Peter Meusburger · Johannes Glückler
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*Editors*

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# Knowledge and the Economy

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Knowledge and the Economy

## Knowledge and Space

Volume 5

### Knowledge and Space

This book series entitled "Knowledge and Space" is dedicated to topics dealing with the production, dissemination, spatial distribution, and application of knowledge. Recent work on the spatial dimension of knowledge, education, and science; learning organizations; and creative milieus has underlined the importance of spatial disparities and local contexts in the creation, legitimation, diffusion, and application of new knowledge. These studies have shown that spatial disparities in knowledge and creativity are not short-term transitional events but rather a fundamental structural element of society and the economy.

The volumes in the series on Knowledge and Space cover a broad range of topics relevant to all disciplines in the humanities and social sciences focusing on knowledge, intellectual capital, and human capital: clashes of knowledge; milieus of creativity; geographies of science; cultural memories; knowledge and the economy; learning organizations; knowledge and power; ethnic and cultural dimensions of knowledge; knowledge and action; and the spatial mobility of knowledge. These topics are analyzed and discussed by scholars from a range of disciplines, schools of thought, and academic cultures.

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# Part I
# Knowledge Creation and the Geography of the Economy

# Chapter 1
# Introduction: Knowledge and the Geography of the Economy

**Johannes Glückler, Peter Meusburger, and Martina El Meskioui**

## Knowledge and the Economy

The traditional understanding of economic growth and regional development rests on the process of raising productive capacity through additional investment and on the leveraging of regional income through increased exports (as in an export-based model). However, the neoclassical growth model demonstrates that additional investment can at best bring an economy into a stable equilibrium, for at some point depreciation and replacement investments deplete the profits from existing production. The Club of Rome has long pointed out the limits of economic growth, clearly identifying them as the dependency of economic development on fixed natural and nonrenewable resources in a world whose population is expanding at a disproportionately high rate (Meadows and Club of Rome 1972). Is economic development finite, then? What drives future economic development? And does geography make a difference to where and how economies develop? Though these fundamental questions lie at the heart of economics, many academic disciplines contribute to the promising answer as to what could make sustained economic growth possible—knowledge.

Of course, knowledge is not novel to economic theory. Relations between educational achievement and economic performance have been discussed since the sixteenth century (see Chap. 2) and empirically studied since the 1820s.[1]

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Some of the early pioneers of economics such as Marshall (1890/1920) and Veblen (1898, 1906) underlined the importance of knowledge for economic evolution and competitiveness.

> Capital consists in a great part of knowledge and organizations: and of this some part is private property and another part is not. Knowledge is our most powerful engine of production; it enables us to subdue nature and force her to satisfy our wants. Organization aids knowledge. (Marshall 1890/1920, p. 115)

Unfortunately, this dynamic approach of economics was long ousted by model-oriented neoclassical theory. The fact that theoreticians of neoclassical economics, like their classical role models, were more interested in equilibrium than in change was ruefully noted early on by Veblen (1898), who, incidentally, was one of the first economists to address the significance of knowledge in modern civilization (Veblen 1906). The classical and neoclassical economists' neglect of change and of economic development as an evolutionary process is something he attributed to a biased, hedonistic view of human beings, one not conducive to an evolutionary perspective on matters.

Some of the standard views that mainstream neoclassical economists had on knowledge were that most of it could be codified and transformed in information; that codified knowledge was a public, tradable, and spatially very mobile commodity; that new communication and transport technologies would diminish spatial disparities of knowledge; that *homo oeconomicus* had access to the knowledge he or she needed for rational decision-making; and that spatial disparities of knowledge were only short-lived. In the last 20–30 years, most of these ideas have been largely discredited, not only in science studies, geography of knowledge, and actor-network theory but also in economics, where they have been gradually replaced by concepts of bounded rationality, evolutionary economics, behavioral economics, learning organizations, new theories of the firm, and the strategic management approach (for an overview see Amin and Cohendet 2004; Gigerenzer 2001; Gigerenzer and Selten 2001; Simon 1956).

For a long time, technological progress had been recognized as a key driver of economic growth. Yet knowledge had been external to growth models (e.g., Solow 1956). When economies grew, growth was more "in the air" than "within the model" until Romer (1990, 1994) and others integrated knowledge as a factor into growth theories. Endogenous growth theory, the economics of knowledge, and other approaches have focused on processes of innovation and the economic preconditions, qualities, and effects of knowledge. New knowledge makes it possible to evaluate situations more realistically than before, to change production functions, to increase productivity, and to replace existing technologies with newer, better performing ones. But just how is new knowledge generated? What is knowledge in the first place? Questions of this kind are the source of a remarkable polyphony not only within economics but also across the social sciences and humanities.

In the social sciences and humanities, knowledge is regarded primarily as a capacity for social action (Stehr 2001), as competence or a result of a learning process. In economics, by contrast, the simplest, but most widely acknowledged,

understanding of knowledge and its intended effect as innovation is that of an outcome (OECD 2005): a new product, technology, process, organization, or marketing concept. For knowledge to be a meaningful economic good, it needs to be tradable, quantifiable, and amenable to valuation. These requirements have reduced much economic theory to a simplified view of knowledge as being little more than information (Ancori et al. 2000), with knowledge being studied only in its codified form as messages or documents (e.g., patents or designs) that can be measured, traded, and tracked. But "humans know things that they have not acquired as information and which, not having been reduced to symbolic representations (code), are held in forms that are not readily available for communication to others—at least not explicitly as information-bearing messages" (Cowan et al. 2000, p. 215). Many scholars have pointed to this tacitness or implicitness of knowledge, a dimension that is less articulable, measureable, or tradable, one that resides in the mind and that is grounded in people's experience and cognition. Whereas some economists have explicitly concentrated on codified knowledge and conceptualize knowledge in terms of the economics of information, others have emphasized the pronounced effects that tacit knowledge has on economic development (Amin and Cohendet 2004; Johnson et al. 2002). Some believe that implicit knowledge can be converted into codified knowledge. Others, though, doubt that economists can escape the complexity of knowledge by assuming codification. As Johnson et al. (2002) phrase it playfully: "to say that all Casanova's skills are possible to codify but that the costs of doing so are very high seems to us to be not only a rather empty statement but also a mystifying one" (p. 254).

However, some of the authors who regard knowledge as a tradable good seem to set store by a naïve model of communication between the sender and the receiver of information. They exaggerate the role of the producer and codifier of knowledge and neglect the cognitive processes taking place in the receiver. They overlook the importance that prior knowledge has for the ability, willingness, or reluctance of potential receivers to accept and integrate certain kinds of information into their knowledge base (for details see Meusburger 2008, 2009b). The quality and accuracy of codifying knowledge is only one side of the coin. The other side consists of the cognitive abilities, orientation knowledge, interests, motivation, attention, emotions, and prejudices of the recipients of information, as well as the spatial and social milieus in which those recipients act. The producers and transmitters of knowledge have limited influence on the extent to which their knowledge is accepted or interpreted elsewhere. A certain type or content of knowledge may be perfectly codified in equations, published in international journals, and well understood by 50–100 theoretical physicists worldwide, but the rest of the world population may just not have acquired the prior knowledge necessary to read and understand the mathematical equations and apply them to its benefit (Meusburger 2009b). Equating knowledge with information, reducing knowledge to a tradable good, and using simplistic communication models account for much of the lack of exchange that economists have with scholars in other disciplines in which the generation and diffusion of knowledge is studied.

Within and beyond this debate, a vast variety of knowledge typologies has emerged, including embrained, embodied, encultured, encoded, and embedded knowledge (Blackler 1995); analytic, synthetic, and symbolic knowledge (e.g., Asheim et al. 2007); and know-what, know-why, know-how, and know-who (Lundvall and Johnson 1994). Abel (2008) stresses the importance of distinguishing between a narrow and a broad sense of knowledge.

> The narrow notion of knowledge refers to knowledge obtained by a methodically well-regulated procedure bound to justification, truth, and verification.…
>
> The broad notion of knowing and knowledge refers to the ability to adequately grasp what something is about… on the one hand and the domain of human capacities, skills, practices, and proficiencies on the other. (p. 12)

Among the categories or forms of knowledge he identifies are everyday knowledge, theoretical knowledge, action knowledge, moral or orientation knowledge, explicit and implicit (tacit) knowledge, verbal and nonverbal knowledge, propositional knowledge (that which can be articulated in a linguistic proposition, such as *I know that*…), nonpropositional knowledge (that which cannot be articulated in a *that*-clause), knowledge relating to matters, and knowledge relating to skills and abilities (Abel 2008, p. 13). This variety exemplifies the theoretical challenge of grasping the phenomenon of knowledge and the way it relates to economic development.

This cursory introduction highlights a fundamental dilemma: Simplistically conceptualizing knowledge as information makes its valuation and trade measurable but loses most of the originality of the empirical phenomenon. By contrast, when scholars conceptualize knowledge as complex capabilities embodied in people and organizations, it no longer fits into the concept of an economic good that can be valued, traded, and accumulated, and its exact measurement becomes an impossibility. In summary, knowledge is difficult to translate into conventional understandings of goods, products, or resources and requires conceptualization more profound than that ventured thus far if it is to unravel the logic of long-term economic development.

## Knowledge and Geography

Because knowledge is divided and distributed between people and places, the process of innovation requires the recombination and movement of knowledge between people and organizations. And because a great deal of knowledge resides in people's minds, it cannot easily be transacted or traded. Processes of recombination therefore entail different forms of interaction and communication. The particularity of knowledge as an economic resource or good raises fundamental challenges for the processes of producing, protecting, storing, reusing, and diffusing knowledge (Bathelt and Glückler 2011):

1. Knowledge is difficult to produce in isolation. Because knowledge is "not given to anyone in its totality" (von Hayek 1945, p. 520), generating it usually depends

on a collective effort requiring different sources of knowledge and agents to be brought together.
2. Knowledge is hard to protect because the marginal costs of production are close to zero, at least for many forms of codifiable knowledge. In contexts of high spatial concentration and density, it may thus spill over to those who command the prior knowledge needed to understand the information. In many competitive situations, however, knowledge need not be protected for long. Knowing something years, months, days, or even minutes in advance (e.g., on the stock market) is sufficient to make large profits. The economic value of knowledge is not stable over time.
3. Paradoxically, knowledge is not easy to store, for it is largely embodied in agents and thus cannot easily be detached from them.
4. Knowledge in one context may be difficult to reuse in another because the underlying understanding may prove to be inappropriate.
5. Some forms of knowledge are difficult to replicate, circulate, and move because they result from cognitive interpretations that depend on experience, skills, and information, among many other contextual factors. Although some categories of codified knowledge can be transferred relatively easily, the comprehension of such knowledge requires additional knowledge, such as scientific knowledge and experience, which are not always available in codified form.

An important lesson to draw from these particularities is that knowledge affects, and is affected by, the geography of the economy—by spatial contexts, milieus, and spatial disparities. No other corporate activity is as concentrated in space as research and development activities and high-level decision-making are. Spatial disparities of knowledge, educational attainment, and technological standards are remarkably consistent over time. The distribution of innovation activities is extremely uneven across territories. For example, half of all high-tech patents filed within the European Union stem from inventors located in only 14 of its regions, five of which are in southern Germany. Such a clustered geography of knowledge production again illustrates the difference between information and knowledge.

This pronounced geographical stickiness and inertia of knowledge and innovation has greatly intensified social science interest in the field of geography. Learning—the process of generating new knowledge from recombining, reconstructing, and reflecting on existing knowledge—benefits from collocation and proximity under certain conditions. Geographical proximity offers local externalities[2] for people engaging in cooperative or rival learning. Aside from generating savings through the collective sharing of the sunk costs of common infrastructure, co-located learning benefits from spillover effects brought about by cooperative and rival practices of learning and imitation. "Being there" (Gertler 2003) is often an essential precondition for taking part in the local buzz (Bathelt et al. 2004; Maskel and Malmberg 1999; Storper and Venables 2004) and for being able to absorb complex knowledge (Sorenson et al. 2006). But being there is not in itself a sufficient condition (Glückler and Ries 2012; Owen-Smith and Powell 2004). Talented individuals need special milieus to become creative or innovative; they are attracted by certain places

(Meusburger 2009a). Knowledge sticks to places and differs from one to the next. In some places, people are able to maintain leadership in innovativeness across even obliquely related technologies and industries over many decades, as in Boston (Glaeser 2005), whereas in other places innovation occurs once and vanishes afterwards. Some cluster and growth policies enhance economic development in some areas but not in others, and none works everywhere (World Bank 2008).

Because processes of knowledge generation are spatially clustered, an increasing global division of labor and the extension and sophistication of global production networks require ever more effective ways to reproduce knowledge over great distances and to collaborate in joint, but spatially distributed, processes of collective learning. This challenge is anything but trivial, as the puzzle of best practice (Szulanski 2003) readily demonstrates. For instance, most corporations have major problems transmitting best practice from one organizational unit to another. Szulanski reported deviations of up to 300 % for the operational performances of one global corporation's diverse subsidiaries. In the same vein, Porter (1985) concludes that "the mere hope that one business unit might learn something useful from another is frequently a hope not realized" (p. 352). If learning and the reproduction of existing templates often fail even within a distributed organization, how much more demanding will distant learning be between organizations and across countries? Research in geography underlines the role of temporary proximity (Torre 2008; Torre and Rallet 2005) and of temporary clusters such as trade fairs and conventions (Bathelt and Schuldt 2008). These approaches facilitate the dynamic conceptualization of the geographies of learning and innovation because they go beyond permanent co-location and thus open opportunities for geography and the other social sciences to be integrated into the knowledge economy more deeply than has been the case up to now.

There is much more to learn about the practices and geographies of knowing and learning (Bathelt and Glückler 2011) in order to improve the understanding of processes of knowledge generation and their effects on uneven economic and regional development. This brief introduction teases out only some of the peculiarities, challenges, and points of integration for scholarship centered on the interconnection between knowledge, spatial contexts (milieus), and the economy. That relationship is keenly affected by geography and history and by those social sciences that conceptualize the nature of knowledge and the processes of knowledge generation, reproduction, and application in society. The present volume contains a selection of papers from various disciplines that all bring original ideas and empirical evidence to the study of the knowledge economy.

The knowledge economy, knowledge-intensive industries, the spatiality of knowledge, the role of proximity and distance in generating knowledge, the transfer of knowledge in networks, and other relations between knowledge, space, and economic development have drawn increasing attention across the scientific community in recent years. The conceptual and methodological multidisciplinarity emerging from this scholarship has enriched the study of these subjects, broadening horizons of research. Yet there has been a remarkable lack of communication between some of the contributing disciplines (Meusburger 2008, 2009a). Neglect of

concepts and definitions used in fields of inquiry other than one's own has complicated interdisciplinary discourse, especially when it comes to the spatiality of knowledge, the role that spatial contexts play in knowledge creation and diffusion, and the relevance of face-to-face contacts.

## The Structure of This Book

Volume 5 in the series on Knowledge and Space treats the multiple relationships between knowledge, the economy, and space. The following twelve chapters are grouped into three parts: knowledge creation and the geography of the economy, knowledge and economic development, and knowledge and geographical clusters. They bring together new concepts and original empirical work from economics, geography, history, sociology, international business relations, and management.

Part I highlights the processes of knowledge creation and exchange from a geographical perspective on the economy. In Chap. 2, "Relations between Knowledge and Economic Development: Some methodological considerations," Peter Meusburger weighs some of the reasons why the relations between knowledge and economic development are not self-evident and why they vary according to the spatial context and the time period in which learning processes and actions take place. He begins by describing historical caesurae that have increased the economic utility of knowledge and the "mercantilization of knowledge" (Lyotard 1979/1984, pp. 5, 51). He then elaborates on various methodological issues that may have an impact on the relations and statistical correlations between indicators of knowledge and indicators of economic performance. He discusses four questions: How should the relations between milieu and knowledge generation be conceptualized? To what degree and under which circumstances is proximity relevant to the generation of new knowledge? What influence does the scale of analysis have on the results of that analysis? And why is the time dimension so important for the economic value of knowledge?

In the subsequent chapter, "A Microeconomic Approach of the Dynamics of Knowledge Creation," Patrick Cohendet, Jean-Alain Héraud, and Patrick Llerena focus on the process of invention. They note that invention necessitates, first, the interaction and coordination of different economic actors and, second, the creation of a shared and common "codebook." The authors aim especially to analyze the phase of invention by observing the microeconomic phenomena that take place during an interval they refer to as the period of research. Their conclusion mentions two issues that deserve specific consideration. First, results of tensions depend on the context in which the inventive idea is developed, on the degree of trust between participating actors, and on the degree of competition in the related industry. Second, the consequences of public policy must be taken into account, for it influences the codification and standardization of collective knowledge.

In Chap. 4, "Knowledge Creation and the Geographies of Local, Global and Virtual Buzz," Harald Bathelt and Philip Turi analyze the effects of new communication

technologies and forms of organization on economic interaction and knowledge creation. By emphasizing the importance of combining computer-mediated communication (CMC) and face-to-face (F2F) interaction, they demonstrate that each medium has its relative strengths and weaknesses. CMC is shown to be more effective than F2F at rapidly disseminating knowledge but unable to establish initial trust between the actors. By contrast, permanent geographical proximity is not required for creating knowledge. Nonetheless, it might be indispensable for conveying tactical knowledge, a function critical in times of uncertainty and ambiguity.

The chapter entitled "Creativity: Who, How, Where?" deals with creative regions and their characteristics. The author, Edward Malecki, searches for the allegedly ultimate foundation that makes economic growth and development possible. He speaks of actors as creative individuals and of their management behavior, seeking to discover where creative milieus occur. He concludes that creativity cannot be planned from scratch by local governments even if the important factors promoting creative environments are basically known.

In Chap. 6, Johannes Glückler conceptualizes knowledge management within a trade-off between organizational coherence and geographical expansion. His extensive corporate case study of a globally distributed medium-sized technology service company explores the relational architecture of interpersonal knowledge transfer among all employees and across all global locations. He uses a social network analysis to illustrate the network of knowledge flow, assess its vulnerability, and investigate the effect that different management programs have on global knowledge exchange. Although geographical separation is a key barrier to knowledge exchange, Glückler finds expatriation programs to be the most effective driver of international interpersonal knowledge transfer.

Part II comprises a set of contributions that deal with the relation between knowledge and economic development. In "Knowledge, Capabilities, and the Poverty Trap," Jan Fagerberg discusses the relation between knowledge and economic growth in the context of development. It has long been assumed in neoclassical theory that economic catch-up is a question of investing in tangible, especially technical, goods and that the rates of investment in poor countries are higher than in rich ones. But recent investigations have shown that "technological capabilities" need to be accompanied by a wider set of "social capabilities." The author's research reveals that the poor state's backwardness is due primarily to a lack of ability to acquire, exploit, and develop new knowledge. Fagerberg discusses the importance of values, beliefs, and institutions that encourage members of a society to contribute actively to the development process.

In the chapter "Economics, Geography, and Knowing 'Development,'" Eric Sheppard examines how geographers have dealt with economic development in recent years and compares their approaches to mainstream economic perspectives. He accentuates the necessity of geographical intervention to overcome sociospatial inequalities.

Chapter 9, "Knowing 'Mycellf'™: Personalized Medicine and the Economization of Prospective Knowledge about Bodily Fate," delves into the scientific discovery of human genetic information that is making health forecasts increasingly possible.

Discussing this specific knowledge of bodily fate, the author, Bronwyn Parry, explores its social and spatial dynamics. She also illustrates the central role that the consumers of such genetic tests play in actively "coproducing" genetic knowledge as an emergent and constantly evolving commodity.

Ulf Matthiesen's chapter, "KnowledgeScapes: A New Conceptual Approach and Selected Empirical Findings from Research on Knowledge Milieus and Knowledge Networks," shows in seven argumentative steps how to outline conceptions of knowledge-based urban regional developments. He stresses the complex interplay between accelerating knowledge dynamics, heterogeneous spatial developments, and conflict-driven transaction fields. This chapter presents new research heuristics and points out the coevolutionary interrelations between knowledge, space, and milieu.

Part III centers on the geography of innovation and discusses the role that geographical clusters have in the generation of knowledge. The reasons that an industry thrives or languishes in a specific region are poorly understood even today, and the factors that augment or stunt the growth of clusters are largely unknown. That research gap prompted the investigations that Maryann Feldman and Elaine Romanelli have conducted into the human therapeutics industry, work now documented in their chapter, "Organizational Legacy and the Internal Dynamics of Clusters: The U.S. Human Biotherapeutics Industry, 1976–2002." Their study is among the first of its kind in that it focuses on the internal industrial demography of cluster development, including both the organizational and geographic origins of entrepreneurs and firms that came to populate biotech clusters. They also point out that those internal dynamics and the ways in which firms relate to one another are decisive factors in a region's economic success or failure.

Whether a geographical territory is innovative or not depends mainly on its specific access to knowledge. This contingency might be a reason why some regions are rich and others are poor. Jochen Streb's chapter, "Knowledge and Space in Economic History: Innovations in the German Empire, 1877–1918," elaborates on the linkages between economic growth and spatial distribution of knowledge in the historical context of the German Empire from 1877 to 1918. Streb's research results show that effects of knowledge spillover between technologically, economically, and geographically related industries were a major source of innovative activities. He underscores the fact that innovative, technologically related industries were often also geographically clustered and that this geographic proximity helped increase the innovative output of the firms involved.

In the final chapter, "Cluster Policy: A Guide to the State of the Debate," Christian Ketels discusses the current state of the academic debate on cluster policy by summarizing the key findings on the existence and impact of clusters and by presenting the basic theoretical argument for cluster policy. He points out that practicable theories and definitions of cluster policy are still being discussed. Is it, for example, a tool for changing the nature of economic geography or rather a way to leverage existing agglomerations as platforms for collaboration to enhance cluster dynamics?

As suggested by the aforegoing overview, this volume addresses a broad audience interested in historical and spatial foundations of the knowledge economy and is intended to close some of the gaps between areas of research on knowledge, the economy, and space. It appears at a time marked by a continuing quest to accommodate new insights that build on, even replace, previous interpretations of the relations between these key facets of human interaction and endeavor. Relations between knowledge and the economy seem self-evident, but this volume shows that the analysis of these relations is one of the most difficult and contested topics in the broad research field of knowledge and space. One difficulty lies in the complexity and unpredictability of these relations. Another is the context-dependency of generating and applying knowledge—a topic that has received little attention in economics. May this volume help in some measure to advance the thinking in all these areas and offer new paths to interdisciplinary approaches for grappling with the issues examined in the pages that follow.

## Notes

1. In 1826 Charles Dupin published the *Carte figurative de l'instruction populaire de la France* (Dupin 1826). This map showed large regional disparities in educational attainment between northern and southern France (reprinted in Meusburger 1998, p. 193). In the tables accompanying the map, Dupin took levels of educational attainment, the number of patents for inventions, and membership in the *Académie Française* and compared them with various economic indicators, an analysis that suggested a correlation between educational achievement and economic performance. One year later he examined these relations in his book *Forces productives et commerciales de la France* (Dupin 1827).
2. Externalities, or external economies, are "services (and disservices) rendered free (without compensation) by one producer to another" (Scitovsky 1954, p. 143).

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# Chapter 2
# Relations Between Knowledge and Economic Development: Some Methodological Considerations

**Peter Meusburger**

The vast majority of experts concur that quantum leaps in the generation and application of new knowledge[1] over the centuries have each fundamentally altered the economic world. The spread of literacy and the invention of the printing press, the steam engine, the telephone, the computer, and many other technologies are only a few examples. Successively and cumulatively, they all brought about abiding economic discontinuities and increased, for a certain period of time, the competitive advantages of those organizations, towns, or regions that created or first adopted these innovations. However, it is far more difficult to substantiate the impact of knowledge on everyday problem-solving and economic action. Indeed, the generation, diffusion, and application of knowledge—which underlie the "four fundamental dimensions of analysis in economic geography, that is, organization, evolution, innovation and interaction" (Bathelt and Glückler 2011, p. 21; see also Storper 1997; Storper and Venables 2004)—attracted surprisingly little attention from mainstream economic geographers until the 1990s.

In this essay I adopt different perspectives in an attempt to show that the relationships between knowledge and economic action (economic competitiveness and economic success) are not as cut and dried as the literature would often have one believe. Whether new knowledge, advanced occupational qualifications, or new research results can be economically used or converted into innovations in their region of origin heavily depends on the social, political, and economic contexts, the available resources, the local potential of a highly skilled and creative labor force, and the knowledge environment in which actors and social systems strive to achieve their objectives. A host of historical examples confirm that new research results, better expertise, higher competence, and inventions do not automatically trigger economic dynamics or enhance competitiveness in the countries and regions where the inventors, scientists, or creative entrepreneurs developed their ideas.

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The first section briefly summarizes some of the current debate's open questions and inadequacies that hamper a deeper grasp of the relations between knowledge and economic performance. In the second section I argue that research interests, at least under competitive conditions, should focus not only on "knowledge per se" but also on time lags in the diffusion and adoption of knowledge and the lead that some actors, organizations, or regions have over others in knowledge, competence, educational attainment, or technology. The third section calls attention to a few salient historical discontinuities and developments that in earlier centuries first increased the economic and political "utility" of literacy, then raised the importance of the level of schooling for economic development and competitiveness, and ultimately prepared the ground for the primacy of scientific research in the economy. This long-term outlook, too, is intended to stress that it is always several conditions that must be met in a region and that several factors must converge there in order for new knowledge or new technologies to come across as economically "useful." The fourth section explains what I mean by context and how one can imagine its effect on the generation and diffusion of knowledge without falling prey to geodeterminism. Under what circumstances can proximity and face-to-face contacts influence a learning process, and when are they less relevant? In the fifth section I name a few reasons why the time dimension also figures as prominently as it does in the analysis of the relation between knowledge and economic development and the comprehension of spatial disparities of knowledge.

## Open Questions and Shortcomings in the Discussion on the Diffusion of Codified Knowledge

Both neoclassical economic theory and Marxism had an extremely simplistic view on the categorization of knowledge, the role of knowledge in economy, and the spatial diffusion of knowledge. Most of these deficiencies have already been identified in detail elsewhere (Meusburger 1980, 1997, 1998, 2009b), but a brief summary of two issues still encumbering the current discussion may suffice here.

The distinctions between codified and tacit knowledge or between explicit and implicit knowledge are very popular but quite problematic and insufficient. I question the assumption by Fujita et al. (1999), Maskell and Malmberg (1999); and many others that the more codified or more public the knowledge involved, the more mobile it is and that knowledge, once codified, is almost instantly available to all firms at zero cost regardless of their location. Making high-grade knowledge[2] public and easily available does not automatically mean that it is understood and accepted. The quality and accuracy of codifying knowledge is only one side of the coin. The other side is the cognitive abilities, interests, motivation, attention, emotions, and prejudices of the potential recipients of information and the milieu they are embedded in. The spatial diffusion of high-grade knowledge hinges more on the skills, experiences, and cognitive processes of the potential receivers of information

than on the willingness of the sender to share his or her knowledge. The producers of new knowledge have limited influence on the extent to which their knowledge is accepted and processed or the way it is interpreted elsewhere. A certain type or content of knowledge may be perfectly codified in equations, published in international journals or made available for free, but it may be understood worldwide only by 50 theoretical physicists. The rest of the world population may just not have acquired the prior knowledge needed to read and understand the published new information and to integrate it in their own knowledge base.

Much more important than the distinction between codified and tacit knowledge is a vertical categorization or ranking of codified knowledge according to how much prior knowledge is necessary in order to understand freely offered codified information and how much time and money it takes to acquire the relevant prior knowledge. Persons who have not completed years of study and research in molecular biology or theoretical physics have little or no use for the available scientific publications in these fields. Some types of scientific knowledge cannot be simply transferred from A to B; to be assimilated, they must be replicated in B with expensive experiments in sophisticated laboratories (see also Callon et al. 1999; Collins 1983, 1985).

Scholars supporting the assumption that codified knowledge is a tradable good should not forget to mention between how many persons and between which locations the specific knowledge is tradable. It makes a difference whether codified information is understood by 50, 10,000, or billions of people worldwide. And it is important to know whether the workplaces of those few persons who understand a given piece of information are evenly distributed in space or concentrated in a few research laboratories. High-grade knowledge is "highly localized and selective in establishing cross-territorial linkages" (Bathelt and Glückler 2011, p. 12).

Prior knowledge is not something people possess. It is something they constantly develop in a way similar to the knowledge spiral described by Nonaka and Takeuchi (1995, p. 71). Such learning processes encompass personal experience, professional training, graduation in a scientific discipline, and "encultured knowledge" (Collins 1993, p. 99, 102; see also Blackler 2002) arising from socialization and acculturation in specific cultural settings or shaped by stable relationships in organizational routines and interpersonal relationships.

## The Importance of Having a Lead in Information, Knowledge and Technology

Many authors (e.g., Foray 2004; Malecki 2010) assert that codified knowledge is ubiquitously available in the age of the internet; that it is *nonexcludable* and therefore difficult to control or to prevent others from using; and that it is *nonrival*, meaning that others can use it, even simultaneously, and that it is therefore inexhaustible. These frequently quoted statements are valid only, if at all, for so-called everyday information easily understood by most people, not for higher grades of knowledge.

These assertions underestimate the complexity of a communication process; they do not take into account the importance of the time dimension in a competitive situation, overlooking the fact that the economic value of certain types of knowledge changes over time. Competencies, skills, and knowledge that are prevalent or shared by a multitude of actors (e.g., the ability to read a book or use a digital notebook) may signify something for the individual's personality development or may be a prerequisite of his or her integration into social systems and participation in economic activities, but they do not unconditionally bestow appreciable advantage in economic competition. It is not widely distributed everyday knowledge that contributes to a person's or organization's economic competitiveness but rather the command of scarce knowledge or a head start in knowledge. I show below that the point in time at which particular information, knowledge, competence, or technology is acquired is very important for competitiveness.

An initial lead, a head start, in knowledge can pertain to many aspects, including an ability to learn and adapt more quickly than others; endowment with exceptional absorptive capacity (a knack for capitalizing early on knowledge developed elsewhere); the acquisition of rare, economically valuable occupational skills; the invention and application of new technologies; the development of more efficient production methods and transport; the use of superior organizational and communication structures; and the practice of keeping vital information secret to name but a few. When research is about economic competitiveness, regionally different potential for economic development, or the explanation of persistent regional disparities, scholarly interest should gravitate more to the asymmetries of knowledge and to the social and regional inequalities in the capacities to take action. Many regions (especially peripheral ones) are unable to profit from processes of modernization or transformation only because their population lacks the educational attainment, professional skills, experience, organizational capacities, or research facilities required for early successful change. Other areas repeatedly take the lead in adopting innovations because their populations are better educated, their top decision-makers more experienced and farsighted, and their technologies more developed than those of their competitors. History shows that such regional disparities of knowledge are often self-perpetuating; they show a remarkable persistence over time and therefore pose a stiff scientific challenge for anybody interested in spatial inequalities of economic development.

To avoid confusion, four points should be kept in mind. First, the generation of new knowledge is generally not about finding some absolute truth or completely eradicating nescience but rather only about expanding the abilities to improve the quality of perception, analysis, problem-solving, and the capacity to act. In a social system operating in a competitive economic, political, or scientific setting, it is imperative to perceive situations as realistically as possible, assess the system's options and resources and those of its rivals as accurately as one can, analyze new developments early, identify feasible solutions and alternatives for looming problems, adapt quickly to new conditions, and shun objectives that would lead to ruin. An evolutionary approach studying the relations between knowledge and economy incorporates most of the aspects associated with the terms *capacity*, *preparedness*,

and *resilience* as defined in the United Nations International Strategy for Disaster Reduction (UNISDR 2009):

**Capacity** The combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals. [p. 5] …

**Preparedness** The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions. [p. 21] …

**Resilience** The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions. [p. 24]

No social system can completely avoid faulty analyses, misjudgments, or overdue responses. But the fewer mistakes it makes in such decision-making situations and the more adaptable and able to learn it is, the more likely its long-term competitive survivability will be.

Second, generating new knowledge (through scientific research, for example) does not quantitatively decrease a lack of knowledge. Instead, new research findings and discoveries give rise to new unanswered questions and risks—to new nescience that can spark new research and learning processes. This issue of the knowledge society, which is simultaneously a risk society, has been thoroughly discussed by Beck (1986), Beck et al. (1996), Moldaschl and Stehr (2010), Smithson (1989), Stehr (2001), and Strulik (2004, 2007, 2010), among others. It is also in the focus of evolutionary economic geography (Bathelt and Glückler 2011).

Third, having an edge in knowledge or expertise can both broaden and restrict the scope that actors or social systems have for taking action. A technological invention, for instance, will usually widen their alternatives and flexibility. However, if an actor or social system has advance knowledge or information that helps analyze a situation more astutely than rivals can, it will generally enable the possessor to recognize and preclude unintended consequences or drawbacks of other options entertained by less well-informed actors. It will therefore shrink the scope for taking action (see also Strulik 2004, 2007, pp. 713–714). Usually, the array of options is much greater in the layperson's mind than in the expert's.

Fourth, new knowledge is always local or scarce for a while, and, depending on its nature, a long time can pass before it diffuses in space and becomes widely available (Bloom 1999, 2001; Meusburger 2009b). Whenever the reception and application of new knowledge calls for prior knowledge that is difficult for the receiver to acquire (e.g., research experience in a specialized field) or requires a particular research infrastructure, this new knowledge will spread only to particular areas and will precipitate new knowledge divides (Matthiesen 2007a, p. 657) and new regional disparities.

Currently, most economic geographers seem to be interested primarily in knowledge-sharing within multilocal organizations and well-established cooperative relation-

ships, such as those in networks, user communities, communities of practice or relations between suppliers and customers. But the everyday world of business is not only about open innovation, free information in social media, and knowledge-sharing between persons who have common interests, trust each other, pursue similar goals, and can easily exchange their knowledge because they have comparable backgrounds. As important as it may be to have social learning systems for jointly solving problems, sharing ideas, setting standards, developing tools, and maintaining relations (Ibert 2010, 2011; Ibert and Kujath 2011), economic geography cannot afford to neglect that economic competitiveness and economic success often rest on exclusive knowledge, secret knowledge, and knowledge protected by patents and copyright. In many cases knowledge is kept secret as long as possible, intentions are deliberately hidden or disguised, and competitors are left in the dark. The literature on the knowledge economy contains relatively little about these practices of secrecy, though precisely such asymmetries of knowledge net the highest profits.

In centuries past it was the alchemist pretending to have secret knowledge about how to produce gold or porcelain who profited enormously from the ignorance of avaricious merchants or rulers (Jütte 2011); today it is the investment banker who promises great assets to people who do not comprehend his financial products. In the most recent financial crisis, customers would never have fallen for many of the financial products they bought had they understood their structure, known the risks, or seen through the fraudulent intentions of their business partners. Business relations are not based only on transparency, open innovation, and selfless knowledge-sharing but rather on the exploitation of knowledge differentials and information gaps. Over history many military conflicts have indisputably been decided by espionage and betrayal, which are synonymous with the gain or loss of an advantage in information.

## The Economic "Utility" of Literacy, Educational Attainment and Research in the Course of History

Whether a society regards new knowledge, insights, technologies, and skills as "useful" is highly contingent on the political, economic, and social framework and level of development. Throughout history, new knowledge and new competencies and technologies have won out on a broad scale if they have served the interests of the powers-that-be; created new latitude for action; responded to an existing need; raised productivity and economic competitiveness; or added to the influence, wealth, and reputation of those in power. New knowledge has been readily adopted if it has contributed to food production (the plough and artificial fertilizer), helped achieve military superiority (the saddle, bow, gun, and radar), facilitated or accelerated transport (the wheel, train, and aircraft) and communication (paper-making, the printing press, and the computer), improved the efficiency of generating and using energy (the steam engine and the electric engine), or increased industrial production (the loom and industrial robots).

The fact that scientific knowledge and so-called orientation knowledge (religions and ideologies) can stabilize and legitimate political power was recognized early on. Caliph Harun al-Rashid (786–809) and his son al-Ma'mun established at their seat of government in Baghdad the "House of Knowledge," where Greek, Indian, and Persian tracts were translated into Arabic (Ahmed 1988, p. 333; Lyons 2009). In other cultural environments, too, rulers built palace schools, academies, and universities at the centers of their power (see Bosl 1972, p. 11; Meusburger 1998, p. 180; Meusburger 2000, 2007, 2008, 2012a), institutions that were intended to support their political interests as well as to augment and legitimate their power. The close coalition between knowledge and power is one of the main reasons why particular highly qualified occupations and power-related functions are tightly clustered at the centers of power in all political systems and why differences between the center and the periphery in the level of training and qualification are incessantly reproduced by migration and strata-specific educational attainment. It also explains why modern telecommunication technologies have tended to strengthen the position of important political and economic centers rather than divest them of functional meaning.

Whereas a high degree of experience, a head start in information, and the ability to analyze situations realistically and to recognize opportunities and risks has ensured human survival since the Stone Age, what people deem to be useful skills and competence has changed repeatedly over time and varied over space. In and before the thirteenth century, for example, science in Europe was not practiced with an eye to gaining economic benefit. It served chiefly moral, ethical, and theological goals instead (and in this respect differed from science in the cultural areas under Arabic influence). Medieval science in Europe was subordinated to theology. In the Middle Ages, knowledge from the natural sciences tended to be of secondary importance, with revealed, religious truth being the highest truth. Although major trading houses have striven to gain informational advantage over their competitors since the early Middle Ages, the economic and social utility of reading, writing, and arithmetical skills was not recognized in Europe until the thirteenth and fourteenth centuries, after Arabic numerals and Arabic knowledge of the natural sciences had spread in Europe. Leases, rental arrangements, and property ownership were usually managed without written records until well into the eleventh century. This modus operandi changed in the twelfth century as memory-based culture gave way to a culture based on writing; as rulers began to govern from a single residence instead of exercising their power by moving throughout their realms; as paper-making technology became known in Europe (Bloom 2001); and as the use of documents, letters, and archives became accepted first at royal courts, then among bishops, counts, knights, and, as of about 1,300, among merchants and businesses as well (see Clanchy 1979, p. 31; Faulstich 1996, pp. 76–80).

However, the increasing use of documents in litigation and the issuance of titleship deeds and wills does not imply that a large part of the population in that era could already read and write; the share of literate people was still modest. The economic importance of literacy was appreciated in the thirteenth century mostly because of fundamental changes in business practices and the commercial relations of the

merchants in those days (Kellenbenz 1973, p. 131). Before the age of the Crusades, the merchant personally accompanied his transports of goods, even over long distances. Business was conducted face-to-face, with the merchant's own goods usually being exchanged directly for other items. No written correspondence, delivery notes, or invoices were necessary. The Crusades radically altered European economic history. The thirteenth and fourteenth centuries saw the advent of branch establishments and bills of exchange, and both the size of commercial organizations and the range of their trade relations vastly expanded. These innovations considerably escalated the amount of time and effort it took to coordinate all the activities, requiring ever more ledgers, tax records, account books, letters, reports, and written transactions. By the mid-fourteenth century, at least long-distance trade required businessmen who were able to read and write (see Bowman and Anderson 1973, p. 249; Meusburger 1998; Sieveking 1901, 1902).

The adoption of double-entry bookkeeping in the late fifteenth century brought about an especially important shift in economic history. As Sombart has written, "Double-entry bookkeeping was born of the same spirit as the systems by Galileo and Newton and the teachings of modern physics and chemistry … Capitalism is simply inconceivable without double-entry bookkeeping" (as quoted in Hoffmann 1993, p. 8, my translation). Double-entry bookkeeping was crucial because it rendered business transactions and the economic situation of an enterprise transparent and predictable, reducing the extent of uncertainty and the danger of misguided decisions. The early introduction of double-entry bookkeeping gave the commercial centers of northern and central Italy immense competitive advantage. Failing to adopt this accounting system promptly enough, the Hanseatic merchants in Northern Europe lagged behind their Italian competitors (see Hoffmann 1993, p. 8).

Beginning in the fifteenth century it was mostly technological progress (new weapons, modern methods of navigation, and superior ships) that handed individual regions or cities an economic edge by enabling them to boost productivity, exploit new resources, extend the geographic range of their shipping on the high seas, and improve their access to new resources and trade routes. The advances thereby lent a global dimension to the asymmetries of power and knowledge (colonial policy) for the first time. As of the sixteenth century, Europe witnessed a growth in the number of publications that underscored the usefulness of schools and universities to the state and endorsed them as a source of the state's wealth and well-being. In *De restituendi scholis* (On the Reinstitution of Universities), a tract written in 1540, the famous German Humanist and scholar Philipp Melanchthon (1497–1560) emphasized the significance of the universities for a country's prosperity:

> Because that is so, … all believers must wish with sincere prayers for God to inspire rulers to restore and adorn the universities, to renew and promote the study of the sciences and sound theories… . Indeed, he [the Prince Elector] does better service to his people and all posterity in this matter [the restoration and modernization of the universities] than if he were to find veins of gold or silver as great as they were in Lydia [and] which increased the wealth of Croesus so much (as quoted in Nürnberger 1961, col. 492; my translation from the German)

Francis Bacon, writing his *Novum Organum* a few decades later (in Latin 1597, English translation 1620), used the now frequently cited formulation *scientia est potentia* (knowledge is power). According to Moldaschl and Stehr (2010, p. 9), the term *potentia* can in this context be defined as the ability to bring something about.

In the sixteenth century, the printing press, the manufacture of precision instruments, and the production of maps helped greatly accelerate the accumulation and diffusion of knowledge. Improvement in the accuracy of available instruments immediately changed the questions that scientists asked and the research methods they used. Experiments and mathematical abstractions led to amazing insights, intensifying scholarly interest in solving *practical* problems and concentrating on technical processes. Princes in the sixteenth century therefore employed court mathematicians and astronomers in order to keep pace with the state of the art in navigation, surveying, and fortification technologies and to increase the eminance of their courts.

In the 1600s, René Descartes (1596–1650), Baruch Spinoza (1632–1677), and Gottfried Leibniz (1646–1716) brought forth a new philosophical kind of thinking, ushering in the Age of Enlightenment, or reflective modernism (Beck 1986). The advance of analytical and mechanistic methods of thought and the revolutionary findings and achievements they produced in the natural sciences (through the work of Galileo, Kepler, Copernicus, and Newton, for example) lit the fuse for the explosion of activity in the natural sciences around mid-century and sent interest in the use of scientific knowledge soaring. The surge in publications in the natural sciences (see Taylor et al. 2010) was accompanied in many countries by a boom in the founding of scientific societies, academies, and journals. Among the first ones were the German Academy of Natural Researchers Leopoldina in Halle (1652), the Accademia del Cimento in Florence (1657), the Royal Society in London (1662–1663), and the Academy of Sciences in Paris (1666). The growing emphasis on practical research in the latter half of the seventeenth century was apparent, for instance, in the discourses of the Royal Society, which turned more and more to mechanics, forestry, dyeing, and insight into trades (Crombie 1967, pp. 123–124; Price 1975, pp. 164–175).

In the mercantilism of the eighteenth century, many territorial rulers in Europe tried to gain a technological advantage by keeping secret their methods for making porcelain, glass, and other lucrative goods, by forbidding the emigration of members of specialized occupations (glass-makers, machine-builders, and silk weavers), or by attracting highly qualified refugees (Huguenots and Jews). According to Lyotard (1979/1984), it was discovered in the late eighteenth century that no technology is possible without wealth (investment) and vice-versa. He called this process the mercantilization of knowledge (p. 51). The state's emerging interest in training the population was manifested not only in the introduction of compulsory education in some countries (e.g., Austria in 1764) but also in the creation of the first technical schools for industry, engineering, agriculture, and mining. In 1794 the École polytechnique in Paris was the first university of technology to be founded, and it was soon taken as a model outside France as well. In 1797, Count György Festetics in Keszthely, Hungary, opened the Georgikon, Europe's first

*Agrarhochschule* (university focused on agriculture), and in 1825 Karlsruhe became home to the first university of technology in Germany.

In the early nineteenth century, reforms in public education were often propagated for reasons of economic modernization. The Prussian state set up model schools in order to respond to the demand for economic knowledge and skills and to create potential for innovation that could continue spurring economic and technical development (see Baumgart 1990, p. 45; Lundgreen 1973, p. 20). The ascendant economic role of the school system and, later, of the universities came about primarily because the industrialization process was coming to depend more and more on new inventions and technologies, new means of transport and communication, and new forms of organization (factories and joint-stock companies).

Competitive advantage had long derived mostly from privileges and monopolies that kings or other territorial rulers granted to merchants, guilds, and cities (e.g., staple rights, the right to hold a market, the right to mint coins, and monopolies on production or trade). When these privileges ended, competitive economic advantage had to be achieved by innovative products stemming from inventions, new technologies, basic innovations, or superior qualifications of the workforce. By the mid-nineteenth century, research, new technologies, and a highly qualified workforce had become an important means of production in Europe. The Second Industrial Revolution, which took place in the final decades of nineteenth century, is commonly known to have been based squarely on goal-oriented, increasingly government-funded research and on new knowledge in chemistry, physics, electrical engineering, and machine building.

Because these new competitive advantages based on research, superior knowledge, and qualifications did not effectively stabilize economic advantages as long as the earlier bestowal of monopolies and privileges had, the protection of intellectual property through patents became an important premise for massive business investment in research and development (R&D). Of course, technical innovations come about even without such protection of the inventor's property rights, but it distinctly fostered innovations and their diffusion and changed the cost-benefit ratio in favor of the innovators. Patent protection was an important incentive system in applied R&D. No business accepts exorbitant R&D costs if the results are immediately available to all rival companies for free (North 1973, p. 227).

Great Britain's edge in the Industrial Revolution arose from many different factors, one of them being that the kingdom adopted and enforced property rights and then patent laws (1623) far earlier than countries on the European continent did (North 1973, p. 228). Similarly, the economic disparities between northern and southern Germany were (and still are) partly due to the fact that Bavaria, Baden, and Württemberg introduced patent rights around 1825 as an outcome of Napoleon's legacy, whereas other German lands waited until 1877 to institute a universal patent law (Kaufer 1989, p. 9).

Until the early nineteenth century, scientific instruments other than astronomical observatories (which were usually funded by princes or academies) had to be privately financed by scientists, and most scientific experiments were conducted in private homes. This pattern held until the mid-nineteenth century, at which juncture

government influence on education and research rapidly grew in Europe. In 1840 the world's first chemistry laboratory was built for Justus Liebig at the University of Giessen. In 1852 Robert Bunsen in Heidelberg received his own laboratory building, the most expensive experimental chemistry facility in the world at the time. This mounting dependence of the natural sciences on expensive equipment and laboratories not only reinforced the impact that the state and business had on research but also compounded the sway that the local context (its research infrastructure and the scientific milieu of a university) had on the research topics and output of the scientists working in it.

In the final decades of the nineteenth century, the importance of research to economic development rose again because technological progress and the competitive advantage it conferred upon the era's pivotal ascendant industries (e.g., chemicals, electrical engineering, and machine-building) was coming ever less from chance inventions or spontaneous, incremental technological improvements. The advantage lay instead with lavishly funded scientific research. A science-driven economy[3] became essential to economic competitiveness. Big industry's first independent research organizations appeared in the 1880s, and in 1887 the creation of the Physikalisch-Technische Reichsanstalt (Imperial Metrological Institute) marked the beginning of independent government-funded research (see Hack 1988; Weingart 1975) in such fields as spectroscopy, photometry, electrical engineering, and cryogenics. To foster scientific work in the German Empire, the Kaiser-Wilhelm-Gesellschaft (Kaiser Wilhelm Society) was founded in 1911, which was continued after World War II as the Max-Planck-Gesellschaft, or Max Planck Society (see Brocke and Laitko 1996). To what extent this primacy of science in industry resulted from "science push" or from "market pull" (Malecki 1997, pp. 80–81) is a question whose answer depends on the product and phase of the production cycle.

Especially persuasive evidence of the economic and political significance of research emerged after World War II, when patents, research results, and blueprints became the most important war booty for the Allies (for details see Gimbel 1990; Harmssen 1951; Lasby 1971). Speaking at a U.S. congressional hearing in 1946, J. C. Greene, the head of the Office of Technical Services (OTS), commented that "these are intellectual reparations, and they are the only solid and permanent reparations we are going to get out of this war" (as quoted in Gimbel 1990, p. 28). Vannevar Bush, the director of the Office of Scientific Research and Development, believed that "such information would help American industry to maintain its place in world trade and provide employment opportunities for discharged veterans" (Gimbel 1990, p. 5). Eager "to obtain the most advanced technological information known to the enemy" (p. 5), officials of the U.S. War Department questioned German technicians, searched their laboratory records and files, and examined industrial products and manufacturing processes used by the Germans. As part of this informational dragnet, 198,000 pages were recorded on microfilm at the Leitz company in Wetzlar; 4,000 at Merck in Darmstadt; 14,000 at Degussa in Constance; 311,000 at I. G. Farben in Höchst; 60,000 at Krupp in Essen; and 1,018,000 at the Berlin Patent Office (p. 63).

It was not until the 1950s, however, that researchers paid attention to the fact that qualifications, expertise, and a lead in knowledge and information were important not only in production but in coordination, management, marketing, and sales as well. It became apparent that competitive advantage can be gained not just through new technologies, inventions, and patents but also through new forms of organization and highly qualified managers who were quick to perceive the salience of new developmental trends and to set the proper course. As of the early 1960s, several published studies containing terms such as *the knowledge society*, *the information society*, *the information economy*, and *the knowledge economy* began to appear. Their authors pointed out that economic growth in "postindustrial" society depended less on financial capital and raw materials than on human resources, intellectual capital, organized intelligence, and organizational capabilities. Pioneers of this new view included Polanyi (1944), Machlup (1962), Bell (1973), Drucker (1969, 1992), Galbraith (1967, 1970) and Gottmann (1979, 1983).[4]

Economists focusing on the knowledge economy devoted little attention to *spatial* disparities of educational attainment, the spatial distribution of jobs for highly qualified and low-qualified persons, the role of the spatial context and the spatial relations involved in the generation and diffusion of knowledge, the spatial mobility of highly qualified people, and other topics that had been studied in the geography of knowledge and education since the early 1970s (for an overview see Meusburger 1980). Priorities have shifted since the mid-1990s, though. In fact, such aspects have meanwhile become outright fashionable, a scope that has the drawback of obscuring some methodological questions and occasioning improper generalizations. A few of the methodological issues to keep in mind when analyzing the relation between knowledge and economic evolution are examined in the next section.

## The Spatial Dimension's Significance in the Generation and Diffusion of Knowledge

### *What Is the Added Value of Considering Spatial Structures and Contexts?*

Research, learning processes, and creativity do not occur in a social, cultural, political, or economic vacuum. They are affected by myriad factors whose local interaction gives rise to a context, be it called a knowledge milieu, "KnowledgeScape" (Matthiesen 2007b), "knowledge culture" (Detel 2007), or "epistemic culture" (Knorr-Cetina 1998). To follow through on new ideas successfully, most creative and highly qualified actors count on finding organizations and structures in which they can develop and apply their creativity and skills, spontaneously interact with other highly qualified people, and feel themselves free of excessive social control. Learning processes can be prompted by role models, local challenges, and circumstantial constraints and are therefore extremely context dependent. Context has an

even stronger affect on the implementation of ideas than on their conception. Creative ideas usually have to be evaluated, legitimated, accepted, and financed by other people, organizations, or institutions. At least in certain stages of a creative process or subsequent innovation process, actors thus have to draw on their social environment, the local communicational culture, organizations, networks, infrastructures, platforms of attention, venture capital, markets, and other factors in order to pursue their ideas or turn them into innovative products.

It is largely acknowledged that context is important for learning processes. In cognitive psychology (Eysenck and Keane 2005) and in concepts of social learning (Greif and Kluge 2004), organizational learning (Mintzberg 1979; Senge 2008), learning regions (Fürst 2003), the concept of *ba* and the knowledge-creating company (Nonaka and Takeuchi 1995), and problem-solving (Dörner 1979; Funke 2006), there is wide agreement that learning is context dependent. In economics, too (see Hayek 1937; Boettke and Sautet 2010), and notably in innovation research, the significance of context for innovation processes was noted early (Beckenbach and Daskalakis 2010, p. 261; Schienstock 2010, p. 297; Znaniecki 1940/1968, pp. 59–61). In many studies, however, scholars treat concepts such as context, structure, knowledge culture, and learning conditions as something abstract and do not relate them to specific places, local milieus, or regions. Except in the geography of science (e.g., Livingstone 1995, 2003; Meusburger 2009a; Meusburger and Schuch 2010; Withers and Livingstone 2011), one rarely encounters the question of why knowledge cultures or learning conditions vary in their spatial dimension, why the dominant knowledge milieu or epistemological culture at university A at a specific time differs from that at university B, or why certain places have developed into "truth-spots" (Gieryn 2002).

There are two more reasons to be more aware of spatial context, local constraints and opportunities, and knowledge milieus than has been the case in economics thus far. First, detailed spatial differentiation of phenomena (indicators), visualization of these patterns, and analysis of spatial relations help the observer grasp the range of social and economic disparities, possible variables of influence, and local potential and handicaps better than if researchers concentrate on *the* economy or on society as an abstract whole or distinguish between only two regions as Krugman (1991) does. Insight into these kinds of spatial patterns also helps one use limited resources more purposefully and effectively.

Second, the visualization and interpretation of patterns and traces is an important phase of the research process in many scientific disciplines. Maps are "a visual language" (Withers and Livingstone 2011, p. 11). Although visualizations are only snapshots of a process conditioned by subjective input of authors and cartographers, one can—with enough expertise—heuristically discover from such patterns hitherto unsuspected interrelationships and factors of influence and derive new hypotheses that can later be verified or falsified with other methods. With many research topics, even someone skeptical of structural data and inclined instead to prefer participatory observation must rely on the interpretation of patterns, traces, and indicators, for what actors do is seldom directly observable. Laboratory studies, too, are in many cases problematic and largely inconclusive because the experimental design cannot capture the complexity of real situations.

## *How Can a Milieu or Context of Action Be Defined?*

A place, milieu, or spatial context of action is not a variable having direct effect. It is to be regarded rather as potential or opportunity that can be used or ignored. Conditions of learning and action and resulting social relations are created by actors at specific places and in spaces of interaction. They are experienced in "communicative life worlds" (Knoblauch 1995, p. 57) and symbolically charged up in grand narratives. The knowledge environment of a place, or "milieu knowledge" (see Matthiesen 2007a, pp. 653–655), arises from the professional competencies, experiences, worldwide social relations of the actors working there and communicating with each other, and path dependencies influencing the infrastructure, resources, and reputation of a place. To achieve their goals, actors need material resources, easy access to certain infrastructures, and support by organizations and important decision-makers. And as actors pursue their goals, they are guided by site-specific rules, organizational structures, and informal social expectations. Places have a symbolic meaning; they shape social relationships. Each site of research is embedded in wider systems of meaning, authority, and identity, and its intellectual milieu is nourished by various types of spatial relations (Withers and Livingstone 2011, pp. 5–7; Meusburger 2012a, b).

> [T]he generation and spatial diffusion of scientific discoveries, the careers of academics, and the development of scientific institutions can be adequately explained only if one knows the networks of the particular scholars involved, the spatial dimension of the cooperative relationships between them, and the geographical mobility of academics… .
>
> Thought processes can take place anywhere, but data collection, empirical research and certain academic discussions cannot. The possibilities for discussing contested ideas and conducting expensive experiments, for becoming part of important networks, for hearing promptly of crucial developments, or for receiving access to restricted data, and the likelihood of meeting with agreement or criticism upon airing new ideas or of having to grapple with controversial theoretical concepts are not equally distributed in space. The success of research projects or the intellectual development and academic careers of young scholars are thus contingent not only on the goals, talents, and creativity of the people involved, but also on existing structures (Meusburger 2012b, p. 12).

The probability of getting a chance to communicate spontaneously with highly qualified scholars, creative artists or important decision-makers, receiving new ideas from the social setting, or finding key people to support one's goals differs from place to place. Certain site-specific knowledge milieus have a better international standing and more actors of exceptional achievement than others do.

Some of a milieu's elements (e.g., expensive research equipment) are tied by their materiality to a given site or are available only at a few places subject to restricted access; others are accessible at several places. Some elements of a milieu have a regional dimension of intermediate range (e.g., a metropolitan region's array of cultural activities or supply of jobs for highly skilled persons), and still others are wide-ranging in effect (e.g., a state's economic, educational, and research policies).

In some cases the impact of a milieu's constituent parts can be pinpointed or demarcated in space because, for instance, a law's validity or an institution's authority to impose sanctions extends no further than particular administrative boundaries.

In other cases the factors may be local (e.g., research infrastructure), but their long-term effects may have no clear borders. Some elements of milieus are seldom used by actors, whereas other elements, such as laws and regulations that carry penalties if violated, have abiding influence. Of course, a milieu's attractiveness does not derive solely from currently provable facts but rather also from past achievements and social constructions such as reputation, myths, and grand narratives. It is described elsewhere (e.g., Meusburger 2012b; Meusburger and Schuch 2010) how outstanding achievements of scientists are transferred to, or projected onto, the institution or milieu where they had conducted their research. To put it succinctly,

> [p]lace names such as Berkeley, Cambridge, and Heidelberg serve as a kind of shorthand for complex and now arcane circumstances surrounding the practice and standards of science…. When projecting scientific prestige onto places, institutions, or even entire universities, one assumes from past experience that superb science is being practiced now and will be in the future, a supposition that, in turn, attracts top scientists…. Interestingly, this projection reflects back onto the scientists working there. The scientific prestige of an institution and that of its academics is thus reciprocal. (Meusburger 2012b, p. 13)

Saying that a given knowledge milieu is site specific occasionally gives rise to the misunderstanding that it is stable and self-reproducing. Nothing would be more misleading than that assumption. Because a milieu results from interactions, internal and external relationships (see also Camagni 1991, p. 140), and learning processes, it is always in motion, never stable. A creative milieu depends heavily on external relations. It constantly has to adopt ideas, theoretical concepts, and methods developed elsewhere and has to be so attractive that highly qualified people gravitate to it from outside. The actors and communicational structures of a milieu thus change continuously. Nevertheless, quality standards, cultural rules, path dependencies, local traditions, and institutional reputation may prove so remarkably durable that the attractive sides of knowledge milieus can persist for a long time despite the constant exchange of actors.

## *Possible Conceptions of the Relations Between Milieu and Actor*

The relations between a milieu and the actors operating within it should not be thought of deterministically. As previously mentioned, a milieu or context of action is not an independent variable exerting direct effect on all the actors present in it. Instead, it constitutes a potential, or a range of opportunities, resources, ideas, challenges, chances, obstacles, and risks. This potential is recognized by some actors, who use it to their advantage, but is ignored or overlooked by others. Whether the locally existing potential is used depends, first, on the personality, expertise, objectives, and abilities of the actors and, second, on whether and how which actors communicate with each other. In other words, a milieu does not operate on its own; its positive or negative characteristics become apparent and operative only by virtue of communication processes, the quality and intensity of interaction, and the resulting actions. Knowledge is a "relational resource" (Bathelt and Glückler 2011, p. 63)

that links and blends material and nonmaterial elements. To be sure, actors constantly depend on resources and infrastructure, but the significance of face-to-face contact and other interactions varies over time. It is usually only particular stages of problem-solving, of a research project, or of a creative process in which spontaneous, unplanned contact, chance input, or the reputation of the location come to have a sustained effect.

It is well known that a given milieu or certain locally available resources, organizational contexts, opportunities, and risks will not lead to the same results with all actors, the reason being the very fact that different actors operating in the same milieu possess different cognitive skills, pursue different goals, use the locally existing communication potential differently, respond very differently to challenges and stimulation, and come to different conclusions in their analyses. This diversity of results is not the decisive question, however. More important is that specific actors with particular cognitive abilities and interests can develop differently in different milieus because they are offered different input, challenges, resources, and opportunities for development there; receive different kinds and levels of support; are exposed to different critique; and can participate in different networks.

Because contexts or milieus represent nothing more than potential, no one can predict which actors will capitalize on existing opportunities, alternatives for action, and locally available contacts and which actors will ignore them or lack the wherewithal to tap into the local set of contacts or bodies of knowledge on offer. Whether and how these contacts and interactions have come about and who has and has not been able to take the opportunities can generally be ascertained and assessed only in retrospect. A critical weakness of research on clusters and networks thus far is a lack of attention to this aspect. Many authors seem to assume that clusters and networks are dominated mainly by qualified decision-makers who understand the available knowledge, gladly draw on it, and share their knowledge with others. But clusters and networks do not guarantee knowledge-sharing. Many attempts to communicate knowledge fail, many actors cannot profit from creative milieus, and the riveting question that is all-too rarely asked is why.

Of course, it is simple to calculate correlations between different variables and to construct models based on them. But most of those correlations vary by spatial dimension, divesting such models almost entirely of predictive value for a specific case. Moreover, these models cannot adequately reflect the complexity and dynamics of social systems. This shortcoming is encountered even in natural sciences. Molecular biologists, for example, have recognized in the past 10 years that they cannot account for the functioning of biological systems solely on the basis of the relation between individual molecules.

One problem with past research is its excessively static approach to the study of the effect that context or milieu has on the actions of people or social systems. As with biographies, the phenomenon should be viewed as a process with many stages. After all, actors taking major steps in their career go from one milieu to a different one. And even if they remain at the same site for decades, the political, social, and economic parameters there can shift.

## *How Relevant Are Spatial Proximity and Distance to the Generation of Knowledge?*[5]

Few research topics suffer from as many misapprehensions, impermissible simplifications, and misleading generalizations as do questions about the importance of proximity and distance in the generation and diffusion of knowledge and the extent to which face-to-face contact can be replaced by indirect contacts or telecommunication. Concepts such as proximity and distance mean little without consideration of the problems that a function is expected to solve, the nature of the information to be exchanged, the degree of competition the organization is exposed to, the autonomy of the organization compared to its rivals, and the quality and duration of the social relations involved. A distinction between intraorganizational (internal) and interorganizational (external) contacts as well as between routine contacts, planning contacts, and orientation contacts seems essential. Research on the office industry (Goddard 1971, 1973; Goddard and Morris 1976), the geography of knowledge and education (Meusburger 1980, 1998, 2008), and the geography of transactions (Gottmann 1979, 1983) has shed much light on the question of the situations in which face-to-face contact (co-presence, proximity) is superior for generating and transmitting various types of knowledge. This work has done the same for the question of the conditions under which information can be exchanged through telecommunication without loss of efficiency. But these early theoretical concepts seem to be widely unknown in today's economic geography.

The significance of proximity and distance can be analyzed from a functional perspective as well as in terms of the symbolic meaning (e.g., reputation) of a place. Functionally speaking, if top-ranking decision-makers or experts must act under harsh competitive conditions in a dynamic, uncertain environment to gain advantage from only a fleeting lead in knowledge and information, then it is vital for them to have ready mutual accessibility and the possibility of spontaneous and unplanned face-to-face contact with other well-informed and important decision-makers from various areas. The more an activity can be governed by a set of regulations and instructions, the more daily routine it has; and the more stable and trustworthy the relations between actors are, the larger the proportion of indirect contacts can become and the less necessary it is to have face-to-face contact (for details see Meusburger 1980, 1998; Meusburger et al. 2011).

In my understanding, the terms center and periphery represent the endpoints of a continuum or of a multilayered spatial hierarchy. In terms of organizational theory, a center is the site of a social system's supreme authority or top decision-making level (Gottmann 1980; Meusburger 1980, 1998, 2000, 2001; Strassoldo 1980), whereas the periphery is characterized by a large share of low-skilled routine work and external control. People at the periphery have little influence; are disadvantaged in the distribution of resources; are excluded from major political, cultural, and economic processes; and command less prestige than those at the center. Such power centers offer a high concentration and diversity of jobs for top-level decision-makers and for highly qualified people in specialized occupations. Functionally,

proximity to the power centers facilitates early access to "weak signals" and "soft," as yet not officially confirmed information (e.g., insider knowledge). Moreover, it grants a certain degree of influence on important decisions and confers various privileges, as shown by the numerous groups operating in political centers. Stockbrokers, bankers, journalists, government ministers, lobbyists, and other people who depend heavily on external face-to-face contacts, never know what the next day will bring. They therefore have to learn of upcoming political decisions early, or set great store by the accurate interpretation of weak signals. For these individuals, proximity to the authorities in different political and economic systems is crucial to the ability to monitor competitors, imitate successful figures, and draw timely conclusions from rumors and the nonverbal communication of other actors. In addition to the long-established centers of power, there are also places at which the powerful, influential, and well-informed meet only periodically (e.g., congresses, fairs, golf courses, and the ski resorts of the jet set).

For some economic activities, though, the symbolic meaning of sites is at least as important as the functional merits of proximity (Meusburger 1980, 1998, 2000; Meusburger et al. 2011). Proximity and distance also have symbolic significance that in many situations can exceed even the functional necessity of proximity. In all social systems and cultures, proximity to their center of power also symbolizes social status, prestige, and reputation. Functionally, many banks could operate just as well at a site outside the financial district. By the same token, the New York diamond merchants need not all have their premises on 47th Street; being located two streets further in one direction or the other would not compromise mutual accessibility. Symbolically, however, a location remote from the power center or the most prestigious site would impair the reputation of many services or organizations. Enjoying proximity to the representatives of the highest authority or having an address at a prestigious spot can affect standing, trust, and security to the actors. An earlier paragraph has already noted how and why places gain a symbolic meaning. This symbolic prestige of places reflects back on the individual actor associated with that place, turning professional activity at a prestigious center into symbolic and social capital. It is often overlooked that the functional meaning of proximity can be replaced by telecommunications more easily than symbolic meaning can. The fact that much of the information needed can now be electronically downloaded at a given site thousands of miles away has not diminished the symbolic meaning of proximity in the least.

It would also be a mistake to regard spatial proximity in and of itself as an independent variable. Not all actors will avail themselves of the proximity's potential to put one person into contact with another. Contrary to expectation in some studies on clusters, spatial proximity of highly qualified or creative actors (e.g., scholars at a university) does *not* automatically lead to an exchange of information and knowledge between them, let alone to creative processes and innovation. Local potential must first be activated in order to have an impact (Kröcher 2007; Meusburger 2009a).

It would be equally erroneous to see cognitive proximity (Boschma 2005; Ibert and Kujath 2011) automatically as a factor that promotes the success of knowledge work.

Research in social psychology shows that cognitive proximity or relational proximity (strong relational ties with friends) can adversely affect the search for solutions to problems. As advantageous as social and cognitive proximity and group brainstorming can be for problem-solving with clear objectives or in routine activities, they also run the risk of prompting the groups to close themselves off from the outside world, neglect having any exchange with their surroundings, develop rigid work patterns, accept suggested solutions too quickly, and then no longer take alternatives into account (for details see Meusburger 2009a).

## *The Significance of the Scale of Inquiry*

The strength of the statistical relation between the population's level of training and qualification, the research input, and research output on the one hand and the level or dynamics of economic development on the other is largely contingent on the scale of inquiry. Depending on whether one is studying actors, organizations, or spatial units and on how large and homogeneous the spatial units of the empirical study are, the same data will yield very different statistical correlations between variables. The specific question posed and the availability of data usually determine the level of aggregation that can provide the most conclusive insights. With some questions, the most reliable results are to be found at the microlevel of the actors; with others, companies, communities, districts, or larger administrative units must serve as the focus of the study. In the nineteenth century, for instance, a very close statistical relationship between literacy, industrialization, and other modernization processes was shown to exist at the level of states and major regions in Europe (Meusburger 1998, pp. 261–264). This connection, however, could not be corroborated at the community level, which prompted individual historians to deny the existence of a correlation between illiteracy and modernization (Graff 1987, 2007).

There are at least two explanations for this discrepancy between the different spatial levels of inquiry. First, different regions and different levels of a hierarchical settlement system do not profit simultaneously and to the same extent from a modernization process induced by investments in research and education. Even when a state has undergone impressive modernization and economic development, the internal, center–periphery, and regional differences in development persist. Generally, they will even grow at the outset of a transformation or modernization process because certain types of communities, by virtue of their internal conditions and external relations, are among the winners in the transformation and others are among the losers (Meusburger 1997).

Second, the spatial concentration of jobs for highly-trained employees (Meusburger 1980, 2000, 2007) translates into a disproportionately high regional mobility of highly qualified persons to a relatively small number of places. Selective migration and the transfer of talent from lower levels of the settlement hierarchy to higher ones are a major reason why some areas do economically not profit from their investments in education. A small town or village may have excellent schools

and produce many talented individuals, but if only a few of its university graduates find commensurate employment on the regional job market or if those graduates do not find the knowledge environment and opportunities they require in order to act on their ideas in their home area, they will have to go elsewhere. The results of this internal selective migration are much less visible at the national level than at the level of communities.

## The Time Dimension's Significance in the Analysis of the Relation Between Knowledge and Economic Development

As observed in the second section of this chapter, most competitive situations are not about knowledge and information per se but rather about a lead in knowledge and information. On the stock market, receiving information just minutes or even seconds in advance is enough to net huge profits. A few hours later, the same information, meanwhile published, would not earn a single penny on the stock market. In academia, days or weeks can decide which author goes down in history as the one credited with a given scientific discovery. And in controversies about patent rights, determining who the originator was may determine the gain or loss of millions of dollars. A lead in knowledge can have especially great impact when a company or country manages to get its own technical standards accepted as the norm throughout the world.

The time dimension can strengthen or weaken the statistical relation between knowledge and economic development for at least six reasons. First, under certain circumstances investment in education and research cannot affect economic development until 10 or 20 years later, after the cohorts with superior training have entered working life and assumed leading positions in business (Meusburger 1997). Mensch (1975), Kleinknecht (1987), Spree (1991), and many others have pointed out that the curve of the incidence of basic innovations precedes the curve of real-term economic development by 12–15 years. The trajectories of research investment and economic returns can even temporarily head in opposite directions (as during the downturn in the Kondratieff cycle). In many cases the rate of basic innovations peaks when the long waves are still in their phases of depression (see Spree 1991, pp. 70–71). According to the depression-trigger hypothesis, a long depression tends to elicit renewed innovation activity. Results of research on the relations between investment in education and research and economic performance will vary considerably depending on whether a statistical relation between variables is studied over a short or a long duration.

Second, economic history teaches that there are always certain windows of time in which it is easier than in others to convert knowledge and qualifications into successful economic action. The value of well-trained, well-informed, and creative actors is clearest in phases of political, economic, and technological upheaval, of instability and uncertainty, and of creative destruction in which new structures are

swiftly built and new effective path dependencies are set for decades. During such episodes of profound political, economic and social change (e.g., the transition from a centrally planned to a market economy in eastern Europe in the 1990s), thousands of far-reaching decisions are made in many key areas within a short span, decisions that require an grasp of contexts and interactions, knowledge about historical experience in other countries, and information about social, technological, and economic trends in development (Meusburger 1997). These phases of major political, economic, and technological realignment can be followed by prolonged stagnation during which entrenched political conditions complicate successful application of new knowledge, only incremental innovations are possible, and immense potential in well-trained working people goes untapped.

Third, concepts such as expertise and rationality cannot be defined in isolation from the time horizon of observation. A decision that may appear to be rational in terms of immediate utility can become a liability to the actor in the medium or long term, ultimately making it irrational. In many cases the referee known as time decides which of the experts' contradictory opinions have proven to be realistic or pertinent and which research approaches have had the most success or the highest predictive value. The history of science is replete with examples illustrating that the significance of scientific or technological breakthroughs may long go unrecognized.

Fourth, cyclical economic crises and surpluses of academics can temporarily diminish the economic value attached to higher academic degrees, reduce the career opportunities open to members of certain birth cohorts for an extended period, and thereby also weaken the relation between the population's level of qualification and economic development. Such oversaturation, however, repeatedly alternates with shortages of well-trained people (see Titze 1990).

Fifth, the strength of the statistical relation between knowledge and economic development depends on when a country or region commences an innovation process, when it introduces particular technologies, or when its population acquires certain qualifications. A country boasting 70 % literacy in 1860—an impressive rate in those days—had an enormous advantage because it was able to take part in myriad economic and social processes of modernization and was able to draw much economic utility from its high rate of literacy. A country attaining that rate only by 1960 ranks among the world's poorest and least developed countries today. Delayed acquisition of knowledge, qualifications, and technologies creates potentially long-term handicaps and path dependencies. For decades, European regions that had illiteracy rates of more 80 % in the second half of the nineteenth century (e.g., some peripheral areas of the Austro-Hungarian Empire, including the Balkans, Galatia, and Bukovina, and southern Italy) were unable to participate in the Industrial Revolution. They lacked the basics for a sophisticated division of labor, efficient administration, and rapid adoption of innovations from the outside. High rates of illiteracy were also a sign of many other social and economic shortcomings (Meusburger 1998, pp. 233–272).

Sixth, the conclusiveness and predictive value of indicators change over time. In the days when only 5 % of an age cohort completed a university education, the

resulting degree could eventually result in high occupational status and the correlation between levels of training and annual income was strong. That correlation weakens considerably when 50–60 % of an age cohort complete a university degree, for many of the graduates must content themselves with a lower occupational status than that of the previous cohort.

## Conclusion

A high level of training, qualification and competence, or large investments in education and research do not automatically lead to economic success, but they do represent potential, or a prerequisite, for meeting certain challenges, avoiding unintended consequences, finding solutions for upcoming problems, seizing opportunities, and adopting certain innovations in time. To be successful in a risky and competitive environment, a social system needs a knowledge milieu that fosters not only the system's internal generation of new knowledge, superior skills, and creative ideas but also the early recognition and adoption of seminal new knowledge and inventions created outside the system. An edge in knowledge, competence, and expertise is the most important strategy for a system's survival in an uncertain and competitive environment. In a competitive society no social system can long afford more than a certain number of flawed analyses, incompetence, and wrong decisions without exhausting its resources or forfeiting its reputation. Knowledge and competence are among the key ingredients of a social system's adaptability, self-organization, and continued development and are therefore basic elements of any evolutionary theory (Bathelt and Glückler 2011; Boulding 1978, 1981).

Whether knowledge (in the broadest sense) can fruitfully be acted upon in occupational careers or turned into economic success depends largely on the political framework, spatial context, and knowledge milieu in which actors and social systems seek to achieve their objectives. A milieu or context, however, is not an independent variable in a cause-and-effect relation influencing what actors do. It represents potential that has to be used by actors in order to achieve an effect. Political, societal, and economic frameworks can also keep creative actors from developing their skills and obstruct the performance of innovative organizations. Although science studies, creativity research, and, recently, evolutionary economics have focused on this issue, many questions remain.

## Notes

1. In this instance, as occasionally elsewhere in this chapter, the word knowledge is used broadly to refer to a great variety of knowledge categories (see Abel 2008, 2012), including skills, qualifications, competencies, expertise, technologies, and wisdom. It can be understood as what Stehr (2001) means by the capacity for social action.

2. Contrary to everyday knowledge that is easily understood by most people, high-quality knowledge is a category of knowledge whose acquisition needs years of study, research, and experience. Various grades of high-quality knowledge can be distinguished, depending on the time and money required for its acquisition.
3. I use this term to mean not just the "idea that nature can be mastered by research in the natural sciences" (Moldaschl and Stehr 2010, pp. 14–15, my translation) but also the ever greater reliance on scientific methods and theory in production processes and the economy at large.
4. On the disciplinary history of the knowledge economy, see Moldaschl (2010), Moldaschl and Stehr (2010), Schienstock (2010), and Stehr (2001).
5. This paragraph summarizes thoughts discussed in more detail in Meusburger (1980, 1998) and Meusburger et al. (2011).

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# Chapter 3
# A Microeconomic Approach to the Dynamics of Knowledge Creation

**Patrick Cohendet, Jean-Alain Héraud, and Patrick Llerena**

There is growing evidence that the process of invention is generally a collective effort that necessitates the interaction and coordination of a multitude of economic actors. Increasingly, the literature on the role of cooperative agreements in R&D emphasizes that the period of research extending from the emergence of the first innovative idea to the moment when a patent can be written and claimed is rarely thought as a patent race between isolated inventors. The interval is characterized instead by the building of R&D consortia, pools of inventors, and collective ventures in local clusters specialized in high tech. The inventive idea needs to come equipped with shared codes, tests, and a "grammar of usage" before it can qualify

The idea discussed in this chapter sprang from an oral presentation at the special session in honor of Ehud Zuscovith at the International J. A. Schumpeter Society (11th ISS Conference), Sophia-Antipolis, Nice, France, in June 2006. It was then first discussed during the Fifth Interdisciplinary Symposium on Knowledge and Space: "Knowledge and the Economy," June 25–28, 2008, at the Villa Bosch Studio, Heidelberg, organized by the Department of Geography, University of Heidelberg and funded by the Klaus Tschira Foundation.

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as having economic potential. Without the building of this public or semipublic "codebook," most inventive ideas are not economically viable.

Cassier and Foray (2002), for example, underlined the role of the R&D consortium as an important tool and organizational mechanism allowing the collective creation of knowledge.

- It creates spaces for sharing knowledge, in which there is a break from technological secrecy and the retention of knowledge by private agents. It generates a new economic category of knowledge called collective or pooled knowledge, which is shared among participants during the period of research.
- It allows agents to develop concerted actions by organizing the division of labour to explore a certain domain and providing an organizational framework to assemble divided and dispersed knowledge.
- It can enable agents to create a more consistent and coherent initial endowment of intellectual property rights, which does not fragment the knowledge base. When the knowledge is initially fragmented (anticommons property), the consortium provides a space in which rights can be exchanged at a low cost, because partners are well identified and some collective learning can occur. (p. 124)

These observations suggest that the period of research during the fruition of an inventive idea is often imbued with economic motives more oriented to pooling and sharing knowledge than to delineating private domains of knowledge and maintaining secrecy. Yet despite ever wider acknowledgement that invention has a collective dimension, the dominant economic approach to invention still focuses on the notion of the solitary inventor in Arrow's (1962) seminal contribution on knowledge creation in the firm and in the logically attendant image of opportunistic patent races between isolated investors.

Arrow's (1962) approach, which we call the "traditional" approach, was intended to highlight the issue of imperfect appropriability and the associated trade-off between incentives to innovate and diffusion. Arrow introduced the strong hypothesis that the development of innovation is reduced to a static two-step process. In his view, the first step is the phase of invention; the second step, the phase of generalized diffusion. The dynamics of creation and the pace of innovation's evolution are, according to him, "crunched" in the description of the static process. The phase of invention is initiated and achieved by a solitary inventor contending with the opportunistic behaviors of the other agents. The new knowledge produced by the solitary inventor is akin to information that possesses the generic properties of a pure "public good" (nonrivalry and nonexclusion). In such a context, the production of new knowledge faces the key problem of appropriability: It is difficult for the inventor to appropriate the benefits that flow from that knowledge. At the level of society, the trade-off between incentives to invent and the diffusion of innovation arises, and the primary solution to this issue is to build a reliable system of property rights. Thanks to these mechanisms, the second phase of the process can start: the controlled phase of generalized diffusion.

The aim of our chapter is to depart from this traditional representation by opening the black box of the invention phase to analyze the complex microeconomic phenomena that take place during the period of research and that favor a collective approach to the process of creation. Our objective is to grasp the processes and procedures through which communities are formed, collective goods produced, and the social benefits of the activity enhanced. In the first part of this chapter, we draw on recent results from the sociology of innovation to present a model illustrating the collective production of knowledge during the period of research. This model revisits Arrow's (1962) contribution and leads to the conclusion that the traditional approach centering on weak appropriability in the process of developing new technologies is valid only for an extreme phase of the period, the interval during which the characteristics of the technology involved are clearly and universally understood. In the second part of the chapter, we derive the principal consequences that this model has for practical regimes of appropriability and for application of this approach to creative clusters.

## A Model of Collective Invention

Most of the empirical work and historical analyses done on the emergence phase of innovation have shown that what matters is the progressive building of collective knowledge and understanding between actors. At this stage, the different players have neither a common language nor a common grammar. The group of agents who succeed in expressing and formalizing an innovative idea is confronted by a core concern: not the risk of being copied (at no cost) but rather the risk of being misunderstood by others (including agents belonging to the same organization). It is the risk that their procedures and experience will not be reproduced by others. Without collective effort to reach a critical mass of common understanding between the various actors committed to the emergence phase of an novel idea, the innovation process cannot be viable. The group of agents at the origin of an innovation must go to great lengths to alert other actors or communities to the usefulness and potentials of its discovery. Arrow's (1962) approach did not capture these features of the emergence phase in the process of an innovation's development; the producer of knowledge acts in isolation. He said nothing about the complementary forms of knowledge necessary for the producer of knowledge to invent and nothing about the community of agents supporting him in the process that leads to the invention.

### *Revisiting the Traditional Arrovian Hypotheses*

To be more precise, as Callon (1999) stressed, the production of knowledge in the emergence phase of innovation tends to exhibit properties that are exactly the reverse of the one postulated by the traditional approach. That is, knowledge is essentially

rival (it is extremely difficult to reproduce the new knowledge in a place other than that where it was first generated) and exclusive (novelty relies heavily on the tacit knowledge of inventors). In this context of emergence, knowledge is also essentially specific. In other words, it can be absorbed and used by a few other agents only. The traditional approach, however, is the opposite, postulating that knowledge has a high degree of generality and that it is potentially usable by a large variety of agents in various contexts. From that perspective, all the agents of the economy are fully capable of absorbing the innovative idea emitted by the producer of knowledge.

The logical conclusion, therefore, is that there are important reasons to support a hypothesis of strong appropriability in the emergence phase. What matters most in that period is not the issue of appropriability but the issue of building a quasi-public good—that critical mass of understanding between inventors or, more precisely, communities of inventors from which codes and grammar of usage of the novelty will be developed incrementally in order to reproduce and extend the initial creative ideas and to make them viable. Moreover, empirical work on the production of knowledge has shown that the active builders of a cognitive platform at this stage of its emergence generally are not the individuals or the organizations but the knowing communities of agents committed to creating and accumulating the new forms of knowledge (Callon 1999). As we show below, individuals and organizations also play an important role in the microeconomics of collective creation, but the fundamental cognitive building of the codes and grammar that will equip the novelty requires the active functioning and interactions of knowing communities.

## *The Vital Role of Knowing Communities*

A knowing community (Boland and Tenkasi 1995, p. 352) can be defined as a gathering of individuals who accept to participate voluntarily and regularly in exchange about a common interest or objective in a given specialized field of knowledge. This regular exchange builds common cognitive platforms and common social norms that assure the cohesion of the community and guide the behavior of newcomers. Knowing communities can deal variously with knowledge. Some may focus on the accumulation and exploitation of a given field of knowledge (communities of practice, as in Lave and Wenger 1991)[1]; others may focus on the exploration of a new field of knowledge (epistemic communities, as in Cowan et al. 2000).[2] This chapter's focus on the period of research seems to naturally highlight the role of epistemic communities that are the foundation of the academic milieu and whose very task is the production of new knowledge. However, it could be misleading to focus solely on these epistemic communities. Building a grammar of usage for the inventive idea also requires interaction with communities rooted in daily practice. Examples are communities of practice that might be found in traditional work divisions and departments or that might also cut across functional divisions, spill over into after-work or project-based teams, and straddle networks of cross-corporate and professional ties.

A growing body of literature underscores the increasing role of knowing communities in society. As the knowledge-based economy expands, they can take charge of certain significant sunk costs associated with the process of generating or accumulating specialized parcels of knowledge. These costs correspond, for instance, to the continual construction of languages and models of action and interpretation that are required for the implementation of new knowledge and that cannot be accommodated by the classical mechanisms of hierarchy or markets. This setting is likely to compensate for organizational limitations (learning failures) that firms endure when confronted with the need to innovate and produce new knowledge continuously.

## *The Process of Collective Invention Viewed as a Codification Process*

Knowing communities are pivotal during the period of research. Step by step, they codify knowledge, starting in a phase when the actors do not know the innovation's characteristics, do not know each other, and are not capable of communicating to reach a point at which the innovation is informed with enough shared understanding and codes to be economically viable. Thus, the development of an invention requires the gradual formation of a common knowledge base, of a model and a grammar that will enable actors to interpret tests, experiences, and contexts of usage.

From that kind of perspective, the above discussion suggests that a critical part of the knowledge production process stems from the dynamics of interactions between knowing communities. These interactions can be approached through the principle of translation and enrollment elaborated in particular by Callon and Latour (1991); on the definition of enrollment in English, see Allen (2004, for example). Interpreting these authors, one can understand the innovative diffusion of ideas (e.g., from the lab to the market) as a process of contagion, with each community trying to command the attention of other communities to convince them of the relevance of the knowledge it has developed.

This decisive process of codification behind the development of innovation is not linear. It generally involves an early phase during which the innovators encounter misunderstandings and skepticism. The first steps in the emergence phase can be long and painful. They generally require the intense involvement of specific individuals acting as boundary spanners to facilitate the dialogue between knowing communities.

## *The Central Role of Boundary Spanners*

It is at this stage that key individuals may be a determining factor in the emergence of innovation. Two communities may interact directly, as when members of the one group randomly meet with members of the other. Mechanisms such as the repetition of those encounters and high-quality communication between communities could

certainly favor this contact.[3] But though these conditions may contribute to narrowing the cognitive distance between communities, they do not ultimately guarantee the spontaneous building of a common grammar and codes between heterogeneous units. Specific individuals functioning as boundary spanners (Allen 1977; Cohen and Levinthal 1990; Tushman 1977) are therefore crucial. They are generally respected members of a given community (frequently its "stars") and have the ability and authority to speak for their community, translating its views and concerns into the language and grammar of other communities. An example is Girvan and Newman's (2001) illustration of community structure in a scientific network in which people work together in tightly knit, but only loosely interconnected, groups. They depicted boundary spanners as the leading members of each community, people who assure the circulation and building of common knowledge between communities.

Once this process of building common knowledge has started, the building of a common base of knowledge can accelerate, eventually spreading through communities by means of various tests and the elaboration of diverse codes. The cumulation of the microadditions to the common base quickens to the point of percolation in the system (Willinger and Zuscovitch 1988), the stage at which the novelty is fully outfitted with a code and grammar that might lead to an economically viable application.

## *The Stabilization Phase of the Process of Invention: Meeting the Traditional Conditions*

The end of the process is marked by what one may describe as the phase of stabilization, during which the innovation's characteristics are fully understood and set forth in codes and procedures that every agent can access and use. It is only then that one arrives at a situation corresponding to the traditional context of knowledge production as described by Arrow (1962). The phase of stabilization is reached when this process is over. Only then have the different actors who intervened in the process built a quasi-public good: the novelty's common knowledge base, which rests on shared codes, norms, and principles. The market opportunities are predictable, the languages are stabilized, the laboratory procedures and tests can be replicated. In that kind of context, knowledge can be treated as "information" and possesses the two generic properties of a pure public good. Only in this situation can imitators with perfect absorptive capabilities "take the innovative ideas and run" without compensation for the producers of the novelty. Only under these circumstances is the hypothesis of weak appropriability valid and conducive to the use of classical policy. This quasi-public platform facilitates imitation, and Arrow's approach can apply. In a way, the character of innovation as a public good in the phase of stabilization owes to the construct of communities innovating throughout their interactive process (see the appendix, which summarizes the differences between the traditional Arrovian approach to the production of knowledge and the collective one discussed above).

## *The Respective Roles of Organizations, Individuals, and Communities*

What the above model suggests is that the process of invention is far from being restricted only to talented individuals or controlled by the strategic vision of organizations (firms and labs). Organizations are where contracts are signed, people hired or fired, and broad competencies managed. They are not the active units building the common base so indispensable for the development of innovation. In our view the active units undertaking the codification process are the diverse knowing communities engaged in the process of invention (as well as the small set of boundary spanners between those communities). These communities are essential in the emergence phase of novelty, after which their role diminishes (and that of organizations increases) as the knowledge base grows and strengthens. When the process stabilizes, organizations become the dominant players. The story of the new knowledge production, at least in this period—that of research—could thus be interpreted as a process in which individuals, organizations, and knowing communities interact, with the knowledge-related activities of each helping to mitigate the limits and possible failure of the others. This story can take place in different spatial contexts, whether a given firm, an entirely academic milieu, a cluster linking scientists and industrialists, or virtual space. Whatever the spatial context, the same types of actors will be present. In the next section we explore the case of creative clusters.

## *The Process of Innovation Beyond the Phase of Emergence*

Once the codebook for the creative idea has been completed, a new phase of the innovative process can commence—diffusion—during which the invention is commercialized and disseminated. In the previous phase, that of emergence, the production of externalities was negligible. The core elements of the production of collective knowledge during the phase of invention are processes of persuasion, translation, and enrollment, which promote the internalization of externalities from one community to another. The externalities were internalized through the process of controlled communications involved in the building of a common knowledge base to make the innovation understandable and viable.

In the diffusion phase, the question of externalities does matter. Our view is that the intense work of codification in the preceding period (research) largely shapes the nature of the next phase in the innovation process. Will the innovation lead to a patent application? If yes, who will obtain the patent and who shares the property rights? How will the licenses, if any, be distributed? What types of markets are targeted? All these questions were tackled and answered in the previous phase. As Cassier and Foray (2002) underlined,

> collective invention produces a new boundary, an original partition between a set of co-ordinated agents and the rest of the world. The question of the dissemination of results and thus of the social returns to collective research . . . raises the question of the composition of the group [those agents who have participated in the period of research], that is, the

> internalisation of knowledge externalities. Is the group composed of all the members of a set (an industry, for example)?—in which case the question of dissemination is less relevant. Or does it consist of a significant part of this set?—in which case collective invention may become an obstacle to the entry of new actors into the industry. Or lastly is it limited to a very small number?—in which case, the question of dissemination beyond the circle is raised. (p. 127)

## Some Main Consequences of the Model of Collective Invention

The results discussed in the previous section raise numerous issues, of which we select the following two: (a) the effect on the interpretation of property rights granted in particular patents and (b) the effect on the interpretation of creative clusters. In these two domains of economics, we believe that the understanding of the dynamics of knowledge creation is too limited if it is restricted solely to the interactions between individuals and organizations. Taking account of the creative role that knowing communities have in these two domains enriches the approach to the dynamics of knowledge creation.

### *The Consequences for the Interpretation of Property Rights*

As Zuscovitch (1998) repeatedly stated, theoretical and empirical evidence supports the hypothesis that rather strong appropriability exists in the development of new technologies. This spontaneously strong appropriability, stemming from the need for a collaborative dimension to the building of a common knowledge base, speeds up the rate of technological progress as a whole. As noted in the previous section, the hypothesis of strong appropriability is particularly valid early in the research period. This important fact was recognized by Winter (1993), who, though acknowledging that the patent system can increase incentives to innovate, suggested that intellectual property rights do not lead automatically to superior resource allocation. He especially stressed that inefficiencies might well occur during the initial phases in the creation of a technology trajectory. When a pool of innovators explores the possibility of a new technology trajectory, the availability of older patents, Winter observed, might block the slow formation of the common base of knowledge required for the creation of such a trajectory (p. 218).

This strong appropriability approach seems to be contradicted by the increasing demand for property rights, which is manifest in all sectors and all countries. Cohendet et al. (2006) saw no contradiction, given the diversity of motives for firms to hold a patent. In addition to granting the right to exclude, patents are fundamental signaling instruments; they enable the producers of a piece of knowledge to have another agent recognize their abilities to innovate. In that sense, patents are vital to the coordination of innovative activities. As a seal of competence, patents offer possibilities for acceptance into innovative networks; they greatly enhance the likelihood

**Table 3.1** The context-dependent modes of using patents

| Phase of innovation | Knowledge essentially codified | Knowledge essentially tacit |
|---|---|---|
| Emergence | Strong exclusion | Weak exclusion |
| | Strong coordination | Strong coordination |
| Stabilization | Strong exclusion | Weak exclusion |
| | Weak coordination | Weak coordination |

From Cohendet et al. (2006)

that the patent holder will receive seed money from banks or specialized organizations. Moreover, we argue that signaling is generally the strongest motive in the emergence phase of innovation, when the actors do not know each other. As the process of innovation matures and approaches the phase of stability, the signaling motive weakens and the exclusion motive intensifies. The period of research can be seen largely as the one leading a creative idea from reliance on purely appropriable knowledge with minimal economic potential to a stage where it is patentable and economically very promising.

The strong appropriability approach seems to be contradicted also by the current practice in some sectors such as pharmaceuticals, where the demand for patents as a means of exclusion is prevalent, even in the earliest phases of innovation. This behavior derives from the contextually dependent sectorial characteristics of the use of property rights. These sectors are the exception rather than the rule. In some of them the nature of novelty is basically contingent upon codified statements right from the beginning of innovation. Because a new drug relies on a small number of molecules that can be easily reproduced if one "steals the formula," knowledge production in the pharmaceutical industry makes exclusion paramount. This statement is in line with Zuscovitch's (1998) conception of technological innovation that takes place within a particular structure, a specific context of industrial products and production processes that differs across industries and over time. Table 3.1 illustrates how the two main dimensions of invention—that of codified and tacit knowledge and that of emergence and stabilization as two sequential phases—lead to four key modes of using patents.

First, the fundamental distinction between tacit and codified knowledge clearly suggests that the tacit context in which knowledge is created influences appropriation conditions and the ability of patents to increase incentives. For instance, in those domains where codified aspects of knowledge seem to be prevalent (chemicals, pharmaceuticals), where the extent of what can be patented is clearly established, understood, and accepted by all actors concerned, the role of patents as an instrument to increase incentive is strong. Conversely, in contexts where the tacit dimension seems to prevail (e.g., software or services), the role of patents as incentives tends to be weakened.

Second, knowledge-based economics gives patents a new function in response to the important need to coordinate the actors in the first stages of creating an innovation. In the emergence phases of a new innovation, the need to build a common

knowledge base is strong, so strategies for collaboration tend to overcome strategies for exclusion. As soon as innovations mature somewhat, and as soon as situations are stabilized and languages are shared, the importance of patents as an instrument of exclusion increases. It follows from this analysis that the role of patents depends heavily on context, sector, and the specific evolution of both. In mature sectors where the technology is tested and coordination is already ensured, actors will tend to favor a traditional patent strategy, whereas in emerging sectors the construction of strong intellectual property rights based mostly on exclusion may induce devastating effects.

Crossing those two dimensions allows one to define very different industrial contexts within each of which the role of patents differs strongly.

## *The Consequences in Terms of Creative Clusters*

Within the context of collective creation, the concept of creative clusters has attracted growing interest (e.g., Andersen and Teubal 1999; Bathelt et al. 2004; Bresnahan et al. 2002; Rullani 2002; Saxenian 1994). Creative clusters are generally viewed as small geographic locations centered on a particular industry that facilitates face-to-face communication between the participants of the clusters. A creative cluster can thus be interpreted as a localized network that uses the territory to provide the dissemination of creative ideas (Rullani 2002). The literature on creative clusters has extensively examined the conditions governing the success of clusters. Some of the primary determinants are large pillar firms (Bathelt et al. 2002), key agents (Saxenian 1994), small worlds (Uzzi and Spiro 2005), regional specialization (Bathelt et al. 2002), and local "buzz" (Storper and Venables 2004).

Drawing on the model described in the previous section, we suggest a sixth prominent feature of creative clusters: In a creative cluster, knowing communities, active individuals, and organizations are constantly interacting. This continuous interaction not only nurtures creative ideas but, even more important, also helps bring about the conditions for success in the periods of research that follow the emission of a creative idea. Creative clusters can be seen as geographical contexts conducive to fertile periods of research, in which the complex codification processes needed for inventive ideas can take place thanks to the multitude of interactions between heterogeneous localized types of economic entities (communities, individuals, organizations).

More precisely, the success of a creative cluster turns on several things. One is the existence of active communities, active talent, and large firms. Another is the capacity of communities to communicate and to build common platforms of knowledge. A third essential is the presence of boundary spanners who are recognized as leading members of their community. These people must able to express and translate the concern of their community into messages understandable by other communities or by "entrepreneurs" who have the talent to integrate the perspectives and

collective visions of diverse knowing communities. To be successful, a creative cluster also requires the existence of firms patient enough to avoid accelerating the process of protecting the inventive ideas and convinced of the virtues and economic merit of collective cognitive development in the period of research.

Creative clusters offer unique places for boundary spanners to meet face to face, for members of a given community to meet members of other communities frequently, for firms to have immediate access to inventive ideas emitted by researchers, and for researchers to attempt immediate replication of experience that others have had in a given lab. Thus, it is not so much the capacity to transmit tacit knowledge within a given geographical space that matters. The success of the innovation process depends far more on the capacity of the geographical milieu to support the period of research efficiently and on the associated codification processes (Fleming et al. 2012).

Saxenian's (1995) approach to Silicon Valley can be reinterpreted as an example of successful interaction between communities, organizations, and individuals. In that context interacting communities (e.g., engineers, software designers, and specialist firms) are genuinely self-organizing in a way that organization emerges from the interactions rather than the reverse. The management of the cluster is largely autopoetic and dependent on the structure of interaction and communication. If a firm goes bankrupt, the collective interaction of communities sees to it that new organizations are formed and that the competencies and experience of individuals are redistributed. Redundancy is maintained, and a systemic vibrancy that emanates from strong local ties prevents the loss of sunk costs. However, we also underscore the role that specific individuals have by virtue of their unique ability to bridge between heterogeneous communities. In the case of Silicon Valley, the leading figure was Frederick Terman (Caribou 2006). Though a talented scientist, his contribution to Silicon Valley was not as a source of any invention. "As a social and organizational innovator, Frederick Terman helped shape the relationships among individuals, firms and organizations in Silicon Valley, creating a community that has encouraged continuous experimentation and technological advance for more than half a century" (Saxenian 1995, p. 1).

## Conclusion

The approach suggested in this chapter emphasizes the role of and the need for collective endeavors in the period of research in any inventive process. Any creative idea must be given a quasi-public codebook revealing its economic properties and potential. This approach focuses on the period of active negotiations and economic decisions that precedes the classical Arrovian phase of invention when a patent can be written and claimed.

The discussion presented in this chapter has raised numerous issues of which two deserve specific attention. The first one is the need to analyze closely the behavior

of the actors involved in the process of invention, for they are torn between the need to participate in collectively building the codebook that is to accompany the creative idea on the one hand and the willingness to "hit and run" at the first favorable moment on the other. The outcome of this tension depends largely on the context in which the innovative idea is developed, the degree of trust between participating actors, and the intensity of the competition in the related industry. In the case of international breast cancer, for instance, Cassier and Gaudillière (1999) showed that participants have effectively shared resources and data to narrow down the gene field, enabling them to target their own work better so as to remain in the race and excluding groups not participating in the consortium. But as the two authors point out, the field of breast cancer genetics was so competitive that once the area to investigate was defined, strategic knowledge was kept secret while each group negotiated with industrial firms, and a patent race started within the consortium itself. The building of the quasi-public good was limited to the writing of a "geographical map" in order to delineate the area to be studied. Analogy with mineral prospecting or deep-sea fishing is obvious: When "geographic" information is shared between a few agents, an initial selection can be made among the groups before the real competition can start.

The tension between building common knowledge and shortening that process for private reasons is also a function of the subtle relationships between communities, individuals, and organizations. In many cases knowing communities are motivated to continue collectively building the codebook for the creative invention, whereas organizations pressure them to move quickly on defining the scope of property rights that will protect it. Just such a goal conflict exists under the regime created in U.S. universities by the Bayh–Dole Act of 1980. Some epistemic communities may be tempted to continue openly circulating and building common knowledge although the university employing them urges them to take out a specific patent on their innovation. Abbreviating the period of research too much entails many risks, including an underdeveloped codebook (which would prevent the expansion and useful application of the creative idea) and the risk of a patent race between participants (who would be drawn into excessive research).

The second issue that deserves special note is the impact on public policy. The decision to build and reinforce the common base of knowledge relating to a creative idea stems basically from local, decentralized arrangements between participants. As already underlined, however, the process is context dependent and thus paves the way for public intervention to facilitate and develop such contexts, particularly when it comes to building and reinforcing local creative clusters. From a different perspective, public involvement in some research consortia could also contribute to accelerating the economic potential of invention. Bach et al. (1995) found that firms associated with public centers of research in innovative consortia generate more indirect effects ("spin-offs") and are more effective at achieving the objective of the research project than firms that do not have such connections. They stressed that the influential role played by the public partners in these consortia is due to the ability of the public units to take charge of the codification and standardization of the collective knowledge within the consortia, whereas the private partners were less keen

on doing so. The result has been a global enhancement of the collective process of research, thanks to the ability to write common codebooks for the inventive ideas that have emerged within the consortia.

## Notes

1. Communities of practice are "groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (p. 38).
2. Epistemic communities are small groups of "knowledge-creating agents who are engaged on a mutually recognized subset of questions, and who (at the very least) accept some commonly understood procedural authority as essential to the success of their collective activities" (Cowan et al. 2000, p. 234).
3. The repetitiveness of interaction between communities expresses the "quantitative" dimension of their mutual relationships. Some communities may meet often (e.g., workers and managers using the same cafeteria), and these exchanges can generate benefits for the firm (e.g., formation of a certain common body of knowledge and circulation of news that "something isn't going well") even if the intensity of the communication is low (e.g., because of minimal common language or grammar that could improve the circulation of knowledge between the communities). Constant interaction between knowing communities stimulates learning processes, creates favorable conditions for resolving conflicts, and promotes economies of scale. Group projects, frequent meetings, and other organizational devices that encourage the socialization of experiences are regularly used by management to compensate for a lack of spontaneous interaction between heterogeneous communities. This approach helps people understand how important it is for firms to construct privileged learning platforms (*ba* in the sense of Nonaka and Konno 1998).

   The quality of communication between communities expresses the "qualitative" dimension of the relationships between communities. Some communities can be joined together through a rich texture of communication, even if the quantitative dimension of their relationships—interaction's "degree of repetition"—is low. Minzberg (1979), for example, cites the well-known example of surgical operations in hospitals, where the members of the different communities involved (e.g., surgeons, anesthesiologists, and nurses) meet infrequently yet know exactly what to do and how to work together on those occasions (thanks to communication between the communities during the training of their respective members). Circulation of knowledge in an innovating firm is based largely on the sharing of codes and languages, which allows various communities to interact. Thus, the circulation of knowledge is a question of the relational or cognitive proximity (Nooteboom 2000) of distributed units and requires attention to syntactic, semantic, and pragmatic communication; shared tacit knowledge; flow and interpretation of information; and trust or other conventions of collaboration.

# Appendix

**Questioning the traditional approach to knowledge production**

| Arrow's (1962) hypothesis on knowledge production (the information perspective) | The questioning of Arrow's hypothesis in a knowledge-based perspective |
|---|---|
| Knowledge treated as "information" possesses the two generic properties of a pure "public good." It is a nonrival good (infinitely expansible without being diminished in quality, so that it can be possessed and used jointly by as many as care to do so). It is a nonexclusive good (impossible or very costly to exclude individuals from benefiting from the good) | Knowledge is not a pure public good. It is a hybrid good that exhibits some properties of public good (the codified part of knowledge that is nonrival and nonexclusive) and some properties of private good (the tacit part that is at least partly exclusive) |
| The only incentive that matters for the producer of knowledge is to experience the full ownership of the new piece of knowledge produced. There is no trade-off between the incentive to be the sole owner of the innovation and other forms of incentive that could influence the behavior of the producer of new knowledge | Appropriation is not the only incentive for knowledge production. Firms do have others incentives than the direct exploitation of the monopoly rent: such as the willingness to maintain the firm on the technological frontier, the search for reputation, the objective of signaling, the need to build an absorptive capacity, and more generally the endeavors of agents to build competencies |
| The producer of new knowledge is a solitary one. In Arrow's perspective, the producer of knowledge acts in isolation. Nothing is said about the complementary forms of knowledge that have been necessary for him to invent. Nothing is said about the community of agents who supported him in the process that led to the invention. Nothing is said about the interest to him of the new piece of knowledge that has been produced. (Is it an incremental invention aiming at improving a current process? Is it a radically new invention opening the perspective of new fields of research?) In such a solitary perspective, an important consequence is that the producer of knowledge is in a position to claim the totality of the invention | The production of knowledge is not a solitary venture. It is generally produced within a community. The community could deliberately aim at producing new knowledge, as the epistemic community does (Cowan et al. 2000). However, the building of knowledge could also be made within other types of communities such as those of practice. Networking between academic organizations and private enterprises is a growing phenomenon that takes different forms. Networks can offer a way to share knowledge complementarities. It is also a way to build collective forms of knowledge and a sufficient level of trust between partners to facilitate the collective creation of knowledge |
| The producer of new knowledge is facing the opportunistic behaviors of the other agents in the market. More precisely, the agents who may capture for free the new piece of knowledge are anonymous. The mechanisms of externalities generated by the producer of knowledge, on which the diffusion process relies, are "isotropic." As in a market mechanism, one can refer to a "representative | The producer of knowledge is not facing the market but a specific structure of interaction of economic agents. As Nonaka and Takeuchi (1995) mentioned, "organisational knowledge creation should be understood as a process that organisationally amplifies the knowledge created by individuals and crystallizes it as a part of the knowledge |

(continued)

(continued)

| Arrow's (1962) hypothesis on knowledge production (the information perspective) | The questioning of Arrow's hypothesis in a knowledge-based perspective |
|---|---|
| agent," who benefits from the knowledge spillovers emitted by the producer of knowledge | network of the organisation. This process takes place within an 'expanding community of interaction', which crosses intra- and inter-organisational *levels and boundaries*" [p. 59] |
| The producer of knowledge is not supposed to have emitting capacities. In other words, he has no ability to "tune" the disclosure/secrecy dimension. He is just supposed to try and avoid the loss of the integrity of the piece of new produced knowledge | The producer of knowledge has emitting capacities. An agent producing new knowledge will generally operate a selection between communities: on one hand, he will consider to which communities the new knowledge is addressed; on the other hand, those communities that he chooses to exclude |
| All the agents of the economy are full capable of absorbing the innovative idea emitted by the producer of knowledge. Any buyer of the knowledge can effectively destroy the market, for he can reproduce the knowledge at very low cost | The other agents are not fully capable of absorbing the innovative ideas emitted by the producer of knowledge |
| The epistemic content of knowledge does not matter. The content of knowledge exhibits a "cognitive" equivalence, meaning that in such a context it is impossible to distinguish between the generic and specific forms of knowledge | The epistemic content of knowledge matters. There are forms of knowledge having a high degree of generality (knowledge that can be potentially used in various contexts by a large variety of agents) and very specific forms of knowledge that can be absorbed and used by few other agents |

From Cohendet and Mayer Krahmer (2001, p. 1573)

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# Chapter 4
# Knowledge Creation and the Geographies of Local, Global, and Virtual Buzz

**Harald Bathelt and Philip G. Turi**

The age of the Internet and radical innovations in information and communication technologies have opened new possibilities to transfer information and knowledge over distance. Although this reality creates new opportunities for economic interaction and innovation, knowledge regarding the effects of these changes on the geographies of production, distribution, and innovation is still limited. Despite the potential for innovative technologies to change communication patterns and, in turn, the nature of knowledge generation processes (see Leamer and Storper 2001; Moriset and Malecki 2009, for example), debates in economic geography and in management or innovation studies are still in their infancy. Moreover, the impacts on spatial production and innovation patterns remain unclear. Leamer and Storper (2001), for instance, predicted that the Internet will likely support tendencies toward de-agglomeration and agglomeration at the same time, yet there is much speculation in such discussions. This ambiguity is used as a starting point for a systematic analysis of the effects that new communication technologies and organizational forms have on economic interaction and knowledge creation. The critical review presented in this chapter underlines the potential effects of combining computer-mediated communication (CMC)[1] with temporary and permanent forms of face-to-face (F2F) interaction.

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In doing so, the assumed priority of local over non-local relationships in the context of economic production and innovation is questioned—a bias that still characterizes some of the cluster literature, at least implicitly. As Oinas (1999) clearly recognized, there is relatively little empirical evidence to substantiate that proximate relations predominate in economic interaction. Other scholars have argued that the local level cannot be seen in isolation from other spatial levels in that local knowledge and competencies are continuously and systematically enriched, fed, and challenged by global linkages (Amin 2004; Bathelt 2006). Such work suggests that the local and global spheres are inseparably interwoven. The analysis presented in this chapter maintains that permanent co-location and F2F communication may be efficient for interaction and knowledge exchange in some economic contexts but not in others. Business leaders located in one region, for example, simply may not like one another or have rather different goals, either circumstance hampering opportunities for regional innovation. Conversely, interaction in global production contexts or networks has become quite common. In short, it is reasoned that different settings can be structured in a way that enables efficient communication and knowledge circulation even over large distances.

In the context of this debate, the role and importance of F2F communication in economic interaction is systematically investigated—associated with day-to-day knowledge generation and continuous innovation. Rather than stressing advantages of proximity *per se*, it is important to analyze the preconditions, characteristics, and outcomes incurred through F2F and other interaction in different spatial settings. Temporary proximity through regular business travel and intense meetings during international trade fairs may, for instance, suffice to replace the need for permanent co-location in exchanging knowledge about technologies and markets. Further, it is suggested that new communication media combined with specific settings for knowledge exchange can mitigate and even overcome the need for permanent co-location. In order to develop this line of thinking further, this chapter moves beyond geographic literature and integrates studies in the field of social psychology.[2] Such studies shed light on how F2F-based communication and knowledge exchange operate and how CMC and virtual interaction can make up for some of the problems that occur during remote collaboration. Although sociologists have also analyzed the role of F2F communication and the influence of the Internet on social interaction, experiments conducted by social psychologists are particularly well-suited to inquiring about the potentialities of non-F2F-based virtual interaction and its spatial consequences in the future. Sociological analyses of the role the Internet has in actual social relations and communication patterns have found, for instance, that existing institutions stabilize prior patterns of knowledge exchange rather than changing them abruptly (Carrasco et al. 2008; Mok et al. 2007). Because such investigations of interaction take place under the influence of preexisting institutions, their ability to predict the potential of new technologies to shift spatial communication patterns may be limited.

The goal of this chapter is to move dialogue beyond a simple dichotomy of local versus global spheres of knowledge exchange and, instead, inform a broader discussion about the potentialities for economic interaction in settings not characterized by permanent co-location of the agents involved. The main contribution of this

analysis is to explore and link different streams of the literature on the role of F2F interaction in processes of knowledge creation that have remained rather separate thus far. Eventually, it is aimed to formulate arguments about the significance of combining various forms of local and distant knowledge exchange and learning.

Structurally, this analysis proceeds in the next section by highlighting important findings from the literature on the role of F2F interaction, its components, and its advantages in transferring knowledge and exchanging information. The third section focuses on the advantages of permanent co-location and regular F2F contact for dynamic knowledge generation in clusters creating what is referred to as "local buzz"—the everyday communication and information ecology between the local agents in a cluster or region. Limitations of knowledge exchange in proximate relations are also pointed out, for they may lead to negative lock-in processes. In the fourth section the idea is pursued that permanent co-location is an exception rather than the rule in complex production chains that can have a global reach. This characteristic has an impact on the spatiality of knowledge flows. The fifth section shows that temporary F2F interaction and "global buzz"—the temporary communication and information ecology between the global agents during an international trade fair or similar occasion—provide opportunities to establish knowledge exchanges between agents located in different regional, cultural, or national contexts. In the sixth section it is argued that computer-mediated interaction across locations can open new potentialities in knowledge creation and innovation through "virtual buzz"—the relational communication and information ecology that develops during CMC—not always available to permanent F2F encounters within groups and corporations. The final section presents conclusions, in which it is asserted that the combination of different forms of permanent and temporary F2F-based *and* virtual interaction will generate new opportunities for integrating knowledge exchange, learning, and innovation on a global scale in the future.

## The Role of Proximity and F2F Interaction

Although information and communication technologies have provided new and unprecedented opportunities for knowledge transfer over distance, a large body of literature continues to stress the benefits stemming from geographic proximity between economic agents. Economic geographers have made a concerted effort to advance the understanding of the importance of "being there" (Gertler 1995) with respect to stimulating local buzz and transferring and implementing new knowledge and technologies (Bathelt et al. 2004). Social psychologists have similarly examined remote and proximate collaboration, especially since the advent of modern information and communication technologies. In examining the efficiency of CMC on group processes and outcomes, this research has lent special attention to the social and cognitive factors that arise during F2F interaction.[3] These characteristics have long been referred to by social psychologists, and it is suggested in this chapter that the debate among economic geographers about learning and innovation in proximate versus remote contexts would also benefit from explicit reference to

some of this literature. Because studies in social psychology accentuate how integrational and informational aspects of F2F interaction afford the transfer of complex knowledge and the stimulation of trust under conditions of uncertainty, they deepen the understanding of the processes that underlie the effects of being there. These tangible benefits accruing subconsciously between interacting agents increase the value of F2F interaction as a mode of communication in exchanging and creating knowledge.

In a foundational analysis of the social psychology of telecommunications, Short et al. (1976) identified a range of non-verbal cues, such as facial expression, direction of gaze, posture, and physical distance, that are observable during F2F exchanges. They distinguished two types of functions played by these non-verbal cues. The first one, the informational function, is concerned with the passage of information from one individual to another through illustrative, emblematic gestures and other non-verbal cues. The second one, the integrative function, includes "all the behaviour that keeps the system in operation, regulates the interaction process, cross references particular messages to comprehensibility in a particular context, and relates the particular context to the larger contexts of which the interaction is but a special situation" (Birdwhistell 1970, p. 26).

These aspects of F2F encounters not only enable the transfer of complex information and knowledge; collectively, they also reduce uncertainties between communicators and, in turn, engender trust. The latter point is critical in economic contexts of production and innovation (Leamer and Storper 2001). Numerous studies in social psychology have shown that cooperative work environments and successful business transactions require the development of trust (Dasgupta 2000; Nelson and Cooprider 1996). Geographical proximity acts as a factor of cohesion by encouraging long-lasting cooperative behavior thanks to the repetition of commitment. As discussed in the next section, such effects are prominent in successful clusters whose existence is based on permanent co-presence and F2F-based knowledge flows between agents. In contrast, distant agents have fewer opportunities for the kinds of exchanges that maintain and develop emotional trust.

Furthermore, F2F interaction creates opportunities for controlling the performance of other agents (Crang 1997). This monitoring can become a mechanism with which to exercise power over others (Allen 1997). In contrast, the absence of a visual channel reduces the possibilities for an accurate expression of the socio-emotional context of the knowledge exchanged and decreases the available information about the self-images, attitudes, moods, and reactions of others. Consequently, knowledge flows important to the innovation process are highly subject to influences by the medium of communication. The benefits and shortcomings of mediums other than F2F interaction hinge, in part, upon their ability to allow for the actualization and transfer of non-verbal cues in exchanging knowledge and information.

As discussed below, different configurations of economic interaction and knowledge creation exist that involve a different mixture of co-location, F2F meetings, and virtual communication. It is investigated how these settings allow agents to benefit from F2F interaction and how continuous interaction supports the creation of particular information and communication ecologies.

## Permanent Co-presence in Clusters and Local Buzz

Much of the research in economic geography has been led by the assumption that spatial proximity is essential to an understanding of economic interaction and innovation because it "is still a fundamental way to bring people and firms together, to share knowledge and to solve problems" (Storper and Walker 1989, p. 80). Significant empirical evidence corroborates this view. In the context of urban or regional agglomerations of industries, or clusters (Gordon and McCann 2000; Malmberg and Maskell 2002; Porter 1990), recent research has linked the importance of proximate relations to the thick web of information and knowledge connecting local agents and circulating between them. The resulting knowledge flows establish a rich information and communication ecology referred to as "noise" (Grabher 2002, p. 209) or "buzz" (Storper and Venables 2004). This local buzz consists of specific information flows, knowledge transfers and continuous updates, and opportunities for learning in organized and spontaneous meetings (Bathelt et al. 2004). The importance and quality of a cluster's buzz are related to a number of partly overlapping features that make this setting especially valuable for processes of knowledge creation and exchange (Bathelt 2007).

First, the co-presence of many specialized firms of a particular value chain and regular F2F contacts between specialists from these firms generate a specific milieu for the exchange of experiences, information, and knowledge within a cluster. In this milieu F2F encounters and the associated non-verbal cues generate informational and integrational advantages in communication that make efficient knowledge circulation feasible. This effect eventually fosters the local embeddedness of firms, promoting fine-grained knowledge flows and interactive learning (Granovetter 1985). Specific information about technologies, markets, and strategies is exchanged in a variety of ways in planned and unplanned meetings.

Second, the agents in a cluster share similar technological traditions and views that have developed over time. They are based on similar day-to-day routines and problem-solving and on a joint history of regular F2F communication. New information and technologies are therefore readily understood. When agents of a similar technological background and realm of experience in a region converse with one another, they automatically know what other agents are talking about. Highly skilled, experienced specialists who have lived in a region for a relatively long time know each another and have already become acquainted with several firms as a result of switching jobs in the area. As positions change hands, knowledge that would be difficult to acquire by other means is transferred between firms (Malmberg and Power 2005).

Third, the diversity of the relationships and contacts within a cluster strengthens and enriches a tight network of information flows, common solutions to problems, and the development of trust. Within these contact networks agents are linked in multiple ways with each other as business partners, colleagues, peers, friends, or community members. As a result, resources can be transferred from one type of relationship to another (Uzzi 1997). Multiplex ties help firms gain access to new information and speed up the transfer of knowledge within the cluster.

Fourth, through the shared history of relationships firms learn how to interpret local buzz and make good use of it. Communities of practice thereby become ever more rooted over time (Wenger 1998). This gradual process helps transfer information and knowledge precisely, interpret new information in the context of a cluster's existing technological competences, and extract the knowledge that might be valuable in future applications. All these outcomes are possible because co-presence and continuous F2F encounters in a permanent cluster enhance the likelihood that people will develop compatible technological outlooks and interpretative schemes. They provide a setting conducive to the formation of joint institutions (Amin and Thrift 1995).

Knowledge flows occur through continuous transaction relations between regional firms, even if their extent is limited, but also through cross-corporate involvement in community activities, industry associations, clubs, and the like. The advantages of permanent co-presence and frequent F2F interaction are further supported by the fact that the firms draw from a joint regional labor market characterized by job mobility and overlapping competencies (Malmberg and Maskell 1997; Malmberg and Power 2005). Through these processes, local buzz is circulated and reinforced. Permanent co-location can translate integrational and informational advantages of F2F interaction and thereby have them become part of the institutional structure available to all local agents. The cluster thus becomes a natural setting for knowledge exchange and generation. In many ways, permanent co-location serves to establish and deepen relational proximity and trust (Amin and Cohendet 2004; Bathelt 2006). It helps establish reliable conditions for economic interaction and configure durable inter-firm knowledge flows.

From research on path-dependent developments, however, it is known that problems can arise if local communication patterns become too rigid and inward-looking, preventing trans-local knowledge flows and necessary adaptations to changes in markets and technologies. From a spatial perspective, negative lock-in can result in a situation in which localized industrial systems collectively run into problems caused by rigid technological and organizational structures (Asheim et al. 2006; Grabher 1993). Excessive local interaction may lead agents to rely too heavily on existing knowledge and well-established problem solutions (Granovetter 1973). They might thus lose their openness to new solutions and more radical innovation. Clusters might, in turn, become insular systems vulnerable to external shifts. As argued in the next section, important knowledge inputs can, and must, be acquired through systematic interaction with agents and firms outside clusters.

## Organizational Co-presence in Global Networks

In a cluster, spatial proximity and shared institutional, social, and cultural characteristics create conditions for firms to engage in continuous knowledge exchange and to develop long-term producer–user relations, especially if they share a common knowledge base and similar goals within a particular value chain (Rallet and Torre 1999).

Focusing on internal cluster interaction is usually not sufficient to generate the conditions for long-term growth and competitiveness. Trying to extend interregional and international linkages is, however, not a routine process with guaranteed success. One way to accomplish it is to establish organizational proximity by merging with or acquiring complementary firms in other parts of the world to create reliable conditions for exchanging knowledge and widening market access in the future (Boschma 2005; Torre and Rallet 2005). International mergers and acquisitions require a measure of cognitive proximity between the participating firms so that the respective agents can ease their communication and integrate their different cultures into a new overarching structure (Nooteboom 2000). At the same time, the capabilities of these firms must be different enough to allow them to benefit from interactive learning and knowledge exchange. International mergers and acquisitions can be viewed as processes bridging multiple distances and establishing a framework for close inter-firm knowledge linkages on an international scale, but the same processes also create stress on existing network relations at the regional level.

However, stating that different types of proximities can be substituted for one another may distract from the limitations on knowledge creation and exchange in particular spatial settings. Global production configurations or peripheral locations, for instance, do not make it easy for firms to find adequate partners for the proximate exchange or transaction of knowledge. They have no choice but to establish linkages over space that provide access to distant markets and knowledge pools. Local F2F interaction is often not an option for these firms. In global production contexts, interaction and knowledge circulation are not based on permanent F2F contact (Dicken et al. 2001; Gereffi et al. 2005). Exchanges often rely on a mixture of different types of more or less hierarchical network relations that are derived from existing ties, organizational bonds, or repeated visits at international trade fairs.

A single specific distance to be minimized in order to establish regular F2F interaction does not exist in complex production arrangements. Firms serve global markets and cooperate with partners located in different parts of the world. From the perspective of market access, it might be imperative for a firm to be reasonably close to its major markets in order to customize its products and learn from knowledge exchange with customers. For research and development (R&D), it might be more important to have R&D facilities close to production operations so as to benefit from constant information feedback and learning-by-doing. Depending on which aspects dominate or have priority, the locational structure of firms can differ considerably (Malecki 2010). No matter how and where marketing, production, or R&D are established, any setting is likely to be associated with proximities on one end and distances on the other. Under these circumstances a single plant within one cluster could cause problems because of large distances to major international markets; it could be associated with substantial risks. Geographical proximity and being there are important issues of corporate organization (Gertler 1995), but it is necessary to specify exactly which proximities are key—that is, proximity to markets, production, innovation networks, or some combination of these factors. For any multinational firm, of course, all three sets of knowledge must be identified and

accessed simultaneously, an act that gives different weight to them depending on the context (Malecki 2010). Because spatial proximity is not possible in all respects with all internal and external partners, firms establish patterns of virtual knowledge exchange and develop organizational layouts that make up for a lack of spatial proximity.

As a rule, then, spatial proximity and permanent F2F knowledge exchange might be possible with some relevant agents but not with all. Many firms have learned how to organize processes of knowledge generation and learning without permanent co-presence and have established alternative settings that work well without requiring co-location and F2F encounters on a daily basis. These settings have become expressions of new geographies of circulation through which knowledge can be created and exchanged at a distance (Amin and Cohendet 2004; Thrift 2000). An example of such interaction is a multinational firm within which managers go back and forth between different sites in different countries in a gradual pattern. By doing so, the managers generate a context of knowledge exchange similar to co-presence between distant places. Another example is that of learning processes and knowledge flows during international trade fairs, which are discussed in the next section.

## Temporary F2F Interaction and Global Buzz

A specific setting for the circulation of global knowledge flows and the exploration of new linkages exists at leading international trade fairs (Borghini et al. 2004; Maskell et al. 2006). These events open up many avenues for knowledge creation and for network and market development on a global basis. Multiple F2F meetings with other participants at these fairs help firms systematically acquire information and knowledge about competitors, suppliers, customers, and their technological and strategic choices (Bathelt and Schuldt 2008). Temporary F2F exchanges provide a sufficient basis for ensuring continuous interaction, even for including complex knowledge flows.

On different occasions, and through different routes, global information about trends and ideas in an industry, as well as all sorts of news and gossip, flow back and forth between the participants who are temporarily clustered at trade fairs. Agents benefit from integrational and informational cues transported through recurring, intensive, often short F2F encounters that lead to global buzz (Schuldt and Bathelt 2011). Like local buzz, global buzz is a multidimensional concept that promotes unique processes of knowledge dissemination and creation through interactive learning and learning by observation. Its constitutive components are related to the dedicated co-presence of global supply and demand; intensive temporary F2F interaction; a variety of possibilities for observation; intersecting interpretative communities; and multiplex meetings and relationships. Verbal and non-verbal cues, visual stimuli, and feelings and emotions, which are omnipresent in the communication and observation processes that take place, are central to the knowledge flows during these events.

International trade fairs bring together leading, as well as less well-known, agents from an entire industry or value chain for the primary purpose of exchanging knowledge regarding the present and future trends in their industry, centered around displays of products, prototypes, and innovations (Bathelt and Schuldt 2008). These events enable agents to gain an overview of the trends in the world market and provide a myriad of opportunities to make contact, ask questions, and engage in F2F exchange with other agents from the same value chain (Prüser 2003; Rosson and Seringhaus 1995; Sharland and Balogh 1996). Exhibitors and visitors benefit enormously from the large variety of different types of informal and formal meetings held with a large variety of agents.

During international trade fairs, focused communities with similar technical traditions, educational backgrounds, and day-to-day experience gather. Participation in the discussions at trade fairs helps reduce uncertainties and the degree of complexity in rapidly changing product and technology markets. Agents are linked in different ways within their contact networks, where they exchange facts, impressions, gossip, and small talk and thereby help transmit experiences with existing products and interpretations of new developments in understandable ways (Borghini et al. 2006; Entwistle and Rocamora 2006). Mixing different types of business-related and other knowledge also helps agents check each other out and establish initial communication that can be continued later. Through regular attendance at international trade fairs, the representatives of firms can find suitable partners to complement the needs of their organizations, establish trust with distant partners, and initiate the development of durable inter-firm networks in production, marketing, or innovation.

These arguments about knowledge creation and learning are next extended to include to virtual contexts having no F2F interaction and to the problems and potentials of such exchanges. Like trade fairs, such virtual contexts can complement or replace local or regional processes of learning and knowledge creation.

## CMC Versus F2F Collaboration in Groups and Corporations

Although it has been suggested above that permanent, regular, or temporary F2F contacts are pivotal in processes of economic interaction and knowledge creation, such encounters are limited in global production contexts. Instead, many firms heavily rely on virtual knowledge exchange through information and communication technologies to organize production, research, and market interaction. In this context traditional studies in social psychology have pointed out the structural differences that exist between CMC and F2F interaction and have emphasized the importance of F2F-based knowledge flows, much in line with the economic geography literature. Social presence theory, for instance, suggests that the absence of non-verbal vocal and physical cues denies users important information about the characteristics, emotions, and attitudes of other agents and thus results in knowledge exchange that is less sociable, relational, understandable, and effective than it otherwise would be (see the overview in Walther et al. 2005).

As shown below, however, potentialities of CMC might far exceed the scope suggested in social presence theory, generating what could be referred to as virtual buzz. Knowledge exchange patterns based on new information and communication technologies have challenged established views that underscore disadvantages of CMC as compared to F2F settings. A central issue of related studies in social psychology has been the determination of how the social meaning of communication and knowledge exchange is affected by the absence of non-verbal cues. A growing body of research contests the presumed differentiation between verbal and non-verbal cue functionalities, at least in terms of their outcome (Garton and Wellman 1993). In particular, scholars have developed conceptions that go beyond the conclusions of social presence theory—two of which are introduced below. First, proponents of social information-processing theory reject the position that CMC is inherently impersonal and that relational information is inaccessible to CMC users. Instead, it is assumed that individuals deploy whatever communication cues they have at their disposal when motivated to form impressions and initiate relationships to exchange knowledge (Walther et al. 2005). Second, equilibrium theorists[4] similarly posit that agents dynamically adapt levels of gaze, proximity, and other behaviors indicative of intimacy to normative levels based on culture and need for affiliation until an "equilibrium level" of comfort is achieved (Olson and Olson 2003). This behavior can provide the basis for the establishment of social relations and a continuous generation and flow of knowledge.

These conceptions raise questions about the implicit superiority of local F2F-based encounters over CMC in distant interaction. Although there are limitations on knowledge creation, the systematic use of CMC facilitates complex economic interaction and can stimulate network formation even without frequent F2F contact. If one includes opportunities to utilize video-based CMC formats and the combination of these virtual encounters with occasional planned F2F meetings, the range of possibly efficient configurations of local and non-local F2F and computer-mediated knowledge flows informed by local, global, and virtual buzz drastically widens. As argued below, it seems that F2F interaction can indeed, in part, be replaced by other forms of computer-mediated contacts—as it is usually not imperative. Possibilities for substitution can be illustrated through empirical findings from research on corporate innovation projects and group collaboration and their associated knowledge flows. The main focus here is on text-based CMC, but the findings also relate to forms of communication that are more technologically advanced than that.[5]

Traditionally, a primary strategy for ensuring a high level of knowledge dissemination in multinational firms has been the co-localization of R&D staff (Song et al. 2007). Innovative activities in the modern knowledge economy, however, entail an increasing social division of labor and are becoming more dispersed over time (Lundvall and Johnson 1994), stretching over large distances. Elements behind this trend are manifold and mean bringing R&D closer to foreign markets, tapping into new knowledge pools, or reducing personnel costs. In addition to co-location and F2F interaction, firms increasingly use virtual forms of collaboration in innovation and knowledge exchange, such as e-mail and video-conferencing (Hossain and Wigand 2004). Investigations of team-based collaboration show that, depending on

the task at hand and the contextual settings, knowledge creation and innovation over distance can be quite successful, as already shown in early studies of CMC. Of course, such collaboration can also fail if organized in an unfavorable context or with wrong expectations.

Contextual differences between F2F interaction and CMC have been shown to affect both the process and outcome of knowledge exchange. For example, Wainfan and Davis' (2004) synthesis from hundreds of studies on virtual collaboration suggested that the group structure in CMC is often broader, yet more agile, than in F2F teams. According to this work, knowledge flows have broadened through wide involvement of experts. Slevin et al. (1998) showed through controlled experiments of group problem-solving that the development of agility, demonstrated by shortened response times and the ability to access additional information, is often aided and accelerated when participants operate close to their regular workplaces. Thus, if production sites are spatially distributed, a dispersed project setting might work better than a F2F setting in which participants have to leave their workplaces for the duration of the project to exchange and create knowledge.

Although it might be harder to form social networks through CMC than through F2F contexts, it is also more difficult to distract or deflect the participants' attention by means of side conversations. When non-verbal cues are reduced, other factors such as common ground, power, and status become much less important, particularly in text-based CMC. In the localized context of a firm, contextual cues such as seating position, office location, and even clothing have been found to influence knowledge flow patterns during employee meetings (Dubrovsky et al. 1991). As shown early on by Sproull and Kiesler (1991), individuals using CMC feel less constrained by conventional norms and rules of behavior. The lack of social baggage attached to electronic messaging may, for instance, help overcome some detrimental hierarchical and social structures that impede decision-making within a group setting. Although this effect still applies to today's e-mail exchanges, it is less true for high-tech video-conferencing.

Although analyses of the nature of group processes mediated through F2F interaction and CMC differ with respect to the exact mode of communication, task type, and individual and group characteristics, results have been consistent across different experimental conditions, especially for text-based CMC (Gibson and Cohen 2003; Wainfan and Davis 2004). It is consistently reported in the literature that synchronous, text-based conferencing groups take longer to complete assigned tasks than F2F groups do (Reid et al. 1997). Consensus frequently follows a leader's F2F push for his or her preferred solution, whereas knowledge exchange in CMC settings shows more evenly distributed participation. The latter effect also emerges during video-conference communication, despite its closeness to F2F exchange (Wainfan and Davis 2004). Depending on the context, this propensity can be an advantage in the beginning of a knowledge creation or decision-making process or a disadvantage in finalizing a project under time constraints. Furthermore, experimental studies have shown that groups using CMC tend to make riskier or more extreme decisions than they do in F2F settings (e.g., Kiesler and Sproull 1992).

In group-based knowledge exchange, studies have shown that participants in text-based CMC systems make more explicit proposals, defer less to high-status members, and show less inhibition than F2F collaborators (Dubrovsky et al. 1991; Hollingshead and McGrath 1995). Rice (1984) showed that, when faced with a dilemma, F2F groups began by analyzing it, whereas CMC collaborators started discussion by proposing a solution. In some cases, group members in CMC suggested solutions before even listening to the thoughts of other participants. Although the context has greatly changed since the introduction of sophisticated communication technologies, many of these generic findings still apply, as in e-mail communication (Wainfan and Davis 2004). Studies have also suggested that some degree of anonymity decreases conformance pressure in text-based CMC settings and allows group members to be less inhibited in their expression of ideas (Baltes et al. 2002). Ideas expressed under these conditions are more likely to be evaluated on their merit rather than on the status of the person presenting them. Such aspects may, of course, be more important in some cultural settings than in others, for instance in rural compared to urban social contexts.[6]

In a study of innovation projects in multinational firms, Song et al. (2007) reported interesting results pertaining to the nature of collaboration and its outcomes. They found that knowledge dissemination between agents is greatest when F2F and CMC settings are combined. There appear to be parts of knowledge creation processes where F2F meetings are key to the development of new ideas and concepts, whereas other parts benefit from work at dispersed workplaces with regular CMC adjustments (e.g., e-mail exchanges). Permanent co-presence may foster knowledge dissemination within a single research facility but may impede knowledge flows to spatially separated production sites. In global production contexts, for instance, co-localization of research staff may lead to the separation of research and production. At the corporate level knowledge dissemination requires that uncertainties and ambiguities be reduced and that both explicit and tacit knowledge be transferred in weak and strong relationships, planned and unplanned meetings, and nearby and far away sites. This heterogeneity suggests that optimal conditions for innovation require that co-location be complemented by virtual interaction (see also Nonaka and Takeuchi 1995).

Examining virtual collaborative practices followed in projects by large firms across numerous sectors, Olson and Olson (2003) made a number of valuable observations in cases of remote collaborations that failed. They found that in situations where collaborative work relied on video- and online-conferencing to substitute for F2F communication, agents spent almost more time managing themselves and their work through information and communication technologies than actually doing real work. In projects in which the stress of using CMC increased over time, interaction frequency seemed to decrease, and the likelihood of failure grew. In response to such conditions, firms reorganized operations so that stressful, highly interactive work could be done in one location. Other looming issues with communication technologies were associated with technical deficiencies. Olson and Olson (2003) noted that in many cases technical difficulties, including the quality of visual display or audio, interfere with interactivity—although that effect might

change with technological improvements. Over time, the interlocutors in firms adapted to such difficulties by identifying themselves before speaking and using more formal protocols for taking turns.

## Conclusion

As demonstrated above, advances in information and communication technologies have radically changed the ways in which firms conduct business (Grabher et al. 2008; Leamer and Storper 2001). Although the intention behind this inquiry is not to provide a representative overview of all the different types of CMC, the examples of F2F interaction and CMC used demonstrate that the two mediums possess unique properties. In processes of exchanging and creating knowledge, each medium has its relative strengths and weaknesses, which play themselves out differently depending on the task. On the one hand, the analysis of corporate work processes and project groups has shown that computer-mediated knowledge exchange is weaker under time constraints and tends to produce poorer decisions than is the case with F2F encounters. However, it allows for knowledge dissemination between more people, and it does so more quickly. On the other hand, F2F interaction is stronger in conveying tacit knowledge, which is critical in times of uncertainty and ambiguity. However, the social baggage that accompanies F2F interaction can be a burden to successful innovation.

In response to potential inefficiencies of CMC and the continuing importance of geographic proximity, corporate actors explore organizational structures that combine both aspects and thereby enable knowledge generation over distance. For Torre and Rallet (2005), a solution lies in the temporary mobility of individuals. The need for F2F interaction in terms of knowledge exchange does not require individuals to co-locate permanently. However, it does require individuals to meet at regular intervals. In many circumstances, problems can be solved through the mobility of individuals, as with business travel. In other cases, individuals collaborating in projects need to meet F2F only during particular phases in the innovation process, especially during times of high complexity and uncertainty. During those periods, F2F interaction as "organized proximity" is critical (Rallet and Torre 2009). During other stages of the innovation process, it may suffice or even be more efficient to rely on CMC settings, such as e-mail contact, for knowledge exchange. Organized proximity, of course, is not a purely geographical concept. It is relational and urges greater interaction among the members of a project, organization, or value chain (Bathelt 2006). It refers to the establishment of a collective culture that generates shared interpretations of new knowledge even if the agents are located in different places. Such commonality in thinking and problem-solving is critical to knowledge generation and innovation.

These findings on the role of F2F interaction and CMC are supported by Leamer and Storper (2001), who suggested that "[t]he Internet will probably reinforce the roundaboutness of production and hence of the importance of face-to-face contact,

though it will also probably make possible greater linkages between different localized clusters at very long distances" (p. 658). In scenarios where proximity is simply untenable, the value of virtual interaction using modern information and communication technologies increases drastically. In these cases, actors are quite willing to put up with and overcome potential deficiencies of virtual interaction. Best practices emerge as individuals cope with the latest technologies.

Trade-offs are inevitable, and staying competitive requires pinpointing a firm's own mixture of settings for knowledge exchange and creation in production, distribution, and innovation. Above all, it is necessary to keep in mind that one important disadvantage of CMC as compared to F2F communication is related to difficulties in establishing initial trust. Such problems may require that complex innovation projects over distance involve agents already sharing trust built up during earlier cooperation in a co-localized setting, but they do not rule out many other projects based on CMC even in complex contexts. In fact, it is foreseeable that combining CMC with other interactive and F2F-based settings may overcome some of the problems with establishing trust. However, one should not equate CMC solely with long-distance communication. It may also be extremely useful to communicate with a colleague next door via CMC technologies, as is best practice in many work contexts.

Just as sound innovation strategies incorporate advantages of both local and global integration, so, too, do firms increasingly rely on CMC and F2F knowledge exchange in combination with each other. To argue that virtual interaction will eventually eliminate the benefits accrued from geographic proximity makes little sense in evaluations of complex economic realities. It also appears misleading to assume a superiority of local over non-local knowledge networks. Instead, it is recognized that modern information and communication technologies have allowed distant and close collaboration to occur simultaneously in economic interaction and knowledge creation. Both phenomena differ in the costs they incur and benefits they generate. The firms and networks best able to make use of both options will likely develop a high degree of flexibility and an "integrative competitive advantage" in the globalizing knowledge economy in the future.

## Notes

1. Throughout this chapter, the term *computer-mediated communication* is used to refer to any type of communication made possible and supported by networked computers. Communication encompassing audio- or video-based exchanges is also included, though CMC has sometimes been primarily related to text-based interaction (Gibson and Cohen 2003; Wainfan and Davis 2004). The nature of such communication has drastically changed over time from simple text-based messages in the 1980s and 1990s to elaborate video-conferencing and other web-based collaborative tools in the 2010s. Although technological progress has certainly enhanced possibilities for virtual interaction and knowledge creation by

imitating the nature of face-to-face encounters, it has also reintroduced possible limitations associated with that kind of interaction, as discussed later in this chapter. The intention of this chapter is to identify the potential of such virtual knowledge exchanges rather than to give a comprehensive overview of all possible variations.

2. The intention is not to provide a representative summary of the social psychology literature. Instead, it is aimed to synthesize some important findings of this literature that are highly relevant to understand the complex spatiality of economic interaction and knowledge creation. The fact that literature is used that dates back to the 1990s and even earlier shows, first, that the potential of CMC technologies to support the establishment of social relations without F2F contact had already been recognized by social psychologists when the debate on regional resurgence in economic geography was in full swing. Second, it demonstrates that even early technologies generated possibilities to replace, or at least complement, the need for F2F-based interaction and enable knowledge generation over distance.
3. Although not always explicitly addressing knowledge and learning, this literature relates to distinct communication settings that involve knowledge exchange through social relations.
4. The use of the term *equilibrium* in social psychology differs from that in economics and economic geography, although some similarities exist. It is not related to aspects of economic exchange or processes of connecting demand and supply.
5. Although empirical studies and experiments in social psychology are usually conducted outside direct economic contexts, such as social networking, their results are generic and relate to the communication of specific knowledge, the coordination of tasks between spatially separated individuals, or the establishment and maintenance of social relations across space. These aspects are relevant to a wide range of knowledge-exchange processes in economic life. They are important to knowledge flows in day-to-day contexts of negotiations, continuous production adjustments, problem-solving, search processes, strategy discussions, and the like—though the associated practices vary between different industries and corporate functions (in the context of communication and interaction within multinational corporations, see Olson and Olson 2003).
6. Of course, modern Internet platforms that involve audio exchanges are not anonymous. Some of the original advantages of CMC may, in part, be reversed through technological developments that reproduce the conditions of F2F encounters, reintroducing some of the social baggage of F2F communication.

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# Chapter 5
# Creativity: Who, How, Where?

**Edward J. Malecki**

Creativity is the art of creating the new: new knowledge, new products, new designs, new works of art, new combinations. Creativity, the generation of novel and useful ideas, can be distinguished from innovation, the process of making money out of creativity (Hall 1996). This distinction helps to explain the recent shifts in fashion from high technology to knowledge to creativity as foci for research. Social scientists are trying to figure out the ultimate foundation, if one exists, for sustainable economic growth and development.

Sustainable development is largely characterized by the balance between jobs and the natural environment, or physical sustainability. It also must include social sustainability, the human-made environment, and the reproductive or socioeconomic environment (Jarvis et al. 2001). Törnqvist (1983, 2004, p. 227) used the term *renewal*, based on various creative processes, in a context similar to sustainability.

Psychologists and management scholars continue to make up the core of researchers on creativity, who focus on individual and organizational characteristics associated with creative outcomes and outputs. The interest of geographers and regional scientists in creativity seems to have been sparked by the publication of Richard Florida's *The Rise of the Creative Class* (2002). Focusing on labor in the United States, Florida does not cite earlier work on the creative city by Landry (2000) and Landry and Bianchini (1995).

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Creativity as a subject in geography began somewhat earlier, in the attempts by Törnqvist (1983) to find "possible common denominators" (p. 94) among creative milieus and by Andersson (1985) to understand regional creativity. Hall (1998) built on these ideas and stressed that "creative cities, creative urban milieux, are places of great social and intellectual turbulence" (p. 286). Such places are in economic and social flux, with large numbers of new arrivals, who mix and merge and generate a cosmopolitan social environment in which talent is more important than wealth (Hall 2000). Cities (or regions) are more than merely creative. Cities have become more important "as the key creative, control and cultural centres" (Amin and Graham 1997, p. 411).

Now, more than 25 years after Törnqvist (1983), we social scientists either know more about or use new words to describe the processes at work in creative milieus. They are not only cities; they can also be corporations and research institutions (Törnqvist 2004).

This chapter has three main sections. The first addresses the question of who is creative, focusing on creative individuals; the second, how organizations try to enhance their collective creativity and the creativity of their employees; the third, where creativity occurs. Although most attention has focused on cities as creative places and on urban creative scenes, rural areas exhibit creativity as well. Apple, IDEO, and Google are used as examples of creative firms.

## Who Is Creative?

A large body of literature in psychology has grown around the idea of creativity (Meusburger et al. 2009). That research has documented that creativity is more than an individual phenomenon identifiable only in geniuses. The consensus view recognizes at least some environmental influences, that determine how large the risks of novelty or change appear (Sternberg et al. 1997). But a more useful perspective is one that resonates with much else within the social sciences: "What we call creativity is a phenomenon that is constructed through an *interaction between producer and audience* [italics added]. Creativity is not the product of single individuals, but of social systems making judgments about individuals' products" (Csikszentmihalyi 1999, p. 314). To what degree, and in what ways, are creative workers "creative"? Scott (2007) noted that "the distinctive forms of human capital that these individuals possess—specifically the *cognitive and cultural* tasks they are called on to perform in their work—are, for the most part, wedged in social grooves and infused with very specific substance" (p. 1473).

Since the publication of *The Rise of the Creative Class* (Florida 2002), the notion of who is creative has become both better defined and more poorly understood. Florida used a blunt instrument in order to define three easily perceived "classes": creative, working, and service. He defined the creative class as "people who add economic value through their creativity" (p. 68) and who "engage in work whose function is to 'create meaningful new forms'" (p. 68).

Florida's broad definition of the creative class has been applied with little alteration to Europe (Florida and Tinagli 2004), the United Kingdom (Clifton 2008), and the world (Florida 2005), but it also has come under serious criticism. Markusen (2006), for example, criticized Florida's lumping artists together with others with whom they have very little in common, such as scientists, engineers, managers, and lawyers. McGranahan and Wojan (2007) concluded that many members of the "creative class" as defined by Florida are not so creative at all, and they exclude occupations with low creativity requirements (based on detailed occupational descriptions) and people involved chiefly in economic reproduction (such as doctors, nurses, and teachers). Scott (2007) agreed, also observing that the work tasks in many of the creative class's occupations are "focused on activities including neoliberal technomanagement, innovation-oriented process and product design, the personalized provision of services, the naturalization of socially-useful aptitudes and beliefs (in educational institutions and the media, for example), and the commercialization of experiences, cultural encounters and leisure pursuits" (p. 1473). Moreover, Pratt (2008) pointed out that the creative class holds out the promise of local growth without specifying a creative process. In the end, Florida added to place-marketing strategies through the use of several layers of proxy variables, but not to the understanding of how growth actually happens.

## Cultural Industries and Creative Industries

Creativity has to some degree merged with culture in the context of the cultural industries, which display some form of human creativity. A growing literature focuses on the creative economy but tends to focus on its definition, delineation, and characteristics rather than on the nature of the creativity within its actors. Creative industries "are at the cross-road among the artisan, services and industrial sectors" (UNCTAD and UNDP 2008, p. 13).

The cultural industries, however, are not the same as the creative industries. As emerging sectors of cultural production, such as multimedia and software production, the audiovisual industries, architecture, and design, became increasingly difficult to fit within traditionally defined sectors of the cultural industries, cultural industries were transformed into the now larger category of creative industries (Richards and Wilson 2007). Table 5.1 suggests many economic activities that contribute to and profit from the various stages of creative industries.

Cultural industries are creative in another sense. In part because of their aesthetic and intangible nature, the cultural industries focus on producing novel products. They are *chart businesses*, "businesses that live or die by the volume and success of their output being valued as 'best' in the market place for a limited period" (Jeffcutt and Pratt 2002, p. 228). The market place exerts peculiar pressures on business organization, stress that might be considered a permanent state of structural instability.

**Table 5.1** Stages and activities in the creative industries production chain

| Stage | Activities |
|---|---|
| Beginning | Ideas, creativity, intellectual property, R&D |
| Production | Ideas into products, places for production |
| Circulation | Distribution, wholesale, marketing |
| Delivery media | Retail, hardware, venues |
| Markets and consumption | Watching, ordering, interacting |

*Note*. Adapted from Montgomery (2007, p. 59, Fig. 1.5). Copyright 2007 by J. Montgomery. Adapted with permission

One can distinguish among knowledge of three kinds: *analytical* (science), *synthetic* (technical), and *symbolic* (creative) (Asheim and Coenen 2005). Symbolic knowledge is increasingly produced not as material objects, but as "signs" (Lash and Urry 1994). These signs are of two types. Those with a primarily cognitive content are informational or postindustrial goods. Signs with primarily aesthetic content are postmodern goods seen, notably, in the proliferation of nonmaterial things, such as pop music, film, and video. Crucially, in creative industries such as fashion design, the overriding purpose is to persuade people to buy certain types of clothing. The same is true of advertising, whose prime purpose is only to persuade people to buy more. Cultural industries have a broader scope than this, including products that "may never make big bucks" (Galloway and Dunlop 2007, p. 29).

The various types of creative workers approach their work differently because their funding comes from different sources. Artists and scientists traditionally have had their work supported by patrons, such as government, a large corporation, a university, or a wealthy individual. Their work is evaluated largely by peer review. They have a very different mindset from that of designers, architects, and engineers, who serve clients, or a succession of clients, and whose work is evaluated by user testing (Stefik and Stefik 2004).

In general, people in the arts and creative industries have chaotic occupational biographies, "portfolio careers" commonly marked by discontinuity; repeated alternation between work, searching, and networking activities; and moves between multiple jobs inside the arts sphere or across several sectors related or unrelated to the arts (Brown 2005; Peiperl et al. 2002). People in the design field build careers in local labor markets in major design centers, such as New York City and Toronto, by constantly using their various networks even while changing jobs frequently. They find new jobs by tapping into both formal and informal networks and intermediaries (Currid 2007; Vinodrai 2006). "People find success in creative industries by casting a wide net through their networks of weak ties, and by being open to the structured randomness that such ties bring" (Currid 2007, p. 85). The tendency of arts occupations to build upon portfolios of experience, applied to a series of projects, contributes to innovation (Oakley et al. 2008).

Patents are a common measure of corporate creativity. Another form of intellectual property right, the trademark, has been much less studied (Mendonca et al. 2004; Ramello and Silva 2006). Apple Inc., for example, has devoted great effort to obtaining a trademark rather than merely patents for its iPod music player. Unlike

the more common utility and design patents, which exist to cover functions and the ornamental look and feel of products and which expire after a set number of years, trademarks can remain in force forever. A trademark was granted in January 2008 by the U.S. Patent and Trademark Office for the three-dimensional shape of the iPod media player (Orozco and Conley 2008).

Most companies, however, now rely on branding rather than trademarks as a sign of differential distinctiveness (Lash and Urry 1994; Ramello and Silva 2006). Apple has gone beyond that practice and sets a higher bar for its competitors. Apple's nontraditional trademark for the iPod includes "the design of a portable and handheld digital electronic media device comprised of a rectangular casing displaying circular and rectangular shapes therein arranged in an aesthetically pleasing manner" (Orozco and Conley 2008, p. R6). In 2007 Apple also secured a trademark on a two-dimensional symbol representing the iPhone and has obtained design patents on the iPhone. In October 2007 the company applied for a nontraditional shape trademark for the iPhone (Orozco and Conley 2008).

## Creative Organizations: How to Manage Creativity—Or at Least Facilitate It

New product development and other R&D efforts—among the activities consistently seen as nonroutine—demand creativity, and large companies have tried many different ways to manage their professional staff involved in innovation and creativity (Gupta and Singhal 1993). The task is difficult because large firms want order, and creativity thrives best in disorder. Indeed, the characteristics of creative organizations have been known for decades, yet they are resisted and killed by most firms (Shapero 1985). Sutton (2001) stressed the importance of hiring people who do not fit the organization, who do not follow the rules, and who try things that are likely to fail. Such people are rarely tolerated in large companies, which are full of rules.

> Efforts to imbue a uniform corporate culture are unlikely to foster independence, divergent thinking and creativity. Atmospheres of uniformity do not enhance creative thought or the likelihood of finding novel or original solutions. They are also likely to be repugnant to highly creative people who are independent, unconventional, inclined to seek out challenge and even "on the edge." (Nemeth and Nemeth 2001, p. 102)

Corporate hierarchies and channels of information flow conflict strongly with the consensus view that "constant, open communication between segments of an organization is an essential ingredient for creative production" (Williams and Boden 1999, p. 375; see also Amabile 1996). The ideal corporate form for innovation or knowledge creation does not exist, but Hedlund (1994) suggested that firms organize as a *heterarchy* rather than as a hierarchy.

Can creativity be *managed*? Nonaka, Toyama, and Konno (2001) believed that the knowledge-creation process cannot be managed in the traditional sense of the word *manage*, which centers on controlling the flow of information. A recent example is software for "idea management" (Flynn et al. 2003). Knowledge is more than

information; knowledge needs to be absorbed and understood (Brown and Duguid 2000). Nonaka et al. (2001) described the task for management:

> Managers can lead an organization to actively and dynamically create knowledge by providing certain conditions: Providing the knowledge vision, Developing and promoting the sharing of knowledge assets, Building, connecting and energizing *ba* or interaction spaces (by supplying necessary conditions, such as autonomy, creative chaos, redundancy, requisite variety, love, care, trust and commitment). (p. 31)

Because all industries face different conditions and environments that, in turn, affect the pace of change and the pressures for innovation, firms are not equally able to create systems that enhance creativity. Perez-Freije and Enkel (2007) found that a larger number and a wider variety of creative processes were present in firms in fast-changing industries than in industries that face only moderate or slow change. Most important, perhaps, is a firm's ability to synthesize contradictions (including efficiency versus creativity, exploitation versus exploration, and speed versus time-consuming resource-building). It is the key to understanding how firms create knowledge. Creative firms synthesize, not just optimize, and they can transcend their boundaries to literally be part of their suppliers, customers, universities, governments, local communities, and competitors (Nonaka and Toyama 2002).

Many companies, including Apple, contract out their product design to design firms such as IDEO. IDEO follows a five-step innovation methodology: observation, brainstorming, rapid prototyping, refining, and implementation (Nussbaum 2004). Although these varying recipes suggest managerialism, they perhaps also represent IDEO's shift from designing products, to designing services, to designing entire customer experiences with products and services (Brown 2008; Utterback et al. 2006, p. 8).

The ultimate business objective is to generate collective knowledge, competence, expertise, and wisdom in order to generate collective creativity. The generation of collective creativity involves creating new combinations of internal and external and of individual and social (Amin and Cohendet 2004; Ancori et al. 2000; Nonaka and Takeuchi 1995; Storey 2000). Fundamentally, innovation or knowledge creation can be seen as a dialectical challenge (Nonaka and Toyama 2002).

Finally, for corporate creativity, temporary co-location and face-to-face interaction are necessary. They are not necessary all the time, so the question arises as to *when* people should be brought together. Research has shown that complex design and planning tasks that are needed early in a project benefit most from co-located face-to-face meetings, where workers think together (Sapsed et al. 2005).

## Where Does Creativity Happen? Creative Places

Just as not everyone is equally creative, so, too, are places different in the degree to which they can exude or facilitate creativity. Place is important in two respects. The first is the planning of workspaces to enhance face-to-face interaction and collaboration and, thereby, to increase creativity (Campbell 2006; Thrift 2000; Toker and Gray 2008). The second is a topic central to geography: How do cities influence

creativity? This discussion of creative places omits the ability of companies to acquire knowledge from temporary clusters, such as trade shows and conferences (Bathelt and Schuldt 2008; Maskell et al. 2006). For scholars in particular, short-term bursts of creativity result from the opportunities for intense knowledge exchange and idea generation at these gatherings, but research on this topic is in its infancy.

Some companies have found that separate spaces for creative activity are useful. For example, IDEO uses smallness as a key way to avoid hierarchy. A typical IDEO site houses 25 employees, and the headquarters in Palo Alto, California, has the company spread through seven buildings (Kelley 2001; Perry 1995).

## *Why Creativity Needs Cities*

The idea that cities are creative places is often stated, most commonly in connection with dense agglomerations of creative people. Rantisi et al. (2006) referred to "the urban as a locus for interaction and experimentation" (p. 1790). In this regard, large cities are privileged. For example, London, New York City, Los Angeles, Paris, and Tokyo are recognized as world cities in every dimension (Sassen 2001). These are "world stars," cities with highly advanced, world-class specialized functions having global reach. They are core hubs in dense international networks of firms and people. They attract top talent within their home nations and from around the world. They have successful world-class knowledge-intensive clusters and are "the place to be" for a certain activity. These cities are the centers of creative industries, including advertising, design, fashion, music, and the arts (Van Winden 2006, p. 308). Florida (2005) named them "global talent magnets" (p. 159).

Some evidence for these general traits exists. The "world cities of knowledge" are generally large (Matthiessen et al. 2006), providing what Törnqvist (1983) described as "communications density" (p. 103) Amara et al. (2005) and Maillat (2001) proposed that both strong learning and strong interactions are the defining characteristics of *milieux innovateurs* or clusters. Cooke (2002) termed such places *knowledge economies*; Scott (2000) called their dynamic a *creative field*. Historically, "creative cities were nearly all cosmopolitan; they drew talent from the four corners of their worlds,… Probably, no city has ever been creative without continued renewal of the creative bloodstream" (P. Hall 1998, p. 285). Scott (2006) agreed: "The mere presence of 'creative people' is not enough to sustain urban creativity over long periods of time. Creativity needs to be mobilised and channelled in order for it to emerge in practical forms of learning and innovation" (p. 299).

No innovative city, however, has remained permanently a leading center. Hall (1998) identified Silicon Valley and Tokyo as having shown a capacity to go through two or more cycles of innovation because "they resemble nothing so much as huge and complex ecosystems, which must be constantly nourished if they are not to wither and die; and that is what they are, human ecosystems which contain a disproportionate number of the world's most creative individuals" (p. 500). Glaeser (2005) added Boston to Hall's short list.

Agglomeration in large cities provides measurable advantages in innovation and creativity. Patent activity in Sweden is higher in larger and denser labor markets and in regions where a larger fraction of the labor force is employed in medium-sized firms (Andersson et al. 2005). This argument is a simple one: Large cities are more likely than towns or small cities are to be the seedbeds of industrial creativity and, perhaps even more, of artistic creativity (Marksuen 2006; Schoales 2006).

Cities may be creative in different ways. Lazzereti (2007) ranked creative cities in Italy according to three criteria that focus on creative industries related to high culture, especially the visual arts (yet Rome and Milan are always in the top three). Other studies take a broader view, citing many sectors and occupations and the interactions among them. Examples include Amsterdam as "a creative knowledge city" (Musterd and Deurloo 2006), Antwerp as a fashion capital (Gimeno Martinez 2007), and Montréal as a site of the technology–art interface (Stolarick and Florida 2006). Currid (2007) described vividly "how creativity works" (p. 77):

> Because creative production requires near-instantaneous access to skill sets, creative industries and people often need immediate acquaintance with and access to lots of different people. This goes both ways. Firms need freelancers and contract workers as well as a permanent creative labor force, while creative people need employment, both temporary and long term.… The city acts as the instant marketplace for these exchanges. (pp. 83–84)

Like Currid (2007), Feinstein (2006) saw creativity not as a momentary outcome, when the light bulb comes on, but as an outcome of creative development, which itself encompasses processes, experiences, and structures. Choosing to develop a creative career in a world-star city provides opportunities to meet the gatekeepers (the field) who are able to label one as creative.

## *The Example of Google*

Google, founded in 1998, has grown dramatically and has become a popular place to do creative work. Google has the grand vision, established by founders Sergey Brin and Larry Page, "to organize the world's information and make it universally accessible and useful."[1] Google keeps much of its operation hidden from view in its network of massive data centers. In addition to the company's profitable search tools and ad placement, the network of data centers constitutes the concept of "cloud computing" through which Google has begun to take on a new role as a research leader in the computer industry (Baker 2007).

Media attention has focused on the firm's headquarters in Mountain View, California, known as the Googleplex (Google 2008; Inside the Googleplex 2007; Stross 2008). Its amenities are intended to attract potential recruits.

> Bright kids just out of college tend to love it, because the Googleplex in effect replaces their university campus—with a dating scene, a laundry service and no reason to leave at weekends. Older Googlers with families tend to like it less, because "everybody, even young mums, works seven days a week." (Inside the Googleplex 2007, p. 58)

The Googleplex facilitates this work, or lifestyle, by providing a workout room with weights and a rowing machine, washers and dryers, massage room, video games, a

**Table 5.2** Google locations Worldwide

| Region and country | City |
|---|---|
| *Asia Pacific* | |
| Australia | Melbourne, Sydney |
| China | Beijing, Guangzhou, Shanghai, Hong Kong |
| India | Bangalore, Gurgaon, New Delhi, Hyderabad, Mumbai |
| Japan | Tokyo, Osaka |
| Korea | Seoul |
| Singapore | Singapore |
| Taiwan | Taipei |
| *Europe* | |
| Denmark | Aarhus, Copenhagen |
| Finland | Helsinki |
| France | Paris |
| Germany | Hamburg |
| Ireland | Dublin |
| Italy | Milan |
| Netherlands | Amsterdam |
| Norway | Oslo, Trondheim |
| Poland | Krakow, Wroclaw |
| Russia | Moscow, St. Petersburg |
| Spain | Madrid |
| Sweden | Luleå, Stockholm |
| Switzerland | Zurich |
| United Kingdom | London, Manchester |
| *North America* | |
| Canada | Montreal, Toronto, Waterloo |
| *Latin America* | |
| Argentina | Buenos Aires |
| Brazil | Sao Paulo |
| Mexico | Mexico City |
| *Middle East* | |
| Israel | Haifa, Tel Aviv |
| Turkey | Istanbul |
| United Arab Emirates | Dubai |

*Note*. From Google (2008) Google Corporate Information: Google Offices. http://www.google.com/corporate/address.html (June 6, 2008). Four additional countries appear on *Google Jobs: Explore our offices*: Czech Republic, Egypt, Greece, and Hungary, in addition to Africa, where eight countries had positions available (in order listed): South Africa, Kenya, Senegal, Nigeria, Rwanda, Republic of Uganda, United Republic of Tanzania, and Ghana. http://www.google.com/support/jobs/bin/static.py?page=intl.html&jobslc=africa (June 6, 2008)

baby grand piano, a pool table, ping pong, a Google Café with outdoor seating, and snack rooms (Google 2008). "We kind of like the chaos," says Laszlo Bock, the personnel boss. "Creativity comes out of people bumping into each other and not knowing where to go" (Inside the Googleplex 2007, p. 58).

In addition to the Goolgeplex, however, Google has 46 other locations (Table 5.2). They might be considered the most creative places, where Google believes it can

attract the pool of the best workers. Although most of these places are among the ones many would agree are creative, others are more puzzling. For example, is Hamburg more suitable in Germany for Google's work and workers than Berlin (Krätke 2002), Cologne (Mossig 2004), or Munich (Sternberg and Tamasy 1999)?

Tokyo is a particularly important lab for Google as it tries to refine its search technology for mobile phones. Japan has become a vast lab for Google "because Japan's 100 million cell-phone users represent the most diverse—and discriminating—pool of mobile subscribers on the planet" (Hall 2008, p. 56). More than elsewhere, Japanese web sites are formatted for cell phones.

> To figure out what mobile Web surfers like, the company relies on user experience groups, or UX in Google-ese. Dozens of participants are given phones with Net access and asked to complete simple tasks, either in a company lab or out on the streets of Tokyo. "We'll tell them: Find me a restaurant for tonight in Shibuya, and we just watch." (pp. 56–58)

Google's knowledge of the digital marketplace is seen as valuable to more traditional companies, but also as very different. Procter & Gamble (P&G), which makes laundry detergent, toilet paper, and skin creams, has a very different understanding of the market for household products. Both firms are learning from each other by having employees spend several weeks inside the other firm. An early reaction from Googlers to a P&G new-product press conference was "Where are the bloggers?" (Byron 2008).

IDEO, like Google, has created a global network of creative people. IDEO's facilities are located in cities that attract both clients and creative people. The current list has eight locations: San Francisco, Boston, Chicago, New York, London, Munich, Shanghai, and Tokyo (IDEO 2008). The talent magnets, it seems, become only more attractive as more companies seek the same workforce.

## Conclusions

This chapter is an attempt to shed some light on the concept of creativity. What it reveals, however, gives reason for pause. First, the depiction of some people as creative and others as uncreative inevitably rankles. The notion of *managing* creativity also seems oddly contradictory, especially in light of open innovation and what Amin and Cohendet (2004) referred to as "a distributed system of knowledge production" (p. 153) that requires inputs from many sources, not only the elite creative class. This chapter has reviewed the vast literature on two faces of creativity—the managed kind and the unpredictable and unmanageable. As symbols, signs, brands, and other intangibles grow in importance, the search for creativity and how to manage it is likely only to increase in importance. The same is true of creative places. From a spatial perspective, Cappellin (2003) represents the managed kind of creativity, proposing nothing less than "territorial knowledge management." At the level of urban planning, Landry (2000) and Montgomery (2007) want to help cities plan for the unpredictable social interaction that sparks creativity.

The symbolic or creative aspects of cities are being used as a policy tool much the same as traditional policy tools—"based on interlocal competition, place marketing, property- and market-led development, gentrification and normalized socio-spatial inequality" (Peck 2005, p. 740). All are unsustainable strategies. This assessment suggests four general aspects of creative regions:

- They have the ability to attract and keep people and capital, characteristics of Markusen's (1996) "sticky places"—and, most important, they are magnets for bright people.
- They evolve an ecosystem consisting of networked social structures and institutional thickness. Few regions have such an ecosystem, and it takes decades to evolve. Malecki and Moriset (2008) add the example of Grenoble to the more familiar Silicon Valley.
- To keep in touch with best practice, a milieu needs a mix of local buzz and global pipelines, or local networks and conduits (Bathelt et al. 2004).
- Creative regions embody an instability that tolerates and welcomes newcomers and their new ideas.

Despite the fact that. these ingredients for creative development are known, no one has a complete, foolproof recipe. The knowledge economy calls for "creative cities"—urban areas that combine concentration, diversity, instability, and a positive reputation. Hospers (2003) concludes, however, that knowledge, creativity, and innovation cannot be planned from scratch by local governments. A great deal simply takes a long time to emerge.

## Note

1. See also http://www.google.com/corporate/ and Google Investor Relations, "What is Google's mission? How did Google begin?" Retrieved from https://investor.google.com/corporate/faq.html#mission

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# Chapter 6
# The Problem of Mobilizing Expertise at a Distance

**Johannes Glückler**

> *The economic problem of society is thus not merely a problem of how to allocate "given" resources …, it is a problem of the utilization of knowledge not given to anyone in its totality.*
>
> (von Hayek 1945, pp. 519–520)

Knowledge is incomplete and unequally distributed in society and space. As unsurprising as this axiom appears to be, it has powerful consequences for the economy in general and for corporate organization in particular. Most corporate ventures today operate from various geographically distributed locations. Every multilocational firm faces the managerial challenge of making localized knowledge available at other places in order to replicate good practice, support innovative practice, and prevent reinvention of the wheel. This problem is especially pronounced in business models that are essentially grounded in expertise services. When expertise is geographically separated, the accumulation and transfer of this diverse knowledge is one of the key opportunities to generate competitive advantage over nationally operating competitors. Successful transfer bestows two potential advantages: (a) the reutilization (exploitation) of expertise in broader markets and (b) the transformation of that expertise into new knowledge (innovation). Conversely, if professional service firms fail to transfer inimitable resources, they miss out on vital opportunities for global business.

This chapter contributes to the debate about effective knowledge transfer in multinational firms. My first objective is to conceptualize this challenge as a trade-off between organizational coherence and geographical expansion. The line of argument is based on both a relational understanding of knowledge (Bathelt and Glückler

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2005, 2011) and a network perspective on the circulation of expertise within multinational service companies (Borgatti and Cross 2003). I define expertise straightforwardly as the cognitive combination of formal knowledge and experience. Expertise is therefore an embodied, people-specific kind of knowledge. My second objective is to apply this relational understanding of knowledge to the empirical context of corporate knowledge transfer by using methods of social network analysis. In particular, I examine the structure of interpersonal exchange of expertise between qualified knowledge workers. Empirically, my intent is to assess the quality of a knowledge network for its connectedness and its vulnerability with respect to potential disruptions in network structure. This structural exploration will improve the understanding of the managerial problems of organizing knowledge flows at a distance. The German-based technology service provider MILECS[1] is an emblematic case for this purpose because the company is widely dispersed. Roughly 200 consultants and engineers are distributed throughout 15 offices in 10 countries across 4 continents. Moreover, the company depends on its ability to mobilize existing localized knowledge and to reuse it in other places to benefit from its internationality.

In the next section I develop a strategic framing of the analysis, conceiving of a trade-off with respect to generating and sharing nontrivial experiential knowledge across geographically distributed corporate units. The concept of know-who is discussed, and an analytical approach to studying knowledge transfer is taken. I then introduce the historical context of the MILECS business case and describe the research methodology before presenting the visual and analytical analysis of the global knowledge network at MILECS. The analysis demonstrates the risks of vulnerability in international knowledge flows when workplaces are geographically dispersed. It also provides evidence of the positive effects that management initiatives have on international knowledge transfer.

## Conceptualizing the Organizational Challenge of Knowledge Transfer

### *Trading off Organizational Coherence and Geographical Expansion*

The geographical organization of a company implies conflicting opportunities that may be conceptualized as a trade-off between two extremes: one where a firm concentrates all its resources in just one location; the other, where a firm's resources (skilled employees) are completely scattered across space. The first extreme offers the advantage of organizational coherence. When all corporate production and use of knowledge is collocated, intrafirm communicational friction is minimized and intrafirm exploitation of local externalities is maximized. Economic geographers who have intensely probed the dynamics of geographical clustering as a response to collective learning and knowledge-sharing between firms (e.g., Malmberg and

Maskell 2002) argue essentially that knowledge activities cluster in response to positive local externalities. Geographical proximity and institutional characteristics make information networks leaky and yield spillover effects (Almeida and Kogut 1999; Jaffe et al. 1993; Owen-Smith and Powell 2004). This clustering, however, has an opportunity cost that results from context redundancy: Basing all of a firm's knowledge on a similar socioeconomic context sacrifices diversity. Knowledge concentrated in one pool may circulate smoothly but entails the risk of long-term lock-in and a decline in innovativeness (Bathelt et al. 2004; Lazer and Friedman 2007).

When a firm's resources are completely scattered across space, the opposite advantage is apparent—knowledge diversity. I argue that the principle of geographical separation is a potential source of diversity. When expertise is constantly reused in different contexts, the variance in contextuality enhances the likelihood that new knowledge will be generated. Geographical separation may thus be conducive to innovation. In particular, the advantages of diversity through geographical knowledge distribution are even more pronounced when expertise is produced and transformed in client interaction than when it is developed in internal laboratory research. In business services, different social, institutional, cognitive, and material contexts provide fertile ground for the emergence of distinct solutions. The fact that firms work intensely at localized client sites spreads learning opportunity over different places and makes every project location a learning site for distinct expertise. Though much of the localized expertise may not be applicable in other contexts, some of it may well help improve problem-solving capabilities in other locations. And even if localized expertise does not directly solve problems in other locations, it may still be valuable when recombined with other localized expertise to produce new knowledge. Though research is often a planned and goal-directed process, many innovations are the result of unintended research output.

Theoretically, even knowledge that is useless in one context may become useful in another. In the late 1980s, when Pfizer, a leading research-based pharmaceutical company, committed its research to the development of a drug for the treatment of angina, the firm's scientists actually found what came to be called Viagra. They failed to cure angina but offered side effects that were conducive to successful commercialization (Chesbrough 2003). However, few organizations are prepared to process such false negatives and therefore leave unintended benefits unpursued. Unlike technology development in closed, permanent laboratory locations that are capital-intensive and long-term, client-driven knowledge services change place by virtue of client location because projects in business services are far more short-termed and geographically more flexible. Hence, an organization that offers specialist expertise to develop customized solutions for specific problems greatly benefits from its ability, first, to make localized knowledge available in other locations and, second, to recombine localized knowledge from different places in order to accumulate expertise and generate innovation. According to Porter's (1986) notion of global markets, knowledge transfer represents one of only a few strategic opportunities to attain global competitive advantage. The downside of the geographical distribution of organizational units, however, is the cost of maintaining organization-wide comprehension and circulation of knowledge. Lost profit is the opportunity cost

of failing to transfer appropriate localized knowledge to other contexts where it can be reutilized and recombined.

In summary, the more geographically diverse a knowledge base becomes, the greater its innovation potential is, but the more costly it is to circulate, reuse, and recombine that distributed knowledge. Should an organization become too dispersed, it may lose its coherence, its ability to interpret and communicate distributed knowledge: "[T]oo wide a dispersion of R&D activities may give rise to leakage of corporate coherence" (Blanc and Sierra 1999, p. 200). The organization would break up into a set of separate knowledge islands. As in the exploitation–exploration problem (March 1991), the knowledge firm has to allocate its resources within a mix of geographical distribution and organizational coherence of its knowledge and learning activities. Ideally, for each investment at a given degree of geographical distribution and a given regime of knowledge circulation, the firm has to decide how an additional investment will pay off better than a different one: Should it set up another geographical unit or rather enhance interunit communication? This chapter explores the case of MILECS, a knowledge-intensive technology consulting firm that largely depends on the accumulation and reutilization of tacit knowledge and individual expertise to gain competitive advantage. The trade-off between geographical distribution and organizational coherence will be used as a conceptual framework for assessing the knowledge architecture of this business.

## *Know-Who: Networks of Personal Knowledge Transfer*

Having defined the trade-off between coherence and diversity, I now turn to mechanisms that facilitate the transfer of knowledge between distinct organizational units of a firm. Lundvall and Johnson's (1994) fourfold typology of economically relevant knowledge has often been used to discuss the differences between know-what and know-why on the one hand and know-how on the other. The former two are in principal codifiable, but know-how is hard or sometimes impossible to codify. Know-how refers to tacit knowledge, to the procedural knowledge of knowing how to use know-what for certain purposes. It both defines and is defined by social context (Gertler and Vinodrai 2005). Given its collective constitution and socially specific meaning, one of the key challenges is its transfer within an organization (Gertler 2003). The fourth type of knowledge—know-who, the social relationships that enable people to retrieve know-how and to enhance their learning process (Borgatti and Cross 2003)—has received only limited attention in current research. Empirically, however, organizational learning is fundamentally a function of know-who. As with know-how, know-who cannot be traded. Or as Lundvall and Johnson (1994) argue, "you cannot buy trust, and if you could buy it, it would be of little value" (p. 29).

Consequently, if one is to analyze the transfer of inimitable, valuable expertise within an organization but across different geographical locations, it is necessary to understand the underlying architecture of interpersonal relations through which that

expertise is channeled (Argote et al. 2003). Empirically, the observed structure of communication frequently diverges from the schematic patterns in formal organization charts (Krackhardt and Hanson 1993). People have different kinds of dyadic relations between them. Some may be arduous and barren while others are intimate and fertile (Szulanski 1996; Szulanski and Jensen 2004). Apart from the quality of an individual relationship, the structure of the overall set of relations in and between organizational units also affects the ease of knowledge transfer. Closed and redundant communication structures tend to reiterate existing knowledge instead of absorbing external knowledge (Bathelt et al. 2004; Grabher 1993). At the other extreme, completely open and noncoherent networks are just as deficient, for they cannot process and collectively transform new knowledge into innovative products. Every organization thus has to find a specific mode of organizational communication that ensures coherent internal knowledge development and exchange as well as sufficient interface with the environment, be it intra- or interfirm. Economically, this problem is nontrivial. Every commitment assigned to other units or locations of a firm reduces the actual commitment to one's own unit. Because network relations require resources to be maintained, interunit relations are costly. Consequently, knowledge transfer needs to convey benefits that compensate the costs of diversified commitments (Hansen 1999). In what follows, this chapter ventures into the microworld of personal knowledge transfer in globally distributed workplaces. In the context of MILECS, two motives drive this research. The first one is to visualize the company's knowledge "architecture" (Amin and Cohendet 2004) as represented by the personal exchange relations of the employees and to find ways to assess its degree of connectedness or vulnerability. The second motive behind the empirical analysis is to assess the effectiveness that selected management programs have on international intrafirm knowledge transfer.

## The Case of MILECS

MILECS was founded as an engineering service firm in the early 1970s and, in its initial years, grew primarily with the help of a few international clients upon whom it piggybacked into its first international markets. When the company had become established, the founder promoted a partnership governance model and began to sell stakes to his senior colleagues. The company opened a few European offices during the 1980s, and its process of internationalization accelerated in the 1990s when it launched operations in Latin America, India, and the United States together with some minor offices to represent the company. Given the company's limited size and extended geographical dispersion, the management of knowledge transfer soon became a key issue. At the annual partners' meeting in 1997, MILECS founded a holding company dedicated to collecting and redistributing the funds necessary for development of an international organization between the local offices. Every national subsidiary had to pay an annual contribution and report financial results to the holding company. In turn, the holding company set up international training

programs and other forms of corporate communication (e.g., a newsletter). The training programs soon became a key element of MILECS's approach to global quality and knowledge transfer: "The backbone of our company is a global training system, which is the same for all employees world-wide. These training programs cover all areas of competence in the firm. They bring people together from all offices and help create the networks for tomorrow" (Senior Partner, Frankfurt, August 7, 2001).[2]

At the same annual meeting, the partners decided to launch a computer-mediated knowledge management system (KMS), which soon went online. Additional staff was recruited to operate the system, which offered a variety of information services: biographical data on employees; a project directory with detailed documentation, literature, tools, and software; a global newsletter; and chat and e-mail services for the worldwide knowledge exchange between the employees. By 2000, the company had grown to include 30 partners and more than 200 consultants. With management decisions among the many owners becoming ever more ponderous, and with the New Economy hype having climaxed, the management board decided to sell the company to a publicly traded software company that had massively expanded by merger and acquisition with a market capitalization of over 1.5 billion euros. Though the founders of the two firms were long acquainted and had repeatedly worked together on projects, the decision proved disastrous. When the bubble in the New Economy burst only a few months later, the investor went bankrupt, burning MILECS's capital reserves entirely.

In 2003 the MILECS partners somehow managed to redeem their stakes and thereby prevented the company from exiting the market. Struggling for survival, the management had to install a rough cost control regime and cut down on all forms of international support by the organization. This intervention had far-reaching consequences. First, the firm halved its costs; slimmed down the holding structure; and relinquished cost, profit, and investment autonomy to the international subsidiaries. Second, it froze programs on international knowledge transfer, such as international training for novices, practice-group meetings of leading experts, and even softer forms of knowledge exchange like the global newsletter. Training programs and meetings were conducted nationally, if at all. Third, MILECS stopped delegating senior staff to overseas operations and thus impeded the transfer of business and management know-how. Fourth, the company abandoned the KMS by laying off the responsible administrators and converting it into a mere project archive. An external assessment of the KMS had proven its limited value for knowledge transfer, concluding that people neither liked to search the database nor wanted to give it their professional commitment. Instead, the system served as the internal yellow pages to retrieve information about reference projects and the colleagues responsible for them. In sum, each national subsidiary was treated overnight as an independent business. The legacy of this intervention is apparent today: "When we managed to buy the company back, we were urged to control costs and cease the support for internal exchange across offices … Today we have consolidated financially, but we don't benefit from our internationality" (CEO, Frankfurt, June 9, 2005).

This self-inflicted crisis was compounded by a generational shift in which many of the most senior partners retired, divesting the company of many established client accounts. By 2005, 2 years after the company's turnaround, MILECS had

consolidated with around 190 employees worldwide and aimed to assess its competitive position in the marketplace. Although the CEO acknowledged the firm's unique international presence vis-à-vis competitors, he found that MILECS did not make any economic use of its internationality. It neither circulated and reused its distributed expertise nor economized on cross-selling opportunities afforded by local access to global client accounts in other markets. The CEO affirmed that "we never wanted to be the largest player; we have always been striving for quality and technology leadership." To increase the value-added that the company enjoyed by virtue of its internationality, the holding management and the global advisory board decided to relaunch the promotion of international knowledge transfer, an idea seriously desired by the rest of the company.

## Data and Methods

Having largely consolidated after the major financial crisis described in the previous section, the company started to assess its state of internationality so that it could commit resources to a global integration of its knowledge and expertise. That context yielded the opportunity for the research reported in this chapter and made it possible to carry out an organization-wide survey on interpersonal knowledge transfer. One of the crucial motives for analyzing the knowledge flow in an organization was to study generic social relationships, research that entailed adoption of a survey method to generate primary observations of dyadic knowledge exchange. The company management, with which I had established contact in 2001, agreed to take part in the research and provided full support. The survey took place in the autumn of 2005 and elicited responses from 129 employees (response rate: 69 %). Most of the 58 individuals who did not participate were support staff or novices in their first year with the company, who, by agreement with the company management, were not invited to complete the questionnaire. In other words, the real response rate exceeded 75 % of the employees. Under conditions of imperfect data, it has been shown that the correlation between real and observed measures of most centrality indicators converges to 1 as the size of the sample increases. When the sample covers 70 % or more of the population, the correlation coefficients for almost all measures are 0.8 or higher (Costenbader and Valente 2003). By and large, network measures of centrality are relatively robust against random network disruptions and imperfect data (Borgatti et al. 2006).

The dependent variable was the personal knowledge-exchange relation between all pairs of employees within the company. To distinguish between information transfer and the transfer of know-how, the two relevant questions were formulated as follows:

1. Information—How important is this person for you to learn about news, events, and work-related information? Note: Information is different from knowledge and advice. Please concentrate only on the person's contribution to your information provision and not on their impact on your learning effects and expertise generation.

2. Know-how—How effective has this person been in giving you professional advice and in thinking through challenging problems at work? Note: Please concentrate on the person's contribution to the development of your professional skills, experience, and expertise by giving advice or collaborating with you and not on the transmission of mere information only.

In the context of the empirical research, however, the employees themselves did not make significant distinctions between these concepts. Both variables were correlated at $r = 0.88$. In the empirical analysis these observations serve as a basis for two measures. First, a visualization technique uses the raw data of interpersonal knowledge exchange to identify the structure of the overall corporate knowledge network and to assess the vulnerability of its structural cohesion (see next section). The second analysis examines the effect that different management programs have on the geographical profile of knowledge exchange for each employee (see the section on spanning boundaries, below). The geographical profile of an employee is represented by the E-I Index (Krackhardt and Stern 1988),

$$\text{E-I Index} = (EL - IL) \div (EL + IL),$$

where *EL* are external linkages and *IL* are internal linkages. The index expresses the proportion of a person's relationships with members of other groups (meaning *offices* in this study). One calculates the index by subtracting the number of internal ties (those within the same office) from the number of external ties (those in other offices) and dividing the difference by the sum of all ties.

## How Vulnerable Is the MILECS Knowledge Network?

The MILECS knowledge network has one main component of 123 employees and six further isolated individuals who are disconnected from the network. These 123 employees reported a total of 956 intensive knowledge-exchange relations, corresponding to a network density of 5.8 % (see Table 6.1). Within the main component the average path length between any two employees was 3.1 steps. The longest geodesic was 7, meaning that there were 9 relations whose longest geodesic captured 6 intermediate contacts between them. Ten percent of pairs of employees were only mutually connected at a path length of five (that is, there were at least four intermediaries between them). Nearly 40 % of all pairs had at least three intermediaries between them. On the whole, the distance-based degree of fragmentation approximated the maximum value of one (*fragmentation* = 0.656).

**Table 6.1** Descriptive statistics on the MILECS knowledge network

| Network measures | Mean | SD | Max | Sum |
|---|---|---|---|---|
| Degree | 7.411 | 6.203 | 39 | 956 |
| Density | 0.058 | 0.234 | | 956 |
| Geodesics (paths) | 3.119 | 1.108 | 7 | 15,006 |

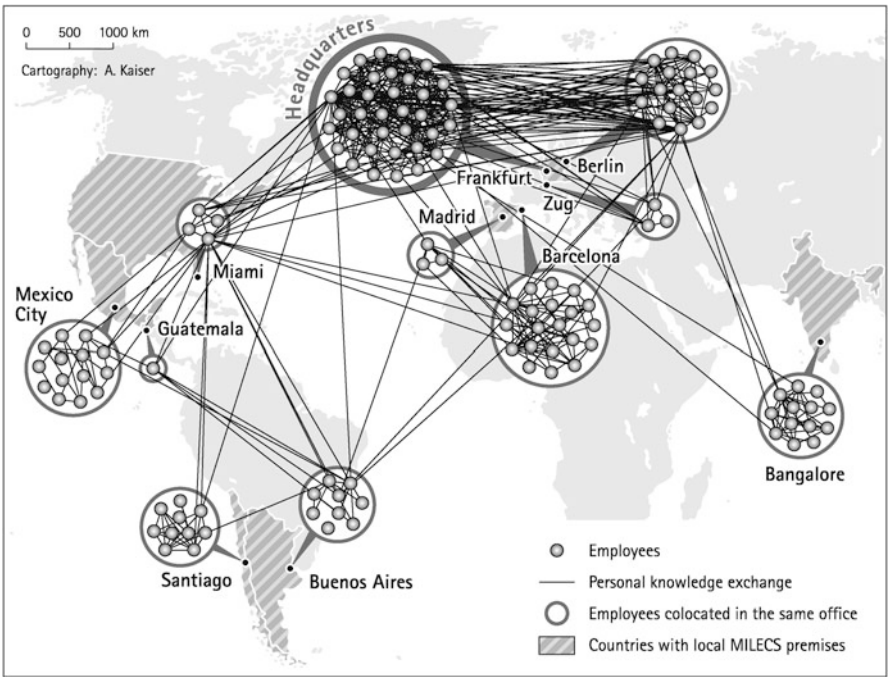


**Fig. 6.1** The knowledge-transfer network of MILECS

Apart from the obvious density of interpersonal exchange within local offices, there were numerous personal knowledge linkages that qualified as important sources of advice and expertise. Generally, every office was linked to at least two other offices in the corporate network. The densest interpersonal exchange linkage existed between the two German offices, where linkages within and between offices seemed equally developed (see Fig. 6.1). If one were to remove these two offices from the network, the result would be the perfect picture of a network suited to customized response conditions (Cross et al. 2005). However, the level of exchange between the Frankfurt and Berlin offices clearly surpassed that between the other offices, which were much more focused on local knowledge circulation.

How vulnerable is the knowledge network of MILECS? Of the several structural problems that Krackhardt and Hanson (1993) identify in specific networks, three are particularly interesting in this context. Networks may suffer from "imploded relationships" (p. 110) as the result of communication remaining solely within a department, or they may be saddled with a "fragile structure" (p. 111), a condition in which a highly coherent group maintains only one strong external communication link with one other group instead of many groups. Networks may suffer from "bow ties" (p. 111), configurations in which many employees depend on one single person rather than on each other and in which that one person controls the communication flow. Using these concepts for an initial graphical assessment makes some

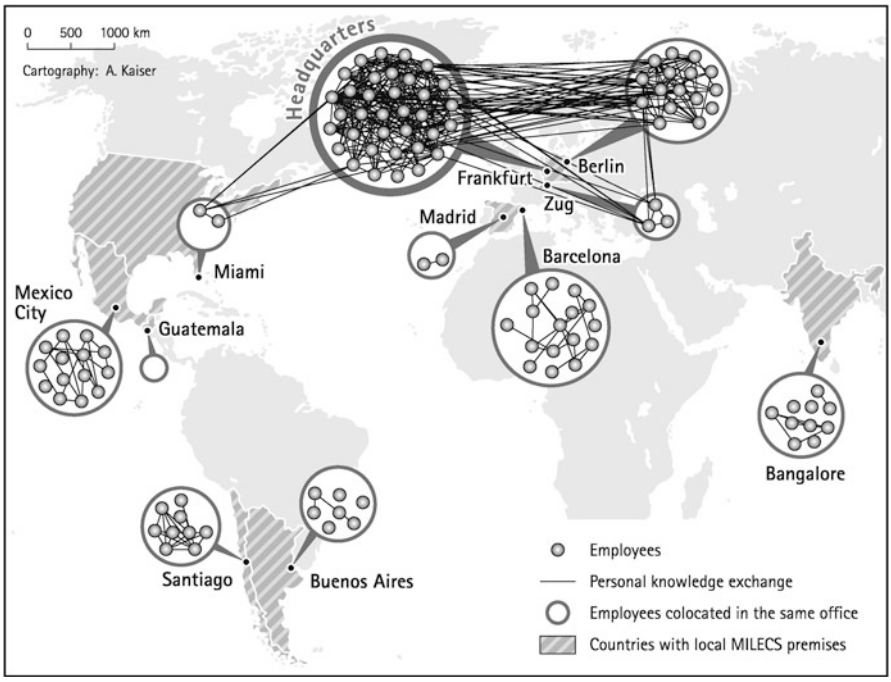


**Fig. 6.2** The same MILECS knowledge-transfer network modeled without 15 key individuals

of the problems evident. MILECS offices in Mexico, Argentina, Chile, and India were rich in local interconnection but rather weak in international knowledge transfer. Their international linkages concentrated mostly on one or a few bow ties as defined by Krackhardt and Hanson (1993).

So what makes this company different from a set of independent, nationally operating firms? The answer is 15 people. If the most important boundary spanners are removed one after another, the international knowledge architecture of MILECS breaks into eight separate knowledge islands (see Fig. 6.2). A knowledge perspective of the firm, therefore, highlights vulnerability and lack of cohesion with respect to the reutilization of the company's core asset. The global organization of this expertise-based service firm depends crucially on only a few individuals who bridge the distinct islands of expertise. These islands are internally connected networks of colleagues who share local knowledge in multiple ways with each other. However, they rely on only one or very few individuals who manage the circulation of expertise and who see to knowledge provision from the other parts of the organization. As long as these boundary spanners accomplish their task of mobilizing expertise between the geographical units of the organization, the knowledge base becomes somewhat accessible and globally reusable. Given the highly fragile structure of knowledge flow, however, the organization runs the risk of forgoing profits simply because it keeps expertise disconnected between the units.

This empirical example highlights the managerial trade-off between geographical diversity and knowledge cohesion. MILECS seems to have overdeveloped its geographical diversity at the cost of knowledge cohesion between the various units of the organization. The general picture of MILECS is not the same for all units, however. The knowledge transfer between the four German-speaking offices in Germany, Switzerland, and the United States cannot be separated even by omitting the most influential employees. In these cases interoffice transfer seems to have developed far more robustly than in the predominantly Spanish-speaking offices. Describing and looking at the visual representation of a network tells something about the vulnerability and overall design of international knowledge transfer.

## What Can an Organization Do to Span the Boundaries?

What kind of management intervention may be appropriate to enhance interoffice knowledge transfer? The extent to which an employee is involved in interoffice knowledge exchange is expressed by the value of his or her E-I index—the relative commitment of that person's set of personal relations to people outside his or her own office. MILECS supports a number of components to facilitate international knowledge transfer, of which three are highlighted in this research. The first of them is training, which measures the number of global training programs in which an employee has taken part. Sixty-eight employees had gone through anywhere from one to thirty international training programs (mean, 4.64). The second component is projects, a dummy variable that captures the assignment to international projects involving the collaboration with colleagues from offices in other countries. In sum, 49 individuals (38 %) reported that they had collaborated internationally. The third component is expatriation, a dummy variable that measures the assignment of an employee to another office for a minimum of 2 months. Thirty-one employees (24 %) reported that they had been assigned abroad for periods longer than 2 months. In addition to these individual management programs, a combined measure called program diversity is used in this chapter to reflect an employee's inclination to make international corporate contacts. It counts the number of different programs (training, project, and expatriation) in which an employee took part.

I also looked at individuals' attitudes toward other locations. The variable called local focus measured the degree to which employees reported full satisfaction about the availability and quality of knowledge in their own office. Local focus was calculated as the average score on a six-point scale ranging from 1 (*disagree*) to 6 (*agree*) measuring the degree of agreement with four statements: (a) The information I can get from colleagues within my office as compared with other offices is first rate and fully sufficient. (b) The expertise I can call on from colleagues at my office as compared with other offices is first rate and fully sufficient. (c) I can find within my office all the contacts and information necessary to win a new client account. (d) The intranet central project documentation (CPD) service is very effective for my work.

**Table 6.2** OLS regression coefficients for predicting knowledge transfer across offices (external-internal index of each employee)

| Independent variables | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
|---|---|---|---|---|---|---|
| Intercept | –0.665*** | –0.633*** | –0.657*** | –0.833*** | –0.191*** | –0.552*** |
| Expatriation | 0.387*** | | | | | 0.218* |
| Projects | | 0.002*** | | | | 0.000 |
| Training | | | 0.0189*** | | | –0.000 |
| Program diversity | | | | 0.157*** | | 0.085* |
| Local focus | | | | | –0.099** | –0.061 |
| $R^2$ | 0.118 | 0.068 | 0.063 | 0.137 | 0.041 | 0.189 |
| Adjusted $R^2$ | 0.104 | 0.053 | 0.049 | 0.124 | 0.026 | 0.150 |
| ($p$) | 0.000 | 0.002 | 0.007 | 0.000 | 0.024 | 0.029 |

* $p<0.1$; ** $p<0.05$; ***$p<0.01$; 129 observations

The effectiveness of the programs on interoffice knowledge transfer was tested by means of simple OLS regression models (see Table 6.2). In the bivariate regression models 1 through 3, all three forms of international encounter were conducive to an individual's future inclination to maintain interoffice knowledge transfer. By far the most effective way to ensure long-term knowledge transfer between geographically separated experts was to assign employees to foreign offices for a period of time (expatriation). International office deployment explained 10 % of an individual's E-I value in the structure of the company's knowledge transfer. Lastly, the mix of measures (program diversity) seems to have been the most conducive to interoffice knowledge relations. Individuals who had experienced office deployment, international project work, and global training were more likely to have pronounced international involvement in knowledge transfer than other employees were. The diversity of international experience accounted for 12.5 % of overall variance in the dependent variable (Model 4). Local focus seemed to hamper internationally oriented knowledge transfer. Model 5 demonstrated that the more an employee was satisfied with local resources, the less inclined that individual was to maintain interoffice knowledge transfer with employees in other offices. This isolated effect, however, became insignificant in the multivariate model (Model 6).

## Conclusion

I have used a corporate case study to explore the structural foundations of international intrafirm knowledge transfer in an industry of knowledge-intensive expert technology services. The case of MILECS has been especially interesting because that medium-sized company is characterized by pronounced geographical dispersion across four continents and by a severe prior corporate crisis that had forced the management to cease all support for international administration and

knowledge management. This research started to provide a diagnosis of the company's knowledge architecture at a time when MILECS was recovering and its leaders were thinking about ways to gain advantage from its global presence. By surveying the entire organization and using methods of social network analysis, I have given insight into the structural aspects of a network for corporate knowledge transfer. As induced by the survey used in the study, the exchange of knowledge focused on problem-solving expertise among colleagues. The knowledge network therefore tended to reflect intraorganizational practices of knowledge exploitation rather than of knowledge exploration.

Visual analysis showed the MILECS knowledge network to be relatively vulnerable as a consequence of many bow ties between offices. Interoffice communication was channeled and mediated by only a handful of key boundary spanners. The difference between a global company and a set of nationally separated knowledge islands was only 15 individuals. It was also found that international knowledge transfer can be enforced and intensified by expatriation programs. Employees who had been deployed to other offices for relatively long periods (usually from several months to 2 years) or who had taken part in various programs involving international contact clearly contributed to the international transfer of knowledge within the company, and their communication had a stronger international orientation than did that of employees who had not experienced such development. Apart from the immediate effect of these measures, their *long*-term influence helps sustain international knowledge transfer.

The interpretation of what these findings mean for corporate strategy is somewhat limited because the detected vulnerability of the knowledge network cannot yet be assessed against reference networks. It remains for future research to identify firm-specific characteristics of variation in network vulnerability and to develop a rationale for evaluating appropriate degrees of robustness in global knowledge networks. Moreover, it would be instructive to take the discrete cases of personal knowledge transfer documented in this survey and link them with archival data about real collaboration in joint projects. Unfortunately, the company could not provide the records needed for this insight into historical patterns of collaboration. Future research that associates survey data with project collaboration will sharpen the understanding of the effects that project staffing policies have on long-term international knowledge exchange.

Lastly, the trade-off between organizational coherence and the knowledge diversity afforded by geographical separation builds a suitable framework for measuring the commitment to corporate knowledge management. This framework weighs the value of knowledge circulation against the value of continuous global expansion and thus emphasizes effective internal knowledge architectures in transnational firms. A knowledge architecture based on the effects of bottlenecks between unconnected knowledge pools is more likely to yield private returns to the boundary spanners and to incur substantial losses from failure to reuse knowledge than it is to produce collective returns to the organization as a whole. Unfortunately, lack of comparative research on this topic currently does not permit the network vulnerability at MILECS to be benchmarked against either normative or empirically assessed

best practices. Organizations that depend on client interaction to generate new knowledge are bound to geographically dispersed learning and should therefore commit substantial intelligence and resources to the effective circulation of expertise within their particular organizational geographies.

## Notes

1. MILECS is a pseudonym for a medium-sized German engineering company dedicated to engineering planning and consulting services in strategy and technology.
2. This quotation and all subsequent ones in this chapter have been translated from German.

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# Part II
# Knowledge and Economic Development

# Chapter 7
# Knowledge, Capabilities, and the Poverty Trap: The Complex Interplay Between Technological, Social, and Geographical Factors

**Jan Fagerberg and Martin Srholec**

For a long time many economists believed that economic catch-up was mainly a question of investing sufficiently in machinery and other tangible factors. At least this was the main message that could be derived from the dominant theory of economic growth, the so-called neoclassical theory, developed in the 1950s by Solow (1956) and others (see Fagerberg 1994, for an extended discussion). Moreover, the theory was based on the assumption that the returns to capital accumulation would be higher in poor environments than in rich ones, an idea that led to the prediction that poor countries under otherwise equal conditions will have higher rates of investment and economic growth than rich countries. Hence, following this line of thinking, economic development should be easy.

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In reality it has not been so easy, as evidenced by the lack of convergence in gross domestic product (GDP) per capita between rich and poor countries during the last few decades (Fagerberg and Srholec 2005). In fact, the gap in productivity and income between the poorest and the wealthiest countries in the world is much wider today than it was a few centuries ago (Landes 1998). As acknowledgment of this evidence spread, the received wisdom about economic catch-up started to be questioned, and new theories emerged focusing on intangibles such as knowledge, learning, innovation, and human capital as the drivers of growth and development (Aghion and Howitt 1992; Lucas 1988; Romer 1990). The proponents of these approaches hold that the failure of many poor countries to develop and catch up with the wealthy ones should not be seen primarily as the result of inadequate investment in physical capital. Rather, the problem is assumed to relate to a lack of ability in these countries to exploit the worldwide pool of knowledge to their own benefit.

Arguably, this change of focus has given birth to more questions than answers. For example, why is it that many poor countries do not succeed in exploiting knowledge to increase productivity and welfare? What are the critical capabilities that poor countries need to develop in order to succeed? In the first section we consider some of the existing literature on this issue and outline a strategy for how to deal with it empirically. That discussion leads, in the second section, to the detection of a set of empirical indicators reflecting the capabilities that have been recognized in the literature as important for development. We also take into account the possibility that these capabilities (and their impact) may be conditioned by historically given factors of geography, demography, and history, to name but a few. We apply factor analysis to find out how these variables interrelate and to explore their relationship with economic development. In the final section we consider the lessons from this exercise.

## Lessons from the Literature[1]

Some of the first systematic attempts to study the relationships between technology, capabilities, and development were made by economic historians who wanted to understand why some countries managed to catch up with the affluent ones while other countries continued to be poor. Half a century ago, Gerschenkron (1962) pointed out that technological catch-up, although potentially highly lucrative, is also extremely challenging. He saw these difficulties as resulting from the cumulative nature of technological advance: With time, the sophistication and scale of technology have increased, making entry more demanding than in the past. Based on a study of the performance of a number of European countries relative to the then leading country—Great Britain—his conclusion was that, to succeed in technological catch-up, less advanced countries had to develop what he called "new institutional instruments" (p. 7), such as organizations capable of identifying the most promising options and of mustering the necessary resources for exploiting these opportunities.[2]

More recently, the view that technological catch-up by late-comers is far from easy has received further backing from a series of empirical studies of industrialization processes in Asia and Latin America (Dahlman et al. 1987; Fransman 1982;

Fransman and King 1984; Kim 1980; Lall 1987). One prominent case is Korea's rise from the ranks of the world's poorest countries to its present status as a First-World technological powerhouse in just three decades. Linsu Kim, who made the authoritative study on the subject, suggested the concept of "technological capability" (Kim 1980, p. 260, 1997) as an analytical device with which to interpret the Korean evidence. He defined it as "the ability to make effective use of technological knowledge in efforts to assimilate, use, adapt, and change existing technologies" (Kim 1997, p. 4).[3] Hence, technological capability includes not only organized research and development (R&D), which arguably is a small activity in many developing countries, but also other capabilities needed for the commercial exploitation of technology. As has become common in the literature, he considered three aspects: production capability, investment capability, and innovation capability. Kim's assessment was that the requirements should be expected to become more stringent, in particular with respect to innovation capabilities, as countries climb up the development ladder. Thus, for a firm or country in the process of catching up, the appropriate level of technological capability is a moving target.

The concept of technological capability has since been used in numerous studies at various levels of aggregation (for overviews see Figueiredo 2006; Romijn 1999). Although initially developed for analyses of firms, it has also been applied to industries and countries. Lall (1992) called attention to three aspects of "national technological capability," as he phrased it (pp. 169–172): the ability to muster the necessary financial resources and use them efficiently; skills, meaning not only general education but also specialized managerial and technical competence; and what he called "national technological effort" (p. 170), which he associated with measures such as R&D, patents, and technical personnel.[4]

Other writers have expanded the perspective to include additional economic, social, cultural, institutional, and political variables. Abramovitz (1986), building on Ohkawa and Rosovsky (1974), used the term *social capability* (p. 387) as a shorthand for such factors. What he had in mind was not only individual skills, as important as these may be, but also what organizations in the private and public sectors are capable of doing and how this is supported (or hampered) by broad societal factors. Abramovitz (1994a, b) particularly emphasized the significance of managerial and technical competence; a stable and effective government capable of supporting economic growth; financial institutions and markets capable of mobilizing capital on a large scale; and the spread of honesty and trust in the population.

The fact that social and cultural factors such as trust may matter for economic development has long been widely accepted.[5] More than 40 years ago, Irma Adelman and Cynthia Morris (1965, 1967), on the basis of an in-depth study of multiple indicators of development in a large number of countries, concluded that "the purely economic performance of a community is strongly conditioned by the social and political setting in which economic activity takes place" (Adelman and Morris 1965, p. 578). They saw economic development as contingent on relatively broad social and political changes accompanying the transition from traditional (rural) ways of life based on a high degree of self-sufficiency to a modern industrialized society characterized by market relationships and new forms of institutions and governance. In a more recent analysis aimed at explaining the difference in levels of development

between two Italian regions, Putnam (1993) argued that the gap had to do with different capacities for responding to social and economic challenges through appropriate forms of collective action, or "social capital," as he put it (p. 167), using an already established sociological term.[6] This contributed to a rapidly increasing body of research on the role of social capital in development (see Woolcock and Narayan 2000).

Although the relevance of such broad social and cultural factors is generally acknowledged, the question of how to research this issue empirically remains a great challenge. Adelman and Morris (1965, 1967), in their initial take on it, sought to identify and measure a wide set of indicators (22 in total) of economic, social, and political modernization, drawing on a number of different sources. They then used factor analysis to explore the relationships between these various indicators. It was shown that the variation in the data could be reduced to four common factors. The most important of them consisted of an amalgam of structural aspects (e.g., share of agriculture and urbanization), socioeconomic characteristics (e.g., role of the middle class, social mobility, and literacy), and the development of mass communication (measured by the spread of newspapers and radios in the population). Temple and Johnson (1998), who replicated Adelman and Morris's study on more recent data, suggested using this factor as a measure for what they called "social development" (p. 966), which in their view embraced both "social capability" and "social capital." They demonstrated that the measure has considerable explanatory power for growth performance. The empirical support notwithstanding, the "development" variable championed by Temple and Johnson is clearly a mixed bag including several aspects, such as indicators reflecting the structural composition of the economy, that arguably have little to do with "social" factors. Furthermore, many new data sources on various aspects of development have become available—including the "World Values Survey" (World Values Survey Association 2006)—since Adelman and Morris's original selection of indicators. It seems reasonable to take these new sources into account in the design of the following analysis, which we discuss in more detail in the next section.

## Data and Analysis

In this section we first consider how the theoretical concepts discussed in the literature (e.g., technological capability, social capability, and social capital) can be measured. We then use factor analysis to explore the interrelationships between technological, social, cultural, political, and other aspects of development.

For the purpose of the analysis, we have collected from various sources data on 40 indicators and 80 countries at different levels of development (see Appendixes A and B for definitions, details on sources and the estimation procedure, and the names of the countries included). Because the time series for many relevant indicators are short, our focus is on recent evidence. In an attempt to increase coverage across countries and limit the influence of shocks and measurement errors occurring

in specific years, we have measured most indicators as 5-year averages (2000–2004). Nevertheless, there were some missing data that had to be estimated.

What we need to do is to identify measureable aspects of the various capabilities discussed in the previous section and analyze how they interrelate. Technological capabilities we define, in the spirit of Kim (1997), as the ability to search for, create, and use knowledge commercially. The term thus includes not only the ability to create "new-to-the-world inventions" (Furman et al. 2002, p. 899) but also to make minor improvements and adaptations to local conditions, which may not be equally glamorous but which may matter a great deal economically. It therefore covers what Kim (1997) called "innovation" capabilities (p. 6) as well as abilities related to organization, production, and commercialization—what he and others had in mind with their emphasis on the "production" and "investment" aspects of technological capability.

The quality of a country's research base is represented by publications in scientific journals, international patent applications under the Patent Cooperation Treaty (PCT), and R&D expenditure. However, it is not enough to be aware of technological opportunities. They also need to be exploited in practice, and that requires competencies in production, marketing, and other operations. Adherence to quality standards formulated by the International Standards Organization (ISO) may be a good indicator in this respect. Although ISO certification is mainly procedural in nature, it is increasingly seen as a requirement for firms supplying high-quality markets and is therefore likely to reflect heavy emphasis on quality in production. We also include three indicators bearing on the use of information and communication technology (ICT): personal computers, internet users, and subscribers of fixed or mobile phones. Although earlier studies such as Lall (1992) did not accentuate this dimension much, a well-developed ICT infrastructure should now be regarded as a must for a country intent on catching up.

The important role that a country's financial system may play in the mobilization of resources for catching-up was pointed out by Gerschenkron (1962) and by more recent research as well (e.g., King and Levine 1993; Levine 1997; Levine and Zervos 1998). We capture this aspect by the amount of credit granted to the private sector and by the market capitalization of companies listed in domestic capital markets. Another important variable stressed by Abramovitz (1994a, b), for instance, and for which there is solid support in the literature, is skills (Barro 1991; Benhabib and Spiegel 1994; Nelson and Phelps 1966; for an overview see Krueger and Lindahl 2001). We include three such indicators: gross rates of enrollment in tertiary and secondary educational institutions, and the level of public expenditure on education.[7]

The quality of governance and institutions is generally acknowledged in the relevant literature as being important to providing incentives for economic agents to create and diffuse knowledge. Although such factors often defy "hard" measurement, especially in a broad cross-country comparison, there exist some survey-based measures, often collected by international organizations, that may throw light on these issues. We find it useful to distinguish between, on the one hand, the "quality of governance" with respect to innovation and economic life in general and the

character of the political system on the other hand. For the former we use survey data reflecting the existence and enforcement of property rights and the perceived extent of corruption, of law and order, of trust in the judicial system's independence, and of the respect for human rights, including women's rights. To measure the character of the political system, we also include variables reflecting the degree of democracy and autocracy, of checks and balances in the political system, of competition for executive and legislative office, of press freedom, and of political rights and civil liberties. Because western democracies tend to score high on most of the latter indicators, a possible interpretation is that the degree of a country's institutional "westernization" is what is being measured.

However, the impact of a government's actions (as well that of private actors) may, as pointed out by Abramovitz (1994b) and others, also depend on the prevailing social values in society. For example, lack of trust may make many socially desirable initiatives extremely difficult to realize. To take this possibility into account in the study, we include World Values Survey data reflecting the degree of trust among the citizens of a nation and the willingness to participate in civic activities. In addition to such measures of "social capital" (see Knack and Keefer 1997, for instance),[8] we also include variables measuring society's openness to people with different characteristics. Arguably, the ability of a country to engage all parts of the population in economically useful activities should be seen as a crucial factor in development.

In recent years a growing body of literature has focused on the extent to which economic development and factors associated with it are conditioned by exogenous factors beyond the control of people living today. Among the variables taken into account in such analyses are historical factors (Acemoglu et al. 2002); ethnic or religious diversity (Alesina et al. 2003; Bloom et al. 2003; Masters and McMillan 2001; Sachs et al. 2004); and aspects related to geography, nature, or both—such as climate, access to the sea, and exposure to diseases (Gallup et al. 1999). It is difficult to deny that such exogenous factors may be important for development, so it seems pertinent to try to incorporate them. Moreover, it is of interest to see whether they operate through the technological, political, social, and other factors considered in this chapter (by affecting capability formation) or whether they have a separate influence (in addition to other factors). Our analysis therefore includes a set of indicators for these kinds of exogenous variables. Historical factors refer to past choices that influence present outcomes whether or not people living today like it. We include the extent to which the given country has experienced armed conflicts in recent decades and the demographic composition of its population. Religion constitutes another set of factors that also may be seen as essentially historical. In our study it is expressed as the shares of the population that are accounted for by the major religions. We bring in the variable of geography by considering the proportion of a country's population living near the sea or navigable rivers, the population's exposure to natural disasters, and the share of the country's area located in the tropics. We also include the prevalence of various serious diseases that are at least partly associated with a country's geography, nature, and climate (malaria, tuberculosis, and HIV).

Table 7.1 outlines the indicators taken into account and contains results of the factor analysis. Three principal factors emerge, explaining 61.8 % of the total variance of the indicators. The first factor is strongly correlated with indicators reflecting R&D, patenting and scientific publications, ICT access or use, a well-developed financial sector, little corruption, a prevalence of law and order, and a well-functioning legal system. It correlates strongly also with a set of variables from the World Values Survey that reflect trust, the openness of society to parts of population with diverging characteristics, and the propensity to take part in civic activities. In addition, this factor loads highly on the share of Protestants in the population and moderately on education and human rights (see Table 7.1, below). Hence, it reflects both technological and social capabilities as traditionally defined, highlighting the strong interdependence between technological, social, and cultural factors in the process of development. We have opted to continue using the term *social capability* for this factor, noting, however, that this choice may be seen as a broadening of the definition.

The second factor correlates highly with the adoption of western-type institutions in the political sphere, a high share of Catholics and a low share of Muslims, and it correlates moderately with women's rights. This factor clearly reflects the prevalence of western values and institutions, so we call it "western democracy." The third factor correlates strongly with the fertility rate; the spread of malaria, tuberculosis, and HIV; and location in the tropics. It correlates moderately with a number of other indicators, too, the most important being low shares of tertiary and secondary school enrollment. This factor seems to reflect some of the mechanisms that continue to keep the poorest countries of the world at the bottom of the development ladder. We label this factor "the poverty trap."

Figures 7.1, 7.2, and 7.3 and Table 7.3 show the relationships between the three synthetic measures and economic development. Figure 7.1 plots our social-capability measure against GDP per capita. The high correlation between the two variables is conspicuous. More than 80 % of the variation in GDP per capita can be "explained" by the broadly defined social-capability measure. Arguably, developing such capabilities must be seen as a "must" for countries that wish to catch up. Analogously, Fig. 7.2 describes the relationship between our measure for western democracy and GDP per capita. As is evident from the graph, the pattern proves to be nonlinear.[9] For the poorest countries there is either a negative relationship or none at all between the degree of westernization of institutions and economic development, depending on whether Saudi Arabia is included in the analysis. For the richer countries in the sample, the curve is almost vertical, indicating that they all have western-type institutions independent of the level of GDP per capita. Only for a relatively small number of medium-income countries do we find evidence of a positive relationship. It may be possible to explain this pattern by positing democratization as an effect of economic development rather than a cause of it, but such conjecture is not something that we can conclusively test for with the present data. Figure 7.3 reports the relationship between GDP per capita and the poverty trap. In this case, too, the best fit is a nonlinear relationship.[10] As with the measure for "western democracy," the poverty-trap factor has no predictive power with respect to differences in GDP

**Table 7.1** Results of factor analysis (factor loadings)

| Indicators | Factor 1 Social capability | Factor 2 Western democracy | Factor 3 Poverty trap |
|---|---|---|---|
| Gross domestic expenditure on R&D | 0.84 | –0.03 | –0.05 |
| PCT international (patent) applications | 0.90 | –0.02 | 0.11 |
| Science & engineering articles | 0.92 | 0.05 | –0.03 |
| ISO 9000 certifications | 0.59 | 0.10 | –0.15 |
| Personal computers | 0.87 | 0.07 | –0.07 |
| Internet users | 0.79 | 0.14 | –0.15 |
| Fixed-line and mobile-phone subscribers | 0.64 | 0.22 | –0.33 |
| Tertiary school enrollment | 0.41 | 0.16 | –0.47 |
| Secondary school enrollment | 0.38 | 0.21 | –0.51 |
| Public expenditure on education | 0.54 | –0.01 | –0.05 |
| Domestic credit to private sector | 0.75 | –0.03 | –0.01 |
| Market capitalization of listed companies | 0.78 | –0.05 | 0.17 |
| Corruption perception | 0.86 | 0.08 | –0.13 |
| Law and order | 0.70 | –0.20 | –0.32 |
| Impartial courts | 0.89 | –0.10 | 0.05 |
| Property rights | 0.69 | 0.26 | –0.12 |
| Physical integrity human rights | 0.39 | 0.23 | –0.41 |
| Women's rights | 0.46 | 0.47 | –0.16 |
| Equal rights to a job for immigrants | 0.70 | –0.04 | 0.03 |
| Acceptance of homosexuality | 0.61 | 0.35 | –0.08 |
| Tolerance and respect for other people | 0.57 | 0.13 | 0.14 |
| Trust | 0.68 | –0.43 | –0.15 |
| Civic action | 0.61 | 0.13 | –0.10 |
| Political rights and civil liberties | 0.23 | 0.79 | –0.12 |
| Freedom of the press | 0.39 | 0.65 | –0.07 |
| Index of democracy and autocracy | 0.03 | 0.88 | –0.09 |
| Political constraint | 0.11 | 0.65 | –0.05 |
| Executive index of political competitiveness | –0.11 | 0.84 | 0.10 |
| Legislative index of political competitiveness | –0.12 | 0.78 | 0.06 |
| Protestant | 0.81 | 0.10 | 0.43 |
| Catholic | –0.26 | 0.56 | –0.07 |
| Muslim | –0.12 | –0.61 | –0.02 |
| Fertility | 0.11 | –0.26 | 0.75 |
| HIV prevalence | 0.11 | 0.09 | 0.65 |
| Tuberculosis prevalence | –0.14 | 0.02 | 0.80 |
| Malaria fatal risk | 0.06 | –0.02 | 0.86 |
| Land in geographical tropics | –0.12 | 0.12 | 0.67 |
| Population within 100 km (62 miles) of ice-free coast | 0.15 | 0.27 | –0.32 |
| Natural disasters | –0.31 | 0.00 | 0.42 |
| Armed conflicts | –0.21 | 0.07 | 0.30 |

*Note*. The number of observations is 80. Three factors with eigenvalue >1 were detected, which explain 61.8 % of total variance; extraction method: iterated principal factors; rotation: oblimin oblique

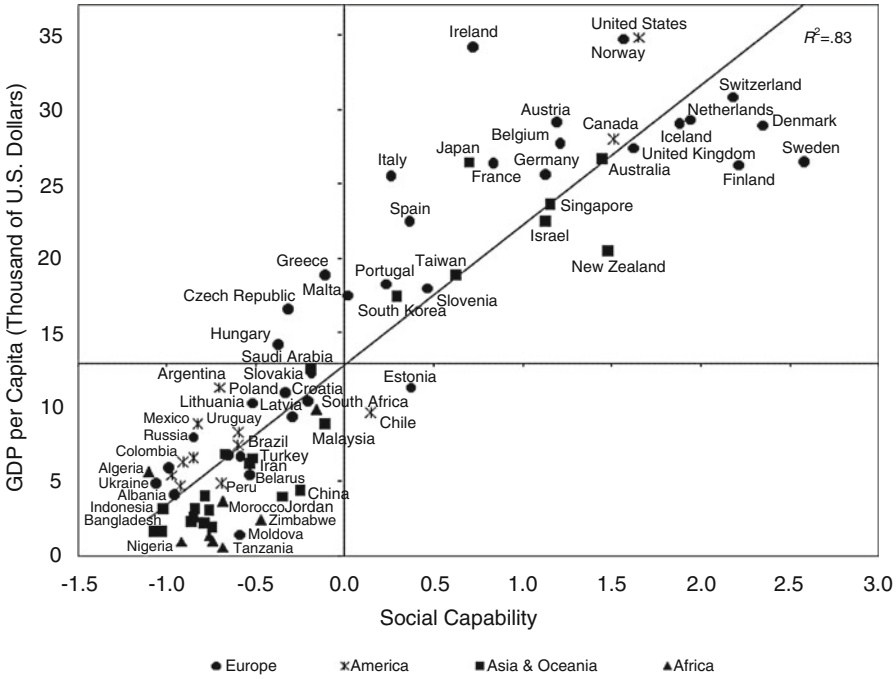


**Fig. 7.1** The relationship between the measure for social capability and GDP per capita

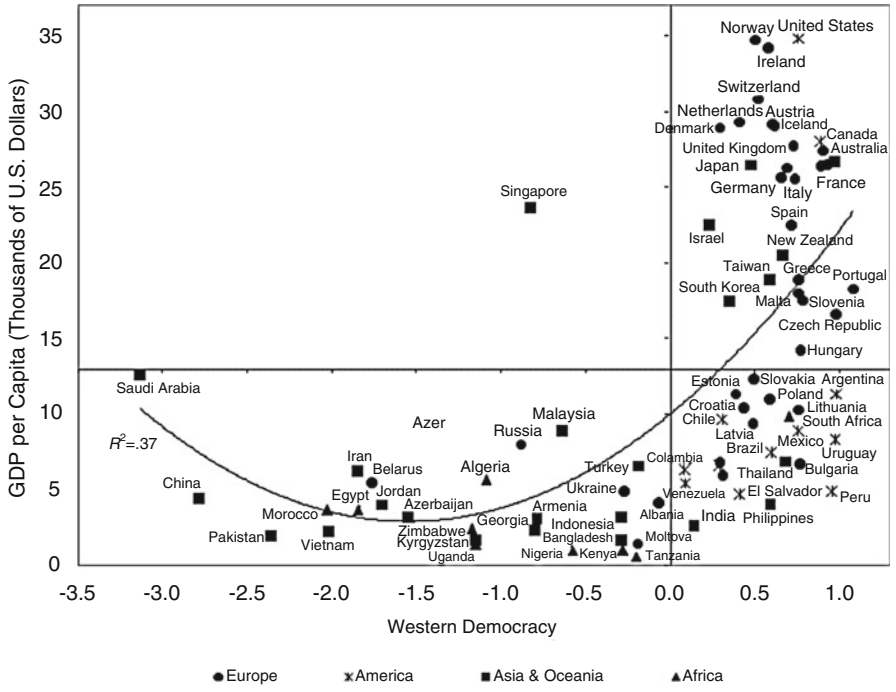


**Fig. 7.2** The relationship between the measure for western democracy and GDP per capita

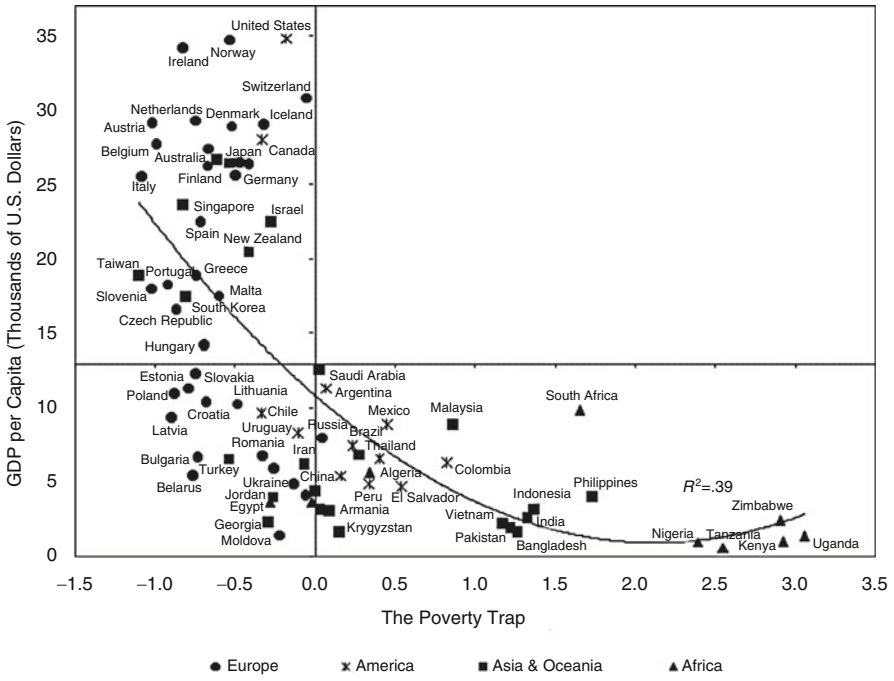


**Fig. 7.3** The relationship between the measure for the poverty trap and GDP per capita

per capita among already developed countries. But it has considerable explanatory potential for a limited number of poor countries in Africa and Asia. They are countries caught in the poverty trap. The combined effect of high fertility rates, low education, and high frequency of serious disease leads to a "vicious circle" that prevents these mostly tropical countries from finding their way out of poverty.

Most of the 11 indicators referring to geography, demography, and history factor out in the separate poverty-trap dimension. An exception is religion, whose influence on the two other principal factors—social capability and western democracy—is notable. As pointed out, social capability, which has the strongest correlation with economic development, has a strong positive correlation with the spread of Protestantism. This finding seems consistent with the arguments of Weber (1905/2002) regarding the focal role that religious attitudes and beliefs may play for development (or the lack thereof). However, as the reader may have observed, Protestantism is also positively (though more moderately) correlated with factors associated with the poverty trap. Furthermore, the shares of Catholics and Muslims are both correlated with our measure for western democracy, albeit in opposite directions. But because the economic significance of the spread of western democracy seems small, these relationships do not necessarily have substantial implications for development. Thus, although the results indicate that religion may be a key variable to take into account, further research is needed to determine the precise nature of its impact.

## Conclusions

Although many writers over the years have emphasized the large potential for development that adoption of superior technologies from other countries entails, this potential has been slow to materialize. The natural question to ask, therefore, is why such catching up, which according to some observers should be easy, seems to be so difficult in practice. One answer that has received much attention in the literature is that catching up in technology does not come for free but rather requires the generation of what has been called technological capabilities, that is, the ability of a country to acquire, exploit, and develop new knowledge. In this chapter we have taken the issue one step further by investigating the possibility that such technological capabilities, if they are to lead to development, need to be accompanied by a broad set of "social capabilities" reflecting not only such things as the provision of education and the existence of quality governance but also the spread of values, beliefs, and institutions that encourage members of society to contribute actively to the development process. As we have shown, there are strong reasons to believe that these prerequisites are real. In addition, some countries, mostly tropical, are also negatively affected by a powerful vicious circle of high fertility rates, low education, and high frequency of serious disease, which hamper the building of capability and perpetuate poverty. Hence, there is no "easy fix" to the problem of underdevelopment.

## Notes

1. The discussion in this section draws on Fagerberg and Srholec (2008a, b).
2. Gerschenkron's work is often associated with his focus on investment banks, which he saw as crucial in mobilizing resources for development. However, as Shin (1996) points out, it is possible to see his writings as an attempt to arrive at a more general understanding of the conditions for catch-up, focusing on the instruments—or capabilities, to use a more recent term—that need to be in place for successful catch-up to take place.
3. Other concepts used in the literature to characterize these requirements include "technological mastery" (Dahlman and Westphal 1981; Fransman 1982, p. 992), "technological effort" (Dahlman and Westphal 1982), "technological capacity" (Bell 1984), "innovative activity" (Fagerberg 1987, p. 88), "innovation capability" (Dahlman et al. 1987, p. 762), "absorptive capacity" (Cohen and Levinthal 1990), "systems of innovation" and "innovation system" (Edquist 1997; Lundvall 1992; Nelson 1993), and "innovative capacity" (Furman et al. 2002).
4. Lall also noted that national technological capability depends not only on domestic technological efforts but also on foreign technology acquired through imports of machinery or foreign direct investment (FDI). This argument also figures in work by advocates of the so-called new growth theory, according to which small countries are at a disadvantage in innovation and depend on free trade and a liberal stance on international capital flows in order to overcome this problem (Coe and

Helpman 1995; Grossman and Helpman 1991). However, empirical support is weak for the view that "openness" to trade and FDI is a notable factor of developing country growth (Fagerberg and Srholec 2008a, b; Görg and Greenaway 2004; Rodrik et al. 2004), and we do not consider the issue further in this chapter.

5. As pointed out by Arrow (1972), for instance: "It can plausibly be argued that much of the economic backwardness in the world can be explained by lack of mutual confidence" (p. 357).
6. For classical texts on the subject, see Bourdieu (1985) and Coleman (1990). In sociology the term is often used as an attribute of individuals, not of communities, as in the tradition of Putnam (1993). For an overview and discussion of different usages of the term, see Portes (1998).
7. Despite a thorough search, we were not able to find information on specialized managerial and technical skills that could be used in this study.
8. Knack and Keefer (1997) used data from the World Value Survey to analyze the relationship between trust, norms of civic behavior, and membership in groups on the one hand and economic growth on the other for a sample of 29 countries, most of which were developed. They found trust and civic behavior (but not group membership) to be positively related to investment and economic growth.
9. A quadratic function ($y = 10.00 + 9.21x + 2.98x^2$) detects a stronger relationship ($R^2 = .37$) than does a linear function ($y = 12.92 + 5.41x$), which arrives at a result of $R^2 = .27$.
10. A quadratic function ($y = 10.85 - 9.37x + 2.21x^2$) detects a stronger relationship ($R^2 = .39$) than does a linear function ($y = 12.92 - 6.03x$), which arrives at a result of $R^2 = .33$.

## Appendix A: Data and Sources

A brief overview of definitions, sources, and coverage of the indicators is given in Table 7.2. The main source of data is the World Bank (World Development Indicators), which combines various sources of data for a large sample of countries. The database has been complemented by data from other international organizations and datasets produced by research projects. National sources were used only for Taiwan when necessary and, in a few cases, for R&D data in developing countries.

Although the selected indicators have broad coverage, in some cases there were missing values that had to be estimated. We used the *impute* procedure in the Stata 9 to fill in the missing values (for details see Stata 2005). In each case we based our estimation on data for other indicators in the dataset. The number of countries with estimated data for each indicator is given in the last column of Table 7.2. We stress that considerable care was taken to check these estimated data against observed figures. If the estimated data exceeded the maximum (or minimum) observed value of an indicator elsewhere, we truncated the data by replacing the estimated values by the maximum (or minimum) observed figure. For some of the governance indicators, we also reversed the scale, though kept the original range, in order to present the indicators in increasing order (with low value signaling weak governance and high value signaling strong governance).

**Table 7.2** An overview of the indicators

| Definition | Unit | Source | Average over period | Estimated data |
|---|---|---|---|---|
| *GDP per capita, PPP (constant 2000 international U.S. dollars)* | | | | |
| Gross domestic product converted to international U.S. dollars by using purchasing power parity rates | U.S. dollars | World Bank (World Development Indicators) | 2000–2004 | 0 |
| *Gross domestic expenditure on R&D (GERD)* | | | | |
| Total (public and private) intramural expenditure on research and experimental development (R&D) performed on the national territory | % of GDP | World Bank (World Development Indicators), OECD[a] (MSTI[b] Database), RICYT,[c] and national sources | 2000–2004 | 9 |
| *International patent applications* | | | | |
| Applications for patents under the Patent Cooperation Treaty (PCT) | Per capita | World Intellectual Property Organization (WIPO), OECD (Patent Databases) | 2000–2004 | 0 |
| *Science & engineering articles* | | | | |
| Scientific and engineering articles published in journals covered by the Institute for Scientific Information's Science Citation and Social Sciences Citation Indexes | Per capita | U.S. National Science Foundation (Science and Engineering Indicators) | 2000–2003 | 0 |
| *ISO 9000 certifications* | | | | |
| Standards, approved by the International Standards Organization (ISO), that define a program of quality management and quality assurance | Per capita | International Organization for Standardization (The ISO Survey, various issues) | 2000–2003 | 0 |
| *Personal computers* | | | | |
| Computers designed to be used by a single individual | Per capita | World Bank (World Development Indicators) | 2000–2004 | 2 |
| *Internet users* | | | | |
| People with access to the worldwide network | Per capita | World Bank (World Development Indicators) | 2000–2004 | 0 |

(continued)

**Table 7.2** (continued)

| Definition | Unit | Source | Average over period | Estimated data |
|---|---|---|---|---|
| *Fixed-line and mobile-phone subscribers* | | | | |
| Fixed lines are telephone mainlines connecting a customer's equipment to the public switched telephone network. Mobile-phone subscribers are those users of portable telephones who subscribe to an automatic public mobile telephone service that draws on cellular technology | Per capita | World Bank (World Development Indicators) | 2000–2004 | 0 |
| *Tertiary school enrollment* | | | | |
| Tertiary students of all ages, expressed as a percentage of the tertiary school-age population | % gross | UNESCO[d] (Global Education Digest) | 2000–2002 | 1 |
| *Secondary school enrollment* | | | | |
| Secondary students of all ages, expressed as a percentage of the secondary school-age population | % gross | UNESCO (Global Education Digest) | 2000–2002 | 1 |
| *Public expenditure on education* | | | | |
| Public spending on public education plus subsidies to private education at the primary, secondary, and tertiary levels | % of GDP | UNESCO (Global Education Digest) | 2000–2002 | 7 |
| *Domestic credit to private sector* | | | | |
| Financial resources provided to the private sector that establish a claim for repayment | % of GDP | World Bank (World Development Indicators) | 2000–2004 | 0 |
| *Market capitalization of listed companies* | | | | |
| The share price times the number of shares outstanding of domestically incorporated companies listed on a country's stock exchanges at the end of the year | % of GDP | World Bank (World Development Indicators) | 2000–2004 | 5 |

(continued)

**Table 7.2** (continued)

| Definition | Unit | Source | Average over period | Estimated data |
|---|---|---|---|---|
| *Corruption perception* | | | | |
| The perceptions of well-informed people with regard to the extent of corruption, defined as the misuse of public power for private benefit, ranging from 0 (*corrupt*) to 10 (*clean*) | Scale from 0 to 10 | Transparency International (Corruption Perceptions Index, various issues) | 2000–2004 | 0 |
| *Law and order* | | | | |
| The degree to which the citizens of a country are willing to accept the established institutions, make and implement laws, and adjudicate disputes, ranging from 0 (*weak*) to 10 (*strong*) | Scale from 0 to 10 | Political Risk Services (PRS) Group (International Country Risk Guide, various issues) | 2000–2004 | 3 |
| *Impartial courts* | | | | |
| The degree to which a trusted legal framework exists for private businesses to challenge the legality of government actions or regulation, ranging from 0 (*weak*) to 10 (*strong*) | Scale from 0 to 10 | World Economic Forum (Global Competitiveness Report, various issues) | 2000–2003 | 6 |
| *Property rights* | | | | |
| The degree to which a country's laws protect private property rights and to which its government enforces those laws. We have reversed the scale of the indicator from decreasing to increasing order, from 0 (*weak*) to 5 (*strong*), while keeping its original range | Scale from 1 to 5 | Heritage Foundation (Index of Economic Freedom, various issues) | 2000–2004 | 0 |
| *Physical integrity human rights* | | | | |
| The average score on a group of four rights known as the "physical integrity rights": rights to freedom from extrajudicial killing, disappearance, torture, and political imprisonment, ranging from 0 (*weak*) to 8 (*strong*) | Scale from 0 to 8 | Cingranelli and Richards (2004) | 2000–2004 | 0 |

(continued)

**Table 7.2** (continued)

| Definition | Unit | Source | Average over period | Estimated data |
|---|---|---|---|---|
| *Women's rights* | | | | |
| The average score on women's economic, political, and social rights, ranging from 0 (*weak*) to 9 (*strong*) | Scale from 0 to 9 | Cingranelli and Richards (2004) | 2000–2004 | 0 |
| *Equal right to a job for immigrants* | | | | |
| Response to the following statement: "When jobs are scarce, employers should give priority to [nation] people over immigrants." 1 (*agree*), 2 (*neither*), 3 (*disagree*). The indicator refers to the sum of the weighed proportions of the responses, which has been rescaled to a range of 0 to 100 | Scale from 0 to 100 | World Values Survey Association (2006) | 1999–2003 | 6 |
| *Acceptance of homosexuality* | | | | |
| Agreement with a statement about whether homosexuality is justifiable. Responses are measured on a 10-point scale from 1 (*never justifiable*) to 10 (*always justifiable*). The indicator refers to the sum of the weighed proportions of the responses, which has been rescaled to a range from 0 to 100 | Scale from 0 to 100 | World Values Survey Association (2006) | 1999–2003 | 5 |
| *Tolerance and respect for other people* | | | | |
| Agreement with the following statement: "Tolerance and respect for other people is an important quality that children should be encouraged to learn at home" | % | World Values Survey Association (2006) | 1999–2003 | 3 |

(continued)

**Table 7.2** (continued)

| Definition | Unit | Source | Average over period | Estimated data |
|---|---|---|---|---|
| *Trust* | | | | |
| Agreement with the following statement: "Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?" Responses are either affirmative ("*Most people can be trusted*") or negative ("*Can't be too careful*") | % | World Values Survey Association (2006) | 1999–2003 | 3 |
| *Civic action* | | | | |
| Response to a question about signing a petition. 1 (*would never do*), 2 (*might do*), 3 (*have done*). The indicator refers to the sum of the weighed proportions of the responses, which has been rescaled to a range from 0 to 100 | Scale from 0 to 100 | World Values Survey Association (2006) | 1999–2003 | 6 |
| *Political rights and civil liberties* | | | | |
| Political rights enable people to participate freely in the political process. Civil liberties allow for the basic freedoms without interference from the state. The indicator is the sum of the indexes of political rights and civil liberties. We have reversed these indexes into increasing order, from 2 (*weak*) to 14 (*strong*), while keeping their original range | Scale from 2 to 14 | Freedom House (Freedom in the World Comparative Rankings, 1973–2005 | 2000–2004 | 0 |
| *Freedom of the press* | | | | |
| Freedom of the press consists of constitutional or statutory protections pertaining to the media and published materials We have reversed the scale of the indicator into increasing order, from 0 (*weak*) to 100 (*strong*), while keeping its original range | Scale from 0 to 100 | Freedom House (Freedom of the Press, various issues) | 2000–2004 | 0 |

(continued)

**Table 7.2** (continued)

| Definition | Unit | Source | Average over period | Estimated data |
|---|---|---|---|---|
| *Index of democracy and autocracy* | | | | |
| Institutionalized autocracies sharply restrict or suppress competitive political participation. Institutionalized democracy is defined as one in which political participation is fully competitive, executive recruitment is elective, and constraints on the chief executive are substantial. The indicator (Revised Combined Polity Score—POLITY2 indicator) ranges from −10 (*autocracy*) to 10 (*democracy*) | Scale from − 10 to 10 | Marshall and Jaggers (2003)—Polity IV Dataset | 2000–2003 | 2 |
| *Political constraint* | | | | |
| The extent to which a change in the preferences of any one actor may lead to a change in government policy. This indicator identifies the number of independent branches of government with veto power over policy change. The indicator is then modified to take into account the extent of alignment across branches of government and to capture the extent of preference heterogeneity within each legislative branch (POLCONIII indicator). The indicator ranges from 0 (*weak*) to 1 (*strong*) | Scale from 0 to 1 | Henisz (2002, 2005) | 2000–2004 | 0 |
| *Executive index of political competitiveness* | | | | |
| Competitiveness for posts in executive branches of government, taking into account such criteria as the degree of balance of power between legislature and executive (e.g., the method of appointing the electoral college), the extent of military influence, and the type of political system (e.g., presidential versus parliamentary). The indicator ranges from 1 (*weak*) to 7 (*strong*) | Scale from 1 to 7 | Beck et al. (2001, 2005) | 2000–2004 | 0 |

(continued)

**Table 7.2** (continued)

| Definition | Unit | Source | Average over period | Estimated data |
|---|---|---|---|---|
| *Legislative index of political competitiveness* | | | | |
| Competitiveness of elections to posts in legislative branches of government. The highest score refers to countries in which multiple parties compete in elections and the largest party receives less than 75 % of the vote. The lowest score refers to countries with either an unelected legislature or no legislature at all. The score is supplemented by information on voting irregularities, candidate intimidation (e.g., whether serious enough to affect electoral outcomes), election boycotts by important parties, rejection of the election results, and other matters. | Scale from 1 to 7 | Beck et al. (2001, 2005) | 2000–2004 | 0 |
| *Protestant* | | | | |
| The proportion of the population affiliated with the Protestant church | % | CIA[e] World Factbook | Latest year available | 0 |
| *Catholic* | | | | |
| The proportion of the population affiliated with the Catholic church | % | CIA World Factbook | Latest year available | 0 |
| *Muslim* | | | | |
| The proportion of the population affiliated with Islam | % | CIA World Factbook | Latest year available | 0 |
| *Fertility* | | | | |
| The number of children that would be born to a woman if she were to live to the end of her child-bearing years and bear children in accordance with prevailing age-specific fertility rates | % | World Bank (World Development Indicators) | 2000–2004 | 0 |
| *HIV prevalence* | | | | |
| The percentage of people ages 15–49 who are infected with HIV | % | World Bank (World Development Indicators) | 2001 and 2003 | 0 |

(continued)

**Table 7.2** (continued)

| Definition | Unit | Source | Average over period | Estimated data |
|---|---|---|---|---|
| *Tuberculosis prevalence* | | | | |
| The percentage of people ages 15–49 who have developed tuberculosis | % | United Nations | 2000–2003 | 0 |
| *Malaria fatal risk* | | | | |
| The estimated proportion of the population at risk of contracting falciparum malaria | % | Earth Institute (Jeffrey D. Sachs Malaria Dataset) | 1996 | 0 |
| *Land in geographical tropics* | | | | |
| The proportion of a country's land area in the geographical tropics | % | Gallup et al. (1999)—CID[f] Geography Datasets | 1998 | 0 |
| *Population within 100 km of ice-free coast* | | | | |
| The proportion of the population within 100 km (62 miles) from an ice-free coast or navigable river buffer | % | Gallup et al. (1999)—CID Geography Datasets | 1994 | 0 |
| *Natural disasters* | | | | |
| Persons killed or affected by disasters of natural origin (e.g., droughts, earthquakes, extreme temperatures, floods, slides, waves, and wind storms), 1980–2004. Unity has been added before the transformation to avoid logs of zero | Logs of victims per capita | UNEP[g] (The GEO[h] Data Portal), based on the OFDA/CRED International Disaster Database, 2004 | 1980–2004 | 0 |
| *Armed conflicts* | | | | |
| The proportion of years during which a country is the location of a war, with "war" defined as a conflict with at least 1,000 battle-related deaths per year | % | Strand et al. (2005) | 1980–2004 | 0 |

[a]Organization for Economic Co-operation and Development
[b]Main Science and Technology Indicators
[c]Red de Indicadores de Ciencia y Tecnología Iberoamericana e Interamericana (Network for Science and Technology Indicators—Ibero-American and Inter-American)
[d]United Nations Educational, Scientific and Cultural Organization
[e]Central Intelligence Agency
[f]Center for International Development at Harvard University
[g]United Nations Environmental Programme
[h]Global Environmental Outlook

## Appendix B

**Table 7.3** Factor scores, by country

| Country | Social capability | Western democracy | Poverty trap |
|---|---|---|---|
| Albania | −0.95 | −0.08 | −0.01 |
| Algeria | −1.12 | −1.04 | 0.36 |
| Argentina | −0.67 | 0.88 | 0.01 |
| Armenia | −0.79 | −0.73 | 0.07 |
| Australia | 1.46 | 0.94 | −0.60 |
| Austria | 1.18 | 0.62 | −1.08 |
| Azerbaijan | −0.86 | −1.52 | 0.04 |
| Bangladesh | −1.06 | −0.30 | 1.22 |
| Belarus | −0.57 | −1.71 | −0.80 |
| Belgium | 1.20 | 0.74 | −1.07 |
| Brazil | −0.60 | 0.63 | 0.34 |
| Bulgaria | −0.59 | 0.77 | −0.73 |
| Canada | 1.51 | 0.91 | −0.28 |
| Chile | 0.14 | 0.32 | −0.29 |
| China | −0.25 | −2.77 | 0.14 |
| Colombia | −0.92 | 0.13 | 0.87 |
| Croatia | −0.21 | 0.43 | −0.67 |
| Czech Republic | −0.33 | 1.01 | −0.82 |
| Denmark | 2.33 | 0.30 | −0.55 |
| Dominican Republic | −0.84 | 0.27 | 0.45 |
| Egypt | −0.68 | −1.88 | −0.25 |
| El Salvador | −0.93 | 0.41 | 0.46 |
| Estonia | 0.36 | 0.41 | −0.79 |
| Finland | 2.20 | 0.69 | −0.65 |
| France | 0.84 | 0.89 | −0.43 |
| Georgia | −0.88 | −0.78 | −0.44 |
| Germany | 1.14 | 0.64 | −0.57 |
| Greece | −0.10 | 0.73 | −0.84 |
| Hungary | −0.39 | 0.80 | −0.70 |
| Iceland | 1.90 | 0.56 | −0.36 |
| India | −0.82 | 0.11 | 1.38 |
| Indonesia | −1.02 | −0.22 | 1.49 |
| Ireland | 0.74 | 0.53 | -0.77 |
| Israel | 1.15 | 0.16 | -0.27 |
| Italy | 0.23 | 0.78 | −1.17 |
| Japan | 0.70 | 0.48 | −0.58 |
| Jordan | −0.33 | −1.79 | −0.32 |
| Kenya | −0.74 | −0.27 | 3.03 |
| Korea | 0.31 | 0.34 | −0.68 |
| Kyrgyzstan | −1.02 | −1.17 | 0.01 |
| Latvia | −0.30 | 0.49 | −0.93 |
| Lithuania | −0.51 | 0.75 | −0.52 |
| Macedonia | −0.99 | 0.32 | −0.19 |

(continued)

**Table 7.3** (continued)

| Country | Social capability | Western democracy | Poverty trap |
|---|---|---|---|
| Malaysia | −0.09 | −0.64 | 0.88 |
| Malta | 0.04 | 0.75 | −0.59 |
| Mexico | −0.83 | 0.76 | 0.33 |
| Moldova | −0.59 | −0.20 | −0.26 |
| Morocco | −0.70 | −1.98 | 0.02 |
| Netherlands | 1.96 | 0.36 | −0.71 |
| New Zealand | 1.49 | 0.63 | −0.39 |
| Nigeria | −0.87 | −0.67 | 2.55 |
| Norway | 1.56 | 0.49 | −0.61 |
| Pakistan | −0.75 | −2.36 | 1.27 |
| Peru | −0.67 | 0.92 | 0.37 |
| Philippines | −0.78 | 0.61 | 1.76 |
| Poland | −0.36 | 0.64 | −0.87 |
| Portugal | 0.22 | 1.09 | −0.93 |
| Romania | −0.65 | 0.29 | −0.32 |
| Russia | −0.85 | −0.86 | 0.09 |
| Saudi Arabia | −0.13 | −3.26 | 0.20 |
| Singapore | 1.16 | −0.80 | −0.70 |
| Slovakia | −0.21 | 0.54 | −0.73 |
| Slovenia | 0.47 | 0.74 | −0.99 |
| South Africa | −0.16 | 0.71 | 1.72 |
| Spain | 0.35 | 0.75 | −0.73 |
| Sweden | 2.55 | 0.96 | −0.59 |
| Switzerland | 2.17 | 0.54 | −0.08 |
| Taiwan | 0.66 | 0.53 | −1.01 |
| Tanzania | −0.69 | −0.19 | 2.48 |
| Thailand | −0.69 | 0.77 | 0.48 |
| Turkey | −0.53 | −0.17 | −0.42 |
| Uganda | −0.75 | −1.19 | 2.94 |
| Ukraine | −1.07 | −0.26 | −0.16 |
| United Kingdom | 1.63 | 0.86 | −0.79 |
| United States | 1.64 | 0.77 | −0.17 |
| Uruguay | −0.59 | 0.94 | −0.21 |
| Venezuela | −0.96 | 0.05 | 0.16 |
| Vietnam | −0.82 | −1.94 | 1.08 |
| Zimbabwe | −0.52 | −1.12 | 2.58 |

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# Chapter 8
# Economics, Geography, and Knowing "Development"

**Eric Sheppard**

In recent years, much attention has been given to a deep question about knowledge and the economy: How do conceptions of what an economy *is* shape expectations about how economies *function* (e.g., Mitchell 1999, 2005b)? In this chapter I investigate how geography matters to such debates. I do so through an examination of what has become a widespread discussion of how geography matters to economic development. I examine the thinking about development that emerges from mainstream economists, deploying their conceptions of geography and comparing and contrasting it with that popular among economic geographers. Even as economists have turned to criticize the last two decades of market-led (hereafter: neoliberal) globalization in ways that resonate with geographers, distinct differences persist in what is meant by development and in views about whether capitalism can eradicate poverty. I assert that these disagreements reflect, *inter alia*, differences in how geographic space is conceptualized.

Since about 1995, geography has gained steadily increasing attention from economists in debates about globalization and economic development (e.g., Collier 2007; Gallup et al. 1999; Krugman 1991, 1995; Rodrik et al. 2004; World Bank 2009). In particular, it has been argued that geography is important in accounting for the persistent, widening geographies of poverty and economic inequality accompanying neoliberal globalization. A research program in geographical economics rooted in mathematical models of monopolistic competition was initiated by Krugman (1991) to try and account for the fact that some regions industrialize whereas others do not. By contrast, Sachs (Gallup et al. 1999; Sachs 2001, 2005) has maintained that physical geography is a strong determinant of the conditions of possibility for economic development. Although the significance of geography to theories of economic development has been the subject of divided opinion among

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economists (Rodrik et al. 2004), its presence in these debates is indisputable. Indeed, geography moved to the center of global development policy-making with the publication of the *World Development Report 2009*: *Reshaping Economic Geography* (World Bank 2009).

Anglophone geographers (e.g., Blaut 1999; Lawson 2010; Peet 2006; Sheppard 2011b) have responded to this attention from nongeographers with considerable skepticism, however, for two reasons. First, there is broad disagreement with the shared presumption of the neoclassical tradition of economic theory that has underwritten neoliberal globalization. To put it bluntly, mainstream economists' theoretical proclivities are rejected by the majority of economic geographers, who favor heterodox approaches to economics. Second, geographers find economists' conceptualization of geography to be seriously deficient. One group of economists does not attempt to theorize geography at all, simply treating it as a natural feature of the world: "Geography is as exogenous a determinant as an economist can ever hope to get" (Rodrik et al. 2004, p. 134). By contrast, geographers have concluded that the geographical organization of the earth's surface is an endogenous and emergent outcome of, *inter alia*, economic processes, one that is nevertheless worthy of separate attention because it shapes the further evolution of those processes. I call this proposition the sociospatial dialectic (Plummer and Sheppard 2006). (Within economics, North 2005, makes an analogous point about institutions: Their emergent nature does not mean that their distinct effects can or should be reduced to the individual decisions of "rational" actors.) The second group of economists, catalyzed by Krugman (Fujita et al. 1999; Krugman 1991, 1995), theorizes the emergent nature of the space economy, dubbed "second nature" by Krugman (1993). This perspective is favored by the World Bank (2009). Nevertheless, economic geographers have concluded that this theorization of geography remains anemic (Sheppard 2000, 2006b).

Interestingly, this is a moment when analyses of globalization are converging, making for a challenging test of whether different ways of knowing space matter to how the economy is known. Geographers' vigorous critiques of structural adjustment, neoliberalism, and the World Trade Organization (WTO) are now echoed by those very development economists whose theories rationalized the turn to neoliberalism in the 1980s. Sachs (2005), Stiglitz (2002, 2006), Stiglitz & Charlton (2005), Rodrik (1997, 2007), and Easterly (2001, 2006) have brought such critiques into the public domain, using their status to draw more public attention than geographers such as Harvey (2003, 2006) or Peet (2003, 2007) do. I focus on this moment of convergence for my comparative analysis, holding that, although mainstream development economists and economic geographers share lines of criticism, the two camps diverge completely on the question of what development is and whether capitalism can achieve it.[1]

## Revisionist Development Economics?[2]

Sachs (2005) has been particularly enthusiastic about a role for geography in shaping the conditions of possibility for economic development. Drawing on fine-resolution geospatial data to compute population density and Gross Domestic Product (GDP)

per capita and per square mile worldwide, he and his colleagues have calculated a statistically significant regression in which tropicality and distance from navigable water predict levels and rates of growth of GDP per hectare (Gallup et al. 1999). The regression equation is derived in reduced form from a standard neoclassical single-sector economic growth model augmented with possibilities of increasing returns, a model in which higher transport costs (measured by distance to navigable water) and lower productivity (measured by tropicality) diminish equilibrium growth rates, *ceteris paribus*.

Sachs (2001) and Gallup et al. (1999) conceptualize geography as a topographic and climatic gradient whose pace of change is almost imperceptible within the time frame of human society. It is thus regarded as lying outside society, as a given state of affairs that shapes societal possibilities and makes places "prisoners of geography" (Hausmann 2001). Because geography prevents rates of economic growth from equalizing across places, he contends that development institutions and states must intervene in order to level an economic playing field distorted by that geography. Yet Sachs does not view this argument as simply environmental determinism. He has asserted that the many real problems faced in societies located near the equator (e.g., disease vectors, pests and vermin, poor transportation, and limited agricultural innovation) are a result of inappropriate global priorities rather than environmental causes. He has noted, for example, how drug companies have failed to address tropical diseases because developing lifestyle drugs for well-heeled customers in the global North is more profitable (Sachs 2001). Nevertheless, nature is mobilized in ways that treat the human and nonhuman worlds as separable, that direct attention away from societal causes of uneven development, and that promote a vision of development as a common capitalist trajectory that all societies should follow.

Sachs (2005) subsequently extended this analysis to a more comprehensive argument that poverty can be eliminated through targeted sociospatial interventions, promoting what he calls "clinical" economics:

> On numerous occasions . . . I have been invited to take on an economics patient—a crisis-ridden economy—in order to prescribe a course of treatment. Over the years I have marveled at how that experience is akin to that of my wife Sonia's clinical practice of pediatrics. I have watched in awe, often in the middle of the night, how she approaches a medical emergency or complicated case with speed, efficacy, and amazing results. Development economics today is not like modern medicine, but it should strive to be so. (p. 75)

As Sachs describes it, a clinical approach recognizes the complexity (like individuals) of economic systems, preaches the importance of differential diagnosis, pays attention to the context within which the "patient" is embedded, and entails monitoring, evaluation, and comparison of goals with outcomes, as well as more attention to ethics.

> [T]he development economics community does not take on its work with the sense of responsibility that the tasks require. Providing economic advice to others requires a profound commitment to search for the right answers . . . [and] to be thoroughly steeped in the history, ethnography, politics, and economics of any place where the professional advisor is working. (pp. 80–81)

For Sachs (2005), economic health stems from a competitive and innovative capitalist national economy. He explicitly adopts a Rostowian account of capitalist

development as proceeding in stages: a theoretical framework that defines the healthy economic body in terms of a set of outcomes or performance indicators that constitute the goal of differentiated interventions. Clinical intervention, then, entails identifying how particular factors fall short of where they should be, creating economic diseases to be overcome. He advocates a big push to overcome structural problems in particular national economies: a global program of spending, coordinated by the United Nations because the Bretton Woods institutions are dominated by the rich nations. This program should cancel burdensome national debts (releasing national resources for investment), push trade liberalization that no longer benefits the richest nations, direct scientific research toward the particular problems of poor countries (to accelerate innovation and agricultural productivity and to reduce disease), and decrease the pace and impact of climate change (by stabilizing greenhouse gas emissions in the first world and providing assistance to the much more vulnerable global South). To justify such coordinated interventions into the global economy, Sachs reasons that it is not only affordable but also in the self-interest of residents of the global North (because it curbs protest, terrorism, and immigration emanating from the global South).

Rodrik (1997, 2007), highly skeptical of Sachs's elevation of geography to a prime explanatory factor (see Sachs 2001, 2005; Gallup et al. 1999), shares his concerns about unfettered neoliberal globalization. Rodrik's motivation stems from a conviction that globalization under the post-Washington consensus has brought many benefits and that resistance to it may throw the baby out with the bathwater. Thus, there should be room for different countries to pursue distinct policies sensitive to national particularities instead of a one-size-fits-all policy regime, a tolerance that would alter the neoliberal policy consensus so that nation–states are enabled to exert more territorial authority over economic flows crossing their borders (when a national consensus exists about such issues). Like Sachs, he posits that there is only one, neoclassical set of viable economic principles and that policy prescriptions should be tailored to the specifics of national circumstance. Yet, whereas Sachs advocates a more developmental state and global redistribution, Rodrik (convinced that national institutions are the key) stresses national-scale territorial empowerment.

Stiglitz (2002, 2006) and Stiglitz and Charlton (2005) is the most vocal mainstream critic of the Washington Consensus. He has castigated the International Monetary Fund (IMF) for its lack of transparency, observing that power inequities in the supranational institutions governing the world economy hurt the global South. He has come out against structural adjustment and biopiracy and for policies that promote greater equality and national debt relief and that stimulate aggregate demand in the global South. As Stiglitz (2002) puts it, countries with "a proven track record" (p. 242) should be given financial aid and the freedom to decide how to use it, instead of being told what to do. Yet he believes in neoliberal globalization once the playing field is leveled, arguing that trade can promote development once the WTO is reformed to eliminate its current de facto bias in favor of the global North (Stiglitz and Charlton 2005). For example, richer countries should be forced to guarantee open access to imports from poorer countries, with poorer countries being accorded the right to restrict imports from richer countries. Stiglitz (2006) notes that

"the end of the Cold War gave the United States . . . the opportunity to reshape the global system based on its own self-interest and that of its multinational corporations" (p. 277). Presenting global Keynesianism as the solution, he proposes tipping the playing field in favor of the global South, formulating global rules to prevent corporations from playing one territory off against another, granting unconditional debt forgiveness for countries, and creating a global bank that lends to those in need.

The Keynesian turn promulgated by these three theorists has received some endorsement in the 2009 World Development Report's discussion of geography and development (World Bank 2009). The kind of economic geography taken up in that publication is the one popularized by Krugman ("second nature," see 1993) rather than the physical geography ("first nature" in Krugman 1993) stressed by Sachs (2001) and Gallup et al. (1999). The report notes that capitalist economic development is always spatially uneven but that well-targeted policy interventions can manage these inequalities. The key is to enhance spatial integration and promote agglomeration economies and factor mobility. Three kinds of interventions are identified ("three I's"): institutions (aspatial policies with spatially uneven effects), infrastructure programs, and spatially targeted incentives. Incentives should be avoided whenever possible but are legitimate on occasion. Three spatial scales of intervention are also identified—local (the urban hinterland), national, and international—each of which poses a geographical challenge ("three D's"). Respectively, they are density, distance, and division. Taken together, these I's and D's constitute a three-by-three table of policy interventions ("an I for a D": World Bank 2009, p. 23). At the local and national scales the policy mixes of building communications infrastructures, promoting growth poles, and enhancing the mobility of labor and capital, coupled with limited incentives to help "lagging areas" (World Bank 2009, p. 84), read very much like the spatial Keynesianism popular in North America and Europe from the 1950s through the 1970s (Brenner 2004).

Easterly (2006) agrees with Sachs's, Rodrik's and Stiglitz's diagnosis that the Bretton Woods institutions have failed the global South's poor, but he concurs with little else, reserving as much ire for Keynesian do-gooders of all stripes as for these institutions. For him, global big-push initiatives are doomed to fail because they are infused with the conceit that the global North holds all the answers.

> The White Man's Burden emerged from the West's self-pleasing fantasy that "we" were the chosen ones to save the Rest. . . . The Enlightenment saw the Rest as a blank slate—without any meaningful history or institutions of its own—upon which the West could inscribe its superior ideals. (p. 23)

Although it may seem that Easterly (2006) is channeling Said's (1978) *Orientalism*, he lies much closer to Edmund Burke, the nineteenth-century English conservative who criticized liberalism for trampling on the individual rights and local cultures of Indians in the zeal to remake India in liberals' own image (Mehta 1999). Like Sachs, Rodrik, and Stiglitz, Easterly sees all humans as equally able and creative and seeks to enable everyone to unleash their potential. Yet, like Hayek, he sees market mechanisms and individual freedom as the key. He divides the world into planners (e.g., The Bretton Woods institutions and Sachs) and seekers (the entrepreneurial spirit in everyone). From this perspective, the tragedy of the world's poor is

that they have been caught up in the maw of a self-serving development industry that has failed to deliver. Only the free market can provide the incentives, attentive to local context, that enable the poor to succeed as capitalist entrepreneurs. Under such conditions the poor become responsible for their own success or failure.

Peruvian economist Hernando de Soto shares Easterly's faith in the ability of markets to unleash the entrepreneurial acumen of the very poor. De Soto, credited with converting Peruvian President Alberto Fujimori (1990–2000) from Keynesianism to neoliberalism, states that the principal source of poverty is the lack of clearly defined property rights. In this view the principal source of capital for small businesses is self-finance from the wealth accumulated in entrepreneurs' homes and businesses. The poor in the global South, living in squatter settlements and working in the informal economy, cannot take advantage of such potential sources of capital (which de Soto 2000, estimates as exceeding US$9 trillion worldwide). The reason is that the homes and economic activities of the poor are not legally registered in their own names and that processes of registration are enormously time-consuming, bureaucratic, and costly. He maintains that the United States experienced the same situation in the late eighteenth century but was able to overcome it and should be taken as a model for the global South to follow in order to move from a "non-Western" to an "advanced," western capitalist property system (de Soto 2000, p. 172).

## Thinking "Development"

The previous section documents how discourses in mainstream development economics have come to challenge neoliberal globalization as articulated through the Washington Consensus. These mainstream critics differ substantially on the merits of Keynesian or Hayekian solutions, the question of which interventions to prioritize, and the relative importance of institutions and "geography" (and, within the latter, on the importance of "first" versus "second" nature). Nevertheless, these disputes orbit fairly tightly around a shared belief in the capacity, in principle, of U.S.-style democratic capitalism to solve poverty. This belief is based on a faith in what proponents term the laws of economics.

In constituting what count as the laws of economics, this mainstream stance has produced the most effective and cohesive paradigm in Anglophone social science of the last century.[3] The effectiveness of this particular research program (Lakatos 1970) is not in doubt. Even what outsiders would perceive as relatively minor deviations from the program within the field of economics are marginalized as heterodox. Practitioners of heterodoxy, largely excluded from canonical journals and departments, share the position stated by a group of French economics students who, in a June 2000 open letter to their teachers, declared that mainstream Economics is simply autistic with respect to such alternatives:

> If serious reform does not take place rapidly, the risk is great that economics students, whose numbers are already decreasing, will abandon the field in mass, not because they have lost interest, but because they have been cut off from the realities and debates of the contemporary world. We no longer want to have this autistic science imposed on us. (Open

letter from economics students to professors and others responsible for the teaching of this discipline, par. 4, translated from the French original) Retrieved from http://www.paecon.net/PAEtexts/a-e-petition.htm

In turn, the hegemony of the mainstream economic epistemological community during the past century has had the effect of constituting the world through the enactment of these laws, with the effect of making their realism seem self-evident (Mitchell 2005a). These laws are, first, universals: They not only marginalize intellectual alternatives but are claimed to be ubiquitously applicable across space and time. Second, they separate the economic from, and frequently elevate it above, other aspects of socionature. Indeed, proponents frequently claim that these laws can account for all domains of human action including the human relationship to nature (consider, for example, the current popularity of carbon markets). Third, they are grounded in mathematical languages, which enhance their status as scientific. Fourth, they constitute a spatiotemporal imaginary in which territories are to be judged by the degree to which they deviate from practicing these laws.

The social ontology underlying this program is well known, but its spatiotemporality has received less attention. Briefly, its social ontology imagines the economy as composed of individuals who are more or less equal in their social capacities, differing in their given preferences and endowments. Markets clear as a result of informed individuals making self-interested choices, placing the economy in a neoclassical equilibrium that functions like Adam Smith's invisible hand: "It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own interest. We address ourselves, not to their humanity but to their self-love" (Smith 1776, I.ii.2).[4] This argument is central to mainstream economics, indeed to European liberalism and enlightenment, because of its claim that the secular pursuit of self-interest results in neither chaos nor oppression.

The spatiotemporal ontology of mainstream economics has scalar, spatial, and temporal aspects. One scale dominates: the human body. The principle of methodological individualism, that economies are rooted in the rational choices of individuals, is paramount. To gain legitimacy, theoretical models must be constructed on such "microfoundations"—even in network economics where a relational approach to human action is adopted. Individual actions, in turn, are aggregated into territorialized macroeconomic propositions (e.g., aggregate production functions), which are assumed to be adequate to describe the movements of urban, regional, and (most commonly) national economies. This scalar ontology treats scalar units as fixed and given and linked with one another in bottom-up ways that conform to hierarchy theory in ecology. That is, processes at a particular scale are mobilized by actions emanating from smaller scales and constrained by events at larger scales (Wu 1999).

This bottom-up scalar ontology is accompanied by a Cartesian spatial ontology: At any scale, the individual entities—from bodies to nations—are conceptualized as autonomous and homogeneous objects with particular characteristics. Each such entity has, in principle, equal agency (the United States is as powerful as Kiribati), which is exercised in the name of wealth creation. The performance of individual entities, in competition with one another, depends on a set of attributes that give

them individuality. Thus, nations are characterized by place-specific attributes such as resource endowments, governance, culture, climate, and topography. Some such attributes have been conceptualized as a source of difference, but not of inequality. A prime example is Ricardo's (1821) brilliant idea of comparative advantage, which is used to argue that differences in resource endowments do not result in unequal exchange when trade is unrestricted. The enduring popularity of this idea stems in large part from its empirically problematic discursive effect of "proving" that geographical difference does not tilt the playing field of global competition (Sheppard 2005). More generally, as also in Walrasian microeconomic theory, if differences between economic agents can be commodified, they do not undermine the efficacy of competitive equilibrium (Sheppard and Leitner 2010).[5] Above the scale of the body, Brenner (2004) calls this Cartesian ontology "methodological territorialism" (p. 38), the assumption "that all social relations are organized within self-enclosed, discretely bounded [national] territorial containers" (p. 38). This ontology induces the analyst of regions to seek explanations in the attributes of territories rather than in, say, their relational effects on one another.

These ontologies have had a profound effect on how development is conceptualized. First, economic development is assumed to be closely approximated by a single wealth index recorded for each nation–state: Gross National Income is the norm, but the Human Development Index is a common modification. The centrality of economic wealth statistics, ignoring trenchant feminist and environmentalist critiques of such measures (Waring 1988), stems from their consistency with microfoundations. Second, a nation's place-based attributes are regressed on differences in national performance in order to explain such differences (as in Sachs's regression model attributing development to geography). As a result, nations are ranged along a one-dimensional scale, conventionally approximated as a sequence of stages that nations must pass through to achieve development (Rostow 1960). It follows from this logic that the nations with the highest scores are the most advanced and that others should learn from them.

Temporality is treated separately from spatiality and typically reduced to a chimera. The economy is commonly assumed to approximate a market-clearing equilibrium,[6] meaning that dynamics need not be incorporated. When dynamics are included, the economy is typically conceptualized as moving along a predetermined dynamic equilibrium path (clearing the market over time), with agents holding perfect knowledge of and rational expectations about the future. Such stringent side conditions for mathematical theory construction stem from the problems that time and uncertainty present for the rationality of an economy based on individual choice. If individuals commonly failed to realize the intended consequences of their actions, leaving their expectations unfulfilled, it would not be rational for them to act on the basis of self-interest, an outcome that would call into question this fundamental building block of mainstream economics. Such a potential attack on the hard-core propositions of this theory can be finessed by sticking to equilibrium outcomes and by endowing agents with perfect foresight.

Such an approach to temporality has posed deep problems for those economists willing to recognize the nonergodic nature of the world.[7] When the future is not simply unknowable but uncertain—plagued with unpredictable twists and turns (Knight 1921)—how can humans, even those who are economists, retain faith in their capacity to know and act on the world (Rosser 2004)? Uncertainty was a major issue for both Hayek and Keynes. Notwithstanding severe personal, intellectual, and political differences, the two men shared a skepticism of deterministic mathematical economics. Hayek believed fundamentally in the capacity of the market to circulate the information necessary to guide rational action in complex self-organizing societies riven with radical uncertainty, and he defended competitive individualism as the basis of liberty (Hayek 1937, 1948). Keynes (1936) believed that radical uncertainty about the future, a consequence of the absence of markets providing the necessary information, induces individuals to hoard money in times of uncertainty (their "liquidity preference," p. 108). This tendency, in turn, requires state-led, demand-side, macroeconomic intervention to alleviate unemployment in times of crisis (Keynes 1936; Weatherson 2002). North (2005) also places Knightian irreducible uncertainty at the center of any historical account of economic change that is to remain faithful to the laws of economics: "The study of economic change must . . . begin with the ubiquitous efforts of human beings to deal with and confront uncertainty in a non-ergodic world" (p. 5; see also Knight 1921). In this view individual agents face two kinds of uncertainty in their environments: natural, and socially constructed. Territorial societies thus develop institutions (including cultural systems, risk markets, and governance structures) to manage the uncertainties their residents confront (often a consequence of their own actions). It then follows that the success (wealth) or failure (poverty) of national economies depends on their ability to develop effective institutions.

By taking temporality seriously as an unknowable future, Hayek, Keynes, and North have posed serious challenges to the rationality of microfoundational equilibrium approaches to the economy. At the same time, however, they share the mainstream paradigm's predilection for grounding economic theory in the choices of autonomous individual agents, its belief in a monistic (capitalist) economics, and its conviction that spatiality is a relatively minor complication. The fact that the spatial extent of economic systems enhances agents' uncertainty is acknowledged but is not seen as posing any deep problems. Macroscale features of the economy, and of the institutions governing it, are equated with national territories, which become the natural units of analysis for any study of geography and development. Stageist thinking about development is a natural consequence. Explaining why Europe became the center of capitalism after 1492, North (2005) thus identified attributes of Europe that, in his opinion, make it better suited to developing institutions for managing uncertainty. He meant individualist belief systems that can underwrite "impersonal exchange" (which he contrasted with Soviet collectivism), themselves rooted in "fundamental demographic/resource constraints that become embodied in religions" (p. 136), combined with a fractured European geography of small territorial economies that enabled competition between different

institutional and cultural assemblages. Consider Europe's historical success by comparison to alternatives:

> The failures of the most likely candidates, China and Islam, point the direction of our inquiry. Centralized political control limits the options, . . . The lack of large-scale political and economic order created the essential environment hospitable to economic growth and ultimately human freedoms. (p. 137)

These observations are remarkably similar to those of post-1945 modernization theorists, who extended Rostow's economic model into a more general teleological theory of development (e.g., McClelland 1961; Parsons 1966). North (2005) follows their train of thought in three ways, asserting that (a) Northwestern European cultural and institutional contexts are richer than those elsewhere: "the richer the cultural context in terms of providing multiple experimentation and creative competition, the more likely the successful survival of the society" (p. 36); (b) the prosperity of these societies is due to their superior cultural/institutional mix (p. 36); and (c) other societies should thus emulate this mix if they wish to succeed (pp. 155–165). Such reasoning has been extensively criticized for its tautological structural functionalism (i.e., the claim that the copresence of attribute X and outcome Y suffices to demonstrate that Y must have been caused by X) (e.g., Giddens 1979), for its neglect of the asymmetrical relational connections between places that may be every bit as important as territorial attributes in causing uneven development (e.g., Cardoso and Faletto 1979), and for its Eurocentrism (e.g., Blaut 2000).

## Provincializing Discourses on Geography and Development

I have shown that mainstream economists, despite the recent trenchant internal criticisms of neoliberal globalization summarized above, typically conceptualize geography as fixed and exogenous to the economy, space as Cartesian (methodological territorialism), scalar dynamics as functioning from the bottom up (methodological individualism), and time as either trivial or tamable by means of market and/or institutional mechanisms that manage nonergodicity. I have also argued that this spatiotemporality underwrites a particular idea of development: indexed in terms of wealth and conceptualized as a unitary trajectory—a sequence of stages—along which all territorial societies must progress if they are to become developed. It is also, not coincidentally, a *capitalist* trajectory. The conclusion drawn by Adam Smith (like Winston Churchill) is that capitalism is the worst form of economic system—except for all the others. Put otherwise, if poverty and underdevelopment are to be eliminated, then capitalism must be the solution.

This worldview emanates from a particular location: the "metropolis" of global capitalism. The mainstream economic theories that emerged in societies that have achieved wealth prescribe their form of economic system as appropriate and as necessary everywhere for other societies to emulate this success. By the same token, expertise is assumed to be located in the global North, from where societies are ranked as more or less sophisticated or advanced on the basis of their capacity to adopt these prescriptions.

The fact that prescriptions emanating from the global North often differ from the practices that the United States and other countries actually used to secure wealth (Chang 2002) or that these prescriptions have fluctuated wildly over the last 50 years (from state-led national development to neoliberal globalization and perhaps now global Keynesianism) does not seem to give such experts pause.

One should not conclude from the hegemonic status of this worldview, however, that it is the only legitimate way of knowing the economy. Alternative spatialities, associated with very different conceptions of the economy, geography, and development, create the conditions of possibility for conceptualizing and constituting the economy differently. The taken-for-granted status of the mainstream theory enables it to masquerade as universal, scientific knowledge about geography and development. Yet, like all such monistic knowledge systems, it emerged as a local epistemology carved out of a particular context (eighteenth-century British Lockean liberalism; see Poovey 1998, Sheppard 2005). Before accepting this worldview on faith, therefore, it is important to interrogate how it fares as it diffuses beyond its time and place of origin to the provinces of the metropolis (Chakrabarty 2000). Such an interrogation requires creating an intellectual environment in which it is forced to engage with other local epistemologies propounding alternative interpretations (Longino 2002). There are, of course, many such alternatives. In this chapter I restrict attention to one emerging out of a similar geohistorical context with a very different sociospatial ontology and a distinct conception of development: that of geographical political economy (Sheppard 2011a).

## Geographical Political Economy

In contrast to the naturalized, exogenous geography and methodological individualism and territorialism of mainstream "Northern" economics, geography as conceptualized in geographical political economy is both uneven and endogenous to the economy. For example, the distance between two places (e.g., to navigable water, as in Sachs 2005) is not given; it depends on the intensity and ease of spatial interactions connecting them and on the socioeconomic forces creating those interactions (e.g., making waters navigable). Geographers stress the importance of recognizing that spatial structures are produced through socioeconomic processes if social theory is to avoid spatial fetishism (Sheppard 1990). Yet it is equally important to recognize that produced spatial structures have their own distinct effects on socioeconomic processes. A foundational principle of geographical political economy, then, is that society shapes geography and geography shapes society: the sociospatial dialectic (Plummer and Sheppard 2006).

Second, this approach eschews methodological individualism.

> Economic actors are neither fully rational nor autonomous. Their interests and preferences are shaped by their sociospatial position, their knowledge is imperfect, and they engage in collective action. Their actions shape, but also are shaped by, the social structures and cultural context in which they find themselves. As Marx quipped, they make the world, but not a world of their own choosing. (Plummer and Sheppard 2006, p. 622)

Third, unlike the focus that neoclassical economics puts on market exchange, the prime driving force of capitalist economic change is taken to be commodity production in the name of capital accumulation. Commodity production takes time and involves considerable uncertainty about whether investments will be recouped and profits realized—particularly given the spatially extensive and interdependent nature of the economy. Space itself is one such commodity, manufactured by producers of communications and transportation equipment and infrastructure (Sheppard and Barnes 1990). Money must be advanced to initiate commodity production under conditions of uncertainty: about potential competitors' technologies and strategies, about the ability and willingness of suppliers to deliver inputs to the factory on time and under budget, and about customers' willingness to purchase the commodity once it reaches them. As is well known, in any spatially extensive capitalist economy, with agents occupying different positions in the production process (capitalists, laborers, and land and resource owners), profits can be made only when the net revenue is divided unequally, favoring capitalists over their hired workers (Morishima's Fundamental Marxian Theorem, Morishima 1973). Production technologies differ across sectors and regions (Rigby and Essletzbichler 1997), and wages and profits no longer equate with the marginal productivity of capital and labor but become subject to political struggle. Disequilibrium is the norm rather than the exception; Nash equilibria become implausible; comparative advantage need not hold; and the spatially extensive economy is characterized by unintended consequences, conflicts of interest, and uneven geographical development.

More generally, geographical political economy entails a *relational* ontology. The geographies of capitalism coevolve with its socioeconomic characteristics (Amin 2002; Massey 2005; Sheppard 2002, 2006a), whereby the possibilities faced by every economic agent and by each place are conditioned by the shifting and uneven relations connecting them with others. These relations reflect complex patterns of sociospatial positionality, which are produced through economic possibilities but which also condition them:

> Positionality means, first, that differently positioned subjects have distinct identities, experiences and perspectives, shaping their understanding of and engagement with the world . . . subjectivities, imaginaries, interests and knowledge (Haraway 1988). It frames . . . the starting point for action. . . . Second, positionality emerges relationally, through connections and interactions with differently positioned subjects. Third, unequal power relations are part and parcel of positionality. . . . Thus positionality is simultaneously about difference and inequality—while calling into question the generality and [norms] of any positionality. . . . Finally, socio-spatial positionality is not fixed. It is re-enacted on a daily basis, in ways that simultaneously reproduce and challenge positionalities. . . . [E]veryday practices routinely reproduce pre-existing positionalities, giving them a durability that seemingly naturalizes them. Yet they remain social constructs, always subject to the possibility of transformation. Through subjects' practices and imaginaries, relations of power and situated understandings are contested and re-negotiated, as are socio-spatial relations, thereby potentially transforming socio-spatial positionalities. (Leitner et al. 2008, pp. 163–164)

In short, the power relations unequally shaping the conditions under which individuals and the places they inhabit can prosper under capitalism cannot be reduced to a Marxian conception of economic class. Identities are also shaped by constructions of

gender, race, and geographical location, whose unequal effects coevolve with the economy and whose place-based characteristics shift with the economic, political, cultural, and demographic processes through which places are interconnected.

This sociospatial dialectic implies a very different conceptualization of development. Instead of an exogenous geography that inhibits the otherwise beneficial consequences of neoliberal globalization (unless it can be commodified), conflict, disequilibrium, and uneven development are reproduced and reinforced through the spread of capitalist economic relations. No such power and wealth hierarchies are permanent: Some people and places can rise to the top as others become marginalized. Yet the marginalization of some places and people is inherent to a globalizing capitalism. In this view, poverty and underdevelopment are not simply original conditions—symptoms of tradition or geographical disadvantage—that capitalism can overcome (with appropriate interventions). Instead, capitalism entails the development of underdevelopment, reproducing and reinforcing impoverishment (Amin 1974; Frank 1978).

Because the kind of development associated with capitalism engenders poverty and marginalization (and environmental degradation), it can hardly be the solution to unrealized livelihood possibilities in the global South. The Rostowian vision, that expertise located in the global North's development experiences and conceptions of the economy can be deployed everywhere to eliminate impoverishment, is no longer adequate. For one thing, this expertise has been found wanting. Northern policy prescriptions have run the gamut from Keynesian to neoliberal forms of capitalism during the last 60 years, yet income inequality has been escalating and environmental degradation has been accelerating. For another, those in the global South who have experienced capitalism as undermining their livelihood practices and local ecologies—even when they seek to follow Northern policy prescriptions—often are reluctant to abandon long-standing alternative practices for the market. Indeed, contestations of capitalism and of associated measures and norms of development have been on the rise since the 1999 "battle for Seattle" (Wainwright 2007).

For the new development economists, the solution to such problems is to make increasingly globalized capitalism more palatable and equitable through targeted interventions in particular places so that the dream of the invisible hand can be realized. For geographical political economists, who conceptualize the capitalist space economy as complicit with persistent sociospatial inequality, there are no such grand solutions. Capitalist norms and measures of development are not universally applicable. Rather, peripheral regions will need to experiment with noncapitalist (or more-than-capitalist) economic systems in order to empower their residents to achieve their own visions of development. Such experiments may include state-led approaches to achieve economic prosperity measured in conventional ways—the path followed by Germany, Japan, and the United States (Chang 2002). But they may also include very different ways to realize very different notions of the good life. In this regard, geographical political economy aligns itself with postcolonial theory. Promoting capitalism in a positionally differentiated world cannot achieve the stated goals of its proponents—prosperity for all who are willing to work. Space must be reserved for geographically variegated paths and strategies for change (Blaut 1993; Gibson-Graham 2006; Massey 1999; Sheppard 2002).

## Conclusion: Acknowledging Geography, Provincializing "Development"

There are many ways of knowing the economy, many local epistemologies, of which one has become hegemonic. This way of knowing conceptualizes development in terms of monetary wealth and long and healthy lives, and it conceptualizes globalizing capitalism as the means through which all places and people can realize those aspirations. The new development economists, despite their trenchant criticisms of neoliberal globalization, subscribe to this path (supplemented by the "correction" of "market imperfections"). In this vision, geography is exogenous to the economy. It is a potential source of such imperfections, and methodological territorialism rules. By contrast, when one conceptualizes geography as relational and as coevolving with the economy, with attention to how commodity production shapes this sociospatial dialectic, then multivalent and emergent understandings of development and the economy become possible. Adoption of a particular sociospatial ontology thus has fundamental implications for the ways in which the analyst comes to know the economy and development, and thereby for the kinds of policies and practices necessary to overcome sociospatial inequality.

## Notes

1. Inevitably, any comparative analysis suffers from some essentialism. Not all economists are in the neoclassical mainstream, and some economic geographers align themselves closely with this mainstream. Further, there are substantial differences within these two groups. For brevity, I abstract from such complexities, acknowledging the danger of oversimplifying differences and underplaying potential lines of engagement. I have, however, selected the subfield in economic geography that shares with economics a concern for stating theory in mathematical terms—biasing my analysis in favor of a subspace where common ground is more likely than elsewhere. It thereby becomes possible to confine the analysis to one that highlights how the assumptions made, *inter alia* about space, shape how the economy becomes known.
2. For more detailed discussion, see Sheppard and Leitner (2010).
3. As noted by one of this chapter's referees, this discussion focuses largely on longstanding ontologies shaping mainstream economics, which economists themselves have recently begun to destabilize through discussions of the "new" growth theory, complexity theory, behavioral economics, and recent work in theories of international trade and direct investment. For analysis of some of these developments, see Plummer and Sheppard (2006) and Sheppard (2000, 2011b, 2012).
4. Attending to the cognitive and even neural aspects of choice-making, mainstream economists recently have come to recognize that limited information, uncertainty, and limited choice-making capacity result in less than rational choices. To date,

however, the response to this realization is that individuals should be "nudged" to make the right choice through social engineering (Thaler and Sunstein 2003, 2008).

5. Perhaps Sachs's claims about geography have proven more controversial among mainstream economists than Krugman's because Sachs argues that tropicality and navigability cannot be commodified and thus necessitate global intervention on behalf of the global South.
6. Krugman's (1991, 1995) geographical economics was controversial because he claimed that geography makes more than one equilibrium outcome possible.
7. In ergodic systems distributions of future possibilities are well defined and do not depend on the history of the system. In nonergodic systems the opposite is the case. They include systems exhibiting dynamical and computational complexity, such as nonlinear dynamical systems of the kind popularized under the rubric of complexity theory.

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# Chapter 9
# Knowing Mycellf™: Personalized Medicine and the Economization of Prospective Knowledge about Bodily Fate

**Bronwyn Parry**

The "personalization" of medicine and health-care provision is the ungainly progeny, if you will, of an assignation between two of the most potent scientific and economic drivers of our time: genomics and neoliberalism. The molecular revolution of the 1980s first conferred the means to derive genetic information from the body through the extraction and analysis of DNA and the subsequent mapping of the human genome. Further advances in the analysis of human genetics have culminated in a number of genome-wide association studies that, as McCarthy and Hirschhorn (2008) reported, are now producing unprecedented volumes of information on the structure and action of specific genes in the general populace. They also, necessarily, convey information on the role that the presence or absence of specific genetic mutations play in altering the reaction of an individual to a specific pharmaceutical or therapy or in predisposing him or her to the acquisition of particular diseases. This information therefore imparts, in theory at least, a kind of prospective knowledge of bodily fate.

Knowledge about bodily constitution, performance, decline, and failure has, of course, long been utilized historically to develop new medicines and treatments for disease. More recently, it has also been employed in the design of sophisticated pharmaceuticals and therapies for use in either largely privatized or nationally subsidized health-care economies such as those found in the United States and the United Kingdom, respectively. This knowledge has been derived primarily from genealogical studies of disease acquisition or from large-population, wide-cohort studies such as clinical trials. It has been employed with the aim of providing averagely effective treatments at reasonable cost for the largest possible number of recipients. The new-found ability to extract highly specific genomic information from individuals has the capacity to fundamentally alter the

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dynamics of the collection and use of personal bioinformation and, thus, the economics and politics of health care. It does so by facilitating the creation of care regimes and therapies that are predicated not on the needs of a general population but rather on the particularities (weight, age, gender, and genetic composition) of the "patient–consumer" for whom interventions will be specifically "tailored."

Neoliberal economies, one could contend, have a well-documented predilection for valorizing an individual's apparently inalienable right to seek out courses of action that facilitate their well-being, even potentially at the expense of a broader collective. Hence, it is perhaps unsurprising to discover a milieu innately disposed to devising new ways of commercializing access to and use of this highly specific personal information for individualistic use. One of the primary ways of economizing access to this knowledge is through the generation and marketing of direct-to-consumer (DTC) genetic tests. Since 2004, a number of start-up genome analysis companies have begun to grant consumers (at least those with the inclination and sufficient capital) access to genotyping services that enable them, from the comfort of their own home, to analyze and identify the extent to which their genetic profile places them at "risk" of adverse drug reactions or predisposition to disease. The tests are designed not only to inform but to empower them, to build a platform for directed intervention, such as the production and consumption of bespoke "preventive" medicines and therapies. Knowledge—or at least prospective knowledge—of one's bodily fate (e.g., predisposition to disease, hypersensitivity to allergens, and propensity to weight gain) is thereby marketed to individuals as a new type of commodity that, it is argued, will afford them, in keeping with the tenets of neoliberalism, unprecedented levels of personal autonomy in health care.

My intention in this chapter is to explore the social and spatial dynamics of this new knowledge economy in greater depth. I begin by outlining the nature of these emerging markets, critically assessing the kinds of personal knowledge that they are commoditizing and the mediums through which that knowledge is produced and consumed. I place particular emphasis on the informational nature of this economy and the opportunities that informationalism affords (see also Parry 2004b) for the creation of globally extensive networks of supply and demand. However, rather than perpetuating the classical and rather static conception of production and consumption as distinct domains and of the resultant product as a fixed, unchanging entity, I wish to illustrate (following Grabher et al. 2008) the central role that the consumers of such genetic tests play in actively "coproducing" genetic knowledge as an emergent and constantly evolving commodity. In the final section of the paper, I turn to consider issues of regulation. I begin that section by exposing some inconsistencies in the way that the collection and circulation of bioinformation is regulated in clinical and virtual settings and by reflecting on the uneven geographies of regulation that are evolving in this arena as a consequence. The chapter concludes with some brief thoughts on the complexities of attempting to regulate a knowledge economy that is so thoroughly coproduced.

## DTC Genetic Testing as an Emergent Bioinformational Economy

In late 2007 it was announced that the large California-based biotech company Genentech and the Internet provider Google were to join with two other large venture capital firms to make a substantial investment in a new DTC genetic-testing start-up company to be known as 23andMe.[1] Genetech's interest in marketing DTC genomic profiling and analysis had already been evidenced in the company's desire to let interested consumers know their own fully decoded genome, "delivering" a copy of it on a CD or similar data device. Genentech initially projected that full genome analysis would cost something in the region of US $350,000, but other analysts were confident that advances in technology and economies of scale would, in time, reduce the cost to as little as US $1,000. 23andMe and other like companies are designed to fill a niche for entry-level access to genomic profiling through a kind of GeneLite analysis: genotyping rather than full sequencing of an individual's genome. By surface mail, the consumer sends the company a saliva sample, which is then subjected to rapid analysis of a given number of single-nucleotide polymorphisms (SNPs) within that sample. The number of analyzed SNPs largely determines the cost of the profile. Whereas 23andMe will genotype 580,000 SNPs in an individual's genome for US $1,000, a rival company, Navigenics, offers to genotype 1.8 million SNPs for US $2,500 plus US $250 per year thereafter (Kaye 2008, p. 180).

23andMe's "Personal Genome Service" initially proposed to analyze an individual's risk of propensity to 13 diseases and inherited health conditions through risk-profile genotyping based on association studies (i.e., through comparison of the genetic profiles of people who have a disease with the profiles of those who do not). The demand for the service has been such, however, that the company will now analyze predisposition for up to 90 diseases and conditions at the cost of US $399 instead of US $999, with even further reductions available with its Christmas Multi-Pack special. Commenting in a press release in October 2008, when the Personal Genome Service was named Time Magazine's Invention of the Year, the company's cofounders, Linda Avey and Anne Wojcicki, made explicit reference to the potential of the service to "democratize genetics."[2] They noted that "[i]n the past only élite researchers had access to their genetic fingerprints, but now personal genotyping is available to anyone who orders the service online." It was asserted that these consumers would also benefit from the opportunity to link up virtually through their "online community features that allow customers to connect to others with similar genetic make-ups or interests and learn about the latest research."

The Mycellf™ to which this chapter's title refers is the trademarked Internet domain name of the biotech firm Sciona, based in Boulder, Colorado.[3] Sciona offers consumers another type of DTC genetic test kit. This kit, which can be ordered by mail, includes a DNA swabbing system, known as the DNA Personalized Genetic Assessment, and a diet and lifestyle questionnaire. MyCellf™ uses the swab to test for variants in 27 genes that purportedly affect diet and lifestyle and then couples that information with a consumer questionnaire to create what the company describes as "a confidential and personalized MyCellf™ Action Plan."[4] According to the firm's publicity, the consumer can use the MyCellf™ Action Plan to "make your

most important health decisions based not on fad or fashion, but on a personalized scientific roadmap that avoids the one-size-fits-all guide to health."[5] Although both of these enterprises are based in the United States, the informational nature of the service is such that it can be performed with a great degree of geographic separation between producer and consumer. Samples of DNA and saliva can be posted from anywhere in the world and results delivered electronically as long as payment is made online.

## "Democratizing" Access to Genetic Testing: Some Considerations

Two significant factors distinguish the operation of DTC testing from that undertaken in clinical settings. The first is a broadening of the consumer base. Genetic testing has historically only been offered to and requested by individuals whose risk for a specific disease or health condition was recognized through clinical assessment. Now, however, companies such as 23andMe and Sciona are actively targeting individuals who are not unwell and who have no documented propensity to disease or ill health. The question of why such individuals would wish to analyze their prospective risk of ill health has not been investigated in any great detail but will be addressed further in the following sections.

The second associated factor is the mode of delivery for these tests. When consumers are already patients, genetic tests are typically ordered by the client's health-care provider and the results of those tests are communicated to the client directly with support from genetic counselors if required. The separation between producer and consumer in DTC testing raises a number of concerns. The first relates to the veracity of the results received by the consumer. As pointed out by clinicians Hudson et al. (2007, p. 635) in a statement given on behalf of the American Society for Human Genetics, the analytic validity of a test may be compromised if the test was conducted in an unlicensed laboratory, and its clinical validity may be equally undermined by a lack of robust scientific evidence to support the purported correlation between the genetic variant and a particular health condition or risk.

Although relatively large companies such as Sciona have invested considerably in obtaining certification of their laboratories under the U.S.'s Clinical Laboratory Improvement Act of 1988 to demonstrate the reliability and accuracy of their testing services, many smaller enterprises neither have this kind of certification nor are likely to acquire it even if they were to seek it. Consumers are also generally unaware of the existence of laboratory certification requirements and consequently may inadvertently order services from companies that use inaccurate or unreliable genetic tests. These quality control concerns are not unique to DTC testing, but they take on a particular significance in this context for at least three reasons. First, barriers to entry are low for this market, a circumstance that encourages a proliferation of unlicensed service providers and unwary consumers. Second, there is a lack of robust regulatory oversight in this domain (a matter to which I shall return shortly).

Lastly, the genetic information that consumers are asked to interpret, without professional support, is extremely complex.

Although there is some evidence that specific genetic variations may be closely associated with risk of disease acquisition in some cases (as in Duchenne Muscular Dystrophy and Huntington's Disease), the majority of diseases and health conditions are thought to be the product of multiple genetic variations and complex environmental interactions. It is exceptionally difficult for even qualified geneticists to determine how, or in what ways, the presence of a particular SNP alters rates of disease acquisition. As Hunter et al. (2008) write, "there are very few observational studies and almost no clinical trials that demonstrate the risks and benefits associated with screening for individual gene variants, let alone testing for many hundreds of thousands of variants" (p. 105).

Yet DTC testing takes the analysis of this information out of the hands of qualified medical practitioners—and indeed outside the institutional, clinical setting in which it would normally be reviewed and discussed. This raises concerns that consumers may well misinterpret the findings and fall prey to anxieties about their fate that, although unfounded, may well become overblown in their minds. It is thus no coincidence that companies and other organizations that provide DTC testing often issue categorical legal disclaimers, such as that offered by 23andMe, which reminds clients that the company's service is "not a test or kit designed to diagnose disease or medical conditions" . . . and that the genetic information provided by 23andMe "does not translate into a personal prediction."[6] They also require clients to complete an associated and exceptionally permissive consent form in order to minimize legal liability and prospective claims.[7]

Given the questionable utility of the analysis and the genetic information furnished, the question arises as to why individuals are so keen on accessing it. Understanding their interest requires one to consider what kind of knowledge is really being economized in these circumstances, and how. There is a presumption that an individual's genetic information is what is commoditized and that the transaction is a relatively simplistic and linear one between producer and consumer, each of whom occupies a distinct and separate role in this market. I want to challenge that notion (as in Parry and Gere 2006) by exploring, first of all, the nature of the product commoditized in this context and then the dynamics of its production and consumption.

## Commoditizing "Material Evidence of Your Latent Future"

As I have noted elsewhere (Parry 2007), there is a commonplace assumption that new genetic analysis techniques such as genetic mapping, DNA sequencing, and SNP analysis do two unprecedented things. The first is to make knowledge about the body and its fate more accessible and, hence, more "legible" than in the past. They do so by allowing information about the structure and function of the body that was once embedded within its corporeal fabric to be extracted and rendered in new machine-readable formats. This readability is significant because the information

can then be processed and circulated electronically and digitally and can be represented visually as a series of scans, maps, or printouts. Another assumption is that the ability to convey this information in more legible mediums will help make human bodies ever more "intelligible"—enabling people not only to "read" themselves and their fates with a greater degree of fidelity or veracity but also to control them more effectively than ever before.

The second purportedly unprecedented thing accomplished by these new techniques was identified by the eminent sociologist of science Helga Nowotny in a lecture at the London School of Economic and Political Sciences in 2007. Developing a familiar, but nevertheless compelling, argument about the kinds of information produced by the contemporary life sciences, she suggested that they consequently equip the recipient with a powerful form of probabilistic knowledge about his or her likely fate. Nowotny suggested that the specificity of the information that is produced through advanced techniques such as genetic testing is, in part, what affords it such potency. She maintained that its singularity (the fact that it is unique to the individual) and its veracity (that it can be objectively verified through observation) endow it with a hitherto unrivaled kind of fidelity.

What is brought into view with such potent, probabilistic knowledge is, as Nowotny (2007) stressed, "material evidence of your own latent future" (my transcription of her lecture)—knowledge, and this is the key point, that individuals can employ to shape those prospective fates through choice and active intervention. It is this knowledge, I contend, that is actually the commodity that consumers of DTC genetic tests are seeking. It is not the genetic information *per se*, but rather what customers believe to be irrefutable, material evidence of their own latent future, there to be witnessed with their own eyes, that they are really purchasing.

But is this knowledge really the kind produced by genetic testing? Is the posthuman body—one opened up to view, available to be mapped, published, edited by the advanced instruments and technologies of technoscience—necessarily any more "legible" than the corporeal bodies of the pre-Enlightenment? Is the knowledge of the body that these techniques produce more potent and more revelatory than any held before? I think in most instances not. In fact, it could be said that "vernacular" rather than technoscientific knowledge of bodily fates has historically been as powerfully prescient, and indeed perhaps remains more prescient, than anything now produced even by some of the most advanced genetic testing and analysis.

For example, seventeenth-century vernacular genealogical knowledge of the prevalence and recorded patterns of inheritance of disorders such as dropsy, epilepsy, and breast cancer gave rise in many cases to minutely accurate and surprisingly similar forms of anticipatory knowledge about one's latent future. They were certainly as robust as anything gleaned from the almost astrological forms of star-gazing that are still needed to divine one's fate just by examining sections of one's published genome.

Perhaps, without being too fey, it is possible to assert that in this apparently very postmodern, popular embrace of DTC one is in fact witnessing a return to a surprisingly premodern desire to determine one's destiny. Moreover, success in this endeavor continues to rely for its success now, as it did in earlier epochs, as much

on a communal, if rather weak, form of "biosociality" as it does on employment of any new technoscientific approaches. In order to make sense of DTC genetic test results, consumers ideally need to discuss them with a wider community of similarly afflicted individuals. They begin the task of divining their fate by having their personal genome decoded in a process that is surprisingly akin to having a personal horoscope drawn up. Although the resulting chart may yield some portents, the predictive power of these omens can be arrived at only through a more idiomatic and dialectical process of assessment and discussion. In an increasingly fragmented and individuated society, opportunities to be enrolled and engaged in wider communal "kinship networks"[8] are limited, a constraint that may go some way to explaining the particular appeal of the socially networked community of clients that online DTC testing companies so willingly provide. For these online communities perform a complex role in their constituents' lives: acting as a space within which consumers can perform their new identities as "at risk" individuals while actively coproducing the very disease for which they are at risk.

## Coproducing Genetic Knowledge as a Lively Commodity

As Grabher et al. (2008) have observed, the historical conception of consumers as little more than passive recipients of an unchanging product has been critiqued in recent research that highlights their role as calculative agents who seek out opportunities to participate in the now fully iterative practice of shaping the social and spatial dynamics of production and consumption. The active "enrollment" of such individuals into wider, often now digitally realized communities of like consumers, opens a dialectical space in which their knowledge and experience of a product's use is capitalized on in processes of reconfiguration and refinement to the mutual advantage of both producer and consumer.

Eschewing the presupposed significance of face-to-face interactions in knowledge production, exchange in these networks increasingly takes place through a virtual engagement with others in dispersed online constituencies—be they consumers of open-source computer software, digital games, sports equipment, or, in this case, genetic tests. In such instances both the geographic and epistemic loci of interaction, and thus of power, become decentered: "The internet pushes the development process beyond the familiar organisational domains and transforms innovation into an activity that is spread across multiple locations and that mobilises ever-more-heterogeneous sources of knowledge in real time" (Grabher et al. 2008, p. 262).

The active enrollment work undertaken by online providers of DTC testing such as 23andMe and Sciona conforms to the model of codevelopment set out by Grabher et al. (2008). Online consumers of genetic tests are enlisted into virtual communities in epistemic spaces (sociospatial forums and cybersites) created for them by the two companies. In these spaces, expertise in interpretation of results and research shifts ineluctably from the domain of the clinical geneticist to the patient–consumer, so stylized. At first blush this engagement might be thought to

accord the latter group little more than a weak, or what might be termed facile, form of biosociality (see Rabinow 1999; Rose 2006). It is appropriate enough for those whose genetic disease remains prospectively in their latent future but of less use to those for whom its actual realization requires everyday involvement in socially and politically active "disease communities."

To dismiss their function as such would, however, be to overlook two economically significant roles they play. The first is in generating further forms of bioproductivity for companies. The second, and equally important, one is in granting participants opportunities for "scripting the self"—creating and then reworking narratives about the architecture and lived experiences of their own bodies and genomes that then become available as epistemic and practical sites of engagement for interested researchers and clinicians. Motivations for involvement in such communities are thus multiple.

Participants both seek and supply company researchers and clinicians with extremely detailed "embodied" knowledge of their bodies, diseases, and health conditions. In addition, participants proffer information about their reactions to diagnosis, which, in turn, suggest entry points for targeted interventions (preventive drugs and therapies, for example) that the company or its commercial partners can then generate. Participants may also gain an opportunity to acquire, with committed and continued involvement in the online community, the status of a quasi expert in a given genetic condition with attendant authority and kudos. Others, especially those with an interest in researching health disposition and genealogy, may embrace opportunities to consolidate their membership within wider demographics and geographies of kinship and idealized identity formations (Nash 2004).

In codevelopment the boundary between consumption and production inevitably becomes very porous, particularly as these kinds of consumer involvement can have economically generative effects (Parry and Gere 2006). One of the most significant challenges for companies such as DTC genetic-testing providers who seek to harness the knowledge or intellectual labor of consumer–patients is how to discipline what can be a series of rather irregular, tenuous, or even fractious engagements to best productive effect. As argued by Grabher et al. (2008), practice communities are "fuzzy and unruly social formations . . . driven by a delicate amalgamation of intrinsic, social, and extrinsic motivations that may easily turn into a disruptive mixture . . . communities learn and forget, get bored or turn angry, consolidate or drift apart" (p. 270). Regulating and maintaining loyalty to the community while preventing disenchantment or destabilization is a common concern. A further challenge for companies that offer a single entry-level service such as genetic testing is to find ways of converting what would be a one-off instance of consumption into a continued cycle of economically productive user engagement.

One creative way in which these two goals are now met by DTC genetic-testing companies is by incentivizing participants of their online communities to become directly involved in clinical research and testing of prospective treatments for diseases for which they appear to be at risk. 23andMe has generated a research spin-off called 23andWe to realize this aim, reasoning that it affords participants (and, of course, the company) "the opportunity to leverage their data by contributing it to studies of genetics" (as quoted in Lee and Crawley 2009, p. 38).[9] Participants are

invited to contribute their bodily resources and labor to such ventures in a variety of forms, be they in vitro, in vivo, or digitally. In other words, what is economically and socially leveraged in these arrangements is either (a) the actual DNA derived from the swab or saliva sample sent in by the participants, (b) the digitally rendered sequence of that DNA or other bioinformation derived from it, or (c) each participant's whole body as an experimental site.

23andWe has already entered into formal collaborations with specialist disease research institutions such as the U.S.-based Parkinson's Institute, and has documented plans to extend such collaborations with other research partners. Although, as the company notes, new genetic technologies have allowed genetic research to advance rapidly, the bioeconomies of tissue and DNA sourcing and supply have struggled to keep pace with demand. Progress has been further hindered by the fact that association studies "require both genetic and personal information from thousands—sometimes tens of thousands—of people," a "costly, time-consuming and logistically difficult process."[10]

The company appeals directly to the purportedly democratizing capacity of such ventures, along with the mutuality, authority-building potential, and associated valorization of the dilettante that typifies the dynamics of coproduction. It does so by inviting participants to become involved "in research as collaborators, advisers and contributors by conducting studies that correlate their responses to online surveys with their genetic data. The idea is to enable large studies that would be infeasible using current methods, which typically involve recruiting patients through physicians' practices and other means." The company goes on to comment that its intention is to "share the results of our research and show you how your contributions are making an impact by posting regular updates on this website."

The large, longitudinal cohort studies to which 23andWe refers are, of course, far from infeasible. In fact, they currently underpin the construction of the world's largest contemporary biobanking ventures, such as BioBank UK. However, such studies are undoubtedly more economically inefficient (in the short term at least) than the DTC method of bioinformation collection outlined above. The latter approach, in keeping with the ethos of coproduction, maximizes opportunities for profitable marketization by catalyzing and commoditizing a previously untapped, but potentially inexhaustible, fount of *unfettered* genetic knowledge, furnished, in this case, by "dilettante" collectors. By unfettered I mean largely free from the constraining effects of regulatory oversight.

Distinct parallels are evident between the DTC mode of genetic collection and that which characterized the study of natural history during the seventeenth and eighteenth centuries in Great Britain. At that time cadres of "gentlemen collectors" were charged with and enthusiastically embraced responsibility for collection of the biological specimens and field data later employed in wider Imperial projects of collection and classification in the service of both taxonomy and economic botany (Collet 2010; Parry 2004b). These specimens and data were drawn similarly vortex-like toward metropolitan centers of expertise such as museums of natural history and botanical gardens. Their accumulation there allowed scientists to observe the relationships between the collected materials and thereby gain an overview

that would have otherwise been all but impossible for a single individual in a single location to obtain. Arguably, the research scientists at 23andWe, like their historical counterparts, have begun to experience a similar "Copernican revolution" (Latour 1987, p. 224). Having been the weakest, because they remained at the center and saw nothing, they have suddenly "become the strongest, familiar with more places [and forms of knowledge], not only than any native, but any travelling companion as well" (p. 224).

A second example of this kind of coproduction of genetic knowledge was Sciona's clinical trial of their nutrigenetics program, which involved the active recruitment of 93 individuals with a history of weight-loss failure,[11] with Sciona using the Mycellf™ Genetic Test Kit to screen approximately half of them for genetic variants that affect metabolic rates (see Arkadianos et al. 2007). The researchers then specifically tailored Mycellf™ diet and exercise programs for these individuals to fit their genetic profiles. In this instance the participants provided not only samples of their DNA sequence and personal information but also their bodies as complex assemblages and sites of clinical experimentation, engagement, and ultimately intervention. The reported success of the trial is presumably its own reward for the participants (unlike the case in other clinical trials where participants are monetarily remunerated). The company, in return, acquires tools that enables it "to determine which nutrition and exercise protocols will get results and what nutrigenetic interventions will promote longevity."[12] That is to say, it obtains the essential knowledge necessary for refining and personalizing the products further, simultaneously consolidating customer involvement, loyalty, *and* ongoing consumption of an ever-evolving retinue of more and more sympathetically tailored interventions and products.

## Regulatory Landscapes: Incommensurabilities and Complexities

As knowledge about individual bodies and fates becomes increasingly available, expectations arise that it will make for health-care interventions that are more individualized and therefore potentially more effective than those of the past. Consumers in the West are increasingly demanding such tailorization, the biomedical establishment is ever more cognizant of the need to address these demands, and, as illustrated in this chapter, the neoliberal capitalist edifice in the form of start-up genetic-testing, mapping, and analysis companies are certainly gearing up to the task of meeting them. The demand to undertake genome-wide association studies and to continue research into personalized risk reduction therapies such as life-long consumption of preventative drugs keeps increasing, and the economic motivations to offer personalized therapies are intense. One identified impediment to progress is the lack of well-characterized biological materials, particularly DNA drawn from individuals from whom a detailed health and genetic profile can be obtained. By involving consumers willing both to provide their own DNA samples and to actively recruit others in their communities to fill in online questionnaires about health disposition, 23andWe, for example, aims to greatly expand the pool of available DNA sequence and disease association data on which commercial (and possibly clinical) researchers may draw.

People who participate directly in online communities and who are actively involved in the coproduction of new therapies and treatments through their involvement in clinical trials will be very aware of the fate of their donated resources, be they informational or corporeal. Others consumers, though, may remain largely unaware of the various ways in which their genetic material and information is now employed by DTC genetic-testing companies. This nescience raises the question of the ways in which DTC genetic-testing practices are currently regulated and of the significance attached to the emergent distinctions between the controls that govern the use of this material for research purposes in clinical settings and those that govern its use in online or virtual settings.

The consent forms that consumers are required to complete before they are allowed to access commercial DTC genetic-testing services are, in comparison to those acquired in clinical settings, sometimes extraordinarily permissive. In the past clients have simply had to "tick the box" at the end of an online form to signify their agreement to a range of statements relating to the prospective use of their donated DNA and genotype information. The online consent form by 23andMe,[13] for example, contains such disclaimers as:

- You understand that your genetic and other contributed personal information will be stored in 23andMe research databases and that authorized personnel of 23andMe will conduct research using said databases. ("Summary," par. 10)
- You acknowledge that 23andMe may enter into partnerships with other non-profit or commercial organizations to conduct scientific research on data collected by 23andMe. ("Summary," par. 11)
- You understand that you should not expect any financial benefit from 23andMe as a result of having your genetic data processed or shared with research partners, including commercial partners. ("Summary," par. 12)

Elsewhere in the agreement responsibility for the oversight of research undertaken with the data derived from 23andMe is devolved to the "institutional review boards" of the collaborating research partner organizations (see "Collaborative Research," sentence 5). This devolution, however, is elliptical. In instances where tissue is drawn from 'banks' overseen by other review boards, the only requirement is to ensure that the donors to those banks have completed consent forms on recruitment. Conversely, researchers in clinical settings who seek to recruit individual donors to specific disease studies that are to be undertaken by their own institution are required to set out in considerable detail exactly how, where, and for what explicit purposes the collected DNA and information will be used. A generic consent intended as a contractual indemnity of the researchers and their institution for possible misuses of the collected resources would, in a clinical setting, be instantly dismissed by an institutional review board.

In addition, clinical researchers are governed by meticulous protocols that strictly delimit how, where, and to whom such materials may be circulated. All U.K. tissue banks that loan resources, whether material or informational, are required under the Human Tissue Act of 2004 to establish appropriate auditing systems for regulating and tracing the procurement, handling, and distribution of relevant material from the point of acquisition to the point of disposal. Compliance with this law is typically achieved through a Material Transfer Agreement (MTA), a regulatory mechanism

imported into human tissue economies from the domain of bioprospecting (Parry 2004a). MTAs govern the transfer of materials from the owner ("the provider") to a third party ("the recipient") who may wish to use the material for research purposes. For institutional providers, an MTA affords control over the distribution of the material, enabling them to restrict the use of the material to noncommercial research and reducing the provider's legal liability for any subsequent use the recipient makes of the material. In the United Kingdom, human tissues and cells can be transferred only to other institutions and third parties under the terms of an MTA, whether they are located domestically or internationally.

In contrast, DTC genetic testers appear to be subject to much less stringent control. In the version of 23andWe's consent document cited above, for example, readers are rather lackadaisically informed that "23andMe may grant researchers associated with partner organizations access to aggregated data from our database of genetic and other contributed personal information for specific research queries. . . . Once information is shared with research partners, we cannot guarantee that it will be destroyed upon request."[14] In the text's summary, paragraph 5 ("You are guaranteeing . . ."), responsibility for assessing compliance with national regulations on the transfer of tissue, such as those established under the Human Tissues Act of 2004, is neatly (although perhaps not legally) devolved to the citizen donors. It requires them to confirm that their submission of a sample "is not subject to any export ban or restriction in the country in which you reside"—as if they would know.

Paragraph 9 of the summary in the same version of 23andM3's consent agreement further requires the donors to agree to "take responsibility for all possible consequences resulting from your sharing access to your genetic and other contributed information." As Manson and O'Neill (2007) have astutely noted, such broad generic consents have no moral or legal purchase, for consent is a propositional attitude. That is, it cannot be assumed that consent to the generic aspects of the proposal guarantees consent to its more specific ones, particularly if they are unspecified by the proposer or are overlooked or simply misunderstood by the consenting party. An individual may well "consent to some intervention under a given description, without grasping other propositions that follow logically from the one to which [they] consent" (pp. 12–13). Manson and O'Neill write that consent is fundamentally opaque and is shaped by the inferences an individual draws about what it is he or she is being asked to consent to—inferences that may vary dramatically from one person to another. It therefore seems entirely unethical for DTC genetic-testing companies to require donors to absolve such companies of all legal liability "arising from . . . disclosure [whether intentional or inadvertent] or use of your genetic or other contributed personal data [for diagnostic or other purposes]"[15] when the former purpose is open to wide interpretation and the latter remains wholly unspecified.

The privacy considerations that arise in these kinds of circumstances are also acute. If such resources can now be freely circulated internationally without regulatory oversight or legal liability as part of a burgeoning global economy in bioinformation, there is little guarantee that a cadre of interested third parties ranging from medical insurers to employers may not also gain access to them. As stated by J. Lupski, a professor of molecular and human genetics at Baylor College of Medicine in

Houston, Texas, "the proposition that a person's genetic data might be 'outsourced' to academic researchers or nonprofit groups, even with privacy protections and consumer consent, is especially troubling" (as quoted in "Genome Scans," 2008, p. A17). This is a matter that should ideally have been addressed before the service reached the consumer marketplace.

It seems appropriate to conclude this chapter by highlighting some of the efforts being made to regulate this burgeoning economy in donated bioinformation. Kaye (2008), for example, has drawn attention to the decision by the Departments of Health in California and New York in June 2008 to issue "cease and desist" (p. R182) notices to some 13 commercial companies, including Sciona, that were offering genetic testing services. The grounds for action in such cases were rather prosaically functional, with companies being required to produce proof that their laboratories are properly licensed and certified and that tests were requested by physicians. In California, firms were given 2 weeks to demonstrate their adherence to these standards, with the threat of a US $10,000-a-day fine for failure to comply.

Some providers, such as Sciona, immediately ceased to accept orders from California residents. However, larger personal genomics companies, including Navigenics and 23andMe, positively welcomed the tighter regulation. The cofounder of Navigenics, David Agus, argued that "it was the best thing in the world [for deterring] all these Mom-and-Pop people who were trying to get into it" (Davies 2010, p. 184). However, the suggestion that consumers should be legally restrained from ordering genetic tests on their submitted samples over the Internet provoked an outraged response from many, with the Californian editor of *Wired* magazine, Timothy Goertz, arguing at the time that it was both "insulting and a curtailment of my rights to put a gatekeeper between me and my DNA . . . regulation should protect me from bodily harm and injury, not from information that's mine to begin with" (p. 184). Meeting these new legal requirements temporarily slowed the activities of some DTC genetic-testing providers, but it is has done little to limit their numbers. For most providers, meeting such legal obligations has become a mere technicality. Those who have found the requirement to have tests ordered through state-licensed physicians difficult have since mounted challenges based on the argument that it is wrong to interpose a physician between an individual and that person's right to access information about his or her risk of disease. The argument is that over-the-counter blood-pressure or pregnancy-testing services that furnish similar information in an unmediated way are commensurate, but unregulated, technologies (p. 185).

Although these and other governmental regulatory mechanisms such as the European Union's Additional Protocol on Genetic Testing (2008)[16] go some way to restricting the ways in which DTC genetic-testing services are offered within a nation–state or union of states, they are largely ineffective in regulating global access to DTC genetic testing. That kind of control would require the creation of a uniform, internationally enforceable, regulatory regime. The unevenness of the existing regulatory landscape brings the complexities of attempting to introduce effective oversight of this new economy into sharp relief. For example, European regulatory bodies have made it clear that, as long as genetic tests are carried out in laboratories outside Europe, the companies making the tests available will not be subject to European law even though the consumers of those tests may reside in European countries.

Finally, it is perhaps worth reflecting on just how difficult it is, in reality, to regulate an informational economy and commodity that is so thoroughly coproduced. For it seems that it will remain exceedingly difficult to impose external regimes of regulation effectively as long as the consumers of these new types of genetic knowledge remain simultaneously as actively involved as they are in producing that knowledge and in finding new methods of facilitating its exploitation. While these individuals remain so committed to the project of reading and knowing their prospective bodily fates, of producing what they see as a scientifically verifiable map of their latent future, they are unlikely to countenance attempts to restrict their rights to do so without loud and vocal appeal to their "human right to know" on the grounds of its direct relationship to their well-being and security.

## Notes

1. Press release retrieved from https://www.23andme.com/about/press/20071119/
2. For the passages quoted in this paragraph, see paragraphs 6 and 2, retrieved from https://www.23andme.com/about/press/20081030/
3. http://www.thegeneticgenealogist.com/2007/02/15/mycellf-%E2%80%93-the-science-of-you/
4. Retrieved from http://www.thegeneticgenealogist.com/2007/02/15/mycellf-%E2%80%93-the-science-of-you/
5. Ibid.
6. Retrieved from paragraphs 4 and 3, respectively, at https://www.23andme.com/about/consent/?version=1.3
7. https://www.23andme.com/about/consent/
8. One's "kin" in this case are similarly afflicted individuals to whom one is also linked biologically, albeit distantly, through shared genetic traits.
9. See also https://www.23andme.com/research/
10. This quotation and those in the following paragraph were retrieved from http://winterdoden.blogspot.de/search/label/science
11. See http://www.nutraingredients-usa.com/Industry/Sciona-study-reveals-nutrigenetics-could-secure-long-term-weight-goals
12. http://www.prnewswire.co.uk/news-releases/groundbreaking-study-proves-personalized-diet-based-on-genetics-leads-to-significant-advances-in-long-term-weight-management-and-blood-glucose-levels-153477315.html
13. See https://www.23andme.com/about/consent/?version=1.3
14. Paragraph on "Collaborative Research," sentences 3 and 6, retrieved from https://www.23andme.com/about/consent/?version=1.3
15. See "Summary," par. 15, sentence 2 of consent form, retrieved from https://www.23andme.com/about/consent/?version=1.3
16. Art. 6, Additional Protocol to the Convention on Human Rights and Biomedicine, concerning Genetic Testing for Health Purposes, retrieved from http://conventions.coe.int/Treaty/en/Treaties/html/203.htm

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# Chapter 10
# KnowledgeScapes

## A New Conceptual Approach and Selected Empirical Findings from Research on Knowledge Milieus and Knowledge Networks

**Ulf Matthiesen**

## Conceptual and "Real Life" Contexts Within the Knowledge Movement

The emergence of post-traditional knowledge societies has propelled human resources, continuous learning processes, and knowledge itself into the limelight as a—if not *the*—core issue in social and cultural developments and economic growth. In response, European policy-makers are trying to support these dynamics through a wide range of implementation-oriented measures and directive instruments (e.g., the Lisbon–Gothenburg strategy). In the meantime, however, it has become fairly clear that knowledge-based societal developments follow complex pathways with vexatious causalities and unintended consequences. The utopian charm of knowledge-based societal and economic formations therefore seems to be wearing off. With new and challenging knowledge-based disparities and cohesion problems arising, the factual pathways of spatial developments are coming to depend on a broad array of untraded, but socioeconomically crucial knowledge-based contexts and interdependencies.

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This chapter is written in honor of Thomas Luckmann—my first teacher of sociology and sociology of knowledge in Frankfurt on the Main—on the occasion of his 85th birthday. The text is based on research conducted by fellows of the Research Department of "Knowledge Milieus and Spatial Structures" at the Institut für Regionalentwicklung und Strukturplanung (Institute for Regional Development and Structural Planning, IRS), located in Erkner, near Berlin, Germany. The IRS is part of the Leibniz Gemeinschaft (Leibniz Society).

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Such change is generating new spatial dynamics and surprising constellations often characterized by growing disparities and the copresence of dynamic growth, tendencies of stagnation, and processes of severe shrinkage. Areas marked by brain-drain, heavy employment losses, and difficulty with territorial cohesion frequently border on areas noted for brain-gain, dynamic hot spots, and revitalized cultural landscapes (*Kulturlandschaften*). For these reasons, one-size-fits-all solutions for knowledge-based urban developments (and their blueprints à la xyz valleys) are becoming obsolete, and the institutional and organizational distinctiveness of knowledge-based developmental arrangements is becoming more and more decisive. At the same time, these knowledge-based dynamics seem to intensify context dependencies of spatial developments, which, in turn, reinforce context dependencies of governance strategies and change-management approaches. This type of knowledge-based increase in context dependency, as one might call it, deserves enforced additional attention in further spatial research and spatial politics.

Within this constellation of disparitarian sociospatial development dynamics and increasing knowledge-based context dependencies, spatial policies habitually focused mainly on "hard structure" are coming under pressure. Current governance debates in Germany are expanding the concepts of public investment to encompass an investment in minds, not just an obsession with roads and concrete. Nevertheless, the danger posed by quick, placebo-like policy recommendations in the complex field of knowledge-based economic and sociospatial developments remains high (for discussions of these interdependencies, see Bürkner and Matthiesen 2007; Matthiesen 2004, 2005a).

## *The Knowledge Movement*

These pivotal, but not yet fully understood, knowledge-based societal transformation processes and their accompanying governance rearrangements served as a backdrop to a veritable "knowledge movement" (Foss 2006, p. 12) in sociospatial research and policy in the first decade of this century. "Knowledge" as a topic in its own right became all the rage in a number of fields, from cultural anthropology, urban sociology, and economic geography to management and governance studies (Amin and Cohendet 2004; Cooke 2006; Eisenhardt and Santos 2003; Foss 2006; Grandori and Kogut 2002; Howells 2002; Kunzmann 2004; Läpple 2004; Malecki 2000; Maskell 2000; Meusburger 2000, 2006, 2008, 2009; Nonaka and Takeuchi 1995; Nullmeier et al. 2011; Schamp 2002; Willke 2007). This knowledge movement has cut across traditionally separate disciplines and usually discrete urban policy and strategy fields and has entailed a proliferation of approaches that place knowledge at center stage. It stresses the overwhelming importance of knowledge-sharing practices—of connectivity between knowledge actors, knowledge milieus, knowledge nodes, knowledge transaction zones—which are often based on sociological notions of network ties (Grabher 2002, 2006; Granovetter 1985; Kogut 2000; Läpple 2004; Matthiesen 2004, 2006a, 2007a, c; Matthiesen and

Reisinger 2011; Tsai 2001, 2002). The attendant knowledge management approaches have led not only to the formation of a further huge body of literature but have also fostered organizational practices and governance arrangements of cities and regions around the world, more or less successfully addressing knowledge and learning, innovation and creativity, universities, and research and development (R&D) as core competencies of city regions (CRITICAL 2003–2006; Easterby-Smith and Lyles 2003; Florida 2005; Kröhnert and Klingholz 2007; Kühne 2007; Landeshauptstadt München 2005; Landeshauptstadt Potsdam 2007; Spender 2005; Storper 1997).

All these approaches rest on the conviction that the production and management of knowledge has become a seminal issue in creative solutions, learning processes, competitive dynamics, international strategies, the building of resources, the boundary-spanning of institutions, and many other conflict-driven issues within real world processes of city region developments. Within the knowledge movement there is widening agreement to differentiate further between various forms of knowledge, diverse "architectures of knowledge" (Amin and Cohendet 2004), and distinct interaction dynamics within knowledge-sharing processes (e.g., translation, transaction, and transcoding). Each of these discriminations implies different governance and policy needs. The term *KnowledgeScapes* (*Wissenslandschaften*) refers to spatially relevant, landscape-like forms of interplay between "soft" (informal) and "hard" (formal) types of knowledge-based interaction. It stands for the approach presented in this text, an approach that, applied to salient knowledge-based spatial developments, offers analytical and policy propositions pertaining to these topics.

## *Transformation*

Especially after 1989, transformations (radical structural change) and their developmental pathways attracted much attention in different disciplines, from Neo-Schumpeterian and Hayekian economics to geography, political science and sociology. KnowledgeScapes research concentrates on two of these transformational pathways: (a) postsocialist transformations since 1989 and (b) transformations caused by developments in post-traditional knowledge society (Matthiesen 2006b) in cultural landscapes, economics, politics, and the corresponding life worlds. The KnowledgeScapes research team at the Institut für Regionalentwicklung und Strukturplanung (Institute for Regional Development and Structural Planning, IRS), where the work discussed in this chapter was conducted, was confronted with different types of intersection between postsocialist and knowledge-based transformational pathways. Eastern Germany and Berlin-Brandenburg in particular have proven to have an exceedingly rich variety of disparitarian spatial developments, transformational pathways, and overlappings (see Matthiesen 2007b). Growing disparities within this coevolutionary world of space and knowledge call for intervention, yet politicosocial interventions and strategic planning seem to be losing some of their efficacy.

This point is illustrated by an example from our research in postsocialist peripheral regions of eastern Germany, where there is a strong trend toward heavy brain drain, especially among young, well-educated women (see Kröhnert and Klingholz 2007). It gives rise to the impending danger that local competency levels and their knowledge resources will sink below the level needed to engage local actors in creative and innovative action at all. The hazard is that impoverished knowledge milieus in some eastern German peripheral regions, even on a small scale, will become unable to reverse losses of human resources by promoting brain-gain processes and innovative action schemes. In this sense, certain eastern German peripheries in today's knowledge society run the risk of sliding into a competency trap against which no mainstream policy instruments seem to work (see Matthiesen 2005a, 2007b, c). With the continuing crisis in Germany's federal fiscal system, these perils have escalated considerably, although the governments in most of the country's new *Länder*—the five states that were reintroduced on the former territory of the German Democratic Republic—are trying to slightly raise or at least stabilize spending on their knowledge-, learning- and research-based areas. Yet even enlarged public funding in impoverished knowledge milieus of eastern Germany seems unable to solve the structural problems of new knowledge-based sociospatial imbalances, disparities, and their competency traps, for localized social and cognitive forms of capital have suffered lasting damage in recent decades. In sum, although we have found an astonishing array of political and societal interventions in the regions of eastern Germany, disparitarian spatial dynamics seem to be spreading. The demand for intervention is mounting, but the effects of intervention are diminishing, and the resources will diminish, too.

## *Relevant Discourse Contexts*

Competing discourses, theoretical paradigms, and research heuristics have multiplied and developed fruitfully since the late 1990s within the fields of research and governance relating to space, knowledge, and milieus. Nevertheless, the complexity of the problems at hand have thus far made extensive domains of knowledge-based socioeconomic and spatial coevolutions seem vastly undertheorized, with definite implications for research and governance. Fortunately, the members of the KnowledgeScapes research team are not alone in the effort to respond to this gap (see the preceding comments on the knowledge movement; the overview in Grabher 2006; as well as Meusburger 2006, 2008, 2009; and Matthiesen 2006a). The contributions by Peter Meusburger, Eberhard von Einem, Klaus Kunzmann, and Eike W. Schamp have been additional incentives for inquiries in this foggy field (see their contributions in Matthiesen 2009a).

Along with these representatives of research traditions, a number of other conceptual and practical sources and discourse contexts have become important for the work on KnowledgeScapes. Conceptually, it has drawn on—

- social constructivism (with phenomenological underpinnings). See Berger and Luckmann (1967) and the Schütz–Husserl tradition of knowledge analysis

(Knoblauch 2005; Luckmann 2002; Sprondel 1979). This school of thought emphasizes the overwhelming importance of everyday knowledge and its intricate interrelations with expert knowledge. See also the critical observations by Hacking (1999).

- the ethnographic tradition of site-oriented knowledge studies. See the remarkable study by Galison (1997) on "doing" microphysics in transdisciplinary trading zones of knowledge.
- the theory of communicative action by Habermas (1984–1987), who developed a nontrivial theory of communication.
- neoinstitutionalism (in its sociological, political, and economic versions), which enables one to sharpen the focus on institutional contexts of knowledge-based spatial developments. (see Cooke and Morgan 1998; Hollingsworth and Boyer 1997).
- new space-related social science approaches in economic geography that underscore the specificities of urban and regional knowledge–space relations (Bathelt and Glückler 2002; Läpple 1991, 2006) and sociology (Löw 2001; Sturm 2000).
- the geography of learning and knowledge in a strict sense (see Livingstone 2003; Meusburger 1998, 2000, 2006, 2008, 2009; Strübing 2004).
- new competing approaches to the production and transaction of knowledge and its institutional contexts (see Nowotny et al. 2001, and the triple helix approaches discussed in Bender 2004, and Leydesdorff and Etzkowitz 1998).
- Granovetter (1985) and the new economic sociology that investigates embedding and disembedding practices of networks and milieus.
- evolutionary network approaches centering on the phenomenon of the "coevolution" of space, knowledge, and interaction (see Boschma 2004; Grabher 2006; Pelikan and Wegener 2003; Schamp 2002, 2009).
- recent policy and governance approaches clearing the way to knowledge-based governance concepts (see Blatter 2006; Heinelt 2007; Nullmeier 1993; Nullmeier et al. 2011; Ostrom 1990; Willke 2007).
- research on the renaissance of the city (see Läpple 2004), which deals with the "surprising" new knowledge-based reinvention of urban clustering effects.
- learning-oriented approaches in economic geography (see Amin and Cohendet 2004; Foss 2006; Maskell 2000).
- the Georg Simmel tradition (Humboldt University Berlin) and its cultural foundations of research on urban space: Anticipating the cultural and spatial turn, Simmel (1903) looked closely at the interplay of formal and informal processes of cultural, social, and economic institution-building in urban spaces, an inspection that has become essential for the KnowledgeScapes' milieu-based approach.

Key practical and methodological sources informing our work have included grounded theory by Strauss (1991; see Strübing 2004) and Oevermann's "objective hermeneutics" (1991, 2002). As guidelines for our research, they open up new ways to detect the tricky interrelations between knowledge, space, and interaction dynamics. They also help us triangulate qualitative and quantitative procedures in coevolutionary research on space, knowledge, and milieu.

Perfectly in keeping with the American pragmatist tradition, the scholars engaged in KnowledgeScapes research (see Matthiesen 2009a, b) have opted for the core concept of "knowledge as the capacity to act," for empirically grounded theories in the tradition of Anselm Strauss and Thomas Luckmann, and for new knowledge-based governance approaches. "Theory" in this sense no longer stands in stark contrast to empirical research and the fields of praxis. Instead, new interesting knowledge-based interplays and coupling modes have emerged.

Even this abbreviated list of influences and orientations may help show why we believe the transaction field of space, knowledge, and milieus largely lacks a theoretical underpinning. We still find a host of thickets, labyrinths, and a morass of foggy areas and paradigm hypes (see Florida 2005) and of "instrumental models" in policy discourses (Davoudi 2006, pp. 15–17). At the same time there are many fruitful cross-disciplinary research programs for coming to terms with the conflict-driven and disparitarian coevolution dynamics of space, knowledge, and interaction. This constellation makes the current debate interesting, tangled, and creative.

## Coevolution of Space and Knowledge

The research on knowledge milieus and KnowledgeScapes stresses the evolutionary perspective in two respects. First, the main interest is in nondeterministic interrelations and reciprocal effects between (a) interaction dynamics in milieus and networks, (b) different knowledge forms and knowledge cultures, and (c) spatial dynamics, especially at the local or regional level—with national, European, and global extensions. Second, the KnowledgeScapes-Research focuses on path-like effects of types of sociospatial transformations, which in some areas are entangled in hybrid intersections with postsocialist transformation pathways.

The line of research on knowledge milieus incorporates a "weak" concept of coevolution, one that fits in with our methodology for reconstructive case studies in the tradition of grounded theory (Strübing 2004) and objective hermeneutics (Oevermann 2002). The decision to adopt these approaches implies that the KnowledgeScapes research team did not so much as try to develop a fully fledged evolutionary theory. Such a theory would incorporate the identification of effective causal dynamics between specific components of developments in space, knowledge, and milieu in a strict causalistic reading of natural coevolutionary processes as in the Darwinian triad of differentiation, selection, and stabilization. By contrast, we are persuaded that it is still far too early for such a demanding general theory about the specific coevolutionary dynamics between space, knowledge, and interaction (including the specification of stages). This more cautious conviction is especially strong with regard to new, culturally contextualized, knowledge-based spatial structuring processes.[1]

Nevertheless, increasingly interesting discourses on coevolutionary dynamics are enabling researchers to take important steps toward at least a general scheme for the socioeconomic explanation of knowledge-based economic, technological, and

governance innovations (see, among others, Boschma 2004, 2007; Boschma et al. 2002; Dybe 2003, who tests evolutionary economics within eastern German peripheries; Gilsing and Noteboom 2004; Pelikan and Wegner 2003; and Sotarauta and Srinivas 2006).[2] Despite this flourishing research scene and the undisputed preeminence of evolutionary economic geography and its achievements, the field sometimes is described even from within as still in its infancy (e.g., Boschma 2004, see especially Schamp 2009).

As soon as one transcends the globalized world of market rules and broadens the research to include the flexible creativity of knowledge-based spatial interaction dynamics in general, the scope encompasses even more complex research fields, for which constitutive rules (as meant by John Searle and speech act theory), basic interrelations, structuring effects, and transaction dynamics have yet to be detected and their coevolutionary functioning spelled out. Responding to this selective challenge indeed has become a major intention of KnowledgeScapes research. Basic concepts of path creation, path dependency, and path constitution have to be elaborated more precisely than in the past (see Meyer and Schubert 2007). Moreover, the rich literature on social evolution and its stages and sequential "logics"—from Piaget (1972), Popper (1972), and Habermas (1984–1987) to Eder (2004) and Miller (2006)—must be recontextualized within a "spatial turn" of current coevolution concepts.

Despite the relative infancy of the coevolutionary perspective, the members of the KnowledgeScapes research team are convinced that it offers heuristics fruitful enough to generate detailed falsifiable hypotheses on interrelations between space, knowledge, and interaction and to reconstruct knowledge-based "real-world" interrelational structures within this tricky field. Methodologically, it helps in this context to use minimally and maximally contrasting case studies to extrapolate the rule-governed dynamics of coevolutionary development. The "holy" Darwinian triad of differentiation, selection, and stabilization may thereby still direct research informatively and raise vital questions. It includes the acknowledgement that meaning-based social, political, and economic systems always interact via cultural codification processes (such as understanding and trust), implying that metaphorical differentiation, selection, and stabilization may sometimes be intermingled with nonmetaphorical reasons, causes, intentions, and their unintended consequences. Self-fulfilling cultural prophecies may play a part in this context by influencing the sustainability of knowledge-driven societal regimes or even the truth conditions of metaphorical "Darwinian" dynamics of coevolution à la differentiation, selection, and stabilization (see the section entitled "The Zone of Knowledge Transactions," below). In this "weak" sense (for a much stronger version see, for example, Schamp 2002, 2009), our research team's evolutionary concepts operate in close connection to the evolutionary paradigm encountered in economics, policy, network research, and technology studies. However, a great deal of conceptual and empirical work remains, including conceptual differentiations, selections, and stabilizations.

Methodologically, we remain unconvinced by mainstream quantitative research strategies for probing tangled knowledge-based micro- and mesoprocesses of spatial dynamics. Finding them wanting, we have adopted social-constructivist

and structuralist-reconstructivist research heuristics. The dual goal has been (a) to reconstruct latent as well as overt coevolutions of structure and structuration between space, knowledge, and milieus (by means of minimally and maximally contrastive case studies) and (b) to generalize them carefully into coevolutionary types of relations between space, knowledge, and milieus (through case-based structural generalizations (see Oevermann 1991, 2002)).

## The Catch in KnowledgeScapes Research

This section now briefly illustrates some relevant research fields, accompanying hypotheses, and empirical findings of the research on KnowledgeScapes. The work on knowledge-based spatial dynamics addresses four aspects.

1. The interplay of formal and informal interaction networks and milieus in knowledge-based spatial dynamics
2. The social construction and application of decisive knowledge forms, knowledge bundles, KnowledgeScapes within this process, and the conceptual template on the research heuristics of KnowledgeScapes
3. The relevance and functioning of the transaction and translation zones of knowledge within knowledge-based spatial developments
4. New forms of spatially relevant interplay between governance arrangements and KnowledgeScapes

An initial working hypotheses of the IRS research on knowledge milieus was that the interplay of formal (strategic) and informal (milieu-like) interaction networks is crucial (see Matthiesen 2001), especially within the fields of knowledge-based interrelations. Despite, and sometimes because of, mounting efforts to codify forms of personal knowledge and tacit knowledge, researchers have accumulated strong empirical evidence on the growing importance of the factual interplay that informal milieus and personal knowledge have with formal interaction systems and institutions and their stocks of codified expert knowledge. This substantiation is particularly apparent with regard to highly complex knowledge-based interaction systems (see "Selected Empirical Findings," below, and the contributions of IRS researchers in Matthiesen 2009a, b).

The interplay of formal with informal networks triggers the particular spatial effects of economic, social, and cultural dynamics of action. Within the research field of interaction dynamics between knowledge actors, the KnowledgeScapes research therefore concentrates on exemplary types of interplay between formal and informal processes of networking and milieu generation. This perspective is always connected with the focus on case-specific interrelations between knowledge forms and knowledge bundles, competencies, and capacities.

The role of codified and noncodified, of tacit and explicit knowledge changes considerably from one institutional and interactional context to the next. Our first research hypothesis was thus initially consistent with recent research and literature

in the field: It stressed the structural importance of tacit and noncodified knowledge in, for example, innovation processes (see the work of the Nonaka school of knowledge management, such as Nonaka and Takeuchi 1995). However, KnowledgeScapes research quickly showed that the actual effects of these interplays received only rhetorical mention in most analytical approaches. One effect is that the role of tacit and implicit knowledge in formal and informal institutions still remains poorly understood and possibly underestimated. This shortcoming on the research and conceptual side has far-reaching consequences for perspectives on governance, planning, and empowerment in knowledge-based societies and their spaces.

For these reasons we have centered our analysis predominantly on differences and modes of coupling in the interplay of informal milieu-like interactions with formal (strategic) networks. The notion of KnowledgeScapes as defined in this chapter's first section underlines this research topic. Two examples from our research can illustrate this point.

1. We stumbled across quite different sociospatial effects of *identical* actor constellations and identical constellations of soft and hard network bundles. Furthermore, we found astonishing, though hidden, influences of older strong-tie milieus (stemming partly from pre-1989 branches of semiconductor production in Frankfurt on the Oder). In the Frankfurt case during first decade after 1989, this milieu variously infiltrated city administration, its planning department, and university administration, entrenching nondifferentiation solutions and lock-in strategies. After a severe crisis in the city's economy, the same lock-in milieu surprisingly served as an incubator for prosperous creative breakthroughs from 2006 on. Obviously, a learning process accompanied by preference changes had taken place within this KnowledgeScape. This development had substantially rearranged the deep-structure mix of soft (i.e., milieu-like) and hard (i.e., strategic) types of interaction, even though nothing changed at the surface-structure level of actor coalitions and formal institutional arrangements.
2. We conducted research on innovation milieus of local, regional, and global competency in Erlangen, Germany (Siemens), and Eindhoven, The Netherlands (Philips). On the one hand, we found clear dissimilarities in the soft structuring processes of these milieus and in the degree and type of embeddedness of the various high-tech research groups involved (strategic networks in "Medical Solutions/Systems"). On the other hand, both types of embeddedness showed similar "creative" interrelations between hard strategic interaction systems and soft milieu-like affiliations. Both coupling modes of soft and hard interaction structures fostered innovativeness, despite stark differences in the integration and embedding practices of knowledge milieus within the region.

From cases like these, we learned that a pressing question remains: How do actors constitute *effective* forms of knowledge transaction? This issue always implies the strategic coupling of soft and hard network structures into case-specific KnowledgeScapes. When it came to bringing about effective solutions, we also found that the relevance of corresponding contexts and embedding structures like knowledge cultures increased.

## KnowledgeScapes: Research Heuristics and Conceptual Template

### *Forms of Knowledge*

Like many others we were initially very stimulated by Polanyi's (1958) dualistic concept of knowledge (tacit–explicit; codified–uncodified; see also Howells 2002). Our case studies, though, made this concept increasingly insufficient and ultimately even misleading. In order to fine-tune our analysis of knowledge landscapes, we started to differentiate between different forms of knowledge and ultimately arrived at a typology of nine knowledge forms.[3] Moreover, the empirical material showed separate knowledge domains and different knowledge bundles, structuring the respective fields of action and their relevance systems (see Figs. 10.1 and 10.2).

Empirically, we have delved into one cardinal and specifically "modern" bundling process in which four knowledge domains are discernible—(a) science, research, and experts; (b) policy and governance; (c) markets; and (d) life worlds—with

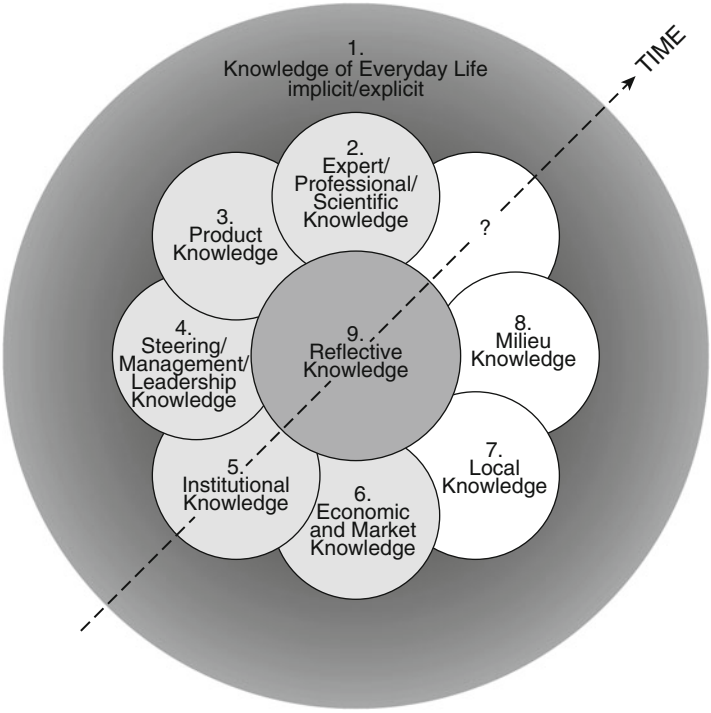


**Fig. 10.1** A typology of nine forms of knowledge (From Matthiesen (2009c, p. 15). Copyright 2009 by U. Matthiesen. Adapted with permission)

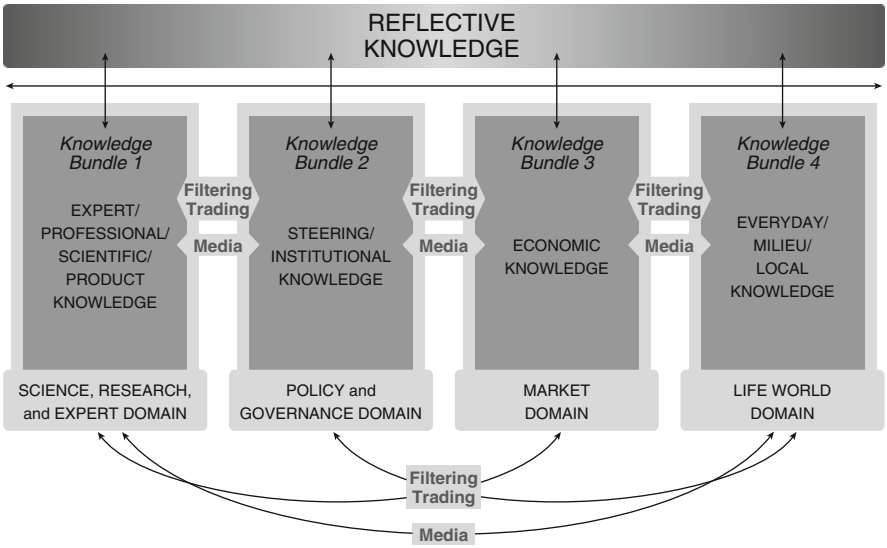


**Fig. 10.2** Bundling of knowledge forms within knowledge domains—Steps to operationalize the conceptual framework (From Matthiesen (2009c, p. 16). Copyright 2009 by U. Matthiesen. Adapted with permission)

each domain integrating a different constellation of forms of knowledge (see Fig. 10.2). Even more so, we have found it indispensable to accentuate the structural relevance of reflective knowledge.

## *KnowledgeScapes*

To improve the analysis of knowledge-based interaction dynamics, we had to break down the common dualistic distinction between formal and informal interactions or institutions. Early research results indicated that it may be useful in this context to discriminate between at least three levels of culturally codified space–knowledge types of interaction: KnowledgeScapes, knowledge cultures, and the habitus of a given city region, indicating a distinct logic of such regions (see Berking and Löw 2008, and their concept of *Eigenlogik der Städte*, the intrinsic logic of cities; see this chapter's final section, "Strengthening of Specificities"). The first two levels are of special importance in the debates presented in this chapter (see Fig. 10.3).

Level I indicates how soft and hard networks are integrated within case-specific KnowledgeScapes. In turn, KnowledgeScapes are contextualized by different knowledge cultures (Level II) and constitute discrete knowledge-based forms of the habitus of a distinct city region (Level III) (for an extended application of this heuristic device within a specific case study, see Matthiesen and Reisinger 2011). In general, the heuristics of KnowledgeScapes emphasizes the role of transaction

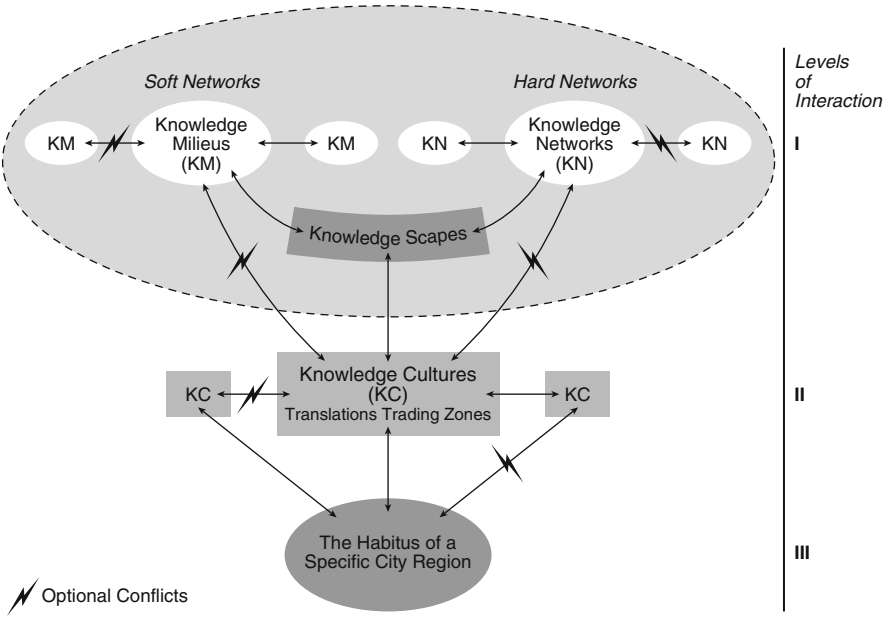


**Fig. 10.3** Three levels of knowledge-based interactional dynamics: Options and conflicts (From Matthiesen (2009c, p. 16). Copyright 2009 by U. Matthiesen. Adapted with permission)

dynamics, conflicts, and translation options between different knowledge cultures, knowledge milieus, and KnowledgeScapes. (Conflicts are indicated by the double-headed arrows.)

Our empirical case studies (see below) have shown the fruitfulness of these empirically grounded conceptual distinctions. In several constellations they have also substantiated the innovative effects of knowledge conflicts (crisis as a birthplace of novelty; see Joas 1992; Oevermann 2002) and the creative effects of heterogeneous knowledge cultures.

## Zone of Knowledge Transactions

All empirical research that the members of the KnowledgeScapes research team have conducted in the coevolutionary field of space, knowledge, and milieus has demonstrated an increasing relevance of the intermediary zone of interaction dynamics. Actors in this zone include knowledge holders, knowledge producers, knowledge absorptionists (see von Einem 2009), knowledge sharers, bypass technicians and leakage detectors, knowledge elites, and even knowledge troubadours (e.g., Serres 1997). We therefore coined the term "zone of trans" for this predominant

research field (see Matthiesen and Reisinger 2011). We chose this expression because it reflects at least the semiotic fact that many metaphors addressing creational knowledge-sharing contain the prefix "trans," as in *trans*codings, *trans*lations, *trans*actions, and *trans*fers—including different ways of trading, using, and expanding our knowledge. The outstanding importance of this transaction zone stems from two facts. First, researchers and other human beings are not too well equipped methodologically to study "knowledge in the head" directly. Second, social processes of knowledge-sharing; their functioning (whether good or poor); and the accompanying conflicts, control mechanisms, bypass techniques, and other aspects are ontologically critical for space-structuring effects of knowledge at large (see Livingstone 2002; Meusburger 1998). The transaction zone includes new professional roles (competition observers, mediators, knowledge-offshoring specialists) as well as older professions like translators and traders of knowledge. Our special focus on the zone of trans also takes in the quickly expanding variety of institutional arrangements tailored to the production, distribution, and absorption of knowledge (see Nowotny et al. 2001). The presentation of empirical findings from KnowledgeScapes research (see below) will characterize some of these new knowledge-based professional roles and production sites within their interactional settings.

To prevent premature generalizations, we selected for our research minimally and maximally contrasting research fields, ranging from peripheral lock-in-driven postsocialist micronetworks to the innovation-centered high-tech teams of global-players in the medical development of picture-archiving and communication systems (PACS). The elaborated research heuristics of KnowledgeScapes proved well suited to in-depth research in sometimes conflict-driven, sometimes routinized, sometimes innovative, sometimes boring, sometimes exceedingly creative fields of translation and transaction, trading, transcoding, and transfers of knowledge.

I single out in advance three rather general research findings from our project:

1. A rapidly growing kaleidoscope of knowledge-centered professional roles and institutions in knowledge production is emerging, as are their space-structuring effects.
2. Within the same knowledge-based socioeconomic processes, other professional roles are dramatically losing authority and status, with new types of sociospatial disparity effects forming (e.g., a digital divide). Fostered by the ever briefer validity span of knowledge, new frontiers of current knowledge automatically produce new milieus that fall behind—and an ever growing stock of non-knowledge.
3. Again and again it became important to draw attention to the relevance of crisis and conflict and of power within the field of knowledge. The twin roles of bypass technician and leakage detector in many fields of the post-traditional knowledge society may indicate new conflict-driven arenas within the KnowledgeScapes.

One conclusion is that new knowledge-based disparities show up in these societies, not temporarily, but in a systemic fashion.

## Selected Empirical Findings

This section provides a summary of selected empirical results from the IRS-led project on KnowledgeScapes. We members of the research team selected a span of minimally and maximally contrasting types of contemporary space and structural contexts in order to test our hypotheses. For example:

1. A peripheral city with serious postsocialist transformational problems and recent new options for escaping path-like lock-in effects (the twin cities of Frankfurt on the Oder, located on the German side of the Oder river, and Slubice, situated directly opposite on the Polish side).
2. The metropolitan region of Berlin-Brandenburg, which is still in transition and which features a hybrid mix of knowledge-based growth, stagnation, and shrinkage tendencies (falsifying many of Florida's 2005, "creative" 3-T assumptions; see von Einem 2011);
3. Four contrastive European city regions with strong global players in two different fields of innovation (for high-tech medical solutions: Siemens in Erlangen, Germany, and Philips in Eindhoven, The Netherlands; for aeronautic engineering and aircraft manufacturing: Airbus in Toulouse, France, and Airbus in Hamburg, Germany).

   Some of the results are highlighted in this section (for more details, see the studies of the research team in the two-part special issue of *disP* guest edited by Matthiesen 2009a, b).

### *Frankfurt on the Oder–Slubice: Town-Planning and Cross-Border University Relations*

This small research group, consisting of Thomas Knorr-Siedow and Heidi Fichter-Wolf, examined urban knowledge networks connecting the peripheral city of Frankfurt on the Oder with Slubice and the German–Polish border region in its direct vicinity. Specific knowledge-based research objects in this project were town-planning as a particular kind of KnowledgeScape and cross-border university cooperation spanning two contrastive national-regional knowledge cultures with one of the harshest European language barriers between them.

Knorr-Siedow's inquiry into the KnowledgeScape of town-planning in Frankfurt detected strong milieu ties within the town-planning branch, each with peculiar path effects, harking back to the pre-1989 milieu of a socialist semiconductor plant as a decidedly generative core even after 1989. In some cases the dissemination of this milieu throughout the city resulted in innovative start-ups; in other cases it induced rather poor innovation performance, as in city planning itself, in university and local public administration, and their knowledge cultures. The research team thus found strong and lasting influences of the pre-1989 milieu and their knowledge bundles (referred to as the *Halbleiter-Milieu* [semiconductor milieu]) reaching from informal

production networks into formalized strategic networks of the city itself. Instead of simplistic and deterministic forms of causality expectations, Frankfurt on the Oder was shown to have strong context dependencies in its developmental paths, which built up into a particular gestalt of the coevolution process of space, knowledge, and milieu. After years of dire economic underperformance accompanied by severe shrinkage, the city was able to attract promising international investors for the manufacturing of solar energy plates (Conergy AG, Odersun, and First Solar) as of 2006. These temporary successes with industrial settlement have strengthened competence bridges extending back to the pre-1989 production of semiconductor plates and the knowledge milieus of that period. Cumulatively, they have made it possible to recombine old competencies with sustainable future-oriented knowledge domains and knowledge-based production lines. However, heated current political and economic debates on the extent and time-span of state-subvention for solar industries, especially in East-Germany, endanger these temporary industrial settlement successes considerably.

In this case KnowledgeScapes research has shown how milieu-generated medium-term path effects of postsocialist transformations influence prospects of knowledge-based city economies. These path effects should therefore never be underestimated or camouflaged in transformation research. This study has also shown that crisis functioning as a seedbed for creative breakthroughs may have dual outcomes: It can facilitate strong-tie milieus with lock-in path effects or foster new solutions in production and institution-building even in peripheral regions. The KnowledgeScapes approach thereby successfully reconstructed detailed case-specific modes of coupling crisis with innovation, without underestimating path effects from earlier social spatial structures.

The study by Fichter-Wolf and Knorr-Siedow (2009) addresses a peculiar KnowledgeScape that strengthens cross-border university relationships between Frankfurt on the Oder and Slubice, crossing one of the most evident linguistic divides in Europe (that between the German and Slavic language families). The dominant research interest was in institutional and knowledge-culture relations between the German-based University of Viadrina in Frankfurt on the Oder and the Collegium Polonicum in Slubice on the Polish side of the Oder river. The author found massive empirical evidence for the importance of knowledge cultures (see Fig. 10.3, Level II). In some cases the importance of knowledge cultures flashes through border-specific conflict-driven learning processes between national epistemic communities and institutional backgrounds. In this context the dynamics of coevolution encompass two complexes: (a) the importance of knowledge cultures themselves and (b) the ambiguous role played by strong-tie knowledge milieus, which since late 1989 have been able to develop within cross-border relations, too. Whether they do promote creativity or strengthen redundancy largely depends on the coupling mode of knowledge domains within KnowledgeScapes (see Figs. 10.2 and 10.3).

The case study on Frankfurt on the Oder and Slubice proved how conflict-driven relations between knowledge cultures may even strongly affect the formal, institutionalized interaction dynamics, be it within the city or in cross-border relations

between Polish and German university actors. Without consideration of these utterly different knowledge cultures, any Europeanized attempt (in frameworks such as the Lisbon–Gothenburg process and beyond) to influence the governance of coevolutionary processes of space and knowledge proactively will be in vain or at least badly hampered. In this sense the cross-border university case study by Fichter-Wolf and Knorr-Siedow (2009) underscores the importance of knowledge cultures as contextual structures in which KnowledgeScapes are embedded (see Fig. 10.3, KnowledgeScapes Levels I and II; Matthiesen 2005a, pp. 57–61).

Generally speaking, the conspicuous differences between German and Polish knowledge cultures highlight what usually functions implicitly and thus remains unnoticed. This observation clearly corresponds with results from Schütz's (1967) phenomenological knowledge studies on "the world as taken for granted" (pp. 74–76). Three aspects may be singled out:

1. Knowledge cultures serve as crucial mediators and translators for the respective "world as taken for granted."
2. Knowledge-based interaction dynamics (KnowledgeScapes)—whether in the economic, political, or social sphere—are always embedded in particular knowledge cultures, with distinct relevancy structures, values, and connectivities, along with holistic interpretational schemes and gestalt presuppositions.
3. Knowledge cultures differ vastly in their specific coupling modes of knowledge forms (see Fig. 10.2) and their formal and informal interactional or institutional arrangements. (On the surprisingly hybrid and ingenious Polish interactional coupling mode known as "*znajomosti* networks, mixing private and professional life styles, tacit and explicit knowledge," see Matthiesen 2001, p. 813.)

In summary, research on conflict-driven real world-KnowledgeScapes within the German-Polish city of Frankfurt-Slubice showed how the variety of knowledge cultures and their factual couplings of knowledge forms and interaction dynamics are central to understanding and explaining their space-structuring effects in this twin city.

## *The Metropolitan Region of Berlin-Brandenburg in Transition: Contrastive KnowledgeScapes and Heterogeneous Branding Strategies*

The second project to be summarized in this section has been conducted by Petra Jähnke, Toralf González, and Gerhard Mahnken (see González et al. 2009). They are focusing on Berlin-Brandenburg, a northeastern German metropolitan region incorporating widely different spatial dynamics of development: stagnation and modest growth in the center, accompanied by conditions highly attractive to the "creative class," pronounced shrinkage tendencies in the peripheries, and strong growth dynamics in some parts of the suburban belt around Berlin. This description applies to the region's economy, innovation, and demographic developments. From

a short and medium-term perspective, knowledge-based development strategies within this metropolitan area (cluster politics) even seem to be escalating the spatial heterogeneity of the capital city and region surrounding it (via brain-drain effects, see Bürkner and Matthiesen 2007). For detailed case studies of this heterogeneous and disparitarian regional development, the research team selected two maximally contrastive KnowledgeScapes of this metropolitan region: Berlin-Adlershof and Teltow-Stahnsdorf.

Adlershof, one of Germany's largest campuses of R&D and media, is situated on the southeastern periphery of Berlin. Since the early 1990s, Adlershof has received top political and funding priority and enjoyed ample investment in public infrastructure. Teltow-Stahnsdorf is a smaller, but very innovative, R&D and production area with little public funding. It is located in the prospering southwestern suburbs of Berlin. Market dynamics rather than public funding have played the main role in the development of Teltow-Stahnsdorf, one example being the dismantling of socialist high-tech production lines. (One of former East Germany's largest semiconductor manufacturing plants, with 13,000 workplaces, had been located in Teltow.)

In short, Adlershof and Stahnsdorf represent maximally contrasting transformational knowledge pathways. They are contrastive in at least four senses: size, amount of funding, spatial location, and the dynamics of spatial development. In both places, however, milieu-like trust relations and lasting network effects, in some instances stemming from socialist times, are as important as ever (as in the case of Frankfurt on the Oder). Above all, the former production-oriented East German knowledge culture was marked by comparatively close and direct couplings between theory and practice within a "milieu of engineers," as coined by González et al. (2009, p. 27). At least in niche markets of high technology at a global level, the milieu of engineers has proven to be quite successful under the new conditions entailed by postsocialist regimes of knowledge-based competition. Two bundles of knowledge forms are paramount in this context: (a) engineering competencies and research competencies, together with the product and process knowledge in both of those fields, and (b) engineering competencies in combination with market knowledge. Especially when there is little or no public funding, as in the Teltow-Stahnsdorf case, these two couplings of knowledge forms played an indispensable role in the invention of high-tech products for niche markets enjoying European and global competitive advantages.

In Adlershof Jähnke detected in detail how trust relations from the era of the German Democratic Republic in several cases greatly facilitated the necessary couplings between formal and informal networks, generating prosperous KnowledgeScapes. Old trust-related knowledge milieus (soft structuring processes) have been combined with new strategic relations between global and local networks (hard and formalized structuring processes). The resulting broad diversity of modes of local embeddedness impelled Jähnke to develop an initial typology categorizing forms of spatial stickiness at Adlershof. This typology may be of considerable relevance for knowledge-based location practices elsewhere. The embeddedness typology includes location testifiers as well as location-detached and location-independent actors (see González et al. 2009, pp. 23–27).

In the contrasting case of market-driven Teltow-Stahnsdorf, which is situated within the "knowledge belt" (Kühne 2007) in Berlin's southwestern suburbs, González directed one part of his research to "the brightest minds" (self-attribution, see González et al. 2009, p. 29) of high technology within the milieu of engineers. He found amazing knowledge-based professional mutations and learning processes, such as those that turned engineers into market- and knowledge-sensitive successful entrepreneurs. These actors integrated different knowledge domains, competence profiles, and networking capacities, including a considerable amount of reflective knowledge. Within the Teltow-Stahnsdorf KnowledgeScape a new gestalt of postsocialist engineer–entrepreneurs appeared as a core of new postsocialist knowledge elites. Via crisis-driven learning processes they enlarged their capacity in complementary fields usually outside engineering professions and finally experienced entrepreneurial success. Their concentration on innovative high-tech production niches proved to be capable of competing successfully with those "in the rest of the world" (China, Korea; see González et al. 2009, p. 29).

The scrupulous case reconstructions in Teltow-Stahnsdorf helped clarify other critical processes (e.g., leakage and leakage detection) within the zone of knowledge transactions. The astounding innovativeness in the local milieu of engineers led them to invent semiprofessional practices for detecting knowledge leaks. This development prevented the drift of Teltow's core and domain knowledge to China and elsewhere in Far East.

Integrating heterogeneous spatial dynamics within a concise strategy for public branding remains a predominant challenge for the metropolitan area of Berlin-Brandenburg (with its collocated processes of growth, stagnation, and shrinkage). Official branding slogans seem patently uninspired. Since 2006, the listless slogan has been "Hauptstadtregion Berlin-Brandenburg" (Capital City Region of Berlin-Brandenburg). Obviously, it does not fit the metropolitan region as a whole, especially in view of its unduly shrinking peripheries and the uncoupled hinterland. Mahnken has therefore explored this fundamental branding problem by asking how different frames of branding within this metropolitan region can be integrated into a knowledge-based gestalt. Indisputably, persuasive branding strategies have to be wedged through the Scylla of false homogeneity (right-wing tendencies!) and the Charybdis of excessive heterogeneity (i.e., loss of the capacity to act). In this context Mahnken successfully reconstructs public and network-specific deliberation processes that take place between institutional actors, intermediaries, and civil-society networks, in which new empowering knowledge-based brands for the metropolitan region as a whole are at stake (see Fig. 10.3, Level III: Habitus of a specific metropolitan region).

The main results reported by this research team can be recapitulated in five points from the leading perspective—the coevolution of space, knowledge, and milieus:

1. These case studies underline and differentiate path effects of strong-tie networks ("milieus") now operating under sharply intensified globalized competition.
2. The impact of bundling processes (between different forms of knowledge and competencies, such engineer–entrepreneur or engineer–researcher) is growing considerably.
3. A typology of locational stickiness can be reconstructed with different coupling modes in the respective KnowledgeScapes, a step that can reflexively integrate complementary knowledge domains.

4. Knowledge leakage as a companion of success is becoming a severe and general problem, increasingly to be solved by local and regional means.
5. Adequate and inspiring branding strategies are urgently needed within knowledge-based city regions. City regions are competing more and more as "individuals" with distinct competency traits—exhibiting particular characteristics and even a specific intrinsic logic (see Berking and Löw 2008; Löw 2009; Matthiesen 2008; see also the final section below). This double increase in competition and distinctiveness is closely associated with the growing heterogeneity of spaces, competencies, and milieus in city regions (be they large metropolitan regions or smaller "knowledge-pearl" regions like Heidelberg).

## *Four European City Regions with Strong Global Players: Erlangen (Siemens), Eindhoven (Philips), Toulouse and Hamburg (Airbus)*

As in the other KnowledgeScapes research projects, a third group of scholars—Kerstin Büttner, Corinna Hölzl, and Gerd Held—did not tackle the immense institutional and organizational complexities of Global Players in toto. Instead, they followed two steps of complexity reduction:

1. They selected high-tech research and production departments of firms in which one could expect to find significant global and local networking processes, continuous knowledge flows, and innovative zones of trans (see Matthiesen and Reisinger 2011).
2. As in the other cases, interaction dynamics, KnowledgeScapes, and the interplay of informal milieu structures with strategic formal networks remain a primary topic. Minimally and maximally contrasting research fields were selected: Erlangen (Siemens) and Eindhoven (Philips) on the one hand; Toulouse and Hamburg (both Airbus) on the other. (For detailed presentation of research results reported by this team, see Matthiesen 2009b, pp. 7–55).

### Erlangen (Siemens) and Eindhoven (Philips)

Opting to study the development of picture-archiving and communications systems (PACS) as a research and production complex, the team members explored one of the most advanced and most profitable knowledge-intensive processes of product development within the medical divisions of Philips and Siemens. Büttner (for Siemens in Erlangen) and Hölzl (for Philips in Eindhoven) investigated (a) the interplay of formal innovation networks with informal knowledge milieus and (b) the extent of global networks and the ways in which they are related to local and regional network structures and to their corresponding types of stickiness (see Malecki 2000, pp. 103–110; Markusen 1996).

Interestingly enough, the two global players had chosen different, but successful, organizational strategies to survive the harsh competition within the highly profitable

PACS domain. Because Siemens tries to bundle substantial amounts of competence within localized domain knowledge and thereby integrates global competence networks, the company was more reluctant to resort to massive outsourcing than Philips was. The result was stronger local connectivity to the city region of Erlangen. This regionalized embedding strategy, however, may shift when top management changes, as happened in Erlangen: Heinrich von Pierer retired as chief executive of Siemens in May 2007 and was succeeded 2 months later by Peter Löscher, whose "coevolutionary" motto is "evolution rather than revolution."

Despite these differences, both global players have focused in recent years on worldwide client networks as the most important sources for innovation, especially on what are known as reference client's networks with relatively open zones of knowledge transaction and cultural knowledge-sharing styles. This latter kind of network implies a paradigmatic shift within the zone of trans. The core locus for the production and acquisition of new knowledge is not in the heads of research geniuses or in local competence networks or laboratories but rather in strategically selected global reference client networks, in their knowledge-bundling practices, and in the embedding knowledge cultures. Their integration within the specific knowledge culture of Siemens as a global player considerably differs from that at Philips. Siemens in Erlangen tries to strengthen locally situated knowledge domains to make them stickier in the long run.

This research thus clearly verifies Massey's (1999) and Berking's (2004) hypothesis of the global reconstruction of the local. In that sense, and beyond older global–local dualisms, this competitive KnowledgeScape reconstitutes new hybrids of local-regional-national-European-global knowledge connectivities. It integrates worldwide competencies of clients with very specific localized domains. It thereby proves that global competency networks, under certain circumstances, may even strengthen the stickiness of *local* KnowledgeScapes. In the Philips case, though, the Massey–Berking hypothesis has to be recast to account for the fact that domain knowledge in Eindhoven is not as concentrated in one location as it is at Siemens in Erlangen and therefore develops different modes for coupling global and local competence profiles.

### Toulouse (Airbus) and Hamburg (Airbus)

Held, in his line of research on KnowledgeScapes, compares the knowledge-based processes of interactional structuring at Airbus in Toulouse, France, with those at Airbus in Hamburg, Germany. A key finding in Held's comparisons, too, is the growing importance of different knowledge cultures as embedding structures for high-tech production strategies in both regions.

Increasingly, this new role of culture—more specifically, of knowledge culture—is being stressed by different institutional actors in aeronautics engineering and aircraft manufacturing, ranging from the Airbus management with its branding strategies to the trade unions at the company. Recent conflicts between France and Germany, specifically between Toulouse and Hamburg concerning the A 380 and A 350, for instance, seem to drive home the importance of different knowledge

cultures when it comes to grappling with production problems and seeking solutions. A complex array of knowledge bundles, relevance structures, values, competencies and identities interact at these levels—under the overarching theme of knowledge cultures and KnowledgeScapes.

Again, the IRS research team's strategy of minimally and maximally contrasting case studies within different KnowledgeScapes, seen from a coevolutionary perspective, can help illustrate what is usually "taken for granted" (Schütz 1967, p. 89): the fact that knowledge cultures are pivotal embedding mechanisms for innovative and strategic interactions and their spatial effects. This growing importance of knowledge cultures is bound to have profound consequences for "real-world" dynamics within the coevolution of space, knowledge, and milieus. And surprisingly new localizing effects may result from worldwide networks of client competency: Those networks take forms of knowledge competency encompassing proximity-based interaction dynamics and milieus and integrate complex bundles of them into sustainable forms of KnowledgeScapes.

## Orientational Knowledge and Knowledge-Based Governance

The research-guiding, pragmatist concept of knowledge as the capacity to act has direct consequences for the perspectives that KnowledgeScapes research has on governance arrangements and their multilevel operations. The following four points may help indicate some of these new relations between governance and KnowledgeScapes (see Heinelt and et al. 2011; Matthiesen and Reisinger 2011).

### *1. Knowledge as the Capacity to Act*

The KnowledgeScapes research team endorses a pragmatistic rather than a cognitivistic concept of knowledge, conceiving of knowledge as the capacity to act. In this sense action/praxis and knowledge/theory are no longer dichotomized universes in the research world. It follows that analyses of KnowledgeScapes are used as analytical tools to address practical problems, mostly in explicit ways, sometimes more implicitly.

### *2. Complexity and Steering Modes*

Coordinators of the interdisciplinary European Union (EU) project entitled "Governance for Sustainability" (GFORS, 6th Framework Programme, Priority 7), which involves research institutions from nine countries, invited us to adopt the KnowledgeScapes approach to improve their conceptual framework from the perspective of knowledge (see Heinelt et al. 2011; Nullmeier 1993; Nullmeier et al. 2011).

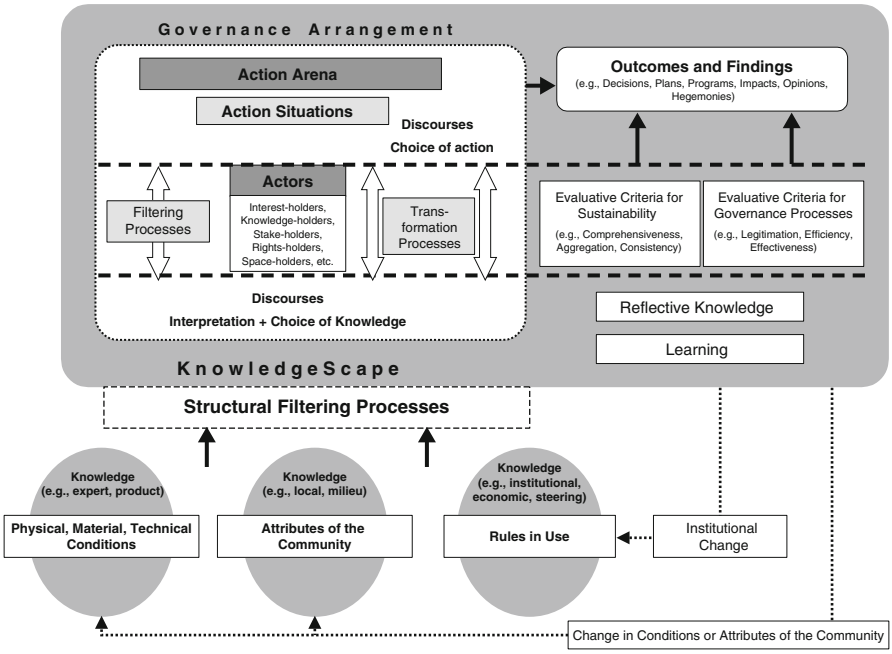


**Fig. 10.4** Action- and knowledge oriented processes of governance (From Matthiesen (2009, p. 22). Copyright 2009 by U. Matthiesen. Adapted with permission)

The scholars in this international project network were keenly interested in creative and regulative impacts of bundles of goal-specific forms of knowledge and in the role of reflective knowledge therein (Fig. 10.4).

From experience within this large project network, the KnowledgeScapes researchers have learned that any instrumental model of knowledge management and approach to governance (see Davoudi 2006) inadmissibly reduces the complexity of the many interfaces within the factual coevolution processes taking place between space, knowledge, and milieu. Instrumentalist governance models lose much of the specificity of knowledge regimes, knowledge landscapes, and their architectonics. In addition, any instrumentalist reduction of complexity becomes empirically divorced from phenomena such as creativity, novelty, surprising coevolutionary turns, crisis-like ruptures, and especially from self-organizing capacities of actor networks, which are so prominent in knowledge-based socio-spatial networks.

In this sense our EU research experience underlines the critique against strong instrumentalist steering ambitions within the coevolutionary world of space, knowledge, and interaction (see again Davoudi 2006). The main thrust of our research has thereby shifted toward orientational knowledge and case-specific proposals for fruitful learning and effective deliberation processes. This *deliberational* steering mode, together with a systematic integration of self-organizational capacities, is what

our KnowledgeScapes approach (and its core concept, milieu) clearly emphasizes. In keeping with this research strategy, we aim to strengthen case-specific and contextualized mixes and creative balances of top-down and bottom-up modes of governance.

In contrast to instrumentalist versions of steering, planning, and governance, the deliberational type of orientational knowledge (in line with the "Enlightenment model" by Davoudi 2006, pp. 16–20) integrates at least three complementary tendencies: (a) close consideration of context structures and transformational path effects, as the sketches of empirical case results above have tried to make plausible; (b) respect for and detailed study of embedding cultural structures, such as the case-specific effects of knowledge cultures; and (c) high regard for self-organizational capacities, especially among the informal networks of milieus. In cases of strong-tie non-innovativeness, however, fairly energetic strategic intervention may be needed to break up circular routines, redundancies, and homogenizing traits.

## *3. Effective Types of Governance within Coevolutions of Knowledge and Space?*

The KnowledgeScapes approach faces two crucial imperative questions—often posed by policy-makers and praxis-oriented actors: Are there clear-cut decontextualized indicators for "effective" forms of coupling knowledge, interaction, and governance? Are there general rules of allocation, composition, and construction for successful, innovative, spatially relevant actor networks and knowledge milieus in cities and regions?

The first plain answer is "No!" The second, more elaborate answer is that we, as KnowledgeScapes-Researchers, do not see any decontextualized recipes and aggregational rules by which to arrive at the most effective allocations and bundling types of coupling between knowledge, interaction, and governance. Quite the contrary, we are impelled to move ever more toward case-study generated, context-sensitive typologies of effective couplings between knowledge, space, and interaction. And these couplings are indeed highly praxis relevant, effective, and sometimes sustainable.

Of course, certain decontextualized general principles for knowledge-oriented spatial policies may be extracted. They all tend in the same direction and have little or nothing to do with restrictive financial contexts. For example, one stringent demand is for

> a program of sustained generic support [in the wider knowledge policy field]—through generous and long-term investment in universities, technical colleges, public research institutes, basic science and technology programmes, arts, media and cultural industries, and centres of experimental and future knowledge. Such a programme would help to secure not only a varied ecology of [KnowledgeScapes] but also a foundation for emergent, new, and unanticipated discovery. (Amin and Cohendet 2004, p. 138)

This description of principles holds true in a trivial sense, although nobody really knows in advance what is happening in such large-scale systems of interaction between knowledge and space. Because public resources are becoming increasingly scarce, one has to open up the black—or better, blue—box of sustained generic supporting visions (*Leitbilder*) and take a much more detailed look at factual coevolutionary interdependencies than has been the case thus far.

Even the seemingly well-defined criterion called effectiveness occasions a contextual halo structure, decentering objective effectiveness criteria. Hence, the second best answer to the urgent question about *effective* governance rules, including effective knowledge bundles, leads to a case-specific, contextualized effectiveness criterion. This criterion depends on sufficient knowledge about field- and case-specific coevolutionary, triple-helix structures integrating different knowledge forms, milieus, and networks within specific zones of knowledge transactions (see Matthiesen and Reisinger 2011, pp. 94–114). For research, this contextualized effectiveness criterion has an interesting policy consequence. As in the comparable case of an "evolutionary analysis of economic policy" (Pelikan and Wegner 2003), the outcomes of such an evolutionary triple-helix analysis are not simple sets of prescriptions but rather the basis for further developments (e.g., via "learning," "deliberation," and "preference changes") in the fields of orientational knowledge and of policy thinking (see the convincing analysis of the slippery fields of "evidence-based planning" in Davoudi 2006).

## *4. Strengthening of Specificities and the Intrinsic Logic of Cultural Landscapes!*

One important governance rationale behind the KnowledgeScapes approach is, therefore, to strengthen the specific knowledge potential of individual city regions (see the new research paradigm referred to as "Die Eigenlogik der Städte," or the "Intrinsic Logic of Cities," in Berking and Löw 2008; Matthiesen 2008). The times when regional policies under the spell of the logic of subsumption where simply deduced from societal metaconcepts (e.g., Postfordism, Information society, xyz valleys, and blueprint developments) have run their course. Instead, the salient, effective, and rather general policy proposal within this field from the point of view of KnowledgeScapes research is to strengthen local and regional cultural heterogeneity and tolerance in post-traditional knowledge societies. This assessment applies especially to societies with strong homogenizing tendencies (due to continuous processes of brain drain processes from EU peripheries, including postsocialist countries beyond them).

In summary, KnowledgeScapes-Research can show in detail how knowledge-based spatial developments are accompanied by new types of options, problems, conflicts, and sustainable solutions. These processes do not promise eternally

prosperous regional development but "produce" new, sometimes surprising couplings of growth, stagnation, and shrinkage, together with crisis-like interruptions as seedbeds of creative breakthroughs. The challenging research goal therefore remains to better understand and explain the coevolutionary dynamics between knowledge, space, and networks in this context. I understand our KnowledgeScapes approach as one attempt to come to grips with some of these hybrid dynamics and their causal, quasi-causal, reasonable, and unintended interdependencies. It accentuates the interplay of formal and informal network effects and of knowledge forms and knowledge cultures within KnowledgeScapes. It takes them seriously in terms of conceptualization, empirical research, and governance. From the outset the KnowledgeScapes approach has informed, and been informed by, practiced networking with other research paradigms, as was indicated by the considerable list of conceptual influences early in this chapter. Now, it depends even more on cooperation with and learning *from* them, for knowledge and non-knowledge obviously are dialectically intertwined with each other. Sharing of knowledge within fruitful zones of knowledge transaction therefore remains essential in order to further improve comprehension of the coevolution of space, knowledge, and milieu.

## Notes

1. Knowledge in its multiple (sometimes reflective) forms (see Figs. 10.1 through 10.3) with hybrid embeddings and differentiated transaction zones in urban regional spaces may pose an even greater challenge than other types of space to the strong causal explanatory claims made in leading theoretical approaches to coevolution in the fields of knowledge–space interaction (see Boschma 2007; Schamp 2009). In addition, it seems necessary to reintroduce the somehow forgotten distinctions between causes, reasons, intentions, and unintended consequences in order to understand and explain these processes. In knowledge-based spatial developments they are later increasingly accompanied and contextualized by learning, processes of deliberation, learning-based preference changes, and cultural codification processes. Taking that step could re-integrate saliant aspects of the former reason–causes debates within analytical action philosophy and speech-act theory into the discourse domain of KnowledgeScapes—after the spatial turn, that is.
2. For a more detailed discussion of these knowledge forms, see Matthiesen (2005b). As Peter Meusburger (2006) rightly observes, any visual model is apt to be misunderstood as a description of static relations and mechanistic interactions. This risk makes the time axis in our model critical.
3. See, for example, the heavy impact of knowledge cultures on the cross-border relations between Germany (Frankfurt on the Oder) and Poland (Slubice), as analyzed by Fichter-Wolf and Knorr-Siedow (2009, and above).

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# Part III
# Knowledge and Geographical Clusters

# Chapter 11
# Organizational Legacy and the Internal Dynamics of Clusters: The U.S. Human Biotherapeutics Industry, 1976–2002

**Maryann Feldman and Elaine Romanelli**

The mechanisms underlying why an industry thrives in one place while languishing in another remain poorly understood. Case histories enrich the understanding of the development of industries within particular regions, especially those that are known, post hoc, to be successful. These case studies provide little systematic explanation, however, for the factors that distinguish differential growth, especially among regions with similar initial resource endowments. Anecdotal evidence notwithstanding, few researchers have attempted to characterize the internal processes that generate local entrepreneurship. Only by systematically comparing differences in the development processes of regions that have similar early resource endowments will social scientists be able to explain why industries develop in some regions but not others. Until we researchers track the geographic patterns of entrepreneurial and organizational migrations across regions over time and begin to systematically investigate the characteristics of regions that attract and repel investment by firms, we will be left to assume simply, if unsatisfactorily, that the location of industrial clusters was preordained—the obvious result of resource endowments or historical accidents. Regional leaders will continue to invest and to compete, but social science will have little to say about how they might compete in more effective ways and ultimately influence the outcomes of economic development.

Industrial clusters are a pervasive and persistent feature in the organization of economic activity. Prevailing theory has emphasized the importance of resources as an explanation for the location of industrial clusters, arguing that innovative activity

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tends to cluster in regions where resources relevant to the performance and survival of firms are most abundant. Many resources have been included, such as the presence of skilled labor and access to transportation (Krugman 1991), proximity to markets and input suppliers (Baum and Haveman 1997; Storper and Christopherson 1987), the presence of universities and research organizations (Zucker et al. 1998), and cultural and institutional supports for entrepreneurial activity (Saxenian 1994; Sorenson and Audia 2000; Stuart and Sorenson 2003). Yet when one considers spatial patterns, there is always the concern of endogeneity; firms and resources develop in tandem, and causality is difficult to attribute. The presence of resources may affect productivity but not account for the location of firms. Indeed, the actions of entrepreneurs create and augment the resources that define successful clusters (Feldman et al. 2005).

This chapter begins to fill the empirical gap in the understanding of industrial clusters by examining the influence of entrepreneurs' organizational backgrounds, or what we term organizational legacies. In any new industry, entrepreneurs come from a variety of backgrounds. These backgrounds provide founders with different expectations, operating procedures, and business models: imprinting expectations and routines that affect the viability of the newly founded firm. Certain backgrounds are comparatively conducive to openness and information-sharing, so entrepreneurs from those organizations are more likely to start firms that provide knowledge spillovers conducive to regional growth. Thus, the differential composition of existing firms in a place influences further entry. After controlling for resource endowment and industry size, we find that a high percentage of firms that are imprinted with practices open to information-sharing and networking yield the internal dynamics that encourage subsequent formation of new firms.

We investigate the development of the human therapeutics industry, an important segment of the biotechnology industry—the commercial application of scientific discoveries in genetic engineering—starting in 1976 with the founding of the first firm to use modern biotechnology and continuing until 2002. Our work is the first that we know of to consider the internal industrial demography of cluster development, including both the organizational and geographic origins of entrepreneurs and firms that came to populate biotech clusters (see also Romanelli and Feldman 2006). It is also one of the few studies—Saxenian (1994) and Sorenson and Audia (2000) being two important ones—to consider cluster development in the context of multiple, competing regions. Though our findings are limited to patterns that we can observe in just one U.S. industry, they establish a basis for theorizing about the dynamics of clustering both within and across geographic regions that may be formally tested in this and other emerging industries. By focusing on where the entrepreneur was previously employed, we capitalize on the notion that careers situate entrepreneurs in a social structure of existing firms that facilitates or constrains the flow of opportunities and resources (Burton et al. 2002, p. 232).

The first section of this chapter examines spatial clustering in the human biotherapeutics industry. Basically, there are three competing hypothesis that explain cluster growth: resource endowments, the long-term impact of initial events, and organizational legacy. Our findings show that simple geographic patterns support

neither of the first two hypotheses. Our focus is on organizational legacy, the topic developed in the second section. In the section thereafter we discuss our data and present methodological issues related to studying cluster dynamics. The fourth section presents empirical results from our inquiry. The chapter concludes with a discussion of the development of industrial clusters.

## The Development of the U.S. Human Therapeutics Industry

The start of the human biotherapeutics industry in the United States begins in San Francisco in 1976 with the founding of Genentech, arguably the first commercial firm dedicated to the use of biotechnology (see Table 11.1). The commercial viability of biotechnology was established in 1978, when Eli Lilly licensed Genentech's clone of a human insulin gene. Genentech's first public offering (IPO) on October 14, 1980, ushered in a veritable gold rush, with an increased number of new firms entering the field (Wade 1980). In addition, incumbent human therapeutics firms started working with rDNA. For example, Cetus Corporation, located in San Francisco and originally founded in 1971 to work on cancer therapies, publicly announced in 1978 that it was beginning work with biotechnology. In March 1981, Cetus raised $107 million, at that time the largest IPO by a new corporation in U.S. history, even though the company prospectus mentioned no potential for profitability until 1985.

This attractive investment climate and the response to the new industry by start-ups and existing firms alike heralded a steeper growth trajectory for the industry. As Fig. 11.1 demonstrates, the number of firms in the U.S. biotherapeutics industry rose by 22 % per annum from 1976 to 2002. From 1976 to 1984, the number of

**Table 11.1** Companies established in the U.S. Human Biotherapeutics Industry before 1980, by metropolitan statistical area

| Metropolitan statistical area | Company (year of founding or entry to the industry) | No. of companies, 2002 |
|---|---|---|
| Albuquerque, New Mexico | Summa Medical (1979) | 0 |
| Boston-Cambridge-Quincy, Massachusetts | Biogen (1978) | 53 |
| Dallas-Fort Worth-Arlington, Texas | Wadley Biosciences (1978) | 2 |
| Durham, North Carolina | Medco Research (1978) | 20 |
| Philadelphia-Camden-Wilmington, Pennsylvania-New Jersey-Delaware-Maryland | Centocor (1979) | 19 |
| San Diego-Carlsbad-San Marcos, California | Hybritech (1978) | 54 |
| San Francisco-Oakland-Fremont, California | Genentech (1976)<br>Cetus Corp (1978)<br>Hana Biologics (1979) | 57 |
| Washington-Arlington-Alexandria, D.C.-Virginia-Maryland-West Virginia | Genex (1977) | 14 |

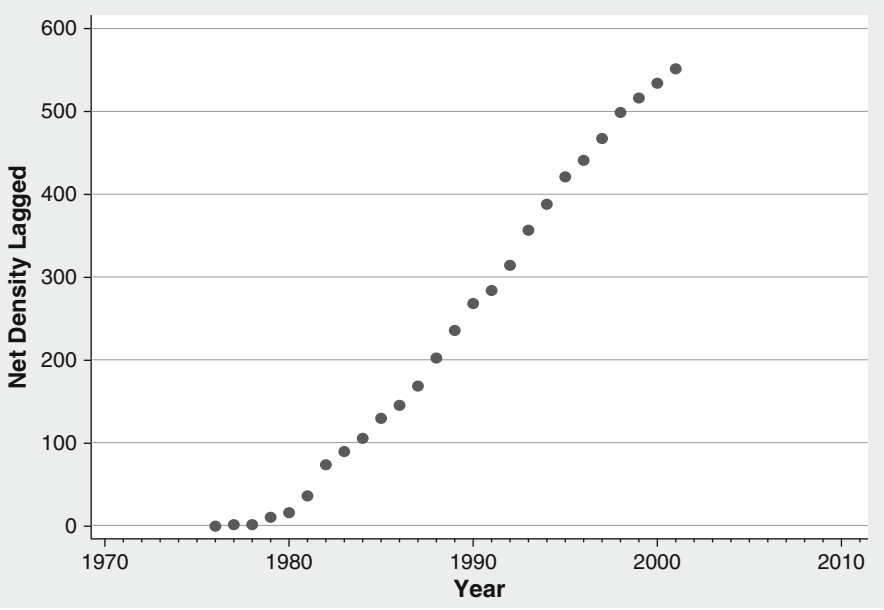


**Fig. 11.1** Growth in the number of firms in the U.S. human biotherapeutics industry, 1976–2001 (Source: Authors' computation from BioScan data)

human biotherapeutics firms almost doubled each year, with the rate slowing in the mid-1980s. In 2002 there were 522 human biotherapeutics firms in the United States.

Having sprouted in the San Francisco Bay area, the industry expanded geographically as new firms entered. By 1980, human biotherapeutics firms could be found in 8 regions in the United States. By 1985, such firms could be found in 30 cities; and by 2002, in 60 regions. Overall, from 1976 to 2002, 75 regions had become home to at least one biotherapeutics firm.

In terms of the industry location quotient, however, regions were not similar in their patterns of growth (see Table 11.2).[1] For example, there were 35 human biotherapeutics firms in New York in 1985 and 47 in 2002. Compared to the size of the New York region's population, such companies are overrepresented in New York, with more than 10 % of the industry being located there. The location quotients of over 30 for the region of Durham, North Carolina, and 12 for that of San Diego, California, reveal even stronger apparent advantages. Notably missing are regions such as Chicago, Illinois, which would appear to be a logical location for human biotherapeutics firms given its prominent research universities and existing pharmaceutical firms. There were six firms in Chicago in 1985 and eight in 2002.

Arthur (1990) and Rauch (1993) challenged the primacy of resources as an explanation for the location of industrial clusters, arguing instead that an early lead in a region's concentration of similar new firms can promote the formation of an

**Table 11.2** Regional distribution of firms in the U.S. human biotherapeutics industry, 1985 and 2002

| | 1985 | | | 2002 | | |
|---|---|---|---|---|---|---|
| Metropolitan statistical areas | No. | % of industry | Location quotient[a] | No. | % of industry | Location quotient |
| Albuquerque, New Mexico | 2 | 1.20 | 3.034 | 0 | 0.00 | 0.000 |
| Atlanta-Sandy Springs-Marietta, Georgia | 1 | 0.60 | 0.617 | 3 | 0.69 | 0.583 |
| Austin-Round Rock, Texas | 0 | 0.00 | 0.000 | 3 | 0.69 | 1.481 |
| Baltimore-Towson, Maryland | 0 | 0.00 | 0.000 | 2 | 0.46 | 0.732 |
| Birmingham-Hoover, Alabama | 1 | 0.60 | 0.000 | 2 | 0.46 | 1.185 |
| Boston-Cambridge-Quincy, Maine-New Hampshire | 18 | 10.78 | 6.492 | 53 | 12.18 | 7.659 |
| Boulder, Colorado | 2 | 1.20 | 15.446 | 5 | 1.15 | 10.654 |
| Chicago-Naperville-Joliet, Illinois-Indiana-Wisconsin | 6 | 3.59 | 1.228 | 8 | 1.84 | 0.479 |
| Cleveland-Elyria-Mentor, Ohio | 1 | 0.60 | 0.775 | 3 | 0.69 | 0.872 |
| Dallas-Fort Worth-Arlington, Texas | 1 | 0.60 | 0.459 | 2 | 0.46 | 0.240 |
| Durham, North Carolina | 2 | 1.20 | 10.563 | 20 | 4.60 | 30.774 |
| Houston-Baytown-Sugar Land, Texas | 5 | 2.99 | 0.907 | 12 | 2.76 | 1.580 |
| Los Angeles-Long Beach-Santa Ana, California | 9 | 5.39 | 1.436 | 15 | 3.45 | 0.654 |
| Madison, Wisconsin | 0 | 0.00 | 0.000 | 4 | 0.92 | 4.956 |
| Miami-Fort Lauderdale-Miami Beach, Florida | 0 | 0.00 | 0.000 | 5 | 1.15 | 0.621 |
| Minneapolis-St. Paul-Bloomington, Minnesota-Wisconsin | 1 | 0.60 | 0.000 | 3 | 0.69 | 0.628 |
| New Haven-Milford, Connecticut | 1 | 0.60 | 2.110 | 8 | 1.84 | 5.297 |
| New York-Northern New Jersey-Long Island, New York-New Jersey-Pennsylvania | 35 | 20.96 | 2.963 | 47 | 10.80 | 1.632 |
| Philadelphia-Camden-Wilmington, Pennsylvania-New Jersey-Delaware -Maryland | 5 | 2.99 | 1.248 | 19 | 4.37 | 2.303 |
| Salt Lake City, Utah | 2 | 1.20 | 2.252 | 6 | 1.38 | 4.495 |
| San Diego-Carlsbad-San Marcos, California | 9 | 5.39 | 5.440 | 54 | 12.41 | 12.154 |
| San Francisco-Oakland-Fremont, California | 20 | 11.98 | 8.073 | 57 | 13.10 | 9.206 |
| San Jose-Sunnyvale-Santa Clara, California | 8 | 4.79 | 9.116 | 21 | 4.83 | 7.174 |
| Seattle-Tacoma-Bellevue, Washington | 5 | 2.99 | 3.659 | 17 | 3.91 | 3.886 |
| Trenton-Ewing, New Jersey | 4 | 2.40 | 21.039 | 5 | 1.15 | 10.654 |

(continued)

**Table 11.2** (continued)

| Metropolitan statistical areas | 1985 | | | 2002 | | |
|---|---|---|---|---|---|---|
| | No. | % of industry | Location quotient[a] | No. | % of industry | Location quotient |
| Washington, D.C.-Arlington-Alexandria, D.C.-Virginia-Maryland-West Virginia | 9 | 5.39 | 3.107 | 14 | 3.22 | 2.071 |
| Subtotal *of* human biotherapeutics firms in U.S. metropolitan statistical areas | 146 | 87.04 | | 388 | 89.20 | |
| TOTAL human biotherapeutics firms in the entire United States | 167 | 100.00 | | 435 | 100.00 | |

[a]The location quotient is a measure of the concentration of industry in a region compared to the national average for that industry. In this table, the location quotient is calculated by means of a fraction whose numerator expresses the proportion of human biotherapeutics firms in the given region divided by the national number of human biotherapeutic firms. The fraction's denominator expresses the population in the region divided by the national population. A location quotient of one indicates that the distribution of local firms mirrors what one expects, given the region's population. A location quotient above 1 indicates that the region has a higher-than-average concentration, and a score of less than one is indicative of a lower-than-average concentration

industrial cluster. Arthur (1990) demonstrated that a small early lead can generate positive feedback in regions with fewer or inferior resources. We add that high uncertainty characterizes the early evolution of new industries: The nature and, hence, the location of the best resources for the emerging industry are unknown. The number of new firms in a region serves as a heuristic for prospective entrepreneurs. If entrepreneurs respond to such heuristics, positive feedback would guarantee that even small early leads, which might be accidental, could guarantee lasting regional differences in cluster sizes.

Figure 11.2 shows the growth in the number of human biotherapeutics firms for the eight regions that benefited from an early start. They are places where firms were located before 1980, a year that is notable for the granting of the Cohen-Boyer patents, which covered gene splicing; the passage of the Bayh–Dole Act, which enabled universities to license academic discoveries; and the Genentech IPO. All these events directed attention to the emerging biotechnology industry and the increase in the number of firms entering it.

The fastest growing clusters—Boston and San Francisco—mirror the national growth trajectory. San Diego started more slowly but caught up to the most rapidly growing group, an interesting feat given the city's smaller size and resource base. Although Arthur (1990) hypothesized that early entry is associated with agglomeration development, our data reveal that, despite an early lead, the industry failed to develop in Albuquerque and Dallas. Neither location had more than three firms at any one time. Thus, early entry does not appear to fully explain success at building an industrial cluster.

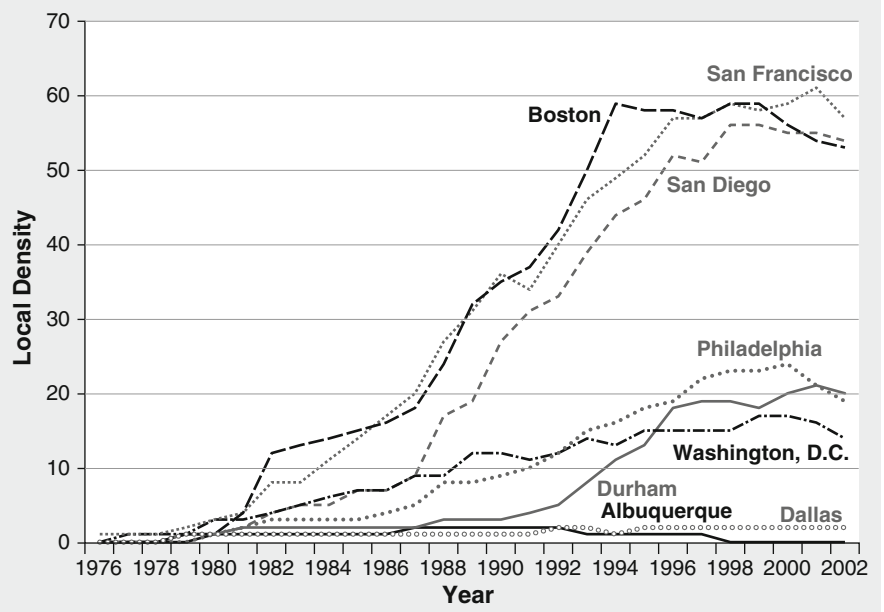


**Fig. 11.2** Number of firms in the U.S. human biotherapeutics industry by region, regions with at least one firm prior to 1980

Aside from the fast-growing regions and the regions where the industry did not develop, there is a middle group of regions. The cities of Durham, North Carolina; Philadelphia, Pennsylvania; and Washington, DC—arguably the second tier—grew more slowly than it did in Boston, San Francisco, and San Diego, but the experience was not uniform. For example, the Durham region had a substantial increase in the number of biotherapeutics firms with the entry of second-generation spin-offs after 1991. Washington, DC, and Philadelphia did not experience a similar lift, but the new firms that entered the biotherapeutics industry in those two cities came mainly from academic and research institutions or large companies (Romanelli and Feldman 2006). These observed differences suggest that internal dynamics may account for different underlying patterns of growth.

The concept of industrial clusters draws attention to the internal organization of firms within a geographically defined area. There is general agreement that clusters tend to persist because of positive externalities resulting from close geographic proximity; greater geographic density of firms both facilitates social interaction among individuals at related and competing firms and promotes innovation and experimentation. The exchange of valuable information about R&D, production, and markets may improve the performance and survival chances of the individual firms and encourage others to enter.

For a given technology and place, the propensity of firms to share information may be a differentiating characteristic that drives cluster growth (Rosenthal and

Strange 2003; Saxenian 1994). Social networks provide a means for reducing uncertainty and may create a shared vision of the emerging technology and the appropriate business model. Rosenthal and Strange (2003) found that a concentration of similar small firms, a proxy for local cohesion and culture, yielded subsequent greater formation of new firms. This connection suggests the salience of internal cluster dynamics for the ability of a cluster to grow and realize critical mass. Few studies, however, have explored either the organizational or geographic origins of entrepreneurs and firms populating an industrial cluster. Although some scholars (e.g., Freeman 1986; Gompers et al. 2005; Romanelli 1989; Stinchcombe 1965) have considered the characteristics of organizations that may be more or less prolific generators of new organizations, little empirical evidence has been brought to bear on the question of regional dynamics that generate the new firm entry fundamental to the growth of industrial clusters.

## Entrepreneurship, Organizational Legacy, and Cluster Growth

When an industry is new, entrepreneurs perceive an opportunity based on their work in existing organizations. In a dynamic process, "organizations create their own competition by providing the skills and background that provide for credibility for the entrepreneur. They provide the knowledge of opportunity by placing the person in a position to know about unserved or badly served markets" (Freeman 1986, p. 39). Entrepreneurs may similarly perceive opportunity at existing organizations anywhere in an industry's value chain. However, when an entrepreneurial opportunity is present, "the probability that a man or group of men would be motivated to start a company is dependent on the social structure [of the organization] and the position of men within it" (Stinchcombe 1965, p. 147). Therefore, not all organizations have the same propensity to encourage entrepreneurship. After controlling for resource endowment and early entry, one finds that regional growth may be determined by internal cluster dynamics due to the composition of firms within an industry.

The literature has established that organizations imprint onto entrepreneurs recipes or logics that dictate internal operations and procedures and affect the profitability and success of the new venture (Baron et al. 2001; Burton et al. 2002; Feldman et al. 2008). Organizational imprinting also affects how firms interact with external environments (Marquis 2003). Saxenian (1994) documented how the networked structure of Silicon Valley contributed to flexibility and economic growth greater than that achieved by the more hierarchical organizations in Massachusetts's Route 128. Hierarchies tend to shelter their core competencies from the external environment and not engage with local communities. By contrast, networks are embedded with their local environments, and their more fluid boundaries promote rapid exchanges of information (Podolny and Page 1998; Powell 1990; Smith-Doerr 2004). Saxenian (1994) argued that, even though Silicon Valley and Route 128 were similar in terms of resources, the local culture of information sharing determined the growth of the local economy.

Consistent with the idea of internal cluster dynamics and organizational legacy, Jacobs (1969) suggested that cluster growth is driven by what she described as "breakaway firms" (pp. 97–99), a British term designating businesses that are started by entrepreneurs with experience in the same industry. Such practice was formalized by the medieval guilds: "An apprentice learned the work in an existing organization, then became a journeyman employed in the same organization or others similar, and then, if all went well, he set up a shop on his own as a master and took on apprentices" (p. 66). The process is tied to innovation because breakaways experiment with variations learned from prior work and find new ways of creating value. Jacobs's conceptualization has a decided local orientation that grounds the entrepreneur in a community of practice and social relationships. A more formal way of putting it is that employees from existing organizations in the same industry have the intellectual capital, in terms of both their knowledge of the technology and their professional networks, to start companies in the same location. Established firms in the industry may serve as a training ground—an advanced apprenticeship for entrepreneurs. This observation is certainly part of the lore of Silicon Valley, where semiconductor firms form a family tree in a cascading series of spin-offs from Fairchild Semiconductor, the original firm of its type in Silicon Valley (Kenney and Von Berg 1999).

Certain types of organizational legacies may encourage networking and information-sharing and, by thus encouraging the formation of new firms, may be associated with the development of industrial clusters. This dynamic may operate in one of two ways. First, a geographic collection of firms started by individuals who have similar backgrounds may be more likely to share common networks and to be willing to exchange information than is the case with firms started by individuals from dissimilar backgrounds. Second, organizational legacies that are less hierarchical may be more conducive to information-sharing. Experience in certain types of organizations may provide a legacy more conducive to information-sharing and the free flow of ideas than experience in other types of organizations does, thereby linking organizational type and regional growth. For example, Smith-Doerr (2004), in examining the career paths of women scientists, characterizes pharmaceutical firms and universities as hierarchies, whereas she sees biotechnology firms to be operating as network organizations. She finds that biotechnology firms offer greater opportunity for career advancement, especially for women, than hierarchical organizations do, an assessment consistent with the idea that networked organizations promote greater learning and information exchange. These different types of organizational legacies may determine the local environment, with a large percentage of entrepreneurs coming from less hierarchical organizations that encourage the creation of firms. Saxenian (1994) argued that semiconductor producers in Silicon Valley, most of whom had been the founders of their firms, were far more supportive of employees (managers and engineers) who sought to strike out on their own than producers elsewhere.

Table 11.3 shows the number of human biotherapeutics firms in the U.S. from 1976 through 2002, broken down by type of organizational legacy. Most of the firms (455, or 66 %) were established as start-ups, and the remaining 44 % were existing

**Table 11.3** Firms in the U.S. biotherapeutics industry by types of entry and organizational origins

| | All firms | | |
|---|---|---|---|
| Origin or type of organization | No. | % of entrants | % of startups |
| *Startups* | | | |
| From university or research institute | 205 | 30 | 45 |
| From an existing biotherapeutics organization | 70 | 10 | 15 |
| From pharmaceutical organization | 24 | 3 | 5 |
| From multiple source types (hybrid) | 50 | 7 | 11 |
| From venture capital firm | 64 | 9 | 14 |
| From other type of firm | 21 | 3 | 5 |
| No information | 21 | 3 | 5 |
| Subtotal | 455 | 66 | 100 |
| Spin-off from exiting organization outside the pharmaceutical and biotherapeutics industries | 55 | 8 | |
| Direct entries by established firms | 62 | 9 | |
| Subsidiaries | 75 | 11 | |
| Mergers | 30 | 4 | |
| Joint ventures | 11 | 2 | |
| TOTAL | 688 | 100 | |
| Relocated Firms | 60 | | |

A local start-up is defined as a firm whose founding entrepreneur had been employed in the same metropolitan statistical area (MSA) as the new firm. Hence, the total sample of 688 firms excludes 60 firms that had relocated from one MSA to another within the U.S. biotherapeutics industry as well as those firms started by an individual from another MSA. Percentages have been rounded to whole numbers

firms that began using biotechnology for human therapeutics. Table 11.3 demonstrates that 10 % of start-ups were formed by entrepreneurs previously employed in the human biotherapeutics industry. This finding suggests that once a firm exists in the industry in a location, regardless of how it entered, it may become an incubator for other breakaways. We expect that firms with this type of legacy will be associated with greater cluster growth than will firms without this legacy and that the most vibrant clusters will have a higher proportion of firms with this legacy than will less vibrant clusters. We hypothesize that most successful clusters may be those in which Jacobs's description of breakaway firms is operative.

Scientists from universities or private research institutes founded half of the start-up biotherapeutics firms. These firms account for the geographic dispersion of the industry, which mirrors the geographic distribution of academic institutions. Academic scientists have the intellectual capital to start companies yet are imprinted with hierarchical expectations (Smith-Doerr 2004). They lack the appropriate organizational legacy to encourage entrepreneurship, promote commercial networking, and ultimately put their region on an attractive growth trajectory.

The pharmaceutical sector probably affords the industrial background most relevant for human biotherapeutics. Five percent of the human biotherapeutics start-ups had this type of organizational legacy. A key difference is that the traditional pharmaceutical industry focuses on chemistry, whereas the new industry focuses on genetics (Galambos and Sturchio 1998). Moreover, pharmaceutical firms, though they represent an older organizational blueprint that certainly provides knowledge about product markets and distribution, are less externally focused and networked than biotherapeutics firms are.

Part of the folklore in the industry is the importance of start-up firms created by venture capitalists who identify an opportunity and then create a company by hiring the appropriate human capital and licensing technology. The venture capital model is associated with contact to big industry and with an ability to network. Gompers et al. (2005) showed that organizations funded by venture capital were more likely to generate other new entrepreneurial firms than were organizations created or funded in other ways. For this industry segment, 15 % of the firms were attributed to a venture capital legacy.

Whereas many firms are created by entrepreneurs engaged in a solo effort, other firms are founded by collective team efforts that bring together individuals from diverse backgrounds (Ruef et al. 2003). This second alternative has been documented in biotechnology, where it is common for a founding team to follow a hybrid model composed of academic scientists and individuals with a business background, either venture capitalists or someone previously at a biotechnology firm (Liebeskind et al. 1996; Powell et al. 2002). Of the firms in the biotechnology sector, 11 % have this type of hybrid legacy. A hybrid organizational legacy positions the new firm at the intersection of diverse social and informational networks. The hybrid form is expected to increase access to different types of expertise, and the presence of a comparatively high proportion of these firms may increase the high velocity of information flows.

Entrepreneurship is often described as a local process encouraged by certain types of cultural norms, business climates, or industrial milieus. This concept has proven notoriously difficult to model and is thus impossible to adequately convey to people seeking advice on economic development. Many economic development pundits advocate networking as a means to spawn clusters. Our results suggest that internal cluster dynamics drive the connectivity of firms, shape their openness to sharing and promoting experimentation, and encourage the formation of new local start-ups. Individual entrepreneurs, their firms, and the locations involved shape an internal logic that constitutes a supportive culture promoting the types of information exchange associated with industrial clustering. Some templates, such as those formed via apprenticeships in industry, may be more conducive than others to promoting information-sharing and the construction of a local culture of entrepreneurship and may thus increase the number of new firms entering the sector. In the next section we set up an empirical model to test the effects of organizational legacy on the entry of new firms.

## Data, Methodology, and Sources

### *Sample and Dependent Variable*

Our dependent variable is the number of local start-up firms in U.S. Metropolitan Statistical Areas (MSAs), counted annually from 1976 to 2002. A local start-up is defined as a firm where the entrepreneur was previously employed in the same geographic area. Thus, we exclude firms that relocated from one MSA to another within the U.S. biotherapeutics industry and those started by individuals who had been employed in another MSA. This decision allows us to capture the effect of local variables on local entry. There were 75 such regions that had more than one human biotherapeutics firm at some point during the 27-year period under study. Our dependent variable is a count variable, and we use pooled cross-section data in the estimation. The distribution of the number of firms exhibits overdispersion and an excess number of zeros. We use the zero-inflated negative binomial regression model with fixed annual effects to account for the influence of period differences and other sources of heterogeneity that varied over time.

We identified 688 firms—including both U.S. and foreign-owned organizations—that were engaged in human biotherapeutics research and product development in the United States over the study period. Data on the firms were collected primarily from *BioScan* (1987–2004), a comprehensive industry directory that provides information about the characteristics of biotechnology firms and about product research, strategic alliances, and management teams. Although data were collected through 2004, we ended the study period at 2002 because of lags in reporting by *BioScan* (1987–2004), especially in its listings of new firms. Firms in the human biotherapeutics industry were identified from a review of actual products in research or production as indicated in *BioScan* and supplemented by an extensive review of business and industry press publications.[2] These data were used for all the tables and figures included in this chapter.

We tracked firms over time with specific attention to changes in the names and organizational forms of the firms. Human biotherapeutics is a turbulent industry with a large number of firm failures, acquisitions, mergers, and cessations of activity in human biotherapeutics. In some cases, acquired firms were left intact as separate operating subsidiaries of the acquiring organizations. In other cases their assets were absorbed into the activities of the acquiring organization. In the first scenario, we coded the exit of the original organization and the entry of a new organization as a subsidiary even if the name of the organization did not change. We proceeded similarly with mergers, coding the exits of the merging organizations and the entry of a new organization even when the merged organizations continued under the name of one of the merging organizations. To avoid double counting, we coded the last year of existence for the acquired or merging organizations as the one in which the acquisition or merger occurred and the first year of the new firm's existence as the year following the acquisition or merger.

We cannot claim that our sample encompasses all human biotherapeutics firms operating in the United States over the period under study. In particular, we suspect we may not have identified very small firms, especially those that existed during the earliest and latest periods of the study. Nonetheless, our extensive inquiries into the histories of biotherapeutics entrepreneurs and firms and into the evolution of the U.S. biotechnology industry as a whole turned up only a few that were never listed in *BioScan* (1987–2004). They were included in our database when we found them. We therefore believe that our coverage of the industry is comprehensive. Of particular interest to questions explored in this chapter is that we have no reason to believe our coverage is biased toward biotherapeutics activity in particular regions.

Additional data were collected from published sources such as Security and Exchange Commission (SEC) 10 K reports, databases of newspapers and other published sources, extensive web-based searches, and personal interviews. Data were verified and triangulated from these multiple sources.

## *Geographic Coding*

Geographic origins and destinations of entrepreneurs and organizations were coded using the 2003 U.S. Office of Management and Budget (OMB) Bulletin No. 03–04, which lists MSAs and combined MSAs, among other groupings, based on information obtained in the 2000 census. As described in the bulletin, the designation of MSAs is based on their having "at least one urbanized area of 50,000 or more population, plus adjacent territory that has a high degree of social and economic integration with the core as measured by commuting ties" (p. 1). A total of 362 MSAs (not including Puerto Rico) were listed, encompassing 1,090 counties, approximately 35 % of all U.S. counties, and about 83 % of the U.S. population. We classified the MSA locations of firms in the study as well as the organizational origins of their entrepreneurs and antecedent firms, using zip code data that allowed us to identify counties (the core units of MSAs) and thus the relevant MSAs themselves.

The use of MSAs and combined MSAs, rather than city or state geographic boundaries, is attractive for identifying regions of activity in that MSAs are designated on the basis of regional economic integration independent of political boundaries. We use the OMB's 2003 geographic classification scheme, which is based on the 2000 Census of Population. The period under study is long, and both the distribution of the population across regions and the economic integration within regions have not been static. The decision to classify location raises the possibility that a firm may be incorrectly attributed to a location at the time of an entry or exit event. For example, under the 2003 classifications, a firm located in Worcester County, Massachusetts, would be part of the Worcester MSA. But Worcester used to be considered part of the Boston MSA, so without a consistent classification, a firm could be classified as located in Boston and then Worcester without ever changing its physical address. Our procedure classifies the organization as located in the Worcester MSA over the entire period.

To explore the extent of this difficulty, we tracked the classifications of counties from 1976 through 2002. The classification schemes changed most dramatically after each decennial U.S. census, with new MSAs being designated and old MSAs being reorganized in terms of their county components. These shifts sometimes combined counties hitherto classified as separate MSAs and sometimes separated counties previously classified under another MSA. Except for the addition of wholly new MSAs (e.g., Corvallis, Oregon, in the 2003 classification), the MSA classifications over the study period are remarkably consistent. Approximately 85 % of the MSAs listed in the 2003 bulletin were also listed in the 1976 bulletin; changes in their county compositions reflected mainly the addition of one or more adjacent counties.[3] Assuming that the 2003 classifications represent trends in population growth and regional economic integration that were developing long before the official classifications, we feel comfortable using the single classification scheme to designate regions over the entire period under study.

## *Organizational Legacy*

To track the organizational origins of entrepreneurs and firms in the industry, we collected data on the types of organizations where founders were previously employed. Six categories of organizational origins were used: (a) universities or research institutes, (b) existing human biotherapeutics firms, (c) traditional pharmaceutical firms, (d) venture capital firms, (e) hybrids of the above categories in cases where two or more entrepreneurs emerged from different sources, and (f) other types of organizations. Classification was based on the founder's immediately prior place of employment and is restricted to entities in the same MSA. Sixty-eight percent of the firms were founded in the regions in which the entrepreneurs had been previously employed.

The variables of organizational legacy are calculated as the number of firms with founders of a specified background divided by the total number of biotherapeutics firms in the region. What we refer to as the science legacy variable is thus the proportion of academics whose start-ups in the cluster still existed in the prior year. We omitted the proportion of firms founded by entrepreneurs with a variety of experiences in other sectors of biotechnology or completely different industries.

## *Control Variables*

We controlled for two primary regional resources: the total dollar amount of research awards from the National Institutes of Health (NIH) and the total dollar amount of venture capital awards made to biotherapeutics firms in the region. The average NIH grant lasted approximately 3 years, and we use a simple arithmetic average of the total dollar amount of NIH awards received in a region, lagged by 1 year. These data

were obtained from the NIH. Data on venture capital awards were obtained from Venture Expert. They, too, were lagged by 1 year. We also controlled for the number of human biotherapeutics firms at both national and regional levels to account for density-dependent effects (Hannan and Freeman 1989). Finally, we included MSA population, which was to control for region size. Table 11.4 provides descriptive statistics.

We estimated the model separately for two roughly equal periods: 1976–1989 and 1990–2002. This decision splits our study into two roughly equal periods, but it is justified for other reasons. The industry started in 1976 and moved to a steeper growth trajectory after 1990 because of the convergence of factors such as several successful IPOs, a general increase in the patenting and licensing of university intellectual property, and an intensification of scientists' involvement in commercial activity. The choice also makes our results comparable to the study by Zucker et al. (1998, p. 291), who examine the development of the U.S. biotechnology industry from 1975 to 1990. They note that specialized academic human capital was the principal determinant of the growth and location of the industry in the early period but speculate that this pattern would change as the industry developed and the science became more routine. Although we present empirical results for both periods that we have selected, our results are robust when we estimate the model by using different temporal delineations around the breakpoint. Thus, we conclude that the pattern of development did evolve from the early founding of the industry.

## Empirical Results

Table 11.5 presents the empirical results based on the zero-inflated negative binomial model. Our dependent variable was the number of new local human biotherapeutics start-up firms in a geographic location in a year. Column 1 provides a baseline model with the control variables for the 75 MSAs for the 27-year period (1976–2002). All controls were significantly related to the number of biotherapeutics firms in a region in a year. The NIH and venture capital resource variables were positive and significant. Moreover, the coefficients on both national and local population densities exhibited the expected curvilinear (inverted U-shape) relationship to population size.

Column 2 adds in the organizational legacy variables. The coefficients on these variables measure the effect that concentrations of existing firms with different types of organizational legacies had on local new firm start-ups. The largest impact on the formation of new firms was associated with a concentration of existing firms with the hybrid legacy that involved a founding team with different types of organizational backgrounds ($b = 2.152$). The second largest impact was associated with the biotherapeutics legacy ($b = 1.614$), followed by the venture capital legacy ($b = 1.460$) and the academic science legacy ($b = 1.403$). The coefficient on the biotherapeutics legacy was significantly different (at a 95 % confidence interval) from that for the science legacy but not from the coefficient on the venture capital legacy.

**Table 11.4** Descriptive statistics on U.S. regions relevant to the biotherapeutics industry

| | Regions before 1985 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | Control variable | Mean | *SD* | Min | Max | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | Pharmaceutical legacy | 0.04 | 0.16 | 0.00 | 1.00 | 1.00 | | | | | | | | | |
| 2 | Human biotherapeutics legacy | 0.00 | 0.00 | 0.00 | 0.07 | 0.01 | 1.00 | | | | | | | | |
| 3 | Academic science legacy | 0.06 | 0.22 | 0.00 | 1.00 | 0.10 | 0.06 | 1.00 | | | | | | | |
| 4 | Venture capital legacy | 0.01 | 0.08 | 0.00 | 1.00 | 0.03 | 0.06 | 0.12 | 1.00 | | | | | | |
| 5 | Hybrid legacy | 0.01 | 0.10 | 0.00 | 1.00 | 0.00 | –0.01 | 0.00 | 0.01 | 1.00 | | | | | |
| 6 | Log of population | 13.54 | 1.22 | 10.53 | 16.64 | 0.12 | 0.05 | 0.12 | 0.10 | 0.02 | 1.00 | | | | |
| 7 | Log of total NIH expenditure | 14.34 | 5.19 | 0.00 | 19.73 | 0.07 | 0.04 | 0.14 | 0.08 | –0.21 | 0.54 | 1.00 | | | |
| 8 | Log of venture capital investment | 0.44 | 1.24 | 0.00 | 5.52 | 0.21 | 0.16 | 0.39 | 0.17 | 0.20 | 0.31 | 0.16 | 1.00 | | |
| 9 | Local density | 0.89 | 2.74 | 0.00 | 30.00 | 0.41 | 0.21 | 0.36 | 0.20 | 0.07 | 0.39 | 0.20 | 0.56 | 1.00 | |
| 10 | National density | 51.22 | 45.81 | 1.00 | 129.00 | 0.21 | 0.07 | 0.25 | 0.17 | 0.05 | 0.03 | 0.02 | 0.32 | 0.24 | 1.00 |
| Descriptive statistics for regions after 1984 | | | | | | | | | | | | | | | |
| 1 | Pharmaceutical legacy | 0.12 | 0.28 | 0.00 | 1.00 | 1.00 | | | | | | | | | |
| 2 | Human biotherapeutics legacy | 0.05 | 0.16 | 0.00 | 1.00 | –0.04 | 1.00 | | | | | | | | |
| 3 | Academic science legacy | 0.26 | 0.38 | 0.00 | 1.00 | –0.18 | –0.09 | 1.00 | | | | | | | |
| 4 | Venture capital legacy | 0.06 | 0.19 | 0.00 | 1.00 | –0.09 | –0.03 | –0.03 | 1.00 | | | | | | |
| 5 | Hybrid legacy | 0.03 | 0.14 | 0.00 | 1.00 | –0.02 | 0.01 | –0.09 | –0.04 | 1.00 | | | | | |
| 6 | Log of population | 13.70 | 1.21 | 10.56 | 16.72 | 0.09 | 0.26 | –0.01 | 0.21 | 0.02 | 1.00 | | | | |
| 7 | Log of total NIH expenditure | 15.43 | 5.12 | 0.00 | 20.85 | –0.04 | 0.14 | 0.25 | 0.13 | –0.25 | 0.55 | 1.00 | | | |
| 8 | Log of venture capital investment | 1.53 | 2.09 | 0.00 | 6.26 | 0.10 | 0.12 | 0.12 | 0.11 | 0.14 | 0.47 | 0.32 | 1.00 | | |
| 9 | Local density | 4.71 | 10.74 | 0.00 | 61.00 | 0.09 | 0.27 | 0.08 | 0.09 | 0.08 | 0.45 | 0.29 | 0.55 | 1.00 | |
| 10 | National density | 334.75 | 104.73 | 144.00 | 452.00 | 0.04 | 0.18 | 0.13 | 0.03 | 0.04 | 0.05 | 0.07 | 0.09 | 0.12 | 1.00 |

**Table 11.5** Empirical results, with the number of local biotherapeutics start-up firms as the dependent variable

| | 1976–2002 | | Year < 1990 | Year > 1989 |
|---|---|---|---|---|
| Control variable | Model 1 (baseline for 1976–2002) | Model 2 with organizational legacy variables) | Model 3 (estimates for 1976–1989) | Model 4 (estimates for 1990–2002) |
| Human biotherapeutics legacy | | 1.614 (0.113)** | 1.326 (0.366)** | 1.430 (0.124)** |
| Hybrid legacy | | 2.152 (0.175)** | 2.701 (0.382)** | 1.825 (0.192)** |
| Academic science legacy | | 1.403 (0.080)** | 1.622 (0.143)** | 1.208 (0.097)** |
| Venture capital legacy | | 1.460 (0.121)** | 1.602 (0.216)** | 1.252 (0.148)** |
| Pharmaceutical legacy | | 0.987 (0.104)** | 0.852 (0.192)** | 0.945 (0.126)** |
| Log of population | 0.087 (0.029)** | 0.074 (0.019) | 0.201 (0.048)** | 0.018 (0.020) |
| Log of total NIH expenditure | 0.0317 (0.009)** | 0.041 (0.007)** | 0.029 (0.015)** | 0.038 (0.008)** |
| Log of venture capital investment | 0.044 (0.005)** | 0.041 (0.004)** | 0.030 (0.007)** | 0.038** (0.004) |
| National density | 0.011 (0.001)** | | | |
| National density squared | −1.64e−05 (1.13e−06)** | | | |
| Local density | 0.164 (0.008)** | 0.107 (0.005)** | 0.194 (0.016)** | 0.106 (0.004)** |
| Local density squared | −0.002 (0.008)** | −0.001 (0.006e−02)** | −0.004 (0.004e−01)** | −0.001 (0.05e−03)** |
| Annual fixed effects | | Included | Included | Included |
| Constant | −3.129 (0.385)** | −11.537 (245.114) | −12.757 (485.333) | −2.312 (0.710)** |
| *N* | 2,025 | 2,025 | 1,050 | 975 |
| Log likelihood | −2,989.316 | −1,944.617 | −561.052 | −1,323.878 |

* significant at the 0.1 level
** significant at the 0.05 level
*** significant at the 0.01 level

The proportion of founders from the pharmaceutical industry had the lowest impact on subsequent new firm entry ($b = 0.987$). In this model we included the figure on annual fixed effects rather than the figure on national density and national density squared, which are also annual fixed effects. The results were robust to this change in specification. They suggested that the relative concentrations of these organizational legacies have differential impacts on new firm entry.

Column 3 provides estimates for the period from 1976 to 1989. Early studies of the biotechnology industry emphasize the role of academic scientists as entrepreneurs and demonstrate an unambiguous local orientation in starting companies. Kenney (1986), documenting the changes that accompanied the early origins of the industry, described biotechnology as a university-industrial complex with a prominent role for academic scientists who started companies to commercialize their discoveries. He noted that many academic scientists start companies without resigning their academic jobs and that locating their companies near their universities was a natural outcome. Zucker et al. (1998) extended this finding and suggested that the location of biotechnology firms is primarily due to the presence of star scientists, who had published a large number of genetic sequence discoveries. These discoveries created the intellectual capital for new companies, and the stars' prominent academic status created scientific credibility that attracted investors.

From 1976 to 1989, the hybrid legacy had the highest impact on subsequent new firm entry ($b = 2.701$). This finding was consistent with many of the well-publicized cases and the conventional wisdom about biotechnology start-ups. We did not control for the size of the founding team, and hybrid teams by nature consist of more than a single founder. The importance of the hybrid model reflects a solution to the uncertainty associated with creating a new business model for an emerging industry and suggests that the blending of different types of expertise may facilitate experimentation and a search for information that creates an environment conducive to encouraging others to start firms. In this early period, the science legacy and the venture capital legacy were statistically equivalent. Both of them had a greater impact on the formation of new firms than the biotherapeutics legacy did. There may not have been enough human biotherapeutics firms at that time to provide apprenticeships for nascent entrepreneurs.

Column 4 provides estimates for the period from 1990 to 2002. In this second time frame the relative importance of the organizational legacies was different. The hybrid legacy still had the largest coefficient (1.825), but the next largest coefficient was that for the biotherapeutics legacy (1.430). These two coefficients were equivalent at the 95 % confidence level, so these types of legacies are equivalent in terms of generating additional start-up activity.

The science legacy appeared to have declined in importance and was statistically significantly lower than the coefficients on the hybrid legacy and the biotherapeutics legacy in the second period. As Zucker et al. (1998) had hypothesized, a larger proportion of founders from academic backgrounds had a larger impact in the earlier period than in the later one. The venture capital legacy was statistically equivalent to the science legacy but had standard error suggesting greater variability in the

impact of this type of organizational legacy from place to place. These results suggest a lower number of new start-ups when the local industry is dominated by academic start-ups.

The pharmaceutical legacy variable had the lowest coefficient of all the organizational legacies. This result supports a speculation that experience in the pharmaceutical industry does not translate into creating an environment conducive to cluster growth. The ways of conducting business in biotherapeutics may differ too greatly from those of other industries. And with most of the large, established pharmaceutical firms being close to 100 years old and thus having little memory of their own entrepreneurial experience, it seems likely, based on Saxenian's (1994) reasoning, that they did not encourage any inclinations of their talented employees to leave the firms in order to pursue an entrepreneurial enterprise. Our results suggest that these large pharmaceutical firms also exerted a stultifying influence on the pace of regional growth. Certainly, this possibility may explain the industry's lack of development in New York City or Chicago. We may speculate that the interconnectedness of firms in the regions with a large number of local pharmaceutical founders may be lower than in regions with a small number of such entrepreneurs. The literature suggests that the expertise needed to start companies in a new industry would come from older related industries. Our finding suggests that experience in the pharmaceutical industry, though associated with success at building firms (Higgins 2005), may not provide the types of information-sharing and openness required to encourage start-ups and build geographic clusters.

By the second period, a relatively large proportion of existing firms with a biotherapeutics legacy had become more important to encouraging new firm start-ups than had been the case in the first period even when we controlled for other variables such as the number of existing firms or local density. This shift in the ranking of the coefficients suggests temporal development within the industry. The organizational development in the early stages of an industry reflects the search for a new model that involved bringing together diverse types of expertise and experimenting with new business models. Certainly, the early genesis of the biotechnology industry required bringing together cutting-edge science with commercial interests. It was unlikely that any one individual would possess these diverse skills, so the hybrid team became an effective model. After 1990, organizational legacy within the same industry had gained importance and was statistically equivalent to the hybrid legacy.

## Reflections on the Development of Industrial Clusters

There are very few chances to observe the start of a new industry and to trace its spatial and temporal development. Biotechnology is a notable recent exception. Genentech, arguably the first biotechnology firm, was founded in 1976 by Bob Swanson, a venture capitalist with Kleiner & Perkins, and Herbert Boyer, a biochemist

at the University of California, San Francisco. The chance to participate in what promised to be a revolution in the diagnosis and treatment of human disease along with the allure of significant monetary reward motivated many academic scientists, pharmaceutical company executives, business investors, and others to start new firms (Kenney 1986). Thus, biotechnology, which might have simply been a research technique, became the platform of an entirely new industry. The economic potential of biotechnology was not lost on policy-makers and economic development officials. Biotechnology is the type of innovative activity that benefits from agglomeration economies, and the tendency of biotechnology firms to locate in close proximity to universities and research institutions has been studied extensively (Audretsch and Stephan 1996; Owen-Smith and Powell 2003; Prevezer 1997; Stuart and Sorenson 2003; Zucker et al. 1998). It is no surprise that governments offer a variety of incentives and subsidies in an attempt to build an industry in their region. After all, many regions have some resource endowment that may be leveraged to encourage the formation of new firms or to attract firms from other locations. Despite these inducements most efforts of this kind do not succeed.

Industrial clusters develop within complex contexts of national and even international influence. Although explanations for the location and growth of industrial clusters have emphasized local factors, including the presence of important resources that promote the formation of new firms, few studies have examined the growth of industrial clusters in the context of multiple regions. Although it often seems obvious in retrospect that a cluster would have developed in a particular region, and although historical analysis may point to seemingly unique resources that were available in the region, policy recommendations cannot assume this inevitability.

We find that the human biotherapeutics firms developed in 75 regions in the United States. However, the greatest spur to growth appears to be a tendency of entrepreneurs to leave local, established biotherapeutics firms to found additional biotherapeutics firms—the breakaway phenomenon described by Jacobs (1969). Regions with a high proportion of these individuals have a beneficial organizational legacy that facilitates information-sharing and perhaps a common vision for the cluster. This study shows that the largest impact in terms of generating new start-ups is associated with the hybrid legacy in the early period of the development of the U.S. biotherapeutics industry and with both the hybrid legacy and the biotherapeutics legacy in the later period. Many regions continued at a relatively steady pace to generate new biotherapeutics firms founded by entrepreneurs from local universities and research institutes. Notably, our results suggest that these efforts will bear the most fruit if they provide a training ground for the next generation of entrepreneurs. However, we also find that only those regions exhibiting this secondary, or second-generation, growth from the biotherapeutics firms themselves will expand to substantial sizes relative to other clusters.

Our study indicates that geographic regions differ in rates of entrepreneurial activity that are not explained by variations in resources or the advantages of an

early start. Some regions, such as Silicon Valley, appear to have developed cultures of information and employee exchange that naturally support elevated rates of entrepreneurial activity. This finding suggests that internal dynamics and the ways in which firms relate to one another may be the essence of what makes certain environments more auspicious than others. At the same time, this evasive quality, known as the local entrepreneurial culture or innovative milieu, has proven difficult to model empirically.

We can only speculate about the conditions and processes that led the entrepreneurs and firms in some regions to produce second-generation growth, but our findings are consistent with many case histories of cluster development that emphasize regional cultures and patterns of social interaction (Murtha et al. 2001; Saxenian 1994; Storper and Venables 2002) as critical to the rise of an industrial cluster. Second-generation growth, which involves entrepreneurs leaving established firms in a cluster to found competing new organizations, requires that the entrepreneurs believe in their abilities to attract capital and, especially, human resources to support their new organizations. It is difficult to conclude that such beliefs could develop unless the leadership of the earlier organizations was supportive of new entrepreneurial efforts. Moreover, any policies such as non-compete agreements that limit the ability of skilled apprentices to make the move to become entrepreneurs and apply their expertise will limit the formation of an industrial cluster. Gilson (1998) concludes that entrepreneurial growth has been promoted by California's decision not to honor non-compete agreements.

Industrial clusters are not only a universal feature in the spatial arrangements of industries but also an essential component in the economic evolution of industries. Clusters provide both a near-term source of economic wealth and a long-term foundation for future economic growth. Underlying the clustering phenomenon are mechanisms that facilitate the interchange and flow of information between firms. The organizational legacy of founders in an industry may provide training and experience that is useful in subsequent entrepreneurial efforts and may influence the density of local networking possibilities. We find that academic scientists have a greater impact on the formation of other firms by starting their own firms in partnership with individuals experienced in business rather than starting firms with other academics. A diverse hybrid start-up team induces experimentation and gives the firm a more extensive external network than it would otherwise have if the founder team were homogenous.

We have not limited our consideration of legacy to successful firms or specific industry leaders. Indeed, we have considered simply the internal composition of firms within a geographic region, and we do find empirical regularities. Whereas many places attempt to recruit big pharmaceutical firms as a way to develop a local industry, we find that the impact in terms of encouraging new start-ups is lessened by this type of organizational experience. The fortunes of firms and regions may be linked in ways that have not been previously explored.

## Notes

1. The location quotient is a measure of the concentration of industry in a region compared to the national average for that industry. In the context of this chapter, the location quotient is calculated by means of a fraction whose numerator expresses the proportion of human biotherapeutics firms in the given region divided by the national number of human biotherapeutic firms. The fraction's denominator expresses the population in the region divided by the national population. A location quotient of one indicates that the distribution of local firms mirrors what one expects, given the region's population. A location quotient above 1 indicates that the region has a higher-than-average concentration, and a score of less than one is indicative of a lower-than-average concentration.
2. We are indebted to Martin Doyle, an MBA graduate of the McDonough School of Business at Georgetown University, whose earlier master's degree in microbiology and extensive industry experience aided in the classification of firms engaged in human biotherapeutics research and product development.
3. Though the OMB bulletins reporting MSA classifications describe numerical criteria based on commuting to designate the inclusion or exclusion of counties in particular MSAs, the system is not scientific, and we found substantial evidence of arbitrariness in the decennial classification systems. For example, even in years between the decennial census reports, certain counties, usually those on the geographic edges of regions might be included or excluded from 1 year to the next. The classification system is said to be influenced by the opinions of Congressional delegations as well.

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# Chapter 12
# Knowledge and Space in Economic History: Innovations in the German Empire, 1877–1918

**Jochen Streb and Nicole Waidlein**

## The Historical Economics of Innovation

Economic historians suppose that a geographical territory's long-run economic growth results mainly from the successful innovation activities of the individuals and firms located there (Mokyr 1990). Their ability to generate innovations, in turn, depends above all on the amount and diffusion of knowledge in this territory. In other words, unequal distribution of knowledge in space might explain "why some [regions or countries] are so rich and some so poor" (Landes 1998). We elaborate on these considerations in two main steps. In this section we discuss the economic linkages between growth and knowledge generally assumed in the historical economics of innovation. In the following sections we analyze the causes and consequences of the unequal distribution of innovations and knowledge in the German Empire from 1877 through 1918. Throughout the chapter, we especially note the empirical problems of quantifying innovation activities and knowledge spillover in a historical context.

In general, the main driving forces of economic growth can be identified by a macroeconomic Cobb-Douglas production function in which we assume that a region's economic output Y depends on the three tangible inputs referred to as labor (L), capital (C), and land (T) and on the productivity level of the economic activities (A).

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Transforming this production function, we end up with what Clark (2007, pp. 197–199) has called the fundamental equation of growth:

$$g_y = g_A + \beta \cdot g_c + \gamma \cdot g_t \tag{12.1}$$

The production elasticities β and γ measure the share of a region's income accounted for by the owners of capital and land, respectively. In this equation $g_y$, $g_c$, $g_t$, and $g_A$ are the annual growth rates of output per worker, capital per worker, land per worker, and the productivity level. The fact that γ is very low in developed societies allows us to ignore the input land (T) and simplify the Eq. (12.1) to

$$g_y \approx g_A + \beta \cdot g_k \tag{12.2}$$

Long-term economic growth per capita thus depends on only two factors—on the increases of the productivity level and on the capital accumulation per capita. Equation (12.2) also demonstrates that a 1 % growth in the productivity level leads to a 1 % increase in the output per worker, whereas a 1 % growth in capital per worker increases the output per worker by only β percent, with $\beta < 1$. If Clark (2007) was correct that, in the industrialized world, the accumulation of real capital (C) explains just about one quarter of the long-term growth in output per worker, then three quarters of long-run economic growth has been caused by the permanent growth in the productivity level (A).

Whereas the development of output, labor, and capital can be estimated by using historical data, the productivity level (A) is not directly observable and has to be calculated as the difference between the output per worker and the capital endowment per worker weighted by capital's production elasticity. This residual reflects, among other factors (see Denison 1967), the economic impact of technological, organizational, and social innovations. Hence, economic historians do not doubt that innovations are what drive long-term economic growth. These scholars do argue, however, about the necessary preconditions[1] for a nation's or a region's sustainable growth. For example, a region's capability to create a steady stream of innovations might be influenced by its formal institutions and cultural norms (DeLong and Shleifer 1993; North 1990; North and Weingast 1989), its endowment with real and human capital (Aghion 2008), and its industrial and corporate structure.[2] However, to develop successful innovations, the creation, diffusion, and adoption of new knowledge is essential. For that reason we focus this chapter on the influence that knowledge and knowledge spillover have on a region's capability to innovate.

In the tradition of Alfred Marshall, Kenneth Arrow, and David Romer, it is often assumed that the geographical concentration of firms with the same line of business fosters *intraindustry* knowledge spillover because geographical proximity facilitates personal communication between researchers of different firms, a rapid movement of highly skilled labor between firms, and even industrial espionage (for a short review of this literature, see Baten et al. 2007). Lundvall (1988), by contrast, emphasized the importance of *interindustry* knowledge exchange between upstream and downstream firms. He stressed that suppliers learn from regular communication with their long-term customers about the essential characteristics of those innovations

that the latter will demand in the future (see Lundvall 1988; Streb 2003). Jacobs (1969) also supposed that knowledge spillover emerges especially between different industries within urban agglomerations.[3] Murmann (2003) underlined the importance of knowledge spillover between educational organizations and firms. Comparing the performance of chemical firms in the American, British, and German dye industry, he showed that, in the nineteenth century, a chemical firm's capability to innovate depended strongly on the new knowledge and human capital provided by universities in the firm's national innovation system.

Despite the various differences of all these approaches, the claim is that innovative knowledge is at least partly tacit (see Polanyi 1989) and will therefore spillover mostly via personnel communication within some given geographical boundaries. Explaining why one region has profited more from its own knowledge production than other, more distant regions, this geographical limitation of knowledge spillover accounts for the uneven geographical distribution of innovations and economic growth over time.

The aim of this chapter is to present evidence for important technological and geographical knowledge spillover during German industrialization in the late nineteenth and early twentieth centuries. We have two research hypotheses:

1. Innovation booms in leading technological sectors accelerated innovating activities in technologically related industries via knowledge spillover.
2. Knowledge spillover between technologically related industries were considerably facilitated by geographical proximity.

To prove these hypotheses empirically, we have to find adequate measures for both successful innovation activities and knowledge spillover (see Metz and Watteler 2002). For that purpose it is useful to divide the typical innovation process into three consecutive stages: invention, innovation, and diffusion. (This innovation process is, of course, not linear; it is characterized by interdependencies between the different phases.) In the invention phase, a firm (or a private inventor) employs labor, capital, and knowledge to find a new product or production method. The outcomes of this search process are kept secret or patented. In the innovation phase, the pioneer attempts to build up an economic market for its technological invention. Like the invention phase, the innovation phase is risky and can end in failure. If it is successful, competing firms will try to imitate or refine the innovation of the pioneer firm in the diffusion phase. These imitating activities require some kind of knowledge spillover from the pioneer firm to the competitors.

Table 12.1 shows the commonly used empirical indicators of the inputs and outputs of the three stages of the innovation process. Not one of these indicators is perfect. That is why the choice of a special indicator depends on both the availability of data and the focus of the innovation analysis. In the historical economics of innovation, output indicators are generally preferred to input indicators for two reasons. First, few empirical data that quantify the inputs into the different stages of the innovation process are available for the period before World War II. Second, and more important, the relationship between innovation input and innovation output is not constant. For example, R&D productivity, which is defined as the ratio between R&D output and

**Table 12.1** Indicators of innovation activities

| Phase | Input indicator | Output indicator |
|---|---|---|
| Invention | R&D expenditures by private firms<br>R&D expenditures by the government<br>R&D expenditures by public research organizations | Patents |
| Innovation | | Long-lived patents<br>Lists of innovations compiled by experts |
| Diffusion | | Productivity |

*Note*: Adapted from Spoerer et al. (2007)

R&D expenditures, differs significantly over time, between industrial sectors, and between individual firms.

However, the output indicators also have their disadvantages. Much is said about the shortcomings of patents as a measure for innovativeness. As Griliches (1990) stated: "Not all inventions are patentable, not all inventions are patents and the inventions that are patented differ greatly in 'quality', in the magnitude of inventive output associated with them" (p. 1669). The first two parts of this statement refer to the well-known fact that the propensity to patent varies across industries. Some industries try to appropriate the returns on their inventions primarily by keeping them secret, whereas others, like the chemical and pharmaceutical industries, prefer patenting instead. Because of industries' different propensities to patent, it might be misleading to interpret an industry's comparatively high number of patents automatically as a sign for its alleged above-average innovativeness. The problem that is addressed in the final part of Griliches's statement is probably the more serious one. Mere patent counts allocate the same weight to every patent regardless of its economic value for the patentee or society, so using the number of patents as an indicator of new technological knowledge conducive to economic growth leads to a potentially very large measurement error. To decrease this measurement error, it is necessary to distinguish patents with a high economic value from those with a low one. In the next section we explain why an individual patent's life span can be used as an indicator of its private value.

Lists of important innovations compiled by scholars of the history of technology frequently show a selection bias because these experts often prefer basic innovations and product innovation to incremental innovations and process innovations. Productivity growth as a measure of innovation activities is also inaccurate. As we have already mentioned, changes in the efficiency level (A) express more than just successful innovations. Because of that ambiguity, the observable productivity growth may lead one to overestimate the influence of innovations.

Accurately measuring knowledge spillover seems even more difficult than measuring innovations. Krugman (1991, pp. 53–54) stated that knowledge spillovers were indiscernible and left no paper trail by which they might be observed. The imperceptibility of knowledge spillovers explains why studies of knowledge spillover rely mostly on crude proxies or indirect measures. Two main approaches exist.

With the microeconomic one, the researcher tries to trace the path of knowledge spillover directly by using patent citations (see Jaffe and Trajtenberg 2002). The geographical distance between the actual patent applicant and the holder of the basic patent informs about the regional diffusion of knowledge. Taking the macroeconomic approach, one assesses the diffusion of knowledge indirectly by measuring the spatial correlation of data, such as expenditures for R&D, employees in R&D, and patent applications (see Döring 2004). In a later section of this chapter, we employ this macroeconomic approach to measure knowledge spillover within German regions. In the next section, however, we explain first why we use long-lived patents as an indicator of successful innovation activities in the German Empire from 1877 through 1918.[4]

## Long-Lived Patents in the German Empire

Our observation period begins with the passage of the German patent law of 1877, which for the first time in German economic history enabled inventors to apply for patent protection not only in single German states like Prussia but in the whole German Empire (Seckelmann 2006, pp. 86–106). Our prime data source is the German patent office's annual *Verzeichnis der im Vorjahre erteilten Patente*, a register that lists all patents granted in the preceding year, including the technological class of the invention and the name and location of the patent holder. The name and location of the patent holder allows us to tell whether a particular patent was held by a German or foreign patentee, by a private inventor, or by a firm. The register also contains a list of all patents still in force, information that enables us to calculate the life spans of specific patents.

Patent protection in the German Empire could last up to 15 years but was not for free. To keep the patent, the patentee had to pay a renewal fee at the beginning of each year. This annual fee came to 50 Marks in the first 2 years and increased by 50 Marks each year up to 700 Marks with the onset of the 15th year. The decision on whether to renew the patent depended on the holder's expectations of the future returns on and costs of holding the patent. The costs were determined by the renewal fees demanded by the patent office and were thus foreseeable with certainty. By contrast, the future returns on a patent were highly uncertain and could stem from two major sources. First, a patentee could use a patent to increase his or her profits by selling the innovation as a temporary monopolist or by licensing another producer to do so. Second, a patentee could use the patent to prevent sales of competitors' innovations that had the potential to decrease the market share of his or her own products that had already been established. We assume that patent holders under the German Empire renewed their patents if, and only if, the current value of the expected future returns exceeded the current value of the future costs. For that reason, we regard a long life span of a historical patent as clear evidence of its comparatively high private economic value.

A basic question raised by this life-span approach is how many years a patent had to remain valid in order to be interpreted as a high-value patent. Figure 12.1

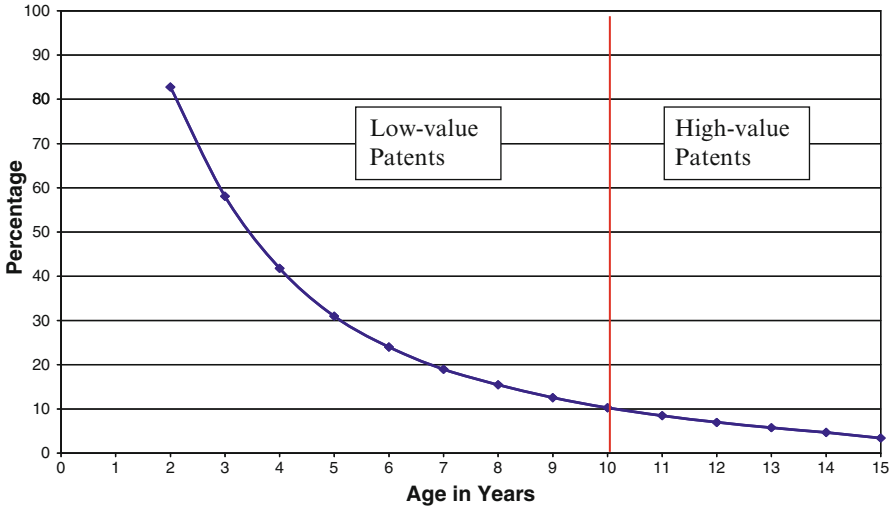


**Fig. 12.1** The survival rate of German patents: patent cohorts, 1891–1907 (From Reichspatentamt 1914, p. 84)

shows that about 70 % of all German patents granted between 1891 and 1907 lapsed after just 5 years and that this rate decelerated after the fifth year. About 10 % of all patents survived 10 years or more, with 4.7 % of all patents reaching the maximum age of 15 years. In the process of developing the Baten-Streb patent database, we decided not to calculate the entire life span of every patent registered in the German Empire during the period under study. This decision was determined by the focus of our research. Unlike other research (e.g., Pakes 1986; Schankerman and Pakes 1986; Sullivan 1994), our study combined detailed data about individual patents (patentee, location, patent class) with information about their individual life spans. Making out an individual patent's whole life span would have been generally possible because our annual data source also included a long list of patent numbers that were still in use in the respective year. Doing so, however, would have meant seeking the patent number in up to 15 annual lists, a task that would have taken at least 15 min for each of the 311,000 patents in our population. Given the budget constraints on our project, we therefore chose instead to use the cut-off point of 10 years, a duration requiring us to search "only" for those individual patents that survived at least that long.

The decision was not arbitrary. According to the pioneers of this approach, the life span distinguishing high-value patents from low-value ones is somewhere between 5 and 15 years. Pakes (1986) observed that an inventor in an initial stage of an innovation process is often highly uncertain whether his or her idea can be profitably exploited in the future. The low renewal fees at the beginning of a patent's life allow the inventor to use the patent as a comparatively inexpensive option that protects the new knowledge and gives him or her the time to learn more about the

invention's technological and economic prospects. As indicated by the usually high mortality rates in the early years of a patent cohort, most of the patents turned out to be worthless. Hence, the patents that survived this learning process and lasted at least 5 years can conceivably be interpreted as the high-value patents of our sample. Narrowing the range further, Schankerman and Pakes (1986) found that most of the value of the patent stock built up in the post-World War II period in the United Kingdom, France, and the Federal Republic of Germany was concentrated in the upper 5 % of the long-lived patents. In our case adoption of that cut-off would have meant selecting only those patents that attained the maximum life span of 15 years. Instead, we followed Sullivan (1994), interpreting the upper 10 % of the long-lived patents as the high-value patents of our total patent population. Exploiting the information given by the survival rate of Fig. 12.1, we selected all patents that survived at least 10 years. This selection process gave rise to a database containing 39,343 long-lived patents that we interpret as the high-value patents of the German Empire in the next two sections.[5]

## Technological Knowledge Spillover in the German Empire[6]

The German patent office assigned every patent to exactly one of 89 different technological classes that characterized either the industry in which they were developed (e.g., technological class 21: electrical engineering), the industry that used or produced the resulting products (e.g., technological class 45: agriculture), or a particular technological field (e.g., technological class 14: steam engines). Table 12.2 lists the 18 technological classes that contained the most high-value patents of all 89 classes from 1877 through 1918.

This ranking could lead to the impression that technological progress during German industrialization relied mainly on electrical engineering; chemicals, including dyes; and scientific instruments, three categories that together included more than one quarter of all high-value patents granted in the period under observation. Three arguments refute this simple conclusion. First, we have already mentioned that industries such as electrical engineering and chemicals generally seemed to have a higher propensity to patent their inventions than, for example, the machine and automotive industries, which also try to protect their inventions by keeping secret how to make them. Second, the technological classes recognized under German patent law significantly differed in the breadth of the technological field they covered. Patents in the fields of electrical engineering were concentrated in class 21; those for chemicals, in classes 12 (chemicals) and 22 (dyes). Patents pertaining to mechanical engineering were spread over several classes, such as 47 (machine parts), 49 (metal-processing), 14 (steam engines), and 63 (vehicles). Many "machinery patents" were also found in less obvious classes, like 45 (agriculture, including agricultural machinery) and 86 (weaving, including textile machines) to name just a few. Third, our sample was dominated by the many high-value patents of the general pre-World War I patent boom, during which electrical engineering

**Table 12.2** Ranking of technological classes in Germany, 1877–1918

| Rank | Class | Number of high-value patents | Share in all high-value patents (%) | Cumulated share (%) |
|---|---|---|---|---|
| 1 | 21 Electrical engineering | 3,350 | 8.51 | 8.51 |
| 2 | 12 Chemicals (without dyes) | 2,840 | 7.22 | 15.73 |
| 3 | 22 Dyes | 2,206 | 5.61 | 21.34 |
| 4 | 42 Scientific instruments | 1,584 | 4.03 | 25.37 |
| 5 | 15 Printing | 1,429 | 3.63 | 29.00 |
| 6 | 49 Metal-processing | 1,202 | 3.06 | 32.06 |
| 7 | 20 Railroad installations | 1,146 | 2.91 | 34.97 |
| 8 | 47 Machine parts | 1,137 | 2.89 | 37.86 |
| 9 | 72 Firearms | 1,003 | 2.56 | 40.42 |
| 10 | 8 Dyeing | 928 | 2.36 | 42.78 |
| 11 | 45 Agriculture | 904 | 2.30 | 45.08 |
| 12 | 52 Sewing | 706 | 1.79 | 46.87 |
| 13 | 80 Earthenware | 675 | 1.72 | 48.59 |
| 14 | 46 Internal combustion engines | 627 | 1.59 | 50.18 |
| 15 | 30 Health care | 615 | 1.56 | 51.74 |
| 16 | 13 Steam boilers | 605 | 1.54 | 53.28 |
| 17 | 81 Transportation | 601 | 1.53 | 54.81 |
| 18 | 14 Steam engines | 553 | 1.41 | 56.22 |

*Note*: Adapted from Streb et al. (2006, p. 353)

patents were especially numerous. Electrical engineering thereby holds the leading position in Table 12.2 even though this technological class did not dominate patenting in the decades before 1900. These three observations together lead to the conclusion that technological progress in the broad field of mechanical engineering played a much more prominent role during German industrialization than Table 12.2 might suggest.

We were able to solve most of these problems by analyzing the patenting activities in the 89 technological classes over time. It turns out that the ranking of the technological classes presented in Table 12.2 was not constant from 1877 through 1918. In general, different technological classes boomed in different subperiods. Figure 12.2 presents this finding by using gray bars to show the major patent booms from 1877 through 1918. We define a major patent boom of a specific technological class as the period in which this technological class held an annual rank no less than its average rank in every year and one of the three highest ranks in at least 1 year of this period. In years when a technological class ranked first, this bar is colored black.

We can distinguish four different waves of technological progress: (a) the railroad wave (1877–1886), (b) the dye wave (1887–1896), (c) the chemical wave (1897–1902), and (d) the wave of electrical engineering (1903–1918). The railroad wave was dominated by patents in three technological classes—steam boilers (class 13); steam engines (class 14); railroad installations (class 20), which also accounts

for inventions concerning rail tracks, rail switches, and signals; machine parts (class 47); and metal-processing (class 49). Traditionally, the railroad industry is regarded as Germany's leading sector in the mid-nineteenth century. By increasing demand for coal, iron, and advanced engineering technology, this industry caused the parallel growth in the German coal-mining, iron, and steel industry and in mechanical engineering. Our finding supports the conjecture that the railroad industry generated forward and backward linkages by not only selling and buying tangible goods and services but also functioning as a focal point for the exchange of intangible new technological knowledge in the field of mechanical engineering, as indicated by the patent boom in most of the industries of the railroad cluster from 1877 through 1886 (see Fremdling 1975, p. 5). The industries of the railroad cluster sustained their above-average patenting activities until the early twentieth century.

This continuity, however, did not prevent the new industries of the Second Industrial Revolution—chemicals and electrical engineering—from taking over the technological lead in the mid-1880s. This fundamental change first led to the dye wave (1887–1896), in which patents relating to new dyes (class 22) ranked first in every year. Figure 12.2 reveals that the invention of new synthetic dyes eventually accelerated the development of new and complex chemical and mechanical dyeing procedures that were needed to process the innovative synthetic dyes and that those processes were patented in technological class of dyeing (class 8). This new knowledge then spilled over from the innovative chemical industry to the downstream textile industry. The main channel of this knowledge transfer was the newly invented customer-consulting service (see Streb 2004) of the German dye manufacturers who regularly informed textile firms about both new dyes and new dyeing methods. Streb et al. (2007) pointed out a statistical bidirectional Granger causality between German net cloth exports and patents in the technological classes of dyes and dying, an observation suggesting that the interindustry knowledge spillover between chemical and textile firms under the German Empire created an upward spiral of endogenous growth. First, the German textile firms notably increased their international competitiveness by exporting cloth colored with the innovative dyes. The increasing demand for synthetic dyes among the prospering textile firms encouraged further R&D projects by the innovative chemical firms, leading to new patents and, via customer-consulting, to additional economic benefits for the German textile industry. This upward spiral, however, was not indefinite and came to an end when the technology for synthetic dyes had been fully exploited. Dyestuffs remained the dominating business of the German chemical firms in the late nineteenth century, but the research laboratories also started to explore other new technological fields such as inorganic acids, pharmaceuticals, and synthetic fertilizers. The growing importance of these new products was revealed during the chemical wave (1897–1902), when the field of chemicals without dyes (technological class 12) usually ranked first in the number of high-value patents.

A very interesting facet of the wave of electrical engineering (1903–1918) is the boom in patents on scientific instruments (technological class 42), which began sometime after the one in electrical engineering (technological class 21). Generally, the number of patents in the field of scientific instruments that are needed to develop

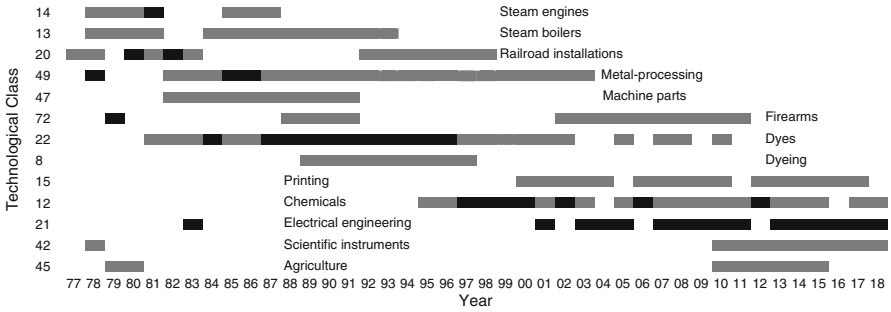


**Fig. 12.2** The major patent booms in Germany, 1877–1918 (Adapted from Streb et al. 2006, p. 359; The highest rank of printing was 4. The highest rank of agriculture from 1910 through 1915 was 5. The less important technological classes are not shown: 6 (brewery, rank 2 in 1877, average rank: 31), 36 (heating systems, rank 2 in 1878, average rank: 35), 68 (metal working, rank 1 in 1877, average rank: 40), 76 (spinning, rank 3 in 1881, average rank: 25, and 89 (sugar, rank 2 in 1879, average rank: 44)

innovations in most of the other technological fields can be interpreted as an excellent indicator of an economy's innovative potential. In this respect, the high number of such patents from 1910 through 1918 might indicate that German industry in that period was well-equipped to produce another generation of high-value patents.

We conclude that the burst of innovative activities in each of the four technological waves depicted in Fig. 12.2 eventually went beyond the leading sector, occurring with a time lag in a couple of other industries that were technologically and economically linked to the original creator of the basic innovations. In this process new knowledge spilled over both from the leading sectors to their customers and suppliers and from the customers and suppliers back to the leading sectors.

## Geographical Knowledge Spillover in the German Empire

The distribution of the regions characterized by above-average innovation (the darkly shaded areas in Fig. 12.3) shows that the high-value patents were not more or less uniformly spread across Germany during industrialization. Instead, they were geographically clustered in a broad belt that reached from the districts on the Rhine river in the west to Greater Berlin and Saxony in the center.[7] The dominance of the Rhine region and Greater Berlin is consistent with Sokoloff's (1988) seminal finding that the patenting activities in early nineteenth-century America were concentrated in metropolitan areas and along waterways. Sokoloff explained this geographical clustering of patents mainly by demand factors. He based his argument on the assumption that the profitability of a patent increases with the size of the market where the corresponding innovation can be sold. This correlation led Sokoloff to conclude that firms which were either located near highly populated metropolitan

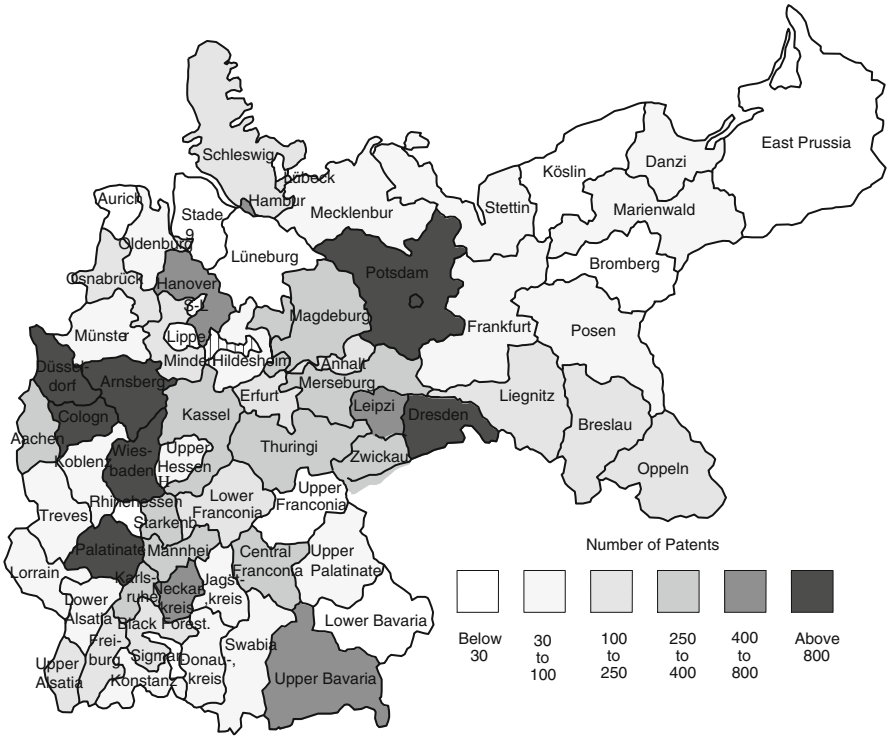


**Fig. 12.3** The geographical distribution of high-value patents in Germany, 1878–1914 (Adapted from Streb et al. 2006, p. 364)

areas or able to transport their products at low cost along navigable waterways to distant markets had much higher incentives to take out patents than did firms in more remote areas. Accordingly, patents were concentrated in the two former types of region. Demand factors, however, also determine the firms' original choice of location. That is why it is necessary to distinguish clearly between a firm's choice of location and its decision to patent.

Sokoloff (1988) was well aware of this problem and controlled for the division of the labor force between agriculture and manufacturing. It turned out that his estimated positive relationship between firms' proximity to navigable waterways and the intensity of patenting was robust to the inclusion of this variable, which is supposed to measure the level of industrial activity in a region. Hence, in Sokoloff's sample demand factors seemed to influence the geographical distribution of patents independently from the original choice of location.

The German case, however, suggests that, because of the uneven geographical distribution of industries, the aggregated level of industrial activity might not be the variable adequate for distinguishing between the demand effects on the firms' location and patenting decision. Obviously, the broad west–east strip of German regions

with an above-average number of high-value patents was also the favored location of those industries in which most of the high-value patents originated. Long before the German patent law of 1877 actually came into force, these industries' original choice of location might have been influenced by a variety of factors, such as expected market volume or the availability of raw materials and intermediate products. Large chemical firms like BASF and Bayer, for example, preferred to settle on the banks of the Rhine river, which served not only as an important navigable waterway but also as a water source and a medium for disposing of effluents. It is therefore conceivable that the great majority of all chemical firms in Germany during the latter half of the nineteenth century located themselves along waterways. Consequently, waterway areas had both an above-average density of chemical firms and, because of this industry's intense patenting activity, a higher number of patents than did regions with a lower level of industrial activity dominated by industries with an underaverage level of patenting. The same argument holds for mechanical and electrical engineering. Firms engaged in the field of mechanical engineering were especially concentrated in the geographical neighborhood of iron and steel producers (i.e., in the Greater Ruhr area) and near textile firms (i.e., in Saxony). Berlin was the center of German electrical engineering. To test the robustness of the relationship that Sokoloff (1988) proposed between firms' proximity to metropolitan areas or mass transportation infrastructure and the intensity to patent, it would thus be advisable to control not only for the general level of industrial activity but also for the activity levels of different industries located in the regions under consideration.

With respect to the share in all high-value patents, the ranking of the most innovative German regions changed during the four waves of technological progress. Table 12.3 allows us to distinguish regions with steady, decreasing and increasing relative innovativeness. Berlin and Düsseldorf kept their leading position during the whole period under consideration but it is interesting to note that Düsseldorf, first, was able to catch up to Berlin during the dye period, and then, considerably fell behind in the period of electrical engineering. Wiesbaden and Palatinate also increased their innovativeness during the dye period, whereas Potsdam developed its innovative potential mainly during the period of electrical engineering. Dresden and Leipzig, which ranked third and fourth, respectively, during the railway period, displayed decreasing relative innovativeness in the following waves of technological progress.

To test whether these changes in the ranking of the most innovative regions could be caused by the transition from one technological wave to the next, we calculated for every technological class an index of technologically revealed comparative advantage. Following Cantwell (1989), we used the location index (LI), where $n$ denotes the number of patents; subscript $i$, the region; subscript $j$, the technological class; and $n_G$, the total number of high-value patents granted to German patentees in the period from 1877 through 1918:

$$LI_{ij} = \frac{n_{ij} / n_i}{n_j / n_G} \tag{12.3}$$

**Table 12.3** The most innovative regions during the four waves of technological progress, by percentage of all high-value patents per wave

| Railway (1877–1886) | | Dyes (1887–1896) | | Chemicals (1897–1902) | | Electrical Engineering (1903–1914) | |
|---|---|---|---|---|---|---|---|
| Region | Patents | Region | Patents | Region | Patents | Region | Patents |
| Berlin | 11.7 | Berlin | 10.7 | Berlin | 11.7 | Berlin | 14.2 |
| Düsseldorf | 5.6 | Düsseldorf | 10.7 | Düsseldorf | 9.3 | Düsseldorf | 8.9 |
| Dresden | 3.8 | Wiesbaden | 6.2 | Wiesbaden | 5.4 | Wiesbaden | 5.6 |
| Leipzig | 3.8 | Palatinate | 3.9 | Dresden | 2.8 | Potsdam | 4.2 |
| Wiesbaden | 3.3 | Dresden | 3.0 | Palatinate | 2.7 | Palatinate | 2.6 |
| Arnsberg | 2.8 | Cologne | 2.7 | Arnsberg | 2.3 | Arnsberg | 2.3 |
| Cologne | 2.7 | Arnsberg | 2.5 | Cologne | 2.2 | Cologne | 2.3 |
| Magdeburg | 2.6 | Leipzig | 2.1 | Potsdam | 2.2 | Dresden | 2.2 |
| Hamburg | 2.2 | Chemnitz | 2.0 | Hamburg | 2.1 | Leipzig | 2.0 |
| Karlsruhe | 2.1 | Hamburg | 1.7 | Leipzig | 2.1 | Neckar | 1.8 |

*Note*: Adapted from Streb et al. (2006, p. 366)

If $LI_{ij}$ is equal to 1, then patents in technological class *j* are equally represented in the region *i* and in Germany. If $LI_{ij}$ is greater than 1, then region *i*'s patenting activities are specialized in technological class *j*.

Table 12.4 presents for every region named in Table 12.3 the five technological classes with the highest location index. In some regions these technological classes formed a cluster of economically and technologically related industries that are named in the last column. Bold letters indicate clusters of three or more related industries; normal letters, two related industries. Strikingly, this calculation shows that most of the regions with steady innovativeness and all of the regions with increasing innovativeness possessed at least one innovative cluster, whereas the regions with decreasing innovativeness generally did not. This pattern is evidence supporting the hypothesis that interindustry knowledge spillover between geographically concentrated firms was a key source of innovation activities during the period under study. Berlin specialized in electrical engineering, including signaling and alarm systems and lighting, a fact that perfectly explains the city's impressive innovative achievements during the wave of electrical engineering. Wiesbaden and the Palatinate enjoyed revealed comparative technological advantages in chemicals and did particularly well during the waves of dyes and chemicals. Regions like Düsseldorf and Potsdam heavily depended on mechanical engineering but were nevertheless able to retain or even improve their rank among the most innovative regions after the railroad wave had ended. The development of the Cologne, Potsdam, and Neckar regions suggests that a fifth wave of technological progress—in automotive manufacturing and internal combustion engines—started to build in the early twentieth century. The spatial correlation of the patenting activities of technologically and economically related industries suggests that interindustry knowledge spillover appreciably increased a region's innovativeness from 1877 through 1914.

To learn more about the various channels of knowledge spillover, Baten et al. (2007) gathered economic information on 2,407 firms located in the state of Baden

**Table 12.4** Revealed comparative technological advantages and innovative clusters

| | Revealed comparative advantage | | | | | |
|---|---|---|---|---|---|---|
| Region | 1 | 2 | 3 | 4 | 5 | Innovative cluster |
| *Continuous innovativeness* | | | | | | |
| Berlin | Electrical engineering (21) 3.2 | Signaling (74) 3.1 | Lighting (4) 2.4 | Printing (15) 2.3 | Railroad installations (20) 2.0 | **Electrical engineering** |
| Düsseldorf | Firearms (72) 4.2 | Cutting tools (69) 4.1 | Metal sheets (7) 2.7 | Iron production (18) 2.5 | Dyes (22) 2.4 | **Mechanical engineering** |
| Wiesbaden | Dyes (22) 4.3 | Metallurgical engineering (40) 3.0 | Shoes (71) 2.6 | Chemicals (12) 2.5 | Ore-preparing (1) 2.1 | Chemicals + Metallurgical engineering |
| Arnsberg | Pumps (59) 11.3 | Fuel (10) 9.1 | Drying and roasting (82) 8.9 | Tools (87) 6.8 | Mining (5) 6.7 | **Mining** |
| Cologne | Rope-making (73) 13.7 | Ore-preparing (1) 7.7 | Harnesses (56) 7.4 | Writing implements (70) 5.6 | Internal combustion engines (46) 8.3 | |
| *Increasing relative innovativeness* | | | | | | |
| Palatinate | Dyes (22) 5.3 | Chemicals (12) 3.8 | Dyeing (8) 2.5 | Shoes (71) 2.4 | Chemical metal-processing (48) 1.5 | **Chemicals including dyes** |
| Potsdam | Toys (77) 4.9 | Photography (57) 4.8 | Vehicles (63) 2.5 | Railroad construction (19) 2.2 | Burning systems (24) 2.0 | **Mechanical engineering** |
| Neckar | Internal combustion engines (46) 8.3 | Bakery (2) 7.9 | Tanning (28) 5.3 | Book-binding (11) 4.7 | Cutting tools (69) 3.6 | Mechanical engineering |
| *Decreasing relative innovativeness* | | | | | | |
| Dresden | Glass (32) 11.8 | Tobacco (79) 11.5 | Control engineering (60) 8.9 | Paper-processing (54) 4.6 | Foodstuff (53) 3.5 | |
| Leipzig | Book-binding (11) 13.7 | Musical instruments (51) 9.9 | Harnesses (56) 7.4 | Spinning (76) 3.9 | Printing (15) 3.3 | Books |

| | | | | | |
|---|---|---|---|---|---|
| Magdeburg | Salt works (62) 30.4 | Hat-making (41) 12.4 | Control engineering (60) 9.0 | Harnesses (56) 7.6 | Ore-preparing (1) 6.6 |
| Hamburg | Haberdashery (44) 6.7 | Ship-building (65) 6.4 | Sewing (52) 5.3 | Foodstuff (53) 4.7 | Harnesses (56) 4.4 |
| Karlsruhe | Haberdashery (44) 8.9 | Harnesses (56) 8.3 | Travel equipment (33) 6.4 | Water supply (85) 5.8 | Explosives (78) 5.2 |

*Note*: Adapted from Streb et al. (2006, pp. 366–367)
The number in parentheses names the technological class of the German patent statistic. The value behind the closing parenthesis shows the location index

(the Mannheim, Karlsruhe, Freiburg, and Konstanz regions referred to in Fig. 12.3) and matched it with 329 high-value patents granted to these firms in the years from 1877 through 1914. Their econometric results suggested that Baden's small and medium-sized innovative firms relied heavily on knowledge spillover both from upstream R&D-intensive firms (Lundvall-type externalities) and from technical and commercial schools (Murmann-type externalities) in their geographical neighborhood. By contrast, Baden's large innovative firms were apparently able to cross geographical boundaries and acquire new knowledge (and human capital) from distant German and foreign regions.

## Conclusions

To identify the major causes of innovativeness and economic growth, scholars usually compare the historical development of different countries such as Great Britain, Germany, or the United States. Our findings suggest, however, that the concentration on highly aggregated country-level data might be misleading. Germany's rise to one of the leading economic powers in the late nineteenth century was less a nationwide phenomenon than a development driven by the outstanding innovativeness of particular German regions in which successful innovation activities were fostered by interindustry knowledge spillover between technologically and economically related industries. The fact that both the creation and diffusion of innovations were geographically concentrated implies that, in the nineteenth and early twentieth centuries, new technological knowledge could not cross large distances easily at no cost but tended to be bound to particular regions and the firms located there. To understand why these regions were able to sustain their above-average innovativeness over time and across different technological waves is an important desideratum for future research projects on the determinants of long-term economic growth.

## Notes

1. Abramovitz's (1986) findings that economically backward countries needed some "social capabilities" for catching-up to the most advanced countries might be true for innovativeness in general.
2. As the economist John Kenneth Galbraith (1957) stated: "In the modern industry shared by a few large firms, size and the rewards accruing to market power combine to ensure that resources for research and technical development will be available. . . . The net of all this is that there must be some element of monopoly in an industry if it is to be progressive" (p. 88).
3. In economic geography scholars also analyze the economic impact of Marshall-Arrow-Romer advantages and Jacobs externalities.
4. A country's most valuable patents can also be identified by the fact that they have been additionally filed in foreign countries. See Degner and Streb (2010).

5. An enlarged version of this patent database contains an additional 27,340 high-value patents of the Weimar Republic (1919–1932). We use these data not only for geographical analysis but also for industry and firm-level studies. See Labuske and Streb (2008) and Degner (2009).
6. This section and the next are an abbreviated and updated version of Streb et al. (2006).
7. To control for population density, we also divided the number of high-value patents by regions' population in the year 1910. See Figure 5 in Streb et al. (2006, p. 365). According to this calculation, some regions in the southwest such as Neckarkreis or Mannheim improved their relative innovativeness, whereas other regions such as Potsdam or Dresden fell behind. However, both maps show nearly the same geographical distribution of patenting activity, so we are confident that the following text of this chapter can use the absolute number of high-value patents to identify the development of Germany's most innovative regions correctly.

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# Chapter 13
# Cluster Policy: A Guide to the State of the Debate

**Christian Ketels**

Interest in the role of economic geography in explaining differences in prosperity levels across locations is growing (Spence et al. 2009; World Bank 2009). Contrasting strands of the academic literature are contributing to this debate. Researchers representing the New Economic Geography approach apply models that incorporate increasing returns and mobile factors to explain the emergence of regions having different densities of economic activity (Royal Swedish Academy of Science 2008). The work on clusters—regional agglomerations of companies, research institutions, government agencies, and other organizations in a specific area of business activity related through various knowledge and economic linkages (Porter 2008; see also Ketels 2011)—breaks this analysis down to the level of density in specific activities. Scholars have also used related approaches to look at regional innovation systems (Cooke 1992; Gertler and Asheim 2006), industrial districts (Becattini 1990; Porter and Ketels 2009), and locations that are home to a "creative class" (Florida 2002).

Although there is widespread agreement that geography matters for the patterns of economic activities and outcomes to be observed, there is little consensus on whether there is a case for policy intervention. Arguments are made for (Porter 2007, 2008) and against (Duranton 2011). Others acknowledge the theoretical case for intervention (Norman and Venables 2004) but point out the complex implementation issues that render practical success unlikely (Venables 2008). In the meantime, practitioners in the economic development community have made their choice, and especially cluster-based economic policies and programs have become widely used (Borras and Tsagdis 2008; Davies 2006; Freser 2005; Oxford Research 2008; Pietrobelli and Rabelotti 2006; Yusuf et al. 2008; Zeng 2008).

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In this chapter I explore the current state of the academic debate on cluster policy, a term that, for lack of a broadly accepted definition, I propose to understand inclusively. In the following pages I therefore use it to mean all efforts by government—alone or in collaboration with companies, universities, and other agents—that are aimed at enhancing the competitiveness of clusters. This definition excludes efforts by other entities acting alone, such as purely private cluster initiatives, and general governmental policies that are not directed at clusters (but that might affect them). In this broad, but by no means exhaustive, review of the quickly growing literature, I first summarize the key findings on the existence and impact of clusters. I then review the work on the emergence and evolution of clusters, a topic particularly relevant for policy that is ultimately intended to change the trajectory of such paths. The second part of the article addresses the topic of cluster policy. It sets out by presenting the basic theoretical argument for cluster policy. I discuss two opposing understandings of how cluster policy should be conducted, arguing that their different underlying definitions of what cluster policy is lie at the heart of the widely diverging opinions on the use of cluster policy. Most of the actual cluster policies discussed in the section thereafter are found to be very unlike those that the critics have in mind when arguing against cluster policies. Lastly, I examine matters of implementation that have a crucial bearing on whether and when cluster policy is beneficial and how large these benefits might become.

## Clusters as Building Blocks of a Modern Economy

### *Clusters and Economic Performance*

Economic activity is distributed unequally across space, and these differences in density have significant implications for productivity and prosperity across locations (Porter 2004; World Bank 2009). Activity in some industries, for example, is distributed across regions in overall patterns that are consistent with the distribution of aggregate economic activity, whereas activity in other industries concentrates heavily in a few locations, deviating greatly from those overall patterns (Porter 2003). Among this latter group, there are specific groups of industries that tend to collocate, building clusters (Porter 2003). Regional economies end up with distinct specialization profiles reflecting the presence of the clusters that have located there.

Marshall (1890) was the first economist to argue that clusters arise because of specific benefits that firms can enjoy from locating close to others engaged in related activities. The conceptual and empirical research on these benefits that drive divergence across regions has focused on three main mechanisms: (a) the local market demand to attract more specialized suppliers and interact with them more efficiently (Amiti and Cameron 2007), (b) a deeper labor market to provide access to more specialized skills (Eriksson and Lindgren 2009; Huber 2010), and (c) concentrated innovation activity to create local knowledge spillovers that support the emergence

of new ideas and better practices (Aharonson et al. 2007; Audretsch and Feldman 2003; Thompson 2006). There is significant empirical evidence that each of these sources matters (Dauth 2010; Ellison et al. 2010), with their relative weights driven by cluster-specific factors.

The unfettered push toward collocation in clusters is held in check by countervailing effects that drive convergence across regions. Competition for specialized labor and other inputs among companies in the same industry raises the cost levels within clusters. The intense rivalry with direct competitors in a cluster cuts into the margins that companies can charge. There is clear evidence that these factors matter as well, especially at the level of narrow industries (Braunerhjelm and Thulin 2009; Delgado et al. 2010b). The tendency of economic activities to be collocated depends on the balance between these opposing forces. Clusters emerge where the forces for divergence dominate. Activities remain local when the forces for convergence dominate. Clusters typically account for about a third of total employment (Porter 2003).

The size of the cluster sector is to a large degree a reflection of broad patterns in economic composition, especially the degree of service-orientation the economy has reached. The pattern of specialization within the cluster sector, however, turns out to be a major driver of economic performance. Regions with strong clusters (high levels of specialization in groups of related industries) excel in terms of wages, attraction of foreign direct investment, productivity, and prosperity (Bobonis and Shatz 2007; Porter 2003). Figure 13.1 shows the relationship between cluster portfolio strength and regional prosperity for European regions. These studies do not prove causality, but they do indicate the close relationship between clusters and economic outcomes. Differences in cluster specialization could explain around one third of the difference between the U.S. and the European levels of GDP per capita (European Commission 2007).

Clusters are obviously not the only drivers of regional prosperity. A substantial body of literature argues that a broad range of fundamental factors, including the nature of institutions, the quality of factor conditions, the openness of markets, and the geographic location itself, are critical (Gallup et al. 1999; Hall and Jones 1999; Sachs and Warner 1995). The competitiveness approach (Porter 1990) integrates clusters into a comprehensive framework building on these ideas. Clusters amplify the strengths that these fundamentals provide but depend on them and cannot eliminate their weaknesses.

In the literature on economic geography, the sheer scale of economic activity in a region is discussed as another possible explanation of prosperity differences across regions. This argument comes in two varieties. In one, it is argued that cross-cluster spillovers are more important than within-cluster spillovers, meaning that absolute size and density matter most, not relative specialization (Brülhart and Sbergami 2008). In another approach it is argued that heterogeneity—the absence of specialization—in high-density urban regions is central to "creativity" (Florida 2002; Jacobs 1961/1992). Both of these models predict a very unequal world of a few prosperous large regions (core, or urban) and many poor small regions (periphery, or rural) as a result of larger substantial mobility across regions. By contrast, the cluster model predicts that regions of similar fundamentals can reach similar sizes and levels of prosperity if they each develop their own patterns of specialization.

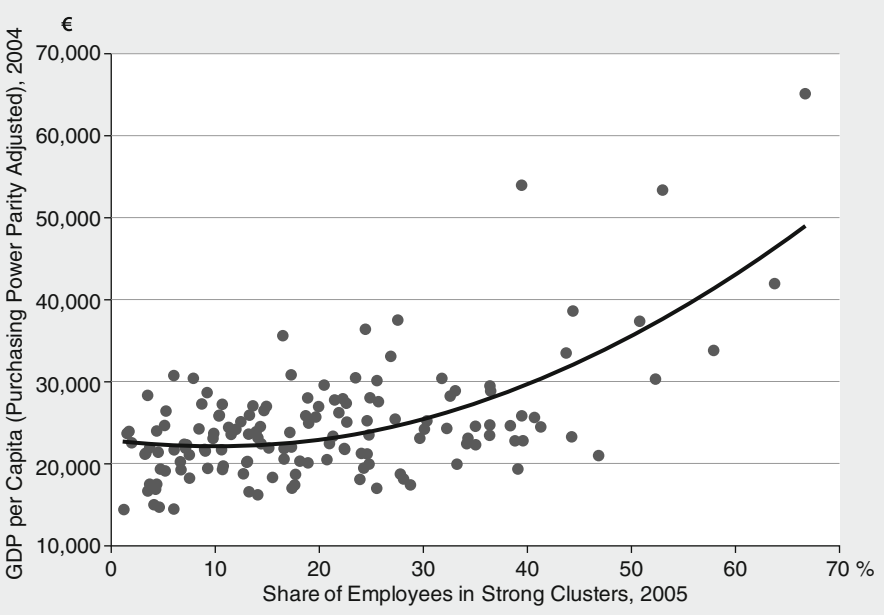


**Fig. 13.1** Cluster portfolio strength and regional prosperity in European countries, Nomenclature of Units for Territorial Statistics (NUTS), Level 2. Strong clusters are defined by $LQ > 2$. Shown are NUTS regions in the EU-15, excluding Portugal and Greece. Data are from European Cluster Observatory ISC/CSC cluster codes 1.0, data set 20070510 (Copyright 2008 by Christian Ketels. Adapted with permission)

A number of empirical studies test the impact of all three dimensions: cluster specialization, the quality of economic fundamentals, and the degree of urbanization (e.g., Brülhart and Mathys 2007; Carlino and Hunt 2007; De Groot et al. 2008; Fritsch and Slavtchev 2008; Lall and Mengistae 2005; McDonald et al. 2007). There is no clear consensus across these studies, but the overall evidence suggests that each of the dimensions plays an independent role. Looking at the two related to geography, one finds evidence that cross-cluster agglomeration remains the dominant force in developing economies and is losing power in advanced economies, where instead cluster specialization is figuring more and more (Brülhart 2009; Krugman 2008; World Bank 2009). Cluster specialization explains a significant share of the prosperity differences among the European Union's first 15 member states (EU-15), a group of countries broadly similar in competitiveness. But cluster specialization explains far fewer of the prosperity differences across the EU-25 countries, where disparities in competitiveness are much more pronounced.

Recent studies indicate that specialization and diversification do not necessarily conflict with each other. The advantage of large metropolitan areas seems to be that they can combine these two characteristics. In other words, the size of such areas enables them to create critical mass in individual clusters while supporting an overall

portfolio of clusters that provides a breadth of knowledge and capabilities. And the advantage of diversification seems to be greatest when it happens in "related clusters," that is, in activities that share common aspects of knowledge or capabilities. High specialization in a narrow industry supports high levels and growth of productivity. Employment growth, however, is likely to occur in related industries within the cluster, not in the already highly present industry itself, where competition for input factors drives up costs (Delgado et al. 2010a).

The positive impact of cluster strength on economic performance works through several distinct channels (Porter 2008). Companies within clusters achieve higher levels of productivity (Boasson and MacPherson 2001; Greenstone et al. 2010). They are able to do so because the presence of specialized suppliers and service providers shortens reaction times and the need to maintain comparatively high levels of working capital. Indeed, companies within clusters *must* achieve superior levels of productivity because the intense competition on input and end markets requires both constant improvement of efficiency and the adoption of best practices. The effect of intensified competition is felt not only by companies but also by employees, who reportedly work longer hours in strong clusters (Rosenthal and Strange 2008). Companies within clusters attain superior levels of innovation (Audretsch and Feldman 2003; Fornahl et al. 2010; Moreno et al. 2004). The cluster environment leads to higher pressure to innovate, a richer source of relevant ideas, and lower costs of turning ideas into new products and services. There is accumulating evidence that clusters have an especially notable impact on the commercial use of knowledge, not just on the creation of knowledge itself (Sölvell and Protsiv 2008). Lastly, clusters promote an environment conducive to entrepreneurship. New companies rely more on external assets and capabilities than incumbents do. Clusters provide access to them, which elevates the levels of entry in cluster environments (Freser et al. 2008; Glaeser and Kerr 2009; Guiso and Schivardi 2007). More important, survival rates and firm growth are higher in clusters as well (Audretsch and Dohse 2007; Delgado et al. 2010a; Wennberg and Lindqvist 2010).

## *Cluster Evolution*

The literature reviewed up to this point indicates that clusters exist and have an important impact on economic outcomes. But how do clusters arise? On the whole, the knowledge about the processes of cluster evolution is still largely based on case studies. This literature suggests that clusters emerge where economic transactions across locations are feasible *and* where there are location-specific factors that forge a nucleus for cluster development. The first condition is crucial for cluster dynamics to become relevant but is often neglected in policy discussions. Where trade across locations is inhibited, the productivity benefits of clusters are irrelevant and the seeds of cluster evolution have no opportunity to come to fruition. Deep market integration has a much longer history in the United States than in Europe, a fact that very likely accounts for the stronger cluster profile of many U.S. regions.

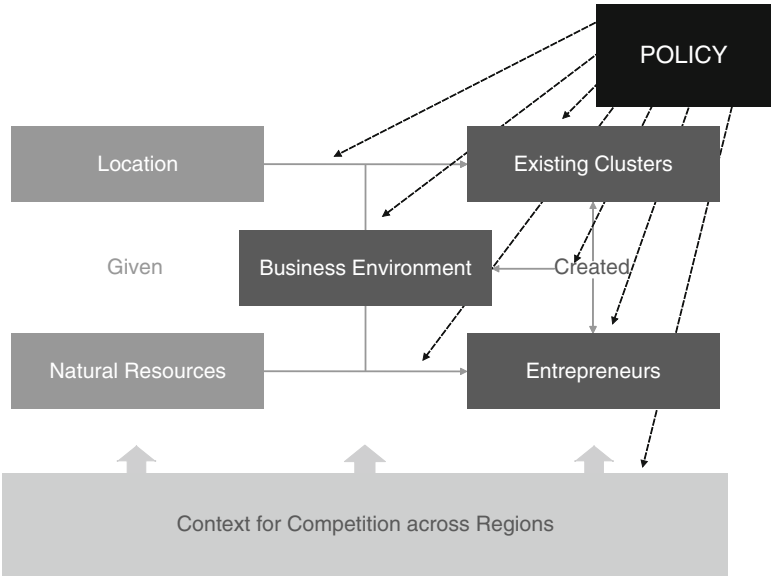


**Fig. 13.2** The emergence of clusters (Copyright 2008 by Christian Ketels. Adapted with permission)

This example also suggests that the reduction of trade barriers because of globalization will boost the role of clusters, even though individual clusters have experienced everything from explosive growth to fast decline (Rabelotti 2001). Well-established incumbent clusters with strong inherent position prosper because they can serve a growing international market. But incumbent clusters that have resulted from trade barriers and have had only a relative advantage when serving a limited geographic market come under mounting pressure. New clusters grow where rising competitiveness and advantageous cost positions provide a platform to serve global markets. Quite tellingly, the outsourcing of economic activities to emerging economies has again taken place in clusters (Enright et al. 2005).

As for the second condition, researchers have found that various types of nuclei are involved. Figure 13.2 provides an overview of the most significant of these nuclei. Endowments of natural resources and a geographic location close to trading routes are frequently important. Specific elements of the business environment, such as the presence of a prominent university or of unique local demand, can trigger the development of a cluster (Braunerhjelm and Feldman 2006; Bresnahan and Gambardella 2002). Individual companies, be they local entrepreneurial start-ups or investments from outside firms (Manning 2008), can, through spin-offs and the attraction of other companies, "anchor" clusters that may develop sufficient independent strength to survive the demise of the initial anchor (Treado and Giarratani 2008). A factor that has gained increasing attention is the function of existing clusters as a breeding ground for new clusters. There is compelling evidence that

new clusters register much more vigorous employment growth if they are related to clusters already strong in a region (Delgado et al. 2010a). Consistent with these findings, the specialization profile of regions has been shown to develop in a path-dependent process of related diversification (Neffke et al. 2009).

Literature on the life cycle of clusters is expanding (Bergman 2006). Many clusters seem to follow an S-shaped development path. After what is often a long phase of gestation, a cluster achieves a size where cluster effects set in and growth accelerates. This growth then becomes self-reinforcing; cluster effects culminate, and growth explodes. Over time, growth moderates as the cluster reaches its market potential and congestion effects become more relevant. Some clusters then manage to reinvent themselves, finding a new market or technology to ignite a next phase of cluster dynamisms. Others, however, get locked into existing technologies and gradually shrink as their markets disappear or other clusters develop more dynamism (Maskell and Malmberg 2007; Saxenian 1994). This thinking finds its reflection in the work on regional economies (Audretsch et al. 2008).

These existing life-cycle studies have a drawback, however. They work well retrospectively tracking the path of successful clusters but have only limited predictive power. They do not lend themselves particularly well to the early identification of clusters that will ultimately blossom. Many case studies suggest that the process of cluster development is complex and fragile (Feldman and Francis 2004). Chance events might be seminal, especially in the early stages of cluster evolution (Storper and Walker 1989). The literature has identified a number of factors that spur cluster development, but there is no comprehensive model that integrates them. And there are virtually no robust empirical studies on their relative significance (Van der Linde 2003, is an exception) or their sufficiency in triggering the growth of successful clusters. This gap in the literature poses a significant challenge for policy-makers hoping to influence the emergence and development of clusters.

## Cluster Policy

Cluster research over the last 20 years has to a large degree focused on identifying what clusters contribute to the market success of companies and the performance of regions. Not surprisingly, the evidence that clusters are important for economic success has attracted the interest of policy-makers. But although there is an emerging consensus on the usefulness of clusters as an analytical tool, such accord is still a long way off in the academic discussion on cluster policy.

Governments, meanwhile, have over the last few years launched an impressive array of cluster policy programs. This revival, after a first wave of interest in the wake of *The Competitive Advantage of Nations* (Porter 1990; see Aranguren et al. 2006, on the experience of the Basque country, one of the early adopters of cluster policy), has been driven chiefly by policy-makers' escalating frustration with traditional approaches at a time when pressure to improve competitiveness has been building (Davies 2006; Freser 2005).

## *The Theoretical Motivation for Cluster Policy*

Economists regard policy interventions as justified when specific conditions restrict the ability of the normal market process to lead to optimal outcomes from an overall welfare perspective. Such "market failures" underlie the traditional motivation for economic policy. The local externalities that give rise to clusters constitute market failures such as—

- coordination failures, because individual companies take account only of the impact that their decisions have on themselves, not on others, be it about whether to locate in a cluster or what investments to undertake there.
- information asymmetries, for even if companies wanted to consider the impact their actions have on others, the knowledge necessary to make the right "social" decision is dispersed among the cluster's many participants.
- path dependency, for decisions of cluster participants today affect the cluster's possible evolutionary path in the future. Coordination failures and information asymmetries in making these decisions thus have a dynamic dimension as well. Moreover, social and private discount rates might differ—an additional source of market failure.

If cluster policy addresses such market failures, it does not diminish global welfare. Under some assumptions, the free competition between rational governments in supporting clusters even leads to the best possible outcome, not a race to the bottom (Norman and Venables 2004). Although these arguments do not prescribe specific policy interventions, they do indicate the direction that cluster policy should take. Policy intervention should always target the market failure at its source. Policy can subsidize activities that are underprovided because of coordination failures or differences in discount factors. And policy can facilitate platforms for collective action to overcome coordination failures and information asymmetries. Figure 13.3 depicts this argument graphically.

Policy approaches can be compared for both their actual impact (in addressing the problem or market failure) and their potential costs (in leading to distortions or government failure). Figure 13.4 shows the relative mix of impact and distortions for different policy approaches. Policies that target individual companies are highly effective but also very distortionary. Policies that target the entire economy are only slightly distortionary, if at all, but they are often also not very effective. Policies aimed at individual industries come somewhere between these two poles. Cluster policy, however, offers a superior mix of benefits and costs. It is organized around a group of industries that by definition have strong linkages. Aiming policy at them will thus not only be effective but will even trigger additional benefits from positive spillovers that are induced. The policy is neutral within the cluster where competition for factors of production is the sharpest; it is distortionary only relative to activities outside the cluster, where other skills and assets are needed by definition. Although some distortion remains, the approach promises a potentially better balance of effects.

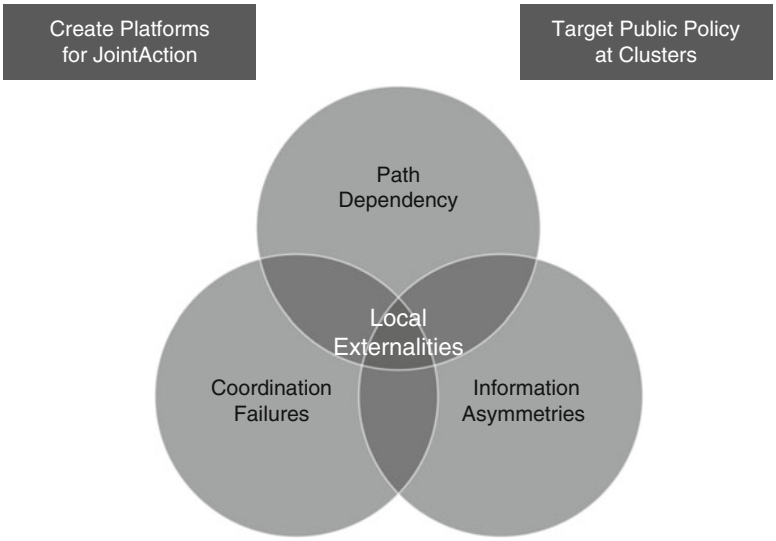


**Fig. 13.3** The case for cluster policy (Copyright 2008 by Christian Ketels. Adapted with permission)

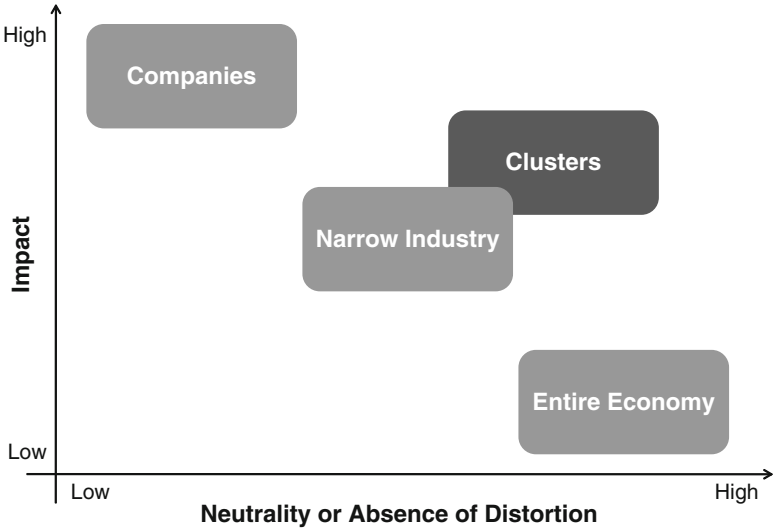


**Fig. 13.4** The impact and neutrality of government policies (Copyright 2010 by Christian Ketels. Adapted with permission)

In practice, efforts to grapple with market failure are never perfect (Rodrik 2008). They suffer from government failures in implementation (some reasons for which are lack of knowledge to target the intervention, inability to provide incentive-neutral funding, and incapacity to resist political pressure by interest groups seeking

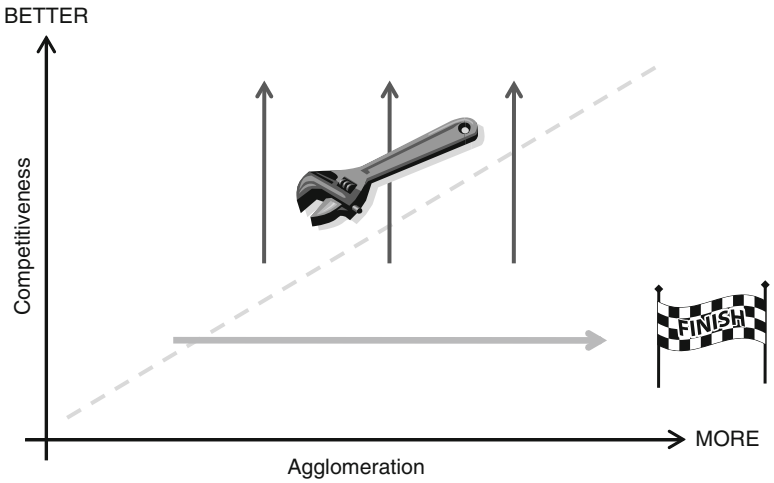


**Fig. 13.5** Two perspectives on cluster development (Copyright 2008 by Christian Ketels. Adapted with permission)

beneficial treatment) and might have unintended side-effects, entailing collateral costs that outweigh the benefits. This observation is also true for cluster policy and has led to a debate on whether cluster policy is useful or harmful.

## *The Theoretical Debate About Cluster Policy*

In the academic debate the strongest criticism of cluster policy does not come from researchers who claim that locational factors are irrelevant but rather from economic geographers and others who fully subscribe to the view that locational factors are important. Some analysts disapprove of the "fuzzy" nature of the cluster framework (Martin and Sunley 2003). Their criticism raises some pressing conceptual issues but has little relation to the practical problems policy-makers face when deciding on whether and how to implement cluster policy. It has also been challenged on more conceptual grounds (Benneworth and Henry 2004; Motoyama 2008). A more fundamental criticism of the motivation for cluster policy (Duranton 2011) turns out to be highly revealing for how the lack of a generally accepted definition of cluster policy continues to hamper the debate. To understand these different views on cluster policy, it is useful to go back to a simple diagram that relates agglomeration to competitiveness (see Fig. 13.5). The evidence discussed in the section on "Clusters and economic performance", above, points to a positive relationship between the two dimensions, a fact that is generally accepted by critics as well as advocates of cluster policy. (As discussed above, there is disagreement on how tight this relationship is relative to other factors.) But how should cluster policy

intervene to move a location from a place at the bottom left to the top right? This question is where the fundamental difference comes in.

In one approach agglomeration is the key policy lever; as agglomeration progresses, competitiveness will naturally follow as cluster effects set in. With agglomeration as the ultimate goal, efforts to attract companies through incentives—ranging from tax rebates to free infrastructure—naturally come to the forefront of the policy debate. Economic geography-based approaches, too, center on the effects of traditional tax, trade, and regional policies on agglomeration patterns (Baldwin et al. 2003). Dynamic models in "new economic geography" provide guidance on when and how these instruments should be used in order to have maximum impact (Brenner 2003, 2008): The process of agglomeration is characterized by crucial junctures at which patterns of economic geography are determined. For economic policy, this observation implies that intervention has to occur early—before the crystallization of the patterns that determine the future location of a dominant cluster. That intervention also has to be massive, meaning that it must give a boost so significant that the location acquires critical mass in order to far surpass all potential rivals. And it implies a priority on identifying a few clusters on which economic development then hinges.

If massive targeted subsidies in the early phase of cluster emergence are the policies under discussion, should they be used? Critics of cluster policy are not the only ones who counsel against resorting to them, for such policies require the policy-maker to have an abundance of information and ability and are therefore likely to fail. Furthermore, there is debate as to whether such policies could even have sufficient effect. With current economic geography being aligned with the fundamentals, some researchers find that policies encouraging a marginal company to change location have very limited impact on the productivity of other companies (Martin et al. 2008). Other analysts arrive at opposite results, with significant implications for the productivity of companies in the proximity of companies that have changed location (Greenstone et al. 2010).

In another approach competitiveness is portrayed as the vital policy lever; as competitiveness builds, agglomeration will naturally increase as the cluster becomes more attractive for new entrants (Rodriguez-Clare 2005). With competitiveness as the ultimate goal, clusters become a process tool to design and implement policies more effectively. The instruments then targeted at existing clusters are well known from innovation policy, regional policy, and enterprise policy. They are supplemented by actions that specifically favor collaboration on their use and that create platforms for collaboration within an agglomeration. The competitiveness literature, including the insights on cluster evolution, offers guidance on when and how to use these instruments. This assistance, though, is radically different from the model that critics of cluster policy have in mind. The focus should be mainly on agglomerations that have already passed the early stages of development (Rodriguez-Clare 2007). In other words, the fundamental conditions for economic success are in place, and active collaboration can become a "turbo" for the use of existing strengths. The emphasis of policy interventions should be on enabling collaboration and channeling resources in a different way, using moderate amounts of new funding. Major new

funding is not necessary and could become harmful by compounding the potential for distorting incentives. And though a selection of clusters is needed for the commitment of sufficient resources and attention to any one initiative, economic development is the result of many clusters in all regions that are flourishing, not just a few per country.

If these policies are the ones under discussion, should they be used? Even the critics of cluster policy have a slightly favorable view: Improvements in the fundamentals of competitiveness are a sensible goal, and the suggested approach mitigates their downside. But they remain skeptical about whether cluster efforts can sufficiently promote underlying competitiveness. Proponents of cluster policy, meanwhile, see enough evidence that such efforts can in fact lead to a much more meaningful implementation of policies for honing competitiveness (Cortright 2006; Mills et al. 2008; Porter 2008; Waits 2000).

There remains a fair degree of disagreement in the debate about cluster policies. This difference of opinion stems at least partly from a lack of effective communication between theoretical research and policy practice. This communication failure leads to a fundamental disconnect on what cluster policy is and how it is related to efforts to upgrade competitiveness. For many researchers, improving competitiveness is fundamentally an automatic process driven by the self-interest of companies and politicians. For most governments, improving competitiveness is a complex challenge of identifying action priorities and mobilizing allies to work on them. Cluster policy has the potential to respond to these real challenges, which the critics assume will be taken care of automatically over time.

## *The Practice of Cluster Policy*

The number of cluster programs launched by governments around the world has soared in the last few years. There is significant heterogeneity in objectives, tools, and—as far as can be already seen—results.

Most cluster programs, especially in advanced economies, pursue traditional economic policy objectives in new ways:

- Innovation policy is the field of widest adoption for cluster programs. France (Pôle de Compétitivité), Germany (Spitzencluster), Japan (Industrial Cluster Program, METI; Knowledge Cluster Initiative, MEXT), Sweden (Vinnväxt), and, most recently, the United States (i6 Challenge program) have launched efforts in this direction, all trying to foster leading innovation clusters in the respective country. The Chilean cluster program (run by InnovaChile Corfo) is an example of a similar program in an emerging economy. Many of these endeavors are open to all types of clusters, whereas some concentrate on specific categories like biotech (German BioRegio competition) or energy (E-RIC[1] program in the United States).
- A close second is regional policy, where the main objective is to spur regional growth (with innovation a possible, but not the only, driver). Examples include

the RDA cluster efforts in the United Kingdom, the multiple cluster programs of German and Austrian states, and the Small Business Administration Regional Innovation Cluster program in the United States.

- A third, more heterogeneous group of cluster programs includes those that aim to upgrade company sophistication, mainly among small and medium-sized enterprises (SMEs). The German Competence Networks program falls broadly into this category. A range of EU-supported efforts aims at helping SMEs internationalize. Many programs funded by aid organizations in developing and emerging countries, such as the Inter-American Development Bank's cluster program in Colombia and the cluster program of the Brazilian Micro and Small Business Support Service (SEBRAE) Project in Minas Gerais (Brazil), are of a similar nature, often with a specific focus on enhancing exports (Ketels et al. 2006).
- Then there are specific programs where clusters have been used as an organizing principle in other areas, such as the U.S.'s Workforce Innovation in Regional Economic Development (WIRED) program on building workforce skills, and the cluster approach that Invest: Sweden and ProsperAr (Argentina) take to investment attraction.
- A final, quite different group of cluster programs includes those that aim to drive diversification by developing new clusters. Examples are the cluster program in Saudi Arabia; the cluster efforts in many of the Gulf countries; and many similar initiatives in Asia, from Singapore to China. There are also numerous programs in regions across the OECD to create new "high-tech" clusters, with the most popular targets having shifted from information technology to life sciences and then to "creative" and clean energy clusters.

Cluster programs differ significantly in the tools they use, not only their objectives. The contrasts to traditional policy approaches are often more pronounced in this dimension than in others.

- The vast majority of programs rely on the financing of specific activities conducted in the cluster. In advanced economies these financing structures diverge from traditional policies in two main ways. First, many of them must be structured as a cluster initiative in order to qualify for funding. There is no funding for individual companies. Second, an increasing number of programs allocate money through competitive process. There are no criteria whose fulfillment means automatic eligibility for government support. All of the previously mentioned efforts related to innovation policy follow this model. The regional programs listed also require cluster collaboration structures, but not all of the programs have a clearly competitive element. In emerging economies quite another path is often taken, with funding, directed credit, or tax incentives being granted to companies in target sectors, much as in traditional industrial policy programs. This approach has been used by many Asian countries, but also by OECD regions with ambitious plans to attract new clusters.
- Another group of programs provides or supports cluster management. Especially the Austrian and some of the German state-level programs operate in this way.

In Germany, the program for regional development was specifically changed to allow the funding of cluster management activities. The EU has recently started trying to improve cluster-management practice through training, networking, and tools for cluster managers. Many of these programs are designed to upgrade the funding schemes discussed above.

- The final group of programs gives direct support in the form of infrastructure, other input factors, and specific regulatory environments relevant to specific clusters. Such help is one of the preferred instruments in countries and regions intent on attracting new clusters. Dubai, for example, has made extensive use of free zones (e.g., finance, media, and semiconductors). Singapore's Biopolis, too, offers physical infrastructure and other incentives.

Although the understanding of cluster programs is growing, there is still painfully little systematic data on their impact. The limited quantitative evidence that does exist points to moderately positive effects (Dohse 2007; Dohse and Staehler 2008; Engel and Henrik 2004; Falck et al. 2008; Fromhold-Eisebith and Eisebith 2008). The reviews of individual programs tend to find positive returns for the participants and an expanded capacity for joint action (see, for example, the review of the Swedish Vinnväxt program by Cooke et al. 2007). Robust economic results are hard to pin down, however. Successful cluster development is mostly a function of sound economic fundamentals and significant collocation of related activities (Lindqvist, Ketels, and Sölvell 2003). Cluster programs can supplement those kinds of fundamentals and affect cluster development but are very unlikely to produce clusters on their own (Konakayama and Chen 2007; Meier zu Köcker 2008; Sölvell 2008; Wolfe 2008).

Although there is no dramatic empirical evidence of the effectiveness of cluster programs, programs that have steered free of attempts to create clusters seemed to have fared at least as well as the traditional policy programs that governments use. Measured against this real benchmark instead of the theoretical benchmark of an ideal policy, cluster programs have come out relatively well. Accordingly, the cluster policy debate among government officials has shifted its emphasis from whether to launch programs to how to organize them (see, for example, High Level Advisory Group on Clusters 2008).

## *Challenges in the Practice of Cluster Policy*

Government officials discuss many details of how cluster programs should be designed. The effective engagement of the private sector, the combination of local with global linkages, and the measurement of impact are often mentioned as key issues. In this section I discuss three particular challenges that have rather broad conceptual importance and require a practical answer to the question of designing cluster programs appropriately.

The first challenge is how to scale up the impact of cluster programs. Simple arithmetic suggests that working with one regional cluster, even a sizeable one,

is unlikely to generate economic outcomes that are meaningful for the overall regional economy. The average regional cluster accounts for about 1 % of total employment in a region (European Cluster Observatory 2008); larger clusters, maybe up to 5 %. Upgrading one cluster will tend to have only a moderate impact on the regional economy overall. There is a range of ideas for how cluster policy can be designed to affect the regional economy (High Level Advisory Group on Clusters 2008; Ketels 2009; Pietrobelli and Rabelotti 2004). Regional officials should take a portfolio perspective on their cluster efforts, addressing the different needs of clusters at different stages of development and leveraging the linkages across clusters. They should leverage the experience of the cluster efforts for economy-wide improvements. And they should integrate their cluster efforts into a broad economic strategy that identifies the specific value the location has relative to others of similar standing.

The second challenge is how to spur the development of new clusters. The evidence discussed indicates that cluster programs work best for strong, established clusters. But the limitations of a cluster policy confined to "strengthening the existing strengths" is obvious for less advanced economies and regions in a process of structural change (Ketels and Memedovic 2008; Landabaso 2001). Some researchers suggest that diversification efforts can be based on a cluster approach when development paths are designed to leverage existing clusters for a push into related fields (Delgado et al. 2010a; Hausmann and Klinger 2007). These ideas have informed a discussion about "smart specialization" as a new concept for regional policy in Europe (Foray et al. 2009), one according to which existing cluster structures would serve as the basis for regionally specific development strategies. Identifying the potential for new economic activities is seen as something that only companies can do. The significant positive external benefits that it yields instills theoretical motivation for governments to assist this discovery process.

A third challenge in conceiving an appropriate design for a cluster program is the question of where to use cluster programs instead of more traditional policy approaches. The evidence discussed indicates that cluster programs work best if the economy's fundamentals are solid. But in emerging and developing economies these fundamentals have significant weaknesses almost by definition. Poor business environments are likely to be a far more serious obstacle than the weakness of clusters is. And with fragile political institutions the move toward cluster policies can open a Pandora's box of interventions, as noted by the European Bank for Reconstruction and Development (2008). Still, regional concentrations of related activities are prevalent even in emerging and developing countries (World Bank 2009; Zeng 2008). Under such demanding conditions, efforts to establish and develop clusters should be directed to creating the local and regional social capital required in order to upgrade competitiveness in the future. And cluster efforts should be supported with limited resources (which are often sufficient for collaboration) and managed by institutions that are outside direct political influence.

## Conclusions

Cluster policy is a field undergoing dynamic development in which the clarity of the conceptual discussion has not always kept pace with the efforts of government officials. Although there is an emerging consensus on what clusters contribute to the modern economy, the discussion on a workable theory of cluster policy is still very active. The absence of a consensus on the usefulness of cluster policy is to a major degree the consequence of confusion about what cluster policy actually is. If cluster policy is understood as a tool to change the nature of economic geography artificially, there are many conceptual and practical arguments against its use. If, however, cluster policy is seen as a way to leverage existing agglomerations as platforms for collaborative enhancement of cluster dynamics and as effective channels through which to deliver economic policies, it has much potential.

Whether cluster policy can fulfill this potential is not only a matter of clarifying a conceptual debate that is too often conducted in the parallel worlds of different, isolated research traditions. It also depends on the way cluster policy is implemented in practice. The number of efforts to improve the actual practice of cluster management and cluster policy design has risen significantly over the last few years, but academic research has in great measure been too detached from the reality of the problems government officials and cluster initiative managers face to be of much help.

Further progress in the debate on cluster policy debate will have to be driven by additional data. For clusters, there is now an increasing amount of quantitative data that have facilitated a new wave of empirical research. For cluster policy, there is nothing comparable. The existing impact assessments are case-by-case analyses and tend to be focused on improving the specific policy program in place, not on broadly learning about better cluster policy. This approach for impact assessment is a start, but more has to follow.

## Note

1. Regional Innovation Cluster (RIC).

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# Abstracts of the Contributions

## Introduction: Knowledge and the Geography of the Economy

**Johannes Glückler and Peter Meusburger**

**Abstract** This introductory chapter revisits the crucial role of knowledge and innovation in the process of economic development. It challenges some of the persistent puzzles in traditional economic thought about knowledge and prepares the scene for an inclusive and open multidisciplinary dialogue about the concept, creation and reproduction of knowledge. Is economic growth finite? What drives future economic development? Does geography make a difference to where and how economies develop? Though these fundamental questions lie at the heart of economics, many academic disciplines contribute to the promising answer as to how knowledge could make sustained economic growth possible. This introduction develops a geographical perspective of the knowledge economy and offers points of departure for a more realistic and situated approach to the relation between knowledge and economy.

## Relations Between Knowledge and Economic Development: Some Methodological Considerations

**Peter Meusburger**

**Abstract** Although superior knowledge, competence, and expertise; high levels of training; and major investment in education and research are often regarded as prerequisites of economic success, the relationships between knowledge and economic action are not as straightforward as they may seem in the literature. The spatial, social, political, and economic context in which actors or social systems seek to achieve their objectives largely determines whether competence or research can be parlayed into economic success. Yet a milieu, or context, is not an independent

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variable in a cause-and-effect relation influencing what actors do. It represents potential that actors must be able and willing to use to achieve the desired effect. It can also impede some actors in the development of their skills and can obstruct the performance of innovative organizations. The author tries to shed additional light on the relationships between knowledge and the economy.

## A Microeconomic Approach to the Dynamics of Knowledge Creation

**Patrick Cohendet, Jean-Alain Héraud, and Patrick Llerena**

**Abstract** The aim of this contribution is to analyze the period of collective research extending from the emergence of the first innovative idea to the moment when a patent can be written and claimed. The authors argue that the period of collective research is characterized by the building of public or semipublic good in order to equip the innovative idea with a "codebook" (shared codes, tests, and "grammar of usage") and to reveal its economic potential. They emphasize the role of knowing communities as the active units in the dynamic process of invention and discuss some of the consequences in two domains of application: property rights and creative clusters.

## Knowledge Creation and the Geographies of Local, Global, and Virtual Buzz

**Harald Bathelt and Philip G. Turi**

**Abstract** This chapter is a systematic investigation of the effects that new communication technologies and different organizational forms of economic interaction have on knowledge creation and innovation processes. The emphasis is on the potential of combining computer-mediated communication (CMC) with forms of temporary and permanent face-to-face (F2F) interaction. It is pointed out that permanent co-location and F2F interaction may be efficient in some contexts but not in others and that temporary and virtual interaction, supported by CMC, is increasingly becoming the basis for establishing trans-local production networks. By combining results from social psychology with economic geography, the authors argue that there is no generally superior spatial fix for economic interaction. Different spatial configurations can be advantageous in different production and innovation contexts, even over large distances, without permanent or even regular F2F contact.

## Creativity: Who, How, Where?

**Edward J. Malecki**

**Abstract** Human creativity is both individual and collective. As symbols, signs, brands, and other intangibles grow in importance, the search for creativity and how to manage it has increased in importance. Organizations such as corporations and research institutions try to enhance and manage the collective creativity of their employees, but creativity remains to a large degree both unpredictable and unmanageable. The location of creativity is mainly urban, as people interact within cities to generate creative places and urban creative scenes. Just as creativity cannot be managed completely, it cannot be fully planned.

## The Problem of Mobilizing Expertise at a Distance

**Johannes Glückler**

**Abstract** In this contribution the author conceptualizes knowledge management within a trade-off between organizational coherence and geographical expansion. He focuses on an extensive corporate case study of a globally distributed medium-sized technology service company in order to explore the relational architecture of interpersonal knowledge transfer among all employees and across all global locations. A social network analysis is used to illustrate the network of knowledge flow, assess its vulnerability, and investigate the effect that different management programs have on global knowledge exchange. Although geographical separation is a key barrier to knowledge exchange, expatriation programs are found to be the most effective driver of international interpersonal knowledge transfer.

## Knowledge, Capabilities, and the Poverty Trap: The Complex Interplay between Technological, Social, and Geographical Factors

**Jan Fagerberg and Martin Srholec**

**Abstract** This chapter explores the suggestion that technological capabilities, if they are to lead to development, need to be accompanied by a broad set of social capabilities reflecting not only such things as the provision of education and good governance, but also the spread of values, beliefs, and institutions that encourage

members of society to contribute actively to the development process. The empirical analysis presented in the chapter, based on a large dataset of relevant indicators for countries at different levels of development, lends considerable support to this suggestion. However, the analysis also shows that some countries, mostly tropical, are disadvantaged by a powerful vicious circle of high fertility rates, low education, and high frequency of serious disease, which hamper the building of technological and social capabilities and perpetuate poverty. The authors conclude that there is no easy "technological fix" to the problem of underdevelopment.

## Economics, Geography, and Knowing "Development"

**Eric Sheppard**

**Abstract** Theories and conceptions of the economy profoundly shape how it comes to be known. In this chapter the author compares and contrasts the socio-spatial ontologies of economists and geographers, theorizing the relationship between geography and economic development. These groups of scholars share the view that neoliberal globalization has undermined development prospects for the disadvantaged, but their contrasting ontologies generate different understandings of capitalism and of how to resolve this problem. Economists know capitalism as in principle capable of alleviating poverty and uneven geographical development, concluding that development is best achieved by following a common path to capitalist development everywhere, as pioneered by advanced capitalist societies. Geographers know capitalism as generative of inequality and uneven geographical development, as a system that forces disadvantaged social groups and geographical locations to find different approaches to development in order to overcome their current disadvantage.

## Knowing Mycellf™: Personalized Medicine and the Economization of Prospective Knowledge about Bodily Fate

**Bronwyn Parry**

**Abstract** The author explores the emergence of direct-to-consumer (DTC) genetic testing as a means of economizing information or knowledge about "bodily fate." She begins by examining the parallels and incommensurabilities between the kinds of bodily information that have been produced historically and those now generated by the application of advanced genome sequencing technologies. She then explores how contemporary understandings of disease are coproduced by individuals identified as potential constituents of disease communities by these forms of testing. The chapter concludes with a review of the implications that this involvement in the coproduction of understanding of disease has for the global regulation of DTC genetic testing.

## KnowledgeScapes: A New Conceptual Approach and Selected Empirical Findings from Research on Knowledge Milieus and Knowledge Networks

**Ulf Matthiesen**

**Abstract** The complex interplay between accelerating knowledge dynamics, heterogeneous spatial developments, and conflict-driven transaction fields is a core constellation of actual societal and spatial processes. Many of the interdependencies involved are not yet precisely understood, and verified causal explanations are scarce. This chapter presents a new research heuristics in order to advance inquiry in this foggy field. It addresses the coevolutionary interrelations between knowledge, space, and milieu. The conceptual outfit, major empirical findings, and selected strategic and governance-related consequences for knowledge-based urban regional developments are sketched out in seven short argumentative steps.

## Organizational Legacy and the Internal Dynamics of Clusters: The U.S. Human Biotherapeutics Industry, 1976–2002

**Maryann Feldman and Elaine Romanelli**

**Abstract** Using data on the human biotherapeutics industry in the United States from the period 1976 through 2002, the authors explore the organizational origins of entrepreneurs to understand the location and size of industry clusters. Specifically, they examine the effect that different types of organizational legacy—defined as the organization in which the entrepreneurs were previously employed—have on the entry of new firms. The study reveals that regional resources influence the location of industry clusters but that concentrations of entrepreneurs who hail from the same population exert an important, differentiating influence and define a local culture that affects the propensity for information-sharing and collaboration. This research shows that the largest impact on local entry stems from a concentration of founders with prior experience in organizations that are more networked than hierarchical.

## Knowledge and Space in Economic History: Innovations in the German Empire, 1877–1918

**Jochen Streb and Nicole Waidlein**

**Abstract** Analyzing a new data set of 39,343 high-value patents, the authors find ample evidence that interindustry knowledge spillover between technologically,

economically, and geographically related industries were a major source of innovative activities during German industrialization. It is discovered that most of the parallel patent booms of the successive waves of technological progress (railroads, dyes, chemicals, and electrical engineering) occurred in innovative industries that were closely related technologically. The authors then show that these industries were often also geographically clustered. Nearly all German regions that maintained or improved their above-average innovativeness over time had at least one innovative cluster in the fields of mechanical engineering, electrical engineering, or chemicals. The existence and success of these innovative clusters suggest that knowledge spillover between firms of different industries occurred frequently and increased the innovative output of the firms involved.

## Cluster Policy: A Guide to the State of the Debate

**Christian Ketels**

**Abstract** Although there is increasing consensus that the presence of clusters enhances economic outcomes, there is little consensus on whether there is a case for policy intervention. If cluster policy is understood as government efforts to create agglomeration artificially, the existing research finds clear reasons to be pessimistic about the ultimate welfare implications of such interventions. But if cluster policy describes government efforts to use existing agglomerations to deliver economic policies or upgrade a region's competitiveness more effectively, the outlook is much more positive. The evidence on cluster policies actually implemented provides examples of both types, but the large majority falls into the second category. Remaining challenges have more to do with scaling up the impact of cluster efforts, dealing with emerging clusters, and adopting cluster policy to conditions in developing economies.

# The Klaus Tschira Foundation

Physicist Dr. h.c. Dr.-Ing. E. h. Klaus Tschira established the Klaus Tschira Stiftung (Klaus Tschira Foundation) in 1995 as a not-for-profit organization conceived to support research in the natural sciences, mathematics, and informatics and to foster public understanding of these sciences. Klaus Tschira's commitment to this objective was honored in 1999 with the "Deutscher Stifterpreis," the prize awarded by the National Association of German Foundations. Klaus Tschira is a cofounder of SAP AG in Walldorf, one of the world's leading companies in the software industry.

The Klaus Tschira Stiftung provides support mainly for research in the natural sciences, mathematics, and applied informatics and funds educational projects at schools and universities. The resources are largely used for projects initiated by the foundation itself. It commissions research from institutions such as HITS (Heidelberg Institute for Theoretical Studies), formerly known as EML Research, founded by Klaus Tschira. HITS focuses on new theoretical approaches to interpreting the rapidly increasing amounts of experimental data. In addition, the Klaus Tschira Stiftung invites applications for projects that are in line with the central concerns of the foundation.

The seat of the Klaus Tschira Stiftung is Villa Bosch in Heidelberg (Fig. 1), the former residence of Carl Bosch (1874–1940), the Nobel Prize Laureate for Chemistry. Carl Bosch, scientist, engineer, and businessman, joined BASF (Badische Anilin- & Soda-Fabrik) in 1899 as a chemist and became its CEO in 1919. In 1925 he was appointed CEO of the then newly created IG Farbenindustrie AG, and in 1935 he became chairman of the supervisory board of this chemical conglomerate. In 1937 Bosch was elected president of the Kaiser Wilhelm Gesellschaft (later renamed as the Max Planck Gesellschaft), the premier scientific society in Germany. Bosch's work combined chemical and technological knowledge at its best. Between 1908 and 1913, together with Paul Alwin Mittasch, he solved numerous problems in the industrial synthesis of ammonia, drawing on a process discovered earlier by Fritz Haber (Karlsruhe), who won the Nobel Prize for Chemistry in 1918. The Haber-Bosch process, as it is known, quickly became the most important method of producing ammonia—and remains so to this day. Bosch's research also influenced

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high-pressure synthesis of other substances. He was awarded the Nobel Prize for Chemistry in 1931, together with Friedrich Bergius.

In 1922 BASF erected a spacious country mansion and ancillary buildings in Heidelberg-Schlierbach for its CEO, Carl Bosch. The villa is situated in a small park on the hillside above the Neckar river and within walking distance from the famous Heidelberg Castle. As a fine example of the style and culture of the 1920s, Villa Bosch is considered one of the most beautiful buildings in Heidelberg and has been declared a protected cultural site. After World War II, it served as a domicile for high-ranking military staff of the United States Army. Thereafter, a local enterprise used the villa as its headquarters for several years. In 1967 Süddeutsche Rundfunk, a broadcasting company, established its Heidelberg studio there. Klaus Tschira bought Villa Bosch as a future home for his planned foundation toward the end of 1994 and had the building restored and modernized. Combining the historic ambience of the 1920s with the latest infrastructure and technology, Villa Bosch reopened in new splendor in mid-1997, ready for fresh challenges. Seminars and conferences are held today in the auditorium of the Villa Bosch Studio.

The former garage, located 300 m west of the villa, now houses the Carl Bosch Museum Heidelberg, founded and managed by Gerda Tschira and dedicated to the memory of the Nobel laureate, his life, and his achievements.

This book is the result of a symposium entitled “Knowledge and the Economy,” which took place at Villa Bosch (Fig. 2).

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**Fig. 1** Villa Bosch (© Peter Meusburger, Heidelberg)

**Fig. 2** Participants of the symposium "Knowledge and the Economy" at Villa Bosch in Heidelberg (© Thomas Bonn, Heidelberg)

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