs_sector	0.391304	0.705882	0.230769	0.294118
cs_innov	0.608696	0.636364	0.492308	0.363636
~cs_innov	0.391304	0.521739	0.507692	0.478261
cs_comp	0.391304	0.620690	0.338462	0.379310
~cs_comp	0.608696	0.565657	0.661538	0.434343
cs_tam	0.521739	0.750000	0.246154	0.250000
~cs_tam	0.478261	0.473118	0.753846	0.526882
cs_edad	0.521739	0.516129	0.692308	0.483871
~cs_edad	0.478261	0.687500	0.307692	0.312500
cs_gen	0.858696	0.564286	0.938462	0.435714
~cs_gen	0.141304	0.764706	0.061538	0.235294

Table 5 also shows that innovation and size are the most salient conditions in the results. In other words, these two conditions appear in 5 of the 10 configurations. Therefore, as per Woodside and Zhang (2013), technology-based YICs with more than five employees have a better structure for accessing subsidies.

Consistent with Ragin's (2008) claim that configurations with greater coverage are empirically more relevant, we analyzed configuration number 8 (Table 5), which was the configuration with the greatest coverage. This analysis yielded the following finding: (sector*innovation*size*age), where (*) is the logical operator AND. This configuration implies that the YICs that access subsidies in the Region of Valencia are from the services sector, are technology-based firms, have more than five employees, and are run by an entrepreneur who is younger than 40 years old.

Table 6 shows six causal configurations that lead to the failure to access subsidies. The configurations are coherent with the results yielded by the first analysis, although absence of the condition *sector* notably appears in four of the six configurations. This condition indicates that firms in the productive sector encounter greater difficulties in accessing subsidies.

4 Conclusion

The aim of this study was twofold. First, we extended research into a specific type of innovative company: young innovative companies (YICs). Second, we compared two analysis methodologies, drawing on data from research by Mas-Tur and Simón-Moya (2015).

The aim of Mas-Tur and Simón-Moya's (2015) was to verify whether different factors affected companies' likelihood of accessing subsidies. These factors

Table 3 Truth table (access to subsidies)

Sector	Innov	Comp	Tam	Edad	Gen	Number	Sub	Raw consist.	PRI consist.	SYM consist
0	0	0	1	0	0	1	1	1.000000	1.000000	1.000000
0	0	1	1	1	1	1	1	1.000000	1.000000	1.000000
0	1	0	0	0	0	1	1	1.000000	1.000000	1.000000
0	1	0	1	0	1	1	1	1.000000	1.000000	1.000000
0	1	0	1	1	0	1	1	1.000000	1.000000	1.000000
0	1	1	0	0	0	1	1	1.000000	1.000000	1.000000
0	1	1	1	1	1	1	1	1.000000	1.000000	1.000000
1	0	0	0	1	0	1	1	1.000000	1.000000	1.000000
1	0	0	1	0	1	1	1	1.000000	1.000000	1.000000
1	0	1	0	0	0	1	1	1.000000	1.000000	1.000000
1	1	0	1	1	0	1	1	1.000000	1.000000	1.000000
1	1	1	0	1	0	1	1	1.000000	1.000000	1.000000
1	1	1	1	1	0	1	1	1.000000	1.000000	1.000000
0	0	1	0	0	0	2	1	1.000000	1.000000	1.000000
0	0	1	1	0	1	2	1	1.000000	1.000000	1.000000
0	1	1	0	1	1	2	1	1.000000	1.000000	1.000000
1	1	0	0	0	0	2	1	1.000000	1.000000	1.000000
0	0	0	1	0	1	3	1	1.000000	1.000000	1.000000
0	0	0	1	1	1	3	1	1.000000	1.000000	1.000000
1	1	1	1	1	1	3	1	1.000000	1.000000	1.000000
1	1	1	1	0	1	4	1	1.000000	1.000000	1.000000
1	1	0	1	1	1	9	1	1.000000	1.000000	1.000000
0	1	1	1	0	1	5	1	0.800000	0.800000	0.800000
0	1	1	0	0	1	4	0	0.750000	0.750000	0.750000
0	1	0	0	0	1	3	0	0.666667	0.666667	0.666667
0	0	0	0	1	1	5	0	0.600000	0.600000	0.600000

1	0	0	0	0	1	5	0	0.600000	0.600000	0.600000
1	0	1	1	1	1	5	0	0.600000	0.600000	0.600000
1	1	0	1	0	1	10	0	0.600000	0.600000	0.600000
1	1	0	0	0	1	7	0	0.571429	0.571429	0.571429
0	0	0	0	0	1	2	0	0.500000	0.500000	0.500000
0	0	1	0	0	1	2	0	0.500000	0.500000	0.500000
0	0	1	0	1	1	2	0	0.500000	0.500000	0.500000
1	0	1	1	0	1	2	0	0.500000	0.500000	0.500000
0	1	0	0	1	1	4	0	0.500000	0.500000	0.500000
1	0	1	0	1	1	5	0	0.400000	0.400000	0.400000
1	0	0	1	1	1	6	0	0.333333	0.333333	0.333333
1	1	0	0	1	1	16	0	0.312500	0.312500	0.312500
1	0	0	0	1	1	13	0	0.307692	0.307692	0.307692
1	1	1	0	1	1	8	0	0.250000	0.250000	0.250000
0	0	0	0	0	0	1	0	0.000000	0.000000	0.000000
0	0	1	1	1	0	1	0	0.000000	0.000000	0.000000
0	1	0	0	1	0	1	0	0.000000	0.000000	0.000000
1	0	1	1	1	0	1	0	0.000000	0.000000	0.000000
0	1	0	1	1	1	2	0	0.000000	0.000000	0.000000
1	0	1	0	0	1	4	0	0.000000	0.000000	0.000000

Table 4 Truth table (failure to access subsidies)

Sector	Innov	Comp	Tam	Age	Gen	Number	~Sub	Raw consist.	PRI consist.	SYM consist.
0	0	0	0	0	0	1	1	1.000000	1.000000	1.000000
0	0	1	1	1	0	1	1	1.000000	1.000000	1.000000
0	1	0	0	1	0	1	1	1.000000	1.000000	1.000000
1	0	1	1	1	0	1	1	1.000000	1.000000	1.000000
0	1	0	1	1	1	2	1	1.000000	1.000000	1.000000
1	0	1	0	0	1	4	1	1.000000	1.000000	1.000000
1	1	1	0	1	1	8	1	0.750000	0.750000	0.750000
1	0	0	0	1	1	13	0	0.692308	0.692308	0.692308
1	1	0	0	1	1	16	0	0.687500	0.687500	0.687500
1	0	0	1	1	1	6	0	0.666667	0.666667	0.666667
1	0	1	0	1	1	5	0	0.600000	0.600000	0.600000
0	0	0	0	0	1	2	0	0.500000	0.500000	0.500000
0	0	1	0	0	1	2	0	0.500000	0.500000	0.500000
0	0	1	0	1	1	2	0	0.500000	0.500000	0.500000
1	0	1	1	0	1	2	0	0.500000	0.500000	0.500000
0	1	0	0	1	1	4	0	0.500000	0.500000	0.500000
1	1	0	0	0	1	7	0	0.428571	0.428571	0.428571
0	0	0	0	1	1	5	0	0.400000	0.400000	0.400000
1	0	0	0	0	1	5	0	0.400000	0.400000	0.400000
1	0	1	1	1	1	5	0	0.400000	0.400000	0.400000
1	1	0	1	0	1	10	0	0.400000	0.400000	0.400000
0	1	0	0	0	1	3	0	0.333333	0.333333	0.333333
0	1	1	0	0	1	4	0	0.250000	0.250000	0.250000
0	1	1	1	0	1	5	0	0.200000	0.200000	0.200000
0	0	0	1	0	0	1	0	0.000000	0.000000	0.000000
0	0	1	1	1	1	1	0	0.000000	0.000000	0.000000

0	1	0	0	0	0	1	0	0.000000	0.000000	0.000000
0	1	0	1	0	1	1	0	0.000000	0.000000	0.000000
0	1	0	1	1	0	1	0	0.000000	0.000000	0.000000
0	1	1	0	0	0	1	0	0.000000	0.000000	0.000000
0	1	1	1	1	1	1	0	0.000000	0.000000	0.000000
1	0	0	0	1	0	1	0	0.000000	0.000000	0.000000
1	0	0	1	0	1	1	0	0.000000	0.000000	0.000000
1	0	1	0	0	0	1	0	0.000000	0.000000	0.000000
1	1	0	1	1	0	1	0	0.000000	0.000000	0.000000
1	1	1	0	1	1	1	0	0.000000	0.000000	0.000000
1	1	1	1	0	0	1	0	0.000000	0.000000	0.000000
0	0	1	0	0	0	2	0	0.000000	0.000000	0.000000
0	0	1	1	0	1	2	0	0.000000	0.000000	0.000000
0	1	1	0	1	1	2	0	0.000000	0.000000	0.000000
1	1	0	0	0	0	2	0	0.000000	0.000000	0.000000
0	0	0	1	0	1	3	0	0.000000	0.000000	0.000000
0	0	0	1	1	1	3	0	0.000000	0.000000	0.000000
1	1	1	1	1	1	3	0	0.000000	0.000000	0.000000
1	1	1	1	0	1	4	0	0.000000	0.000000	0.000000
1	1	0	1	1	1	9	0	0.000000	0.000000	0.000000

Table 5 Analysis of sufficient conditions. Subsidies

Configuration no.	Sector	Innovation	Competition	Size	Age	Gender	Coverage		
							Raw	Unique	Consistency
1	●			○		○	0.054348	0.010870	1.000000
2		●			○	○	0.043478	0.010870	1.000000
3			●	○		○	0.054348	0.021739	1.000000
4	○			●	○		0.119565	0.054348	0.916667
5		○	○	●	○		0.054348	0.010870	1.000000
6	○	○		●		●	0.097826	0.043478	1.000000
7	○	●	●		●		0.032609	0.032609	1.000000
8	●	●		●	●		0.152174	0.130435	1.000000
9		●		●		○	0.032609	0.010870	1.000000
10	●	●	●	○			0.043478	0.043478	1.000000

Note: *Black circles* '●' indicate the presence of the condition. *White circles* '○' indicate the absence of the condition
Solution coverage: 0.510870
Solution consistency: 0.979167
Frequency cutoff: 1.000000
Consistency cutoff: 0.800000

Table 6 Analysis of sufficient conditions. No subsidies

Configuration no.	Sector	Innovation	Competition	Size	Age	Gender	Coverage		
							Raw	Unique	Consistency
1	●		●	○	○	●	0.061538	0.061538	1.000000
2	●	●	●	○		●	0.092308	0.092308	0.750000
3	○	●	○	●	●	●	0.030769	0.030769	1.000000
4	○			○	●	○	0.015385	0.015385	1.000000
5	○		●		●	○	0.030769	0.030769	1.000000
6	○		○	○	○	○	0.015385	0.015385	1.000000

Note: *Black circles* '●' indicate the presence of the condition. *White circles* '○' indicate the absence of the condition
Solution coverage: 0.246154
Solution consistency: 0. 888889
Frequency cutoff: 1.000000
Consistency cutoff: 0.750000

consisted of entrepreneurial characteristics (age and sex), company attributes (sector and size), and business activity factors (degree of innovation and competition within the company's sector). To achieve their objective, the authors of the aforementioned study performed correlational analysis to observe relationships between the variables under study. Subsequently, the hypotheses derived from the literature review were tested using binary logistic regression analysis. In the current study, we tested our results using QCA for the same set of variables. This method assumes that the influence of certain factors on an outcome depends on how these factors are combined rather than the level of presence of the factor per se (Ragin, 2008).

Hence, some variables that were individually significant in the regression analysis (such as size of the company and gender of the entrepreneur) became irrelevant when using a method that focused on 'combinations of elements'. This shows that there is no unique path to accessing subsidies. Nevertheless, certain variables seem to be found in the majority of combinations. This is the case of size and degree of innovation.

QCA also allowed us to perform an analysis of negation to determine the causal configurations that lead to a failure to access subsidies. As mentioned by Legewie (2013), good practice in QCA advocates analysis of negation to provide coherence and a more complete perspective to results.

After performing these analyses, we can highlight a research opportunity in performing comparative studies of two (or more) analysis techniques. It is thus possible to draw conclusions and make recommendations with a broader scope. The comparison of traditional statistical methods with novel analysis methods (like QCA), may prove particularly interesting.

Finally, this work has some limitations that may create opportunities for future research. On the one hand, the results may not be generalized to other areas or regions with characteristics different to those of the Valencian Community. This might be an opportunity for future research that may include inter-region comparisons. On the other hand, this study uses crisp QCA because of the limitations of the variables. Thus, this study may be completed by the use of the fuzzy set QCA technique. Unlike traditional QCA, whose main restriction is the use of binary variables, QCA based on fuzzy sets allows considering degrees of membership, thus combining the main advantages of qualitative and quantitative studies.

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Applying QCA and Cross-impact Analysis to the Study on ICT Adoption and Use by Croatian SMEs

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Abstract QCA reduces complexity and richness of each individual case through the process of Boolean minimization. This poses a challenge for future development of QCA as a case study method. We address this challenge and propose complementing QCA with cross-impact analysis. This latter method provides an in-depth, holistic analysis of a single case by focusing on the set of factors that are an essential part of each case, and focuses on capturing and analyzing interactions between these factors. That is, after deriving causal explanations, researchers can return to the cases and capture their complexity and interactions. Application of both methods is demonstrated in this paper in the context of ICT adoption and use in Croatian SMEs. While QCA provides a macro overview of a number of cases and identifies seven key factors that influence SMEs' adoption of ICT, cross-impact analysis has a case-based focus that provides additional insights into SMEs actual experiences and challenges with ICT use. The alignment between the two methods produces important implications for the future development of QCA towards in-depth case analysis and exploring the complexity of each case.

Keywords Cross-impact analysis • ICT adoption • ICT value • Interactions • QCA

1 Introduction

Qualitative Comparative Analysis (QCA) has been developing over the last two decades, and its use has been increasing in a range of areas. QCA has become very popular among social science researchers, and in the area of business and management and has been applied to the issues including organizational management

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_17

(Romme, 1995), labor management (Coverdill, Finlay, & Martin, 1994) public management (Kithenerm, Beynon, & Harrington, 2002), strategic management (Greckhamer, Misangyi, Elms, & Lacey, 2008), forestry management (Hellström, 1998), as well as to the entrepreneurship literature (Krivokapic-Skoko, 2001). QCA was also used in policy analyses such as labor policy analysis (Biggert, 1997) and social policy analysis (Amenta & Poulsen, 1996). Fiss (2007) explored the use of QCA and Boolean algebra in exploring organizational configurations. Some of the fuzzy-set approaches to QCA are highly illuminating, such as comparison of international approaches to resource management (Stokke, 2007) and comparative analysis of the national competitive advantages of Turkish and Greek economies using Porter's well-known model of competitiveness (Özlem, 2004). QCA approaches have been used before in studies on innovation, and for instance Rihoux and Ragin (2009) examined organizational innovation by political parties.

More recently, QCA scholars started considering future development of this method as a mixed-method (e.g., Marx, Cambré, & Rihoux, 2013; Rihoux, 2003; Rihoux, Álamos-Concha, Bol, Marx, & Rezsöhazy, 2013; Rihoux & Lobe, 2009). This discussion proposes two approaches to QCA development, one focuses on quantitative analysis using regression and factor analysis, and the other on qualitative oriented case study methods. QCA demands a constant interaction between the empirical research and theoretical arguments (Ragin, 1987). Hence it was originally conceived as being case oriented (Ragin, 1987), and researchers such as Rihoux and Lobe (2009) as well as by Rantala and Hellström (2011) insisted on complementing QCA with in-depth analysis of individual cases. However, QCA does not capture complexity and richness of each individual case as it reduces these through the process of Boolean minimization and arriving at parsimonious causal explanations.

The aim of this chapter is to contribute to this discussion and to demonstrate how QCA can be further connected with case analysis in a way that captures complexity and richness of an individual case. More specifically, we suggest complementing QCA with a systems theory method, cross-impact analysis. We explore the application of these two methods in the context of Information Communication Technology (ICT) adoption and use in Croatian small and medium sized enterprises (SMEs). In this paper, ICT is used interchangeably with Information Technology (IT). Although the two methods are different in their nature and focus, we investigate the idea of complementing QCA with cross-impact analysis as a valuable path for QCA development.

The structural characteristic of the Croatian economy highlight the critical need for support of SMEs and their further development, as well as the importance of adopting and using ICT. Successful SMEs are recognized as being an important component in industrial development, and consequent generation of social benefits of most economies. SMEs are a major driver of economic development in modern economies and the adoption and the use of ICT represents the fundamental source of innovation, competitiveness and the basis for their survival on the world market. In addition, ICT has been described as altering the structure of whole industries, dampening profitability and levelling business practices. SMEs are not immune to these effects and must find a way of successfully adopting and using this new technology.

This chapter starts by a brief overview of key features of QCA. Subsequently, we outline QCA applications to studies on innovation and focus on the use of QCA in a study on ICT adoption in the context of Croatian SMEs. Third section introduces systems theory and cross-impact analysis and explains how the method can be applied to the same context of ICT and entrepreneurship. The chapter ends by discussing potentials and challenges of extending QCA with cross-impact analysis.

2 Qualitative Comparative Analysis (QCA)

Qualitative comparative analysis (QCA) is a comparative research method that provides causal analysis for a moderate number of cases. QCA does this in a systematic way using a configurational approach to understanding complex phenomena (Ragin, 1987). QCA conceptualizes cases as combinations of attributes and treats each case holistically and preserves its full causal complexity. This conjectural or combinatorial nature is a key feature of causal complexity (Ragin, 1987, p. 25). This method uses the logic of Boolean algebra to determine the most parsimonious sets of inter-related conditions that explain the outcomes observed among a given set of case examples. In particular, the method identifies *necessary* and/or *collectively sufficient* conditions to produce an outcome. Cases are treated as complex configurations of attributes within an 'holistic' method. Thus QCA focuses on the holistic *configuration* of factors in each case that are either present or absent. Furthermore, unlike large-scale statistical studies, where inclusion or exclusion of a single case is unlikely to affect results substantially, with QCA a single case can have a dramatic effect on conclusions. Thus, the further a researcher gets from full enumeration of the relevant cases, the greater the possibility that a different sample will give different results.

The method builds on the strengths of explanatory and interpretive research by primarily examining complexity through the intensity of in-depth investigation of a moderate number of cases, while maintaining rigor, replicable procedures and the use of formal logic. The dialogue between theory and evidence is well structured. Starting from theoretical arguments that determine the minimum set of case attributes, QCA proceeds indicatively by simplifying the complexity of the evidence in a systematic, stepwise manner. When doing QCA, cases are transformed into the unique combinations of selected causal conditions and associated outcomes, and then compared and interpreted holistically focusing on their attributes. Thus, in applying QCA each case remains contextualized as a whole—as a meaningful, interpretable and specific configuration of causal conditions/attributes and outcome variables. The focus is primarily on comparing and interpreting these unique configurations of attributes, not cases per se. QCA appears to be of substantial utility in research situation with contextual and multiple causal relations. It is particularly useful in studies of small to intermediate sample sizes (Denk, 2010; Fiss, 2007; Kogut & Ragin, 2006; Marx, 2010; Ragin, 1987, 2000; Rihoux & Ragin, 2009). The method assumes that causal variables are effective only when operated

in conjunction with each other, and consequently the impact of each causal variable should be discussed only in a particular context. QCA also accepts that more than one configuration of causal variables may generate the same outcome. Accordingly, QCA discovers different paths to the emergence of an outcome and therefore enables the analyst to classify the outcomes based on different configurations of the causal variables.

Being based on Boolean algebra, the algebra of logic and sets, the method systematizes and transforms empirical evidence into algebraic forms suitable for data reduction and represents the attributes of the cases in presence-absence dichotomies. These dichotomies are then included in a truth table—a raw data matrix which comprises causal conditions and outcomes across the cases—as a tool for data reduction while maintaining the integrity of each case. Each row in a truth table represents either a logically possible or an empirically observed configuration of attributes, or causal and outcome conditions. The truth table is completed when all the cases and codes on the causal and outcome conditions are displayed using binary mathematical forms. This matrix of binary data is then subjected to a procedure of Boolean minimization. The procedure involves comparing groups of the cases based on the presence/absence of the outcome conditions and the presence/absence of the selected causal conditions. These logical combinations, as represented in Boolean primitive equations, are compared with each other and then logically simplified. The comparison ends up with a logically minimal Boolean expression as an output of the analysis. This provides logically minimal configurations or the most parsimonious description of the combinations of causal conditions that produce a given outcome.

The two alternative types of approaches to QCA are the crisp and fuzzy-set QCA. Both involve the combination of qualitative and quantitative data and the assessment of case membership in all possible logical combinations of causal factors described by the presence, absence or (in fuzzy-set QCA) partial membership of selected causal conditions. The extension of QCA to incorporate the concept of fuzzy sets allows for the degree of membership to vary, capturing two aspects of diversity that researchers readily observe in the field: differences of kind and differences of degree.

A common concern with the employment of crisp-set QCA and Boolean algebra is that they require dichotomous variables and they do not allow for fine-grained measures of the attributes in question. In order to overcome this limitation, Ragin (2000) has incorporated ideas of fuzzy-set logic into QCA and this method has become quite popular within general social research methodology (Cooper & Glaesser, 2011; Denk, 2010; Herrmann & Cronqvist, 2009), as well as business and management research (Kvist, 2003; Pajunen, 2008; Stokke, 2007). The fuzzy-sets allow for continuous coding of variables according to the degree of their association with the qualitative categories of interest. With fuzzy-sets, the values of both independent and dependent variables are not restricted to the binary values of 0 and 1, but may instead be defined using membership scores ranging from ordinal up to continuous values.

2.1 QCA and Organizational Innovation

An innovation is: "an idea, practice or object that is perceived new by an individual or by another unit of adoption" (Rogers, 2003, p. 12). The condition for classifying technology as an innovation is that ICT users have to perceive the technology as being new. Thus, innovation is considered to be a subjective matter (Rogers, 2003). On the basis of this definition, new technology which is introduced into an organization can also be considered to be an innovation. Moreover, the words "innovation" and "new technology" have become synonyms.

According to Ganter and Hecker (2014) QCA is particularly suitable for configurational analysis of organizational innovation. Following Ragin (1987) and further applied by Fiss (2007), an innovation configuration is a specific combination of factors that are collectively sufficient to produce a particular innovation-related outcome. The configurational approach takes a systemic and holistic view of organizations, and this approach assumes complex causality and nonlinear relationships, as well as equifinality where the system can reach the same final state, from different initial conditions and by a variety of different paths (Fiss, 2007, p. 1181).

Previous innovation studies have used QCA approaches (e.g., Rihoux & Ragin, 2009). Lambert and Fairweather (2010) used fuzzy-set QCA (fsQCA) to identify system-wide configurations of participation in networks that result in innovation success and failure. They examined 43 cases of innovation in New Zealand's farming, building, and energy sectors. The outcome of innovation itself and fsQCA's ability to accept degrees of difference was considered to be particularly useful. Rather than categorizing innovations as either successful or unsuccessful—the dichotomous approach of 'crisp set' QCA—the authors assigned membership according to sales, profits, and the temporal, spatial and hierarchical characteristics of the diffusion of these innovations. The results demonstrate that technology users are more likely to successfully innovate when they are: (a) well financed, not undertaking significant manufacturing, and holding relevant IP; or, (b) well financed, engaged in other businesses, and again with relevant IP.

Cheng, Chang, and Li (2013) used fuzzy set QCA to examine configurational paths to successful product innovation by high-tech firms in Taiwan. They identified several specific combinations of causal factors (i.e., organization-related, project-related, process-related, product-related, market-related, and newness of innovation) leading towards product innovation. These findings, embedded in the principles of QCA, support the suggestion that no one factor is a key to success and more than one causal path may be sufficient to achieve an outcome—a successful product innovation.

The results of other QCA research (e.g. Ganter & Hecker, 2014) in the innovation area show that several configurations of contextual factors lead to organizational innovation. Fiss (2008) looked at the organization of high technology firms, finding different causal configurations as one moves from average performance to high and very high levels of organizational performance.

2.2 Application of QCA to Croatian SMEs

We used the Qualitative Comparative Analysis (QCA) and its formal language—Boolean algebra to identify necessary and sufficient factors for ICT adoption in 15 Croatian SMEs. Adopting ICT itself is not a guarantee of improved performance of a company, so we extended the investigation process into interactions among factors relevant in the post-adoption period using cross-impact analysis. This is described in Sect. 3. The specific literature which looked into the necessary and sufficient factors leading to adoption of ICT, by SMEs (Brooksbank, Kirby, & Kane, 1992; Iacovou, Benbasat, & Dexter, 1995; Julien & Raymond, 1994; Kirby & Turner, 1993; Premkumar & Roberts, 1999; Ratnasingham, 1997) formed the basis for the empirical component of this study. Table 1 highlights the findings of some of these studies. It shows that while there are a wide range of factors influencing successful adoption, there seem to be some common characteristics such as perceived benefits and the attitude of top management.

Table 1 Factors influencing IT/ICT adoption in SMEs. Adapted from Rashid and Al-Qirim (2001, pp. 66–67) and Van Akeren and Cavaye (2000)

Study	IT/ICT applications explored	Necessary factors	Sufficient factors leading to adoption
Kirby and Turner (1993)	Inventory control, sales, purchasing, and others	– Perceived benefits – CEO's IT knowledge – CEO's attitude towards adoption of IT	– Perceived usefulness of the technology – External pressure to adopt IT
Julien and Raymond (1994)	Internet access and EDI and others	– The level of assertiveness, rationality and interaction of business decision processes, structural sophistication of the firm	– Rationalization, benefits and uses of the technology to an organization, – Centralization – Complexity
Iacovou et al. (1995)	Sales, purchasing, personnel and payroll, CAD/CAM, EDI, MRP, and others	– Perceived benefits – CEO's IT knowledge – CEO's attitude towards adoption of IT	– Perceived ease of use and/or usefulness of the technology – Organizational readiness/benefits
Thong and Yap (1996)	Accounting, Inventory control, sales, purchasing, personnel and payroll, CAD/CAM, EDI, MRP, and others	– Size – CEO's innovativeness – Employee's IT knowledge – Attitude towards IT	– Employee's IT knowledge – Information intensity
Premkumar and Roberts (1999)	Email, Online data access, Internet access and EDI	– Relative advantage – Top management support – Size – Competitive pressure	– Relative advantage

Overall, the literature suggests that factors influencing ICT adoption can be grouped into four categories, namely, technological, organizational, individual and external environmental factors. First, based on Rashid and Al-Qirim (2001), we used the composite effects of the selected five constructs (relative advantage, complexity, compatibility, costs and image) as a proxy for technological (innovation) factors. Every innovation has certain characteristics which help to explain the rates of its adoption. Innovations that have a higher relative advantage (being perceived better than the idea it supersedes) compatibility "with existing values, past experiences and needs of potential adopters", as well as reduced ICT complexity in terms of "difficulty to understand and use it", are adopted more rapidly (Rogers, 2003, pp. 15–16).

Second, another five constructs were used as a proxy for organizational factors: size, quality of ICT capabilities, information intensity, specialization and top management support. Success of ICT adoption is the result of ongoing social, managerial and economic practices within an organization. ICT is not fixed and independent from the organizational context. Instead, it emerges from that organizational context. Organizational factors are important in adapting organizational and business processes to the possibilities which ICT offers.

Third, with respect to individual factors, Poon and Swatman (1999) emphasized the importance for innovation adoption of the individual characteristics of the manager, such as education, age, experience, and psychological traits. They found that a manager's innovativeness and IT knowledge have a positive effect on IT adoption. Our framework, therefore, includes manager's innovativeness and IT knowledge of the manager and staff grouped under the individual factors.

Fourth, the external environment would play a significant role in the adoption of new technologies, but was not included in many ICT empirical studies. Thong and Yap (1996) found competition insignificantly influencing IT adoption in small businesses, while in contrast Premkumar and Roberts (1999) found that competitive pressure was the only factor influencing ICT adoption. Following these considerations the environmental factors for the study include three constructs (supportive economic policy for ICT adoption, competition/competitors and supplier/buyer pressure). The outcome is conceptualized as a composite set of four forms of different level of ICT adoption—computers, intranet and internet, home sites, and finally e-commerce.

To explore ICT adoption by Croatian SMEs we designed a questionnaire which focused on seven factors shown in Table 2 as influencing ICT adoption (Rashid & Al-Qirim, 2001; Van Akeren & Cavaye, 2000). The questionnaire was sent to 100 SMEs in Croatia. In sum, 20 % of SMEs from all regions of Croatia responded. From these 20 responses, five were not usable. It is also important to note that most of the responses did not provide us with the financial structure of their businesses, while some of them asked us not to publish their contact details.

We used dichotomized causal and outcome conditions of being either present of absent. By applying Boolean minimization to the truth table of the Croatian comparative case studies (in which X_i means the factor is present and x_i means that it is absent) we derived empirically based Boolean equations outlining casual conditions leading towards positive innovation outcomes (Y_1; Y_2; Y_3; Y_4):

Table 2 Causal and outcome variables

Frameworks/ Codes	Causal variables/constructs	Codes of present variables	Codes of absent variables
ENV	Supportive economic policy for IT adoption	X_1	x_1
	Competition/competitors	X_2	x_2
	Supplier/buyer pressure	X_3	x_3
TEH	Technological factors	X_4	x_4
ORG	Organizational factors	X_5	x_5
IND	Manager's knowledge of IT	X_6	x_6
	Staff's knowledge of IT	X_7	x_7
Outcomes/forms of IT/ICT adoption			
CI	One computer connected to Internet	Y_1	y_1
NCI	Intranet and Internet	Y_2	y_2
HS	Home site	Y_3	y_3
EC	E-commerce	Y_4	y_4

$$Y1 = \{x1 * x2 * x3 * x5 * (X4 + X6)\} \quad (1)$$

$$Y2 = Y3 = Y4 = (X4 * x2 * x3 * x4 * x5) \quad (2)$$

The results presented in the two equations above demonstrate that Croatian SMEs adopt all types of ICT, from computer connected to Internet as a basic form of ICT (Y_1[1]), to advanced ICT applications such as Intranet and Internet (Y_2), home site (Y_3) and e-commerce (Y_4). Adoption of ICT is caused by different factors, as suggested in the two equations. The first equation shows that there are two causal pathways for the introduction of basic form of ICT (Y_1). The first pathway highlights technological factors (X_4) and the second one manager's IT knowledge (X_6) as critical factor for ICT adoption. Environmental factors such as government's support policy, and organizational factors ($x_1 * x_2 * x_3 * x_5$) are absent and not significant for ICT adoption.

Adoption of more sophisticated forms of ICT, such as intranet and intranet (Y_2), home site (Y_3), and e-commerce (Y_4), is explained by the second equation (function $Y_{2,3,4}$). The only critical factor for adoption of advanced ICT is technological factors (X_4), while environmental/support policy and organizational factors are absent ($x_2 * x_3 * x_4 * x_5$).

These results show that the analyzed SMEs adopted ICT as a result of individualistic and technological essential influencing factors. Supportive organizational and environmental factors were not present during the adoption process either for the basic or more advanced forms of ICT adoption.

[1] The results reported in this section are from work previously completed by: Skoko, H., Krivokapic-Skoko, B., Skare, M., & Ceric, A. (2006). ICT Adoption Policy of Australian and Croatian SMEs. *Managing Global Transitions*, *4*(1), 25–40.

The most significant hurdles for SMEs adopting ICT were technical problems, infrastructural issues (bad connections), limited human resources, as well as problems linked to the current economic situation and lack of the legislative and governmental support. These hurdles were evenly spread among the analyzed SMEs. In addition, several firms reported problems with business partners which have not installed any form of ICT, resulting in the under-usage of their own ICT technologies. Moreover, it is confirmed (the area of agreement) that for adopting IT/ICT in Croatia there is little political support and that the process is left for individuals to do it on their own based on their IT knowledge and IT skills.

Use of QCA was beneficial in understanding which factors lead to adoption of basic (Y_1) and advanced ICT (Y_2, Y_3, Y_4) in SMEs. These results can be used by Croatian policy makers in developing supportive ICT adoption regulations for SMEs. On the other hand, QCA does not provide additional insights into the complexities of using ICT in each individual SME. Such insights seem valuable in furthering our understanding of how SMEs use ICT and how they create ICT value. Factors that affect this process may be different from the ones considered in Table 2. Identifying these factors, and understanding their role in the process of ICT value creation seemed relevant to our research aim. As QCA cannot provide insights into this process, we needed to use another method.

3 Systems Theory and Cross-impact Analysis

3.1 Systems Theory

Systems theory focuses on exploring the principles and general laws that govern systems (Skyttner, 1996). In doing so, systems theory draws on principles of biology, physics, and engineering. Most phenomena can be conceptualized as systems, including organizations. A systems theory regards each element of a system is connected to every other element in that system, either directly or indirectly (Ackoff, 1971). This is evident from the definition of a system as a "set of dynamic elements maintaining integrity via mutual interactions" (Von Bertalanffy, 1972, p. 17). Interactions are considered to be the most important characteristic of any system, and thus, present "a distinct and legitimate form of inquiry" (Trochim, Cabrera, Milstein, Gallagher, & Leischow, 2006, p. 540).

Interactions are of particular importance for theories of complexity, such as self-adaptation, self-organization and co-evolution (Dann & Barclay, 2006). Complexity theories arise from various natural sciences that study complex systems. Based on these, understanding a complex system requires knowing not only how its parts behave separately, but also how they interact together to form a whole (Bar-Yam, 1997). The complexity in a system arises when ". . .many interdependent agents are interacting with each other in a great many ways", which leads to unintended or emergent properties of the system (Waldrop, 1992, p. 11). As systems theory

focuses on such interactions, its applicability in the field of management and innovation seems to be particularly appropriate, given the nature and speed of change in the business environment (Cilliers, 1998).

Interactions among a system's elements define and affect the overall behavior and outcomes of the system. That is, a system is a product of interactions among its elements. Therefore, it has properties that none of its parts has which is commonly expressed as a system being more than the sum of its parts. This is further evident from Ackoff's (1971) explanation of a system. He proposes that a system is a set of two or more interrelated elements that satisfy the following conditions (Ackoff, 1971):

- The behavior of each element has an effect on the behavior of the whole;
- The behavior of the elements, and their effects on the whole, are interdependent, as determined by the state or type of activity in at least one other part of the system;
- All subsystems have an effect on the behavior of the whole, but none has a solely independent effect on it

The focus of this paper is on an ICT value creation process that is conceptualized as a system. This system can be defined as a set of interrelated and interdependent elements, namely, ICT, its users and organizational context, which maintain integrity via mutual interactions (Von Bertalanffy, 1972). In order to understand a system, we need to investigate the interactions among its elements. It is through these interactions that a system's elements influence one another, and the behavior and outcomes of the system. A systems theory research method, cross-impact analysis, is used for this purpose.

3.2 Cross-impact Analysis

Cross-impact analysis, as an application of systems theory, emphasizes the whole system instead of individual components, and focuses on the purpose for which a system was created, together with the interactions, interdependences and relationships among the components of a system (Messerli, 2000; Schlange, 1995). In order to be able to apply this method to a system, it is critical to identify the system of interest and its elements. Thus, cross-impact analysis can be used to focus on understanding the complexity of a single case [such as a business organization or a system process of ICT value creation (Ceric, 2015a)].

Cross-impact analysis was developed by Helmer (1972) and Gordon and Hayward (1968) as a forecasting technique that is an alternative to the Delphi method. Several modifications have been made to the original method as described by Cole, Allen, Kilvington, Fenemor, and Bowden (2007). All versions of the method produce a ranking of a system's elements by mathematically evaluating the cross-impact matrix. This matrix is defined as "a mathematical network model that can be used to numerically portray complex systems" (Cole et al., 2007, p. 383). That is, it

captures information on the direction and strength of each relationship among any two factors in a system. Direction of a relationship between two factors indicates whether an increase in factor "X" results in increase (positive direction) or decrease (negative direction) in factor "Y" (negative direction) (Kardaras & Karakostas, 1999). The strength of a relationship is the degree to which one factor influences the other (Kardaras & Karakostas, 1999). Vester and Hesler (1982) developed a simplified scoring strategy that quantified the impact of one factor on another on a fuzzy scale 0, 1, 2 and 3 (no impact, weak impact, medium impact and strong impact).

Simple mathematical techniques are applied to a cross-impact matrix in order to classify factors in a system, as suggested by Vester and Hesler (1982). First the active sum (AS) (sum of all values in each row of a cross-impact matrix) and the passive sum (PS) (sum of all values in each column of a cross-impact matrix) are calculated, as they are the basis for calculating the degree of activity (AS/PS) and degree of interrelation (AS*PS) for each factor. Using the last two indicators for classifying a system's elements enables development of a functional factor typology that categorizes the system's elements based on the influence each element exerts on other elements, and the influence each element receives from other elements (Cole et al., 2007).

Lastly, the values of the degree of activity and degree of interrelation are used as coordinates for depicting each element in a coordinate system. More specifically, degree of activity is used as an x-coordinate, and degree of interrelation as a y-coordinate for positioning each factor in the map of interactions. Such visual representation of the position that each element has in the system enables clear classification of the system's elements, and provides further insights into the overall system.

3.3 Application of Cross-impact Analysis in a Croatian SME

Cross-impact analysis involves three steps: (a) identification of the system and its elements, (b) assessing direction and strength of all interactions and (c) visually depicting all elements in a coordinate system (Asan, Bozdağ, & Polat, 2004; Ceric, 2015b). These steps were applied to a medium-sized Croatian organization. The pseudonym for this business used in this paper is "Drunken Millionaires" (DM). This organization provides a good context for application of the cross-impact analysis due to a recent change in its focus and greater reliance on ICT. Cross-impact analysis can further capture the different elements that maintain the status-quo (inability to take advantage of the ICT) and elements that push the system towards change (improving the organizational ICT capability and the ICT effects).

DM has over 300 employees, and it has developed and grown since it was established in the 1940s. It has been developing in three directions: the main business activity, sales and marketing. Due to different goals and focus of each of these activities, its ICT applications have been implemented with different purposes

and with little communication between departments. As a result of this independent development of ICT in each department, the organization is facing several problems. ICT applications in each department are not compatible with one another and this is hindering further growth of the organization, as well as limiting the availability of the relevant financial and business information necessary for daily decision-making, and employees needing to manually enter information from one system into the other.

In order to identify the elements of the ICT value creation system in this organization, semi-structured interviews were conducted with 16 organizational stakeholders from different departments and different levels of the organizational hierarchy (see Appendix for more information). Interview questions were designed based on a review of the IT literature. It is through content analysis of these interviews that 23 factors were identified as elements of the ICT value creation system in DM. These factors can be grouped into technological, individual, organizational and external environmental factors. In addition, four types of ICT effects, namely informational (access to internal and external information), strategic (creation of competitive advantage), transactional (business efficiency) and transformational (expanded capabilities) (Gregor et al., 2004), have been considered to be part of the system.

All relationships have been assessed by the two IT managers in the organization in terms of the strength and direction of each via a survey and fuzzy scale (as discussed earlier). The organization had several IT employees (who had no formal IT training). For this reason only the two IT managers were asked to participate in the survey. The principal researcher was present during the survey to ensure consistency and validity of the information provided by the IT managers. Based on the information on the interactions among the identified set of factors, degree of activity and degree of interaction were calculated as discussed earlier. Lastly, a map of interactions was constructed, as presented in Fig. 1.

The map of interactions visually represents all elements of the system and their functional position in the system. Analysis of the position of the system's elements provides important insights into the role of each factor in the system. By dividing the map of interactions into quadrants, based on the degree of activity and degree of interrelation, we can gain clearer insights into the position of each element in the map of interactions. This is illustrated in Table 3.

As illustrated in Table 3, the system's elements can be classified as outcomes, drivers, goals or trends based on the specific combination of their degrees of activity and interaction. Each of these groups has significant implications for managing the ICT value creation system in DM. Drivers have a strong influence on the system, and thus bring change to the rest of the system. They are a source of instability in the system. These elements should be chosen as part of the solution for improving the system.

The organization is using some of its drivers in order to introduce change in the system. Organizational strategies, previously focused on expansion and growth, are now focusing on strengthening the organization's market position specifically based on using ICT. Improving the alignment between organizational and ICT

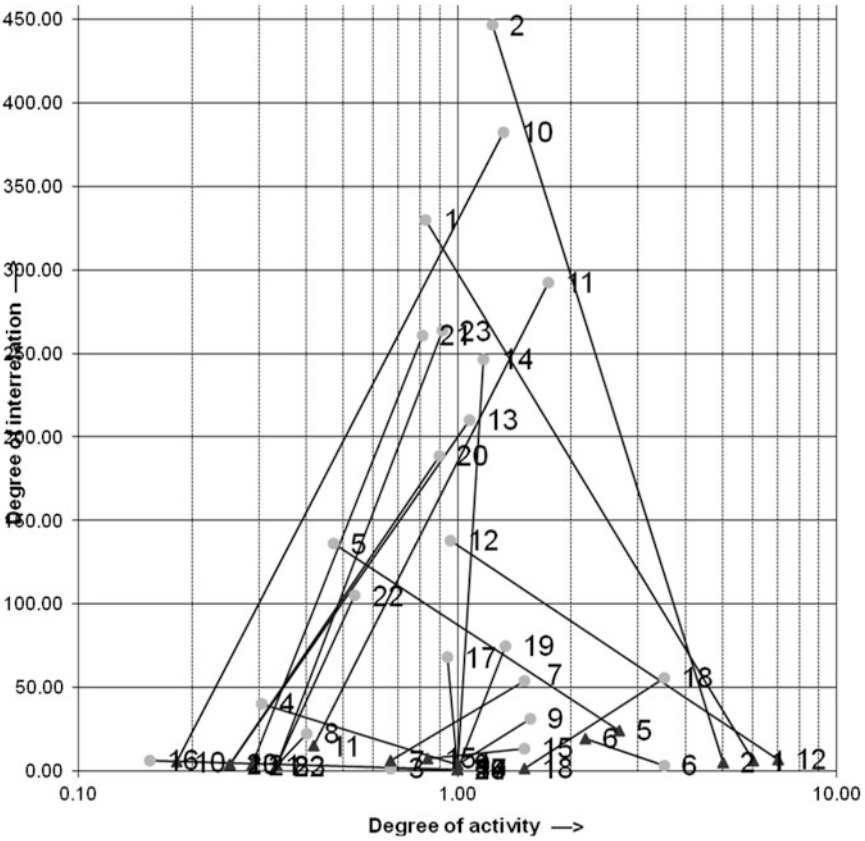

Fig. 1 Map of interactions in DM (Ceric, 2015a). *Note*: Elements of the ICT value creation system identified in Fig. 1 are numerically coded (see Table 3)

strategies will take much hard work as they have been unconnected and have been developing independently of one another in the past. DM's managers have started to provide additional support to IT innovations. A new IT manager has been employed in order to strengthen the IT support in the organization. It will take time for the drivers indicated here to change the system. ICT compatibility is another driver that has the highest degree of interactivity and the only driver that inhibits the system and its development. Due to independent ICT development in each department, the existing ICT applications in DM are not compatible with each other. This creates a major hurdle for the organization, and the first IT issue to be dealt with. However, caution is needed when dealing with such highly interactive elements. Their influence is difficult to control and to manage due to their high interactivity with the system. Influencing ICT compatibility may lead to dramatic changes in the system.

Outcomes of the system are highly responsive to changes in the system. They themselves change, but instead of exerting the influence back on the system, they

Table 3 Classification of the system's elements at DM based on their position in the map of interactions

Outcomes of the system Degree of interrelation: high Degree of activity <1 • ICT integration (F1)* • ICT use (F5)* • Organizational culture (F12)* • Informational ICT effects (F20) • Strategic ICT effects (F21) • Transactional ICT effects (F22) • Transformational ICT effects (F23)	**Drivers of the system** Degree of interrelation: high Degree of activity >1 • ICT compatibility (F2)* • Managers' support (F10) • Organizational strategies (F11) • IT support (F13) • Alignment between ICT and organizational strategies (F14)*
Goals of the system Degree of interrelation: low Degree of activity <1 • ICT openness (F3) • ICT user friendliness (F4)* • Employees' ICT attitudes (F8) • Customers (F16)* • Suppliers (F17)*	**Trends in the system** Degree of interrelation: low Degree of activity > 1 • Trends in the market (F18)* • Partner Company (F19)* • Employees' ICT knowledge (F7) • Managers' ICT knowledge (F9)* • ICT seminars (F15) • Users' age and previous ICT experience (F6)*

Symbol '*' indicates system's elements that have potential inhibiting effect on the system

absorb it. Outcomes are thus, important indicators of change in the system, as well as the result of managerial activities. It is important to recognize them, in order not to include them as part of the solution as changing them will not change the system. All four ICT effects are identified as outcomes of the system as outlined in Table 3. This means that the way the system is organized, or disorganized, affects realization of ICT benefits. Due to several ICT issues in DM, ICT benefits cannot be fully achieved. Resolving ICT issues will present a change in the system, which will result in different levels of realized ICT effects.

Additional indicators, ICT integration, ICT use and organizational culture are also expected to respond to the change in the system. However, we must acknowledge the current inhibiting potential of these elements. ICT applications in DM have not been well integrated with the organizational business processes. This has been a source of issues for the organization, and it inhibited DM's strategic partnerships and the enhancement of its supply chain. Organizational culture is reflected by its pseudonym. The focus in DM was on purchasing IT gadgets for individual users regardless of their actual ICT skills and needs. Following the independency and self-focus of each department, ICT tools have been implemented independently in each department. This is where organizational culture has contributed to the current issues with ICT in DM.

Trends have an impact on the system, but due to their low degree of interrelation, this impact is observed in the long-run only. Thus, they affect the evolution of the system, and may present constraints for its future development. For example, DM

needs to respond to market trends and the Partner Company, which have a potentially inhibiting influence on ICT development in the organization. First, DM is experiencing difficulties with adapting to the market trends and increased competition as it is lacking in ICT competencies. Thus, market trends can be detrimental to its future success if it does not resolve the ICT issues that have been previously discussed. Second, due to its dependence on its Partner Company in producing its services, DM has been using the same ICT applications as the Partner Company in one of its departments. This inhibits further ICT development in DM that requires updating of this particular ICT application. However, this cannot be done as it would result in ICT incompatibility with the partner organization and inability to produce its service.

Additional internal trends such as employees' age and previous ICT experience, employees and managers' ICT knowledge, as well as ICT seminars affect the system. More specifically, there are many older employees who struggle with developing ICT skills. This again presents a hurdle for ICT development and its full utilization. Both employees and managers need to further develop their ICT knowledge. Managers' ICT knowledge, in particular, is critical for further ICT developments in the organization. It is due to their lack of ICT knowledge and awareness of ICT benefits that they did not support ICT development, and ultimately, the reason why many of the ICT issues described above have occurred.

Goals have a minimal influence on the system, and require much influence from the system in order to change. Based on its previous functioning, the system contains ICT applications that are mainly open to change, a perception by employees of ICT as being user friendly and a desire for new ICT applications (hardware and software). At the same time, DM's relationships with its customers and suppliers have been limited by the technological issues.

Based on the discussion provided here, we can see that ICT adoption investigated in the first section of this book chapter does not necessarily lead to organizational success in a particular firm. Focusing on the situation within an organization has provided additional insights into the challenges that the organizations are facing in creating ICT value. By considering these insights we can provide a context for QCA findings as well as further practical implications for both managers and policy makers.

4 Discussion of Results

We suggest that QCA can be improved with a detailed case study analysis (Ganter & Hecker, 2014), that is "sequential analysis of causal processes as an additional research stage in case study research" (Marx et al., 2013, p. 33). We propose the use of the cross-impact analysis as a sequence to QCA analysis. In this chapter we have outlined the application of both methods in investigating ICT adoption and ICT value creation in Croatian SMEs. Our analysis started by identifying Boolean logical functions and patterns of ICT adoption across the selected Croatian

SMEs. QCA was particularly useful in identifying configurations of seven factors that cause firms to adopt ICT. While it is one thing to understand what causes adoption, it is quite another to understand how to capture the benefits of ICT adoption. QCA was not able to provide insights into what a firm must do to garner these benefits. Thus, we applied cross-impact analysis to one SME where we investigated the ICT value creation process as a system. This method provides an in-depth, holistic analysis of a single case by focusing on the interactions among elements of a system.

The results of the cross-impact analysis seem to complement those based on the QCA. More specifically, QCA identified two causal pathways leading towards the ICT adoption in Croatian SMEs. The first pathway stresses the critical role of the managers' IT knowledge, and the second pathway emphasizes technological factors as critical for ICT adoption. Technological factors in particular were found to be critical for the adoption of advanced ICT applications. These findings illustrate that SMEs in Croatia will adopt ICT if their owners and managers have sufficient IT knowledge, and if ICT provides the SME with relative advantage, is simple to use, compatible with users' values and business processes, affordable and enhances the organizational image. On the other hand, organizational factors such as quality of ICT capabilities and top management support did not seem to play any role in ICT adoption.

ICT adoption is an innovation for SMEs, but this innovation can enhance or inhibit the firm's success. There is a danger that ICT innovations might be circumvented by members of a firm during the implementation period. Thus, further understanding is needed into how SMEs create ICT value, and which factors are important in creating benefits from adopted ICT. The IT literature emphasized the role of technological, individual organizational and environmental factors in transforming potential into realized ICT value (Davern & Kauffman, 2000; Melville, Kraemer, & Gurbaxani, 2004; Wade & Hulland, 2004).

Results from the cross-impact analysis demonstrate that the four groups of ICT effects (informational, strategic, transactional and transformational), that we considered to be the indicators of realized ICT value, are the outcomes of the ICT value creation system in DM. This reflects that they are a result of interactions among the system's elements. These interactions shape the ICT effects and determine the degree of their realization. Elements classified as drivers are particularly influential in changing the system and its outcomes. The drivers in DM are managers' support, IT support, ICT compatibility, as well as organizational strategies and their alignment with ICT strategies. Most of these drivers are organizational factors, and their role in gaining benefits from an organizational innovation has been neglected by the QCA.

Next, results from the cross-impact analysis illustrate that environmental factors, trends in the market and Partner Company, also have an impact on the ICT value creation system. They affect the system's development and evolution, and their effects are observed with a substantial time-lag. Again, environmental factors have not been emphasized as important in ICT adoption, based on our results. However, they seem to affect the way DM transforms potential into realized ICT value. The

findings from the cross-impact analysis seem relevant for understanding how an organization gains benefits from adopted ICT. These findings complement the QCA results.

Based on the results presented in this paper, we believe that cross-impact analysis can complement QCA, and together, these methods can provide further insights into organizational innovation and a range of other business research phenomena. QCA provides general insights into configurations that are seen to suggest organizational benefits when viewed across a number of firms. Then cross-impact analysis can be applied to a number of cases (individually) to discover the detail within particular firms that allow the QCA results to work or not.

On one hand, QCA provides a mezzo view of a phenomenon (in this case adoption of ICT) by comparing different cases to identify necessary and sufficient factors affecting the phenomenon. This can provide further insights necessary for development of government policies. On the other hand, cross-impact analysis provides insights from a micro level, that is, in the context of each specific case. Thus, the use of this method may lead to further understanding of how a certain phenomenon affects the organization at large, and which additional contextual factors are important.

5 Concluding Remarks

Future development of QCA along the mixed-method paradigm has already been identified as fruitful and desired. Initially developed as a case-oriented comparative method QCA focuses on transforming cases as configurations of causal conditions and outcomes, which are then systematically compared through a process of Boolean logical minimization. As QCA provides a systematic comparison of cases and identification of general patterns of a limited number of cases (Marx et al., 2013) it also makes researcher to move away from full complexity (a detail description of a single case with its own idiosyncrasies) to a more parsimonious explanation of the emergence of a particular outcome. For this reason, we suggest that complementing QCA with cross-impact analysis could serve as a bridge from combinatorial complexity and multiple conjectural causations towards an in-depth case study analysis that focuses on interactions between elements of a phenomenon of interest.

The data set observation provided by QCA is not saying much about "causal processes or mechanisms linking conditions with one another" (Marx et al., 2013, p. 34). We have addressed this gap and proposed that QCA should be complemented with a cross-impact analysis. That is, after deriving causal explanations and logically minimal equations that result from Boolean analysis, the researchers can return to the cases and capture their complexity and interactions. Cross-impact analysis can reveal the 'black box' of causal mechanism by capturing and analyzing interactions of the factors/elements responsible for emergence of outcomes. This approach can enhance the interpretation of QCA findings, and

provide further insights into the phenomenon that is being researched. It can also serve as a starting point towards observing and capturing the essence of complex phenomena.

Cross-impact analysis can capture complexity of a single case, as it evaluates and analyses interactions among dynamic elements of a system. Cross-impact analysis results can be used to analyze 'what-if' type of scenarios based on the captured strength and direction of all interactions in the system. These features can further expand the usability of QCA, and its contributions. Using cross-impact analysis can provide additional insights into the relationships between potential causal variables and the outcomes. This seems valuable as QCA may present challenges for researchers such as contradictory rows (Ragin, 1987) where cases that have the same combinations of the causal conditions do not show clear tendencies towards the outcome. That is, a combination of potential causal variables sometimes leads to the outcome and sometimes not. Based on the ability to capture and analyze interactions, we believe that cross-impact analysis can provide further insights that can clarify this issue, and partly respond to this particular limitation of QCA.

Apart from contradictory rows, cross-impact analysis can address other limitations of QCA, such as the use of dichotomized data of presence/absence for causal conditions and outcomes and consequently oversimplification and certain level of arbitrariness. Cross-impact analysis has ability to differentiate interaction based on their strengths (strong, medium, weak or none) and therefore can soften the rigidity of categorical data. Another limitation of QCA is that it is by nature static as it does not include time dimension in causal analysis. This is an on-going issue in the literature although there are some improvements and innovations in incorporating dynamics into QCA (Caren & Panofsky, 2005). On the other hand, cross-impact analysis provides understanding on the impact of interactions on the system in the short-, medium-, and long run. For example, drivers and outcomes are focused on short- and medium-run, while trends and goals on the long-term.

While research in this chapter contributes to furthering developments of QCA as a case based method, it has some limitations. The main limitation of this study is in relation to generalization of the findings. The research was conducted in Croatian SMEs, and due to specific nature of Croatian developing economy, the results may not be applicable to developed countries. Next, cross-impact analysis was applied to a single organization as an illustration. Findings based on a single case cannot be generalized to other cases. Thus, there is need for future research on applying QCA in the area of ICT adoption in SMEs in developed countries, as well as application of cross-impact analysis to several cases in order to generate more insights into challenges that SMEs experience in adopting and using ICT. This will increase the generalization of the findings.

Acknowledgements The authors would like to thank Professor Kevin Parton for his comments on previous drafts of this paper.

Appendix

Table 4 Participants in the semi-structured interviews

Interviewees	Number of interviewees
Employees (ICT users)	5
IT employee	1
IT managers	2
Members of Board of Directors	3
Senior managers	4

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Configurational Analysis in the Evaluation of Complex Public Programs: Application in the Area of Knowledge Transfer

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Abstract The aim of the chapter is to present the lessons learnt from the application of the configurational method to the evaluation of the "SPIN" public regional program. The objective of this complex program was to increase the intensity of knowledge transfer (KT) between universities and enterprises. After pilot implementation of the Model, there was a huge need for an evaluation study which would provide recommendations relating to the enhancement of the success of the further applications. Comparative case study methodology was applied in order to cope with the complexity of the program. As a result of the analysis, three models of implementation were distinguished.

Keywords Case study • Configurational analysis • Evaluation • Knowledge transfer

1 Introduction

As Owen and Wahl (2010) state, "knowledge transfer is the exchange of information through networks where knowledge transfer is about transferring good ideas, research results and skills between universities, other research organizations, business and the wider community to enable innovative new products and services to be developed" (p. 218). KT between universities and enterprises is perceived by both experts and regional policy makers as the key determinant of innovative economy (Leydesdorff, 2013; Leydesdorff & Etzkowitz, 1996). However, its intensity in Poland is relatively low (European Commission, 2015). Thus, there are many measures implemented in the country in order to change the situation. The aim of

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_18

the chapter is to present the lessons learnt from the application of the configurational method to the evaluation of the "SPIN" public regional program. The objective of the program was to increase the intensity of knowledge transfer between universities and enterprises in Lesser Poland. After pilot implementation of the model, there was a huge need for an evaluation study which would provide recommendations relating to the enhancement of the success of the further applications. The complexity of the task stemmed from both entanglement of KT processes and the need to draw conclusions from four different implementations. Therefore, comparative case study methodology was applied.

SPIN Model is broadly described in other publications (Antosz, Drożdżak et al. 2015; Antosz, Strycharz, Krupnik, & Szklarczyk, 2015). Therefore, in this chapter Authors focus on the application of comparative case study methodology. In the article, the following issues will be described: the position of comparative case studies in the evaluation of the "SPIN" program, the study of KT using case study methodology, and the project of approach use and its results. The chapter ends with a reflection on the use of the approach of comparative case studies in the evaluation of the described program.

The distinctiveness of the chapter is threefold. Firstly, the described approach is based on the merits of Qualitative Comparative Analysis, but was adapted due to a low number of cases. Secondly, the configurational approach was supported by other methods (social network analysis and implementation analysis). Lastly, the study depicts the mechanisms leading to a successful public program aimed at the enhancement of KT between universities and enterprises.

2 The Idea of a Regional Public SPIN Program

The key element of the program is the SPIN Model, which was designed for three categories of KT stakeholders: regional authorities, academic institutions, and entrepreneurs.

For each of these groups, the model is slightly different. For regional authorities the concept means a regional program intensifying the transfer of knowledge from science to economic activity in areas strategic for the development of the region. This concept was put into the framework of a logical model of intervention, that is, broken down into categories such as resources, activities, outputs, results and impact. The most important resources are: knowledge of intervention mechanisms, financial resources, and teams associated with particular areas of expertise. The key action is the establishment and functioning of Knowledge Transfer Centers (KTCs), whose operation should be transposed onto agreements, common applications and projects implemented in cooperation with representatives of business and public administration. From a slightly longer perspective, new links between science and business will be established and the competences of entrepreneurs, representatives of local governments and scientists will increase. In addition, the universities participating in the project will become more involved in the transfer of knowledge

Table 1 Dimensions of the SPIN Model (Antosz, Drożdżak et al., 2015)

Dimension	Goal of the dimension	Related barriers
Competences	Increasing domain-specific and knowledge transfer competences among the knowledge creators and recipients	1. Insufficient experience and knowledge among academic staff 2. Insufficient experience and knowledge among knowledge recipients
Processes	Providing skills to strategically plan, organize and adequately finance a center for knowledge transfer	1. Insufficient experience and knowledge among academic staff
Analyses	Providing skills to create up-to-date and useful knowledge necessary to run a center for knowledge transfer (esp. diagnosing needs and evaluating effects)	1. Insufficient experience and knowledge among academic staff
Communication	Increasing engagement of internal actors (university authorities, other units in charge of technology transfer) and external actors (knowledge recipients, business environment institutions) in knowledge transfer	1. Lack of strategic management of knowledge transfer at universities 2. Reluctance for cooperation among fellow researchers 3. Insufficient experience and knowledge among knowledge recipients
Transactions	Improving protocols and procedures assuring efficient and effective knowledge transfer	1. Insufficient IP regulations 2. Lengthy, time-consuming and complicated procedures

(at the level of results). At the level of impact, the results will translate into socio-economic development.

For research units, the SPIN Model is a concept functioning in the framework of the entities responsible for the transfer of a certain area of knowledge (KTC). The framework for the functioning of these units has been designed taking into account the specific nature of the field and with reference to issues identified in the diagnosis that need to be influenced (with the five dimensions that correspond to the challenges specified at the stage of the diagnosis: processes, analyses, competences, communication and transactions). Table 1 shows the dimensions of the SPIN Model.

The business model of the units is based on providing value to entrepreneurs and local government units. The main tasks of the centers involve the promotion of technologies under development, networking, brokering and providing R&D services.

The program was implemented in Lesser Poland in the framework of a partnership between the Marshal's Office and three universities. Four Centers for Knowledge Transfer were established at universities participating in the program (AGH University of Science and Technology, Cracow University of Technology and the Jagiellonian University). Each Centre is dedicated to a specific field of technology (biotechnology, smart grids, energy-saving buildings and translational medicine).

Researchers from the Centre for Evaluation and Analysis of Public Policies at the Jagiellonian University were responsible for the implementing the diagnosis, designing interventions, supporting the implementation and the summarizing evaluation. As a result, they had a unique opportunity to participate in the program from its very beginning.

The program was implemented in four phases: the diagnosis (August–October 2012), the design of the SPIN Model (November 2012–March 2013), test implementation (April 2013–March 2015), the summarizing evaluation and the development of the final version of the Model (April–June 2015).

The summative evaluation of the program was based on three methods: comparative case study, social network analysis and implementation analysis. Comparative case studies were conducted in order to explain the differences between the effects of implementation in each field of technology. Causes accounting for the observed discrepancies were investigated. The use of two other methods enriched the analysis with additional data and conclusions. Social network analysis was associated with one of the tasks of the KTC: the creation of new networks of cooperation between enterprises and universities. In order to measure the effectiveness of the program in this regard, the measurement of the four networks at two points in time was carried out (at the beginning and soon before the end of the intervention). Implementation analysis focused on interactions between program stakeholders and mechanisms which led to the observed effects of the program. Figure 1 shows the place of comparative case studies within the whole project.

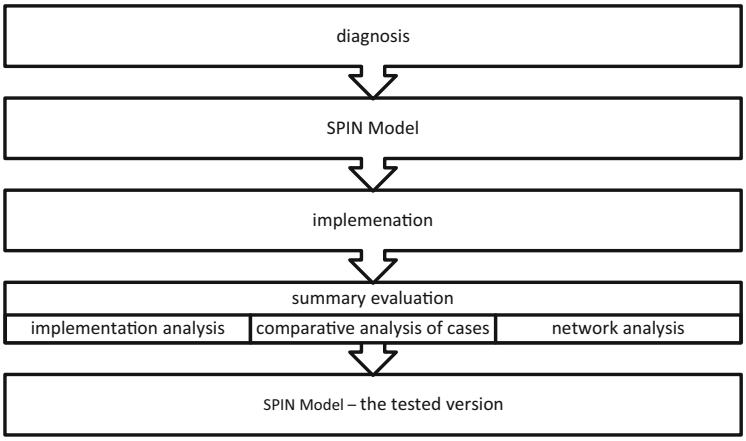

Fig. 1 Comparative analysis of cases in the context of the SPIN project

3 The Study of KT: The Complexity and Methodology of the Case Study

From the perspective of public administration, which aims to assess the impact of interventions, there is a temptation to treat the evaluation in a highly instrumental way, as a procedural requirement necessary to meet the course and impact of intervention in the documentation. This is facilitated by focusing on evaluation criteria and related research questions: *If? Who? To whom? To what extent?* and *How much?* As a team responsible for internal evaluation in the SPIN project, we decided to go beyond the standard range of evaluation questions through the use of case study methodology, allowing more focus on the study of causality in the complex social configuration of elements which make up the chain of KT from senders to recipients (cf. Bozeman, 2000; Cummings & Teng, 2003). In attempting to answer *why* and *how* the KTCs achieve certain effects, the aim was to acquire practical guidance in situations when responding to standard evaluation questions would not guarantee any meaningful recommendations in relation to future implementations, which differ in many respects (e.g. technological and institutional). We also assume that only an in-depth analysis of the *why* and *how* questions could provide the opportunity to explore the relatively universal mechanisms (or at least their most important scenarios) which would allow us to strengthen the effectiveness and usefulness of the subsequent implementations of the SPIN Model. At this point, the benefits of using case study methodology in evaluation should be discussed.

3.1 Using Case Studies in Evaluation

There is varying interest in the use of case studies in evaluation: certain textbooks do not even mention this method of evaluation, in some case study plays a marginal role, and others devote significant attention to the issue (Yin, 2014). Stufflebeam and Shinkfeld (2007), creating a ranking of methods used in evaluation and considering 26 of them, put case study in fifth place among the eight methods that they consider to be the best approaches to planning and conducting evaluations. The three most frequently occurring applications treat case study as (1) a part of the whole evaluation, which is the most common configuration, (2) a basic method of evaluation (3) part of a two-level evaluation (i.e., where the main evaluation consists of a number of smaller, "partial evaluations") (Yin, 2014).

In the first, most popular, configuration, the advantage of using case study lies in clarifying the mechanisms linking an intervention with a specific outcome, while other experimental or quasi-experimental methods are generally used as principal ones and mainly focus on the evaluation of the strength of the relationship between the intervention and its results. The rationale for the use of case study in evaluation is the complexity of the phenomenon to be described and explained (Yin, 2013). Case studies are used successfully to supplement and improve the program theory

and theory of change (Mookherji & LaFond, 2013; Vellema, Ton, de Roo, & van Wijk, 2013). Wherever the researcher's attention is focused on the evaluation of complex processes or complex implementation, case study is an appropriate research method and can be used independently. An additional benefit in such a case is providing useful information when it is still too early to see the results of the intervention. A case study may play a formative role in helping to correct the intervention. In addition to focusing on interventions or implementation, the case study method may be used to assess the results of interventions, as well as to explain the connections between the intervention and results. Generally speaking, case studies may perform the following functions in evaluation:

1. clarifying the causal relationships in interventions carried out in which an environment is too complex to be adequately explained with the help of surveys or experimental methods,
2. describing how an intervention functions in a real environment,
3. explaining or expanding selected issues of evaluation, and
4. indicating situations in which an intervention does not lead to a single, consistent set of results (Yin, 2014).

This last feature appears to be particularly valuable and useful from the perspective of the SPIN Model. Analyzing effects in the scope of KT achieved by KTCs, we could observe and reflect on various configurations of effects, some of which were more desirable than others, some expected or assumed, and some not.

A case study (of various types and configurations) was, is and can be successfully used in evaluation of, for example, policies affecting transfer of knowledge and innovation, enriching them with a deeper reflection on causality in relation to the results of public intervention and activities conducted in a complex system of interdependence within the social world (Yin, 2014). The great advantage of this method, which we found to be a promising supplement to evaluation, is its flexibility: the increased number of analytical techniques and ways to organize and present data, multiple test patterns and the possibility to combine it with other methods (*mixed method research*). In the case of SPIN, as has been pointed out, the results obtained by analyzing cases were connected, among others, with the results of implementation and network analysis. Flexibility and the possibility to connect the individual pieces of the puzzle into a common picture of KT allows, in our opinion, better understanding and control of the relationships between the senders and receivers of the transfer, the channels of communication which they use, the environment and the subject of the transfer itself, knowledge. Analysis techniques used in the case study method such as logical models have proved particularly useful for this purpose. The use of analytical schemes allowing for the comparison of cases also carries additional cognitive benefits.

In the literature of the subject, case studies appear in the context of different research patterns, and this is why we refer to case studies, analysis of multiple cases (*multi-/multiple case analysis*), comparative case analysis or the method of comparing cases (which is used in particular in political sciences). In the SPIN project we used the term "comparative case studies", because its very name adequately

describes the research method, so the term has a high communicative value. As Yin points out, there is no separate "method of comparison of cases", but only case studies based on different research schemes (according to the classification adopted by this author (Yin, 2014), the scheme which we have used is a study of a number of separate, fully-fledged cases (KTCs) considered in relation to their environment). By calling our study a "comparative analysis of cases" we also intend to emphasize a direct reference to Qualitative Comparative Analysis—QCA (Ragin, 1987), which is an analytical technique that has provided us with important inspiration regarding the analysis and conclusions concerning differences in the effects of the transfer of knowledge between the cases which we had considered.

3.2 Challenges in the Context of Formulating the Recommendations

As has been pointed out, the purpose of undertaking additional research efforts in the project was to improve the quality and relevance of the recommendations formulated by our team with a view to possible future implementations of the SPIN Model. It is worth emphasizing that qualitative methods, in this case study, tend to aim at creating *analytical generalizations* of the results, i.e. at ensuring that they will be applied in similar situations (Yin, 2014). The aim of referring back to theory is to generalize conclusions and increase external accuracy, as well as develop analytical techniques such as QCA (Befani, 2013; Ragin, 1987; Rihoux & Lobe, 2009). As regards generalizing conclusions, Mookherji and LaFond (2013) also point out a very important role played by a correct, theory-based selection of cases to study in this respect. Although selection of cases in this study did not take place since the cases were given to the Authors, we have devoted a considerable amount of time and discussion to achieving a good understanding of the specifics of the cases and expressing them in the language of variables arising from the main findings of the research on transfer of knowledge.

4 The Design of a Comparative Analysis of Cases

The main research question to be answered through a comparative analysis of cases was:

Why did center A, operating in the environment Oa, achieve Ea results in terms of KT, while center B, operating in the environment Ob, achieve Eb results?

In the analysis of effects in the field of KT achieved by each KTC throughout the SPIN project we decided to turn to the ideas underlying configuration comparative analysis: QCA (Ragin, 1987). We realized that trying to identify the mechanisms responsible for the KTCs achieving certain effects, we would need tools and strategies

(1) enabling the control of many different, interrelated conditions, (2) recognizing these conditions in terms of their necessity and sufficiency, and (3) favoring the construction of comparative models for the effects of KT. As the initial list of conditions that we wanted to take into account in the analysis of effects describing the KTC and their surroundings lengthened, we became more determined to control the growing complexity of the subject and scope of the study, and at the same time free ourselves from the risk of subjectivity and arbitrariness of conclusions. Treating our KTCs as individual cases, each with its own surroundings, from the beginning we had to deal with a scheme in which there were four cases and dozens of variables to be taken into account. In line with the QCA assumptions, conducting a configuration analysis could not work: the number of cases was too low for the number of considered conditions (Marx & Dusa, 2011). At the same time, encouraged by the example of other researchers who sought to simplify the initial scheme, e.g. through the construction of smaller (in terms of the number of conditions considered) models which competed with each other (see Avdagic, 2010 in: Emmenegger, Kvist, & Skaaning, 2013), we decided to use the QCA guidelines and ideas (not: the method as a whole) as much as possible. In our view, the end result became an organized and well-documented case study, which provided interesting results and conclusions, potentially supplying the analysis of counter-factual states in which we see the desired method of ex-post evaluation of programs such as SPIN.

4.1 Adapting the Idea and "the Coaching Role" of QCA

Firstly, thanks to the inspiration given by the QCA, we began to think of our KTCs and their surroundings in terms of sets of characteristics that may be associated with the effects of KT. These sets would not be coincidental, but constructed in two ways: one, by selecting the conditions indicated in literature as essential for the effective transfer of knowledge; the other, by explication (using logic models created by researchers on our team, each of whom was responsible for cooperation with one of the KTCs, including performing participatory observation) of the most characteristic features of our cases. As a result, the sets combined certain universal conditions, important for KT, without sacrificing openness to the specific nature of cases. Focusing on the sets of selected characteristics and their mutual interaction on the results, we were able to identify some regularity in a complex configuration of the factors shaping the level of effects. Analyzing each of the four KTCs into a set of several features we have gained a fuller picture of similarities and differences between the centers and their surroundings. We could also, like in the QCA, make further simplifications, including rejecting these features from the mainstream of conclusions which proved poor or completely unsuccessful at differentiating between particular KTCs and their surroundings. While the solutions provided by QCA may be regarded as a formal record, simultaneously fulfilling the function of communication between objectives and effects, conducting an individual assessment of KTCs on the basis of the developed sets of features contributed to the commonality of ways

to define concepts and a better understanding of the effects achieved by individual KTCs by setting the reference system and relativization of assessment in relation to the centers. Looking for main and alternative explanations for the effects achieved by KTCs, we aimed at possibly far-reaching reduction of the considered factors in order that the final model included only those conditions which can be considered as necessary or sufficient. We have turned crucial terminology for the search for formal solutions in the QCA (Legewie, 2013), into a kind of "Ockham's razor" in pursuit of a possible simplification of the complex impact of the characteristics of KTCs and their surroundings on the effects. We tried to alleviate the weakness of such an approach in relation to the typical use of the QCA by triangulating applications and controlling their consistency with logic models developed for the various centers. Finally, thinking in terms of the configuration of characteristic features and the complete explication of assumptions supported by various members of the research team allowed us, just like in QCA, to identify such configurations, potentially relevant to effects, that are not represented by any of our four cases, and may occur in the subsequent SPIN Model implementations at other universities or in other technological areas. For example, among the three models described later in this text the reader will not see a case in which the substantive leader of implementation (a professor, the "face" of the center) would be released from his or her duties by his university and assigned to the management of the KTC (which, as stated in the evaluation, was one of the significant factors undermining the effectiveness of a KTC).

4.2 Description of Tools and Research Activities

In the first place, as part of a comparative analysis of cases, we have analyzed the literature of the subject and chosen a theoretical framework for the study of the transfer of knowledge by a KTC implementing the SPIN Model. We used Bozeman's (2000) model of KT and the scheme of nine terms of successful KT (Cummings & Teng, 2003). Later the tables for assessing the intrinsic characteristics and environment of the particular KTC implementing the SPIN Model were developed.

4.2.1 Developing Sets of Characteristics of KTCs and their Environment

Finally, the initial list of features of KTCs and their surroundings includes 13 characteristics of the centers and 12 characteristics of surroundings (Table 2).

Researchers working with individual KTCs were asked to add more features significant from the point of view of the specifics of each of the KTCs. It turned out, however, that the list seems to fully describe the factor potentially associated with the level of KT and only the thresholds used to determine the presence or absence of given characteristics of issues raised at that stage. We were forced to expand the scale of assessment and in most cases use the ordinal scale, which better reflected

Table 2 List of features of KTCs and their surroundings

Characteristics of the centers	Characteristics of surroundings
Nature of relationships with other universities relevant to the activities of KTCs (including Technology Transfer Offices)	Incidence of systemic barriers to collaboration between researchers and industry
Nature of the regulations for the cooperation with industry	Level of systemic support for innovation in the field of the KTC's activity (legislation, funding, etc.)
Nature of a system of incentives for scientists working at the KTC (Debackere & Veugelers, 2005)	Relationship between the scientific discipline and industry (Lee, 1996)
Scope of the offer (Zhang, Baden-Fuller, & Mangematin, 2007)	Absorption potential for KT and innovation among recipients in the region (Gilbert & Cordey-Hayes, 1996)
Level of codification of knowledge transferred	Absorption potential for KT and innovation among the general public (including the foreign public)
Level of development of knowledge transferred	Mutual networking of key customers (the level of connection with mutual contacts)
Business experience of the KTC management	Level of competitiveness in the industry
Business experience of other staff of the KTC	Attitudes to KT in scientific units co-operating with the KTC (Hewitt-Dundas, 2012)
Academic status of the KTC management	Quality of research in scientific institutions cooperating with the KTC
Structure of the decision-making process in the KTC	Business experience of the collaborating scientists
Strategy of KT	Availability of cooperating scientists,
Number of KT tools used	Possibility of direct contact between the KTC and business partners (geographical distance) (Jassimudin, 2007)
Centrality of the KTC's position in networking with external entities	

the true differentiation between KTCs and their surroundings. Referring to the QCA terminology, we can say that we have moved from the standard, strong definition of a set of conditions (crisp-set QCA) to defining a fuzzy-set QCA. Each of our researchers completed a questionnaire which included, in total, 25 features listed above. The next step was comparing the evaluations of the KTCs and their environments obtained by our team of researchers and reducing the number of characteristics to be considered. After preparing a comparison table in Excel, at the first step we moved aside all the qualities that turned out not to differentiate between KTCs and their surroundings (not excluding, however, the fact that we would refer to those qualities when interpreting the results, for example when interpreting the level of achieved effects, one should consider the limiting effect of the low availability of the scientists cooperating with the KTC in each of the cases). Those qualities were:

- the incidence of systemic barriers to collaboration between researchers and industry (equally inconvenient for all cases),
- business experience of the collaborating scientists (rather limited for all cases),
- the availability of cooperating scientists (rather low for all cases),
- the possibility of direct contact between the KTC and business partners (which proved to be non- problematic),
- the centrality of the KTC's position in networking with external entities (which proved to be firm and noticeable for each KTC in concurrently performed social network analysis).

We focused instead on the differences between KTCs and their environment, choosing those differences which in the literature devoted to the transfer of knowledge are indicated as most important (e.g. the level of systemic support for innovation in the field of the KTC's activity, the relationship between the scientific discipline and industry or the attitudes to KT in scientific units co-operating with the KTC). At this stage, attempting to understand what motivations were behind the diversity of KTC evaluations and their environment on particular dimensions, we also made changes of selected features into those more synthetic, which we believe casted real differences in a more accurate way (for example, "the nature of leadership" feature has been constructed at this step).

Finally, to build models of the conditions responsible for the differences in the effects of KT, we chose:

(a) in the case of characteristics of the centers:

1. the nature of the system of incentives for scientists working at the KTC,
2. the level of codification of knowledge and level of the development of transferred knowledge that we merged into one condition: the level of development of the offer,
3. the nature of leadership (change from management's earlier business experience, management type and nature of the decision-making process),
4. the business experience of staff,
5. the size of the budget allocated to promotion and brokering (earlier the number of KT tools used);

(b) in the case of the surroundings of the centers:

1. the level of systemic support for innovation in the field of activity of KTC (legislation, funding, etc.),
2. the relationship between industry and discipline,
3. attitude of individuals cooperating with the KTC in KT.

The reduced number of characteristics were then subject to the next round of assessment in research team, aiming this time to make the differentiation between centers as simple as possible (ideally, dichotomous, although this was not possible in every case). At the same time, researchers working with individual KTCs worked on the development of logic models defining the conditions behind the effects

achieved by KTCs. For each of the KTCs 3–5 key features were selected, which according to the researchers affected the level of results achieved by the KTCs.

4.2.2 Development of the Category of Results

Observing the activity of centers established in the phase of the test implementation of the SPIN Model, the results of the activities of KTCs are divided into three basic categories:

1. The "sales" effects (implementation of technology and commercialization of knowledge)
2. The effects increasing implementation capacity (including expansion of the network of contacts, signing cooperation agreements, joint applications for projects, etc.)
3. Effects of increasing the scientific potential (e.g. applying and implementing research projects without the cooperation with business partners / without the implementation of these projects).

The above-mentioned three categories of effects are arranged in sequence from the most desirable effects, from the point of view of long-term results of the implementation of the SPIN Model (category 1), through the effects required of the SPIN project as a kind of minimum which signifies a good investment of funds (category 2) to the last significant effects from the point of view of the transfer of knowledge, focusing on purely scientific development (category 3). While it may be expected that the effects belonging to the second category will have a bearing on the effects of the first category, given enough time and ensure the sustainability of centers, to, whereas "business future" effects of the latter category is, at best, distant in time and hazy. The emphasized categories of effects in terms of their use to describe the KT effects achieved by the centers implementing the SPIN Model served as ideal types, while for various reasons (more on which will be said later) there could be no question of classifying various KTCs to only one of the three distinguished categories. For each of the effects' category some detailed indicators have been assigned. They derived from monitoring of KTCs activity during the implementation of SPIN Model, as well as from other evaluation activities conducted by the research team (e.g. social network analysis). These indicators were used to describe KT effects of SPIN Model implementation in the following part of the section.

5 The Results of the Comparative Analysis of Cases

5.1 The Models of Comparing Results

The development of models comparing the effects consisted of juxtaposing the conditions selected and reduced in the way described in Sect. 4.2.1. with the features of centers and their surroundings selected on the basis of logic models (3–5 most important for each particular KTC). We were guided by the following assumptions for the models, which should:

1. consist of the lowest possible number of significant conditions/variables (thus the reduction to the conditions which truly reflected the differences),
2. be as general as possible, i.e. free from any characteristics of particular persons or institutions, and
3. have the greatest explanatory power.

The first two assumptions could be assured by the principal investigator, while third resulted from several discussions within the research team.

Focusing further analyses on models rather than on implementing KTCs led to a more general reflection on the consequences of establishing KTCs with specific characteristics under certain environmental conditions. The goal was to make the analyses relevant not only to particular KTCs, but also to other similar cases. The implementation of these guidelines and the analysis of reduced sets of conditions led us to believe that it is necessary to design and present three models:

Model 1—a model that will extract the specifics of the KTC implementation in a pre-existing scientific unit and the consequences that arise for the very definition of implementation in such a case,

Model 2—a model that will show what can happen when the implementation has an ambitious and dedicated leader who is a fast learner, and it happens in a difficult and complex area of science and in a relatively unfavorable environment, and

Model 3—a model where success appears to be most probable and relatively easy to attain with respect to expenditure that has to be incurred.

These models are explained in a metaphorical way in the subsequent part of the paper. Each model is also described in terms of the final set of features we used to identify it. Then, at the end of this section, we try to show how each model, represented by particular KTC(s) coped with achieving various types of effects. Certainly the most interesting element of the analyses are those passages in which we attempt to show how the KTCs representing other models achieved similar results in terms of KT and why KTCs representing a similar model achieved different effects.

5.1.1 Model 1: Anchor of the Past at the Forefront of Brokering (Represented by: MCB)

In the first model, one can talk about two specific conditions for implementation: It can take place in a situation where (1) the SPIN project is implemented by an already existing research unit, and when (2) there is a person with managerial experience in its management, who understands the psychology of team management well.

In such a model the vision and strategy which were chosen when the unit was established, even before the intervention, will have a significant impact on the results. If these targets are established as more scientific, such a unit will find itself in a conflict of identity as a result of taking on the commitment of implementing KT. KT as a notion will, in a unit of this type, always compete with participation in the scientific discourse and community. Thus, the pressure exerted on the commercialization of its scientific potential will be limited by the attitude of the managerial staff towards purely scientific activities, or activities not requiring taking various types of business and investment risk associated with the commercialization. On the other hand, if in the past the unit was already focused on transfer activities, its support from the SPIN Model could translate into further strengthening its identity as a KTC.

In this model, however, the entire unit will be efficiently managed by a person highly qualified in terms of managerial skills, with a high level of entrepreneurial spirit and the ability to take risks. This person will be able to very quickly internalize the understanding of KT, and appropriately adjust operational activities. In the particular case of implementation of Model 1, in the Lesser Poland Centre of Biotechnology more than 90 % of the total budget funds were used for active brokering activities: seven workplaces for specialists were created for transfer specialists, whose main task was, among others, to create expanded business networks. In addition, a platform for the development of culture brokering has been created: a team of brokers (even though each of them was working on a different technology) met regularly, discussed their experiences and challenges and planned joint transfer activities. Transfer activity in this model proved to be very high, despite the relatively difficult environment (a weak system of institutional support, a vague relationship with industry, and a rather ambivalent attitude of cooperating research units towards the idea of KT).

Due to the presence of an efficient coordinator, it can be assumed that in Model 1 the focus will be on active brokering, which will be further supported by a system of financial incentives. The outline of Model 1 is presented in Table 3.

Table 3 Characteristics of Model 1

An earlier vision of the organization is not directly related to the idea of KT	A relatively little developed potential commercialization offer	A relatively difficult environment for the area	Emphasis on active brokering and ensuring a financial incentive system for the staff	A committed coordinator with team management competencies

5.1.2 Model 2: Raider of the Lost Ark (Represented by: MOMT)

The second model which can occur in the process of implementing an innovation policy such as SPIN is primarily characterized by the progressiveness of its area. In the case of the SPIN project it is the field of translational medicine, which is a relatively young field, and moreover, there has been considerable debate over its meaning and scope. It is also a field which is largely interdisciplinary; hence the possibilities of commercialization in the area of translational medicine are potentially very numerous. In this area the importance of precisely defining an attractive offer for a KTC's potential customers becomes even more important.

In the case of Model 2, we are dealing with a situation in which the staff of the center is only beginning to look for opportunities to create an offer when the center is established. A possible scenario for such a KTC is putting a significant emphasis on the development of competences of the staff (its own staff or the collaborating scientists) more than on activities purely related to KT. This is due to the lack of specific proposals for the outside world; the possibility of active brokering is therefore significantly reduced.

In the second model (Table 4), we are therefore faced with meandering among different possible directions of development, and structural emphasis is placed on supporting the competences of the staff. If the coordinator has been selected wisely, it may turn out that thanks to their individual personal development, they start to play an increasingly important role for the given KTC. This happened in the Lesser Poland Centre of Translational Medicine, where the coordinator of the project grew into a significant person in the field of leadership, who—if the implementation of the SPIN Model continues—could show the KTC adequate directions for development.

5.1.3 Model 3: Product With(out) the Sale (Represented by: CISI and MCBE)

The third model may apply to situations when there are good external conditions for the implementation of KT and when (thanks to the availability of business practices in the immediate surroundings) in a relatively short period of time one could work out a specific market offer addressed to a specific target group. Analyzing the experiences connected with the SPIN project, it can be concluded that this model can take two directions of development, since the environment provides such possibilities. On the one hand, market proximity may be observed and therefore if an appropriate strategy is adopted by the leaders, the emphasis may be placed on the

Table 4 Characteristics of Model 2

A relatively difficult environment for the area	No clear proposal of value for potential customers	Focus on development of KTC staff competencies	A determined, committed and fast learning coordinator, getting ready to take a leadership role

Table 5 Characteristics of Model 3

The offer relatively highly developed	Favorable legal and institutional conditions	Moderate pressure for active brokering	Moderate determination or "dormancy" of the leaders

development of an offer and purely sales-related activities. On the other hand, the institutional context also creates many opportunities for applying for external funding in broad partnerships. Depending on the attitude of leaders, a center operating according to Model 3 may take one of the paths described above.

Centers which function in a similar way to the characteristics of Model 3 (Table 5), regardless of the financing strategy, present a similar approach to brokering activities. One could say that they devote relatively little resources to purely marketing activities. For example—when compared to Model 1—they do not invest much of their resources into active brokering. It could be argued that the established position of the area gives the leaders of organizations operating under such conditions the feeling that there is no need to aggressively justify the values offered by the KTC to its potential customers.

5.2 Achievements of KTCs

The achievements will be discussed in relation to the categories depicted in Sect. 5.2.2.

5.2.1 "Sales" Results

Two of the four KTCs established in the framework of the SPIN Model testing phase started their activities in an environment that was characterized as generally "less favorable". Especially in fields such as biotechnology or translational medicine, centers were somehow "forced" to ensure that, in addition to working on their own offer, they also conduct actions aimed at strengthening the demand aspect. The significance of this type of action is connected with, among others, overcoming unfavorable attitudes of entrepreneurs towards the scientific community. Actions on attitudes require a long time period and do not yield quick results in the form of orders of goods or services. Achieving "clear implementations" was also limited to a relatively short—24 month—period of the testing phase of the SPIN Model, and apart from this, KTC's co-financing by European funds imposed a limitation upon them in the form of a prohibition on generating profits throughout the duration of the project.

The activity of KTCs at the level of "pure implementation" was therefore limited and a summary of accomplishments of the centers in this area has little comparative value. The nature of the effects which are most similar to the "pure

Table 6 Effects of implementation in KTCs

Name of the center	The number of implementations	The nature of implementations
Lesser Poland Biotechnology Centre	6	One commercialized technology and several instances of commissioned research
Smart Grid Information Centre	5	Expertise of a closed character (devoid of further development of service and cooperation)
Lesser Poland Centre for Translational Medicine	8	Three projects of development work (carried out jointly with the recipient) on innovative solutions (in progress) and several expert consultations
Lesser Poland Centre for Energy-Efficient Building	10	Expertise and research for the benefit of recipients

implementation" (i.e. the development of technology in a form ready to be implemented) is described in Table 6.

Analyzing the above juxtaposition, it should be stated that the most frequent implementation effect occurring in the testing phase of the SPIN Model was in the form of services consisting of providing expertise or research for a potential recipient. Effects of this type are achieved by individuals who fit into the above Model 3 of implementation, which is characterized by a relatively favorable environment for activities in the field of KT and moderate spending on active brokering. A relatively highly developed offer at the stage of entering the project is also a significant factor. It can therefore be construed that a relatively favorable environment for an established KTC, with emphasis on the proximity of business practices, enables creating an offer in the form of expert services and embedding it on the market.

The situation is slightly different in the cases of Model 1 and Model 2. First of all, in the centers fitting these SPIN implementation models, one may see a slightly more differentiation in the effects of implementation.

When it comes to assessing the effects of implementation, it has to be said that the most differentiating features that seem to condition the effects tend to be features of the environment and the degree of product-quality of the offer.

5.2.2 Effects Increasing the Implementation Potential

One of the key dimensions of the activity of the observed KTCs were actions aimed at influencing the demand side. The need to adopt such policies is associated with the previously described challenge related to a difficult environment for business, whose function is to sell academic knowledge to the recipients. In this analysis, we have presented a division that indicates that two KTCs dealt with more favorable environmental conditions. However, even in these cases alone the "demand for innovation" in the region is low.

Table 7 Aspects describing the building of implementation capacity

On-going R&D projects or those for which only applications for funding were submitted.	General agreements signed with potential recipients	The results of the analysis of a network of contacts which a given KTC managed to build	All meetings, conferences, training sessions or seminars attended by potential recipients of the center

Thus, all the centers have been conditioned by the necessity to take measures aimed at raising awareness of benefits of business relationships established with the academic world. General categories in Table 7 are the dimensions through the prism of which we are trying to compare the results of various KTCs regarding building implementation capacity.

The first important dimension of activity in terms of building the implementation potential is running R&D-type projects with external funding. Implementation of such projects requires finding a partner on the side of the entrepreneur, one who is willing to sacrifice their structural resources on working out a common approach to the project and is not afraid to enter into a joint project with a given KTC. Table 8 shows the number of implemented R&D projects, as well as the number of grant applications submitted and potential customers.

Centers also signed a general agreement on cooperation with their implementation partners—we assume that it is an action which requires cooperation, in the course of which a KTC and an entrepreneur get together, building foundations for possible future cooperation.

What clearly stands out from the above data is the fact that MCBE strongly involved their structural resources to strive for the signing of broad agreements with potential customers. This strategy is quite clear in contrast to other centers (especially these implementing Models 1 and 2), and its explanation can be found in the characteristics of the environment ("favorable conditions" for Model 3), the individual decisions of its leaders, and the way of implementing the brokering functions (as explained below).

MCB was relatively most active when it comes to following the path of R&D projects: currently it is implementing three such projects for a total amount of 2.2 million PLN, and it submitted a further nine grant applications for 25.2 million PLN in total. CISI follows the MCB closely, submitting a total of eight applications and running two implementation projects. MOMT—following Model 2—is currently running five implementation projects for a total amount of nearly 10 million PLN, but this center has not submitted any new application forms.

A relationship between the less favorable environment and applying for external funding with less emphasis on direct commercialization may be observed. This strategy could also be enhanced by the fact that both MOMT's and MCB's offers were not well developed at the start of the SPIN project. On the other hand, the strategies of following external financing for R&D projects can also be observed in the case of CISI, which is currently running two implementation projects and has submitted eight grant applications with a total of 32 entrepreneurial partners. These facts dictate the conclusion that in order to increase the likelihood that a KTC will

Table 8 R&D projects, grant applications and agreements with customers

	MCB	CISI	MCBE	MOMT
The number of placed (and being in the assessment phase) applications for implementation grants.	9	8	2	0
The number of on-going implementation projects.	3	2[a]	0	5
Agreements signed with potential recipients	6	20	39	10

[a]For the sake of comparability for all centers we analyze the state of September 2014

take the path of relationships and direct sales, it should (1) act under more friendly environmental conditions, (2) have a relatively well-developed offer and—the key factor—(3) a leader with business experience or a business approach (or a leader identifying himself/herself with the mission to commercialize). This is a largely common-sense conclusion, but the SPIN project experience strengthens this conclusion on the empirical level.

MCBE adopted a strategy of exerting a direct influence on potential customers, and this fact is reflected in the Table 9. It shows that MCBE has conducted the largest number of training hours with customers, the largest number of direct meetings and reached the largest number of individual entities. The last rate is higher for MBCE than for the other three centers combined. As regards different examples in Model 3 (and thus, differences between MCBE and CISI), it is worth emphasizing the blurring or separating of brokering duties between several people responsible for direct contacts with customers in CISI, while in MCBE these tasks were clearly separated and assigned to a single position.

The activity of centers at the level of building implementation potential may be summed up by results of network analysis conducted within the framework of the SPIN project (Table 10). Its results are presented through the prism of indicators such as (1) the total number of contacts established by a KTC, (2) any change in the number of contacts between 2013 and 2014 (3) recognition of the center's brand, and (4) its importance in the network.

The biggest change in the number of contacts held in relation to the beginning of the implementation of the SPIN Model may be observed in the case of centers operating within Model 3. At the same time these are the center having the largest number of contacts and embedded in the largest (as network analysis shows) networks of relationships. In case of differences between the MCB and MOMT it can be assumed that the MCB's clearly better results in terms of the number of acquired contacts seems to be due to the involvement of several brokers and high expenditures on brokering, characteristic for Model 1 (MCB). Model 1 and one embodiment of Model 3 (MCBE) stand out from among others because of their high visibility in their immediate environment. While in the case of MCB one may guess that it is the result of the work of brokers and expenditures on brokering, in the case of MCBE a correlation between the recognizability of the center and the largest number of direct contacts can be observed. In the case of the strategy chosen by the

Table 9 Direct contacts with potential recipients

	MCB	CISI	MCBE	MOMT
The number of training hours completed for potential recipients of the offer	0	14	120	114
The number of direct meetings regarding the offer	126	89	197	87
Number of entities with whom direct meetings were held	60	52	135	14

Table 10 KTC's activity in the field of customer contacts on the basis of the results of network analysis

	MCB	MCBE	MOMT	CISI
The number of contacts (as of the end of 2014)	151	175	44	169
The change in the number of contacts (2013 to 2014)—NI wave 2014—NI wave 2013	110	138	20	122 (including 60 new contacts being scientists from the university)
Brand recognition of centers	65 % (52 out of 81 respondents)	61 % (134 of 218 respondents)	36 % (23 out of 64 respondents)	40 % (50 of 125 respondents)
What part of the contact of the centers are entities most important for the network (%, and N for the highest k-core[a] in one wave)	11.3 % (but in the interpretation it has to be remembered that 40 % of MCB's contacts were international bodies that have not been researched)	19 % I wave has s(4)—34 out of 175 contacts	16 % of I wave has s(3)—7 out of 44 identified	8 % of I wave has s(4)—13 to 169 of identified (not researched)

[a]K-core allows identifying subgroups based on the number of relationships that link them. Within the subgroups, each entity is linked to the other by at least a k-bond

CISI it can be assumed that it is much more selective (networking primarily with those customers with which one will be able to plan joint applications for external funds), which is also reflected in the percentage of direct contacts between particular centers with the most important actors in individual networks (entities with the highest k-core). In comparison with indicators resulting from network analysis, the center implementing Model 2 had the relatively poorest results. However, a comprehensive characterization of that model contributes to the poor results, from a "difficult" environment, to difficulties in developing a clear offer to customers and an entirely different (in comparison to the other models) approach to brokering, in terms of both human and financial resources.

5.2.3 Results Increasing the Scientific Potential

From the perspective of the SPIN project assumptions, the least preferred effects achieved by the centers implementing the SPIN Model have been identified as applications for external funds and projects ran on their own or with scientific partners, without the participation of partners who would also be the recipients. We have concluded that this type of activity, even though it could in the long term contribute to the growing importance of a KTC, is located on the opposite pole from sales-type effects, which in the best way reflect the idea of the KT on which SPIN focuses. We saw the share of consumers in grant applications and currently running projects as a clear criterion for distinguishing projects of a scientific nature (basic research projects or projects not assuming testing nor the implementation of the results) from the implementation projects (or at least projects having a measurable value to the recipient(s)). We have also compared the number of general agreements for cooperation concluded between the centers and other scientific and research units.

It is true that, given the framework consensus of partners implementing the SPIN project regarding the purposes of the project, one should not have expected an intentional course on scientific development (except the case of MOMT with a strong component of scientific staff competence development) and dominance of this type of effect over the others. However, this type of activity did appear and it deserves appropriate attention. Table 11 shows the results of centers raising their scientific potential.

A unit standing out in terms of scientific results is the MCB Centre, operating according to Model 1. It is a scientific research unit that by joining the SPIN project has taken on new responsibilities related to commercialization purposes. According to the original concept, the MCB unit appears to be, first and foremost, a leading international center for high quality research in biotechnology. The significance of this vision is evidenced by MCB submitting applications and running projects in cooperation with a wide network of other scientific institutions (also outside Poland), a total of 21 partners. In the case of the center operating in the framework of Model 2 (MOMT), although the emphasis on scientific type of effects could be more expected than in the case of Model 3, the occurrence of effects in this category seems to be conditioned by the success of activities related to the education and retention of staff. However, it is the centers operating within the framework of Model 3 (CISI, MCBE) that during the period of implementation showed increased movement in the direction of scientific production. This particularly applies to

Table 11 KTCs' results in increasing their scientific potential

	MCB	MCBE	MOMT	CISI
Applications for purely scientific grants	11	1	0	0
Projects ran with external funding of a purely scientific character	2	0	0	0
General agreements with scientific and research institutions	4	2	1	8

CISI, which, though it did not apply for purely scientific grants, turned largely to scientists when establishing new contacts. The number of agreements signed with scientific and research institutions confirm the picture of the relationship outlined above.

6 Conclusion

The comparison between models of KTC implementing the SPIN project and the effects concerning the transfer of knowledge deepened our understanding of the complex relationships among various factors reinforcing and limiting the transfer of knowledge from universities to industry. It seems that we were able to come closer when answering questions of a practical nature, e.g. whether and under what circumstances is it beneficial to invest public funds in the implementation of the SPIN Model. It turns out that even initially unfavorable conditions, such as a difficult institutional environment, a cutting-edge field of knowledge or unenthusiastic attitudes of scientists towards KT, efficient management and a leader who understands the idea of commercialization as well as more funding for brokering can bring about desired effects in terms of stimulating innovation in the region. These are the conclusions of the analysis of effects achieved within the framework of Model 1. On the other hand, a favorable environment (including the demand for entrepreneurial solutions and institutional support) and careful preparation of the KTC's business offer do not in themselves ensure high efficiency in the transfer of knowledge, or at least to a degree which could be expected when taking into account the number of advantages. This is suggested by the results achieved by KTCs representing Model 3. One of the main connectors between potential and possibly positive results, as the example of Model 2 seems to suggest, is leadership and the attitudes of leaders. A fully involved (what the authors have in mind is both involved in the development of the KTC, as well as the availability of leaders defined as the time spent on actually managing a KTC) and self-developing leader can—though perhaps it will take a bit more time—lead to the proper positioning of the KTC in terms of objectives, offers and strategies. The willingness of regional authorities to extend the incubation period of KTCs offers the opportunity to conduct KT in the desired form, that is, one in which the cooperation between the KTC and recipients translates into introducing innovative products and services into the economic world. At the same time, as regards technological areas which have favorable environment and good commercial offer as their starting point, achieving a high level of desired results requires the commitment of leaders with business experience or approaches (or leaders seeing the mission in commercialization). Such persons should act in a relatively autonomous way in relation to their university and its units, devoting all their time to working for the sake of the development of the KTC. Of course, thinking in the longer perspective, one should also take into account long-term measures, aimed at building a culture of commercialization at universities and developing more enthusiastic attitudes of scientists

towards KT. However, with a view to achieving rapid and visible results in terms of KT, the results of comparative case studies which we have achieved attest to the fact that the region's authorities see transferring funds for the development of a KTC into the hands of carefully chosen teams, able to lead the way to commercialization, as beneficial.

In our view, the relationships described above could be observed mainly due to adaptation in comparative case analysis of elements and ideas typical for the QCA. In particular, the solutions adopted made it possible to reduce the number of conditions taken into account which affect KT in a situation where the research material accumulated in the testing period of the SPIN Model was so diverse, complex and ambiguous that the attempt to develop the conclusions for the conditions of effective implementation in a synthetic way turned out to be an extremely difficult challenge.

Despite the limitations stemming from the limited number of cases, the use of some features of QCA significantly improved the quality of the subsequent comparative case study. The research activities related to the comparison of the cases were carried out in three stages, presented in Fig. 2.

The application of described features of QCA enabled the research team to prepare research tools (forms, comparison tables, interview scenarios, etc.) and focused on the search for the configurations of conditions relevant to the effects of the KT. It also supported the preparation of logic models of effects for each center. As a result, the cases were embedded in a broader context of factors defining the issue of KT. What is more, limitations of the study were depicted (i.e. what is not known or what cannot be tested) and proposals for alternative explanations were

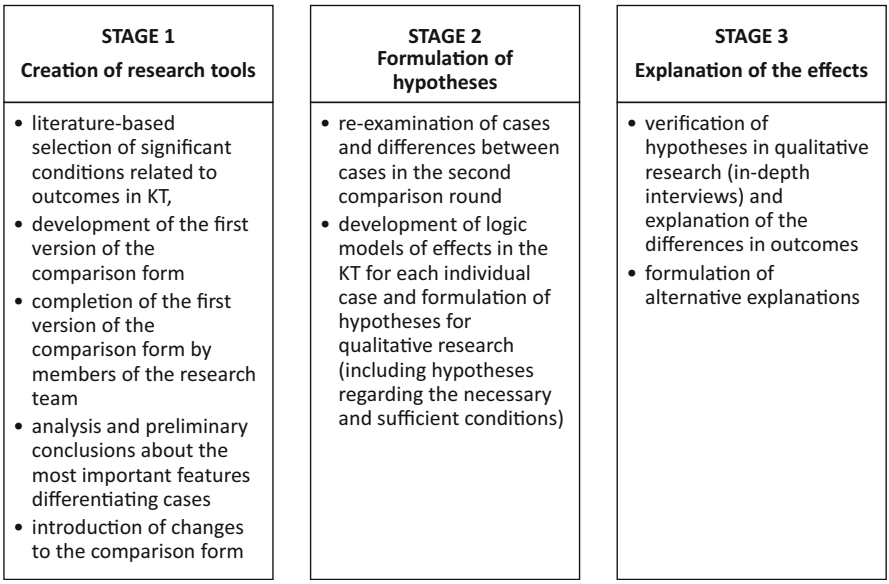

Fig. 2 Three-stage procedure of the comparison of the cases

formulated. An unplanned but important effect of the adaptation of QCA assumptions in the form of raising the communication level within the research team occurred. It happened mainly through explication of individual researchers' assumptions and creation of a common platform for transparent discussion of the effects. In the case of qualitative research such effects prove invaluable.

Just to remember, the main research question to be answered through our analysis of cases was:

Why did centre A, operating in the environment Oa, achieve Ea results in terms of KT, while centre B, operating in the environment Ob, achieve Eb results?

We believe that any further research on the conditions influencing KT results could concentrate in reduced—both theoretically and empirically—set of features applied to precisely described and measured KT effects with supply of the greater number of cases in order to perform the fully-fledged QCA. Our study, as a part of internal evaluation of innovative public intervention, has undergone several limitations. First of all, we had no more than four cases (KTCs). Secondly, we decided to look at SPIN Model implementation's effect from the broad perspective of utility evaluation criterion (Antosz, Drożdżak, Górniak, Orkisz, & Worek, 2010). It led us to analysis of three different and relatively complex categories of effects, instead of having simple measure, which make the results of the study less sharp or unambiguous. Nevertheless, the conditions selected to create and describe models of KTCs proved to play an important role in knowledge transfer, especially in countries where KT from university to industry is not ubiquitous yet. Deepening the investigation on it, with use of other research design and methods could provide some new findings in KT research and evaluation.

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Entrepreneurial Orientation and the Handling of Complexity in Small and Medium Enterprise Research

Markus Braun and Thomas Steger

Abstract Entrepreneurial small- and medium-sized enterprises (SMEs) are regularly operating in very complex settings. The methods and tools used by SME research to account for that complexity are commonly derived from only one of both worlds: Either the world of entrepreneurship with its emphasis on personal traits and characteristics of the entrepreneur, or from the world of large corporations and its focus on singular issues, such as processes or organizations. SME research is stuck in the middle, being the step-child of two unlikely parents who live in worlds apart. Specific research, targeted at entrepreneurial small and medium enterprises as a whole, could help to close this gap and to integrate the different approaches in a comprehensive context. A holistic view of the formation and growth process as well as on later stages, using a company-related perspective, is needed in SME research. One approach that could prove helpful is configurational analysis using the concept of Entrepreneurial Orientation. Configurational approaches are helpful particularly in ongoing transformation phases, as common in young companies. Embedding of Entrepreneurial Orientation in the context of the company therefore could establish an instrument that would make it possible to analyze especially small and medium enterprises in all phases of their lifecycle appropriately. The complexity of the enterprise as such as well as of its environment can hereby be described and analyzed in a holistic way, independent of the stage and age of the company, thus providing a bridging of the gap described above.

Keywords Configurational analysis • Entrepreneurial orientation • SME research

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_19

1 Introduction

There is no doubt that young, emerging companies are regularly operating in very complex settings: Markets are often niche markets with hidden characteristics and may be just emerging or developing rapidly, the dependence on business partners and other players may be very high and hard to control, and a number of resources typically prove to be valuable but very rare, and therefore of strategic value (cf. e.g., Bhide, 1994; Santos & Eisenhardt, 2009; Venkataraman, Van de Ven, Buckeye, & Hudson, 1990). Also, especially technical start-ups deal with new technologies that could change the game in major or minor ways, and may have unforeseen implications for both society in general as well as on specific markets. Furthermore, the resource constraints set on most freshly founded, and often underfinanced, companies lead to a high need to manage this complexity in a most efficient way (cf., Lechner & Dowling, 2003; Timmons & Spinelli, 2009)—and all of this has to happen in an area of extreme uncertainty.

One could argue that the complexity found in the environment of the entrepreneurial company is not an inherent attribute of entrepreneurship, but following the deliberate choosing of this specific environment by the entrepreneur: The founder could very well choose to act in a less chaotic environment, i.e. a stable market with little need for rare resources and being not dependent on relationship with partners. However, this does not only contradict the Schumpeterian approach of "creative destruction" and its inherent tendency to (limited) chaos and complexity, out of which new paradigms may arise (cf., Schumpeter, 1912). Also, from a market point of view, these complexities often serve as barriers to entry (Tushman & Anderson, 1986), making success in this environment more difficult, but also more rewarding, leading in the case of success to above-average returns, and therefore attracting entrepreneurs by nature (cf. Forlani & Mullins, 2000).

While the complexity of the environment of the start-up is quite apparent, the complexity inside the organization is considerably smaller at first look. The entrepreneurial team consists rarely of more than three to four people, and limited resources add to keeping the number of employees manageable, in most cases. Therefore, hierarchies are flat, communication channels direct and ways of decisions short, with decisions often made collectively among the founders. Also, the need to use resources efficiently often takes companies with inefficient and overly complex processes in an early stage right out of the market. This may not be the whole picture, though: Complexity may arise from the fact that most processes are still very informal and subject of constant change. Such may be change in personnel, with not only acquiring additional staff (and therefore additional knowledge and skills) that have to be incorporated, but maybe even loosing important members, whose skills and knowledge have not been absorbed by the company and are therefore hard to replace. Also, the business model or production processes may change, or the product range may be adjusted or extended, as is quite common in the growth process. All of these changes will lead to needs to adapt by other parts of the organization, and therefore to more complex day-to-day operations.

This situation changes quite drastically with time: The environment of the company becomes more stable over the years, with more mature markets, smaller growth rates and more forgiving relationships. On the other hand, surviving companies often have grown to a significant size, thus having a more complex organization as well as more defined processes. Hierarchies and specializations make the decision making process more formalized, which clear responsibilities. Product development has often reached a higher level so that further improvements will not be as drastically as in the first years, and research advances may not be incorporated as fast as in the beginnings. Consequently, the complexity of small and medium enterprises in general is differing significantly from the complexity of start-ups—not necessarily in the amount of complexity, but in the type.

2 Researching Small and Medium-Sized Entrepreneurial Companies

Many concepts have been transferred to the Entrepreneurship and small- and medium enterprise (SME) sector from large corporation research (Tan, Fischer, Mitchell, & Phan, 2009; Torrès & Julien, 2005), arguing that the most successful companies will grow into large-scale corporations, eventually, and may therefore be seen just as 'small large companies'. Thus, relatively little research has been undertaken to develop tools and methods specifically for entrepreneurial SME, or at least to adapt existing tools based on theory building, not only on empirical testing.

While this must not necessarily be a problem, it turns out that most methods and tools are not used for research in entrepreneurial SME because of their great use and valuable contributions, but merely because they are already there, and are already used on (seemingly) similar research subjects. Tan et al. (2009, p. 242) emphasize:

> [T]o date, it is arguable that relatively little of our energies as researchers studying small entrepreneurial firms have been devoted specifically to theory building. To a much greater extent, we have tested, and occasionally marginally refined, theories developed to explain the behavior of larger firms.

This leads to the situation that most tools used today in (entrepreneurial) SME research are neither developed specifically for entrepreneurial SMEs, nor argued for if they account for the specific complexity of small and medium entrepreneurial enterprises. This lack of targeted research and theoretical background that could serve as a base for empirical studies and the development of approaches as well as theories should be seen as a critical issue.

Instead, the methods and tools used for SME research are commonly derived from only one of both worlds: Either the world of entrepreneurship with its emphasis on personal traits and characteristics of the entrepreneur, or from the world of large corporations and its focus on singular issues, such as processes or organizations. SME research is stuck in the middle, being the step-child of two unlikely parents who live in worlds apart.

The decision to use approaches from only one of the two worlds, general business administration or Entrepreneurship, is mostly due to practical considerations. Research often derives concepts and theories from other research subjects, which again focus on partial aspects. For example, a number of studies center on the entrepreneur himself as object of research, while other approaches use organizational theories which do not include the founder's personality at all. In general, intersections or interfaces between these approaches which would allow a cross-over view using both theoretical lenses do not exist. Thus, a continuous, integrated analysis over time is hardly possible. Shane and Venkataraman (2000, p. 217) summarize the problem:

> As a result, many people have had trouble identifying the distinctive contribution of the field to the broader domain of business studies, undermining the field's legitimacy. Researchers in other fields ask why entrepreneurship research is necessary if it does not explain or predict empirical phenomena beyond what is known from work in other fields. Moreover, the lack of a conceptual framework has precluded the development of an understanding of many important phenomena not adequately explained by other fields.

This is not a purely theoretical problem: The methods management consultants use for entrepreneurial SME are either based on entrepreneurship consulting (which consists mostly on financial advising and counseling the entrepreneur), or large company consulting, which consists of advice in specific areas, such as process or innovation consulting. This seems not to be a successful way of providing support for entrepreneurial SMEs: Bennett and Robson (1990) find that consulting for SMEs has relatively small impact on business success, with less impact than e.g. (business) friends, customers or (external) accountants. Chrisman (1989) finds in his empirical study that operational and administrational advice from consultants are not found valuable by entrepreneurs, even if they sought specifically for that type of advice. The reason for this could be found in the failure of understanding the specific needs of entrepreneurial organizations: Rind Christensen and Klyver (2006, p. 305) states that literature agrees that "the main problem in consultancy is how to define the problem in the organization", both in consulting small and large enterprises. Accounting for the variation of complexity of companies in different stages, as described above, therefore seems to be necessary when solving this problem.

Specific research, targeted at entrepreneurial small and medium enterprises as a whole, could help to close this gap and to integrate the different approaches in a comprehensive context (cf. Torrès & Julien, 2005). The specific characteristics of the company need to be taken into account regardless of stage and age of the company. Therefore, a holistic view of the formation and growth process as well as on later stages, using a company-related perspective, is needed in SME research. This perspective allows to look at attitudes and behavior of both individuals as well as organizational units (Covin & Lumpkin, 2011) and would lead to a deeper understanding on how entrepreneurial action is performed. Moreover, it enables a distinction of the enterprise as such from the attitudes and behaviors of the individuals that form the company (Covin & Lumpkin, 2011), making thereby the next step from most entrepreneurial approaches that focus on the entrepreneur as

such. Also, an instrument is needed that addresses the company as a whole, not restricted on single aspects or organizational units of the company and therefore trimming complexity unnecessary.

3 Configurational Approaches in the Field of Entrepreneurship

Configurations (also called archetypes) contain "elements or items that represent a single domain or an aspect of organizations, such as environment, structure, or strategy" (Dess, Newport, & Rasheed, 1993, p. 776). Miller (1996, p. 510) emphasizes the importance of configurations for the company's success: "Configuration, in short, is likely to be a far greater source of competitive advantage than any single aspect of strategy."

Mintzberg, Ahlstrand, and Lampel (1999) explain further that configuration approaches are helpful particularly in ongoing transformation phases, as common in young companies. Embedding of Entrepreneurial Orientation in the context of the company therefore establishes an instrument that makes it possible to analyze especially small and medium enterprises in all phases of their lifecycle appropriately. The complexity of the enterprise as such as well as of its environment can hereby be described and analyzed in a holistic way, independent of the stage and age of the company, thus providing a bridging of the gap described above. Hence, a configurational approach could help to solve the second problem stated above: By accounting for the complexity not only of the organization, but also of its environment in an integrated model.

To account for this holistic approach, the inclusion of different perspectives is necessary. Miller (1987) states that the creation of archetypes of enterprises is basically determined by four imperatives: (1) the environment of the company (including the available technology), (2) the organizational structure, (3) the leadership and (4) the strategy of the company. A change in at least one of these imperatives is a prerequisite for a change of the configuration of the company, and thus for the transition from one archetype to another. Miller (1987) also assumes that configurations, while influenced by all of these imperatives, are in most cases dominated by one of the imperatives. However, he also notes that especially in phases of transition, several imperatives may have influence on each other, thus creating an area of tension in specific archetypes.

Hence, the key for configurational approaches to provide value in the research of entrepreneurial SMEs is the selection of the right variables to describe the research object. Again, usually applied variables are often based on entrepreneurship research, and therefore too dependent on the personality of the founder, or based on research of large corporations, using variables that cannot be measured effectively in small enterprises (e.g. Bruhn, Karlan, & Schoar, 2013; Brunswicker & Vanhaverbeke, 2015; Colombo, Piva, & Rossi-Lamastra, 2014). Thus, what is

needed are measures that span the company's lifetime and organizational growth and can be applied in any state, regardless if the founder is still with the company.

As discussed above, there are four domains determining the definition of archetypes: Structure, leadership, strategy and the environment of the company are imperatives for determining the configuration. First, we will discuss how these domains can be integrated in empirical analysis, i.e., which observable variables can be used that are available also for small and medium-sized companies. Here, we will include well-used variables from the literature, the "usual suspects" used in configurational research. Then, we will expand this first model by including Entrepreneurial Orientation and discuss its implications.

The domain that proves to be least difficult to describe for SMEs is the environment domain. Since the environmental challenges are the same for companies of all size and age, researchers can use established measurements from both entrepreneurship and business research.

The influence of its environment on the company is determined by three main factors, as Dess and Beard (1984, p. 55) explain. With reference to Aldrich (1979), they name the areas of availability of resources ("munificence"), market dynamics and complexity.

The greater the availability of resources in an industry, the higher the amount of reserve assets a company can hold, thus affecting its behavior and attitudes, such as willingness to take risks (cf. Boyd, 1995, p. 305). The availability of resource is according to Aldrich (1979, p. 55) primarily depending on market growth. According to Simerly and Li (2000, p. 38f.), Market dynamics also have significant impact: "[A]s the degree of environmental dynamism varies across industries, it is reasonable to expect that there should be significant differences in the adaptive capabilities required for survival, and that these differences should have performance implications."

Complexity is described by Boyd (1995, p. 306) as inequality of competitors in a given market. However, the competitive structure of an industry does not only lead to more or less complex environmental conditions, but even to more or less hostile conditions. As Covin and Slevin (1989, p. 82) explain: "[T]he findings do suggest general differences in the effective strategic management of small firms in these [hostile resp. benign] environments". They find that the reason for this is the necessary capacity for structural adjustment in hostile environments (cf. Hall, 1980) and for the use of different leadership styles (see Khandwalla, 1976).

While those measures can be easily adapted from organizational and entrepreneurship, this is much more difficult for the three domains of structure, leadership and strategy.

To describe the structure of the company, the size of the organization as well as its maturity can be used. Both of these variables are available for small companies and are well-used in configurational research (e.g. Anderson & Eshima, 2013; Child & Hsieh, 2014; Raymond & Croteau, 2006; Swoboda, Meierer, Foscht, & Morschett, 2011). However, relatively speaking, the structure of the company is for small enterprises less relevant, compared to the other domains (cf. Miller, 1987).

This is also due to the fact that the spread of possible values is relatively small for small companies.

Leadership in entrepreneurial companies are highly dependent of the ongoing influence of the founder, a variable that is specific to entrepreneurial companies. Ogbonna and Harris (2000) discuss that in management research as a whole, the focus has shifted away from the manager/entrepreneur and his personal traits and characteristics to leadership style and behavioral approaches. Furthermore, a number of studies argue that leadership can be measured by level of hierarchies, incentive and monitoring systems, and organizational aspects as controlling and planning systems or degree of specialization (e.g. Greenwood & Hinings, 1993; Hart, 1992; Mintzberg, 1979). Organizational aspects are, in turn, of course also dependent on the structure of the company, especially the before-mentioned aspects size and maturity of the organization. One might argue that these variables may be even more useful when measuring leadership than structure.

Measuring the strategy aspect of SMEs can prove to be quite difficult. Observing the implementation of strategies, like using R&D expenses as measure for innovation, is quite difficult in small companies with no dedicated R&D facilities or even departments. Due to resource restrictions, a number of strategies are also not feasible for SMEs, resulting in similar strategic approaches for most of the smaller companies: Miller (1987) argues that SME strategies build mostly on efficiency, such as cost leadership. This concentration of SMEs on a small number of strategies does not speak in favor of using 'implemented strategy' as a measure.

A number of studies fall back on observing the strategy building process, i.e. not what strategies are used, but how are those strategies derived (e.g. Hart, 1992; Kollmann & Kuckertz, 2006; Miller, 1983), thus including organizational aspects.

With the exception of environment, one can argue that the domains are overlapping to quite an extent, having similar or even the same measures to observe different aspects of the configuration. Furthermore, a number of measurements are working in large enterprises, but are not feasible in smaller companies, especially in the field of strategy. Here, a concept is needed that offers not only practical measures that can be obtained in small-as well as in medium and even large companies, thus allowing to observe the growth path of a company with an integrated tool. Furthermore, it should also offer a holistic view, filling the gaps between the dimensions and linking them together.

4 Entrepreneurial Orientation and Archetypes: A Holistic Approach

One inclusive approach that may prove helpful here is the concept of "Entrepreneurial Orientation". This approach, differing from many other concepts in entrepreneurship research, shifts the focus of analysis from the entrepreneurial behavior

of individuals within a company to behavior or characteristics of the organization itself (Lumpkin, 2011).

Entrepreneurial Orientation is conceptualized usually in three to five dimensions. According to Miller (1983), an organization can only be seen as entrepreneurial oriented if it is willing to (1) take on risk, (2) is innovative, and (3) proactive in the market; Lumpkin and Dess (1996) also find the factors (4) autonomy, and (5) competitive aggressiveness to be important.

It is important to understand that Entrepreneurial Orientation is not a replacement of existing analyses, but rather an addition to the toolkit of the entrepreneurial scholar that helps to cover the entrepreneurial process. This is a crucial point, since it does not limit the concept on new ventures, but opens it for all kind of entrepreneurial behavior. Fayolle, Basso, and Bouchard (2010, p. 716) define Entrepreneurial Orientation as "a collective mindset that encourages and facilitates firm's entrepreneurship behaviours [sic!]". Covin and Slevin (1991, p. 8) emphasize the behavioral aspect as well: "A behavioral model of entrepreneurship is suggested because behaviors rather than attributes are what give meaning to the entrepreneurial process. An individual's psychological profile does not make a person an entrepreneur. Rather, we know entrepreneurs through their actions. [. . .] In short, behavior is the central and essential element in the entrepreneurial process."

However, Entrepreneurial Orientation is not necessarily limited to behavior of the entrepreneur as a single person, but may also refer to the behavior of a company, thus allowing for analyzing companies as a whole and is not limited to a department or an individual (Covin & Wales, 2012). It therefore provides a tool that can model the entire lifecycle of an enterprise and integrates elements of entrepreneurship as well as organizational and strategy research.

Thus, Entrepreneurial Orientation seems to add by allowing exploring new ventures over several lifetime stages, while still keeping the entrepreneurial mindset in focus, thus accounting for the first problem stated above.

Recently, most of the research on Entrepreneurial Orientation focused on it either as a summarized and therefore undifferentiated view of the five components, or on each dimension independently and isolated from each other (Covin & Lumpkin, 2011). A configurational approach to study the composition of Entrepreneurial Orientation itself has been largely neglected (Miller, 2011). However, such an approach may significantly improve our understanding of the development of Entrepreneurial Orientation in the process of corporate development; especially in the context of an external operating environment (see Covin & Lumpkin, 2011; Miller, 1983, 2011). Meyer, Tsui, and Hinings (1993) confirm that configurational approaches provide a holistic view.

We have therefore shown that a configurational approach using Entrepreneurial Orientation may have the potential to provide a stage-independent instrument for analysis of the entrepreneurial company that takes the complexity of organization as well as its environment into account. Also, we have argued for the applicability of configurational approaches in the field of entrepreneurship. Next, we will discuss how Entrepreneurial Orientation could be used in building archetypes. Finally, we

will analyze empirically if the inclusion of Entrepreneurial Orientation will bring additional value to configurational analysis of entrepreneurial SMEs.

5 Entrepreneurial Orientation and the Configurational Imperatives

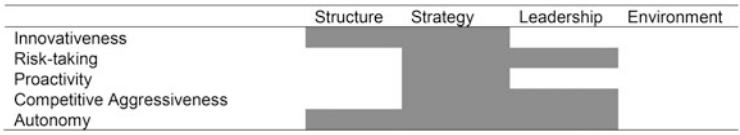
Recent work (Jambulingam, Kathuria, & Doucette, 2005; Wiklund & Shepherd, 2005) use Entrepreneurial Orientation explicitly as an overarching construct, spanning various domains. Each of its dimensions can be seen as an aspect of one or more domains, as shown in Table 1 and discussed in the following paragraphs.

Miller (1983, p. 777) assigns the Entrepreneurial Orientation dimensions of proactivity, risk taking, and innovativeness, as well as entrepreneurship in general, to the strategy domain. Covin and Slevin (1989, p. 79) use the same three elements to represent the "strategic posture" of the company. Lumpkin and Dess (1996, p. 136) emphasize that Entrepreneurial Orientation, including the dimensions of autonomy and competitive aggressiveness, derives from the strategy selection of the entrepreneur. However, entrepreneurship and Entrepreneurial Orientation cannot be seen as purely strategic elements. The attitudes manifested in an organization's Entrepreneurial Orientation are having effects not only on the company's strategy, but also on its behaviors and structures.

The innovativeness of a company can be seen as part of its strategy. The ability to innovate, whether in technical or market, is a competence of the company. Innovativeness as the decision to use these skills in business and to promote them further is a strategic decision, as Miller and Le Breton-Miller (1996) discuss. However, the structure of the company may support implementing this strategy by including the definition of work tasks, i.e. the degree of specialization and cooperation of employees (cf. Saleh & Wang, 1993, p. 15f.).

Also, its risk orientation is partly due to a conscious decision of the company's management about its fundamental orientation, and can therefore be located in the field of the strategy (see Miller & Friesen, 1977). However, more evident than with innovation, the personality of the decision maker in the company plays a decisive role, as Nicholson, Soane, Fenton-O'Creevy, and Willman (2005, p. 170) argue.

Table 1 Categorizing the dimensions of Entrepreneurial Orientation-according to the four imperatives of Miller (1987)



This rather speaks for an assignment to the leading domain, as is done for example in Gartner (1985).

Proactivity is often associated with the domain of strategy, for example by Miller and Friesen (1977), or Julien, Joyal, Deshaies, and Ramangalahy (1997). Lumpkin and Dess (1996, p. 146) emphasize its connection with first-mover strategies (see Lieberman & Montgomery, 1988) and refer to Miller and Friesen (1978, p. 923), which formulate the main question for proactivity: "Does it shape the environment?" All these mentioned points speak for an allocation of proactivity in the strategic domain.

According to Lumpkin and Dess (1996, p. 148), the dimension of competitive aggressiveness refers on the tendency of a company "to outperform industry rivals in the marketplace", which indicates a strategic allocation. Based on Porter (1985), they further state that the target of competitive aggressiveness is "to achieving competitive advantage" (Lumpkin & Dess, 1996, p. 149). An allocation to the strategic imperative seems appropriate, although Miller (1983, p. 785) here as well as for risk orientation, emphasizes the influence of the entrepreneurial personality, which would allow an association to the leadership domain.

Employees of a company that show a certain autonomy lead to the formation of a particular strategy of this company. Mintzberg (1978, pp. 945ff.) notes that in addition to the explicit strategy of the company, it often also develops an emergent strategy out of its modus operandi. Hart (1992, pp. 338ff.) developed such an emergent strategy development as part of its integrative framework and called it "generative mode": "Strategy is made via intrapreneurship—new product ideas emerge upward, and employee initiative shapes the firm's strategic direction." Lumpkin and Dess (1996, p. 141) argue that "the freedom to act independently" is a prerequisite for such initiative by the employees of the company, while high formalization and rigid hierarchies within the organization may hinder it. Hence, autonomy may be allocated either to the field of leadership or structure; Lumpkin and Dess (1996) call it "organizational autonomy". In total, the different dimensions of Entrepreneurial Orientation cover three of the four imperatives given by Miller, with environment as the only aspect not covered. Thus, Entrepreneurial Orientation seems a possible instrument for analyzing entrepreneurial companies over its lifespan as a whole.

As we have seen, the strategy domain is widely covered by the Entrepreneurial Orientation of a company. The different dimensions of Entrepreneurial Orientation all have strategic reference and cover both the content and the process component of the corporate strategy (cf. Ansoff, 1965).

The structural domain can be found in the Entrepreneurial Orientation dimensions of autonomy and innovativeness. However, the size of the company is a limiting factor for both of these dimensions especially in the area of SMEs. Therefore, size will also be included in the analysis, as well as the degree of maturity of the organization, measured by the age of the company.

Risk-taking, competitive aggressiveness and autonomy constitute the domain leadership. The continued activity of the founder will also be included, since in

smaller enterprises, entrepreneurial managers have a great deal of power, as Daily, McDougall, Covin, and Dalton (2002, pp. 390ff.) discuss.

6 An Empirical Analysis of the Contribution of Entrepreneurial Orientation

While we have discussed that configurational analysis based on Entrepreneurial Orientation may be a valuable instrument, its contribution to analyzing complexity is still unclear. Thus, in the next part of this chapter, we will carry out an empirical analysis to see if configurational analysis including Entrepreneurial Orientation adds significant value in analyzing the complexity entrepreneurial SMEs.

To do so, we will compare what configurations can be found in a sample of 744 German SMEs with or without including Entrepreneurial Orientation measures. Our goal is to see if adding Entrepreneurial Orientation to the analysis will allow a more detailed view on the internal and external complexities that face an entrepreneurial SME.

6.1 Sample Description and Operationalizing of the Variables

The sample used in this analysis is based on an online survey that was distributed between April and August 2012. In multiple rounds, ca. 49,000 emails where delivered to companies and self-employed persons in Germany, taken from a business database.[1] 8250 recipients opened the questionnaire, with 1049 recipients finishing all questions.

In the questionnaire, Entrepreneurial Orientation was selected using a 7-point Likert scale. Besides Entrepreneurial Orientation, several statistic data was inquired, such as number of employees, revenues, age of company, and if the founder of the company was still actively involved.

For the questionnaires that were completed, the internet domains of the email addresses were inspected to map the respective companies to one of 21 industries, using the NACE-classification 2.0. During this process, a number of responses were dismissed since they were not given by members of a business, but by members of societies, families or private individuals. The remaining responses were then anonymized.

Based on the industry mapping, each case was then assigned the respective market's competitiveness and dynamics. Following Boyd, Dess, and Rasheed (1993), these data are calculated using historical indices. The Herfindahl-

[1] Discover Europe Package EUROPA 2010—Discover Germany—Companies.

Table 2 Variables and their operationalizing

Entrepreneurial orientation	
Innovativeness	Assessment by employees
Risk-Taking	Assessment by employees
Proactiveness	Assessment by employees
Competitive aggressiveness	Assessment by employees
Autonomy	Assessment by employees
Company structure	
Size of the company	Assessment by employees
Age of the company	Assessment by employees
Leadership	
Founder still active	Assessment by employees
Environment	
Market dynamics	Classification of industry sector
Complexity resp. market competitiveness	Classification of industry sector
Availability of resources	Classification of industry sector

Hirschman-Index (HHI) is a measure for competitiveness and is given by the monopoly commission of Germany each year. In this study, we use the report of the commission given in 2012, containing the data for 2009. Market dynamics are calculated following Simerly and Li (2000, p. 40f.; cf. Boyd, 1995; Dess & Beard, 1984; Keats & Hitt, 1988). They are based on the variance of sector's sales over a time span of 5 years—in this case, 2004 until 2008, as given by the German Federal Statistical Office in the years 2001–2012 (for example, Statistisches Bundesamt, 2010, p. 615). To use this data, the industry branch codes had to be transferred from NACE 1.1 to NACE 2.2. This data was also used to calculate the availability of resources, following Boyd (1995, p. 312).

A final dismissal of responses was necessary because of missing data for a number of industries. Companies of the sectors "agriculture and forestry/fishing", "Mining and quarrying", "Public administration, defense, social security" and "education" were removed from the sample. The final data set used for the analysis was ultimately compromised of 744 companies.

Table 2 gives an overview of the used variables and their operationalization.

6.2 Methodology: Cluster Analysis

To Search for structural similarities in multivariate data sets, the concept of cluster analysis has been proven helpful. Cluster analysis methods are heuristic methods for the classification of observations (of objects or individuals) in similarity groups. They are being used successfully in the field of strategy research (see, for example Hatten, Schendel, & Cooper, 1978; Langan-Fox & Roth, 1995; Zahra & Covin, 1993). The aim is to find groups whose members differ in terms of classifying

characteristics from members of other groups as much as possible, but are homogeneous among the members of one group.

A probabilistic cluster analysis is used, namely the implementation of the 2-step cluster analysis of the software package SPSS IBM Corp, 2011a). As a distance measure, the log-likelihood method is applied, which can be used with both continuous and categorical variables. To determine the number of clusters, both the Bayesian Information Criterion (BIC) and the Akaike information criterion (AIC) are used. The log-likelihood distance measure is principally composed of a normal distribution for continuous and categorical variables. For the present record, these distributional assumptions cannot be confirmed for any of this variable, but empirical tests showed that the software used is fairly robust against violations of these assumptions (IBM Corp, 2011b).

6.3 Results of the Empirical Analysis

To see if Entrepreneurial Orientation leads to a significant contribution in describing entrepreneurial firms, we will compare the resulting archetypes with and without inclusion of the Entrepreneurial Orientation variables. A first analysis shows the cluster analysis not including Entrepreneurial Orientation results in a total of seven clusters, with a silhouette coefficient of 0.6—a value that, according to Kaufman and Rousseuw (1990, p. 88), is linked with reasonably structured data.

In a second step, we introduce the Entrepreneurial Orientation variables as additional data points into the analysis. By including this data, we control for Entrepreneurial Orientation and see if this changes the outcome of the analysis, i.e. the model as such as well as its measures of clustering. By doing so, we essentially control for Entrepreneurial Orientation.

The differences of both analyses are shown in Table 3.

The difference can already be seen in the number of clusters developed by the algorithm. Seven different archetypes are found without the inclusion of

Table 3 Members of clusters including Entrepreneurial Orientation × Members of clusters without Entrepreneurial Orientation

# of companies		Cluster without EO							Total
		A	B	C	D	E	F	G	
Cluster with EO	1	274	0	0	5	0	0	0	279
	2	0	94	0	1	0	0	0	95
	3	0	0	132	6	0	0	0	138
	4	0	0	0	1	78	64	0	143
	5	0	3	0	35	0	42	0	80
	6	0	0	0	0	0	0	9	9
Total	274	97	132	48	78	106	9	744	

Entrepreneurial Orientation, while six archetypes are developing with Entrepreneurial Orientation included in the analysis. While a number of clusters remain (virtually) the same by the inclusion of Entrepreneurial Orientation (i.e., 1-A, 2-B, C-3, 6-G), the clusters D, E, F and G are restructured by using the additional data. To a great part, cluster 5 consists of a combination members of the old clusters D and F, with Cluster F leaving its remaining members to clusters 4 and disappears. The diversity of the results of both models is also confirmed by a chi-square test: A chi-square value of 3161.26 results in a significance of 0.000, showing significant differences in both values. Also, the inclusion of Entrepreneurial Orientation leads to a significant drop of the silhouette coefficient to 0.27—a value that, according to Kaufman and Rousseuw (1990), may point out a weak structure that may be artificial.

Both of these results, the change in the number of clusters in the resulting model as well as the loss of silhouette, strengthen our point that including Entrepreneurial Orientation in the analysis of entrepreneurial small- and medium-sized enterprises makes a difference and may help to cover the complexity of these entities in a more complete picture.

7 Conclusion

As we have argued in this chapter, the use of configurational approaches, accompanied by the use of Entrepreneurial Orientation as measure for structure, strategy and leadership, may have significant impact on developing appropriate tools for analyzing entrepreneurial companies over several life-time stages. Contrary to other tools used in this area of research, this approach is not just adapted from other fields, but may provide a distinctive look at the complexity of small and medium-sized entrepreneurial companies and their environment, that cannot be offered by tools coming from the field of entrepreneur-centered research or research on large companies. Accordingly, our empirical analysis also showed that including Entrepreneurial Orientation in the analysis has significant influence on the resulting archetypes.

Thus, the application of the nowadays well-used Entrepreneurial Orientation in configurational research may help to develop a better understanding of the complex, yet neglected field of entrepreneurial SMEs.

7.1 Implications of this Study

The implications of these findings are important for both the scientific as well as the practical sector. In the scientific community, the introduction of Entrepreneurial Orientation may allow analyzing entrepreneurial companies from their founding over a longer time of their lifespan, making it possible to understand the complex

development of the company as a whole over time. This holistic approach may also help to improve counsel and consult for the owner of these companies as well as the managers. By considering the characteristics of the firm at any time, not only existing tools can be applied more accurately, but also new tools and methods can be developed that take the complex situation of the company into account, compared to reacting just to the environment of the firm.

7.2 Limitations of the Study

This study, naturally, has a number of limitations. First, while the argument for including Entrepreneurial Orientation can probably be fitted to most types of analysis, we focus on configurational analysis. This is mostly due to the fact that configurational analysis is well known for handling complexity, as we have explained earlier in this chapter. However, in studying entrepreneurial SMEs, their complexity should be accounted for regardless the methods applied. We believe that most points we make can be applied with other methods, as well.

Second, the empirical analysis we undertook does not add great value in understanding the complexity of entrepreneurial SMEs as such. The resulting archetypes are not described in depth, neither are they discussed with regard to their specific characteristics. Also, especially the archetypes resulting from the full set of variables do not offer great differentiation, as can be seen on their low silhouette values. However, this is not necessarily a problem: Since the goal of this exercise is not to provide excellent archetypes, but to show that the inclusion of Entrepreneurial Orientation leads to significantly different archetypes. While we have argued in this study for the usefulness and possibility of including Entrepreneurial Orientation in the analysis of entrepreneurial SMEs, the actual application and the task to build meaningful and conclusive models that help to understand the complexity of this companies will hopefully be found in other papers.

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Part IV
Semantic Methods

Capturing the Complexity and Ambiguity of Academic Fields: Determining Consensual Definitions for Small Business Research, Entrepreneurship and Their Shared Interface

Andreas Kuckertz and Christoph Mandl

Abstract Small business management and entrepreneurship are clearly related phenomena but certainly not synonymous. We seek to capture and disentangle this complex relationship between both fields by employing a large-scale survey of small business and entrepreneurship scholars and a content analysis of published research from both areas, from which we derive an implicit consensual definition of each field and the interface between them. Our findings suggest the presence of a relatively strong common bond within the fields that enables researchers to reflect multiple perspectives, while still maintaining each field's distinctiveness.

Keywords Academic field • Content analysis • Definition • Entrepreneurship • Small business

1 Introduction

Small business and entrepreneurship research are undoubtedly related domains. To judge by the volume of published articles, conference contributions and the number of endowed professorships and chairs both fields are flourishing and knowledge of them progressing (e.g. Katz, 2008; Kuckertz, 2013). However, the rapid advances in small business and entrepreneurship research are accompanied by ongoing definitional, conceptual, and methodological challenges (e.g. Davidsson, 2003; Gibb, 2000; Grant & Perren, 2002; Wiklund, Davidsson, Audretsch, & Karlsson, 2011). When scholars describe the attributes of their respective fields, they commonly use terms like *fuzzy*, *fragmented*, and *open to varied interpretations*. The multidisciplinary character of both fields and specificity concerns within the domain of management sciences (Bruyat & Julien, 2001; Shane & Venkataraman, 2000; Stevenson & Jarillo, 1990) make definitions problematic (Davidsson, 2003).

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_20

Broadly agreed definitions for the domain of small business, entrepreneurship research, and the interface between them, which can be seen as the foundation of any framework, are still lacking.

Small business and entrepreneurship research seem clearly distinct from each other only on a surface level, since their adjacent boundaries have become indistinguishable from each other. Such blurring of boundaries presents a challenge to scholars working in both (comparably young and rapidly expanding) fields. As every entrepreneur starts small, the question might be raised as to whether entrepreneurship research could simply be a subdomain of small business research, or viewed from another perspective, perhaps small business research should be viewed as residing in the domain of entrepreneurship research. There is a substantial need for discourse and reflection on the essential nature of both fields and their interface. We seek to close this gap by addressing the following research questions: What is the essential nature of small business and entrepreneurship research, and what is the nature of their interface? Answering those questions will involve attempting to disentangle the close relationship between both fields and establishing a foundation for a broadly agreed conceptualization of both research domains that will contribute to the legitimacy and prosperity of both fields.

When a field is fragmented and its boundaries blurred, it is legitimate to ask scholars what they perceive to be the defining elements of their field, since ultimately, it is the community of researchers that must share a common view of what defines their paradigm (Bruyat & Julien, 2001; Kuhn, 1962). To address this problem, we followed a procedure suggested by Nag, Hambrick, and Chen (2007) and content analyzed published research to disentangle the relationship between small business management and entrepreneurship by conceptualizing consensual definitions of (a) small business research, (b) entrepreneurship research, and (c) the interface between both fields. We do not aim to impose rigid or closed definitions since to do so might harm the future development of both fields given the dynamic and multidisciplinary character of both domains. Instead, our definitions are intended to reflect scholars' latent perceptions of what currently constitutes their field.

To achieve this objective, we conducted a multiple-stage analytical process. As a first step, we asked a large panel of entrepreneurship and small business scholars to read 248 abstracts of articles appearing in leading small business, entrepreneurship and management journals and to evaluate the degree to which specific articles seemed to be a small business article or an entrepreneurship article. Building upon the article categorization, we identified the distinctive lexicon of each field using automated text analysis software. Finally, we constructed the implicit consensual definitions of small business and entrepreneurship research as well as their shared interface from the views of the research community. We conclude the paper by discussing the implications of our analyses for the field and proposing further applications and extensions of our research.

2 Past Efforts to Define the Fields

First, in order to recognize hierarchical structures in the organization of scientific knowledge, we follow accepted convention and differentiate terms like *phenomenon*, *field* and *discipline* as they are often used interchangeably (Zahra & Newey, 2009). By *field*, we mean aggregated areas of study populated (or even dominated) by several key theories that relate to a certain phenomenon (e.g. entrepreneurship or small business) and which inform scholars about the core questions that shape the boundaries of that field. Fields, in turn aggregate to *disciplines*, which share similar objectives to fields, only at a higher level of aggregation. Naturally, disciplines (e.g. economics, psychology etc.) co-evolve through research and the evolution of institutional structures such as cross-field publications or cross-field conferences.

2.1 Small Business

In the domain of small business research, there is as yet no broadly accepted definition of the field. Instead, scholars usually refer to quantitative or qualitative definitions of the small business phenomenon to conceptualize the very nature of their field (see Table 1). When it comes to quantitative attempts to define the concept, the definition is usually reduced to the question of how small a business needs to be to qualify. Most scholars follow policy makers in their classification of small businesses (e.g. the European Union or the U.S. Small Business Administration). The size standards usually include quantitative criteria such as number of employees, sales or balance sheet totals. However, there is no broadly agreed quantitative definition of a small business (Storey, 1994) whereas the appropriateness of the selection and setting of these criteria for research practice is itself subject to discussion (Curran & Blackburn, 2001; D'Amboise & Muldowney, 1988; Peterson, Albaum, & Kozmetsky, 1986).

Relying on quantitative definitions is convenient and appears to be objective and transparent. However, applying quantitative criteria is associated with major drawbacks. Most importantly, quantitative definitions do not inform researchers about the essential building blocks of their field, so gradually add to the impression of small business research as a research context. Moreover, size standards are dependent on specific sectors, and therefore pose challenges for researchers trying to draw generalizable conclusions. Finally, these small business definitions fail to help delimit small business research, because they give rise to tautological definitions along the lines of small business research being concerned with researching small-sized businesses.

Definitions that go beyond size to incorporate qualitative attributes to describe the nature of the small business phenomenon are scarce. Scholars usually refer to the Bolton Committee's Report on Small Business (1971, as cited by Storey, 1994). According to the committee's economic definition, small businesses must satisfy

Table 1 Small business and entrepreneurship definitions related to their field or phenomenon

	Small business	Entrepreneurship
Field		● [Entrepreneurship research investigates] the creation of new organizations (Gartner, 1989) ● [Entrepreneurship research explores] (1) why, when, and how opportunities for the creation of goods and services come into existence; (2) why, when, and how some people and not others discover and exploit these opportunities; and (3) why, when, and how different modes of action are used to exploit entrepreneurial opportunities (Shane & Venkataraman, 2000)
Phenomenon	● A small business venture is any business that is independently owned and operated, not dominant in its field, and does not engage in any new marketing or innovative practices (Carland, Hoy, Boulton, & Carland, 1984) ● [Criteria for a small firm; distinguishing it from a large firm] Small size, management centralization, low level of specialization, an intuitive or informal strategy, an uncomplicated or unorganized internal information system, a simple external information system (Julien, 1997) ● [Small firms must satisfy three criteria] (a) having a relatively small share of their market place, (b) being managed by owners or part-owners in a personalized way and not through the medium of a formalized management structure, and (c) being independent, in the sense of not forming part of a larger enterprise (Bolton Committee, 1971) ● [Characteristics of a small firm that distinguish it from a large firm] Uncertainty, Innovation, Management and Evolution (Wynarczyk, Watson, Storey, Short, & Keasey, 1993) ● A business in which there is no public negotiability of common stock, and a business in which the owners must personally guarantee any existing or any planned financing (Osteryoung & Newman, 1993)	● Entrepreneurship is an act of innovation that involves endowing existing resources with new wealth-producing capacity (Drucker, 1985) ● Entrepreneurship is a process by which individuals-either on their own or inside organizations-pursue opportunities without regard to the resources they currently control (Stevenson & Jarillo, 1990) ● Entrepreneurship is a process of making changes; doing something different, thus creating wealth for the individual and adding value to society (Kao, 1993) ● Entrepreneurship is a way of thinking, reasoning, and acting that is opportunity driven, holistic in approach, and leadership balanced (Timmons, 1997) ● Entrepreneurship is about how, by whom, and with what consequences opportunities to bring future goods and services into existence are discovered, created and exploited (Venkataraman, 1997) ● The entrepreneurial process can be conceptualized as the creation and extraction of value from an environment (Anderson, 2000)

three criteria: (a) having a relatively small share of their market, (b) being managed by owners or part owners in a personalized way and not through the medium of a formalized management structure, and (c) being independent, in the sense of not forming part of a larger enterprise. There has been considerable criticism of this definition. For instance, one of the Bolton Committee's quantitative criteria is that a small business might have 100 employees, a characteristic that would certainly militate against it being managed in a personalized way.

Following the Bolton Committee's economic definition, more recent efforts to describe the phenomenon have predominantly been concerned with the question of how to distinguish small businesses from their larger counterparts (Julien, 1993; Wynarczyk et al., 1993). Torrès and Julien (2005), for instance, claim that small businesses could be distinguished from larger enterprises based on a number of traits such as centralized management, a low level of labor specialization, intuitive and short-term strategies or a focus on the local market. To extend the criticism of Curran (2006), these qualitative definitions fail to illuminate the specific relationship with entrepreneurship, because most of the suggested attributes would apply equally to the field of entrepreneurship.

2.2 Entrepreneurship

Examining past efforts to define the field of entrepreneurship reveals an enormous diversity (see Table 1) in the scope of definitions and in the way people understand and convey the notion of the phenomenon (Gartner, 1990). While an agreed-upon definition may serve to unite the field, research activity seems to fall under different approaches, each with its own focus of attention and underlying set of beliefs (Cunningham & Lischeron, 1991; Davidsson, 2003). This is particularly challenging as the resulting studies, albeit useful, may cover only limited aspects of the phenomenon while underlying values and assumptions can infiltrate the field.

Various definitions of the phenomenon are grounded implicitly or explicitly on the entrepreneur as the primary definitional unit. Entrepreneurship is then seen as the outcome of an entrepreneur's actions, characteristics and attributes (Stevenson & Jarillo, 1990). Definitions of this kind are often too vague and/or cover just a portion of the field. To elucidate, for instance, Anderson (2000, p. 91) defines entrepreneurship as the 'creation and extraction of value from an environment'. Definitions following this pragmatic perspective, alongside various conceptualizations, predominantly account for the multidisciplinary and very fragmented character of the field but at the expense of informing us what the research domain of entrepreneurship is really all about, and how it might differ from that of small business research.

The prominent definition of Shane and Venkataraman (2000) extends this pragmatic view and puts greater emphasis on the concept of opportunity as the defining feature of entrepreneurship research. Regardless of the advances in entrepreneurship research, the very nature of opportunities makes the definition difficult

to operationalize. In particular, the opportunity view could be criticized for being too vague to be informative for entrepreneurship researchers (Davidsson & Tonelli, 2013; Zahra & Dess, 2001). Moreover, relying on the opportunity construct does not shed sufficient light on conceptual differences between entrepreneurship and the domain of small business since the idea of exploiting opportunities in essence applies to any active participant in any market, including entrepreneurs as much as small business managers. Nonetheless, the opportunity view may arguably represent the best effort to date to delineate entrepreneurship as a distinct scientific field (Davidsson, 2003).

Alternatively, scholars argue that entrepreneurship research should be studied from a process perspective where definitions center around the formation of firms or organizations (Gartner, 1989). Increasing the emphasis on new firm formation facilitates the transfer into research practice since it can be measured more conveniently than the identification, evaluation, and exploitation of opportunities. However, this view is not universally accepted either. Shane (2012) argues that firm formation can also be undertaken by people in existing firms or through market mechanisms. Besides, while the opportunity view is criticized as being too broad and vague, the alternative perspective is criticized for being too narrow to cover the full dimension of entrepreneurship research (Davidsson, 2003).

2.3 The Interface of Small Business and Entrepreneurship

Scholars from both fields migrate back and forth between the research domains and/or their parent disciplines, attend joint conferences, and publish in the same journals. These shared structural foundations may also nurture conceptual communalities that are in turn reflected in the nature of the interface between both fields. However, until recently, scholars have not attempted to describe the nature of this interface. To our knowledge, there is neither a definition nor a research agenda for the interface between small business and entrepreneurship research.

A contributing factor to this circumstance might be the absence of a widely accepted definition for the field of small business research. As mentioned earlier, scholars replace this vacuum by conceptualizing their very own qualitative or quantitative definition of a small business that in most cases depends on their individual research context (Storey, 1994). When we turn to definitions describing the small business phenomenon, we find distinctive lexical and definitional elements across these definitions such as *small size*, *independent ownership*, and *not dominant in its field*. However, most of these criteria to describe a small business could equally be applied to entrepreneurial activity. Indeed, despite their potential usefulness to delineate small businesses from their bigger counterparts, they do not inform researchers about the relationship with the field of entrepreneurship.

As mentioned before, relying on the opportunity view (Shane & Venkataraman, 2000), as the best effort to date to define the field of entrepreneurship does not shed sufficient light on the relationship to small business research either, because it

implicitly includes small businesses when they are concerned with the exploration and exploitation of opportunities to create future goods and services (Davidsson, 2003). Consequently, opportunities may serve only as a distinct lexical element for entrepreneurship research that can also be found in many definitions of the phenomenon alongside terms such as *creation process* and *individuals* but not as a distinct definitional element per se that informs researchers about the essential nature of their field and exactly how it relates to small business research.

Apart from the evident lexical differences, both fields clearly merge into one another and their interface has become indistinguishable. It is unclear what are the essential building blocks of each field, where the boundaries between them lie, and more importantly, how each field might enrich the other. This study asserts that establishing the essential building blocks of both fields and defining their shared interface is essential to ensure rigor in research and facilitate theory building. Doing so may ultimately help research in each field to deliver its full potential. Moreover, the intersection of academic fields provides an important forum for creative theory building (Zahra & Newey, 2009) and one that has to date been neglected mainly because of the absence of broadly agreed definitions.

The challenge in defining the field of small business management and entrepreneurship and the interface between them lies in ensuring that any definitions are not too restrictive to reflect the multidisciplinary and fragmented character of the fields. At the same time, a suitable definition should be precise enough to illuminate the nature of the topics and the differences between the field in question and its neighboring domains as well as their parent disciplines. The current research addresses these issues by enquiring of the research community which topics relate to the specific domains. The scholars' answers should help to establish the exact nature of small business and entrepreneurship research, and identify which aspects should be exclusively located in each particular field.

If, as we anticipate, small business and entrepreneurship scholars share an implicit (and perhaps even explicit) consensus on the scope of their respective fields, the relationship between both domains will be exposed. Despite varied theoretical and methodological approaches, and despite the absence of any agreed definition, scholars can be expected to have a broadly shared understanding of what their field encompasses. This implicit understanding can be used to impute consensual definitions of small business management, entrepreneurship, and the interface between them.

3 Data and Method

3.1 Overview of Method

Identifying the unique vocabulary of small business and entrepreneurship research and their adjunct intersection required several steps. First, we developed an online survey including 248 randomly selected titles and abstracts of studies published in

leading small business, entrepreneurship and management journals. Scholars from both fields were asked to classify the titles and abstracts according to the degree to which they deemed each title and abstract to be a small business article, or an entrepreneurship article. Next, we used the panel's ratings to categorize the articles as small business, entrepreneurship, their interface, or neither entrepreneurship nor small business. Using text analysis software, we content analyzed all 248 titles and abstracts to identify the frequently recurring, distinctive vocabulary. Some 25 words appeared in small business titles and abstracts significantly more often than in non-small business titles and abstracts, 28 appeared more often in entrepreneurship studies than in the alternative titles and abstracts and 21 terms were equally rated small business- and entrepreneurship-related and therefore assigned to the shared interface. Finally, the authors worked together to assign the distinctive vocabulary to specific categories based on conceptually related words that contribute to forming the implicit consensual definition of each field and the interface between them.

3.2 Identifying Relevant Texts

The initial step was to generate a pool of articles by randomly selecting from the leading small business, entrepreneurship and management journals selected on the basis of their 5-year impact factor thereby excluding journals with a focus on a subspecialty. Those journals were International Small Business Journal (ISBJ) ($n = 50$), Journal of Small Business Management (JSBM) ($n = 50$), Journal of Business Venturing (JBV) ($n = 50$), Entrepreneurship: Theory and Practice (ETP) ($n = 48$), Academy of Management Journal (AMJ) ($n = 25$) and the Journal of Management (JOM) ($n = 25$) from the volumes for 1991–2011. The aim of the sampling was to ensure a balance between small business and entrepreneurship journal articles. We included management journals as a reference point allowing for statistical analysis due to the distinct lexicon of the field. The 20-year time span broadly covers the fields' research domains, and avoids the problem of overemphasis on the research of a more limited era, therefore mitigating the risk of cycles and momentary fashions. The selected approach to determining the pool of articles to be coded offers several benefits. First, including management articles mitigated rater fatigue or annoyance, which we felt, would have occurred if raters had been asked to rate only small business and entrepreneurship articles. Second, by adding management articles as a reference point, raters were required to make choices that were relatively more discriminating. As a result, the raters' evaluations of the extent to which they deemed articles small business- and entrepreneurship-related, and in turn our extraction of the distinctive lexicon, can be considered relatively conservative.

3.3 Selecting the Panel

We then identified a potential panel by selecting 450 researchers at random from a database compiled by the first author that lists 3500 entrepreneurship and small business researchers who have presented their research at one of the major academic conferences such as the Babson College Entrepreneurship Research Conference or the International Council for Small Business (ICSB) World Conference.

The 450 scholars selected were invited to participate by email and sent a link to a survey. Eleven email addresses proved inaccessible but the action generated 138 useable responses [equating to a solid response rate of 31 % (Baruch, 1999)], which in turn provided 2449 individual ratings.

The panel was diverse in terms of career stage (26 % were professors, 25 % associate professors, 18 % assistant professors, 7 % postdoctoral researchers, 20 % doctoral candidates and 4 % had a different academic status). In terms of primary area of research interest, 73 % reported that to be entrepreneurship, 17 % reported small business and 10 % another research interest. To test for a potential bias between respondent groups, we compared the mean ratings of the 20 most frequently rated titles and abstracts and discovered only one significant difference at the 5 % level suggesting the difference was random. The panel was evidently well acquainted with small business and entrepreneurship research and able to draw on considerable experience, which averaged 11.9 years (*SD* 8.5).

3.4 Classifying the Texts

Each panelist was given access to a web-based survey containing the titles and complete abstracts of 248 randomly generated articles. All the formatting was removed to avoid font style, layout, or design influencing the raters' decisions on the applicable field. Each panelist was asked to rate the titles and abstracts on two separate four-point scales; one for small business and one for entrepreneurship: 1 = clearly not small business (SB)/entrepreneurship (E) article; 2 = probably not an SB/E article; 3 = probably an SB/E article; 4 = clearly an SB/E article. A randomization process ensured that each of the 248 articles was rated ten times on average (*SD* 3, *Min*: 3, *Max*: 16). The intraclass correlation coefficient (ICC) for the field of small business of 0.60 ($p < 0.001$) and 0.66 ($p < 0.001$) for entrepreneurship (Nag et al., 2007; Shrout & Fleiss, 1979) indicates the panelists' ratings correlated closely.

The mean ratings offer a scale of the degree to which an article was deemed SB or E. Such an approach, however, would have the unnecessary and unfortunate result of drawing distinctions between every increment of the scale, including between articles with mean ratings of, say, 1.2 and those of 2.0, which clearly was not the intention. Instead, we used a categorical distinction, treating all articles with mean ratings above 3.0 as SB (a total of 77 articles) or E articles (94 articles)

Table 2 Coding of selected examples of article titles

Article type	Mean ratings SB/E	Article titles
Coded as clearly SB	3.7/2.1	Empirical evidence of banking relationships for Spanish SMEs (Iturralde, Maseda, & San-Jose, 2010)
Coded as clearly E	1.8/3.6	The role of entrepreneurship clubs and societies in entrepreneurial learning (Pittaway, Rodriguez-Falcon, Aiyegbayo, & King, 2011)
Coded as I	3.4/3.6	Growth momentum in the early stages of small business start-ups (LeBrasseur, Zanibbi, & Zinger, 2003)
Coded as miscellaneous	1.9/1.6	UK Export performance research: review and implications (Wheeler, Ibeh, & Dimitratos, 2008)

respectively and those with mean ratings greater than 3.0 for SB and E as the interface (I) between both domains (14 articles). The categorization process is illustrated in Table 2, which offers examples of the titles of several articles and the panel's ratings.

An overview of where the classified abstracts were published is provided in Table 3. This overview reveals the essential nature of the journals in our sample.

Interestingly, small business topics seem relatively rare in the classic entrepreneurship journals such as JBV and ETP, whereas the classic small business journals such as ISBJ and JSBM seem to serve a bridging function between the fields by publishing a substantial number of entrepreneurship articles alongside those with a primary focus on small business research. The relatively high number of articles published in JBV and ETP classified as being neither entrepreneurship nor small business (32 % and 23 % respectively) can be ascribed to studies primarily addressing questions around strategic concepts, indicating that these journals serve a bridging function as well, but rather in the direction of the strategic management domain.

3.5 Extracting the Distinctive Lexicon

To elicit the distinctive vocabulary of small business and entrepreneurship research, we conducted a computer-aided content analysis of titles and abstracts using NVivo software. Compared to surveying keywords or even whole articles, analyzing titles and abstracts concisely presenting the main points of a study represents an efficient way to identify the distinctive lexicon of small business and entrepreneurship research. The limitations on the number of keywords set by journals means that analyzing them would have produced unreliable results, and the resources required to analyze whole articles would be prohibitive (Cummings & Daellenbach, 2009).

Following the procedure suggested by Nag et al. (2007), we decided to focus on individual words because the alternative of examining entire phrases, word groups or word relationships has obvious drawbacks. For instance, phrases such as *venture*

Table 3 Journals and classification of articles

	Small business journals		Entrepreneurship journals		Management journals	
	ISBJ	JSBM	JBV	ETP	AMJ	JOM
Percentage of purely SB-articles	52	58	10	13	–/–	4
Percentage of purely E-articles	30	22	52	58	4	–/–
Percentage of Interface articles	10	10	6	6	–/–	–/–
Percentage of other articles	8	10	32	23	96	96
$n = 248$						

capital, *opportunity recognition* and *entrepreneurial orientation* are commonly used within both domains, but predetermining these phrases would have led to significant bias in our analytical procedure. Besides the biased a priori judgment, the great number of possible word combinations inhibits systematic and proper analysis. Scrutinizing individual words minimizes these biases and we therefore chose it as our analytical approach.

Our content analysis yielded over 42,000 words. To make this large body of text analytically tractable we imposed multiple restrictions on the words we would include in our analysis, but in a way that would not bias the results. First, we excluded duplicates, proper nouns, prepositions, articles, numbers, and certain common descriptors. Next, we consolidated all variations of a root word (for example finance, financial, financed) leaving 1696 unique root words remaining. Then we excluded all words that appeared fewer than ten times among all our abstracts. This was our most significant restriction, but the intention was to establish an essential and distinctive lexicon. This analytical procedure yielded a total of 469 unique root words, or lexemes, which became the basis for our analysis.

The next step identified words that were far more prevalent in those abstracts coded by our raters as small business (ratings $SB > 3$), entrepreneurship (ratings $E > 3$) and the interface (ratings SB and $E > 3$) than in abstracts rated as neither small business nor entrepreneurship (SB or $E \leq 3$). For each word, we calculated the biserial correlation between (a) the number of times the word appeared in an abstract and (b) whether the abstract was coded SB, E, I or miscellaneous. A total of 25 words appeared in small business abstracts with significantly greater frequency ($p < 0.05$) than in non-small business abstracts, 28 in entrepreneurship studies ($p < 0.05$) and 21 at the interface of both fields ($p < 0.05$).

3.6 Imputing the Implicit Definitions

This inductive exercise was undertaken in an iterative manner. First, we developed tentative categories consisting of conceptual clusters of words derived from our text analysis individually for each field and their shared interface (Nag et al., 2007). For example, in the field of entrepreneurship, several words were associated with

individuals (e.g. entrepreneur or founder), some referred to growth (e.g. development, drive or improvement), some dealt with creation (e.g. start, new or build), while others could be attributed to other tentative categories. The full list of the categories for each field and the interface between them is provided below.

Next, we turned to existing definitions to identify conceptual elements recurring when scholars define the phenomenon and/or their field. By relying on past efforts to define the phenomena and/or field and comparing them to our tentative conceptual categories, we were able to identify the major elements in the implicit, consensual definition of each field and their shared interface. Whenever possible, we used the conceptual nomenclature from existing definitions, but at the same time, we did not want to be constrained by prior definitions. Finally, the authors collaborated to assign the remaining words of each field and their shared interface to their respective conceptual categories, paying particular attention to definitional fit and coherence within each category. To ensure parsimony and to maintain simplicity, we developed as few definitional elements as possible, so that every word could be assigned to just one category, although they could also be related to additional categories. Moreover, if the meanings of words were at all ambiguous (e.g. change, growth, etc.), we turned to their specific context before assigning them to a specific category or labeling a definitional element to avoid misinterpreting the terms. By relying on the context in which a specific word most frequently occurred, we were able to make more fine-grained decisions in our attribution and labeling procedure.

4 Results

4.1 Small Business Definition

Analysis of the results on small business research produced 25 distinctive words, which were arranged in four definitional elements. Consequently, we were able to devise the following definition for the field incorporating its distinctive vocabulary:

> Small business research explores how a) management practices b) for small firms c) can help overcome barriers to internationalization, innovation or commercialization d) resulting in organizational change.

The first definitional element, ‘management practices’, as shown in Table 4, is signified by words such as ‘establish’, ‘implement’, and ‘adopt’ which refer to the use of relatively deliberate, planned initiatives whereas ‘skills’, ‘personality’ and ‘orientation’ can be attributed to leadership as a means to initiate organizational change. The second element of the small business definition, ‘for small firms’ specifies the scope of application whereas, as imputed from the distinctive lexicon, ‘size’ remains critical for the field of small business research. The third definitional element, ‘can help overcome barriers to internationalization, innovation or

Table 4 Distinctive vocabulary of small business research

Distinctive words	Word frequency	Correlation of word count and categorization	Definitional elements ("Small business research explores how...")
Management	97	0.22**	...management practices...
Ethics	23	0.13*	
Orientation	20	0.14*	
Personality	16	0.13*	
Skills	10	0.16*	
Firm	171	0.20**	...for small firms can help...
Business	148	0.37**	
SME	70	0.39**	
Ownership	62	0.26**	
Size	45	0.31**	
Enterprise	21	0.15*	
Manufacturing	19	0.22**	
International	38	0.18**	...overcome barriers to internationalization, innovation or commercialization...
Innovation	35	0.14*	
Export	34	0.19**	
Barrier	12	0.18**	
Marketing	10	0.16*	
Markets	10	0.13*	
Change	58	0.14*	...resulting in organizational change.
Establish	18	0.13*	
Internal	17	0.15*	
Adopt	15	0.18**	
Implement	11	0.16*	
Decline	10	0.13*	
Intensity	10	0.15*	

Boldface words formed the conceptual clusters of words; the remaining words were added in a second step with particular regard to coherence and definitional fit
**$p \leq 0.01$; * ≤ 0.05

commercialization' addresses common challenges faced by small businesses such as expanding internationally, innovation management, or the commercialization of products and services, which is signified by words such as 'marketing', 'markets' and 'export'. The final element of the definition, 'resulting in organizational change', comprises terms such as 'change', 'decline', 'intensity' and 'internal' that are devoted to the inbound impact management practices have on their firm.

4.2 Definition of the Entrepreneurship Field

The analytical procedure identified 28 unique words for the field, which led us to create the following definition for entrepreneurship research:

> Entrepreneurship research explores how a) individuals b) on the basis of opportunity c) effectively organize d) any e) growth-oriented f) creation process.

The first definitional element, 'individuals', as shown in Table 5, is represented by words such as 'entrepreneur', 'expert' and 'founder' who are at the same time the key actors and focal unit of analysis in entrepreneurship research. We also included 'psychology' in this element since its very nature is clearly related to individuals. In the second element of the definition, 'on the basis of opportunity', we assembled words such as 'potential' and 'return' which are commonly applied attributes of opportunities. Moreover, we included 'need' due to it being closely related to this element.

The third definitional element, 'effectively organize', pertains to the goal-oriented way entrepreneurs assemble and arrange resources. This element consists of terms such as 'importance', 'key' and 'specific', each of which indicate that the resources in use are scarce and have to be arranged economically. The fourth element, 'any', indicates a potentially broader context of entrepreneurship. In particular, the terms 'EO' and 'culture' could be attributed to corporate entrepreneurship (Kollmann, Kuckertz, & Stöckmann, 2009) whereas 'sustainability' could be predominantly linked to the domain of social entrepreneurship (Kuckertz & Wagner, 2010).

The fourth element, 'growth-oriented,' conceptualizes the key objectives or outcomes of interest in the field; words such as 'development' and 'improvement' align with this definitional element. Finally, the sixth element, 'creation process', contains words such as, 'new' 'create' and 'build' that each reflect the emergence of something that did not previously exist.

4.3 The Interface of Small Business and Entrepreneurship Research

To capture the form of the interface between small business and entrepreneurship research, we arranged the 21 distinctive words in three definitional elements, resulting in the following definition for the boundary-spanning space between both fields:

> The interface of small business and entrepreneurship research explores a) which resources, skills, abilities, competences, and cultural factors b) support growth strategies c) in small firms.

The first definitional element, 'resources, skills, abilities, competences, and cultural factors' is devoted to the resources and capabilities entrepreneurs and

Table 5 Distinctive vocabulary of entrepreneurship research

Distinctive words	Word frequency	Correlation of word count and categorization	Definitional elements ("Entrepreneurship research explores how...")
Entrepreneur	374	0.57**	...individuals...
Founder	41	0.15*	
Psychology	11	0.15*	
Expert	10	0.14*	
Opportunity	42	0.24**	...on the basis of opportunity...
Potential	27	0.13*	
Need	24	0.17**	
Return	20	0.13*	
Importance	54	0.16*	...effectively organize...
Effective	16	0.13*	
Specific	15	0.13*	
Key	14	0.15*	
Goal	10	0.14*	
Sustainability	21	0.14*	...any...
Culture	15	0.15*	
EO	10	0.14*	
Growth	109	0.13*	...growth-oriented...
Development	86	0.24**	
Capture	17	0.14*	
Become	14	0.13*	
Improvement	13	0.13*	
Drive	10	0.14*	
Venture	172	0.22**	...creation process.
New	98	0.19**	
Process	72	0.15*	
Create	53	0.30**	
Start	24	0.14*	
Build	13	0.17**	

Boldface words formed the conceptual clusters of words; the remaining words were added in a second step with particular regard to coherence and definitional fit
**$p \leq 0.01$; * ≤ 0.05

small business managers use to implement and support their growth strategies, as is shown in Table 6.

Apparently, cultural factors are important, signifying the importance of internal and personal adjustment to growth and to an increasingly complex organization. The second definitional element 'support growth strategies' refers to words such as 'international' and 'orientation' implying means and initiatives tailored to the firm and directly linked to 'growth' aspirations. Finally, the focus of attention and primary level of analysis in the interface between small business and entrepreneurship research is the 'small firm'.

Table 6 Distinctive vocabulary of the interface of entrepreneurship and small business research

Distinctive words	Word frequency	Correlation of word count and categorization	Definitional elements ("The interface of small business and entrepreneurship research explores. . .")
Ownership	25	0.19**	. . .which resources, skills, abilities, competences, and cultural factors. . .
Behaviour	15	0.18**	
Skills	13	0.17**	
Culture	13	0.20**	
Competence	12	0.14*	
Person	12	0.15*	
Resource	11	0.16*	
Requirement	10	0.15*	
Ability	10	0.15*	
Human	10	0.22**	
International	42	0.28**	. . .support growth strategies. . .
Strategy	32	0.21**	
Growth	24	0.22**	
Sales	17	0.25**	
Support	15	0.18**	
Orientation	12	0.16*	
Start	10	0.13*	
Business	47	0.22**	. . .in small firms.
Small	36	0.34**	
Industry	11	0.21**	
Company	10	0.16*	

Boldface words formed the conceptual clusters of words; the remaining words were added in a second step with particular regard to coherence and definitional fit
**$p \leq 0.01$; * ≤ 0.05

5 Discussion and Implications

This research revealed that small business and entrepreneurship research are clearly related but distinct areas of research. This study employed a community of researchers to shed light on the relationship between both fields, since those researchers constitute and shape the nature of their field and have an implicit (or even explicit) understanding of what constitutes their research domain. Based on the distinctive lexicon of each domain, we were able to impute consensual definitions for small business and entrepreneurship research and also for their shared interface, in other words, the boundary-spanning space where both fields potentially enrich each other. We did not aim to impose rigid or closed definitions since to do so might have harmed the future development of both fields, given the dynamic and multidisciplinary character of both domains. Instead, our definitions are intended to reflect scholars' latent perceptions of what really constitutes their

field. Taken together, the three definitions clarify the distinctive domains of both areas of research and illuminate how the two fields are interrelated.

Kuhn (1962) asserted that a scientific community does not need a unifying paradigm to exist, but it does need a shared identity. Our research contributes to an understanding of what constitutes the identity of the field of small business and entrepreneurship research. Despite the fact that scholars active in both fields have diverse but complementary conceptual lenses and tools, their assessments of the fields' implicit definitions correlated to a significant extent, suggesting that there is a relatively strong common bond within each field which, in turn, partly explains the rapid advances in both domains.

Despite the absence of a widely accepted definition for the field of small business research, scholars exhibited a profound understanding of what shapes their field. In this regard, the consensual definition of the field differs fundamentally from the qualitative and quantitative efforts used to conceptualize the small business phenomenon. This is because it represents the way the community of researchers thinks about their field, rather than the way they should, or might, or want to think about the field. Thus, the originality of small business research lies in both its phenomena and its research objects. Accordingly, the consensual definition of small business research might represent a first attempt to further conceptualize the essential building blocks of the domain.

The small business definition, based on the distinctive lexicon of the field, reveals the field of small business research apparently to be more problem focused and addressing a number of common challenges faced by small businesses. The field is evidently able to absorb and benefit from a variety of approaches to framing and exploring small business issues. This problem-oriented view of small business research shifts the current perception of the field as a research context encompassing any business satisfying certain size criteria (SMEs to the same degree as entrepreneurial ventures) to one of a proprietary research agenda primarily concerned with overcoming firm-specific barriers. This change in perspective might not only lead to enhanced theory building but also strengthen the legitimacy of the field of small business research. Moreover, the definition will help scholars shed light on unexplained phenomena within the field, enhance the quality of research and prevent that small business research is marginalized as only a research setting.

The consensual definition of the field of entrepreneurship consists of six elements, each with several sub-elements. The definition covers the field in a very broad way, allowing for inclusion of phenomena such as social entrepreneurship or corporate entrepreneurship beyond more traditional perspectives on entrepreneurship. Each component can be examined in various ways, so providing fertile ground for research. The current research shows scholars' latent perceptions of the field of entrepreneurship research include the opportunity view (Shane & Venkataraman, 2000) to the same degree as the firm formation view (Gartner, 1989). Therefore, the consensual definition bridges both perspectives, perhaps contributing to resolving the ongoing dispute within the field. Moreover, the consensual definition extends both views by introducing growth orientation as a key defining feature of

entrepreneurship research. Evidently, individuals start, operate and exit their own businesses for a variety of reasons apart from maximizing economic returns (Shepherd, Wiklund, & Haynie, 2009). However, all entrepreneurial ventures whether a necessity or opportunity driven firm (Kuckertz, Berger, & Allmendinger, 2015) experience some growth (either intentionally or unintentionally) particularly at the beginning when assembling and allocating their resources.

Following Zahra and Newey (2009), we believe that the intersection of scientific fields provides an important forum for creative theory building as it helps uncover new phenomena that challenge existing boundaries of fields and disciplines, and can also generate new ones. According to our analysis, scholars perceive the relationship between small business and entrepreneurship research as a sequence. In other words, entrepreneurship research primarily covers the initial phase whereas small business research is predominantly concerned with issues arising at a later stage. Naturally, the boundaries between the fields are fuzzy, and duplications remain, but those may be particularly useful for the accumulation of knowledge.

As a first step to conceptualizing the shared interface, we have been able to define the nature of this boundary-spanning space. Conceptualizing the interface might help scholars discover further research opportunities. Our analysis identified numerous conceptual elements that permit the exploration of a wide array of theoretical and practical issues related to both domains. Apparently, when entrepreneurship and small business research meet, the entrepreneurial idea is utilized in a positive way to help small businesses achieve growth.

The proposed consensual definitions are based on retrospective data. Nonetheless, they represent scholars' current perceptions on small business and entrepreneurship research and give some indication of where both fields are heading. For the field of entrepreneurship research, we anticipate the emergence of new concepts besides entrepreneurial orientation, sustainability and culture. Those new concepts might shape the very nature of the field as well as our future perception of it. Unlike small business research, which apparently borrows concepts predominantly from the traditional management domain, the field of entrepreneurship may extend the entrepreneurial idea to other unconventional fields resulting in new or modified concepts (e.g. entrepreneurship as an instrument of personality development or entrepreneurship in primary and support activities in a firm's value chain beyond entrepreneurial marketing or entrepreneurial finance). For small business research, we believe that the existence of concepts such as marketing, internationalization and innovation within the distinctive vocabulary of the field signals a clear dependence on traditional management practices, however, as seen by our analysis, not at the expense of risking the distinctive identity of the field. Nonetheless, the field may benefit from increased research efforts on the internal processes of small businesses where organizational change actually happens.

6 Future Research

This study suggests several opportunities for future research. First, the relationship between small business management and entrepreneurship research could be examined from other angles. We based our analysis on the lexical distinction revealed in article abstracts in leading small business and entrepreneurship journals. Future research could complement our findings by contrasting both fields based on other meaningful criteria such as methodology, applied concepts, or underlying theories, assuming the availability of suitable source materials in sufficient quantity (Bort & Schiller-Merkens, 2011; Dobusch & Kapeller, 2013). Moreover, we examined only those journals with the highest 5-year impact factor, excluding less influential academic journals and other publication channels (Fülbier & Weller, 2011). Future research might incorporate those additional sources.

Our objective was to disentangle the relationship between small business management and entrepreneurship; therefore, we cannot draw any conclusions on how both fields differ from or relate to other academic fields and disciplines. The limits of the current research mean a second research avenue opens: the methodology might be used to disentangle the relationships between small business management and/or entrepreneurship and other academic fields such as innovation management or strategic management. Our study not only sheds light on the nature of both fields and their shared interface, but also offers an analytic roadmap with the potential to clarify the relationships between other academic disciplines or research domains as well.

Finally, further research could replicate our assessment in the future. In particular, tracking changing perceptions of both fields over time seems to be a promising avenue. As mentioned before, the fuzzy and fragmented character of both fields might result in an altered scope and essence for either or both. In a similar vein, in order to arrive at the consensual definitions, we had to omit words that appeared only rarely. Therefore, analyzing which words emerge, how perceptions evolve, and how implicit consensual definitions change over time could offer valuable insights.

7 Conclusion

The current research used content analysis to identify consensual definitions for small business and entrepreneurship research as well as to identify the interface between them. Scholars from both fields are linked by a fundamental implicit understanding of what their fields are really all about. Therefore, distilling the essence of small business and entrepreneurship research and disentangling their relationship not only illustrates the latent perception held by the community of researchers, but also contributes to a profound understanding of how transfer and mutual exchange works between both fields. The definitions proposed here are

therefore an important building block that will help both fields to cohere, maintain momentum, and shape their identity.

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What Do Organizations Think Are Their Risks and Uncertainties? Risk Self-Assessments Within Securities Reports as a New Source for Entrepreneurship, Innovation and Technology Research

Terje Grønning

Abstract One of the major complexities of innovation as well as entrepreneurship and technological change processes is that larger or lesser financial and non-financial risks and uncertainties are parts of these processes, since the courses as well as outcomes of the processes are not known in beforehand. Assuming that managers and employees within entrepreneurship, innovation and technology firms are themselves concerned about this aspect of their businesses, it becomes pertinent for researchers to gain an understanding of what their perceptions regarding risks and uncertainties are. Relevant research designs could include e.g. surveys or interviews, whereas this chapter focuses on a possible supplementary approach consisting in using the securities reports submitted to the authorities as a new kind of source for relevant information. The chapter makes use of illustrative quotes from the sections in the securities reports of four biotechnology companies located in the USA and Japan, countries where self-assessments regarding risks the company is facing was made mandatory from 2005 and 2004 respectively. The chapter also includes a section with some suggestions as for how this new source may be utilized within future entrepreneurship, innovation and technology research, and concludes with stating that there are significant promises in connection with using the source, although there are also some challenges.

Keywords Annual reports • Medical biotechnology • Retrospective reports • Risk perceptions • Securities reports

1 Introduction

Drucker (1959) insisted that innovation equals risks in a number of respects. Some risks are associated predominantly with the financial aspects of the corporation and, ultimately, with the sustenance of an organization's activities. Such risks concern

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_21

the possibility of the organization's services or products becoming obsolete already at the time of implementation. Other risks or uncertainties are related to the broader consequences of successfully implemented innovations in the sense that the innovation may have unintended effects in addition to the originally intended effects. These dimensions are to some degree also relevant in connection with processes involving entrepreneurship and technological change (cf. e.g. Alvarez & Barney, 2005).

Studies of how organizations perceive of (or are unaware of, conversely ignore) the risks or uncertainties they are facing should therefore be highly relevant to entrepreneurship, innovation and technology (EIT) research. However, one persistent research challenge concerns how to access the risk perceptions of the researched organizations. One prevalent method for obtaining this information is to conduct a survey, which may result in an overview of how companies perceive of risks, but this approach may nevertheless have its drawbacks such as low response rates or possible problems due to so called common method variance problems, i.e. "variance that is attributable to the measurement method rather than to the constructs the measures are assumed to represent", (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003, p. 879; see e.g. Avolio, Yammarino, & Bass, 1991, for a discussion). Within this method there may be a potential lack of reliability related to uncovering what the perceptions actually are, as well as what they may have been in the company's past (Huber & Power, 1985; March & Shapira, 1987, 1992). Interviews are obviously a feasible alternative, although the issue related to gaining reliable knowledge about current and past events may occur also in this case (Schwenk, 1985). The interview method has also got its resource constraints, especially if the study involves a large number of firms.

In this paper I will hence discuss the feasibility of a source which might serve as an alternative or supplement to surveys and interviews. The approach consist in examining the statements regarding how the company perceives risks relevant to EIT research issues within the securities reports submitted each year to the authorities. Securities reports differ from annual reports and press releases aimed at stockholders and at the general public since they are written for the specific purpose of reporting to the authorities. The companies are obliged by law to offer as truthful information as possible when it comes to financial performance and strategic priorities.

The main idea behind the approach being proposed within the chapter is thus to regard the information contained within these securities reports as a potentially useful source for information when one wants to analyze risk perceptions of firms. The paper is consequently structured as a presentation of some ways of handling securities reports, followed by a discussion of how the securities reports' information regarding risks may be beneficial for EIT research purposes. The first upcoming section contains four parts, and I first explain the way the securities reports are structured in the case of USA and Japan. There is subsequently mention of some studies within finance and accounting where securities reports have been used as a source. The section continues with an explanation of how the main sections of the chapter approaches this source by way of qualitatively assessing the statements and

order them into categories of risks in the vein of the influential framework differentiating between risk types as developed within research on integrated risk management (Miller, 1992). Potential risks as seen from the perspective of the organization are here classified as being related to their origin in either the environment, in the industry in which the organization operates, or within the organization itself. The reference to the existing influential framework on integrated risk management offers some advantages to analyses such as these, such as analytical guidance as well as a link to preceding research within general organization theory.

In the subsequent Sect. 3, I examine the way one may extract the relevant information regarding risks from the securities reports, while focusing on risks and uncertainties originating in the external environments of firms. Section 4 focuses on risks and uncertainties internal to the firm. Since there are references throughout to four different firms these two sections thus serve the purpose of presenting the way one may extract as well as categorize risks based on a multi-firm sample, as well as discussing the relevance or potential of this information when it comes to comparing trends across a number of firms. Section 5 briefly introduces the potential of this source when it comes to applying it to longitudinal studies, by way of introducing data also from past reports for two different firms. Section 6 summarizes the preceding sections in the form of contemplating the advantages and shortcomings of securities reports as a source, as well as in the form of presenting a list of suggestions when it comes to eventually using this source in connection with research projects. The chapter then concludes by stating that there are some challenges in connection with using this material as a potential source, however, since these changes are largely surmountable the perceptions regarding risks and uncertainties as reported within securities reports could definitely be a valuable source addition to future research within EIT field.

2 Methodology

In this section I first briefly describe the way the securities reports are structured, and present selected previous studies which have utilized the securities reports as a source. The section continues with presenting the main facets of a framework which categorizes between different types of risks and uncertainties according to their presumed origin, and which is used as a point of reference within later sections. Finally, the firms used as examples within the chapter are presented.

2.1 The Securities Reports

The institution of securities reports submission is formally known by different names in various countries, and the requirements connected to the report submission may also vary somewhat. In this chapter the discussion is delimited to reports

submitted in the USA and Japan respectively. In the USA the main type of such reports is called "Annual Report on Form 10-K" (sometimes abbreviated as Form 10-K) and is administered by the US Securities and Exchange Commission (SEC). As for Japan, the report is called "Report regarding shareholding" (i.e. "Yuka Shoken Hokokusho" and sometimes abbreviated as Yuho) and is administered by Japan's Financial Services Agency (FSA).[1] As mentioned previously, the authorities began requesting the risk self-assessments within the securities report in the USA and Japan from 2005 to 2004 respectively. The US Item 1A "Risk Factors" includes information about the most significant risks that apply to the company as it sees it. According to SEC (n.d.) companies generally list the risk factors in order of their importance. In practice, this section focuses on the risks themselves, and not on how the company addresses those risks. Some risks may be true for the entire economy, some may apply only to the company's industry sector or geographic region, while some may be unique to the company (SEC, n.d.). On the other hand, Item 7 "Management's Discussion and Analysis of Financial Condition and Results of Operations" (MD&A) gives "the company's perspective on the business results of the past financial year" (SEC, n.d., p. 2) and is supposed to present "management's views of key business risks and what it is doing to address them" (SEC, n.d., p. 2).

The Form 10k includes in addition still another section which is potentially highly relevant for research into risk perceptions of firms, which is Item 7A "Quantitative and Qualitative Disclosures about Market Risk". It should be noted that due to space and resources constraints the material included in in the descriptions and discussions below is delimited to Item 1A, although also e.g. Items 7 and 7A are obviously highly relevant and should most probably be included in concrete research analyses which want to make use of securities reports as a source.

The Japanese Yuho contains an Item 4 called "Risks in connection with operations etc." (i.e. "Jigyo-to no risuku"). Within its Part I "Information about the company" (i.e. "Kigyo joho"), Section 2 "Status of operations" (i.e. "Jigyo no jokyo"). This item thus corresponds roughly to the US Form 10k's Item 1A, and is the focus of the chapter. The Japanese Yuho portion which corresponds to the US Form 10k's MD&A is in Part I "Information about the company" (i.e. "Kigyo joho"), and is Item 3 "Contents of operations" ("Jigyo no naiyo") within Section 1 "Overview of the company" (i.e. "Kigyo no gaikyo"). It is worthwhile to note that the Yuho also includes a closely related Part 1, Section 2, Item 3 "Issues which should be addressed" (i.e. "Taisho subeki kadai"). As in the U.S. case these two Items are also highly relevant when addressing how companies perceive risks and should be included in comprehensive analyses, whereas the examples in this chapter are restricted to only the first of these three Items.

In Japan, the FSA has issued a guideline for how to handle the securities reports submission procedure including a portion designated to the risk perceptions related section. Here there are 11 points of general guidance, ranging from "Special issues

[1] The translations from Japanese sources within this chapter are all done by the chapter author.

pertaining to the corporate group" to "Regarding the future" (FSA, 2015, p. 69 and 72). The guideline thus suggests a rather comprehensive view of what may be understood as risks and uncertainties. The 11 points are, however, suggesting variations of formulations and is by no means any direct guidance as for, e.g., the number of risks to be included nor in what sequence they should be listed. Nevertheless, under the last point "Regarding the future", there is a list of 20 risk factors ranging from "Significant reduction of sales" to "Significant damage to brand image" (FSA, 2015, p. 72), which the FSA suggests might be addressed by the company. However, they also mention that also this list should not be regarded as conclusive.

When reading the U.S. Item 1A and the Japanese Item I-2-4 the first impression is that there is a lack of standardization, at the same time as the companies (based on my limited sample) seem to follow a more or less common logic when listing a series of risks. Companies tend to operate with headings and sub-headings for each risk topic that is being going to be mentioned, albeit without any standardized form or sequence. In the descriptions below, I extract and categorize types of risks and uncertainties primarily based on the headings and the ways the companies have grouped topics, whereas there are also instances of several types of risks mentioned within one single heading. In these cases each and every topic has been extracted and counted as a separate risk perception.

2.2 Existing Analytical Practices: Some Examples

There have in the past been interesting usages of the annual reports directed at the organization's stockholders and general public as a source within management and organization studies (see e.g. Demil & Lecocq, 2010; Tsang, 2002), but there has hitherto been limited use of the securities reports and their sections regarding risk self-assessments. One recent review only mentions the new trend of risk-related information within securities reports in passing as an example of added external pressures for increased risk consciousness within organizations (Bromiley, McShane, Nail, & Rustambekov, 2015). In contrast, several studies within finance and accounting have used securities reports as a source. I will here briefly describe some of these works.

Within the field of finance and accounting there is, firstly, a research stream focusing on issues such as fraud detection and bankruptcy forecasting. Glueck and Willis (1979) as well as Loughran, McDonald, and Yun (2009) manually checked selected companies' securities reports against their annual reports in order to examine how companies may represent themselves differently in the different discourses. Humpherys, Moffitt, Burns, Burgoon, and Felix (2011), on the other hand, use a kind of textual analysis in order to assess the extent of deceptive language. Shirata and Sakagami (2008) used keywords in their content analysis of Japanese securities reports, and found that there were certain nonfinancial keywords which could be used when assessing the financial position of firms. In a

similar fashion, Mayew, Sethuraman, and Venkatachalam (2013) used the MD&A section of US 10k securities reports in order to assess the likelihood of bankruptcy. Their approach was, however, mixed since it used both an automated content analysis and a manual and qualitative investigation when searching for positive and negative expressions.

Secondly, within the broader topic of financial risks and strategic orientations of firms, Moss, Payne, and Moore (2014) constructed an extensive list of 329 deductive and inductive words representing variations of the activities exploration and exploitation of knowledge in order to assess for the presence or absence of either of these in the content analysis of the securities reports. In contrast, another approach develops and subsequently performs analyses according to a pre-determined set of risk type labels or categories (Huang & Li, 2011). The actual expressions within the documents would then be coded as relevant to one of these risk types. However, since companies may be very diverse when it comes to risk perceptions Bao and Datta (2014) suggest a topic model which is even more sensitive to the empirical material than the Huang and Li (2011) predetermined set of labels. In a research project such a list may then be constructed as a combination of generic factors and factors derived from the empirical material at hand. Similarly, Campbell, Chen, Dhaliwal, Lu, and Steele (2014) designed their research mainly around pre-determined risk subcategories (financial risks, legal and regulatory risks, and tax risks), and subsequently finalized a list of more than 300 keywords for use in scans of the securities reports in order to find the occurrences of these keywords and possible correlations with selected variables.

2.3 Approach Taken Within This Paper

In the examples from the existing literature the focus is predominantly on financial risks, and the approaches using labels and categories are usually not including strategic risk issues which are presumably of utmost interest for the EIT research community. Thus, the chapter benefits from insights regarding classification of risks as developed within another tradition, namely the so called integrated risk management framework focusing on both financial as well as strategic risks. The basic tenet of this framework is to theorize a range of different potential risks according to both their locus of origin as well as the type of activity they concern (Miller, 1992; cf. also Andersen, 2014; Bromiley et al., 2015; Miller & Waller, 2003). One class of risks is constituted by general environmental uncertainties. Miller (1992) subdivides these into five main categories, with a total of 26 specific risk types. The main categories are political, government policy, macroeconomic, social and natural uncertainties. At the next level, industry uncertainties are subdivided into the three main categories of input market, product market, and competitive uncertainties, with a total of nine specific types. Finally, firm uncertainties are comprised by the five main categories operating, liability, R&D, credit and behavioral uncertainties, with a total of eight specific types.

It should be noted that the framework is explicitly developed with multinational corporations in mind, and there seems to be an implicit bias towards theorizing the situation of large corporations. Furthermore, the framework is devised with the issue of how to manage the relevant risks in mind, a focus which goes beyond the focus of this chapter. The framework is, however, analytically based, and may in my opinion be applied with some adaptations as a useful yardstick or point of reference in connection with an exercise such as the one attempted in this chapter consisting in evaluating whether there appear to be particular perceptions of risks prevalent within a specific set of smaller or medium sized high technology firms. The relevant adaptations are explained in connection with the presentations in the upcoming sections.

In summary, existing research using securities reports is predominantly dominated by finance and accounting research using text mining techniques, while the use of an approach relying on the framework on integrated risk management (or on some similar, analytically based approaches) offers some advantages for the EIT research communities if it wants to approach securities reports as a source. These are advantages such as analytical guidance and reference points founded within general management and organization theories.

2.4 Overview of the Firms

The descriptions in the following sections make use of references to actual reports and companies (Table 1), rather than discussing securities reports based on a purely formal or conceptual basis. The chapter does not contain exhaustive analyses of these companies, but rather descriptions of selected aspects in connection with their securities reporting for the purpose of illustrating the way companies formulate how they perceive of risks. AnGes MG is one of the first new dedicated biotechnology firms to be listed on the stock exchange in Japan, and like the U.S. Vical its main activities are within the hitherto rather unproven field of gene therapy. AnGes MG has in addition parts of its revenues from the sales of an in-licensed product which is not gene therapeutic. The two other Japanese firms have in contrast to these two drug discovery focused firms a more diversified activity portfolio, with Carna Biosciences (hereafter called Carna) pursuing a pronounced dual business model where services income contribute to the financing of more long term drug discovery activities. Trans Genic is a more pronounced service firm, albeit with a diversified portfolio across three domains of services.

The companies were chosen due to a number of reasons, where the first is that they may illustrate a number of potential usages of securities reports as a source for risk perceptions information. A researcher might on the one hand be interested in pursuing issues such as converging versus differing risk perceptions in similar firms albeit in different national environments. AnGes MG and Vical are similar in the sense that they are of a similar size and conduct similar activities. It might on the other hand be interesting to investigate any similarities and discrepancies regarding

Table 1 The four companies referred to as illustrations (compiled based on AnGes, 2015; Carna Biosciences, 2015; Trans Genic, 2014, and Vical Inc, 2015)

Company	Main activities	Location, year of establishment and IPO, and number of employees
AnGes MG	Drug discovery within gene therapy, therapeutic vaccines, and sales of in-licensed product	Osaka, Japan Est. in 1999 IPO in 2002 47 permanent and 9 temporary employees
Carna Biosciences	Drug discovery supplies and drug discovery and development related to kinase protein inhibitors	Hyogo, Japan Est. in 2003 IPO in 2008 49 employees
Trans Genic	Genomics-related based on knockout mouse producing technology, contract non-clinical drug efficiency and pharmacological tests, and antibodies and reagents business based on proprietary mouse technology.	Hyogo, Japan (with headquarters in Kumamoto, Japan) Est. 1998 IPO in 2002 32 employees
Vical	Drug discovery within gene therapy and therapeutic vaccines	California, U.S.A. IPO in 1987 68 full-time employees, including 7 with doctorate degrees

Note: Figures as of as of end of 2014, except Trans Genic as of March, 2014

risk perceptions within the same cluster. AnGes MG, Carna and Trans Genic are all located within the same biotechnology cluster in Japan, and do in fact constitute most of the listed medical biotechnology companies within this cluster.[2] Furthermore, the companies are in countries where risk related reporting is an actual and mandatory requirement. Finally, there is a pragmatic reason behind the choice in that three of the companies are part of the chapter author's ongoing research activities when it comes to comprehensive long term case studies, and the companies were chosen for practical purposes instead of finding and describing companies unrelated to ongoing research activities.

3 Risks and Uncertainties External to the Firm

What follows in the three next sections is a presentation of the extracts from the securities reports, starting with extracts which may be interpreted as originating in the general environment and at the industry level (Table 2).

[2] The two remaining companies Soiken and Takara Bio were not included here due to both resource constraints as well as the fact that they differ a lot from the three chosen firms, with the former firm having most of its activities within functional foods and cosmetics and the latter being a subsidiary to a large firm.

Table 2 General environment and industry level risks and uncertainties (compiled based on AnGes, 2015; Carna Biosciences, 2015; Trans Genic, 2014, and Vical Inc, 2015)

	AnGes	Carna Bio	Trans Genic	Vical
General—Policy	1	1	2	2
General—Macro-economic	0	2	0	1
General—Natural	0	1	0	0
Industry—Product market	1	0	0	1
Industry—Competitive—Technological uncertainty	0	3	1	1
Industry—Competitive—Rivalry among existing competitors	1	1	0	0

Note: Main categories and sub-categories based on Miller (1992) except those in apostrophes added by author

There as mentioned a total of five overall categories of "general environmental uncertainties" as proposed by Miller (1992, p. 314), but there are within this sample no explicit examples of the two categories political and social uncertainties.[3] It might be the case that the USA and Japan are perceived by the companies as locations where political upheaval is unlikely, and that social unrest or protest has not been of grave concern to this line of business thus far. When it comes to the "government policy uncertainties" category (Miller, 1992, p. 314), however, all the companies are as of 2014 concerned. This relates to any changes or reforms regarding regulations concerning health systems and medicines. AnGes MG, for example, has concerns about any negative implications of "changes in the Pharmaceutical Affairs Law institution [which] may result in not getting our approvals as according to the original plans" (AnGes, 2015, p. 19).

Macro-economic uncertainties usually concern changes in exchange rates. Carna and Vical are concerned in general, while Carna in addition mentions a specific overseas investment they have made in the foreign currency. Natural uncertainties concern implications from disasters, and the companies might all have selected to include this aspect, since they are located in earthquake-prone regions. However, only Carna insists on flagging this as a separate concern mentioning the possibility of an earthquake and its potentially devastating consequence on their ongoing experiments and products in development due to, for example, long term power stoppages (Carna Biosciences, 2015, p. 22).

Moving down to the level of "industry uncertainties" (Miller, 1992, p. 317) we see that all the companies mention risks which may be interpreted as belonging to the category product market uncertainties. Vical is, as reported above, within the gene therapy business and perceives that:

[3] Indeed, a statement like Vical's "[t]he commercial success of some of our product candidates will depend in part on public acceptance of the use of gene therapy for preventing or treating human diseases" (Vical Inc, 2015, p. 25) may be interpreted as a reference to potential social uncertainties, but I have nevertheless treated this case within another category below.

> Serious adverse events, including patient deaths, have occurred in clinical trials utilizing viral delivery systems to deliver therapeutic genes to the patient's targeted cells. Although none of our current products or studies utilize viral delivery systems, these adverse events, as well as any other adverse events in the field of gene therapy that may occur in the future, may negatively influence public perception of gene therapy in general. If public perception is influenced by claims that gene therapy is unsafe, our product candidates may not be accepted by the general public or the medical community. (Vical Inc, 2015, p. 25)

AnGes MG is incidentally and as mentioned within the same segment of gene therapy, which is a field which is characterized by having thus far very few approved medicines. They have a reflection very similar to Vical's: "Gene therapy is a therapeutic method with a high degree of novelty, and at the present stage one cannot deny an inherent unknown risk and there is also a risk that the approach may not reach diversified forms of application" (AnGes, 2015, p. 18). Product market uncertainties thus concern the very raison d'être of the product in question and eventually the very existence of the companies, and it is thus perhaps not so surprising that the gene therapy AnGes MG and Vical are the cases which are being represented within this sample.

These product market uncertainties do thus differ from competitive uncertainties, such as technological uncertainties or rivalry among existing competitors which are constituted as threats of being overtaken by competitors within an existing field of activity. Vical states that "[c]ompetition and technological change may make our product candidates and technologies less attractive or obsolete" (Vical Inc, 2015, p. 27), while AnGes MG underlines that there "is a possibility that there in the future may appear competitive products or products in development" (AnGes, 2015, p. 19).

4 Risks and Uncertainties Internal to the Firm

There are, as evident from Table 3, a number of risk perceptions amongst the illustration firms when it comes to risks internal to the firm, as classified with the help from the main categories suggested by Miller (1992): Operating uncertainties, liability uncertainties, R&D uncertainties, and credit uncertainties. There are, however, in the case of firms such as these smaller biotechnology firms specific sub-categories of risks which appear to be of a somewhat different type than in the Miller (1992) framework, although still fitting into the main categories. One such sub-category which has been added in order to adapt the relevancy of the Miller (1992) framework to EIT research in general and to biotechnology firms in special is the sub-category sales. This is because turnover attains another meaning in the case of many such firms, with insecure levels and duration of the innovation processes as well as of outputs, and hence uncertainties regarding monetary returns. I have therefore included two different types of sales related uncertainties, where the first type is downstream contract uncertainties. Vical finds it sufficient to mention one downstream type of contracts as a potential risk, when explaining

Table 3 Firm level risks and uncertainties (compiled based on AnGes, 2015; Carna Biosciences, 2015; Trans Genic, 2014, and Vical Inc, 2015)

	AnGes	Carna Bio	Trans Genic	Vical
Operating—"Sales"—"Downstream contracts"	3	2	0	2
Operating—"Sales"—"Marketing"	0	2	0	1
Operating—Input supply	1	3	0	0
Operating—Labor—"Key personnel"	1	1	1	1
Operating—Labor—"Recruiting"	1	1	0	0
Operating—Production	0	1	0	1
Liability—Product	1	0	0	1
Liability—Pollutants	0	0	0	1
R&D—"R&D organization"	1	3	0	2
R&D—"Collaboration contracts"	1	2	1	1
R&D—"Patenting"	1	1	1	1
R&D—"Patent liabilities"	1	1	1	1
Credit—"Stock options"	1	1	1	1
Credit—"Losses/cash flow"	2	3	1	2
Credit—"Cost structure"	1	1	0	0
Credit—"Ownership structure"	0	1	0	1
Credit—"Stock prices"	0	0	0	2
Credit—"Unforeseen expenses"	0	0	0	1

Note: Main categories and sub-categories based on Miller (1992) except those in apostrophes added by author

that in connection with the major pharmaceutical firm Astellas they are in alliance with, they "are dependent on ... license agreements ... to further develop and commercialize" a specified product candidate. Thus, "[t]he failure to maintain these agreements, or the failure of Astellas to perform its obligations under these agreements, could negatively impact our business" (Vical Inc, 2015, p. 21). AnGes MG also decided to disclose contract issues in 2014 as a potential risk, but are more general and vague as for the precise contents of these: "In the case any contracts are discontinued before stipulated time or renegotiated in a disadvantageous way for our group [of companies], this may have disadvantageous consequences for our revenues" (AnGes, 2015, p. 22). The second sales-related type of uncertainty, marketing, is present at AnGes MG, Carna and Vical, and reflects their concerns about the marketing of a specific in-licensed product, the potential changes of long term sales relationships within services, and the lack of marketing or sales experience in general respectively.

Other operating uncertainties include input supply uncertainties in the form of manufacturing services (AnGes MG), dependency on specific machinery suppliers (Carna) and dependency on specific suppliers of raw materials (Carna). Labor uncertainties are by Miller (1992) specified as labor unrest and employee safety, whereas other types of labor related uncertainties are mentioned by these firms, namely the danger of losing key personnel and the probability of not being able to recruit the needed qualified staff. Production uncertainty is mentioned by e.g. Vical,

who says that: "We may not be able to comply with applicable manufacturing regulations or produce sufficient product for contract or commercial purposes" (Vical Inc, 2015, p. 27).

Perceiving of product liabilities as a risk is not very widely represented. Perhaps this is due to the fact that the drug discovery firms will invariably function in alliance with pharmaceutical corporations, and the services firms supply to the processes of other firms, and the product liability issue is left as a specific concern to the client firms. The second liability-related type of uncertainty, pollution, is mentioned by Vical only, and concerns any liabilities resulting from using "hazardous materials in our business" (Vical Inc, 2015).

R&D uncertainty is in overall the problem related to "[u]ncertain results from research and development activities" (Miller, 1992, p. 319), whereas it within EIT research would invariably be desirable to point out specific uncertainties at a more detailed level. I have therefore specified four R&D-uncertainty sub-categories as they are decipherable from the company statements. The first, R&D organization, concerns perceptions like: "Our clinical trials or those of our partners may fail to demonstrate adequately the safety and efficacy of any of our product candidates" (Vical Inc, 2015, p. 22).

R&D-related collaboration contracts are different from downstream contracts in that they are most often horizontal in nature and involve either other small firms or research institutions or universities. All the firms specify that such contracts may entail risks.

Patenting uncertainties are important to the firms in two different senses. One kind of uncertainty mentioned by all the firms concerns the patenting process itself in the sense that they may run out of resources for the costly patenting process or run into other difficulties. All the firms also mention another patent related concern, which has to do with any liability claims from other firms regarding patents.

The final main category at the firm level, credit, is by Miller (1992) defined as problems with collectibles, but I find it both necessary and valuable to operate at a more detailed level and sub-divide into five sub-categories. The sub-category stock options, as mentioned by all four firms, concerns the potential stock market repercussions from instituting incentives to managers and employees in the form of stock options. Losses and a potential lack of adequate cash flow is a highly represented sub-category, in that all four firms mention at least one variant of this uncertainty. The sub-category I have called cost structure is prevalent within AnGes MG and Carna only, and concerns the partial dependency on a particular form of income for the financing of their long term drug discovery research. In the case of AnGes MG this is the in-licensing of an external drug for the purpose of marketing in Japan, and in the case of Carna it is the sales of their own service related products.

Ownership structure concerns the risk related to sudden shifts of ownership and the implications such a change might have for the existing management staff and the company's policies. For the two companies mentioning issues which may be interpreted as constituting such a risk, Carna is preoccupied with the fact that large parts of its ownership consists of venture capitalists in spite of the fact that it since long has been listed on the stock exchange, and Vical is preoccupied with the

possibility of existing shareholders instituting a kind of takeover or displacement of current management. The latter type of risk is actually suggested as a separate firm level risk category by Miller (1992), when he highlights the psychological aspects of such a situation and calls it behavioral uncertainty in the sense that there might be, e.g., shifts or disagreements between "a firm's owners and the managers they employ" (p. 319). It might, however, be sensible to include this type of risk as a sub-category under financial matters, since the potential risk may be seen as emerging from changes of the fundamental ownership and control configurations rather than in particular behavioral modes.

Stock prices and unforeseen expenses are risk factors that are mentioned by Vical only, and concerns in the case of the former the company's volatility to downward movements of stock prices, and in the case of the latter the possible extra use of resources on eventual lawsuits.

5 Changes in Risk Self-Assessments over Time

In Sects. 4–5 the focus was predominantly on the possibilities for variance-oriented research, in the sense that the interpretation and classification of different risk-related statements may be aimed at understanding differences and similarities within a population of firms. In this section I will briefly glimpse into some opportunities for retrospectively oriented processes research which would be more interested in understanding the dynamic evolution of firms. Table 4 shows the 2006, 2010 and 2014 total number of risks as stated by the two firms AnGes MG and Trans Genic, as grouped into risk categories and sub-categories. I will due to space considerations comment on only some of these risk perceptions. For example, variations during 2006–2014 regarding the ways of raising concerns regarding policy are first of all evident in the form of the level of detail and amount of words, with AnGes' description decreasing in volume from about 2/3 of a page in 2006 through ca. 1/3 in 2010 to ca. 1/4 of a page in 2014 respectively (AnGes, 2007, 2011, 2015). On the other hand, Trans Genic perceives an increasing degree of such concerns, partly due to their activities within genetics research involving animals. Compared to both 2006 and 2010, where the treatment of animals was described in general terms, the 2014 report identifies this aspect as a distinctive legal concern, in addition to their preoccupation about any changes to the Pharmaceutical Affairs Law (Trans Genic, 2006, 2010, 2014). Thus, data like these on risk perception could be used in connection with interpreting the situation for different firms before and after societal events, such as changes in legislation.

Product market uncertainties were mentioned all 3 years by AnGes MG and concerns, as already reported above, the nature of gene therapy. Trans Genic, on the other hand, does not have any statements which I could interpret as belonging within this category. On the other hand, Trans Genic is consistently preoccupied with competition issues, where they see their proprietary technology as advanced

Table 4 AnGes MG and Trans Genic risk perceptions in 2006, 2010 and 2014 (compiled based AnGes, 2007, 2011, 2015, and Trans Genic, 2006, 2010, 2014)

	AnGes MG			Trans Genic		
	2006	2010	2014	2006	2010	2014
Policy	1	1	1	1	1	2
Product market	1	1	1	0	0	0
Competitive technology	0	0	0	2	1	1
Competitive rivalry	1	1	1	0	0	0
Downstream sales	2	2	3	2	3	0
Marketing	1	1	0	0	0	0
Input supply	1	1	1	0	0	0
Key personnel	2	1	1	2	2	1
Recruiting	1	1	1	1	1	0
Product liability	1	1	1	0	0	0
Pollution	0	0	0	1	1	0
R&D organization	4	4	1	0	0	0
Collaboration contracts	2	2	1	1	1	1
Patenting	1	1	1	2	2	1
Patent liabilities	1	1	1	1	1	1
Stock options	1	1	1	1	1	1
Losses/cash flow	2	2	2	1	1	1
Cost structure	0	0	1	0	0	0
No payment	1	1	0	0	0	0

Note: AnGes MG data for December 31 each of the years, whereas Trans Genic data are for 31 March each of the years

and competitive, albeit always under the risk of being challenged by competitors with alternative solutions.

Downstream sales signify different things in these two cases, since the former company is predominantly within drug discovery whereas the latter is a services firm. The former company had an initial period with a relationship to a single pharmaceutical corporation, whereas it wanted to add the possibilities for new contracts for their additional projects within gene therapy. This issue has persisted as a concern both in 2006, 2010 and 2014. For Trans Genic the notion of downstream alliances is rather in the form of gaining and sustaining a portfolio of returning clients.

Key personnel is an interesting sub-category in that it appears to be decreasing in importance. The reason for the quantitative decline is, however, that whereas the companies continue to mention the dependency on key staff (such as e.g. the CEO and/or key scientists) throughout the period, another factor consisting in fragility and youth of the firm (and hence potential difficulties regarding recruiting) is no longer as relevant as before (AnGes MG in 2015, and Trans Genic in 2006 and 2010). It is the latter concern which has vanished from the most recent report, meaning most probably that the firms have gained in confidence about their attractiveness as a workplace, although the size as such is virtually unchanged. A

related phenomenon is discernable from the AnGes MG attention on R&D organization in early years, reflecting the various ways a young firm tries out various solutions. This is a concern which has later diminished in importance. Similarly, Trans Genic listed early on a concern about the risks entailed with their production of transgenic mice in the event of disasters or accidents resulting in escape incidents, a concern which has not been repeated in the most recent securities report most probably due to increased measures in handling this issue.

6 Suggestions for Ways to Utilize Risk Self-Assessments from Securities Reports

I will in this penultimate section sketch out some reflections and suggestions regarding the way forward when it comes to the usage of this emerging source as an input to EIT research projects. But first of all it might be worthwhile to summarize the benefits and downsides of this source (Table 5).

It has often been stated that all sources and methods have both their pros and cons (see e.g. Langley, 2009), and the observation obviously holds true also in the case of using the securities reports as a source.

The potential benefits include, however, that the source provides access to information from all stock exchange listed firms within a country or region. In addition

Table 5 Selected benefits and challenges arising from using securities reports as a source

Benefits	Challenges
Access to information from all listed firms within a country or region	Does not include non-listed firms, possibilities of common method variance effects if source is used in isolation, and some countries have not instituted the practice
Provides systemic information from companies which often do not prepare glossy separate annual reports intended for shareholders and/or the general public	May contain passages with rather technical language sometimes hard to decipher
Systemic information on the company's established views, based assumedly some kind of consensus within the company	Does not appear clearly from the source how the view was established, and the source's views may essentially represent the views of a dominant founder or CEO rather than management as a collective
Limited reliability problems due to the relative unlikelihood of outright deceptions	Might still be cases of impression management or boilerplates
May contribute to reducing analytical uncertainties and complexities due to the identification of one, systematic source	May function deceivingly and lead to concealment of issues not mentioned in the reports, unless researcher is agile and critical towards source
Managements' views on specific developments including historic ones "as they occur"	Might still be cases of impression management or boilerplates

the type of firms presented in this chapter most often do not prepare glossy separate annual reports intended for shareholders and/or the general public, and the securities reports thus provide for systemic information from companies without public annual reports. It is hence a source for systemic information on the company's established views, based assumedly on some kind of consensus within the company. Since the reports are submitted to the authorities, there is a relatively high unlikelihood of outright deceptions. The source thus represents limited reliability problems. One can gain access to managements' views on specific developments including historic ones "as they occur" by way of looking at past securities reports, and the source may in overall contribute to reducing analytical uncertainties and complexities due to the identification of one, systematic source which may function as a point of reference when it comes to perceptions of risks and uncertainties. As evident from Table 5, downsides include, for example, non-inclusion of non-listed firms within the securities reports system. These firms constitute a huge chunk of firms within especially entrepreneurship research, but are also of interest within innovation and technology research. There are possibilities of common method variance effects if the source is used in isolation. Some countries have not instituted the practice, and it does not appear clearly from the source how the presented view was established. Since the reports are submitted to the authorities there is a reduced likelihood for outright deceptions, however, the source might obviously still contain cases of "impression management" (Goffman, 1959) where an organization tries to represent itself in a better way than reality warrants for. There is also the possibility of so called boilerplates in the reports, meaning terms and expressions reused in a superficial way rather than being annually contemplated and used in a reflective way.

As for utilizing this source there is indeed the possibility of conducting text mining or content analyses like the researchers within financing and accounting, however, assuming that such an approach is both unfamiliar to and of limited relevance to EIT research I will concentrate the reflections around the more familiar approaches regarding qualitative or quantitative collecting of information, and the accompanying methodologies such as case studies, surveys and mixed methods.

Regardless of which methodology we refer to the use of the securities reports self-assessments as data (almost as if they were interviews or survey responses) poses two general problems. The first is that there are possibilities of common method variance effects if the source is used in isolation. However, this problem is still less than in the case of, e.g., a survey, since some of the criteria for common method variance effect creation, such as the researcher's leading sequencing of particular questions (Podsakoff et al., 2003), are absent. Nevertheless, it goes without saying that extreme caution should be used in connection with a stand-alone use of the source. The second general problem is that the data must be systematized in some way or the other, which is both a resource-demanding task as well as a process filled with dilemmas as for how to systematize. Regarding the latter issue of systematizing, the bottom line becomes to secure consistency within the analysis whether one chooses to predominantly refer to an existing analytical framework like in this chapter's examples, or to build a system of categories and analytical dimensions bottom-up specific for the project. In contrast to the single person process performed for the purpose of this chapter, it will in either of these

cases invariably be beneficial to operate with a team of two or more researchers who can check the results of the coding of risks and uncertainties across companies and, if relevant, across a number of years, in order to secure increased validity of the results.

These initial reflections regarding overall constraints lead us on to the various forms of usage of the source as data in triangulation with other sources. Such data triangulation may, as already mentioned, be as references to the other sections within the securities reports, but since it still essentially the same source the possible common method variance effect is not neutralized. Therefore, there is most probably the greatest potential for research productivity and validity when the source is used either qualitatively or quantitatively in conjunction with still other sources.

Separating between qualitatively and quantitatively oriented projects, the source could in the case of the former such as e.g. a single case study based on qualitative data constitute one of the sources together with, for example, interview data, company histories, press releases, observations, and secondary sources. One could in other words juxtapose the statements in reports with any views on the same topic as emerging from the other sources. In a quantitatively oriented project, such as a large sample survey, some similar observations appear to be relevant. In addition to a "survey" of the companies based on the "responses" in the form of securities reports information, these findings could be compared to the findings from the researcher's own survey or surveys conducted by others. These various responses could furthermore be put in a context derived from statistical data on the conditions of the environment where the firms are located with respect to financial, industrial and technological stability or turbulence.

In Sect. 5 the three different years within an 8 years span were chosen for delimited illustrative purposes. One might in a research project be interested in comparing what the perceptions regarding risks are in firms both when they were newly listed on the stock exchange as well as later in history. Both of these firms had their IPOs in 2002, and they are thus comparable in this respect. Both of these firms are university spin-offs, and it might be interesting to compare them in this respect as for how they evolve as they become more and more distant from their place of academic origin. It might also be interesting to compare the evolution of companies which have similar backgrounds as for origins, but which have activities in different fields such as in this case of therapeutics versus services. Still another conceivable research topic could be to study how young and small EIT firms handle the reporting requirements over time in conjunction with the maturing of other management functions. Common to all these research ideas is that they are all longitudinally oriented, and the way the risk perceptions were at particular periods in time could be a valuable addition to data based on other sources regarding the historical evolution of the firms.

The source might turn out to have an especially useful role in so called mixed methods research projects combining data of a quantitative and qualitative data. As pointed out by Molina-Azorín, López-Gamero, Pereira-Moliner, and Pertusa-Ortega (2012), such research projects rarely have a perfect balance between the two types of data. Rather, one type is dominant at the same time as it interplays with

the other type of data. Thus, in a project dominated by quantitative data from an original survey performed by researchers where one main finding was the significant presence of a particular type of risk perception, the project could be enhanced with quotes from the securities reports of selected companies within the sample for the purpose of pursuing these significant findings in depth. Conversely, in a project dominated by qualitative data obtained through the use of multiple sources for the purpose of describing select companies or even only a single company, the securities report data could put the qualitative case(s) in context by way of referring their situation to the situation of a large number of similar companies as derived from a quantification of securities reports statements from these other firms. In this way one may gain a better indication as for how typical versus atypical the perceptions within the qualitatively studied case appear to be.

In addition to these direct, data-collection related possibilities regardless of methodology, the self-assessments could furthermore very well be used actively in the context of data collection. The source may serve as a preparation tool or as a reference point in connection with preparing a questionnaire, or it may serve a similar function before and during interviews. Hence, more informed surveys and interviews may be achieved, both when it comes to illuminating various perspectives on the presence or absence of a specific type of risk perception, as well as when it comes to revealing various perspectives on what the risk perceptions were at a particular time in history.

7 Conclusions

There are in conclusion both potential benefits, as well as possible pitfalls, regarding using securities reports as a source. Benefits include, as reflected above, the availability and completeness of fairly reliable data on established company perceptions regarding risks and uncertainties for large populations of organizations both synchronously for a particular point in history, as well as during a specified period of time. In the future, an overview and evaluation of the status concerning securities reports requirements and practices also in other countries is necessary in order to make this source more readily available for the EIT research community. In some countries the risk perceptions section appears to be absent or only voluntary, and it would, for example, be erroneous in a project comparing firms in two countries to use voluntary and mandatory requirements for direct comparison. The research community should also follow any developments both in the USA, Japan and elsewhere as for any changes towards a standardization of the structure and required contents of the relevant securities reports sections. In conclusion, with the reservations noted above, the section on perceived risks within securities reports narratives could definitely be a valuable addition to sources for use within the portfolio of research methods within EIT studies, given the importance of understanding the complex nature of risks and uncertainties within the organizations which are the foci of this field of research.

Acknowledgements I want to acknowledge two anonymous referees and the editors of this volume for helpful feedback, as well as the Japan Foundation and the Japan Society for the Promotion of Science for research grants in 2012 and 2015 respectively.

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Complexity of Textual Data in Entrepreneurship and Innovation Research

Beth-Anne Schuelke-Leech and Betsy L. Barry

Abstract Innovation and Entrepreneurship are complex activities. They are also primarily language and relationship based. That is, it is largely through verbal communications (speech and text) that ideas are developed and business transacted. New methods are arising which are changing the way that we understand and can investigate innovation and entrepreneurship. Big Data Analytics allow researchers to uncover relationships and meaning in text documents, using a mix of quantitative and qualitative methods. This chapter shows that the complexity issues in innovation and entrepreneurship research with text comes from three sources. The first form of complexity is technical complexity. The second source of complexity is from language itself. The third source of complexity is in the concept itself. Each of these is discussed in detail. Complexity can either be addressed by simplifying the data or finding a mechanism for dealing with the complexity. A method of text data analytics using Corpus and Computational Linguistics deals with the complexity without eliminating data, allowing for a more nuanced investigation of innovation and entrepreneurship. The methodology is demonstrated by investigating how technological innovation and entrepreneurship are discussed in the United States Congress, using a corpus from 1981 to 2014.

Keywords Big data • Linguistics • Text analytics • Unstructured data

1 Introduction

Big Data and Data Analytics are providing new and exciting opportunities to research entrepreneurship and technological innovation. For example, patent data can show the emergence and evolution of a new technology. Bibliometric data can reveal the social

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8_22

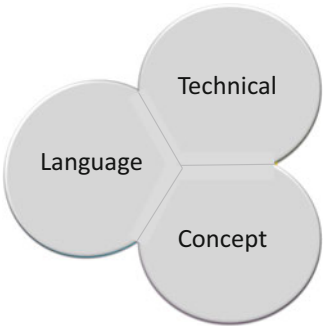

Fig. 1 Sources of complexity

networks of scientific discovery and collaboration. Twitter feeds, discussion forums, press releases, and expert blogs can all be explored to enhance understanding of the innovation and entrepreneurial processes. Though private communications and internal documents remain difficult to obtain, the proliferation of publicly-available documents makes it possible to explore innovation and entrepreneurship in new ways. This chapter explains one emerging method: text data analytics.

Text data is complex. The complexity comes from three sources: (1) technical, (2) language, and (3) concept. Technical complexity comes from the challenges in managing, processing, and analyzing unstructured data. Language complexity comes from the linguistic structure and use of language. Concept complexity comes from the diversity of ways that innovation and entrepreneurship are discussed. These sources of complexity are strata interacting and affecting each other, as indicated by Fig. 1.

The complexity of text data can be dealt with in two ways. The first is to try to simplify the data through techniques such as bag-of-words, which reduces the text to keywords and relies on frequencies and classification to find salience and meaning. Alternatively, a mechanism for dealing with the complexity must be employed. This can be done through applying the methods of corpus and computational linguistics, coupled with computer processing, as illustrated in this chapter.

The next section discusses the three types of complexity in detail. The section that follows presents an example of how text data analytics can be used for innovation and entrepreneurship research by presenting an exploratory empirical study using a corpus of the United States Congress.

2 Three Sources of Complexity

2.1 Technical Complexity

The first source of complexity characterizing unstructured text data is technical complexity. When we say unstructured text data is technically complex, what we are really saying is that it originates from a variety of disparate sources, created for

disparate purposes, existing in disparate file structures with different encoding protocols. Unstructured text data is any text-based artifact that is produced, stored, and consumed (Barry, 2008). Though texts used to be available only as hard-copy documents, a substantial portion of text data exists now in computer-mediated environments. Text data can be created and consumed in personal or professional contexts. They exist in a wide variety of source-types, such as business related communications like email, reports, press releases, and open-source material like social media, blogs, and web pages. In essence, a text-based data source can be any place where written language is used to express ideas, opinions or communicate information. In addition to a variety of source-types, unstructured text may be created and stored in a range of different file structures, such as pdf, txt, html, doc, rtf, etc. Within these different file structures, the text itself can exist in a variety of different encoding protocols, such as ASCII, utf-8, or utf-16 (Darwin, 2008).

Relatively speaking, structured data is easier to deal with, both because of its structure, but also because many of the tools and techniques of data mining have been developed to deal with structured data. Notwithstanding that so much of the data available is unstructured, much of the work in data analytics has focused on structured, numeric data (Chen, Chiang, & Storey, 2012). It is possible to transform unstructured data into structured data by converting text into algebraic vectors. However, the complexity of the text remains.

Creating an analyzable dataset of unstructured text is not as easy as simply importing numbers into a database and then querying the database. All of the technical diversity must be accommodated when taking a collection of files, or documents, or emails, and creating a dynamic, analyzable dataset. The spectrum of source types, file types and encoding protocols mean that the act of transforming unstructured text into an analyzable dataset requires a range of technical expertise, computer processing capabilities, as well as methods of storage and management. For example, gathering open source text data is not a monolithic endeavor. The Congressional corpus was assembled from a public archive that originated as collections of pdfs. Information had to be downloaded systematically, then the text had to be extracted from the pdf using OCR software. Next, text had to be normalized and cleaned, indexed and transformed into an analyzable data set. In sum, technical complexity of unstructured text poses a challenge for text analysis, especially in the era of Big Data, due not only to massive quantities of data, but to the fact that the data are qualitatively diverse.

Technical complexity notwithstanding, gathering, processing and transforming a collection of unstructured text into an analyzable corpus[1] is a significant undertaking. An undertaking that is initiated with a series of decisions that ultimately impact the trajectory of research endeavors. It is essential that a researcher understand what the corpus is going to be used for, because research objectives inform the data transformation processes employed in creating the analyzable corpus. That is, the researcher must first have an idea about the research questions that will be the

[1] In linguistics, a dataset is called a corpus (i.e., body of texts).

centerpiece of empirical investigation. The universe of possible text-based information and documentation can be overwhelming and time-consuming to gather. Electronic information and documentation provide an almost unlimited quantity and quality of data that could be collected and transformed into an analyzable corpus. However, many of these documents would simply be meaningless for any specific analysis. Instead, the researcher needs to first decide the purpose and scope of potential research questions. Simply put, the decisions about what text-based information and documentation to include in a corpus are dependent on what the corpus is going to be used for and the availability of data (Meyer, 2006).

One of the challenges in assembling a corpus is to avoid systematic bias in the documents and texts that are gathered. It is important that one identifies the parameters of potentially relevant documents or subject matter to ensure that consistent practices are used while building of the corpus. Thus, a representative sample of documents needs to be collected. Often these are not available in one location or gathered quickly. Industry familiarity and subject matter expertise are an important component of gathering archived documents that are going to valuable for analysis (Beise & Stahl, 1999; Kuechler, 2007). Conducting a systematic audit of the scope of available documentation is absolutely foundational to building an analyzable corpus. Once the scope is established, then a protocol for gathering the documentation can be developed and carried out.

It is also important to pay attention to the representative time frame that characterizes available documentation. Ideally, a varied corpus of natural language data spans a substantial period of time, but when dealing with electronically archived documentation and today's constraints imposed by the rapid accumulation of data, it is common to have access to material primarily from the recent past. Significant events may also change the quantity or content of communications.

The Internet is a productive and indispensable gateway for gathering data qua text documentation. Though it may be possible to automate the gathering of documents, this can also be difficult for several reasons. The first is purely technical. Web crawlers may be perceived as attempts to hack or disrupt a public website and may result in a shut-down by the site. Some websites will also limit the number of documents that they will allow you to view,[2] even if large quantities are potentially available. This makes it impossible to do large searches on these sites, and instead, requires many smaller, more specific searches. The second reason is related to the nature of the type of documents and data available on the web. In contrast to most document collections, the documents on the web are a heterogeneous collection. Some of the documents are carefully prepared by credible sources. Others are simply informally prepared and presented. Much of what is available on the internet contains errors and sources of documents need to be carefully evaluated before documents are gathered from any particular source (McGregor, 2004).

[2] Many of the federal government websites limit any document search to 1000 returns because of bandwidth limitations.

Another major challenge in building a corpus that is intended to evaluate innovation or entrepreneurship within an industry is that this requires access to relevant documents and an understanding of how innovation is talked about within that industry. Private companies are rarely willing to provide internal communications and documents for external analysis. Therefore, analyzing an organization or industry may require assembling a corpus from publicly-available documents that will be representative of industry and organizational communications and will contain enough of the breadth of communications to make analysis possible.

Publicly-available documents are not the same thing as publicly-focused documents. Documents targeted to lay people may be more polished and avoid industry-specific jargon that communications intended for those familiar with the industry would include. Documents that use language that is representative of the discussions and communications of interest are essential for building a corpus that is reflective of the language and patterns of use. The sanitized language of a document intended for wide-distribution or mass consumption may simply be reflective of how an industry communicates with the wider public, as opposed to how it communicates with itself or its regulator.

Once the documents are collected, the process of transforming them into an analyzable corpus begins. There is no standardized procedure or program for transforming a collection of documents into an analyzable corpus, so, in addition to discussing some of the more general data transformation processes, it is worth noting the importance of the decision-making process when it comes to preparing text-based language corpora. The decisions made at the outset of data transformation will govern all subsequent steps in both methodological and analytical endeavors. When dealing with large text corpora, going back and modifying any aspect of the data transformation process after the fact is often too time-consuming and tedious, so it is important to exercise deliberation when it comes to developing and implementing the methodology. The data prep methods must align with research objectives. For example, it is common to do token-level analyses,[3] so initially it is essential to clearly define what represents the smallest analyzable unit, or token, with respect to how the corpus is prepared, in order to properly interpret the statistics predicated on these constituent units of analysis (Calomiris & Haber, 2014; Teece, 1992). Similarly, special characters that have a similar variant on a standard keyboard, such as “è” and “e” must be normalized to facilitate searching and retrieval using a standard computer keyboard (Berry & Browne, 2005). Thus, our text conversion processes have to accommodate these preferences.

Whenever possible, a small, random sample of documentation from the corpus should be gathered and a qualitative assessment performed before initiating any data transformation processes. It is a productive way to try to understand the nature

[3] Corpora are analyzed at the token-level in linguistics. A *token* is the smallest unit of analysis. For example, the sentence “The blue car hit the green car” has five distinct word types, but a total of seven tokens (see Bailey & Schonhardt-Bailey, 2008, pp. 133–134 for a complete discussion of word types and tokens).

of the data itself and minimize the potential for making uninformed decisions. Once the assumptions about language and language usage in the presence of natural language data have been considered, and there are clearly defined research objectives, it is possible to develop a data-driven methodology that renders an analyzable corpus best suited to the particular research endeavors.

Generally speaking, data transformation includes processes such as text conversion and normalization, tokenization and tagging, all of which are research-dependent. All of these processes can be accomplished with different software packages or custom-made scripts. For our work, the principal data transformation processes are modeled on the processes outlined in the Tobacco Document Corpus Project[4] by Clayton Darwin (Darwin, 2008).

The process proceeds from broad, quantitative assessments of the corpus into more qualitatively-informed investigations of key content in context. Investigating key content in context informs the discovery process, leading to other productive usage-based threads of analysis, and so on (see Teece, 1992). It is worth noting that this method is distinct in that it does not initiate with word or phrase level search and retrieval, building knowledge from the ground up. Rather, this method begins by consulting corpus-wide assessments that allow access to established language within the corpus, relying on attested forms to govern more qualitative investigation of content.

2.2 Language Complexity

The second source of complexity when dealing with unstructured text is language or linguistic complexity. Before discussing language or linguistic complexity in full, it is important to clarify an important point: Linguistic complexity is not to be taken solely as *inter*-language complexity, that is, the inherent complexity that comes when studying or comparing two or more different languages. Linguistics is often regarded as synonymous with multi-lingual. In fact, inter-language research and scholarship is only one small area of the field that applies to text-based data and text analysis. That said, there is a high degree of complexity between different languages that makes text analysis methodologies, as well as cross-linguistic comparisons, a complex research endeavor. However, before you can study differences, or make comparisons between two or more languages, it is important to recognize language and variability inherent in each respective language. Linguistic complexity refers to *intra*-language complexity. One language displays an infinite amount of variability, not only between different speakers and different dialects,

[4] The Tobacco Documents Corpus was constructed as part of the National Cancer Institute, National Institutes of Health, U.S. Department of Health and Human Services (NIH-NCI) grant 1 RO1 CA87490-01, 'Linguistic Analyses of Tobacco Industry Documents' (2001–2004). Information about the project and the corpus can be found here: http://www.claytondarwin.com/TDC/.

but between different contexts, styles and genres. All natural language data, even data from the same source, representing a particular genre, will display a high degree of variability and linguistic complexity.

Unstructured text represents natural language (Barry, 2008) comparable to the way that numbers are the representation of quantities and formulae represent mathematical relationships. Once we understand the patterns of the representations, we understand that the different components of the representation have meaning. So, for instance, "1, 2, 3, 4, 5" represents a sequence of quantities, whereas "12, 345" represents a single, much larger quantity. The commas have meaning just as much as the numerals do and that meaning is unambiguous and clear. However, when dealing with text, we each have an intuitive sense of language that often means that we apply meaning and value unconsciously to familiar words, phrases, and grammatical structures. As domain experts, we run the risk of taking for-granted that words and phrases have a consistent meaning and that the structure of language that we are familiar with is *the only* structure.

Text is essentially a graphical representation of language (Barry, 2008). Thus, unstructured text-based data is natural language data. As natural language data, text is bound to all of the linguistic principles that characterize language and language use. For every one way there is to express an idea or impart meaning in any given language, there are dozens of different ways to impart the exact same idea, or impart precisely the same meaning. However, language is also a habit. Although we have a diverse range of forms to select from, we rely on some linguistic forms over others. When we are referring to the habit of language, we are referring to linguistic norms of occurrence. Linguistic norms illustrate what linguistic variation is the most common, as well as which ones are disproportionately rare or frequent (Stubbs, 2001).

For example, consider the idea of innovation. One way we can speak generally about the subject of new methods, ideas or products is by using all the forms of the word innovation: innovation, innovations, innovate, innovates, innovating, innovated, innovative. In a large, topically diverse corpus, such as the Congressional corpus, indeed, "innovation" is a form used to generally represent and talk about the act of innovating. However, another highly productive way to generally talk about the idea of innovation is by talking about "advanced technology." The idea of "advanced technology" as representing innovation also takes on many forms: advancements in technology, advancements in the technology sector, advancing our technological capabilities, technological advancements, etc. Furthermore, the idea of "advanced technology" as innovation can manifest as "next generation technology" in general contexts. Likewise, the idea of next generation technology can take on different forms: next generation tech, nextgen technology, next gen tech, NG tech, etc. File count: advanc* /2 tech*, tech* /2 advanc* = apprx 29 %. The following 15 forms account for 50 % of the total counts, where as the other 50 % is made up of over 350 forms:

Language is also innovative and it changes over time (Stubbs, 2001). New concepts qua words and phrases make their way into the lexicon on a daily basis, as the way we talk and write today are not necessarily the same as 50 years ago, or

Table 1 Variation of "advanced" in proximity with "technology"

Advanced technology
Technological advances
Advanced technologies
Technologically advanced
Advances in technology
Technological advance
Technology advances
Technological advancement
Advancing technology
Technical advances
Technological advancements
Technology advanced
Advance technology
Advanced technological
Technically advanced

even 10 years ago. For example, the concept and collocation "Big Data" is a fairly recent one that has emerged in tandem with the computer-mediated environments responsible for its creation and proliferation. In the Congressional corpus, the idea of "Big Data" as referring to extremely large datasets analyzed computationally to reveal patterns, trends, and associations dates back to approximately 15 years. For example, in the 106th Congressional session (years 1999–2000) there are only two instances out of a total of 275,512,343 tokens of "big data" and only one is arguably on point: "You were talking about the European model of a big data protection board sitting on top of the Internet" (Congress, 1999, p. 188). The context is a hearing on Internet regulation. Still, it is unclear even in this context that the speaker is talking about a big board to regulate data or a "big data" board. In the following several Congressional sessions, there are scant mentions of big data, all with questionable relevancy, like the previous example. There's evidence of conversations that address the accumulation of vast quantities of data, all by-products of the rise of the digital age, but the vocabulary is still in flux, even if the natient ideas are taking shape. Skip ahead to the 112th Congressional session (2011–2012) and there are several dozen mentions, all on point. There's even several references to a "Big Data" task force. The following Congressional session shows 10 times the amount of "Big Data" conversations. Perhaps in the next decade, there will be some other preferred word or phrase to describe the same general concept. Indeed, the tenants of language variation and change suggest this is likely.

The principles of language variation and change mean that every linguistic style and linguistic genre have both general and unique features, characteristics and lexicons that describe them. Likewise, different industries have specific linguistic characteristics and specialized lexicons that define the language habits attributable to them. For example, the Congressional corpus is topically diverse and an official political record, transcribed by a vetting group of individuals tasked specifically with creating coherent, consist accounts of the political body, and all its associated

activities and business, and then transforming the entire collections into a public archive. Compare this to a collection of open source, natural language texts from a social media forum devoted to Innovation and Entrepreneurship, which allows members to participate in a range of discussions and threads, broadly devoted to an overarching theme. Anybody can participate. Other than some general community guidelines, there is a no quality assurance in these forum data. One can study and measure innovation in both the Congressional corpus as well as the social media corpora, but the completely distinctive styles and genres will impact both the quality and the quantity of the conversations and linguistic complexity surrounding the idea of innovation in each respective corpus.

Linguistic complexity is also due to the fact that form and function are dependent on context (Stubbs, 1996). Meaning is conveyed through linguistic context. There is an old adage in linguistics: Words are known by the company they keep (Firth, 1957). For example, if you have a large collection of unstructured text like the Congressional set, spanning decades and representing a wide range of topics and mixed content, and you are investigating stocks and the stock market, you will quickly learn that the terms "stock" and "stocks" will not always refer to the topic of interest. Stock (noun) as a supply of goods or materials or natural resources, or stock (verb) as the act of keeping a supply of goods will characterize the usage of the term in a productive way. However, when stock is co-selected with the same linguistic context as other economic language (price, dividends, exchange, market) the meaning of stock is more likely to refer to the capital raised by a company through the issuance of shares. It is the relationship between linguistic forms and context that inform interpretation and meaning. Additionally, there will be other lexical forms such as New York Stock Exchange (NYSE), equity market, share capital, all of which are related to the semantic concept of "stock market." The lexical forms related to a concept may be diverse, even though you have what appears to be simple semantic schema such as "stock market" (Stubbs, 2001).[5]

The idea of innovation as the process of innovating also provides a good example about the role of context in linguistic complexity. For example, you may be interested in the overall idea innovation, but you cannot assume that every time somebody is talking about "innovative approaches" that this actually refers to the process of innovating. There can be conversations of "innovative approaches to technology transfer," (Congress, 2013a, p. 3) as well as "innovative approaches to increase children's understanding of peer and family relationships," (Congress, 2013b, p. 402) or "thoughtful, innovative approaches on how to improve the lives of women veterans" (Congress, 2013c, p. 40). In fact, only one of these contexts may support the idea of innovation as the process of innovating. The presence of technology in the conversation of the first example constrains the context in a way that indicates that the entire conversation is likely on point with the innovation process.

[5] This idea of concept complexity is discussed more fully in the next section.

Linguistic complexity is not to be confused with technical complexity. Linguistic complexity is not an IT issue, a software or hardware issue, or a data transformation issue. Rather, linguistic complexity is an expertise issue. Linguistic complexity is much more difficult to accommodate for non-linguist professionals whose object of study is unstructured text-based natural language. Furthermore, linguistic complexity such as language variation and context-based meaning must be acknowledged as governing factors in how ideas and information are tangibly represented, and these facts must be accommodated, during the development of research questions, creation of analyzable text corpora, as well as the implementation of the methodology and analysis.

When considered in tandem, technical and linguistic complexity of unstructured text is compounded when dealing with the quantity of data typical of the era of Big Data. However, it is not only the quantity of the data, but the quality of the data that makes it extremely difficult for a person (or even a team of people) to collect, process and analyze them in a valid and reliable manner (Barry, Smith, Schuelke-Leech, & Darwin, 2015). Large collections of data are only useful if there is some valid and reliable method to extract useful information, discover interesting trends, patterns and correlations that can inform the decision-making process. Thus recognizing and adapting to the quality of both technical and linguistic complexity is a formidable, but necessary aspect of "Big Data" text data analytics.

Every student of introductory empirical methods learns that the tools and techniques of statistical modeling are only useful if appropriately applied to the data. It is possible to execute an Ordinary Least Squares (OLS) regression model using a computer program, but if the normal distribution assumption of the model is violated, the results of the model will be meaningless. Many of the initial attempts to organize and understand large volumes of text data have relied on an evaluation of the frequency of individual words, known as 'bag-of-words' technique. This technique is so named because it literally assumes that all the words in a collection of documents are simply a collection of words, without order, context, or structure. In political science, various attempts have been made to use this technique to look at political speeches (Yu, Kaufmann, & Diermeier, 2008) or press releases (Grimmer, 2010). While these efforts have proven to be admirable first attempts to try to glean information from large amounts of textual data, the removal of context and order necessarily results in limited knowledge or understanding. In using the "bag-of-words" technique, the researcher removes the punctuation and "noise" words. However, these provide an important component of the structure and meaning to the text. To return to the numerical example, it is the equivalent of taking '1, 2, 3, 4, 5' and '12, 345,' removing the commas and saying that the resultant '12345' has the same meaning in both cases. Clearly, this is not true. Removing the commas in the representation creates different meaning because of the decision by the researcher of what is and is not important in the data. This introduces selection bias into the dataset, just as much as if individual observations were discarded in a numerical dataset for a regression model because the researcher decided that they were unimportant or did not fit the model. In essence, it is equivalent to taking a dataset comprised of continuous variables and arbitrarily dividing them into

binomial categories of important and unimportant. This results in a significant loss of information in the dataset. We challenge this approach when it is done with numerically-based datasets and we should question it with the same vigor when it is done with text-based datasets.

The next section demonstrates why natural language texts are more than lists of vocabulary words, but rather they consist of forms that rely on relationships not only between each other to impart and interpret meaning, but also to a bigger concept or semantic schema, which also creates a point of reference for imparting and interpreting meaning.

2.3 Concept Complexity

It is essential to understand how the subject of any study uses language and communicates if we are going to effectively use their text-based documents in research. Each industry has its own words, jargon, and definitions, which layer meaning onto the conversations within that industry. For instance, the word 'operation' will mean something different to a surgeon than it does to a computer programmer within the context of their jobs. The artifacts of industry are language-based. They are predicated on the context and meaning of the language used. In fact, often meaning is tied to context.

Research about entrepreneurship and technological innovation poses a particularly difficult challenge because of the complexity of the process itself and the variability in which the process is discussed. The process of technological innovation is rarely discussed using that term. People—particularly scientific inventors and engineers—rarely state that they are going to innovate. Instead, innovation is an ongoing process of investigation and problem-solving. Similarly, entrepreneurs focus on daily activities and strategy execution, rather than philosophically reflecting on the entrepreneurship process itself. Though some of these discussions and communications are available, and can become the mechanism through which innovation and entrepreneurship occurs and through which it can be explored and investigated, it can be difficult to find a full scope of the discussion. Even when the linguistic artifacts of innovation and entrepreneurship are available, gleaning insights and patterns is only possible if there is a method of analyzing the data. Big Data Analytics, and specifically Text Data Analytics, allow researchers to find patterns and trends in massive amounts of data.

In addition to understanding how the stakeholders within a field discuss or communicate about a given concept, it is also imperative to define the concept as a researcher. In this respect, defining innovation and entrepreneurship can be particularly difficult. Innovation is discussed in many ways. There can be process and product innovations. There can be evolutionary or revolutionary innovations (often difficult to specify ex-ante). Innovations can contribute to existing technologies, replace them, or provide the foundations for completely new technologies. Thus, how the researcher defines innovation is an important component of the

research process, both for determining the theoretical framework, but also in determining the methodological procedure.

Terms and phrases that are used to express a particular concept or idea are called linguistic markers (Labov, 1972). In exploring text data, the linguistic marker for innovation can be defined broadly or narrowly. It may contain few terms or phrases or many. For instance, the linguistic marker for innovation can be narrowly defined: advanced technology; advanced technologies; commercialize; commercialization; innovate; innovates; innovation; marketization; new technology; new technologies; and technology transfer. Alternatively, the linguistic marker for innovation may be more widely defined and include: advanced technology; advanced technologies; advanced manufacturing; biotech; biotechnologies; commercialize; commercialization; scientific discovery; scientific discoveries; engineering; engineer; entrepreneur; invent; invents; invention; innovate; innovates; innovation; marketization; nanotechnology; nanotechnologies; new technologies; new technology; private equity; R&D; research; research and development; research center; research institute; research institutions; research teams; scientific collaboration; spinoff; spinoffs; startup; startups; technology company; tech transfer; technology transfer; and venture capital. With this latter definition, entrepreneurship is obviously wrapped up in the definition and it would be difficult to separate out the connection between innovation and entrepreneurship later. The specific linguistic marker must be validated quantitatively and qualitatively in the entire corpus to ensure that it is productive and meets the research objectives.

In addition to investigating a single concept, such as innovation, linguistic markers can be layered in order to investigate how closely associated concepts are with one another. This layering of linguistic markers allows for research of specific linguistic contexts, from broad to an increasingly focused investigation. The proximity of the linguistic markers is specified by the researcher. The closer the proximity, the more tightly associated the concepts must be in order to return a hit.[6] Defining a concept like innovation broadly with a wide proximity with an associated concept may return too many false positives. On the other hand, defining a concept too narrowly with an extremely small proximity may leave out many relevant hits. Ensuring the accuracy of the results by balancing the completeness of the concept and proximity without giving too many false hits[7] is a significant challenge.

The linguistic and concept complexities require a thorough, qualitative examination of language as a foundation for quantitative inquiry. It is not sufficient to rely on one's own intuition. Instead, it is necessary to investigate and validate the

[6] The term *hit* is used for the each occurrence or incidence in the corpus. The total hits in a search yields the raw frequency count of the search.

[7] This is essentially Type I and Type II errors: leaving out returns that should be included versus including results that should be excluded. False returns are those that include the target words, but are not part of the concept under study. For instance, "The artist did not use colors very innovatively. New technologies could be used. . .." If the concept under study is technological innovation, this result is valid from the words perspective, but not from the concept perspective.

language used to express concepts and ideas, including specific usage and variations (Labov, 1972).

3 Exploratory Empirical Study

As stated previously, dealing with these three types of complexity can be difficult to manage. Simplifying the data by using topics and frequency of words may be appropriate for the research question. However, simplifying the data necessarily results in a loss of the richness and connections in the text. Dealing with complexity can be challenging. Nonetheless, there is a method for dealing with the complexity of text by using computational and corpus linguistics and computer analytics. This method is presented here.

The corpus used in this example is of the United States Congress from 1981 through 2014. It includes the Congressional record (floor debates and speeches from both the Senate and House of Representatives), Hearing transcripts, reports, and other documents from Congress. This corpus is highly variable, both in file type, size, and quality, as well as linguistically diverse, with a wide range of styles and genres. The corpus consists of a total of 93,913 files and over 5.6 billion tokens.[8]

Corpus and computational linguistics presume the connection between content and context of text. Thus, text data analytics using this method provides a mechanism for dealing with complexity during empirical investigation. The method uses computer assistance to process and analyze large document collections, while relying on the understanding of language structure and usage that comes from linguistics. Thus, this is a mixed qualitative and quantitative method. Some of the investigation of language usage must be done manually (by a person) and cannot be done through unsupervised automated methods.

There is no standard process or software that is used for text data mining and analysis, though there are common platform programs that can be helpful. Much of the process is dependent on the decisions made in support of the research objectives and design. In many ways, it can be likened to using Stata to run a regression and then saying that the program is the essential component of the analysis. Instead, we want to demonstrate in this paper that the tools and decisions in text mining are dependent on the research paradigm, objectives, and data. The processes and tools used in this research are python-based tools[9] designed and developed specifically for investigation and analysis of large, technically and linguistically complex collections of unstructured natural language text.

[8] The size of the corpus makes computer assistance in the analysis imperative. Most of the files were originally pdfs, though there were also html and text files. The files were first converted to text files, then converted to utf-8. They were then tokenized and organized according to Congressional terms to preserve the original organization of the archive from which the data was collected.

[9] Python is an open source programming language (www.python.org).

To begin the analysis, a report of statistically salient language was generated for each Congressional session and then compared back to the entire Congressional set. Generally speaking, these reports give an idea of potential topics and themes extant in each respective session, allowing for data-driven content assessments and overall qualitative audits of the corpora. These content assessments, along with subject matter expertise, are the first steps in the qualitative investigation to identify language that is potentially relevant to how concepts of interest are expressly manifested in the dataset. This is the discovery phase of the qualitative investigation into how concepts are concretely represented in text through natural language usage, and it is conducted with a discovery tool designed and developed specifically for data and information mining in large collections of unstructured text-based collections of natural language.

It is important to note here that "concept" is an abstraction. A concept is an idea or set of related ideas that are expressed concretely through language usage. A concept can be thought of as equivalent to a category, which is a practical description of a logical grouping of linguistic markers related through lexical, semantic or pragmatic function.[10] Thus a concept becomes a definable unit of measurement, which in turn becomes the foundation of quantitative assessments. As humans, we are interested in concepts like sustainability. We study language in order to derive a set of linguistic markers that represent how the concept of sustainability is manifested in natural language usage. The sustainability linguistic marker set contains all of the linguistic variations used to describe the concept (environmentally sustainable, renewable energy, green technology, etc.), thus forming a defined category of sustainability language, which we then are able to reliably use as a basis for measurement.

The discovery phase of the qualitative linguistic investigation not only requires identifying linguistic markers and creating linguistic marker sets as defined categories, but also validating the markers in context to ensure that they are consistent and reliable representations, and that categories are, in fact, data-driven rather than merely subjective or based on one's intuition about language use. This phase is critical because linguistic context can impact and constrain the meaning of the language and linguistic forms under investigation. In particular, our discovery tool incorporates a searching function and keyword in context (KWIC) displays of the resultant data.[11] It also generates statistical association reports of other language that co-occurs in the same context with linguistic markers, and linguistic marker sets, used in querying the text. These language association reports, in turn, facilitate the identification of the range of related words and terminology, or the linguistic variation, used to describe a priori categories. This linguistic variation is incorporated into linguistic markers sets qua categories. Each marker is independently validated and each marker set is validated in

[10] A linguistic marker is a term of art in Linguistics. It can refer to any linguistic feature that is indicative of some function of language, or that characterizes a dialect, or that designates a part of speech, etc. A linguistic marker as a linguistic feature is a unit of analysis. These units can be a phoneme, a morpheme, a lexical form, a syntactic construction, etc.

[11] A keyword in context display is aligned around a lexical form (word or phrase) that is the basis of some query. It usually spans out several words on either side of a "keyword" in order to display the context in which the term is used.

toto. Additionally, markers and marker sets are validated across the temporal ranges of the corpus to investigate and accommodate linguistic variation and change over time. This phase of the investigation is iterative and time consuming; however it is critical in developing consistent and reliable linguistic marker sets, especially when doing so in a large, variable, linguistically complex collection of natural language data like the Congressional corpus.

The validity of linguistic markers depends on how the defined category is represented in the corpus. Likewise, how a category is defined matters, as it informs the composition of linguistic marker sets that ultimately become a unit of measurement. A category can be defined by one linguistic marker, or it can be defined by multiple sets of linguistic markers containing thousands of markers each, combined in some logical sequence. A category can be broadly defined, or narrowly defined, depending on the nature of the research question or questions under consideration. Narrow or broad definitions of categories are reflected in narrow or broad linguistic marker sets. Consequently, there is a trade-off between having a linguistic marker set that is too narrow or too broad. The goal is to have results of a query include the full range of the discussion without too many false positives (i.e., results that include the words but are unrelated to the research topic). A more narrowly defined marker set will result in hits that reflect the language of interest, but it risks the exclusion of other potentially productive linguistic variation that is relevant to the category definition. For instance, using only the term "innovation" or may or may not include text about "next generation technology" (or nextgen tech, or ng tech, etc.) for example, or other linguistic variation that could be relevant to innovation as a category. A more broadly defined marker set will return more counts, but not all of these may be of interest. For example, the word "discovery" may be important in the concept of innovation. In practice, the term is used in many different ways some of which are not necessarily related to our defined category of innovation language. Discovery can mean a scientific discovery or invention, but it can also mean legal or political discovery. It can also refer to a NASA program or a television channel. These empirical linguistic facts must be accounted for and accommodated in a principled way, especially when dealing with a heterogeneous corpus of natural language text. Developing linguistic marker sets that make up defined categories begins with identifying the words and phrases that you would reasonably think should be included in the concept and then investigating, validating, and refining the marker set to reflect the actual language usage. That is, it is the result of empirical, principled investigation, not simply applying domain knowledge or personal opinion, both of which can take for granted the variety of language usage.

The marker set for innovation used in the analysis was: advanced technolog*; commercializ*; innovat*; marketization; new technolog*; tech transfer; and technology transfer.[12] The marker set for entrepreneurship was: business within

[12] The * indicates a wildcard, so that any variation of the word beyond the * will be included. So, for example, commercializ* would include commercialize, commercializes, commercializing, commercialization, and so forth.

15 tokens of startup; company within 15 tokens of startup; entrepreneur*; spinoff; startup, and tech within 3 tokens of company. In a more detailed analysis of a specific issue, rather than an exploratory study, these marker sets would be further refined in light of the investigation.[13]

4 Results

Table 2 presents the results for innovation. Looking at the raw frequency counts can be misleading. The frequency of innovation discussions remained virtually unchanged between the 1980s and the 2000s. A more accurate measure is the hits per million tokens, a standardized measure. Using this measure, it is possible to see that the discussions of innovation have increased significantly since the 1980s. In the 1980s, there was an average of 79.0 hits per million tokens. By the 2000s, the hits per million tokens had increased to 130.8.

As a percentage of the tokens in the Congressional corpus, the innovation subcorpora[14] comprises about 0.01 %, a relatively small amount of the overall corpus. It is, of course, difficult to assess how substantial or insignificant the results are absolutely. Instead, it is helpful to look at comparable concepts and associations (see Table 3).

Relative to entrepreneurship, innovation is a larger discussion. Innovation has an average of 105.3 hits per million tokens, while entrepreneurship has an average of 30.6 hits per million tokens. The overlap between innovation and entrepreneurship is also very small. With a proximity of 15 tokens, the associations of innovation and entrepreneurship have an average of 1.79 hits per million tokens. This is approximately 1.5 % of the innovation hits. By comparison, innovation and manufacturing associations are about 3.2 % of the innovation hits, whereas innovation in proximity to an economic linguistic marker yields about 19.9 hits per million tokens, or 18.7 % of the innovation hits. That is, the association of innovation and the economy is much larger than the association of innovation with either entrepreneurship or manufacturing. This indicates that Congress discusses the economic impacts of innovation much more than it does the exploitation and implementation of innovation through entrepreneurship and manufacturing.

Table 4 presents the associations within the innovation subcorpus. Eight categories of interest were identified: (1) Commercial; (2) Finance; (3) Research; (4) Process; (5) Entrepreneurship; (6) Manufacturing and Operations;

[13] Some of the words and terms can be particularly ambiguous or challenging. For instance, "small business" is a common term, but it is not synonymous with entrepreneur. An insurance broker who owns a one-person agency would be considered a small business owner, but it is debatable whether that person would also be considered an entrepreneur. It would depend very much on the specific study being done.

[14] When a subsection of the corpus is created through a linguistic marker, it is known as a subcorpora.

Table 2 Innovation results

Session	Year 1	Year 2	Number of files	Number of tokens	Files with innovation hits	% of Files that contain innovation return	Number of hits	Hits per million tokens
97	1981	1982	5230	424,917,856	2246	42.94	33,512	78.87
98	1983	1984	6506	530,712,147	2832	43.53	43,142	81.29
99	1985	1986	3332	328,261,343	1630	48.92	22,140	67.45
100	1987	1988	5622	460,083,483	2638	46.92	39,365	85.56
101	1989	1990	5134	422,590,786	2412	46.98	34,581	81.83
102	1991	1992	4153	335,393,629	1867	44.96	32,735	97.60
103	1993	1994	4117	375,886,264	2160	52.47	39,487	105.05
104	1995	1996	4858	417,460,481	2447	50.37	37,703	90.32
105	1997	1998	5071	252,394,411	1430	28.20	23,431	92.83
106	1999	2000	6039	275,512,343	1904	31.53	25,798	93.64
107	2001	2002	6026	301,627,593	2239	37.16	32,210	106.79
108	2003	2004	7104	319,856,928	2653	37.35	31,615	98.84
109	2005	2006	4517	232,074,372	2066	45.74	28,553	123.03
110	2007	2008	6940	263,816,803	2625	37.82	29,291	111.03
111	2009	2010	6110	247,243,388	2585	42.31	39,119	158.22
112	2011	2012	6842	246,354,993	2874	42.01	41,592	168.83
113	2013	2014	6312	246,459,969	2624	41.56	36,716	148.97
Average			5524	334,155,693	2308	42.40	33,588	105.30
SD			1097.11	89783098.65	418.86	6.44	6260.26	28.90
Total			93,913	5,680,646,789	39,232	721	570,990	1790

Table 3 Innovation hits per million tokens

Session	Innovation hits	Entrepreneurship hits	Innovation and entrepreneurship terms within 15 tokens	Innovation and manufacturing terms within 15 tokens	Innovation and economy terms within 15 tokens
97	78.87	17.98	1.04	0.82	18.54
98	81.29	21.99	0.98	1.32	17.86
99	67.45	20.18	0.69	0.92	12.59
100	85.56	23.82	0.94	2.50	17.04
101	81.83	21.74	0.82	2.30	15.08
102	97.60	25.02	0.83	4.18	18.11
103	105.05	29.16	1.34	5.13	18.38
104	90.32	32.36	1.08	2.08	16.06
105	92.83	24.10	0.58	1.76	10.65
106	93.64	24.23	0.66	1.40	14.95
107	106.79	24.31	0.86	1.37	16.11
108	98.84	26.90	1.20	3.47	15.06
109	123.03	27.26	1.67	4.09	25.84
110	111.03	36.68	2.12	4.37	22.93
111	158.22	51.26	6.05	6.35	32.25
112	168.83	52.98	4.97	7.93	32.29
113	148.97	60.67	4.60	12.75	34.76
Average	105.30	30.63	1.79	3.69	19.91

(7) Workforce; (8) Sustainability. The Commercial discussions focused on the business of innovation (e.g., revenues, customers, competition, economics). Finance focused on discussions of money and economics (e.g., finance, budgets, credit, investments). Research topics included discussions of scientific discovery, invention, and dissemination. The Innovation Process topic included discussions of technological advancement, innovation, and commercialization. Entrepreneurship includes discussions of starting a new venture (e.g., incorporation, spinoff, SBIR, opportunities, ventures). Manufacturing includes discussions of production, operations, engineering, logistics, materials, and procurement). Workforce focused on topics dealing with people (e.g., employees, education, workers, retirement, healthcare, training). Sustainability included discussions about the environment, climate change, and the green economy (e.g., adaptation, climate change, efficiency, conversation, pollution, waste, water). These categories are not exclusive and some of the associations are included in more than one category. For instance, funding and budgets are both research issues and financial issues. This allows for a more accurate and nuanced analysis of the associations than would be possible if the categories were forced to be mutually exclusive. To assess the relative importance of the category, the number of hits (or occurrences) within three tokens to the left and to the right of the linguistic marker were used. This makes the associations

Table 4 Associations in innovation subcorpus

Session	Commercial	Finance	Research	Process	Entrepreneur	Mnfg and Opns	Workforce	Sustainability
97	64.3	10.8	34.9	33.5	12.9	52.6	15.7	5.5
98	64.0	10.2	34.2	35.8	10.5	53.8	15.1	5.6
99	51.4	7.7	31.5	30.1	8.7	43.4	12.5	5.2
100	67.7	9.8	39.7	39.6	11.4	57.1	16.9	5.6
101	65.5	9.9	36.3	37.5	11.2	55.5	15.4	6.2
102	81.4	13.1	47.0	47.1	16.3	70.0	17.9	8.1
103	85.6	14.1	52.3	52.8	15.8	75.8	20.9	9.3
104	77.2	13.6	42.9	41.5	14.7	62.3	17.9	8.1
105	80.9	12.9	54.6	50.8	14.5	71.1	21.8	9.0
106	84.3	13.6	52.8	49.0	16.8	68.8	23.3	8.6
107	95.5	16.1	56.7	50.6	18.4	74.9	28.8	12.1
108	86.0	14.9	54.5	50.3	15.9	73.6	25.4	9.4
109	111.8	21.8	66.0	60.8	22.3	88.5	28.1	16.4
110	94.7	20.1	63.4	58.2	22.4	82.9	25.4	18.3
111	141.3	32.9	96.7	77.7	36.9	109.8	40.0	15.8
112	151.3	37.6	102.0	93.2	40.9	123.1	50.4	13.3
113	130.7	32.1	81.6	74.0	33.9	95.8	43.5	11.5
Average	90.2	17.1	55.7	51.9	19.0	74.1	24.7	9.9

very tight. While a larger association could be used (of 10 or even 100 tokens), three tokens gives a measure of the relative importance of a topic.

The Commercial associations with the innovation linguistic marker were by far the greatest of the eight categories, supporting the findings that the economy was a greater portion of the innovation discussion. Likewise, it is possible to see that the entrepreneurship category has relatively few associations, with an average of only 19 associations per session, compared to 51.9 for the innovation process category, 55.7 for research, and 74.1 for manufacturing. Likewise, finance and workforce issues are relatively infrequently associated with innovation. Sustainability associations are also relatively rare at only 9.9. Since innovation is often discussed as an important component of transitioning to a more sustainable economy, this result is a little surprising.

5 Discussion and Conclusions

The results show that innovation is a relatively small portion of the Congressional conversation, despite the fact that a substantial amount of research funding comes from the federal government. Also innovation and entrepreneurship are not closely associated in the Congressional discourse. Instead, Congress focuses on the impacts of innovation on the overall economy and the business issues of innovation. This may have significant impacts on innovation and entrepreneurship policy and support at the federal level. However, these results are really only preliminary exploration in a deeper investigation of technological innovation and entrepreneurship in this corpus.

Many research questions arise from these results. For instance, why are innovation and entrepreneurship not more closely associated, as might be expected? What do policymakers discuss with respect to entrepreneurs and entrepreneurship? What do they see as the role of policymakers in these realms? How are science funding and innovation related in the Congressional discourse? Do these discussions differ depending on whether they occur on the Senate and House floor versus in Committee Hearings? How does the discourse change over time?

It is also possible to compare and supplement the Congressional corpus with other corpora, such as subnational (state-level) governments, patent data, or other national governments. These can lead to questions about policy conversations or the diffusion of new research. For instance, are there different discussions at subnational levels of government about these issues? Do patents follow policy discussions or vice versa? Is the military a driver or recipient of technologies? How do other governments deal with issues of innovation, entrepreneurship, university funding, technology transfer, funding? How do international agreements, such as North American Free Trade Agreement (NAFTA), change the discourse about entrepreneurship and innovation domestically?

More broadly, the methodology presented here can be used to explore innovation pathways, emerging technologies, and entrepreneurial activities that can help

to further scholarship and research in these areas. As more text data becomes available, researchers will be able to conduct empirical research using rigorous, principled methodologies that account for the complexity of the data.

Researchers will also need to decide how the data relates to pre-existing theory and how it can be used to contribute to theory building. There is a debate underway currently about whether Big Data Analytics will negate the need for hypothesis testing. Some have suggested that massive amounts of data will reveal patterns and trends about the entire population, making it unnecessary to hypothesize about the population (see Kitchin, 2014). On the other hand, other scholars have recognized that Big Data will present research challenges and opportunities that will significantly change current social science methodologies (see for instance Decker, 2014; Pirog, 2014). Hypothesis testing is the outcome of theory. There is nothing in this methodology which hinders or prevents theory building or hypothesis testing. While it may be necessary to think more carefully about how this can be done, data analytics is another mechanism for understanding and theorizing innovation and entrepreneurship.

This chapter gives an overview of the complexity of text data and a mechanism for dealing with this complexity using computational and corpus linguistics. Technical, language, and concept complexities interact with each other to create a significant challenge for researchers of innovation and entrepreneurship. Text data analytics is a collection of techniques and tools, with differing goals and capabilities. Researchers must be mindful of their research questions as they gather their data and select their analytical methodologies.

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E.S.C. Berger, A. Kuckertz (eds.), *Complexity in Entrepreneurship, Innovation and Technology Research*, FGF Studies in Small Business and Entrepreneurship,
DOI 10.1007/978-3-319-27108-8

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