International Studies in Entrepreneurship

Maribel Guerrero
David Urbano *Editors*

Technology Transfer and Entrepreneurial Innovations

Policies Across Continents

Springer

International Studies in Entrepreneurship

Volume 51

More information about this series at http://www.springer.com/series/6149

Maribel Guerrero • David Urbano
Editors

Technology Transfer and Entrepreneurial Innovations

Policies Across Continents

Springer

Editors
Maribel Guerrero
Facultad de Economía y Negocios
Universidad del Desarrollo
Santiago, Chile

Northumbria Centre for Innovation
Regional Transformation and
Entrepreneurship (iNCITE)
Newcastle Business School
Northumbria University
Newcastle upon Tyne, UK

David Urbano
Northumbria Centre for Innovation
Regional Transformation and
Entrepreneurship (iNCITE)
Newcastle Business School
Northumbria University
Newcastle upon Tyne, UK

Department of Business and Centre for
Entrepreneurship and Social Innovation
Research (CREIS)
Universitat Autònoma de Barcelona
Barcelona, Spain

ISSN 1572-1922 ISSN 2197-5884 (electronic)
International Studies in Entrepreneurship
ISBN 978-3-030-70021-8 ISBN 978-3-030-70022-5 (eBook)
https://doi.org/10.1007/978-3-030-70022-5

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

2020 has been a challenging year, forcing most people and organizations to adapt to new realities given the unexpected events related to the COVID-19 pandemic. Remarkably, 2020 has also marked the celebration of the 40th anniversary of the 1980 Bayh–Dole Act, which fosters knowledge/technology transfer from university to society. This legislation's effectiveness has been explained through millions of innovation disclosures, millions of start-ups created, millions of jobs created, and millions of patents, licenses, and products created in the USA. These societal benefits have explained why the Bayh–Dole Act has been replicated across the globe.

Consequently, 2020 celebrated the past of a successful technology transfer legislation with multiple societal impacts and reiterated the relevance of protecting the future, especially in these unexpected and uncertain times. In this view, although it is generally accepted that since Schumpeter's seminal work on "creative destruction," entrepreneurship and innovation have become strongly related topics in the practitioner world, in the academic world, both topics have been analyzed as independent topics over the last eight decades. Indeed, despite the globalization of the U.S. Bayh–Dole Act policy frameworks over the last four decades, little is still known about the development of entrepreneurial innovations based on the co-creation among multiple actors in a certain space/time as a result of replication of policies that foster entrepreneurship and innovation ecosystems.

Inspired by these academic gaps, the aim of this book was to (1) provide a better understanding of theoretical, empirical, and managerial implications behind technology transfer frameworks that have stimulated the emergence of entrepreneurial innovation across the world, and (2) examine the potential replication of the U.S. Bayh–Dole Act in other jurisdiction including economies that are in transition towards a knowledge-based society. This book represents an effort of multiple outstanding researchers who have provoked the academic debate about the effectiveness of technology transfer policy frameworks that promote entrepreneurial innovations across different continents (Africa, Europe, North America, and South America). Each chapter contributes with novel conceptual frameworks that improve our understanding of the topic through empirical insights obtained from robust qualitative (single/multiple case studies), quantitative (longitudinal and cross-section studies applied in one/multiple countries), or mixed methods. Indeed, each chapter presents a research agenda for extending new metrics that allow capturing the effects of technology transfer policies/legislations on entrepreneurship and innovations, their impacts on economic growth, as well as several implications for multiple stakeholders.

Newcastle upon Tyne, UK — Maribel Guerrero
Barcelona, Spain — David Urbano

Acknowledgments

The authors are very grateful to Professor Al Link and Professor David Audretsch for inspiring and motivating us to move this entrepreneurial research project forward.

Maribel Guerrero acknowledges the Facultad de Economía y Negocios at the Universidad del Desarrollo (Chile), the Northumbria Centre for Innovation, Regional Transformation and Entrepreneurship based on Newcastle Business School at Northumbria University (UK), and the Centre for Innovation Research (CIRCLE) at Lund University (SE) for their invaluable support.

David Urbano acknowledges the Universitat Autònoma de Barcelona for all their support. He also acknowledges the financial support from projects ECO2017-87885-P (Spanish Ministry of Economy & Competitiveness), 2017-SGR-1056 (Economy & Knowledge Department, Catalan Government), and ICREA under the ICREA Academia program.

Finally, the authors are grateful to Nitza Jones-Sepulveda, Shobha Karuppiah, Faith Su, and Susan Westendorf at Springer for their continuous support.

About the Book

This book is about technology transfer policies and entrepreneurial innovations across continents. This book is motivated by the little evidence of the link between the policy frameworks' effectiveness and the emergence of entrepreneurial universities in different contexts.

The first part of the book provides academic tendencies. Based on an exhaustive literature review, the first chapter allows a better understanding of the emergence of entrepreneurial innovations defined as the emergence of entrepreneurial initiatives focused on radical innovations based on the co-creation among multiple actors in a defined space/time due to a policy framework that fosters entrepreneurship innovation ecosystems. Likewise, the second chapter provides the leading trends in technology transfer research.

The next five parts of the book provide empirical evidence in North America, Latin America, the Caribbean, Europe, and Africa as well as in post-socialist countries. Based on the demonstrated positive relationships between technology transfer policies and entrepreneurial innovations across different continents, the book's chapters are the groundwork for suggesting not only a rethinking of the current academic debate of considering entrepreneurship and innovation as two independent phenomena but also a refocusing of the measurement of the effectiveness of technology transfer policy frameworks, especially in transition or emerging economies.

Contents

The original version of this book was revised. The correction is available at https://doi.org/10.1007/978-3-030-70022-5_14

Contributors

José Ernesto Amorós EGADE Business School, Tecnológico de Monterrey, Mexico City, Mexico

School of Business and Economics, Universidad del Desarrollo, Santiago, Chile

Natalja Apanasovich Belarusian Economic Research and Outreach Center (BEROC), School of Business of BSU, Minsk, Republic of Belarus

Sebastian Aparicio Durham University, Durham University Business School, Durham, UK

Damaris Cruz-Amarán Departamento de Ciencias Empresariales, Facultad 1, Dirección de Comunicación Institucional, Universidad de las Ciencias Informáticas (UCI), La Habana, Cuba

James A. Cunningham Newcastle Business School, Northumbria University, Newcastle upon Tyne, UK

Marina Dabić Faculty of Economics and Business, University of Zagreb, Zagreb, Croatia

Management Division, Nottingham Business School, Nottingham Trent University, Nottingham, UK

Hala El Hadidi Department of Business Administration, The British University, El Sherouk City, Egypt

Bruno Brandão Fischer School of Applied Sciences (FCA), University of Campinas (UNICAMP), Campinas, Brazil

National Research University Higher School of Economics, Moscow, Russia

Maribel Guerrero Facultad de Economía y Negocios, Universidad del Desarrollo, Santiago, Chile

Centre for Innovation Research (CIRCLE), Lund University, Lund, Sweden

Northumbria Centre for Innovation, Regional Transformation and Entrepreneurship (iNCITE), Newcastle Business School, Northumbria University, Newcastle upon Tyne, UK

David A. Kirby The British University, El Sherouk City, Egypt

Erik E. Lehmann University of Augsburg and CCSE (Augsburg/Bergamo, Italy), Faculty of Business and Economics, Augsburg, Germany

Albert N. Link Department of Economics, University of North Carolina at Greensboro, Greensboro, NC, United States

Pedro López-Rubio Departamento de Economía y Ciencias Sociales, Universitat Politècnica de València (UPV), Valencia, Spain

Serhiy Lyalkov International University of Andalusia, Huelva, Spain

Vesna Mandakovic School of Business and Economics, Universidad del Desarrollo, Santiago, Chile

Jorge Barrientos-Marín Department of Economics, University of Antioquia, Medellín, Colombia

Radzivon Marozau Belarusian Economic Research and Outreach Center (BEROC), Minsk, Republic of Belarus

Alicia Mas-Tur University of Valencia, Valencia, Spain

Matthias Menter Friedrich Schiller University Jena, Faculty of Economics and Business Administration, Jena, Germany

José M. Merigó Department of Management Control and Information Systems, University of Chile, Santiago, Chile

Ana Millán Department of Financial Economics and Accounting, Pablo de Olavide University, Sevilla, Spain

José María Millán Department of Economics, University of Huelva, Huelva, Spain

Carlos Poblete School of Business and Economics, Universidad del Desarrollo, Santiago, Chile

Norat Roig-Tierno Universitat Politècnica de València, Valencia, Spain

Departamento de Economía y Ciencias Sociales, Universitat Politècnica de València (UPV), Valencia, Spain

Paola Rücker Schaeffer Department of Science and Technology Policy (DPCT), University of Campinas (UNICAMP), Campinas, Brazil

Nikolaus Seitz Ludwig-Maximilians-Universitaet, LMU Munich School of Management, Munich, Germany

Jadranka Švarc Institute Ivo Pilar, Zagreb, Croatia

Andréu Turró Department of Business and Centre for Entrepreneurship and Social Innovation Research (CREIS), Universitat Autònoma de Barcelona, Cerdanyola del Vallés, Barcelona, Spain

David Urbano Department of Business and Centre for Entrepreneurship and Social Innovation Research (CREIS), Universitat Autònoma de Barcelona, Cerdanyola del Vallés, Barcelona, Spain

André van Stel Trinity Business School, Trinity College Dublin, Dublin, Ireland

Center for Entrepreneurship, Kozminski University, Warsaw, Poland

Claudia Yáñez-Valdés Facultad de Economía y Negocios, Universidad del Desarrollo, Santiago, Chile

About the Editors

Maribel Guerrero, Ph.D. is professor of entrepreneurship at the School of Business and Economics (Universidad del Desarrollo, Chile) and Newcastle Business School (Northumbria University, UK). Prof. Guerrero is also an affiliated member of the CIRCLE – Centre for Innovation Research (Lund University, Sweden) and visiting professor of the BEROC – Belarusian Economic Research and Outreach Center (Belarus). Previously, she had a researcher position at the Basque Institute of Competitiveness (Spain) and the Deusto Business School (Spain).

Prof. Guerrero holds a Ph.D. and M.Phil. in business economics from the Department of Business at the Autonomous University of Barcelona (Spain). Her main research interests are focused on:

- The determinants of entrepreneurial and intrapreneurial activities developed by individuals as well as public and private organizations
- The impacts of entrepreneurial and intrapreneurial activities on the societal, economic, and technological development of economies
- The configuration/evolution of entrepreneurship and innovation ecosystems
- The role of diversity and minority entrepreneurship on the configuration of entrepreneurship ecosystems and the socio-economic development of emerging economies

Prof. Guerrero has published several scholarly international publications in academic journals (*Journal of Management Studies, Research Policy, Journal of Technology Transfer, Technovation, Technological Forecasting and Social Change, Journal of Knowledge Management, Small Business Economics, Journal of Small Business Management*) and several special issues and books regarding entrepreneurial universities and technology transfer. She is part of the editorial board of the *Journal of Technology Transfer* (Associate Editor), *Journal of Small Business Management* (Associate Editor), *Technology Forecasting and Social Change* (Advisor Board), and *Small Business Economics Journal* (Reviewer Board).

Prof. Guerrero is the cofounding director of the Spanish Observatory of University Entrepreneurship (2016) and a founding member of the Northumbria Centre for Innovation, Regional Transformation, and Entrepreneurship (iNCITE, 2018). She has led international projects sponsored by Santander Bank, Global Entrepreneurship Research Association (GEM), Spanish Ministries (Education and Industry), Regional Spanish Governments (Catalonia and Basque Country), the Mexican Council of Science and Technology (CONACYT), the Chilean Research Council (CONICYT), the Misum Stockholm School of Economics, and others. She has collaborated in the HEInnovate platform sponsored by the OCDE/European Commission.

Prof. Guerrero is an active research fellow at international consortiums related to the measure of entrepreneurship and innovation activity such as the Global Entrepreneurship Monitor (Chile, Belarus, and Spain), the Panel Studies of Entrepreneurial Dynamics (Spain), and Global University Entrepreneurship Spirit Students' Survey (Belarus). She is also a fellow of the UK Higher Education Association. Currently, she is also a member of the AOM Entrepreneurship Division Executive Committee (Treasurer), board member of the Global Entrepreneurship Monitor Association (GERA), as well as active member of the Strategic Management Society (SMS), Technology Transfer Society (T2S), and others.

David Urbano, Ph.D. is professor of entrepreneurship at Universitat Autònoma de Barcelona (UAB) and ICREA Academia-Research fellow. He is also deputy director at the Centre for Entrepreneurship and Social Innovation Research (CREIS). He has a Ph.D. in entrepreneurship and small business management (UAB / Växjö University, Sweden), an M.A. in applied research in social and cultural anthropology (UAB), and a B.A. in economics and business (UAB). He is a research fellow at IfM Bonn (Germany) and at the Basque Observatory for Entrepreneurship (OVE-EBB), and he regularly visits Haas School of Business (University of California Berkeley).

His research focuses on the analysis of factors affecting entrepreneurship in different contexts, using the institutional approach as a theoretical framework, and combining quantitative and qualitative methodologies.

Prof. Urbano has several scholarly international publications in the fields of entrepreneurship and small business, international entrepreneurship, and innovation, and he also participates in Spanish and international research projects (GEM, PSED, GUESSS). He is associate editor of *Small Business Economics Journal (SBEJ),* consulting editor of *International Small Business Journal (ISBJ),* and member of the board of directors of the European Council of Small Business and Entrepreneurship (ECSB) and president of the Entrepreneurship Division of the Spanish Academy of Management (ACEDE).

Prof. Urbano is currently vice dean of entrepreneurship at the School of Economics and Business (UAB), and he teaches entrepreneurship courses at the UAB (Minor in Entrepreneurship and Social Innovation, Master of Applied Research in Economics and Business – MAREB, and International Doctorate in Entrepreneurship and Management – iDEM) and other international universities. Also, he works as a consultant in entrepreneurship, innovation, and SMEs in many projects of the Catalan and the Spanish governments, the European Union, OCDE, and the private sector. He was co-founder and director of Centre for University Entrepreneurship – CIEU (UAB Emprèn).

Abbreviations

2SPLS	Two-Stage Probit Least Squares
APS	Adult Population Survey
ASRT	Academy of Scientific Research and Technology
AUC	American University in Cairo
AURIL	Association for University Research and Industry Links
AUTM	Association of University Technology Managers
B2B	Business to Business
BEEPS	Business Environment and Enterprise Performance Surveys
BEROC	Belarusian Economic Research and Outreach Center
BICRO	Business Innovation Centre of Croatia
BIOCENTRE	Biosciences Technology Commercialization and Incubation Centre
CBO	Congressional Budget Office
CEE	Central and Eastern European
CIB	Center for Biological Research
CIGB	Center for Genetic Engineering and Biotechnology
CIH	International Center of Havana
CIRCLE	Centre for Innovation Research at Lund University
CIS	Commonwealth of Independent States
CITMA	Ministry of Science, Technology and Environment
CRADAs	Cooperative Research and Development Agreements
CSF	Croatian Science Foundation
CUISO	Cairo University Innovation Support and Patent Registration Facilitation Office
DFG	German Research Society
DOD	Department of Defense
DOE	Department of Energy
EFIGE	European Firms in a Global Economy Internal Policies for External Competitiveness
EFTA	European Free Trade Association
EFW	Economic Freedom of the World Index
EMBRAPII	Brazilian National Association for Industrial Research and Innovation

ERA	European Research Area
ERDF	European Regional Development Fund
ESF	European Science Foundation
ESIF	EU Structural and Investment Funds
ESIF	European Structural and Investment Funds
EU	European Union
EUPART	Enterprise–University Partnership
EWCS	European Working Conditions Survey
FAPESP	São Paulo Research Foundation
FIA	Foundation for Agricultural Innovation
FLC	Federal Laboratory Consortium for Technology Transfer
FOSENTHE	Fostering Entrepreneurship in Higher Education
FP7	Seven Framework Programme
GAO	Government Accounting Office
GCI	Global Competitiveness Index
GDP	Gross Domestic Product
GEDI	Global Entrepreneurship and Development Index
GEM	Global Entrepreneurship Monitor
GERD	Gross Domestic Expenditure on R&D
GICO	Grants and International Collaboration Office
GUCID	University Management of Knowledge and Innovation for Development
HAMAG	Croatian Agency for Small Business, Innovation, and Investment
HER	Efficient Human Resources
HHS	Health and Human Services
HRST	Human Resources in Science and Technology
HUBs	Technology Transfer Centers
ICT	Information and Communications Technology
IDA	Institute for Defense Analysis
INAPI	National Institute of Intellectual Property
INCITE	Northumbria Centre for Innovation, Regional Transformation and Entrepreneurship
INPI	Brazilian Patent Office
IP	Intellectual Capital
IPA	Instrument for Pre-accession Assistance
IPEA	International Preliminary Examining Authority
IPP	Intellectual Property Protection
ISA	International Searching Authority
ISP	Chilean Institute of Public Health
JOTT	Journal of Technology Transfer
LAC	Latin American and Caribbean context
MENA	Middle East and North Africa
MES	Ministry of Higher Education
MFP	Ministry of Finance and Prices
MINAGRI	Ministry of Agriculture

MINCIENCIA	Ministry of Science, Technology, Knowledge and Innovation
MINCOM	Ministry of Communications
MINEDUC	Ministry of Education
MINSAL	Ministry of Health
MSE	Ministry of Science and Technology
NACE2	Statistical Classification of Economic Activities
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NES	National Expert Survey
NIS	National Innovation Systems
NIST	National Institute of Standards and Technology
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary Least Squares
OPCC	Competitiveness and Cohesion
OPP	Opportunity-Based Entrepreneurship
PCC	Communist Party of Cuba
PCT	Patent Cooperation Treaty
PITCE	Industrial, Technological and Trade Policy
POC	Proof of Concept
PPS	Purchasing Power Standards
R&D	Research and Development
R&SD	Research and Science Development
RCTT	Republican Center for Technology Transfer
RIS	Regional Innovation Systems
S&T	Science and Technology
S3	Smart Specialization Strategy
SBIR	Small Business Innovation Research
SCST	State Committee for Science and Technology
SET	Science, Engineering Technology
SIBRATEC	Brazilian Technological System
SIPI	Internal Industrial Property System
SMEs	Small and Medium-Sized Enterprises
STDF	Science, Technology and Development Fund
STEM	Science, Technology, Engineering, and Mathematics
STIS	Science, Technology, and Innovation System
SUM	Municipal University Centers
TEA	Total Entrepreneurial Activity
TEHCRO	Technological Infrastructure Development
TICOs	Technology Innovation Commercialization Offices
TISC	Technology Innovation and Support Centre
TPO	Technology Partnerships Office
TRIPS	Trade-Related Aspects of Intellectual Property Rights Agreement
TTO	Technology Transfer Office
U.K.	United Kingdom
U.S.	United States

UCI	University of Computer Science
UKF	Unity Through Knowledge Fund
USPTO	U.S. Patent and Trademark Office
USSR	Union of Soviet Socialist Republics
UTT	University Technology Transfer
WEF	World Economic Forum
WEF-EOS	World Economic Forum's Executive Opinion Survey
WIPO	World Intellectual Property Organization

List of Figures

List of Tables

Part I
Academic Tendencies

Maribel Guerrero and David Urbano

"Good reviews do not just summarize the literature but provide unique contributions on theory testing, theory development, the identification of research gaps, and suggestions for future research."

– Rauch (2020, p.1)

Schumpeter's (1942) seminal work about "creative destruction" recognized the strong relationship between entrepreneurship and innovation. Interestingly, four decades later, a visionary group promoted the Bayh-Dole Act as an incentive for universities to establish a TTO and position themselves for formally transferring faculty inventions through patent licensing (Link and van Hasselt 2019). Despite these efforts, academic literature continues to stimulate entrepreneurship and innovation analysis as two independent phenomena over the last four decades.

This gap inspired the following two chapters' collaborators to examine the accumulation of literature published from 1970 to 2019 by adopting two perspectives. The first perspective was oriented towards the convergence of entrepreneurship and innovation activities due to technology transfer policy frameworks. Particularly, Chap. 1 provides insights into the role of policies in the emergence of entrepreneurial innovations in different research settings. The second perspective was focused on identifying the leading research trends in technology transfer. Particularly, Chap. 2

M. Guerrero (✉)
Facultad de Economía y Negocios, Universidad del Desarrollo, Santiago, Chile

Centre for Innovation Research (CIRCLE), Lund University, Lund, Sweden

Northumbria Centre for Innovation, Regional Transformation and Entrepreneurship (iNCITE), Newcastle Business School, Northumbria University, Newcastle upon Tyne, UK
e-mail: maribel.guerrero@northumbria.ac.uk

D. Urbano
Department of Business and Centre for Entrepreneurship and Social Innovation Research (CREIS), Universitat Autònoma de Barcelona, Bellaterra, Spain
e-mail: david.urbano@uab.cat

provides insights into the most influential studies published in one of the outstanding journals in this field.

Undoubtedly, both chapters represent an exhaustive compilation of the accumulated knowledge useful for readers interested in understanding these topics. Indeed, both chapters highlight the non-conclusive empirical evidence about the effectiveness of related policy frameworks to entrepreneurship and innovation, as well as the under-representativeness of studies in the context of transition and emerging economies. In this vein, both chapters outline a research agenda with several implications for researchers and stakeholders.

We also invite readers to reflect on these insights into the current unexpected events related to the COVID-19 pandemic (Siegel and Guerrero 2021). In other words, the great value of generating and transferring knowledge among the agents enrolled in entrepreneurial innovation ecosystems. The development of entrepreneurial innovations has allowed a rapid response to healthy and societal challenges globally (e.g., COVID-19 tests, vaccines, follow-up applications, medical instruments). We should explore the public policy tendencies in stimulating entrepreneurial innovations, intellectual property, and knowledge transfer for socio-economic recovery post-COVID-19 pandemic.

References

Link, A. N., & van Hasselt, M. (2019). On the transfer of technology from universities: The impact of the Bayh–Dole Act of 1980 on the institutionalization of university research. *European Economic Review*, 119, 472–481.

Rauch, A. (2020). Opportunities and threats in reviewing entrepreneurship theory and practice. In *Entrepreneurship theory and practice*.

Schumpeter, J. A. (1942). *Capitalism, socialism and democracy*. New York: Harper & Brothers Publishers.

Siegel, D. S., & Guerrero, M. (2021). The impact of quarantines, lockdowns, and 'reopenings' on the commercialization of science: micro and macro issues. *Journal of Management Studies*. https://doi.org/10.1111/joms.12692.

Chapter 1
Academic Tendencies in Policy Frameworks for Fostering Entrepreneurial Innovations

Maribel Guerrero and David Urbano

1.1 Introduction

Entrepreneurship and innovation are strongly related topics since Schumpeter's (1942) seminal work about "creative destruction." Over the last eight decades, the entrepreneurship literature has been oriented to the individual or the firm, while the innovation literature has paid attention to the structure and policies (Zahra and Wright 2011). Despite this disconnection, convergent studies found insights about a positive relationship between robust technology transfer regulations and high-growth entrepreneurship characterized by higher innovation contributions and high-skilled human capital (Guerrero and Urbano 2017, 2019; Mosey et al. 2017; Urbano et al. 2019). The effect of policies may explain entrepreneurial innovation's dynamic rates across territories. According to Guerrero and Urbano (2019), the accumulation of knowledge about technology transfer policies has highlighted the replication of the US technology transfer system and legislative systems. Nevertheless, little is known about the effectiveness of the replicated technology transfer policies for fostering entrepreneurial innovation across the globe (Audretsch 2004; Audretsch and Link 2012; Gorsuch and Link 2018; Guerrero and Urbano 2019; Link and van

M. Guerrero (✉)
Facultad de Economía y Negocios, Universidad del Desarrollo, Santiago, Chile

Northumbria Centre for Innovation, Regional Transformation and Entrepreneurship (iNCITE), Newcastle Business School, Northumbria University, Newcastle upon Tyne, UK

Centre for Innovation Research (CIRCLE), Lund University, Lund, Sweden
e-mail: maribel.guerrero@northumbria.ac.uk

D. Urbano
Department of Business and Centre for Entrepreneurship and Social Innovation Research (CREIS), Universitat Autònoma de Barcelona, Bellaterra, Spain
e-mail: david.urbano@uab.cat

M. Guerrero, D. Urbano (eds.), *Technology Transfer and Entrepreneurial Innovations*, International Studies in Entrepreneurship 51,
https://doi.org/10.1007/978-3-030-70022-5_1

Hasselt 2019a). Current academic discussions claim to clarify questions related to policies, legislation, and strategies implemented by governments across countries/ continents to stimulate entrepreneurial innovations; the effectiveness of replicated United States (U.S.) technology transfer programs (e.g., the Bayh-Dole Act; the Small and Business Innovation Research -SBIR-, and other programs); the measures implemented to evaluate the performance and the success of entrepreneurial innovations policies; and the novel theoretical approaches for a better understanding of the determinants/consequences of entrepreneurial innovations policies. Inspired by these academic discussions, this chapter addresses a literature review for a better theoretical-empirical understanding behind the (un)success of technology transfer policies and legislation that stimulates entrepreneurial innovation across the world. The two research objectives of this chapter are: (a) to provide a better understanding of entrepreneurial innovations across diverse organizational and geographical contexts; and (b) to provide intercountry evidence about the success of governments' interventions to promote entrepreneurial innovations through ecosystems' agents (e.g., replication of U.S. technology transfer policies or new legislation). We revised the accumulation of knowledge linking entrepreneurship, innovation, and policy from 1970 to 2019. Concretely, we identified 431 publications that examine what entrepreneurial innovations mean and which type of policy frameworks have been implemented to foster entrepreneurial innovations worldwide.

The remainder of this chapter is organized as follows. Section 1.2 clarifies the definitions of entrepreneurial innovations adopted in previous studies as well as their connection with a public policy perspective. Section 1.3 introduces a review of the existing literature adopting narrow criteria (entrepreneurship, innovation, and policies) to evidence the contextual focus of previous studies. Section 1.4 highlights an agenda for additional research on this topic. In the final section, we conclude by outlining policy implications.

1.2 Entrepreneurial Innovations and Policy Frameworks

1.2.1 Defining Entrepreneurial Innovations

There is not a consensus about what entrepreneurial innovations mean (see Table 1.1). The concept of entrepreneurial innovation was introduced by Schumpeter (1942). In Schumpeter's perspective, entrepreneurial innovations represented the natural consequence of entrepreneurs' creative destruction when transforming the means into radical/marketable innovations. A plausible explanation was related to certain policies (e.g., tax or labor reforms or incentives) that directly or indirectly influenced the entrepreneurs' transformation of means into radical/marketable innovations. Sixty years later, Von Bargen et al. (2003, p. 315) extended the understanding of entrepreneurial innovations by analyzing a small group of high-growth companies that transformed their industries. The explanation of this transformation

Table 1.1 Entrepreneurial innovations fostered by policy frameworks

Entrepreneurial innovations	Policy focus	Authors
"creative destruction as an inherent consequence of the means of production in the hands of entrepreneurs."	"approached issues of tax policy, wage formation, monetary policy in a pragmatic way."	Schumpeter (1942)
"a small group of high-growth entrepreneurial companies that transformed the industries they entered" p. 315	"how Federal policy changes have steadily pushed the pendulum back in favor of enhancing intellectual property protection for entrepreneurial innovations through myriad changes to the patent and copyright laws" p. 318	Von Bargen et al. (2003)
"entrepreneurial firms that contribute towards a more sustainable society through innovation" p. 1	"how governments can foster or hinder them through tax, incentives, subsidies, and grants" p. 4	Cohen (2006)
"innovations made by outsiders to a specific industry, constitute a crucial ingredient in a well-functioning market economy" p. 488	"how the intensity of competition and competition policy affects the incentive for entrepreneurial innovations" p. 490	Norbäck and Persson (2012)
"as involving the disruption of existing industries and creation of new ones through multi-level processes and stakeholders, multiple actors and multiple contexts that constitute different entrepreneurial ecosystems" p. 1100	"how contexts regulate entrepreneurial innovation … and contexts are (1) industry and technological contexts; (2) organizational contexts; (3) institutional and policy contexts (distinguishing between formal and informal institutions); and (4) social contexts" p. 1100	Autio et al. (2014)
"entrepreneurs that commercialize their inventions or business ideas not only by entering the product market but also by selling them to incumbent firms" p. 13	"how tax policies affect entrepreneurs' choice of riskiness (or quality) of an innovation project, and on their mode of commercializing the innovation (market entry versus sale)." p.14	Haufler et al. (2014)
"enterprises that develop disruptive innovations adopting an entrepreneurial orientation -risk-taking, proactiveness, and innovativeness-… as well as, high-growth orientation" p. 295	"how subsidized public policy programs provide resources for collaborative projects involving universities and enterprises in emerging economies" p. 297	Guerrero and Urbano (2017)
"as new learning organizations that use and transform existing knowledge and generate new knowledge in order to innovate within innovation systems" p. 15	"how National innovation systems affect the generation and diffusion of knowledge and the formation of entrepreneurship through universities and the educational system, public policy, national regulation, and standardization" p. 15	Malerba and McKelvey (2020)

(continued)

Table 1.1 (continued)

Entrepreneurial innovations	Policy focus	Authors
"as the novel products/services/ technologies that have been the outcome of an efficient interface between the agents from local entrepreneurial ecosystems and innovation ecosystems" p. 1350	"intuitively, entrepreneurial innovations could be a proxy to measure the effectiveness of technology transfer policies/legislations" p. 1350	Guerrero and Urbano (2019)
"as innovative and ambitious entrepreneurial activities in emerging economies" p. 1405	"that emerge within environments characterized by favorable policy support towards entrepreneurs, government subsidies for new technology, and R&D transfer" p. 1405	Amorós et al. (2019)

Source: Author

resulted from the government intervention that enhanced intellectual property protection by implementing patent/copyright laws and judicial procurements (Von Bargen et al. 2003, p. 318). A few years later, Cohen (2006, p.1) introduced sustainability by assuming that entrepreneurial innovations contribute to a sustainable society's configuration. In this view, an entrepreneurial ecosystem and the government's interventions play a relevant role in fostering entrepreneurial innovations through tax, incentives, subsidies, and grants (Cohen 2006, p.4). Afterward, Norbäck and Persson (2012, 488) emphasized that the lower number of entrepreneurial innovations explained outsiders' existence within specific industries. In this vein, the intensity of competition policies may incentivize entrepreneurial innovations by a few entrepreneurs with high growth orientation (Norbäck and Persson 2012, p.490). Similarly, Haufter et al. (2014, p.13) explained entrepreneurial innovations as the link between public policies and the commercialization of inventions or business ideas; specifically how tax policies affect entrepreneurs' choice of riskiness (or quality) of an innovation project and their mode of commercializing the innovation (market entry vs. sale) (Haufter et al. 2014, p.14). Then, Autio et al. (2014) adopted an integral perspective to highlight the entrepreneurship ecosystem's intersection and the innovation ecosystem. This intersection was explained through multi-level processes among actors and specific contexts that regulate the development of disruptions of existing industries. In this view, entrepreneurial innovations were understood as the development of entrepreneurial initiatives focused on radical innovations based on the co-creation among multiple actors within a defined space/time (Autio et al. 2014, p.1100). Therefore, entrepreneurial innovations were the result of an effective policy that fosters entrepreneurship and innovation ecosystems. Likewise, Malerba and McKelvey (2020, p.15) extend entrepreneurial innovation definitions with a learning perspective of organizations and how ecosystems influence the generation and diffusion of marketable innovations. Over the last five decades, the literature on entrepreneurial innovations showed an underrepresentation of this phenomenon in the context of emerging economies. Guerrero and Urbano (2017, p.295) expand the definition of entrepreneurial innovations by introducing the relevance of context and how university-industry collaborations allow the emergence of this phenomenon in the context of emerging economies. Particularly, Guerrero and Urbano (2017, p.297) highlighted the crucial role of innovation and entrepreneurship policies and subsidies. Subsequently, Amorós et al. (2019, p. 1405) defined entrepreneurial innovations as innovative and ambitious entrepreneurial activities in emerging economies that emerge within environments characterized by favorable policy support towards entrepreneurs, government subsidies for new technology, as well as R&D policies. It inspired a few researchers to analyze the phenomenon in other emerging economies (Dossou and Ju 2019; Komlósi et al. 2019; Sharma and Sharma 2019; Ahworegba et al. 2020). In this chapter, based on these definitions, we defined entrepreneurial innovations as

> the generation of novel products, services, and technologies that emerged within an efficient interface among agents involved in entrepreneurial ecosystems and innovation ecosystems. Intuitively, entrepreneurial innovations could be considered as a proxy to measure the effectiveness of technology transfer policies, as well as responsible for higher social and economic impacts.

1.2.2 Policy Frameworks

Given the relevance of entrepreneurial innovations, worldwide governments have intervened through several policy frameworks and instruments that directly or indirectly have fostered entrepreneurial innovations. The first analysis reviewed the funding agents acknowledged in the 431 published papers related to entrepreneurial innovations (see Tables 1.2 and 1.3).

The majority of funding agents were related to university centers, government agencies, and other types of foundations in Canada, the U.S., China, and European countries. The constructive signal of analyzing funding agents is that we provide insights into the integration between agents involved in innovation and entrepreneurship ecosystems, especially over the last decade. First, we observe a certain grade of imitation from the U.S. frameworks related to entrepreneurial innovation, innovation, intellectual property, and technology transfer. The best example has been replicating the National Science Foundation structure/organization at national and regional levels across countries. Second, China provides a good example of the democratization of frameworks/instruments (e.g., entrepreneurship, innovation, and technology transfer) for fostering entrepreneurial innovations across provinces and cities. This strategy is positively related to the socio-economic development and growth of China. Third, the European zone has also provided a good example of integrating policy frameworks for fostering entrepreneurial innovations based on specific instruments/programs. It represented a good strategy for allocating adequate funds for innovation and entrepreneurship by all members, especially after the 2008–2010 financial crises. These efforts have contributed to the persistence and resilience within the Eurozone. Fourth, this analysis also reveals the

Table 1.2 Funding agents fostering entrepreneurial innovations

Focus	Funding agents	Country
Entrepreneurship and Innovation (169)	*University centers*: Cornell, Connecticut, Kansas, Massachusetts Institute of Technology, Northwestern, University California Irvine, Utah, Stanford, Virginia, Washington, Warton, Carnegie Mellon, Toronto, and others. *Government*: National Science Foundation, National Institutes of Health, NASA, National Bureau of Economic Research, Atlantic Canada Opportunity Agency, Canadian Social Science Council, and others. *Other foundations:* Alfred P Sloan, Kaufmann, Sorenson Legacy, Bankcard Fund for Political Economy, and others	Canada and the U.S.
	University centers: Shanghai, Beijing, and among others. *Government*: National Science Foundation, Innovation, and Entrepreneurship, Ministry of Education – training programs, special provincial grants.	China
	European Commission: Research and Innovation FP7 program, Horizon 2020 program, EU2inno program, and among others. *Governments*: Agency for innovation and entrepreneurship (Belgium), Danish Social Science Research Council, Finish Innovation Agency, French National Research Agency, German Research Foundation, Greek National Funds, Swedish National Science, Swedish Agency for Economic and Regional Growth, Spanish Ministry of Economics and Competitiveness, and others. *Other foundations*: Broman (Sweden), WIHURI (Finland). *Universities*: Aalto, St. Gallen, Turin, Bocconi, Gothenburg, and others	Europe
Intellectual property and technology transfer (262)	*Government*: National Science Foundation, Department of Health, Department of Energy, Department of Defense, Department of Agriculture, U.S. Army, U.S. patent, and trademarks. *Universities*: Technology Transfer Offices, IP Offices, and others. *Other foundations*: Google, Microsoft, Mayo Clinics, Third frontier program, Leonardo Davinci fellowships, Thomas Edison fellowship, and others	Canada and the U.S.
	Government: National Science Foundation; National Intellectual Property Office; Council of Scientific Industrial Research; Bureau of Science, Technology and Intellectual Property per provinces, Ministry of Education, Ministry of Defense, and others *Other foundations*: Scholarship Council, Petro China, and others	China
	European Commission: European Patent Organization, European Science Foundation (ESF), World Intellectual Property Organization (Geneve), and specific community programs. *Government*: Intellectual Property Offices in the EU25 countries. *Other foundations*: Spain Bank, Max Planck Institutes, and others	Europe

Source: Authors

Table 1.3 Policy Frameworks for innovative entrepreneurship in OECD countries

Policy frameworks	Objective (expectation)	Evidence (reality)	Countries	Source
SS: Direct funding of R&D firms	To induce an "additionality effect" in firms, with the result that investing more of their resources in R&D	The rationale of the intervention's continued relevance and its implementation performance; mainly focused on output additionality—no conclusive evidence.	17 OECD members	Cunningham et al. (2016a, b), OECD (2012a), Steen (2012)
SS: Fiscal measures	To encourage firms to invest in R&D through tax incentives.	Insights underestimate the increasing generosity of R&D tax incentives; full cost is not always transparent.	27 OECD members	Westmore (2013)
SS: Debt and risk-sharing schemes	To reduce the risk for lenders/ investors to facilitate access to external finance for innovative firms. Include subsidized loans and credit guarantees.	Scarce and mixed evidence; mainly focused on the "additionality effect." Poor credit culture without sufficient discipline and substantial administrative costs.	Denmark, Norway, Finland, U.K.	OECD (2011a, b)
SS: Technology extension services	To expand the diffusion/adoption of existing technology and to increase the absorptive capacity of targeted firms	The importance where geographically dispersed firms operate far from international best practices in their industries.	U.S., Japan, Germany, Canada, Spain, and Argentina	Shapira et al. (2011)
DS: Innovation procurement schemes	To stimulate the demand, the commercialization, the critical mass, and the access to funding easier.	Evidence is scarce and no conclusive.	Australia, Finland, Germany, Sweden, U.K.	OECD (2012b)

(continued)

Table 1.3 (continued)

Policy frameworks	Objective (expectation)	Evidence (reality)	Countries	Source
DS: Clusters	To facilitate collaboration on complementary economic activities (e.g., smart specialization)	Most countries have implemented platforms, international and specialized clusters. Scare evidence.	OECD	OECD (2009, 2012c)
RF: Intellectual property rights	Allow innovative entrepreneurs to protect their inventions	An effective IPR system allows entrepreneurs to have more time to grow their businesses before their ideas are imitated	OECD	OECD (2011a, b), WIPO (2004)
RF: Product market	To promote or inhibit competition	The economic effects of PMR are heterogeneous	OECD	Wölfl et al. (2010)
RF: Administrative	Seek to enter markets and also to grow	Evidence is the annual Doing Business report	OECD	OECD (2012d)
CF: Market for technology	Domestic, Foreign, competition	A few evidence on how to get access to technologies	Cross-country	OECD (2010)
CF: Labor and capabilities	Business support, attitudes, skilled capital	Firms suffer from a shortage of skilled labor	OECD	Toner (2011)
CF: Access to finance	Access to debit, venture capital, and other	A few evidence on how innovative businesses are financing their innovations	OECD	OECD (2008)
CF: Access to knowledge	ICT, cooperation, public/private investment	Evidence about networks of knowledge flows	OECD	Winters and Stam (2007)

Source: Authors
Note: *SS* Supply-side, *DS* Demand-side, *RF* Regulatory frameworks, *CF* Complementary frameworks

underrepresentation of funding agencies based in emerging African, Latin-American, and Asiatic economies. Plausible explanations may be related to the limited sources of funding, the absence of publication associated with the funded projects' outcomes, as well as the lack of acknowledgment.

The second analysis reviewed the reports from funding agents in the Organization for Economic Cooperation and Development (OECD) countries (see Table 1.3). The positive signal of this analysis was the recognition of different instruments from a supply-side (direct funding for R&D firms, fiscal measures, debt schemes, technology services), a demand-side (innovation procurement schemes), and connectivity (clusters) associated with elements that facilitated the development of entrepreneurial innovations. Moreover, the implementation of regulatory frameworks focused on intellectual property rights, product market regulation, administrative procurements, and complementary frameworks on financing, market, labor, and transference of knowledge reveal the government interest in technology, innovation, knowledge transfer-commercialization, and entrepreneurship. The negative signal was the limited, mixed, and inconclusive evidence regarding the effectiveness of these listed policy frameworks and instruments (WIPO 2004; OECD 2008, 2009, 2010, 2011a, b, 2012a, b, c, d). As a consequence, nowadays, it is not possible to understand if the objectives have been achieved, if the impacts generated per each dollar beyond them have covered the expectative, or if the metrics are measuring the outcomes correctly (Winters and Stam 2007; Wölfl et al. 2010; Shapira et al. 2011; Toner 2011; Steen 2012; Westmore 2013; Cunningham et al. 2016a, b). By considering the identified dual effects within the policy frameworks, the most critical gap identified in the literature has been the lack of evaluating studies about the effectiveness of technology transfer policies, programs, and legislation. A plausible explanation is the lack of metrics about how each dollar/euro invested in these public mechanisms has been transformed into entrepreneurial innovations and how these entrepreneurial innovations have impacted the regional and economic growth (Guerrero and Urbano 2019).

The third analysis reviewed the globalization of the technology transfer legislation across the globe (see Table 1.4). In North America, Link and van Hasselt (2019b) argue that the 1980 Bayh-Dole Act provided an incentive for universities to establish a TTO and position themselves for formally transferring faculty inventions through patent licensing. In Europe, the policy framework focused on supporting entrepreneurial innovations via intellectual property (Harvey 1992; Azagra-Caro 2011; Kilger and Bartenbach 2002), technology-based firms (Gallochat 2003), and research commercialization (Milthers 2003). In the rest of the world, the emergence of technology transfer policies that supported entrepreneurial innovations started in the 1990s and 2000s. Inspired by the Bayh-Dole Act, Chile and Colombia promoted intellectual property legislation (Reichelt 2007; Castro Peñarrieta and Canavire-Bacarreza 2019), while Brazil and Mexico fostered technology innovation legislation (Pojo et al. 2013; Guerrero and Urbano 2017). Likewise, Asian and African countries implemented patent law (Zolotykh 2003), High technology programs (Guo 2007), Industrial Revitalization programs (Takenaka 2005), technology transfer law (Asmoro 2017), and intellectual property Law (Kochupillai 2010; Reichelt 2007).

Table 1.4 Globalization of technology transfer policies that support entrepreneurial innovations

Continents	Legislation	Entrepreneurial innovations support
North America	USA– 1980 Bayh-Dole Act (Link and Hasselt 2019b)	Via Patents
Latin America	Chile – 1991 Intellectual Property Law (Castro Peñarrieta and Canavire-Bacarreza 2019) Colombia – 1995 Intellectual Property Law (Reichelt 2007) Brazil – 2004 Innovation Law (Pojo et al. 2013) Mexico – 2009 Technology innovation Law (Guerrero and Urbano 2017).	Via intellectual property Via intellectual property Via innovation and exports Via technology-based firms and TTOs
Europe	UK – 1985 Kingman Letter (Harvey 1992) Spain – 1986 Science Law (Azagra-Caro 2011) France – 1999 Innovation Act (Gallochat 2003) Denmark 1999 Inventions Act (Milthers 2003) Germany – 2002 Employee Invention Law (Kilger and Bartenbach 2002)	Via intellectual property Via intellectual property Via technology-based firms Via research commercialization Via intellectual property
Asia	Russia – 1992 Patent Law (Zolotykh 2003) China - 1994 High technology program (Guo 2007) Japan –1999 Industrial Revitalization (Takenaka 2005) Korea –2000 Technology transfer law (Asmoro 2017) India – 2008 Intellectual property Law (Kochupillai 2010)	Via intellectual property Via intellectual property Via technology transfer Via patenting Via intellectual property
Africa	South Africa – 2008 Intellectual property Law (Reichelt 2007)	Via intellectual property

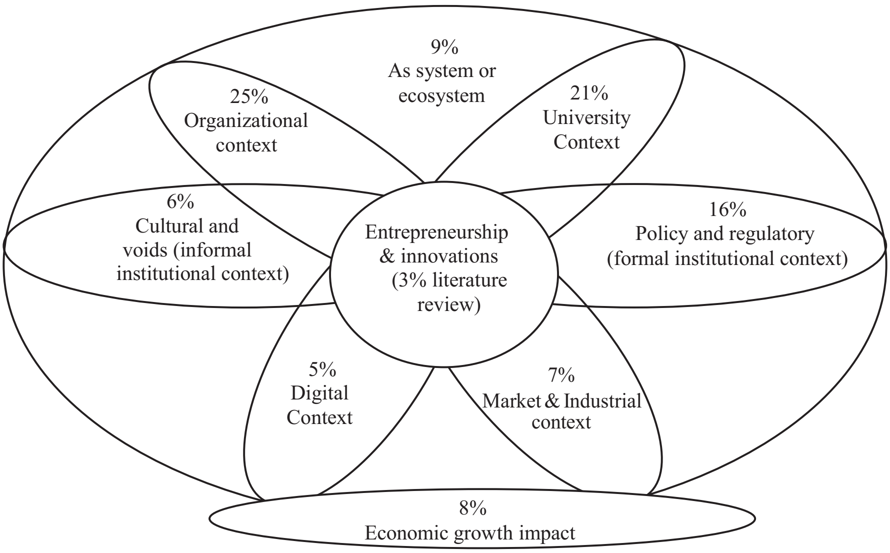
Source: Authors

1.3 The Link Between Entrepreneurship, Innovation, and Policy Frameworks On Published Research

After observing the lower number of publications about "entrepreneurial innovation," we decided to adopt a comprehensive analysis of research published in the Web of Science database better to understand the links between entrepreneurial innovations and public policies. We extend the research adopting the following criteria: (1) using three selecting keywords related to entrepreneurship, innovation, and policies in the title and abstract included per paper; (2) including the analysis of funding agencies acknowledged in the paper; and (3) the period of analysis was from 1971 (since the publication of Schumpeter's seminal work in 1942) to 2019. After the cleaning process, we identified 431 articles, mostly concentrated in the last decade.

By adopting the Autio et al.'s (2014, p. 1098) framework, we coded into one of ten categories— organizational context (strategies), market conditions (industry effects), social context (societal effects), institutional context (informal institutional conditions), public policy (formal institutional conditions), digital context (digitalization effects), university context (university effects), ecosystem (system effect), economic growth (geographical effects), and literature review papers. There are two rational arguments behind the configuration of the framework's categories. First, the framework identifies each contextual dimension, where public regulations and policies could produce influences that provide insights about their effectiveness. Second, the framework allows mapping the geographic research settings where those public regulations and policies.

Figure 1.1 illustrates the published papers' representative trends about the categories related to entrepreneurial innovations from 1971 to 2019. The first trend shows that 47% of publications are concentrated on organizational context (24%) and university context (21%). In the organizational context, the studies focused on analyzing how organizations design strategies, configure networks and modify their governance structures. More concretely, how these organizational actions are positively related to the achievement of sustainable outcomes by adopting orientations towards innovation (R&D and IPR) and entrepreneurship (corporate venturing) (e.g., see Burgelman 1986; Studdard and Darby 2008; Dunlap-Hinkler et al. 2010; Ryan and Giblin 2012; Nathan and Lee 2013; Mrożewski and Kratzer 2017; Urbaniec 2018). However, we also observed a reduced number of publications related to understanding how external technology transfer frameworks are positively associated with the highest organizational performance. Likewise, the published studies contextualized into universities reveal insights about the university capabilities responsible for transforming knowledge into disruptive/commercial



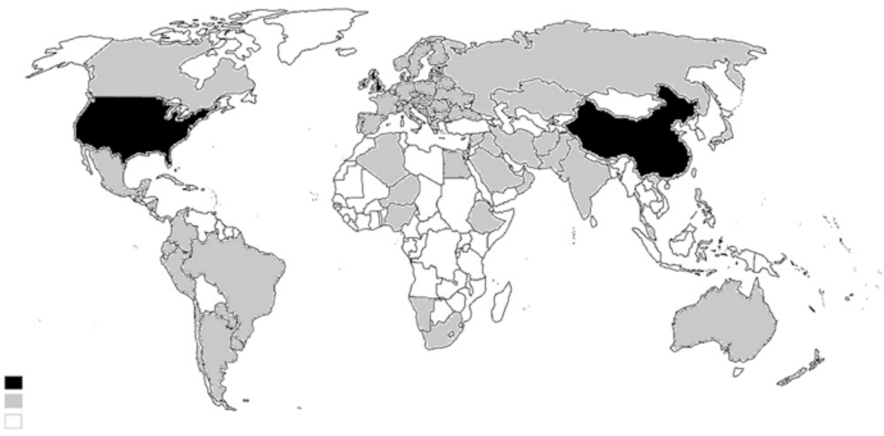
Source: Authors

Fig. 1.1 Linking Entrepreneurship, Innovation, and Policy Frameworks. (Source: Authors) innovations. Also, the studies show how university capabilities are conditioned by IPR laws such as copyright, patents, licenses, trademarks, trade secrets, and among others (e.g., see Goldsmith and Kerr 1991; Zenie 2003; Sáez-Martínez et al. 2014; Thongpravati et al. 2016; Guerrero et al. 2015, 2016; Marozau and Guerrero 2016; Guerrero and Urbano 2012, 2017; Guerrero et al. 2019; Eesley and Miller 2018; Qian et al. 2018).

The second trend, at the institutional context, shows that 16% of published studies focused on evaluating the efficiency of specific policy frameworks, country regulations, and governmental instruments (formal institutional context) that enhance or diminish the development/commercialization of entrepreneurial innovations (e.g., see Lo et al. 2005; Tomes et al. 2000; Woolley and Rottner 2008; Audretsch and Link 2012; Batabyal and Nijkamp 2012; Alcalde and Guerrero 2016; Langhorn 2014; Audretsch et al. 2016; Nnakwe et al. 2018). Moreover, matching informal institutional context, a set of published studies (6%) has explored how certain institutional voids, ethical issues, and culture affect the development of entrepreneurship and innovations (e.g., see Golodner 2001; Brenkert 2009; Letaifa and Rabeau 2013).

The last trend shows that the rest of the published studies explored entrepreneurial innovations associated with ecosystem contexts (9%), digital contexts (5%), market context (7%), and the link with economic development (8%).

By type of economy, Fig. 1.2 shows the geographic view of published papers. Over the last four decades, the most represented context is related to the high-income economies (49%) followed by middle-income economies (21%) and low-income economies (18%). More concretely, over the last decade, we observed an increasing trend in analyzing simultaneously mixed-income economies (12%) in one academic publication. However, cross-country studies are still underrepresented in the literature. Being marked in black represents the most analyzed research



Source: Authors

Fig. 1.2 Mapping Research about Entrepreneurial Innovations Worldwide. (Source: Authors) settings during our revised period. Therefore, being marked in grey means a few studies (e.g., at least one) in these research settings. This book will contribute with relevant insights about entrepreneurial innovations and policy frameworks worldwide.

1.4 Discussing a Research Agenda

Future research agendas on entrepreneurial innovations open a window for investigating the four un-explored contexts.

First, thinking about governmental context, knowledge accumulation demands clarification about the policy frameworks' effectiveness. In particular, frameworks that stimulate entrepreneurial innovations at national and regional levels. It is also crucial to understand the (un)effectiveness in replicating/implementing the U.S. policy frameworks (e.g., Bayh Dole Act, SBIR, and other programs) in other countries, especially in the context of emerging economies. Given the current budget restrictions, it is critical to allocate public resources in innovation, entrepreneurship, and research areas that maximize society's return (e.g., the U.K. excellence framework).

Second, thinking about the emergence of digital contexts, we suggest that future studies analyze digital entrepreneurial innovations (e.g., platforms, technological artifacts, digital ecosystems, and digital entrepreneurship). The unexpected events (e.g., the COVID-19 pandemic and natural disasters) have especially promoted collaboration and disruptive entrepreneurial innovations to respond to the rapidly. We assume that this research line will continue growing in the following years in multiple perspectives (e.g., operational, strategical, open innovation, intellectual management). We also believe that entrepreneurial innovations in digital scenarios may represent a good alternative for emerging economies' socio-economic development.

Third, thinking about the university context, an interesting question may be related to how universities' participation in entrepreneurial and innovation ecosystems has increased entrepreneurial innovations. Indeed, universities' role in stimulating policy frameworks related to intellectual property, technology transfer, entrepreneurship, and universities' role in developing entrepreneurial innovation capabilities in the city, region, or country.

Fourth, thinking about policy-makers context, continue transparency, and follow-up of policy frameworks are crucial for ensuring their effectiveness. It implies robust metrics in both real-time and historical time for evaluating results and reconduct the direction. Future research should propose novel conceptual approaches (e.g., dynamic, evolutionary, and stakeholder) and methodological (e.g., longitudinal) approaches to defining/measuring entrepreneurial innovations and the effectiveness of instruments/programs that stimulate them.

1.5 Conclusions

This chapter represents an effort to draw together research that examines the policy framework's effectiveness that fosters entrepreneurial innovation across continents. Previously, a significant body of empirical research has been contributed to the effectiveness of U.S. technology transfer policies and legislation such as the Bayh-Dole Act and the Small Business Innovation Research Programme (see Audretsch et al. 2002; Mowery et al. 1999; Shane 2004; Siegel et al. 2003). Based on our literature review, the academic debate about policies' effectiveness still demands evidence at country, cross-country, and cross-continent with rigorous methodologies and robust datasets. Consistent with this, we dissect the literature of entrepreneurship and innovation for evidencing the numerous disruptive innovations introduced by entrepreneurial firms and how entrepreneurial innovation could be considered an outcome of effective regulations across regions, countries, and continents (Autio et al. 2014).

Previous studies provide policy-makers with evidence to inform and shape future legislative and technology transfer policies. However, there is a dearth of similar studies in other geographic regions that examine technology transfer policies' effectiveness. National governments in other regions have used a mix of policy approaches to encourage higher technology transfer levels between different actors in national economies. Some government interventions are cross-country, such as Europe's Horizon 2020, the OECD countries, and previous framework programs. Simultaneously, some of these policy initiatives are implemented without any legislative support, as is the case with significant technology transfer policy initiatives in the U.S. This chapter encourages the academic community to explore policies and legislation's effectiveness in a non-U.S. context to develop new empirical insights into technology transfer policies' effectiveness across continents. It is especially crucial for fostering technology transfer activities post-COVID-19 pandemic (Siegel and Guerrero 2021).

Acknowledgments Maribel Guerrero acknowledges the Facultad de Economía y Negocios at the Universidad del Desarrollo (Chile), the Northumbria Centre for Innovation, Regional Transformation and Entrepreneurship based on Newcastle Business School at Northumbria University (UK), and the Centre for Innovation Research (CIRCLE) at Lund University (SE) for their invaluable support. David Urbano acknowledges the financial support from the Spanish Ministry of Economy & Competitiveness [project ECO2017-87885-P], the Economy & Knowledge Department—Catalan Government [project 2017-SGR-1056], and ICREA under the ICREA Academia Programme.

References

Ahworegba, A. H., Omoloba, J. O., & Estay, C. (2020). How firms risk through entrepreneurial innovations: Behavioural patterns and implications. *The International Journal of Entrepreneurship and Innovation, 21*, 146575032090362. https://doi.org/10.1177/1465750320903621.

Alcalde, H., & Guerrero, M. (2016). Open business models in entrepreneurial stages: Evidence from young Spanish firms during expansionary and recessionary periods. *International Entrepreneurship and Management Journal, 12*(2), 393–413.

Amorós, J. E., Poblete, C., & Mandakovic, V. (2019). R&D transfer, policy and innovative ambitious entrepreneurship: Evidence from Latin American countries. *The Journal of Technology Transfer, 44*(5), 1396–1415.
Asmoro, P. K. (2017). Technology transfer in Indonesian state universities: Do IPRS play a significant role? *Indonesian Law Review, 1*, 49–78.
Audretsch, D. B. (2004). Sustaining innovation and growth: Public policy support for entrepreneurship. *Industry and Innovation, 11*(3), 167–191.
Audretsch, D. B., & Link, A. N. (2012). Entrepreneurship and innovation: Public policy frameworks. *The Journal of Technology Transfer, 37*(1), 1–17.
Audretsch, D. B., Link, A. N., & Scott, J. T. (2002). Public/private technology partnerships: Evaluating SBIR-supported research. *Research Policy, 31*(1), 145–158.
Audretsch, D. B., Kuratko, D. F., & Link, A. N. (2016). Dynamic entrepreneurship and technology-based innovation. *Journal of Evolutionary Economics, 26*(3), 603–620.
Autio, E., Kenney, M., Mustar, P., Siegel, D., & Wright, M. (2014). Entrepreneurial innovation: The importance of context. *Research Policy, 43*(7), 1097–1108.
Azagra-Caro, J. M. (2011). Do public research organizations own most patents invented by their staff? *Science and Public Policy, 38*, 237–250.
Batabyal, A. A., & Nijkamp, P. (2012). A Schumpeterian model of entrepreneurship, innovation, and regional economic growth. *International Regional Science Review, 35*(3), 339–361.
Brenkert, G. (2009). Innovation, rule-breaking and the ethics of entrepreneurship. *Journal of Business Venturing, 24*(5), 448–464.
Burgelman, R. A. (1986). Managing corporate entrepreneurship: New structures for implementing technological innovation. In *Technology in the modern corporation* (pp. 1–13). New York: Pergamon.
Castro Peñarrieta, L., & Canavire-Bacarreza, G. (2019). Can intellectual property rights affect multinational enterprises' entry modes? The Chilean case. *International Journal of the Economics of Business, 26*(1), 177–198. https://www.tandfonline.com/doi/pdf/10.1080/13571516.2019.1553656?needAccess=true.
Cohen, B. (2006). Sustainable valley entrepreneurial ecosystems. *Business Strategy and the Environment, 15*(1), 1–14.
Cunningham, P. M., Cunningham, M., & Ekenberg, L. (2016a). Factors impacting on the current level of open innovation and ICT entrepreneurship in Africa. *The Electronic Journal of Information Systems in Developing Countries, 73*(1), 1–23.
Cunningham, P. M., Gök, A., & Larédo, P. (2016b). The impact of direct support to R&D and innovation in firms. In *Handbook of innovation policy impact* (pp. 54–107). Cheltenham: Edward Elgar Publishing.
Dossou Yedehou, L., & Ju, K. T. (2019). Opportunities and challenges for entrepreneurial innovations in Africa on the example of the Republic of Benin. *St. Petersburg State Polytechnical University Journal Economics, 78*(4), 144–156.
Dunlap-Hinkler, D., Kotabe, M., & Mudambi, R. (2010). A story of breakthrough versus incremental innovation: Corporate entrepreneurship in the global pharmaceutical industry. *Strategic Entrepreneurship Journal, 4*(2), 106–127.
Eesley, C. E., & Miller, W. F. (2018). Impact: Stanford University's economic impact via innovation and entrepreneurship. *Foundations and Trends® in Entrepreneurship, 14*(2), 130–278.
Gallochat, A. (2003). French technology transfer and policies. In *Turning science into business: Patenting and licensing at public research organizations* (pp. 139–151). Paris: OECD.
Goldsmith, R. E., & Kerr, J. R. (1991). Entrepreneurship and adaption-innovation theory. *Technovation, 11*(6), 373–382.
Golodner, A. M. (2001). Antitrust, innovation, entrepreneurship and small business. *Small Business Economics, 16*(1), 31–35.
Gorsuch, J., & Link, A. N. (2018). Nanotechnology: A call for policy research. *Annals of Science and Technology Policy, 2*(4), 307–463.

Guerrero, M., & Urbano, D. (2017). The impact of Triple Helix agents on entrepreneurial innovations' performance: An inside look at enterprises located in an emerging economy. *Technological Forecasting and Social Change, 119*, 294–309.

Guerrero, M., Cunningham, J. A., & Urbano, D. (2015). Economic impact of entrepreneurial universities' activities: An exploratory study of the United Kingdom. *Research Policy, 44*(3), 748–764.

Guerrero, M., & Urbano, D. (2019). Effectiveness of technology transfer policies and legislation in fostering entrepreneurial innovations across continents: an overview. *The Journal of Technology Transfer, 44*(5), 1347–1366.

Guerrero, M., Urbano, D., Fayolle, A., Klofsten, M., & Mian, S. (2016). Entrepreneurial universities: Emerging models in the new social and economic landscape. *Small Business Economics, 47*(3), 551–563.

Guerrero, M., Urbano, D., & Herrera, F. (2019). Innovation practices in emerging economies: Do university partnerships matter? *The Journal of Technology Transfer, 44*(2), 615–646.

Guerrero, M., & Urbano, D. (2012). The development of an entrepreneurial university. *The Journal of Technology Transfer, 37*(1), 43–74.

Guo, H. (2007). IP management at Chinese universities. In A. Krattiger, R. T. Mahoney, L. Nelsen, et al. (Eds.), *Intellectual property management in health and agricultural innovation: A handbook of best practices* (pp. 1673–1682). Oxford, UK: MIHR.

Harvey, K. (1992). Managing the exploitation of intellectual property: An analysis of policy and practice in nine UK Universities, Doctor of Philosophy thesis at the University of Stirling, UK.

Haufler, A., Norbäck, P. J., & Persson, L. (2014). Entrepreneurial innovations and taxation. *Journal of Public Economics, 113*, 13–31.

Kilger, C., & Bartenbach, K. (2002). New rules for German professors. *Science, 298*, 1173–1175.

Kochupillai, M. (2010). The protection and utilization of public funded intellectual property bill, 2008: A critique in the light of India's innovation environment. *Journal of Intellectual Property Rights, 15*, 19–34.

Komlósi, É., Páger, B., & Márkus, G. (2019). Entrepreneurial innovations in countries at different stages of development. *Форсайт, 13*(4), 23–34.

Langhorn, K. (2014). Encouraging entrepreneurship with innovation vouchers: Recent experience, lessons, and research directions. *Canadian Public Administration, 57*(2), 318–326.

Letaifa, S. B., & Rabeau, Y. (2013). Too close to collaborate? How geographic proximity could impede entrepreneurship and innovation. *Journal of Business Research, 66*(10), 2071–2078.

Link, A. N., & van Hasselt, M. (2019a). Exploring the impact of R&D on patenting activity in small women-owned and minority-owned entrepreneurial firms. *Small Business Economics*, 1–6.

Link, A. N., & van Hasselt, M. (2019b). On the transfer of technology from universities: The impact of the Bayh–Dole Act of 1980 on the institutionalization of university research. *European Economic Review, 119(october 2019)*, 472–481.

Lo, T. H., Liou, S., & Yuan, B. (2005). Organization innovation and entrepreneurship: The role of the national laboratories in promoting industrial development. *International Journal of Technology Management, 30*(1–2), 67–84.

Malerba, F., & McKelvey, M. (2020). Knowledge-intensive innovative entrepreneurship integrating Schumpeter, evolutionary economics, and innovation systems. *Small Business Economics, 54*(2), 503–522.

Marozau, R., & Guerrero, M. (2016). Conditioning factors of knowledge transfer and commercialization in the context of post-socialist economies: The case of Belarusian higher education institutions. *International Journal of Entrepreneurship and Small Business, 27*(4), 441–462.

Milthers, S. (2003). Changing IPR regulations for researchers in Denmark. In *Turning science into business: Patenting and licensing at public research organizations* (pp. 129–138). Paris: OECD.

Mosey, S., Guerrero, M., & Greenman, A. (2017). Technology entrepreneurship research opportunities: Insights from across Europe. *The Journal of Technology Transfer, 42*(1), 1–9.

Mowery, D. C., Nelson, R. R., Sampat, B., & Ziedonis, A. A. (1999). The effects of the Bayh-Dole Act on US university research and technology transfer: An analysis of data from Columbia University, the University of California, and Stanford University. *Research Policy, 29*, 729–740.

Mrożewski, M., & Kratzer, J. (2017). Entrepreneurship and country-level innovation: Investigating the role of entrepreneurial opportunities. *The Journal of Technology Transfer, 42*(5), 1125–1142.

Nathan, M., & Lee, N. (2013). Cultural diversity, innovation, and entrepreneurship: Firm-level evidence from London. *Economic Geography, 89*(4), 367–394.

Nnakwe, C. C., Cooch, N., & Huang-Saad, A. (2018). Investing in academic technology innovation and entrepreneurship: Moving beyond research funding through the NSF I-CORPS™ program. *Technology and Innovation, 19*(4), 773–786.

Norbäck, P. J., & Persson, L. (2012). Entrepreneurial innovations, competition, and competition policy. *European Economic Review, 56*(39), 488–506.

OECD. (2008). *Promoting entrepreneurship and innovative SMEs in a global economy*. Paris: OECD Publishing. https://doi.org/10.1787/9789264044357-en.

OECD. (2009). *Cluster, innovation and entrepreneurship*. Paris: OECD.

OECD. (2010). Knowledge networks and markets: A typology of markets in explicit knowledge. DSTI/IND/STP/ICCP(2010)3.

OECD. (2011a). Business innovation policies: Selected country comparisons. OECD Publishing. https://doi.org/10.1787/9789264115668-en

OECD. (2011b). *Intellectual assets and innovation: The SME dimension, OECD studies on SMEs and entrepreneurship*. Paris: OECD Publishing.

OECD. (2012a). *Financing business R&D and innovation in OECD science, technology and industry outlook 2012*. Paris: OECD Publishing. https://doi.org/10.1787/sti_outlook-2012-12-en.

OECD. (2012b). *Stimulating demand for innovation in OECD science, technology and industry outlook 2012*. Paris: OECD Publishing. https://doi.org/10.1787/sti_outlook-2012-en.

OECD. (2012c). *Science, technology and industry outlook 2012*. Paris: OECD.

OECD. (2012d). Operational environment for SMEs (dimension 4): Make public administrations responsive to SMEs' needs (small business act principle 4), in SME Policy Index: Eastern Partner Countries 2012: Progress in the Implementation of the Small Business Act for Europe, OECD Publishing. https://doi.org/10.1787/9789264178847-11-en

Pojo, S. D., Vidal, V. S., Zen, A. C., & Barros, H. M. (2013). Management of intellectual property in Brazilian Universities: A multiple case study, working monograph of Insper.

Qian, X. D., Xia, J., Liu, W., & Tsai, S. B. (2018). An empirical study on sustainable innovation academic entrepreneurship process model. *Sustainability, 10*(6), 1974.

Reichelt, K. M. (2007). University technology transfer and national innovation policy: Success stories from Brazil, Colombia and South Africa. International Intellectual Property Institute. http://iipi.org/wp-content/uploads/2010/07/UniversityTechTransfer_072507.pdf

Ryan, P., & Giblin, M. (2012). High-tech clusters, innovation capabilities, and technological entrepreneurship: Evidence from Ireland. *The World Economy, 35*(10), 1322–1339.

Sáez-Martínez, F. J., González-Moreno, Á., & Hogan, T. (2014). The role of the university in eco-entrepreneurship: Evidence from the Eurobarometer survey on attitudes of European entrepreneurs towards eco-innovation. *Environmental Engineering and Management Journal, 13*(10), 2541–2541.

Schumpeter, J. A. (1942). *Capitalism, socialism and democracy*. New York: Harper & Brothers Publishers.

Shane, S. (2004). Encouraging university entrepreneurship? The effect of the Bayh-Dole Act on university patenting in the United States. *Journal of Business Venturing, 19*(1), 127–151.

Shapira, P., Youtie, J., & Kay, L. (2011). Building capabilities for innovation in SMEs: A cross-country comparison of technology extension policies and programmes. *International Journal of Innovation and Regional Development, 3*, 254–272.

Sharma, S., & Sharma, S. (2019). Agri-entrepreneurial innovations for rural prosperity and sustainable development. *Journal of Community Mobilization and Sustainable Development, 14*(1), 206–211.

Siegel, D. S., Waldman, D., & Link, A. (2003). Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: An exploratory study. *Research Policy, 32*(1), 27–48.

Siegel, D. S., & Guerrero, M. (2021). The impact of quarantines, lockdowns, and 'reopenings' on the commercialization of science: micro and macro issues. *Journal of Management Studies*. https://doi.org/10.1111/joms.12692

Steen, J. V. (2012). *Modes of public funding of research and development: Towards internationally comparable indicators, OECD Science, Technology and Industry Working Papers, 2012/04*. Paris: OECD Publishing. https://doi.org/10.1787/5k98ssns1gzs-en.

Studdard, N., & Darby, R. (2008). From social capital to human resource development: A cross-cultural study of the role of HRM in innovation and entrepreneurship in high technology organizations. *European Journal of International Management, 2*(3), 333–355.

Takenaka, T. (2005). Technology licensing and university research in Japan. *International Journal of Intellectual Property Law, Economy and Management, 1*, 27–36.

Thongpravati, O., Maritz, A., & Stoddart, P. (2016). Fostering entrepreneurship and innovation through a biomedical technology Ph.D. program in Australia. *International Journal of Engineering Education, 32*(3), 1222–1235.

Tomes, A., Erol, R., & Armstrong, P. (2000). Technological entrepreneurship: Integrating technological and product innovation. *Technovation, 20*(3), 115–127.

Toner, P. (2011). Workforce skills and innovation: An overview of major themes in the literature, OECD Education Working Papers, No. 55, OECD Publishing. https://doi.org/10.1787/5kgk6hpnhxzq-en

Urbaniec, M. (2018). Sustainable entrepreneurship: Innovation-related activities in European enterprises. *Polish Journal of Environmental Studies, 27*(4), 1773–1779.

Urbano, D., Guerrero, M., Ferreira, J. J., & Fernandes, C. I. (2019). New technology entrepreneurship initiatives: Which strategic orientations and environmental conditions matter in the new socio-economic landscape?. *The Journal of Technology Transfer, 44*(5), 1577–1602.

Von Bargen, P., Freedman, D., & Pages, E. R. (2003). The rise of the entrepreneurial society. *Economic Development Quarterly, 17*(4), 315–324.

Westmore, B. (2013). R&D, patenting and growth: The role of public policy, OECD Economics Department Working Papers, No. 1047, OECD Publishing.

Winters, R., & Stam, E. (2007). Innovation networks of high-tech SMEs: Creation of knowledge but no creation of value. Jena Economic Research Papers, No. 2007-042.

WIPO. (2004). *Intellectual property rights and innovation in small and medium enterprises*. Geneva: World Intellectual Property Organization.

Wölfl, A., et al. (2010). Product market regulation: Extending the analysis beyond OECD countries, OECD Economics Department Working Papers, No. 799, OECD Publishing. https://doi.org/10.1787/5km68g3d1xzn-en

Woolley, J. L., & Rottner, R. M. (2008). Innovation policy and nanotechnology entrepreneurship. *Entrepreneurship Theory and Practice, 32*(5), 791–811.

Zahra, S., & Wright, M. (2011). Entrepreneurship's next act. *Academy of Management Perspectives, 25*, 67–83.

Zenie, F. H. (2003). Innovation and entrepreneurship: From science to practice. *American Laboratory, 35*(20), 42–45.

Zolotykh, N. (2003). Legal regulation of protection and commercialization of intellectual property created by Russian public research organizations. In *Turning science into business: Patenting and licensing at public research organizations* (pp. 153–166). Paris: OECD.

Chapter 2
Leading Trends in Technology Transfer

Pedro López-Rubio, Alicia Mas-Tur, José M. Merigó, and Norat Roig-Tierno

2.1 Introduction

Research on innovation has significantly grown over recent decades and faster than research on other areas, suggesting that academics from multiple disciplines are interested in the effects of innovation activities and processes on the economy (Shafique 2013; Cancino et al. 2017). Schumpeter's seminal works on innovation research (Schumpeter 1934, 1942) coined the terms *creative destruction* and *creative accumulation*: the first concept refers to entrepreneurs and new firms (what he defined as *agents of creative destruction*) introducing change to the economic landscape, undermining and challenging established industry incumbents; the latter focuses on the relevance of large established firms in R&D for technological

P. López-Rubio (✉)
Departamento de Economía y Ciencias Sociales, Universitat Politècnica de València (UPV), Valencia, Spain
e-mail: pedloru@doctor.upv.es

A. Mas-Tur
University of Valencia, Valencia, Spain
e-mail: alicia.mas@uv.es

J. M. Merigó
School of Information, Systems and Modelling, University of Technology Sydney, Ultimo, NSW, Australia

Department of Management Control and Information Systems, University of Chile, Santiago, Chile
e-mail: jmerigo@fen.uchile.cl

N. Roig-Tierno
Departamento de Economía y Ciencias Sociales, Universitat Politècnica de València (UPV), Valencia, Spain
e-mail: norat.roig@upv.es

M. Guerrero, D. Urbano (eds.), *Technology Transfer and Entrepreneurial Innovations*, International Studies in Entrepreneurship 51,
https://doi.org/10.1007/978-3-030-70022-5_2

innovation. After such works, the following pioneers' studies covered economics, sociology, management, organizational studies, psychology, political science, and, very rarely, interdisciplinary contributions. It was not until the early 1980s that a common conceptual framework emerged based around the economics of innovation, technology and growth, the interactive model of the innovation process, and, later, the notion of *innovation systems* (both from national -National Innovation Systems (NIS)- and regional -Regional Innovation Systems (RIS)- approaches), innovation policies, the management of the industrial innovation and the resource-based view of the firm, the technology transfer, and the knowledge management, among others (Fagerberg and Verspagen 2009; Martin 2012).

Innovation policy is a relatively new field of economic policy and policy-makers' agenda, which was not much used a few decades ago and became popular in the 1990s. This term may be used in different ways: broadly as all policies that have an important impact on innovation, which usually includes not only innovation policies but also industrial, R&D, technology, science, entrepreneurship support policies; or more narrowly as policies (or policy tools) named specifically as innovation policy and created with the explicit intent to affect innovation (Edquist 2004; Fagerberg 2017). Nowadays, all the policies mentioned above are generally founded on the NIS and the RIS frameworks since the innovation system approach have been adopted by most of the national and regional public administrations, as well as by supranational organizations such as the Organization for Economic Cooperation and Development (OECD), the European Union (EU), and the World Bank in their attempts to stimulate innovation processes (Bergek et al. 2008). An innovation system consists of a network of economic agents and institutions and policies that influence these agents' innovation behavior and performance (Freeman 1987; Lundvall 1992; Nelson 1993). According to a NIS-based conceptual framework, innovation is an interactive process in which firms that interact with and receive support from institutions and organizations (e.g., industry associations; R&D, innovation, and productivity centers; standard-setting bodies and institutes; and universities and training centers) are crucial in bringing new products, new processes, and new forms of organization into economic use (Mytelka 2000). Although the NIS has always been a key topic in innovation policy research, entrepreneurship has emerged in the last decade as one of the main economic and social catalysts for innovation, becoming a popular topic in innovation policy (López-Rubio et al. 2018a). The current prevalence of entrepreneurship in this field can be reflected in the emergence of novel concepts and the popularization of others already existing such as entrepreneurial innovations (Autio et al. 2014; Guerrero and Urbano 2015, 2019), National Entrepreneurship Systems (NES) (Acs et al. 2014; Lafuente et al. 2016), entrepreneurial society (Audretsch 2007; Audretsch 2014), entrepreneurial ecosystems (Isenberg 2011; Mason and Brown 2014; Acs et al. 2017; Audretsch and Belitski 2017; Spigel 2017), and entrepreneurial universities (Bercovitz and Feldmann 2006; D'Este and Perkmann 2011; Guerrero and Urbano 2012; Audretsch 2014).

This chapter analyzes all documents published by *The Journal of Technology Transfer (JOTT)* between 1977 and 2018. The *JOTT* is an international journal launched in 1977 as the Technology Transfer Society's official journal, which aims to provide an international forum for research on the economic, managerial, and policy implications of technology transfer, entrepreneurship, and innovation. The journal publishes research on management practices and strategies for technology transfer. Articles published in the *JOTT* also explore the external environment that affects these practices and strategies (including public policy developments, regulatory and legal issues, and global trends) and the relationship between the external environment, organizations (governments, public agencies, firms, and universities), and their innovation processes. We adopt a bibliometric perspective for this analysis to provide a dynamic overview of research in the *JOTT* and identify the leading trends in technology transfer research and their relationships with other innovation core topics like entrepreneurship, policies, knowledge, universities, or industry. We use the Elsevier-owned Scopus database because all JOTT volumes and issues are indexed in this database. The Web of Science database, owned by Clarivate Analytics, only includes 2007 onward issues and six articles from 1994. Several articles have compared the two databases in detail (e.g., Mongeon and Paul-Hus 2016; López-Rubio et al. 2018b). This study's relevance derives from its focus on the *JOTT*, whose high impact is reflected by its ranking in Scopus. The *JOTT* is indexed in three Scopus subject sub-areas and lies in the first quartile (Q1) for each of these sub-areas for 2018. The list below shows the *JOTT*'s ranking and the total number of journals in each subject sub-area. These data reflect the strong *JOTT* influence.

- Engineering → Engineering (miscellaneous): #14/771
- Business, Management and Accounting → Accounting: #18/141
- Business, Management and Accounting → Business and International Management: #28/396

Bibliometrics is the study of quantitative aspects of bibliographic material (Broadus 1987). Alan Pritchard coined this term in 1969 to replace the *statistical bibliography*, which was rarely used and was sometimes ambiguous (Pritchard 1969). Nowadays, *bibliometrics*, *scientometrics* (Nalimov and Mulchenko 1969), and *informetrics* (Nacke 1979) are used as synonyms to denote the discipline concerned with the quantitative study of bibliographic material (Sengupta 1992). In this instance, bibliometrics' key advantage is that it allowed us to analyze all documents published in the *JOTT* by considering only the statistical data from the Scopus database. Developing a general picture based on data drawn from scientific databases can be difficult. It requires calculating certain measures, such as aggregate indicators, and producing graphical representations to build an accurate overview of the data. This chapter presents rankings and graphical representations to provide readers with a dynamic overview of the key elements at different times, performing five highly relevant functions. First, it presents the evolution of publications and citations in the journal and the general citation structure. Second, through author keyword analysis, it describes the *JOTT* conceptual framework and its development over time. Third, it identifies the most influential *JOTT* articles of all time according to total citations and citations per year and reviews them to detect the main technology transfer research trends. Fourth, it presents the leading trends in technology transfer based on the evolution of citations per publication for each of these main research trends. Finally, it displays a taxonomy of public policies due to an analysis of the most influential *JOTT* articles from a policy perspective.

2.2 Methodology

As per the definition given earlier, bibliometrics offers tools to study a set of documents' important features. This study focused on a specific journal (the JOTT) and analyzed all JOTT documents between 1977 and 2018. We used the Scopus database because all issues of the JOTT are indexed in this database. The search was conducted on September 30, 2019, and yielded 1289 documents published in the JOTT before December 31, 2018. We adopted a dynamic bibliometric perspective to identify the leading trends in technology transfer at each point in time. This chapter presents some of the most widely used bibliometric indicators, such as the number of published studies, the number of citations, citations per year, citations per publication, citation thresholds, the h-index, and word frequency (Hirsch 2005; Thelwall 2008). These indicators can be used to build an overview of bibliographic material. However, rankings may vary by indicator so that the results may be interpreted differently depending on the key interests established by the scholars analyzing the data (Podsakoff et al. 2008). Each indicator has its own advantages and limitations (Alonso et al. 2009). These limitations can be overcome by evaluating the research field using more than one indicator (Mingers and Leydesdorff 2015).

Bibliometric maps, also known as maps of science, are spatial representations of how disciplines, fields, specialties, and individual papers are interrelated (Small 1999). Therefore, bibliometric mapping can monitor a scientific field to determine its cognitive structure, evolution, and main actors and visualize the results for specific bibliometric indicators (Noyons et al. 1999). This study analyzed the most common author keywords and their co-occurrences in all the JOTT documents to outline the journal's conceptual and theoretical framework (Callon et al. 1983). VOSviewer software was used to map the bibliographic material (Van Eck and Waltman 2010), although other bibliographic software tools also exist (Cobo et al. 2011). The graphical visualization is based on a network representation. The size of the circles and labels is proportional to an item's relevance. The network links items with a strong relationship. The location of an item depends on the cluster to which the item belongs. We used the overlay visualization and the average year of publication, where the item's color indicates its average year of publication.

2.3 Results

This section presents the main results of our analysis. Recall that we analyzed the bibliometric data available in Scopus on documents published in the JOTT between 1977 and 2018. By the end of 2018, the journal had published 1289 documents.

These 1289 documents had received 23,206 citations by September 30, 2019. This equates to 18 citations per document (on average). The h-index is 70, which means that, of the 1289 documents above, 70 had received 70 citations or more by September 30, 2019.

2.3.1 Evolution of Publications and the Citation Structure

Figure 2.1 shows the evolution of annual publications in the *JOTT* and citations of these publications. The *JOTT* has always published fewer than 100 studies per year. The exception is the last year under analysis (2018), in which 111 studies were published. The increase in the number of publications in the last two years is considerable. The number of published studies in 2018 is more than twice the number in 2015. *JOTT* publications had received many citations since 2007 when the threshold for 500 annual citations was surpassed. The thresholds for 1000, 2000, and 3000 annual citations were surpassed in 2010, 2015, and 2018. A maximum of 3065 citations was achieved in 2018.

Another way of measuring the influence and importance of these publications is through their citation structure. Table 2.1 shows the number of documents published each year that exceed certain citation thresholds. Table 2.1 also shows the total number of documents published per year, the total cumulative citations that the documents published in each given year have received, the number of citations per publication, and the h-index for each year. The percentage of documents for each of these indicators is also shown. It is common for newer studies to have fewer citations because they were published more recently. According to Table 2.1, the 539 studies published between 2010 and 2018 have received 7986 citations, the 294 studies published in the 2000s have received 13,604 citations, and the 456 studies published before 2000 have received 1616 citations, resulting in a total of 1289

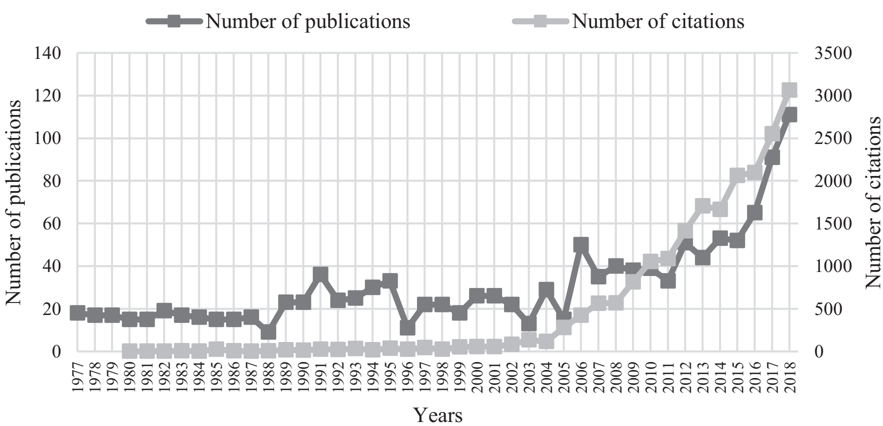


Fig. 2.1 Evolution of publications and citations per year

Table 2.1 General citation structure in technology transfer

PY	>=200	>=100	>=50	>=10	>=1	TP	TC	C/P	h
1977	0	0	0	0	9	18	20	1.1	3
1978	0	0	0	0	5	17	11	0.6	2
1979	0	0	0	1	6	17	29	1.7	2
1980	0	0	0	0	5	15	18	1.2	2
1981	0	0	0	0	7	15	12	0.8	2
1982	0	0	0	0	8	19	19	1.0	2
1983	0	0	0	0	7	17	14	0.8	2
1984	0	0	0	0	8	16	17	1.1	3
1985	0	0	0	1	8	15	30	2.0	3
1986	0	0	0	0	12	15	21	1.4	2
1987	0	0	0	3	13	16	87	5.4	5
1988	0	0	0	1	6	9	62	6.9	4
1989	0	0	0	3	16	23	78	3.4	5
1990	0	0	0	3	13	23	93	4.0	5
1991	0	0	0	2	12	36	60	1.7	4
1992	0	0	0	7	14	24	141	5.9	7
1993	0	0	0	2	16	25	66	2.6	4
1994	0	0	0	1	16	30	50	1.7	3
1995	0	0	0	0	17	33	49	1.5	4
1996	0	0	0	2	7	11	49	4.5	4
1997	0	0	0	5	21	22	153	7.0	7
1998	0	0	1	4	19	22	157	7.1	6
1999	0	0	3	9	17	18	380	21.1	9
2000	1	1	1	7	25	26	567	21.8	9
2001	4	10	14	24	26	26	2603	100.1	20
2002	2	3	7	15	22	22	1557	70.8	13
2003	0	1	2	8	13	13	290	22.3	8
2004	1	10	15	23	29	29	2120	73.1	20
2005	0	0	4	7	14	15	360	24.0	8
2006	2	6	14	42	50	50	2574	51.5	27
2007	0	1	4	22	35	35	846	24.2	17
2008	0	3	10	35	40	40	1524	38.1	21
2009	0	2	8	24	37	38	1163	30.6	20
2010	0	0	9	24	39	39	1084	27.8	20
2011	1	1	4	20	32	33	1022	31.0	16
2012	0	1	2	37	51	51	1080	21.2	19
2013	0	1	3	30	44	44	990	22.5	18
2014	0	1	5	35	53	53	1047	19.8	18
2015	0	0	1	29	50	52	765	14.7	18
2016	0	0	2	36	62	65	910	14.0	18
2017	0	0	1	23	83	91	759	8.3	13
2018	0	0	0	5	81	111	329	3.0	8
Total	11	41	110	490	1048	1289	23,206	18.0	70
%	0.9%	3.2%	8.5%	38.0%	81.3%	100.0%			

Note: PY year of publication, *TP* total publications, *TC* total citations, *C/P* citations per publication, *h* h-index; ≥200, ≥100, ≥50, ≥10, and ≥1 = number of publications with at least 200, 100, 50, 10, and 1 citation, respectively studies and 23,206 citations. Table 2.1 shows that 3.2% of studies have received at least 100 citations, 8.5% have received at least 50 citations, and 62.0% have received fewer than ten citations.

2.3.2 The Evolution of Technology Transfer Frameworks

The main aim of science mapping is to show the research field's structural and dynamic aspects (Noyons et al. 1999; Small 1999). Specifically, the author keywords' co-occurrence analysis is used to study a research field (Callon et al. 1983). The occurrences are the number of times that such a keyword appears in the set of documents, while the co-occurrences count the number of times that a given keyword appears together with the other keywords under study. A limitation of this analysis is that no document published in the JOTT before 2004 has author keywords. Also, a further 48 documents published between 2004 and 2018 have no author keywords. Therefore, the total number of documents with author keywords indexed in Scopus at the time of the analysis was 698.

Figure 2.2 presents the map of author keyword co-occurrence for the entire period under study. The map included author keywords (2004–2018) and was produced using the VOSviewer overlay visualization and the average year of publication of the keywords. The color of the nodes indicates the keywords' average year of publication. Figure 2.2 shows the 32 author keywords with more than ten occurrences and the 100 most representative links. Although the analysis period covers the period from 2004 to 2018, the 32 top author keywords go from 2010,33 (the average publication year of university patents) up to 2015,36 (the average publication year of entrepreneurial universities). Technology transfer and innovation are the most frequently used keywords, each with more than 100 occurrences, followed by entrepreneurship, patents, universities, academic entrepreneurship, and R&D, each with more than 40 occurrences.

Table 2.2 lists these author keywords with the number of occurrences and co-occurrences and the average year of publication, ranked by the number of occurrences. The VOSviewer clusters are shown for guidance and help identify the most connected keywords related to the co-occurrence between them (Van Eck and Waltman 2010). *Entrepreneurial universities*, *small and medium-sized enterprises (SMEs)*, *university-industry collaboration*, *academic entrepreneurship*, *start-ups*, *knowledge spillovers*, *technology transfer office*, and *knowledge transfer* are the newest author keywords average year of publication of later than 2014. *University patents*, *knowledge*, *multinational enterprises*, *nanotechnology*, *spin-offs*, and *R&D* are the oldest author keywords, with an average year of publication of later than 2010 but before 2012.

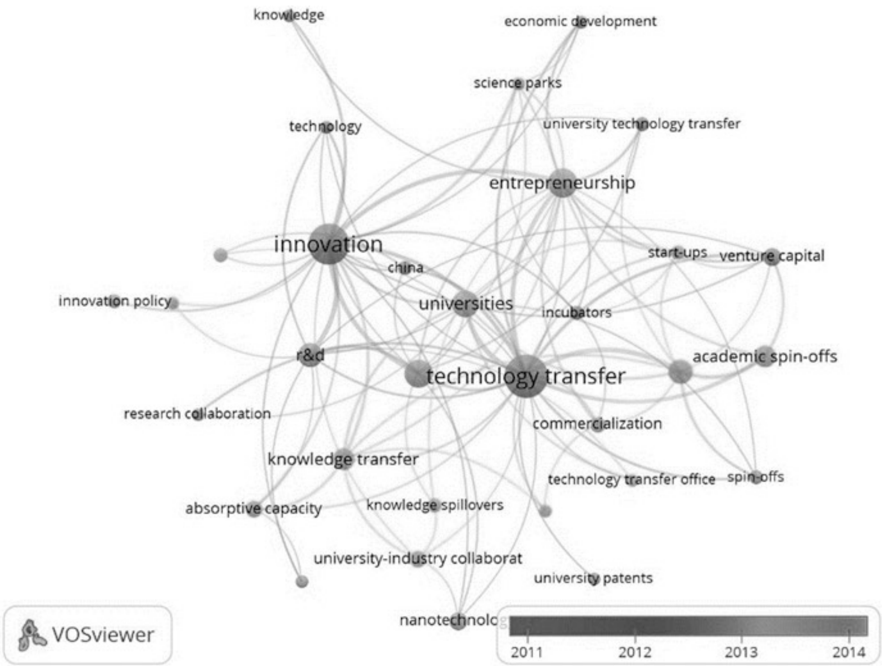


Fig. 2.2 Evolution of technology transfer frameworks

2.3.3 The Most Influential Technology Transfer Studies

Many influential papers have been published in the *JOTT*. One method to identify these influential papers is to classify publications based on the number of citations. The number of citations reflects the article's influence and popularity, and attention from the scientific community (Merigó et al. 2016). The ratio of the number of citations per year was also calculated for all publications. This alternative ratio is important because the total number of citations has a certain bias toward older papers with longer accumulated citations. Table 2.3 ranks the most influential *JOTT* studies indexed in Scopus by total citations. To determine the most influential studies, we used two criteria: (1) the ten most cited articles and (2) the ten articles with the highest number of citations per year. This table displays 16 articles published between 2000 and 2017. For each article, it is shown the ranking by total citations, the total number of citations, the citations per year, the ranking by citations per year, and the number of citations as a percentage of total citations of all articles published in the same year. Four articles in Table 2.3 meet both criteria (i.e., among the ten most cited articles and the ten articles with the highest number of citations per year).

The most cited article, "Regional innovation systems: The integration of local 'sticky' and global 'ubiquitous' knowledge" (Asheim and Isaksen 2002), has 300 citations more than the second-ranked article, "Objectives, characteristics, and

Table 2.2 Most common author keywords from 2004 to 2018

R	Author keyword	Oc.	Co.	Avg. PY	Cluster
1	Technology transfer	126	154	2012.21	Cluster 2
2	Innovation	109	127	2012.28	Cluster 6
3	Entrepreneurship	57	85	2012.93	Cluster 5
4	Patents	53	58	2012.81	Cluster 1
5	Universities	47	64	2012.96	Cluster 3
6	Academic entrepreneurship	41	56	2014.41	Cluster 2
7	R&D	41	55	2011.39	Cluster 6
8	Knowledge transfer	32	37	2014.03	Cluster 1
9	Academic spin-offs	31	39	2013.58	Cluster 2
10	Venture capital	21	33	2012.43	Cluster 2
11	Nanotechnology	21	14	2011.10	Cluster 1
12	University-industry collaboration	20	20	2014.50	Cluster 1
13	Absorptive capacity	19	19	2013.74	Cluster 1
14	Commercialization	17	25	2013.53	Cluster 4
15	Start-ups	15	24	2014.40	Cluster 4
16	China	15	23	2012.47	Cluster 3
17	University technology transfer	15	20	2012.27	Cluster 5
18	Incubators	14	20	2012.29	Cluster 4
19	University-industry linkages	14	15	2013.21	Cluster 3
20	Knowledge spillovers	14	12	2014.14	Cluster 1
21	Spin-offs	13	22	2011.38	Cluster 2
22	Innovation policy	13	8	2012.92	Cluster 3
23	Research collaboration	12	13	2012.58	Cluster 3
24	Knowledge	12	13	2010.42	Cluster 6
25	Small and medium-sized enterprises	12	12	2015.25	Cluster 3
26	University patents	12	8	2010.33	Cluster 2
27	Science parks	11	24	2013.64	Cluster 5
28	Economic development	11	20	2012.27	Cluster 5
29	Technology	11	18	2012.00	Cluster 6
30	Technology transfer office	11	15	2014.09	Cluster 4
31	Multinational enterprises	11	12	2010.45	Cluster 1
32	Entrepreneurial universities	11	11	2015.36	Cluster 4

Note: R ranking by the number of occurrences, *Oc*. author keyword occurrence, *Co*. author keyword co-occurrence, *Avg. PY* author keyword average year of publication

outcomes of university licensing: A survey of major U.S. universities" (Thursby et al. 2001). Asheim and Isaksen's (2002) article heads the ranking by citations per year. Two other articles have more than 30 citations per year: "Why do academics engage with industry? The entrepreneurial university and individual motivations" (D'Este and Perkmann 2011), and "Entrepreneurial ecosystems in cities: establishing the framework conditions" (Audretsch and Belitski 2017). Another interesting

Table 2.3 Most influential technology transfer studies per citations

RTC	TC	C/Y	RCY	Article	%C in PY
1	660	38.8	1	Asheim and Isaksen (2002)	42.4
2	358	19.9	11	Thursby et al. (2001)	13.8
3	344	18.1	15	Lee (2000)	60.7
4	338	26.0	6	Bercovitz and Feldmann (2006)	13.1
5	308	38.5	2	D'Este and Perkmann (2011)	30.1
6	305	23.5	9	Cooke and Leydesdorff (2006)	11.8
7	265	14.7	22	Franklin et al. (2001)	10.2
8	258	14.3	25	Owen-Smith and Powell (2001)	9.9
9	231	15.4	19	Mowery and Sampat (2004)	10.9
10	212	12.5	32	Oughton et al. (2002)	13.6
18	174	29.0	4	Bozeman et al. (2013)	17.6
19	174	24.9	7	Guerrero and Urbano (2012)	16.1
29	134	26.8	5	Audretsch (2014)	12.8
76	65	32.5	3	Audretsch and Belitski (2017)	8.6
110	49	24.5	8	Vrontis et al. (2017)	6.5
135	41	20.5	10	Scuotto et al. (2017)	5.4

R ranking by total citations, *TC* total number of citations, *C/Y* citations per year, *RCY* ranking by citations per year, *%C in PY* citations a percentage of total citations received by all articles published in the same year

method to observe these 16 articles' influence is calculating the number of citations as a percentage of total citations received by all articles published in the same year. It is also useful to examine the evolution of these articles (Prévot et al. 2010). The 1289 documents under analysis had received 23,206 citations by September 30, 2019, when the search for this study was conducted. The column "%C in PY" in Table 2.3 shows the percentage of citations of the 16 most influential articles concerning the total citations received by all the articles published in the same year.

According to the percentage of the citations received in their year of publication, three articles may be considered most disruptive: "The sustainability of university-industry research collaboration: An empirical assessment" (Lee 2000), with 60.7%, Asheim and Isaksen's (2002) article, with 42.4%, and D'Este and Parkmann's (2011) article, with 30.1%. The citations of these 16 articles' annual evolution show that Asheim and Isaksen (2002), and D'Este and Perkmann (2011) authored the most influential articles in recent years. "The development of an entrepreneurial university" (Guerrero and Urbano 2012), "From the entrepreneurial university to the university for the entrepreneurial society" (Audretsch 2014), and Audretsch and Belitski's (2017) article must also be added to the list of most influential articles for the year 2019.

2.3.4 Evolution of the Leading Trends in Technology Transfer

The main aim of this chapter was to identify the leading trends in technology transfer. This aim was achieved by reviewing the most influential articles published in the *JOTT*. Based on the articles' aims, scope, and conclusions, Table 2.4 presents the technology transfer topics and research trends addressed by each article.

Table 2.4 Most influential technology transfer studies

Article	Main TT-related topics	Main TT research trends
Asheim and Isaksen (2002)	Knowledge types, creation, and learning in regional innovation systems	Knowledge management
Thursby et al. (2001)	Patents and university licensing	University licensing and patenting
Lee (2000)	University-industry collaboration	University-industry collaboration
Bercovitz and Feldmann (2006)	University-industry relationships, knowledge base, and entrepreneurial university	University-industry collaboration, knowledge management, and entrepreneurial universities
D'Este and Perkmann (2011)	University-industry collaboration and entrepreneurial university	University-industry collaboration and entrepreneurial university
Cooke and Leydesdorff (2006)	Knowledge infrastructures at a regional level	Knowledge management
Franklin et al. (2001)	Entrepreneurial universities and entrepreneurial policies to develop new start-ups	Entrepreneurial universities and entrepreneurial-oriented policies
Owen-Smith and Powell (2001)	University patents	University licensing and patenting
Mowery and Sampat (2004)	University-industry relationships and university patenting	University-industry collaboration and university licensing and patenting
Oughton et al. (2002)	Innovation, technology, and industrial policies at a regional level	Entrepreneurial-oriented policies
Bozeman et al. (2013)	Research collaboration, academic entrepreneurship, and knowledge transfer	University-industry collaboration and knowledge management
Guerrero and Urbano (2012)	Entrepreneurial university missions	Entrepreneurial universities
Audretsch (2014)	Entrepreneurial university role evolution	Entrepreneurial universities
Audretsch and Belitski (2017)	Urban entrepreneurial ecosystems	Entrepreneurial ecosystems
Vrontis et al. (2017)	Knowledge types and performance in knowledge-intensive firms	Knowledge management
Scuotto et al. (2017)	Digital ecosystems and absorptive capacity in SMEs	Entrepreneurial ecosystems and knowledge management

R ranking by total citations, *TC* total number of citations, *C/Y* citations per year, *RCY* ranking by citations per year, *% C in PY* citations a percentage of total citations received by all articles published in the same year

Complementary, Table 2.5 shows the most influential *JOTT* studies for each technology transfer research trend. Six main technology transfer research trends are identified: (1) knowledge management, (2) university licensing and patenting, (3) university-industry collaboration, (4) entrepreneurial universities, (5) entrepreneurial-oriented policies (since the beginning of the 2000s), and (6) entrepreneurial ecosystems (since 2017). These trends highlight knowledge, universities, entrepreneurship, industry, and policies as the major dynamics in technology transfer or the main forces that drive development and change in technology transfer processes. These results corroborate and complement the *JOTT* conceptual framework data.

Knowledge management is the process of creating, sharing, using, and managing an organization's knowledge and information (Nonaka 1994; Gaviria-Marin et al. 2018). This research trend covers some of the keywords that form the *JOTT* conceptual framework, such as *innovation*, *patents*, *knowledge transfer*, *absorptive capacity*, *knowledge spillovers*, and *science parks*. Six articles address this trend focused on diverse knowledge-related issues such as knowledge types in different environments (Asheim and Isaksen 2002; Bercovitz and Feldmann 2006; Vrontis et al. 2017), knowledge infrastructures (Cooke and Leydesdorff 2006), and knowledge transfer in different contexts (Bozeman et al. 2013; Scuotto et al. 2017).

Three of the six research trends are directly related to universities: university licensing and patenting (Owen-Smith and Powell 2001; Thursby et al. 2001; Mowery and Sampat 2004), university-industry collaboration (Lee 2000; Mowery

Table 2.5 The most influential technology transfer trends

Knowledge management	University licensing and patenting	University-industry collaboration	Entrepreneurial universities	Entrepreneurial-oriented policies	Entrepreneurial ecosystems
Asheim and Isaksen (2002)	Thursby et al. (2001)	Lee (2000)	Franklin et al. (2001)	Franklin et al. (2001)	Audretsch and Belitski (2017)
Bercovitz and Feldmann (2006)	Owen-Smith and Powell (2001)	Mowery and Sampat (2004)	Bercovitz and Feldmann (2006)	Oughton et al. (2002)	Scuotto et al. (2017)
Cooke and Leydesdorff (2006)	Mowery and Sampat (2004)	Bercovitz and Feldmann (2006)	D'Este and Perkmann (2011)		
Bozeman et al. (2013)		D'Este and Perkmann (2011)	Guerrero and Urbano (2012)		
Vrontis et al. (2017)		Bozeman et al. (2013)	Audretsch (2014)		
Scuotto et al. (2017)					

and Sampat 2004; Bercovitz and Feldmann 2006; D'Este and Perkmann 2011; Bozeman et al. 2013), and entrepreneurial universities (Franklin et al. 2001; Betcovitz and Feldmann 2006; D'Este and Perkmann 2011; Guerrero and Urbano 2012; Audretsch 2014), which corresponds to the influence of some of the keywords that are prominent in the *JOTT* conceptual framework, including *academic entrepreneurship*, *entrepreneurial universities*, *academic spin-offs*, *university-industry collaboration*, *university-industry linkages*, *university technology transfer*, *university patents*, and *research collaboration*.

Lastly, three research trends focus on entrepreneurship issues: entrepreneurial universities (Franklin et al. 2001; Betcovitz and Feldmann 2006; D'Este and Perkmann 2011; Guerrero and Urbano 2012; Audretsch 2014), entrepreneurial-oriented policies (Franklin et al. 2001; Oughton et al. 2002), and entrepreneurial ecosystems (Audretsch and Belitski 2017; Scuotto et al. 2017), which can be defined as "a set of interconnected entrepreneurial actors (both potential and existing), entrepreneurial organizations (e.g. firms, venture capitalists, business angels, banks), institutions (universities, public sector agencies, financial bodies) and entrepreneurial processes (e.g. the business birth rate, numbers of high growth firms, levels of 'blockbuster entrepreneurship', number of serial entrepreneurs, degree of sell-out mentality within firms and levels of entrepreneurial ambition) which formally and informally coalesce to connect, mediate and govern the performance within the local entrepreneurial environment" (Mason and Brown 2014, p. 5). Such research trends reflect the increasing importance of entrepreneurship in innovation policies and innovation systems to the point that the concept of a national entrepreneurship System (NES) was coined in 2014 (Acs et al. 2014). These research trends are closely linked to some areas of the *JOTT* conceptual framework, including *academic entrepreneurship*, *academic spin-offs*, *venture capital*, *start-ups*, *incubators*, and *spin-offs*.

Another interesting issue to analyze is the evolution of these research trends. Figure 2.3 presents the annual evolution of the number of citations per study for each research trend. This ratio is used instead of the total number of citations because the total number of citations is an absolute value that does not consider the number of articles addressing each research trend. As such, total citations favor research trends that are addressed by more articles. For instance, the university licensing and patenting research trend is linked to two articles published in 2001 and one published in 2004. Therefore, the number of citations per study for this research trend is calculated by dividing by two from 2001 to 2003 and dividing by three from 2004 to 2019. According to Fig. 2.3, entrepreneurial universities, university-industry collaboration, and knowledge management have become the leading trends in technology transfer since 2015, with entrepreneurial ecosystems emerging in 2019.

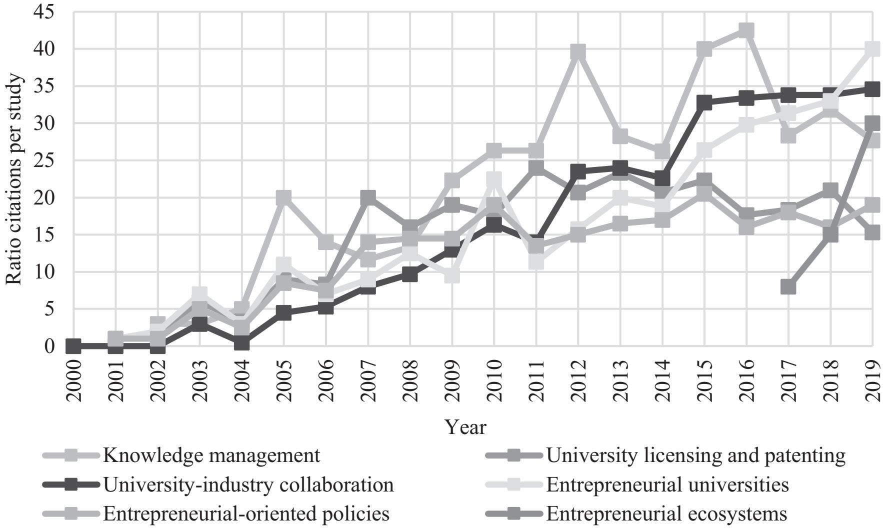


Fig. 2.3 Evolution of citations per technology transfer research trends

2.3.5 Technology Transfer, Entrepreneurship and Innovation Policies

During the last three decades, policy-makers have increasingly focused on innovation in economic performance and the solution to challenges. For that reason, the innovation policy concept has become widespread and commonly used. However, although they were not labeled specifically with such name, innovation policies already existed before that time. In a broad sense of the definition, innovation policies are any kind of policies (or policy instruments) that impact innovation (Edler and Fagerberg 2017). The most influential articles published in the *JOTT* also shed light on the importance of public policies as one of the main factors affecting the environment for technology transfer (Bozeman 2000). A qualitative text analysis of these 16 articles shows that the words *policy* and *policies* are found in all of them, except in the paper by Vrontis et al. (2017). A more profound review allowed us to identify the kinds of policies mentioned and dealt with in these articles, either as a main goal in the study or as a variable required for the analysis. Such policies can be grouped into three different types: technology transfer, entrepreneurship, and regional innovation policies (see Table 2.6).

According to the most influential *JOTT* studies, university licensing and patenting, and university-industry collaboration are the most prevalent policies in the technology transfer process, with special mention to the Bayh-Dole Act of 1980, a piece of legislation that is widely credited with stimulating significant growth in university-industry technology transfer and research collaboration in the

Table 2.6 Taxonomy of policies according to the most influential technology transfer studies

Types of policies		Articles
Technology transfer policies	University licensing and patenting policies	Thursby et al. (2001), Owen-Smith and Powell (2001), Mowery and Sampat (2004), Bercovitz and Feldmann (2006), D'Este and Perkmann (2011), Audretsch (2014)
	University-industry collaboration policies	Lee (2000), Owen-Smith and Powell (2001), Mowery and Sampat (2004), D'Este and Perkmann (2011), Bozeman et al. (2013), Audretsch (2014)
Entrepreneurship policies	To support start-ups	Franklin et al. (2001)
	Regional entrepreneurial-oriented technology/innovation and industrial policies	Oughton et al. (2002)
	To support entrepreneurial universities	Guerrero and Urbano (2012)
	Regional/urban innovation and entrepreneurship policies	Audretsch and Belitski (2017)
	To support SMEs	Scuotto et al. (2017)
Regional innovation policies	Regional innovation policies in different kinds of clusters	Asheim and Isaksen (2002)
	Regional entrepreneurial-oriented technology/innovation and industrial policies	Oughton et al. (2002)
	Regional innovation policies in the knowledge-based economy	Cooke and Leydesdorff (2006)
	Regional/urban innovation and entrepreneurship policies	Audretsch and Belitski (2017)

US. Regarding entrepreneurship, the most influential *JOTT* studies mention or tackle with policies to support technology-based start-ups (Franklin et al. 2001), entrepreneurial universities (Guerrero and Urbano 2012), entrepreneurial ecosystems (Audretsch and Belitski 2017), or SMEs (Scuotto et al. 2017), as well as regional policies oriented to stimulate entrepreneurial activities (Oughton et al. 2002). Interestingly, all types of innovation policies mentioned in the most influential *JOTT* studies are considered from a regional perspective: this is the case of regional innovation policies in different kinds of clusters (Asheim and Isaksen 2002) or the knowledge-based economy (Cooke and Leydesdorff 2006), regional (or even urban) policies in entrepreneurial ecosystems (Audretsch and Belitski 2017), and regional technology/innovation and industrial policies (Oughton et al. 2002).

2.4 Conclusions

This chapter provides a dynamic overview of the JOTT studies from 1977 to 2018 using bibliographic data from the Scopus database. The aim was to show major trends in technology transfer by analyzing all JOTT publications and reviewing the most influential articles published in JOTT over this period. Additionally, the main types of policies considered in the most influential JOTT articles were identified. The Scopus search was conducted on September 30, 2019, and a wide range of bibliometric indicators was considered. The JOTT is a scientific research journal that focuses on management practices and strategies for technology transfer and the external environment that affects these practices and strategies. The journal's Scopus rankings indicate that the JOTT is an influential journal with a high impact in the three subject sub-areas where it is indexed: Engineering (miscellaneous), Accounting, and Business and International Management. The JOTT lies in the 1st quartile (Q1) in all three subject sub-areas.

In the author's keyword analysis, the joint assessment of the number of occurrences and the average year of publication shows that technology transfer, innovation, entrepreneurship, patents, universities, academic entrepreneurship, and R&D were the most frequent keywords in the JOTT between 2004 and 2018. Regarding their evolution, entrepreneurial universities, small and medium-sized enterprises (SMEs), university-industry collaboration, academic entrepreneurship, start-ups, knowledge spillovers, technology transfer office, and knowledge transfer have gained importance in recent years.

The most influential JOTT studies were identified by considering both the total number of citations and the citations per year for each paper. This search identified 16 articles. "Regional innovation systems: The integration of local 'sticky' and global 'ubiquitous' knowledge" (Asheim and Isaksen 2002) is the most cited article, followed by "Objectives, characteristics, and outcomes of university licensing: A survey of major U.S. universities" (Thursby et al. 2001) and "The sustainability of university-industry research collaboration: An empirical assessment" (Lee 2000). Asheim and Isaksen's (2002) article also has the most citations per year, followed by "Why do academics engage with industry? The entrepreneurial university and individual motivations" (D'Este and Perkmann 2011) and "Entrepreneurial ecosystems in cities: establishing the framework conditions" (Audretsch and Belitski 2017). These 16 articles were also analyzed from a dynamic perspective by using the citations received in each article's year of publication and the citations' annual evolution. The percentage of citations received in the year of publication suggests that "The sustainability of university-industry research collaboration: An empirical assessment" (Lee 2000), "Regional innovation systems: The integration of local 'sticky' and global 'ubiquitous' knowledge" (Asheim and Isaksen 2002), and "Why do academics engage with industry? The entrepreneurial university and individual motivations" (D'Este and Perkmann 2011) are the most disruptive articles. The annual evolution of citations suggests that "Regional innovation systems: The integration of local 'sticky' and global 'ubiquitous' knowledge" (Asheim and Isaksen

2002) and "Why do academics engage with industry? The entrepreneurial university and individual motivations" (D'Este and Perkmann 2011) have been the most influential articles in recent years. "The development of an entrepreneurial university" (Guerrero and Urbano 2012), "From the entrepreneurial university to the university for the entrepreneurial society" (Audretsch 2014), and "Entrepreneurial ecosystems in cities: establishing the framework conditions" (Audretsch and Belitski 2017) should also be considered among the most influential articles for the year 2019.

The 16 most influential JOTT articles were examined, revealing six main research trends in technology transfer: (1) knowledge management, (2) university licensing and patenting, (3) university-industry collaboration, (4) entrepreneurial universities, (5) entrepreneurial-oriented policies (since the beginning of the 2000s), and (6) entrepreneurial ecosystems (since 2017). According to these results, knowledge, universities, industry, and entrepreneurship are the major dynamics in technology transfer processes. The evolution of the research, as mentioned above trends shows that entrepreneurial universities, university-industry collaboration, and knowledge management have become the leading trends in technology transfer in the last few years, with entrepreneurial ecosystems emerging as a major trend in 2019. Additionally, the review of the 16 most influential JOTT articles also shows the relevance of different kinds of public policies within this field, especially technology transfer, entrepreneurship, and regional innovation policies. Two main implications can be inferred from these results.

First, considering one possible definition of technology transfer based on Roessner (2000):

> The movement of know-how, skills, technical knowledge, or technology from one organizational setting to another. Technology transfer from science occurs both formally and informally. Technology, skills, procedures, methods, and expertise from research institutions and universities can be transferred to firms or governmental institutions, generating economic value and industry development.

Our analysis shows that both the research mentioned above trends and kinds of public policies are in line with the technology transfer definition, but they also add a new factor: the entrepreneurial specificity of universities, policies, and ecosystems. Entrepreneurship is a potential source of innovation that has become a popular topic in recent years. The rise in popularity of entrepreneurship can be traced to the need for countries and regions to innovate and generate competitive advantages based on local agents, processes, and dynamics to compete in the globalized world economy (Autio et al. 2014).

Second, the innovation literature has been historically focused on the structure and policies, while entrepreneurship literature has been oriented to the individual or the firm (Zahra and Wright 2011). Entrepreneurship fits into NIS research in some specific ways because NESs "fundamentally resources allocation systems that are driven by individual-level opportunity pursuit, through the creation of new ventures, with this activity and its outcomes regulated by country-specific institutional characteristics. In contrast with the institutional emphasis of the National Systems of Innovation frameworks, where institutions engender and regulate action, National

Systems of Entrepreneurship are driven by individuals, with institutions regulating who acts and the outcomes of individual action" (Acs et al. 2014, p. 476). Our analysis shows that technology transfer is a research field where both areas (innovation and entrepreneurship) coalesce since the most influential JOTT articles establish relationships, in one way or another, with different types of technology transfer, entrepreneurship and innovation policies.

Although this chapter provides a complete and comprehensive picture of the leading trends and public policies in technology transfer by considering all JOTT publications, it has some limitations. JOTT publications before 2004 have no author keywords. Moreover, a further 48 documents published between 2004 and 2018 have no author keywords, so the total number of publications with author keywords indexed in Scopus at the time of the analysis was 698. Although researchers should consider this limitation when consulting the JOTT conceptual framework results, this bibliometric analysis identifies the most significant trends and public policies in technology transfer according to the most influential JOTT articles.

Acknowledgments Norat Roig-Tierno wishes to thank Project GV/2019/063, funded by the Generalitat Valenciana, and Project RTI2018-093791-B-C22, funded by Ministerio de Ciencia, Innovación y Universidades and FEDER, for supporting this research.

References

Acs, Z. J., Autio, E., & Szerb, L. (2014). National systems of entrepreneurship: Measurement issues and policy implications. *Research Policy, 43*(3), 476–494. https://doi.org/10.1016/j.respol.2013.08.016.

Acs, Z. J., Stam, E., Audretsch, D. B., & Connor, A. O. (2017). The lineages of the entrepreneurial ecosystem approach. *Small Business Economics, 49*, 1–10. https://doi.org/10.1007/s11187-017-9864-8.

Alonso, S., Cabrerizo, F. J., Herrera-Viedma, E., & Herrera, F. (2009). H-index: A review focused on its variants, computation, and standardization for different scientific fields. *Journal of Informetrics, 3*, 273–289. https://doi.org/10.1016/j.joi.2009.04.001.

Asheim, B. T., & Isaksen, A. (2002). Regional innovation systems: The integration of local 'sticky' and global 'ubiquitous' knowledge. *Journal of Technology Transfer, 27*(1), 77–86. https://doi.org/10.1023/A:1013100704794.

Audretsch, D. B. (2007). *The entrepreneurial society*. Oxford: Oxford University Press.

Audretsch, D. B. (2014). From the entrepreneurial university to the university for the entrepreneurial society. *Journal of Technology Transfer, 39*(3), 313–321. https://doi.org/10.1007/s10961-012-9288-1.

Audretsch, D. B., & Belitski, M. (2017). Entrepreneurial ecosystems in cities: Establishing the framework conditions. *Journal of Technology Transfer, 42*(5), 1030–1051. https://doi.org/10.1007/s10961-016-9473-8.

Autio, E., Kenney, M., Mustar, P., Siegel, D., & Wright, M. (2014). Entrepreneurial innovation: The importance of context. *Research Policy, 43*(7), 1097–1108. https://doi.org/10.1016/j.respol.2014.01.015.

Bercovitz, J., & Feldmann, M. (2006). Entrepreneurial universities and technology transfer: A conceptual framework for understanding knowledge-based economic development. *Journal of Technology Transfer, 31*(1), 175–188. https://doi.org/10.1007/s10961-005-5029-z.

Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S., & Rickne, A. (2008). Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. *Research Policy, 37*, 407–429. https://doi.org/10.1016/j.respol.2007.12.003.

Bozeman, B. (2000). Technology transfer and public policy: A review of research and theory. *Research Policy, 29*(4–5), 627–655. https://doi.org/10.1016/S0048-7333(99)00093-1.

Bozeman, B., Fay, D., & Slade, C. P. (2013). Research collaboration in universities and academic entrepreneurship: The-state-of-the-art. *Journal of Technology Transfer, 38*(1), 1–67. https://doi.org/10.1007/s10961-012-9281-8.

Broadus, R. N. (1987). Toward a definition of "Bibliometrics". *Scientometrics, 12*, 373–379. https://doi.org/10.1007/BF02016680.

Callon, M., Courtial, J. P., Turner, W. A., & Bauin, S. (1983). From translations to problematic networks: An introduction to co-word analysis. *Social Science Information, 22*(2), 191–235. https://doi.org/10.1177/053901883022002003.

Cancino, C., Merigó, J. M., & Coronado, F. (2017). Big names in innovation research: A bibliometric overview. *Current Science, 113*(8), 1507–1518. https://doi.org/10.18520/cs/v113/i08/1507-1518.

Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2011). Science mapping software tools: Review, analysis, and cooperative study among tools. *Journal of the American Society for Information Science and Technology, 62*(7), 1382–1402. https://doi.org/10.1002/asi.21525.

Cooke, P., & Leydesdorff, L. (2006). Regional development in the knowledge-based economy: The construction of advantage. *Journal of Technology Transfer, 31*(1), 5–15. https://doi.org/10.1007/s10961-005-5009-3.

D'Este, P., & Perkmann, M. (2011). Why do academics engage with industry? The entrepreneurial university and individual motivations. *Journal of Technology Transfer, 36*(3), 316–339. https://doi.org/10.1007/s10961-010-9153-z.

Edler, J., & Fagerberg, J. (2017). Innovation policy: What, why, and how. *Oxford Review of Economic Policy, 33*(1), 2–23. https://doi.org/10.1093/oxrep/grx001.

Edquist, C. (2004). Systems of innovation: Perspectives and challenges. In J. Fagerberg, D. Mowery, & R. Nelson (Eds.), *Oxford handbook of innovation* (pp. 181–208). Oxford: Oxford University Press.

Fagerberg, J. (2017). Innovation policy: Rationales, lessons and challenges. *Journal of Economic Surveys, 31*(2), 497–512. https://doi.org/10.1111/joes.12164.

Fagerberg, J., & Verspagen, B. (2009). Innovation studies: The emerging structure of a new scientific field. *Research Policy, 38*, 218–233. https://doi.org/10.1016/j.respol.2008.12.006.

Franklin, S. J., Wright, M., & Lockett, A. (2001). Academic and surrogate entrepreneurs in university spin-out companies. *Journal of Technology Transfer, 26*(1–2), 127–141. https://doi.org/10.1023/A:1007896514609.

Freeman, C. (1987). *Technology policy and economic performance: Lessons from Japan*. London/New York: Pinter Publishers.

Gaviria-Marin, M., Merigó, J. M., & Baier-Fuentes, H. (2018). Knowledge management: A global examination based on bibliometric analysis. *Technological Forecasting and Social Change, 140*, 194–220. https://doi.org/10.1016/j.techfore.2018.07.006.

Guerrero, M., & Urbano, D. (2012). The development of an entrepreneurial university. *Journal of Technology Transfer, 37*(1), 43–74. https://doi.org/10.1007/s10961-010-9171-x.

Guerrero, M., & Urbano, D. (2019). Effectiveness of technology transfer policies and legislation in fostering entrepreneurial innovations across continents: An overview. *Journal of Technology Transfer, 44*, 1347–1366. https://doi.org/10.1007/s10961-019-09736-x.

Guerrero, M., Cunningham, J. A., & Urbano, D. (2015). Economic impact of entrepreneurial universities' activities: An exploratory study of the United Kingdom. *Research Policy, 44*(3), 748–764.

Hirsch, J. E. (2005). An index to quantify an individual's scientific research output. *Proceedings of the National Academy of Sciences of the United States of America, 102*, 16569–16572. https://doi.org/10.1073/pnas.0507655102.

Isenberg, D. (2011). *The entrepreneurship ecosystem strategy as a new paradigm for economy policy: Principles for cultivating entrepreneurship. Babson Entrepreneurship Ecosystem Project*. Babson Park: Babson College.

Lafuente, E., Szerb, L., & Acs, Z. J. (2016). Country level efficiency and national systems of entrepreneurship: A data envelopment analysis approach. *Journal of Technology Transfer, 41*(6), 1260–1283. https://doi.org/10.1007/s10961-015-9440-9.

Lee, Y. S. (2000). The sustainability of university-industry research collaboration: An empirical assessment. *Journal of Technology Transfer, 25*(2), 111–133. https://doi.org/10.1023/A:1007895322042.

López-Rubio, P., Roig-Tierno, N., & Mas-Verdú, F. (2018a). Mapping top leading regions and trending topics in innovation policy research. Paper presented at the XLIV International Conference on Regional Science, Valencia, Spain, 21–23 November 2018.

López-Rubio, P., Roig-Tierno, N., & Mas-Verdú, F. (2018b). Technology transfer: A comparison between web of science core collection and scopus. *Information and Innovations, 13*(2), 53–69. https://doi.org/10.31432/1994-2443-2018-13-2-53-69.

Lundvall, B. A. (1992). *National systems of innovation: Towards a theory of innovation and interactive learning*. London: Pinter.

Martin, B. R. (2012). The evolution of science policy and innovation studies. *Research Policy, 41*, 1219–1239. https://doi.org/10.1016/j.respol.2012.03.012.

Mason, C., & Brown, R. (2014). *Entrepreneurial ecosystems and growth oriented entrepreneurship*. Paris: Final Report to OECD.

Merigó, J. M., Cancino, C., Coronado, F., & Urbano, D. (2016). Academic research in innovation: A country analysis. *Scientometrics, 108*, 559–593. https://doi.org/10.1007/s11192-016-1984-4.

Mingers, J., & Leydesdorff, L. (2015). A review of theory and practice of scientometrics. *European Journal of Operational Research, 246*, 1–19. https://doi.org/10.1016/j.ejor.2015.04.002.

Mongeon, P., & Paul-Hus, A. (2016). The journal coverage of web of science and scopus: A comparative analysis. *Scientometrics, 106*, 213–228. https://doi.org/10.1007/s11192-015-1765-5.

Mowery, D. C., & Sampat, B. N. (2004). The Bayh-Dole Act of 1980 and university-industry technology transfer: A model for other OECD governments. *Journal of Technology Transfer, 30*(1–2), 115–127. https://doi.org/10.1007/s10961-004-4361-z.

Mytelka, L. K. (2000). Local systems of innovation in a globalized world economy. *Industry and Innovation, 7*(1), 15–32. https://doi.org/10.1080/713670244.

Nacke, O. (1979). Informetrie: Ein neuer Name für eine neue Disziplin. *Nachrichten für Dokumentation, 20*, 212–226.

Nalimov, V. V., Mulchenko, Z. M. (1969). Naukometriya. Izuchenie Razvitiya Nauki kak Informatsionnogo Protsessa. (Scientometrics. Study of the development of science as an information process), Nauka, Moscow, (English translation: 1971. Washington, D.C.: Foreign Technology Division. U.S. Air Force Systems Command, Wright-Patterson AFB, Ohio). NTIS Report No.AD735-634.

Nelson, R. R. (1993). In R. R. Nelson (Ed.), *National innovation systems. A comparative analysis*. New York/London: Oxford University Press.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science, 5*(1), 14–37. https://doi.org/10.1287/orsc.5.1.14.

Noyons, E. C. M., Moed, H. F., & Van Raan, A. F. J. (1999). Integrating research performance analysis and science mapping. *Scientometrics, 46*(3), 591–604. https://doi.org/10.1007/BF02459614.

Oughton, C., Landabaso, M., & Morgan, K. (2002). The regional innovation paradox: Innovation policy and industrial policy. *Journal of Technology Transfer, 27*(1), 97–110. https://doi.org/10.1023/A:1013104805703.

Owen-Smith, J., & Powell, W. W. (2001). To patent or not: Faculty decisions and institutional success at technology transfer. *Journal of Technology Transfer, 26*(1–2), 99–114. https://doi.org/10.1023/A:1007892413701.

Podsakoff, P. M., MacKenzie, S. B., Podsakoff, N. P., & Bachrach, D. G. (2008). Scholarly influence in the field of management: A bibliometric analysis of the determinants of university and author impact in the management literature in the past quarter century. *Journal of Management, 34*, 641–720. https://doi.org/10.1177/0149206308319533.

Prévot, F., Branchet, B., Boissin, J. P., Castagnos, J. C., & Guieu, G. (2010). The intellectual structure of the competence-based management. In R. Sanchez, A. Heene, & T. E. Zimmermann (Eds.), *A focused issue on identifying, building, and linking competences – research in competence-based management* (Vol. 5, pp. 231–258). Bingley: Emerald Group Publishing Limited.

Pritchard, A. (1969). Statistical bibliographic or bibliometrics? *Journal of Documentation, 25*(4), 348–349.

Roessner, J. D. (2000). Technology transfer. In C. Hill (Ed.), *Science and technology policy in the US, a time of change*. London: Longman.

Schumpeter, J. A. (1934). *The theory of economic development: An inquiry into profits, capital, credit interest, and the business cycle*. Cambridge, MA: Harvard University Press.

Schumpeter, J. A. (1942). *Capitalism, socialism and democracy*. New York: Harper.

Scuotto, V., Del Giudice, M., & Carayannis, E. G. (2017). The effect of social networking sites and absorptive capacity on SMES' innovation performance. *Journal of Technology Transfer, 42*(2), 409–424. https://doi.org/10.1007/s10961-016-9517-0.

Sengupta, I. N. (1992). Bibliometrics, informetrics, scientometrics and librametrics: An overview. *Libri, 42*(2), 75–98. https://doi.org/10.1515/libr.1992.42.2.75.

Shafique, M. (2013). Thinking inside the box: Intellectual structure of the knowledge base of innovation research (1988–2008). *Strategic Management Journal, 34*, 62–93. https://doi.org/10.1002/smj.2002.

Small, H. (1999). Visualizing science by citation mapping. *Journal of the American Society for Information Science, 50*(9), 799–813. https://doi.org/10.1002/(SICI)1097-4571(1999)50:9<799::AID-ASI9>3.0.CO;2-G.

Spigel, B. (2017). The relational organization of entrepreneurial ecosystems. *Entrepreneurship Theory and Practice, 41*(1), 49–72. https://doi.org/10.1111/etap.12167.

Thelwall, M. (2008). Bibliometrics to webometrics. *Journal of Information Science, 34*(4), 605–621. https://doi.org/10.1177/0165551507087238.

Thursby, J. G., Jensen, R., & Thursby, M. C. (2001). Objectives, characteristics and outcomes of university licensing: A survey of major U.S. universities. *Journal of Technology Transfer, 26*(1–2), 59–72. https://doi.org/10.1023/A:1007884111883.

Van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics, 84*(2), 523–538. https://doi.org/10.1007/s11192-009-0146-3.

Vrontis, D., Tharassou, A., Santoro, G., & Papa, A. (2017). Ambidexterity, external knowledge and performance in knowledge-intensive firms. *Journal of Technology Transfer, 42*(2), 374–388. https://doi.org/10.1007/s10961-016-9502-7.

Zahra, S. A., & Wright, M. (2011). Entrepreneurship's next act. *Academy of Management Perspectives, 25*(4), 67–83. https://doi.org/10.5465/amp.2010.0149.

Part II
Empirical Evidence in North America

Maribel Guerrero and David Urbano

"Possibly the most inspired piece of legislation to be enacted in America over the past half-century was the Bayh-Dole Act of 1980… More than anything, this single policy measure helped to reverse America's precipitous slide into industrial irrelevance".

– The Economist (2002)

In the 40th anniversary of the Bayh-Dole Act, policy briefs or reports have constantly shown multiples socio-economic indicators related to this legislation's effectiveness. However, a few academic studies have analyzed the accumulated positive/negative effects of this legislation and how this legislation stimulates the emergence of new/complementary policy frameworks and instruments (Link and van Hasselt 2019). Undoubtably, North America best practices have nurtured the replication of effective legislation in multiple contexts. It has represented the internationalization phenomenon of technology transfer policy frameworks across the globe.

Inspired by the current academic trends, this part of the book focused on providing empirical evidence about the relationships within the technology transfer process at U.S. federal laboratories. Concretely, Chap. 3 quantitative estimates the relationship between R&D, invention disclosures, and patent applications metrics. For potential readers, this chapter provides a better understanding of the effectiveness of technology transfer policies by quantifying the path from R&D spending to

M. Guerrero (✉)
Facultad de Economía y Negocios, Universidad del Desarrollo, Santiago, Chile

Centre for Innovation Research (CIRCLE), Lund University, Lund, Sweden

Northumbria Centre for Innovation, Regional Transformation and Entrepreneurship (iNCITE), Newcastle Business School, Northumbria University, Newcastle upon Tyne, UK
e-mail: maribel.guerrero@northumbria.ac.uk

D. Urbano
Department of Business and Centre for Entrepreneurship and Social Innovation Research (CREIS), Universitat Autònoma de Barcelona, Bellaterra, Spain
e-mail: david.urbano@uab.cat

the patent application, as well as made emphasizes the quantitative importance of networks. Indeed, several implications for TTOs managers and promoters of entrepreneurial innovations. This chapter also highlights the relevance of a research agenda on the role of R&D and the role of invention disclosures (i.e., scientific creativity) in federal laboratories, as well as the difficulties in gathering multiple metrics in terms of the associated capabilities for testing this phenomenon.

Paradoxically, given the absence of public information across the technology transfer process, we encourage the academic community to extend the analysis about the effectiveness and impacts of technology transfer across multiple research agents (universities, federal laboratories, research centers) through interview-based case studies. Empirical studies legitimize the relevance of continuing reinforcing technology transfer policy frameworks for generating multiple benefits to societal development and well-being. The chapter provokes the debate and suggests some recommendations for academics, policy-makers, entrepreneurial innovators and ecosystem's agents.

References

Link, A. N, van Hasselt, M. (2019). On the transfer of technology from universities: The impact of the Bayh–Dole Act of 1980 on the institutionalization of university research. *European Economic Review*, 119, 472–481.

The Economist. (2002). Innovation's golden goose, 14 December 2002, p. 3. http://www.economist.com/node/1476653?story_id=1476653.

Chapter 3
Technology Transfer at U.S. Federal Laboratories: R&D Disclosures Patent Applications

Albert N. Link

3.1 Introduction

In the early 1970s, and then again in the late 1970s and early 1980s, the U.S. economy experienced a significant slowdown in productivity growth.[1] In response to this slowdown, which was also occurring in most industrialized nations, U.S. President Jimmy Carter initiated s Domestic Policy Review in 1979. The Review charged Congress to pursue eight corrective policy initiatives, the first of which was to enhance the transfer of information from federal laboratories into the economy (Carter, 1979, p. 64):

> Often, the information that underlies a technological advance is not known to companies capable of commercially developing that advance. Therefore, I am taking several actions to ease and encourage the flow of technical knowledge and information. These actions include [the improvement of] the transfer of knowledge from Federal laboratories.

Soon after that, Congress passed the Stevenson-Wydler Technology Innovation Act of 1980 (Public Law 96-480).

> It is the purpose of this Act to improve the economic, environmental, and social well-being of the United States by … promoting technology development through the establishment of centers for industrial technology [within Federal laboratories and] stimulating improved utilization of federally funded technology developments by State and local governments

[1] See Bozeman and Link (2015), Leyden and Link (2015) and Link and Oliver (2020) for an in-depth discussion of the productivity slowdown and the various policy responses initiated by Congress in the early 1980s. See also Link and Oliver (2020) for an elaboration of the enabling legislation discussed in this section of the chapter.

A. N. Link (✉)
Department of Economics, University of North Carolina at Greensboro,
Greensboro, NC, USA
e-mail: anlink@uncg.edu

M. Guerrero, D. Urbano (eds.), *Technology Transfer and Entrepreneurial Innovations*,
International Studies in Entrepreneurship 51,
https://doi.org/10.1007/978-3-030-70022-5_3

> and the private sector … It is the continuing responsibility of the Federal Government to ensure the full use of the results of the Nation's Federal investment in research and development. To this end, the Federal Government shall strive where appropriate to transfer federally owned or originated technology to State and local governments and the private sector.

Several amendments followed the passage of the Stevenson-Wydler Act.[2] In particular, the Federal Technology Transfer Act of 1986 (Public Law 99-502) established,[3] among other things, the Federal Laboratory Consortium for Technology Transfer (FLC), and the then National Bureau of Standards (which later became the National Institute of Standards and Technology, NIST) was to be the FLC's host laboratory. The FLC was charged to:

> … develop and (with the consent of the Federal Laboratory concerned) administer techniques, training courses, and materials concerning technology transfer to increase the awareness of Federal laboratory employees regarding the commercial potential of laboratory technology and innovations …

While not an amendment to the Stevenson-Wydler Act, technology transfer from federal laboratories was also emphasized in *U.S. Technology Policy*, issued by President George H. W. Bush in 1990 (Executive Office of the President, 1990, pp. 1–6)[4]:

> A nation's technology policy is based on broad principles that govern the allocation of technological resources … The goal of U.S. technology policy is to make the best use of technology in achieving the national goals of improved quality of life for Americans, contained economic growth, and national security … While the government plays a critical role in establishing an economic environment to encourage innovation, the private sector has the principal role in identifying and utilizing technologies for commercial products and processes … Government policies can help establish a favorable environment for private industry [by improving] the transfer of Federal laboratories' R&D results to the private sector [and by expediting] the diffusion of the results of Federally-conducted R&D to industry, including licensing of inventions …

Finally, the National Technology Transfer and Advancement Act of 1995 (Public Law 104-113) strengthened the purpose of the Stevenson-Wydler Act:

> Bringing technology and industrial innovation to the marketplace is central to the economic, environmental, and social well-being of the people of the United States.

---

[2] A detailed discussion of the amendments to the Stevenson-Wydler Act is in Link and Oliver (2020). See footnote 10 below.

[3] As Link, Siegel and van Fleet (2011) showed for Sandia National Laboratories and for the National Institute of Standards and Technology (NIST), patenting activity did not increase in response to the Stevenson-Wydler Act. Patenting activity did increase after the passage of the Federal Technology Transfer Act, which included the following guideline: "The head of the agency or his designee shall pay at least 15 percent of the royalties or other income the agency receives on account of any [patented] invention to the inventor (or co-inventors) if the inventor (or each such co-inventor) was an employee of the agency at the time the invention was made."

[4] Arguably, *U.S. Technology Policy* is the first complete U.S. statement on technology policy since the productivity slowdowns.

Surprisingly, the academic and policy literatures related to technology transfer from federal laboratories is limited, perhaps due to laboratory imposed access barriers to information about mechanisms and metrics associated with technology transfer activities.[5,6] However, limited information about the technology transfer activities of federal laboratories, aggregated to the federal agency level, is available through agency technology transfer reports submitted annually to the Technology Partnerships Office (TPO) at NIST.[7] The available information has only begun to be studied systematically.[8]

The remainder of this chapter is outlined as follows. In Sect. 3.2, selected technology transfer mechanisms are described as a step toward understanding and quantifying the technology transfer process in a federal laboratory. In Sect. 3.3, an empirical model is presented; the model is used to quantify specific relationships within the technology transfer process. In Sect. 3.4, the federal agency data used to estimate the model are described. The empirical results from the estimation of the model are presented and discussed in Sect. 3.5. The chapter concludes in Sect. 3.6 with qualifying remarks about the statistical findings presented in this chapter along with a suggested roadmap for future research.

3.2 Technology Transfer Mechanism

Renewed research and policy attention to technology transfer activities in federal laboratories was initiated through President Barrack Obama's 2011 *Presidential Memorandum—Accelerating Technology Transfer and Commercialization of Federal Research Support of High Growth Businesses*[9]:

> Innovation fuels economic growth, the creation of new industries, companies, jobs, products and services, and the global competitiveness of U.S. industries. One driver of successful innovation is technology transfer, in which the private sector adapts Federal research for use in the marketplace... I direct that [Federal laboratories] establish goals and measure performance, streamline administrative processes, and facilitate local and regional partnerships in order to accelerate technology transfer and support private sector commercialization.

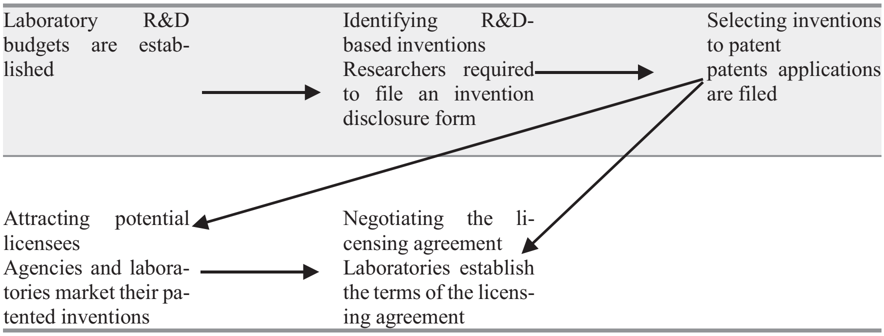
[5] Research access barriers exist even when technology transfer studies are commissioned by NIST. See the related discussion in RTI International (2019).

[6] The relevant academic and policy literatures related to technology transfer in federal laboratories is reviewed in Link and Oliver (2020).

[7] These annual reports are required under the Technology Transfer Commercialization Act of 2000 (Public Law 106-404).

[8] One of the first systematic efforts to study technology transfer in federal laboratories using these data is by Link and Oliver (2020).

[9] The Board on Science and Technology Policy at the National Academies (the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine) recently commissioned a study on Advancing Commercialization from the Federal Laboratories. See, https://sites.nationalacademies.org/PGA/step/PGA_191994.



Source: Based on GAO (2018, p. 11).

Fig. 3.1 Elements of the Technology Transfer Process in a Federal Laboratory. (Source: Based on GAO (2018, p. 11))

Building on the theme of President Obama's *Memorandum*, President Donald Trump, in his *The President's Management Agenda* (Trump, undated, p. 47), set forth the goal to: "Improve the transfer of technology from federally funded research and development to the private sector to promote U.S. economic growth and national security" for modernizing government for the twenty-first Century. Specifically, (p. 47):

> For America to maintain its position as the leader in global innovation, bring products to market more quickly, grow the economy, and maintain a strong national security innovation base, it is essential to optimize technology transfer and support programs to increase the return on investment (ROI) from federally funded R&D.

Of course, to embrace these presidential initiatives from a research as well as from a policy perspective, and to identify the outcomes associated with the Stevenson-Wydler Act and its amendments, the process of technology transfer in a federal laboratory must first be understood.[10] The shaded areas in Fig. 3.1, which are based on the U.S. Congressional Budget Office (CBO) description of key elements of the technology transfer from federal laboratories, highlight the portions of the technology transfer process in a federal laboratory that are relevant to this study; we refer to these shaded areas as representing the internal [my emphasis] portion of the technology transfer process.[11]

---

[10] Relevant amendments to the Stevenson-Wydler Act are, according to Schacht (2012): the Federal Technology Transfer Act of 1986 (Public Law 99-502), the 1988 Omnibus Trade and Competitiveness Act (Public Law 100-418), the 1990 Department of Defense Authorization Act (Public Law 101-189), the National Defense Authorization Act for FY1991 (Public Law 101-510), the 1996 Technology Transfer Improvements and Advancement Act (Public Law 104-113), and the Technology Transfer Commercialization Act of 2000 (Public Law 106-404).

[11] The GAO illustration of elements of the technology transfer process is intended to emphasize licensing agreements. However, regardless of the output of the technology transfer process being emphasized, the internal portion will be similar if not identical to what we have shaded in the Fig. 3.1.

Simply, the technology transfer process beings with the laboratory's investments in research and development (R&D), and some of the results from R&D become inventions (as well as other knowledge-based outputs, such as publications) that are formally disclosed to the laboratory's technology transfer office (TTO) through an invention disclosure form. An invention disclosure form is a vehicle through which the laboratory collects information pertaining to inventions created by the federal and non-federal employees who created an invention using laboratory facilities.[12]

In an ideal world, as described by Fig. 3.1, the technology transfer process begins with R&D, and then the rest of the process is based on disclosed inventions. Namely: *R&D → Invention disclosures → Patent applications → Patents awarded → Patents licensed*.[13] The *R&D → Invention disclosures → Patent applications* portions of this process, as shown in the shaded areas in Fig. 3.1, are laboratory specific, meaning that they are internal to the federal laboratory.

The *Patents awarded → Patents licensed* portion of the process involves the *external* [my emphasis] portion of the technology transfer process. I refer to this as the external portion because it is influenced by activities external to the laboratory, such as the infrastructure of the U.S. Patent and Trademark Office (USPTO), changes in patenting regulations, as well as the cyclical nature of market demand for laboratory-based patented technology.

While a laboratory's R&D budget is the motivating force behind the technology transfer process as described throughout Fig. 3.1, the genesis element of the process is the transition from R&D activity to invention disclosures. Absent invention disclosures, there will not be patent applications,[14] and absent patent applications, there will not be licensable patents issued, which are the technology transfer vehicle emphasized in Fig. 3.1.[15]

Thus, as previously stated, the purpose of this chapter is to quantify the laboratory-specific internal portion of the technology transfer model in Fig. 3.1, for the purpose of emphasizing the policy importance of understanding both the *R&D → Invention disclosures* relationship and the *Invention disclosures → Patent applications* relationship. To date, these internal processes have not been systematically quantified across the federal laboratories in U.S. agencies.[16]

---

[12] "The collection of this information is required to protect the United States rights to inventions created using Federal resources. The information collected on the form allows the Government to determine: (1) If an invention has been created; (2) the status of any statutory bar that pertains to the potential invention or that may pertain to the invention in the future. The information collected may allow the Government to begin a patent application process." See, https://www.federalregister.gov/documents/2019/08/07/2019-16882/proposed-information-collection-nist-invention-disclosure-and-inventor-information-collection.

[13] It is not unusual for the licensing process to begin at the patent application stage.

[14] The Stevenson-Wydler Act required federal laboratories to establish invention reporting practices.

[15] Another important technology transfer mechanism, although not shown in Fig. 3.1, is CRADAs (Cooperative Research And Development Agreements), and patent applications can result from CRADAs. See, Chen, Link, and Oliver (2018).

[16] See Link (2019) for an initial empirical study of the relationship among elements of the technology transfer process relevant to one federal laboratory, NIST.

3.3 Empirical Model

The empirical model considered in this chapter is based on the internal laboratory relationships shown in the shaded areas in Fig. 3.1. The first is the *R&D → Invention disclosures* relationship and the second is the *Invention disclosures → Patent applications* relationships. Consider a model of inventions disclosures within a federal laboratory of the form:

$$\textit{Invention disclosures} = \mathrm{f}\left(HC, TC\right) \tag{3.1}$$

where *HC* refers to human capital, and *TC* refers to technical capital. A reduced form of Eq. (3.1) is:

$$\textit{Invention disclosures per 100 scientists} = \mathrm{F}\left(TC\right) \tag{3.2}$$

where the variable *Scientists* is used to approximate *HC*, and the functional form of f (·) need not be the same as F (·). As previously mentioned, and as discussed in the following section of this chapter, the available data on technology transfer in federal laboratories are laboratory data aggregated to the agency level. Using agency-level metrics, Eq. (3.2) might be expressed as:

$$\textit{Invention disclosures per 100 scientists} = \mathrm{F}\left(R\,\&\,D \textit{ per 100 scientists}, X\right) \tag{3.3}$$

where the variable *R&D per 100 scientists* approximates *TC* and where vector **X** includes agency fixed effects.[17] And along with Eq. (3.4), the second component of the internal laboratory relationship might be expressed as:

$$\textit{Patent applications per 100 scientists} = \mathrm{F}\begin{pmatrix} \textit{Invention disclosures} \\ \text{per 100 scientists, X} \end{pmatrix} \tag{3.4}$$

3.4 Data and Descriptive Statistics

The TPO at NIST assembles each agency's annual technology transfer report into a composite annual report entitled *[Fiscal Year]: Summary Report to the President and the Congress*.[18] From these annual reports, agency data are available on *Invention disclosures* and *Patent applications* by fiscal year (FY). Data on these two

[17] There could be portions of *TC* that are not related to the laboratory's R&D budget, and part of the R&D budget may include investments in *HC*. Imprecisions associated with the measures of *HC* and *TC* used to estimate these two equations are discussed.

[18] See, https://www.nist.gov/tpo/reports-and-publications.

Table 3.1 *R&D budgets* (millions $2019) by fiscal year and by agency

Agency	DOD	DOE	HHS	NASA
FY 2003	80,788	11,518	37,735	14,553
FY 2004	87,749	11,593	37,949	14,375
FY 2005	90,731	11,130	37,665	13,710
FY 2006	92,946	10,740	36,253	14,131
FY 2007	96,230	11,004	36,077	14,106
FY 2008	96,856	11,657	34,904	13,345
FY 2009	96,124	12,152	36,639	10,367
FY 2010	96,963	12,674	37,144	10,833
FY 2011	90,720	12,239	35,758	10,434
FY 2012	83,798	12,167	35,310	12,734
FY 2013	72,426	11,829	32,933	12,154
FY 2014	72,097	13,002	33,248	12,742
FY 2015	71,253	15,407	32,322	12,224
FY 2016	77,264	15,927	34,025	14,086

Source: https://www.aaas.org/programs/r-d-budget-and-policy/historical-trends-federal-rd#

technology transfer metrics are available from FY 2003 through FY 2016 for each of 11 agencies.[19] However, there are four agencies that are R&D and invention disclosure intensive: the Department of Defense (DOD), Department of Energy (DOE), Health and Human Services (HHS), and National Aeronautics and Space Administration (NASA). These four agencies accounted for an average of just over 91 percent of all agency R&D and nearly 92 percent of all agency invention disclosures—the key variables in Fig. 3.1 and in the analysis that follows—over the FY 2003 through FY 2016 time period.

The data on *R&D* used in this chapter are shown in Table 3.1, the data on *Invention disclosures* are in Table 3.2, the data on *Scientists* are in Table 3.3, and the data on *Patent applications* are in Table 3.4.

Table 3.5 provides a definition of how the variables in Eqs. (3.3) and (3.4) are measured. Descriptive statistics on these variables are in Table 3.6.

[19] These agencies are U.S. Department of Agriculture, Department of Commerce, Department of Defense, Department of Energy, Health and Human Services, Department of Homeland Security (data are available for limited years), Department of Interior, Department of Transportation, Department of Veterans Affairs, Environmental Protection Agency, and National Aeronautics and Space Administration.

Table 3.2 *Invention disclosures* by fiscal year and by agency

Agency	DOD	DOE	HHS	NASA
FY 2003	1332	1469	472	1485
FY 2004	1369	1617	461	1612
FY 2005	534	1776	452	1682
FY 2006	1056	1694	442	1749
FY 2007	838	1575	447	1514
FY 2008	1018	1460	437	1324
FY 2009	831	1439	353	1412
FY 2010	698	1616	337	1735
FY 2011	929	1820	351	1748
FY 2012	1078	1661	352	1656
FY 2013	1032	1796	320	1627
FY 2014	963	1588	351	1701
FY 2015	781	1645	321	1550
FY 2016	874	1760	320	1554

Source: https://www.nist.gov/tpo/reports-and-publications

Table 3.3 *Scientists* by fiscal year and by agency

Agency	DOD	DOE	HHS	NASA
FY 2003	8993	4880	12,137	11,017
FY 2004	8627	4747	11,967	11,355
FY 2005	8768	4663	11,771	11,173
FY 2006	8662	4562	11,558	11,109
FY 2007	8962	4502	11,571	11,244
FY 2008	9042	4634	11,909	11,485
FY 2009	9640	4763	12,620	11,555
FY 2010	10,701	4928	13,246	11,751
FY 2011	11,171	4877	13,546	11,821
FY 2012	11,571	4731	13,676	11,594
FY 2013	11,759	4629	13,861	11,564
FY 2014	12,009	4476	13,988	11,430
FY 2015	11,935	4501	14,311	11,214
FY 2016	12,636	4559	16,566	11,191

Source: https://www.fedscope.opm.gov/employment.asp

3.5 Data and Descriptive Statistics

The regression results from the separate estimation of Eqs. (3.3) and (3.4) are in Table 3.7; the regression results from estimating Eqs. (3.3) and (3.4) as a system are in Table 3.8.[20] The variables enter the models as natural logarithms so that the slope coefficients can be interpreted as elasticities.

[20] In separate regressions, we estimated equations (3.3) and (3.4) using data for the deleted seven agencies. Collectively, they represent less than 10% of the R&D in federal laboratories. The models do not hold for these agencies. These results are available from the author on request.

Table 3.4 *Patent applications* by fiscal year and by agency

Agency	DOD	DOE	HHS	NASA
FY 2003	810	866	279	231
FY 2004	517	661	216	207
FY 2005	354	812	230	209
FY 2006	691	726	166	142
FY 2007	597	693	261	127
FY 2008	590	904	164	122
FY 2009	690	775	284	141
FY 2010	436	965	291	150
FY 2011	844	868	272	128
FY 2012	1013	780	233	130
FY 2013	942	944	230	150
FY 2014	916	1144	216	140
FY 2015	884	949	222	129
FY 2016	941	999	269	129

Source: https://www.nist.gov/tpo/reports-and-publications

Table 3.5 Definition of the variables in Eqs. (3.3) and (3.4)

Variable	Definition
Invention disclosures	The number of invention disclosures per fiscal year by agency as reported by the Technology Partnerships Office at NIST; see Table 3.2.
Scientists	The number of STEM occupation employees per fiscal year by agency, measured in hundreds, as reported by the Office of Personnel Management; see Table 3.3.
R&D	The R&D budget per fiscal year by agency, measured in millions $2019, as reported by the American Association for the Advancement of Science; see Table 3.1.
Patent applications	The number of patent applications per fiscal year by agency as reported by the Technology Partnerships Office at NIST; see Table 3.4.
Agency controls	Binary variables for DOD, DOE, and HHS; NASA fixed effects are captured in the intercept term.
FY	The fiscal year (FY) count variable; accounts for time trends.
Recession	Equals 1 for the years of the Great Recession (FY 2007 – FY 2010), and 0 otherwise

Notes: STEM occupation employees are those employees in an agency who are trained and working in the fields of Science, Technology, Engineering, and Mathematics. The variables *Invention disclosures per Scientists*, *R&D per Scientists*, and *Patent applications per Scientists* are measured as natural logarithms

The OLS regression results from Eq. (3.3) are reported in column (1) of Table 3.7. They suggest that a 10 percent increase in the R&D intensity of an agency, that is in *R&D per 100 scientists*, is associated with a 4.63 percent increase in *Invention disclosures per 100 scientists*. R&D investments fuel scientific creativity as measured by invention disclosures. The results from Eq. (3.4) are in column (2) of Table 3.7. They suggest that a 10 percent increase in *Invention disclosures per 100 scientists* is

Table 3.6 Descriptive statistics on the variables in Eqs. (3.3) and (3.4) by agency mean, (standard deviation), [maximum, minimum]

Variable	Agency			
	DOD (n = 14)	DOE (n = 14)	HHS (n = 14)	NASA (n = 14)
Invention disclosure	952.36 (225.08) [534, 1369]	1636.86 (124.95) [1439, 1820]	386.86 (60.04) [320, 472]	1596.36 (130.04) [1324, 1749]
Scientists (00s)	103.20 (14.95) [86.27, 126.36]	46.75 (1.51) [44,76, 49.28]	130.52 (14.06) [115.58, 165.66]	113.93 (2.46) [110.17, 118.21]
R&D	86138.93 (9783.18) [71,253, 96,963]	12359.93 (1535.81) [10,740, 15,927]	35568.71 (1858.62) [32,322, 37,949]	12842.43 (1465.71) [10,367, 14,553]
Patent applications	730.36 (207.71) [354, 1013]	863.29 (132.79) [661, 1144]	238.07 (40.47) [164, 291]	152.50 (35.66) [122, 231]

Note: The variable *Scientists* is measured in 100s of STEM occupation employees

Table 3.7 OLS regression results from Eqs. (3.3) and (3.4), n = 56 (standard errors in parentheses)

Variable	(1) ln(*Invention disclosures per 100 scientists*)	(2) ln(*Patent applications per 100 scientists*)	(3) ln(*Patent applications per 100 scientists*)	(4) ln(*Patent applications per 100 scientists*)
ln(*R&D per 100 scientists*)	0.4630 (0.1787)[a]	--	−0.1034 (0.2298)	0.1386 (0.2092)
ln(*Invention disclosures per 100 scientists*)	--	0.4397[b] (0.1578)	0.4672[b] (0.1699)	--
DOD	−1.3569[b] (0.3662)	1.8483[b] (0.1095)	2.0673[b] (0.4983)	1.01852[b] (0.4292)
DOE	0.5166[b] (0.1697)	2.2284[b] (0.1688)	2.2911[b] (0.2212)	2.5224[b] (0.1968)
HHS	−1.9689[b] (0.1739)	1.0135[b] (0.2611)	1.1476[b] (0.3957)	0.2119 (0.0254)
FY	−0.0159[a] (0.0070)	0.0039 (0.0085)	0.0029 (0.0089)	−0.0028 (0.0085)
Recession	−0.0646 (0.0624)	−0.0424 (0.0775)	−0.0372 (0.0790)	−0.0706 (0.0789)
Intercept	31.8936[a] (14.4417)	−8.6330 (17.3201)	−6.2382 (18.2696)	5.1997 (17.4662)
R-squared	0.9711	0.9731	0.9732	0.9690

Notes: NASA fixed effects are captured in the intercept term
[a]Significant at.05-level
[b]Significant at.01-level

Table 3.8 2SLS regression results from Eqs. (3.3) and (3.4) estimated as a system, n = 56 (standard errors in parentheses)

Variable	(1) ln(*Invention disclosures per 100 scientists*)	(2) ln(*Patent applications per 100 scientists*)
ln(*R&D per 100 scientists*)	0.4704 (0.1562)[a]	--
ln(*Invention disclosures per 100 scientists*)	--	0.3229[b] (0.1546)
DOD	−1.3785[a] (0.3201)	1.7925[a] (0.1007)
DOE	0.5154[a] (0.1478)	2.3397[a] (0.1605)
HHS	−1.9676[a] (0.1535)	0.8242[a] (0.2522)
FY	−0.0158[b] (0.0063)	0.0040 (0.0076)
Recession	−0.0629 (0.0566)	−0.0472 (0.0665)
Intercept	32.1115[b] (12.9723)	−8.5663 (15.6137)
F-level	261.76[a]	262.98[a]
R-squared	0.9698	0.9699

Notes: NASA fixed effects are captured in the intercept term
[a]Significant at.01-level
[b]Significant at.05-level

associated with a 4.40 percent increase in *Patent applications per scientists*. Not all inventions disclosed to a laboratory's TTO, as shown in Fig. 3.1, are selected for patenting.[21] The empirical results from Eqs. (3.3) and (3.4), reported in Table 3.7, together suggest that a 10 percent increase in *R&D per 100 scientists* is associated with a 2.04 percent increase in *Patent applications per 100 scientists*.[22] The regression results in column (3) and column (4) in Table 3.7 show that there is not, in the specifications considered, a direct relationship from *R&D* → *Patent applications*

[21] Choudhry and Ponzio (2020) suggested a new technology transfer metric for federal agencies to consider, namely, a Filing Ratio. Their Filing Ratio for an agency equals the number of new patent applications divided by the number of new inventions disclosed for a given period of time. Link and Oliver (2020) estimated a Filing Ratio for the four agencies considered in this chapter over the period of FY 2008 though FY 2015. Link and Oliver report the following: DOD = 0.862, DOE = 0.564, HHS = 0.678, and NASA = 0.085.

[22] Since a 10% increase in *R&D per 100 scientists* is associated with a 4.63% increase *in Invention disclosures per 100 scientists*, and since a 10% increase in *Invention disclosures per 100 scientists* is associated with a 4.40% increase in *Patent applications per 100 scientists*, then a 10% increase in *R&D per scientists* is associated with a 2.04% ((4.63 × 4.40)/10) increase in *Patent applications per 100 scientists*.

among the laboratories in the four agencies studied. The estimated coefficient on *R&D per 100 scientists* is not statistically significant in either equation.

The regression results from estimating Eqs. (3.3) and (3.4) as a system are in Table 3.8. The 2SLS regression results suggest that a 10 percent increase in the R&D intensity of an agency, that is in *R&D per 100 scientists*, is associated with a 4.70 percent increase in *Invention disclosures per 100 scientists*. The results from Eq. (3.4) suggest that a 10 percent increase in *Invention disclosures per 100 scientists* is associated with a 3.23 percent increase in *Patent applications per scientists*. Together, the empirical results from Eqs. (3.3) and (3.4) suggest that a 10 percent increase in *R&D per 100 scientists* is associated with a 1.52 percent increase in *Patent applications per 100 scientists*.[23]

Other variables in Eqs. (3.3) and (3.4) are agency fixed effect controls to account for agency differences in emphasis on technology transfer per se, a fiscal year (*FY*) variable to control for trend and autoregressive patterns, and a variable to control for recessionary (*Recession*) effects on scientific activities including budgets.

3.6 Conclusions

Patent applications by a laboratory are, based on the results presented in Table 3.7 and Table 3.8, a prerequisite for patents issued to a laboratory and in some instances a prerequisite to patent licenses. It is through the patent licensing process that federal laboratory technologies are transferred to private sector firms and/or public sector organizations as shown in Fig. 3.1. Thus, quantifying the path from R&D spending to patent application not only informs public policy but also emphasizes the quantitative importance of such networks.

For example, if technology transfer from federal laboratories is to continue to increase over time, as is important for national economic growth, then it is necessary for invention disclosures to continue to increase over time. And, for invention disclosures to continue to increase over time, R&D funding must also continue to increase over time. If R&D funding to a laboratory does not increase over time, that is if the resources requisite for new scientific ideas as reflected through new invention disclosures do not increase over time, then eventually technology transfer efforts might stagnate or even decline.[24,25]

[23] Since a 10% increase in *R&D per 100 scientists* is associated with a 4.70% increase *in Invention disclosures per 100 scientists*, and since a 10% increase in *Invention disclosures per 100 scientists* is associated with a 3.23% increase in *Patent applications per 100 scientists*, then a 10% increase in *R&D per scientists* is associated with a 1.52% ((4.70 × 3.23)/10) increase in *Patent applications per 100 scientists*.

[24] Recall that President Obama's 2011 Memorandum called for "accelerating technology transfer."

[25] New invention disclosures might decline even in the absence of continued or even increasing R&D. Bloom et al. (2020, p. 1138) make the point through examples, although mostly from the

As obvious as this argument in support of continued R&D funding in federal laboratories is, one should be cautious in generalizing from the quantitative findings presented in this chapter. The data studied in this chapter represent federal laboratory activity aggregated to the agency level. Each federal laboratory is unique in its mission, and it is unique in the manner in which its TTO is organized to determine patenting priorities. Thus, one should not expect that the quantitative relationships presented in Tables 3.7 and 3.8 will hold for each individual laboratory. Also, the strength of the relationships considered in this chapter are dependent on the reduced form specification for Eqs. (3.3) and (3.4). Additional research to develop and estimate structural models is certainly warranted and encouraged.

In addition, available technology transfer metrics have not been precisely measured, and not all relevant variables that support the technology transfer process are even available. The only measure of an agency's technical capital (*TC*) is its R&D budget, and embodied in an R&D budget are expenditures for scientists. Thus, R&D budget data overstate relevant *TC*, and accordingly, human capital (*HC*) is somewhat double counted.[26] Caveats aside, the statistical analysis in this chapter does emphasize the need for additional academic and policy research on the role of R&D and on the role of invention disclosures (i.e., scientific creativity) in federal laboratories.

Laboratory specific information on technology transfer metrics is difficult to obtain as documented in the recent study of laboratory technology transfer activity by RTI International (2019) under the sponsorship of NIST. Thus, future research related to technology transfer in federal laboratories might proceed through interview-based case studies. Excellent examples of such an interview approach are described in IDA (2013a, b).[27]

Acknowledgments The author thanks Michael Hall (National Institute of Standards and Technology, NIST), John Scott (Dartmouth College), and Chris Swann (University of North Carolina at Greensboro) for their helpful comments and suggestions on earlier versions of this chapter. Any remaining shortcomings are our own.

References

Bloom, N., Jones, C. I., Van Reenen, J., & Webb, M. (2020). Are ideas getting harder to find? *American Economic Review, 110*, 1104–1144.

Bozeman, B., & Link, A. N. (2015). Toward an assessment of impacts from U.S. technology and innovation policies. *Science and Public Policy, 43*, 369–376.

Carter, President Jimmy. (1979). *Joint hearings before the U.S. Senate Committee on Commerce, Science, and Transportation and the select committee on small business and to the U.S. House*

private sector, that good ideas are becoming harder to find, and they conclude that: "[o]ur robust finding is that research productivity is falling sharply everywhere we look."

[26] See Link and Scott (2019a, b) for an illustration of this fact for NIST.

[27] See also, Link and Scott (2019c).

of Representatives Committee on Science and Technology and the Committee on Small Business. Washington, DC: Government Printing Office.

Chen, C., Link, A. N., & Oliver, Z. T. (2018). U.S. federal laboratories and their research partners: A quantitative case study. *Scientometrics, 115*, 501–517.

Choudhry, V., & Ponzio, T. A. (2020). Modernizing federal technology transfer metrics. *Journal of Technology Transfer, 45*, 544–559.

Executive Office of the President (1990). *U.S. technology policy*. Office of Science and Technology Policy, Washington, DC.

Government Accounting Office (GAO). (2018). *FEDERAL RESEARCH: Additional actions needed to improve licensing of patented laboratory inventions. Report to the Chairman, Committee on the Judiciary, House of Representatives, GAO-18-327*. Washington, DC: Government Accounting Office.

Institute for Defense Analysis (IDA). (2013a). *Exemplar practices for Department of Defense Technology Transfer, IDA Paper P-4957*. Alexandria, VA: Institute for Defense Analysis.

Institute for Defense Analysis (IDA). (2013b). *Expediting the transfer of technology from government laboratories into the aeronautics industry, IDA Paper P-4952*. Alexandria, VA: Institute for Defense Analysis.

Leyden, D. P., & Link, A. N. (2015). *Public sector entrepreneurship: U.S. technology and innovation policy*. New York: Oxford University Press.

Link, A. N. (2019). Technology transfer at the U.S. National Institute of Standards and Technology. *Science and Public Policy, 46*, 906–912.

Link, A. N., & Oliver, Z. T. (2020). *Technology transfer and U.S. public sector innovation*. Northampton, MA: Edward Elgar Publisher.

Link, A. N., & Scott, J. T. (2019a). Creativity-enhancing technological change in the production of scientific knowledge. *Economics of Innovation and New Technology, 29*, 489–500.

Link, A. N. & Scott, J. T. (2019b). Technological change in the production of new scientific knowledge: A second look. *Economics of Innovation and New Technology*. https://doi.org/10.1080/10438599.2019.1705004.

Link, A. N., & Scott, J. T. (2019c). The economic benefits of technology transfer from U.S. federal laboratories. *Journal of Technology Transfer, 44*, 1416–1426.

Link, A. N., Siegel, D. S., & van Fleet, D. D. (2011). Public science and public innovation: Assessing the relationship between patenting at U.S. national laboratories and the Bayh-Dole Act. *Research Policy, 40*, 1094–1099.

Obama, President Barack. (2011). *Presidential memorandum – accelerating technology transfer and commercialization of federal research in support of high-growth businesses*. Washington, DC: The White House.

RTI International. (2019). *Overview and analysis of technology transfer from federal agencies and laboratories*. Research Triangle Park: RTI International.

Schacht, W. H. (2012). *Technology transfer: Use of federally funded research and development*. Washington, DC: Congressional Research Service.

Trump, President Donald. (undated). *The President's management agenda*. https://www.whitehouse.gov/omb/management/pma/.

Part III

Empirical Evidence in Latin America and the Caribbean

Maribel Guerrero and David Urbano

"If you cannot measure it, you cannot improve it."

– Peter Drucker

We have observed a special interest in the configuration of entrepreneurial and innovation ecosystems in the Latin American context over this decade (Guerrero et al. 2020). Although the public administrations' efforts for establishing technology transfer policy frameworks (e.g., intellectual property law or technology-based firms promotion in Argentina, Brazil, Chile, Colombia, and Mexico), the unique characteristics of the Latin American context have limited the convergence of intellectual capital, technology transfer, and entrepreneurship (Fischer et al. 2020). Concretely, the region's main challenge has been generating novel knowledge/technology that could be transferred/commercialized within the productive system. The lack of public information has been another challenge faced by researchers interested in these topics (Guerrero and Urbano 2017). It explains why little is known about the effectiveness of the implemented technology transfer policies in promoting entrepreneurial innovations in the Latin American context.

M. Guerrero (✉)
Facultad de Economía y Negocios, Universidad del Desarrollo, Santiago, Chile

Centre for Innovation Research (CIRCLE), Lund University, Lund, Sweden

Northumbria Centre for Innovation, Regional Transformation and Entrepreneurship (iNCITE), Newcastle Business School, Northumbria University, Newcastle upon Tyne, UK
e-mail: maribel.guerrero@northumbria.ac.uk

D. Urbano
Department of Business and Centre for Entrepreneurship and Social Innovation Research (CREIS), Universitat Autònoma de Barcelona, Bellaterra, Spain
e-mail: david.urbano@uab.cat

This part of the book contributes to this academic debate by providing quantitative and qualitative evidence about this phenomenon. Chapter 4 quantitatively provides insights about how narrow R&D policies, in conjunction with an entrepreneurial innovation ecosystem, positively affect the proxy of entrepreneurial innovations measured as the high ambitions innovative entrepreneurship activities from the Global Entrepreneurship Monitor (GEM). Chapters 5 and 6 discuss the retrospective evolution of determinants and outcomes of technology transfer policies implemented in Brazil and Chile. Both chapters highlight challenges and opportunities for entrepreneurs, academics, researchers, policymakers, and ecosystem agents.

This part of the book opens a window for debating technology policy frameworks' effectiveness, the particularities of entrepreneurial innovations across all Latin American countries, and the big sustainable challenges that will face this region given the current unexpected events (COVID-19 pandemic). We expect that these chapters inspire readers to continue evidencing and debating entrepreneurial innovations and technology transfer policy frameworks' effectiveness.

References

Fischer, B., Guerrero, M., Guimón, J., & Schaeffer, P. R. (2020). Knowledge transfer for frugal innovation: Where do entrepreneurial universities stand? *Journal of Knowledge Management*. https://doi.org/10.1108/JKM-01-2020-0040.

Guerrero, M., Urbano, D. (2017). The impact of Triple Helix agents on entrepreneurial innovations' performance: An inside look at enterprises located in an emerging economy. *Technological Forecasting and Social Change*, *119*, 294–309.

Guerrero, M., Liñán, F., & Cáceres-Carrasco, F. R. (2020). The influence of ecosystems on the entrepreneurship process: A comparison across developed and developing economies. *Small Business Economics*. https://doi.org/10.1007/s11187-020-00392-2.

Chapter 4
Ambitious Entrepreneurship and Its Relationship with R&D Policy in Latin American Countries

José Ernesto Amorós, Carlos Poblete, and Vesna Mandakovic

4.1 Introduction

Substantial evidence has suggested that economic growth not only depends on the dynamism of large companies, but also small and medium entrepreneurial enterprises play a key role for the economic and social development (Grilo and Thurik 2005; van Stel et al. 2005; Bowen and De Clercq 2008; Levie and Autio 2011). In this context, entrepreneurship as the engine of economic and social growth is related to a combination of individual and framework conditions such as education levels, business climate, and legal and political conditions (Bowen and De Clercq 2008; Sobel 2008). However, entrepreneurship is a highly heterogeneous phenomenon, where the economic and social contribution of different entrepreneurial ventures tends to differ drastically depending on the firm's features (Amorós et al. 2019b; Baumol 1990; Shane 2009). In this context, there are some entrepreneurs that commit their social and human capital to pursue business opportunities characterized by their level of innovation and novelty (Levie and Autio 2011). This group of entrepreneurs follows strategic decisions that include the *ambition* to become high-growth oriented and, at the same time innovative practices. Prior studies have suggested that these innovative-ambitious entrepreneurs impact their local environment positively, contributing to the overall economic welfare (Acs et al. 2008; Autio 2007). Within this study we argue that entrepreneurs' ambitions may be increased

J. E. Amorós (✉)
EGADE Business School, Tecnológico de Monterrey, Mexico City, Mexico

School of Business and Economics, Universidad del Desarrollo, Santiago, Chile
e-mail: amoros@tec.mx

C. Poblete · V. Mandakovic
School of Business and Economics, Universidad del Desarrollo, Santiago, Chile
e-mail: cpoblete@udd.cl; vmandakovic@udd.cl

M. Guerrero, D. Urbano (eds.), *Technology Transfer and Entrepreneurial Innovations*, International Studies in Entrepreneurship 51,
https://doi.org/10.1007/978-3-030-70022-5_4

through an institutional framework fostering effective R&D transfer, good quality of governmental interventions and innovation systems. This is a priority in the Latin American and Caribbean context (LAC), where the region must build resilience through strengthening fundamentals such as infrastructure, skills, and innovation—areas in which the region performs relatively poorly. Concretely, since R&D transfer increases the flow of information and market competitiveness, there is a reduction of advantages of the economy of scales allowing new ventures to enter. Therefore, technological developments trigger the reallocation of resources and the overall demand of entrepreneurs. Analogically, government interventions can play an active role in enhancing the effectiveness of R&D transfer, generating not only an increase in the type of entrepreneurial opportunities, but also in how entrepreneurs will pursue it.

Based on previous research (Amorós et al. 2019a; Guerrero and Urbano 2019), the main aim of this chapter is to explore the extent of the effectiveness of R&D transfer, government intervention, and pro-innovation mechanisms in the likelihood of being an entrepreneur with high ambitions of growing, in the particular context of LAC. Institutional economics is used as the conceptual framework of this study. In specific, we consider the quality of public policy and programs as formal institutions or "the rules of the game" (Baumol 1990). The case of LAC is interesting for several reasons. First, the rate of entrepreneurial activities is considerably higher than other "emerging economy" regions (i.e., Southern Asia, East Europe). Second, it is characterized by a particular institutional setting, which includes some of the largest economies in the world (Brazil and Mexico) and also some of the most notorious social and economic inequality (Aguinis et al. 2020; Messina and Silva 2017). Accordingly, scholars have pressed for a deeper understanding of the entrepreneurial activity in the region in order to provide concrete strategies for encouraging high-impact entrepreneurial activities. Our empirical exercise includes two levels of analysis. Hence, we use a hierarchical two-level model. The first one is on an individual-level that analyses the characteristics of early-stage entrepreneurs and the second is the country-year level variables, where the focus is put on the effectiveness of R&D transfer and policies that could enhance the individual propensity to be innovative-ambitious high-growth oriented entrepreneurs. The individual-level data comes from the Global Entrepreneurship Monitor (GEM) Adult Population Survey (APS) database. The APS covers a representative sample of the population (at least 2000 cases per year) in each participant country (Reynolds et al. 2005). We use data for 2006–2017, gathering 48,258 observations of early-stage entrepreneurs from 14 LAC countries. The country-year panel is unbalanced since not every country participated every year in the study. We complement the APS data with country-level data mainly from the World Economic Forum's Global Competitiveness Index, the World Bank Development Indicators and the National Expert Survey (NES) from GEM that also provides relevant information about effective R&D transfer mechanisms and policies that foster entrepreneurial innovation. To generate the dependent variable, we combine innovative and potential high-growth opportunity-driven early-stage entrepreneurs (innovative ambitious entrepreneur). It is particularly relevant in the case of LAC economies to consider only opportunity-driven

Total Entrepreneurial Activity (TEA) and not necessity-driven entrepreneurs, mainly because of the impact of economic fluctuations in unemployment that pushes individuals to engage into entrepreneurial activities (Mrożewski and Kratzer 2017). The independent variables at the national level include the evaluation of R&D expenditure, support policies for entrepreneurship, evaluation of the efficiency of technology transfer and subsidies.

This chapter provides new insights for research with both a theoretical and empirical approach. From the theoretical point of view, although studies about regulations as key elements of entrepreneurship are increasing, little research is based on institutional economics from emergent economies and specifically in the case of Latin America. From the practical perspective, the results could be very useful for the design of governmental policies and strategies to foster entrepreneurial spirit among society, distinguishing between the different levels of development between countries. The special emphasis on R&D in emergent countries of Latin America is a novelty approach that follows the call for more integrative research that uses institutional context applied to developing economies (Bruton et al. 2010, 2013).

The remainder of this chapter is outlined as follows. In Sect. 4.2, the theoretical framework to understand the phenomenon is described. In Sect. 4.3, the contextualization of R&D transfer in the Latin American countries is presented. In Sect. 4.4, an empirical model is presented. In Sect. 4.5, the empirical results are discussed. The chapter concludes in Sect. 4.6 with the conclusions and a suggested roadmap for future research.

4.2 Theoretical Framework

In this section, we will develop conceptual elements that are relevant to understand some formal mechanisms that may foster entrepreneurial dynamics from macro-institutional perspectives. Bruton et al. (2010) explain that entrepreneurs make their decisions based on the context in which they are involved. This is particularly relevant for developing economies, such as Latin America, where formal institutions constrain more than encourage the opportunity-based entrepreneurship dynamics (Aparicio et al. 2016). We want to put special emphasis on the role of R&D transfer, the governmental intervention and innovation systems in entrepreneurship.

4.2.1 The Role of R&D Transfer in Entrepreneurship

According to Verheul et al. (2002) a dual relationship can be found between technological advancement and entrepreneurship, where technological developments can act as a driving force of the demand for entrepreneurship (Wennekers and Thurik 1999), but also start-ups themselves can contribute by spreading and developing innovation (OECD 1996). Evidence suggests that R&D transfer can be favorable for small-scale production as technology contributes to making cheaper capital goods by making specialization more flexible (Piore and Sabel 1984; Carlsson 1989; Loveman and Sengenberger 1991). Furthermore, by transferring R&D, a process of creative destruction emerges, since information technology creates better access to information, leading to an increase in the competitiveness of established small businesses and start-ups (Audretsch and Caiazza 2016; Audretsch and Thurik 2001). Therefore, R&D transfer may induce a reallocation of resources towards new products (Verheul et al. 2002), leading to more intense demand for entrepreneurship (Casson 1995), which should increase the number of products in an early stage of their product life cycle (Klepper 1996; Klepper and Simons 2000).

Overall, technological developments lead to more dynamism in the economy, by making product life cycles shorter (Verheul et al. 2002). Consequently, small businesses are favored, in comparative terms with big established firms, since less advantage from economies of scale can be obtained. According to Verheul et al. (2002), economic dynamism entails risks that can be better absorbed by small businesses that easily adapt to new situations than large static businesses. Additionally, some mechanisms of R&D could be related to the availability of higher education institutions to transfer basic and applied research to the market. At the same time, the role of these institutions in terms of specific training new generations of entrepreneurs that have better technical and managerial competences could be very relevant in order to create better conditions for more dynamic and competitive new firms (Kantis et al. 2016a, b; Levie and Autio 2008; Martinez-Fierro et al. 2016).

4.2.2 The Role of Government Intervention in Entrepreneurship

Public policy has incentives to actively encourage the level of entrepreneurship inspired on the importance of the small business sector for economic growth and job creation (Acs et al. 2016; Storey 1998, 2016), although policymakers can also develop and foster entrepreneurship policies in response to an undesired economic phenomenon, such as unemployment and economic stagnation (Verheul et al. 2002). Evidence suggests that policies that seek to warrant quality entrepreneurship indirectly can create jobs, promote national and international competitiveness, economic development and growth (Mason and Brown 2013). The government can influence entrepreneurship both directly, through support policies, and indirectly by developing policies not directly aimed at influencing the level of entrepreneurship (Amorós et al. 2016a, b; Audretsch and Thurik 2001; De Koning and Snijders 1992; Storey 1998, 2016). For example, when stipulating a competition policy, the government can influence the market structure, which itself influences on the number and type of entrepreneurial opportunities (Verheul et al. 2002). Policy intervention in the economy may influence some determinants of the individual decision-making processes, and in that way indirectly co-determine, for example, business ownership. Indeed, government policies dealing with regulation of entry and privatization may influence opportunities to start a business. According to Verheul et al. (2002), fiscal incentives, subsidies, labor market regulation and bankruptcy legislation directly co-determine the net rewards and risks of the various occupational opportunities. Further, skills and knowledge of individuals can be influenced through consulting or education, which also may influence and change individuals' preferences (Levie and Autio 2008). Hence, the government can fulfill different roles in the economic and legal environment (Dau and Cuervo-Cazurra 2014; Valdez and Richardson 2013). Public policies fostering entrepreneurship can create a lawful framework in which the property rights of all market parties are guaranteed and protected or even correct certain aspects in case of market failure (Thai and Turkina 2014). By doing so, government intervention can influence the number and type of entrepreneurial opportunities, and also the number and type of potential entrepreneurs, by influencing the availability of resources, skills and knowledge of individuals, and also influencing the preferences of individuals (Amorós et al. 2019b).

4.2.3 The Role of Innovation in Entrepreneurship

Innovation is a key determinant of the benefits among entrepreneurial activity according to Schumpeter's seminal theory of entrepreneurship. This theory defines innovation as a new combination related to technological, marketing, and organizational aspects of the subject (Schumpeter 1934). Therefore, innovation refers to new goods or an improvement in the quality of goods, and a new or improved method of production. Schumpeter stated that through innovation, the economic system is driven away from the "neighborhood of equilibrium", where innovation itself is included from incremental improvements (i.e., new to a firm) to radical invention (i. e., new to the global market).

Since Schumpeter's theories and subsequent studies of the role of innovation on firm development (Winter 2006), the binomial relationship of innovation and entrepreneurship, constitutes an indissoluble and complementary link (Landström et al. 2015) that help understand many manifestations of competitive and dynamic entrepreneurship activity (Drucker 2006). Innovation is not only based on isolated activities because entrepreneurs interact with many actors within specific institutional settings (Malerba and McKelvey 2018). A relevant actor is governmental policy around innovation. Under the notion of National Systems of Innovation (Freeman 1987) entrepreneurs can be stimulated through central direction and explicit planning mainly by enhanced cooperation, communication, and feedback among various institutional actors. According to Autio et al. (2014), there are two main mechanisms to regulate and shape the quality of entrepreneurial innovation: selection effects and strategic choice effects. Selection effects operate through social legitimacy costs and opportunity costs created by the entry choice. Strategic choice effects drive post-entry situations, such as perceptions of feasibility and desirability. Therefore, in an institutional context, ultimately the influences are either pre-entry behaviors or post-entry behaviors. According Malerba and McKelvey (2018), entrepreneurship activities could be “affected by the complementarities in knowledge and capabilities of actors linked within innovation systems and relies upon existing and new networks and channels through which knowledge is communicated, shared or generated”. Examples of institutions that shape direction and potential rewards, including economic outcomes, are property protection, regulation of entry, the rule of law, among others. Regions which provide a set of entrepreneurial support networks (Leyden 2016; Kenney and Patton 2005) can influence on entrepreneurial behaviors; for example, the form of innovation pursued, in terms of radical or incremental innovation. These would push individuals to pursue faster growth and high expectations to compensate opportunity costs or even their ambition is the response to a collective institutional effort which nurtures individuals’ subjective value of innovation (Poblete 2018).

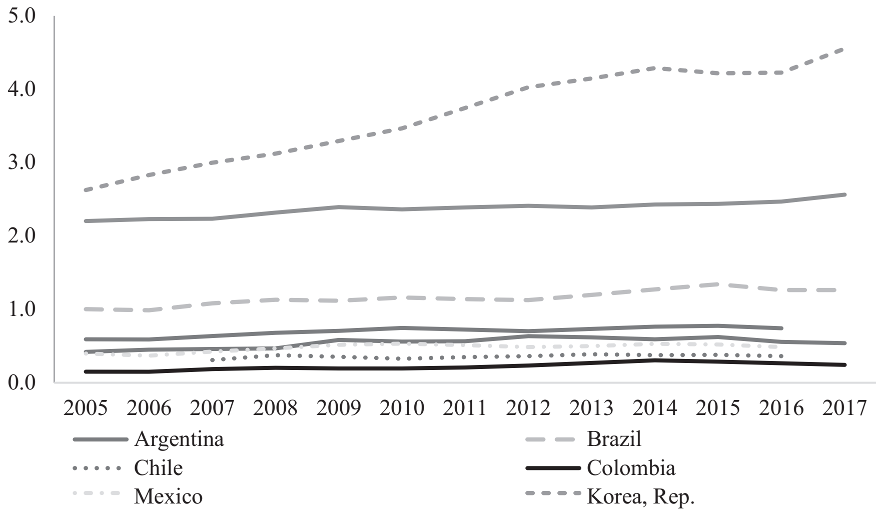
4.3 The Entrepreneurship Dynamics in Latin America Context

Latin America has experienced, on average, significant economic growth in the last two decades. However, the region has presented several socio-political fluctuations that have not allowed the consolidation of their development in a sustainable manner. In this scenario, one interesting question is, what is the role of entrepreneurship in LAC? Entrepreneurship, as the process through which new economic activities and organizations come into existence (Shane and Venkataraman 2000; McMullen and Dimov 2013; Wiklund et al. 2011), matters since it is a vital determinant of economic growth (Audretsch and Thurik 2001; Audretsch et al. 2001, 2002; Carree and Thurik 2005; Carree et al. 2002).

Within the GEM project, LAC countries have been characterized by high levels of entrepreneurial attitude (Kelley et al. 2011). An indicator of these generally positive attitudes is the percentage of the population reporting good opportunities to do business. While the fact still remains that recognition of opportunities does not necessarily conclude with the creation of new businesses, there is a positive correlation between the perception of opportunities in LAC countries and the number of people involved in entrepreneurial activity. However, although LAC countries have great potential to generate competitiveness and well-being through the creation of new businesses, in general, they have not been able to consolidate a more innovative entrepreneurial dynamic (Kantis 2005, Kantis et al. 2016a; Lederman et al. 2014). Indeed, the dynamism of new firms in LAC is smaller compared to other emerging regions, such as Southeast Asia, also the rate of necessity-based entrepreneurship is comparatively high (Kantis et al. 2004; Autio 2005, 2007; Minniti et al. 2006). It should be noted, though, that necessity-based entrepreneurs do not constitute a negative fact per se. Indeed, many weak institutional frameworks have created an informal lifestyle and the emergence of many “survival entrepreneurs” (de Soto 1989).

Similarly, poor environmental conditions could be a barrier to the subsequent growth of these new companies (Capelleras and Rabetino 2008). The lack of innovative new firms in the region could be linked to multiple factors, but the majority of them are directly or indirectly related to three main issues. First the disconnection of research and development with new venture creation that causes inappropriate mechanisms for technology and knowledge transfer, second and a consequence of the previous point, the scarce use of new technologies in the majority of new business models and ventures, and finally the lack of consistent policy and public programs that support innovative (technology-based) new firms. Some facts:

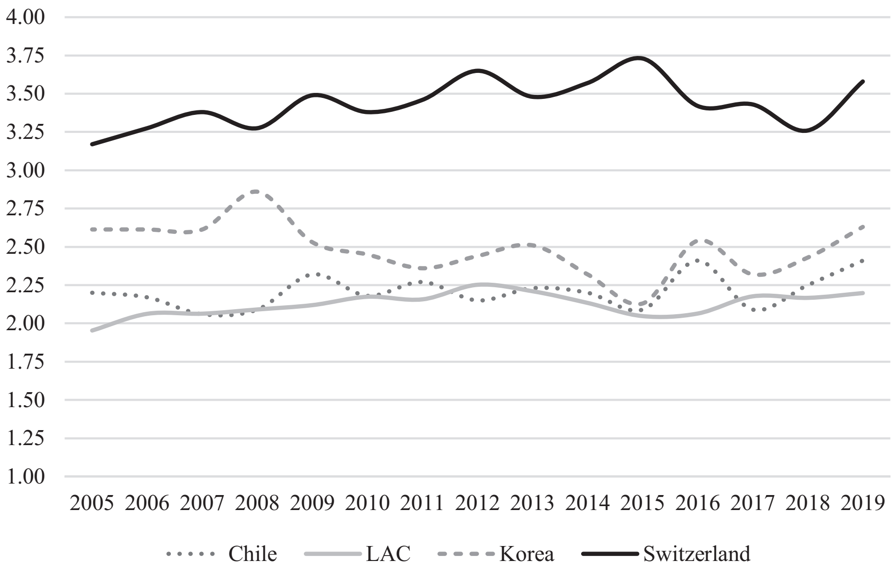
LAC countries do not invest in R&D at the same pace as other emergent and developed economies. Figure 4.1 illustrates a longitudinal series from 2005 to 2017 of the investment in R&D in percentage of GDP. Even Brazil having one of the largest ratios in the region with 1.3% of its GDP in R&D, is practically at the half of the investments when compared to the average of OECD countries. And very far from Korea that invests 4.6% of its GDP in R&D (2017 data). In average, LAC performs very poor in this indicator and other large economies of the region like Argentina, Chile, Colombia, or México have less than 0.6% of GDP investment in R&D. Additionally, many of the investments in R&D in LAC come from the public-governmental sector that could also be considered a market distortion because it is very "fuzzy" how this R&D could be allocated in new venture creation (Amorós, Fernández and Tapia 2012). This phenomenon, very present in emerging countries, including LAC ones -- with some notable exceptions, such as China, emphasizes that these economies do not have the internal conditions to develop a stronger entrepreneurship environment. Many of these countries lack of large and dynamic markets, the scientific infrastructure, the human capital, and the specialized industrial



Source: Authors

Fig. 4.1 Total expenditure of R&D as percentage of GDP (selected economies). (Source: Authors) clusters that typically attract more innovative new ventures and also foreign investments in R&D. LAC countries, in particular, have been struggling with attracting foreign R&D. This is reflected in a report of the United Nations Economic Commission for Latin America and the Caribbean, which found that in 2013 the region attracted only 3% of global R&D foreign direct investment projects, whereas China attracted 34%.

The fact that LAC countries perform relatively poorly in the dynamics of entrepreneurial competitiveness, but at the same time have a large number of entrepreneurs, can be perceived as a paradox (Amorós et al. 2012). Evidence suggests that other developed and emerging regions have transitioned from the stage of efficiency to the innovation-driven stage, characterized by the diffusion of knowledge, increased diversity between SMEs and large companies (Acs and Amorós 2008). For developed economies, new firms are crucial in terms of technological improvement and innovation (Porter et al. 2001), but new companies in most LAC countries have a small-scale production system and therefore have less relationship with innovation (Audretsch and Thurik 2004), consequently, the products and services they offer have lower added value compared to those of large companies (Kantis et al. 2004). In LAC, knowledge transfer mechanisms, including cooperation in R&D between small and emergent new firms and large established ones is very scarce. According to the opinion of key experts across different LAC countries, GEM data demonstrates that R&D transfer for entrepreneurship endeavors is one of the opportunity areas when it is compared with some other advanced economies. For example, Fig. 4.2 illustrates the GEM's evaluation of R&D transfer from 2005–2019



Source: Authors

Fig. 4.2 R&D transfer evaluation (1–5 Likert Scale). (Source: Authors) comparing average LAC countries, Chile the most competitive country in the region, South Korea (as we mentioned, one of the countries that invest more in R&D) and Switzerland (considered by the World Economic Forum, one of the most competitive economies in the world and leader on R&D). As we can see, in average the LAC region has an important gap in R&D cording qualitative evaluation of the experts.

On the other hand, the entrepreneurial aspirations of people involved in new venture creation in LAC countries reflect the qualitative nature of the business activity. For example, entrepreneurs have different aspirations regarding their business, such as the degree of innovation that their products or services will have, whether they will implement new productive processes, seek access to external markets or how to finance business growth. However, if these aspirations are fulfilled, they potentially can significantly affect the economic impact of these entrepreneurial activities. High levels of aspiration indicators prevail in many LAC countries, for example with respect to a certain level of innovation (relative innovation) of the products or services offered by entrepreneurs (Kelley et al. 2011). Precisely a very important part of these aspirations is related to the notion of ambitious entrepreneurship. Seminal work from David Birch in late 70s and subsequent empirical corroborations, demonstrate that pro-growth and dynamic firms are very relevant for job creation (Birch 1987). These types of new firms could have different definitions or approaches, but the recent literature highlights the relevance of growth aspiration (Reynolds et al. 2005) that is related with more strategic and competitive behavior (Levie and Autio 2011) and also relevant for the entire entrepreneurial eco-system (Stam 2015). In the context of LAC, these new firms also have a relevant role in regional development. As Kantis et al. (2016a, b) highlight, it is relevant not only to consider ex-post analyses of young firms that demonstrate their growth in terms of employees or revenue, but also include new ventures that have the genuine desire to grow. In addition, to examine what mechanisms are behind these ambitious entrepreneurs, it is very relevant to understand what conditions exist that could determine this behavior.

4.4 Methodology

4.4.1 Sample and Data Sources

Our empirical approach is based on a hierarchical structure model that has two levels of data analysis; individual and country-year level. We use individual-level data from the Global Entrepreneurship Monitor's (GEM), Adult Population Survey (APS) database. The APS covers a representative sample of the population (at least 2000 cases per year) in each participant country (Reynolds et al. 2005). We use longitudinal data from 2006–2017. The analysis includes an unbalanced panel of a final sample of 48,258 early-stage entrepreneurs from 14 countries from LAC. The

Table 4.1 Countries participating in the study

Country	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Argentina	x		x	x	x	x	x	x	x	x	x	x
Brazil	x	x	x	x	x	x	x	x	x	x	x	x
Chile		x	x	x	x	x	x	x	x	x	x	x
Colombia	x		x	x	x	x	x	x	x	x	x	x
Costa Rica					x		x		x			
Ecuador			x	x	x		x	x	x	x	x	x
El Salvador							x		x		x	
Guatemala				x	x	x		x	x	x	x	
Mexico	x		x		x	x	x	x	x		x	x
Panama				x		x	x	x	x	x	x	x
Peru						x	x	x	x	x	x	x
Puerto Rico								x	x	x		
Trinidad and Tobago					x	x	x	x	x			
Uruguay	x		x	x	x	x	x	x	x	x	x	x

Source: Authors

panel is unbalanced because not all countries participate every year, Table 4.1 shows the list of the countries participating each year.

Data for country-year variables were collected from different sources for the same period. We complement the APS data with country-level data from the, WEF's Global Competitiveness Index and GEM "National Expert Survey". Detailed definitions of the variables are next.

4.4.2 *Dependent Variable at the Individual Level: Innovative Ambitious Entrepreneurship*

Entrepreneurship literature highlights the relevance of perceived opportunities in the initial motivation of the individual (i.e., Dimov 2010; Levie and Autio 2011). One of the main indicators from GEMs'APS is the Early-Stage Entrepreneurial Activity, TEA.[1] This indicator permits the identification of the likelihood of an individual to be involved in the creation of a new firm. The individuals involved in TEA are classified in relation to their motivations to pursue entrepreneurial activities. One of these categories is the opportunity-based entrepreneurship (OPP), which comprises individuals who voluntarily undertake action to create a new venture to

[1] This index is based on the life cycle of the entrepreneurial process, which is divided into two periods: the first covers nascent entrepreneurs who have undertaken some action to create a new business in the past year but have not paid any salaries or wages in the last 3 months, and the second includes owners/managers of businesses that have paid wages and salaries for more than 3 months but less than 42 months (Bosma et al. 2009).

pursue perceived business opportunities. They have a "pull motive," such as gain independence or increase personal or family income, challenge, status, and recognition[2] (Reynolds et al. 2005). Because OPP (or the general TEA) could incorporate any type of entrepreneurial activity, including self-employment, this classification can involve low-growth or no-growth entrepreneurship. In the GEM data, nearly 50% of all start-up attempts do not expect to create any jobs within 5 years. High-potential entrepreneurs, in contrast, are typically individuals who face attractive employment choices in the labor market (Autio 2007). For high-potential entrepreneurs, the decision to start a business is a highly strategic choice between becoming an employee with a secure salary or being self-employed with a relative risk. Additionally, as stated previously in the conceptual framework, innovation plays an important role in developing more new competitive firms. Innovativeness is also considered part of the entrepreneurial orientation (Lumpkin and Dess 1996). Innovation helps new firms undertake some activities that are strongly related to better performance (Kreiser et al. 2013) and international orientation (Golovko and Valentini 2011). This is also very relevant to the Latin American context (Amorós et al. 2016a, b). Since the decisive element of creative labor is embodied in the entrepreneur, in other words, he or she acts as the personification of innovation.

Based on the previous argumentations, our dependent variable involves innovative ambitious entrepreneurial activities. We calculated it like a continuous variable based on individual-level data from GEM. This variable is a rescaled (1–6) sum of entrepreneur innovation perceptions about whether all of the potential customers consider that the entrepreneur's product or service is new and innovative (3 points scale); if there are no competitors offering the same services and/or products to potential customers (3 point scale) and the high-potential entrepreneurs that take value 1 for those respondents that being opportunity-based entrepreneurs also manifest their intention to hire or create 20 or more jobs within 5 years.

4.4.3 Country-Level Predictors

Country Innovation and Business Sophistication We use the indicators from the World Economic Forum's Global Competitiveness Index (GCI). GCI includes a weighted average of different components that measure different aspects of country-level competitiveness. These components are grouped into 12 categories called the pillars of competitiveness. We use the combination (average) of two indicators: the first is related to Business sophistication, that includes "elements that are intricately linked: the quality of a country's overall business networks and the quality of individual firms' operations and strategies" (WEF 2017), and second the innovation pillar. "Innovation is particularly important for economies as they approach the

[2] The opportunity-based entrepreneurs are defined by the criteria established by GEM methodology according to which they perceive themselves as "I'm in this start-up to take advantage of a business opportunity".

frontiers of knowledge, and the possibility of generating more value by merely integrating and adapting exogenous technologies tends to disappear." The GCI Innovation pillar includes measures about investment in research and development (R&D), the presence of high-quality scientific research institutions; collaboration in research and technological developments between universities and industries, and the protection of intellectual property. These indicators are measured in a scale from 1 to 7 where 7 is the best rate at the country level.

R&D expenditure we use total gross R&D expenditures (as % of GDP) of businesses and governments and to proxy the efforts in knowledge creation across countries, from the World Bank. Although R&D expenditure has always been directly linked and positively associated with innovation growth, notably in technological innovations (Lehmann and Seitz 2017).

Entrepreneurial framework conditions we use data from the GEM's National Expert Survey, NES (Reynolds et al. 2005). NES is part of the standard GEM methodology and is a source of harmonized, internationally comparable data that measures the environment for new and growing firms. The NES is carefully designed and refined to capture informed judgments of national, key informants regarding the status of several *entrepreneurial framework conditions* in their own economies.[3] These indicators are measured in a scale from 1 to 5 where 5 represents the best level of evaluation. For this study, we put emphasis in conditions that are linked to the effectiveness of technology transfer polices and legislation that fosters entrepreneurial innovations. Three particular questions answered by the experts:

Policy support towards entrepreneurs: In my country, the support for new and growing firms is a high priority for policy at the national government level

Government subsidies for new technology: In my country, there are adequate government subsidies for new and growing firms to acquire new technology

R&D transfer efficiency: In my country, new technology, science, and other knowledge are efficiently transferred from universities and public research centers to new and growing firms

4.4.4 Individual-Level Controls

International Orientation This variable is also based on GEM APS individual level data. This variable was coded with "1" for those respondents who declared to have more than 25% of their customers from outside their country. Otherwise were coded a value of "0".

[3] The NES is similar to other surveys that capture expert judgments to evaluate specific national conditions. For example, the WEF index uses similar surveys to construct its indices (Sala-i-Martin et al. 2010). For more details about NES methodology see www.gemconsortium.org.

Education The skill enhancing effect of education influences entrepreneurial activity: highly educated entrepreneurs will recognize more opportunities (Kwon and Arenius 2010; Guerrero et al. 2015). We use GEM APS data that categorizes individual level data about their education degrees from non-formal education to postgraduate degrees.

Gender Also taken from GEM, gender variable takes the value of "1" if the respondent is female and "0" if it is male. Cross-country studies on entrepreneurial behaviour have shown that early stage entrepreneurship varies significantly by gender (Bosma et al. 2009; Minniti et al. 2006; Stephan et al. 2015a).

Age Age is an important influence on entrepreneurial activity (Levesque and Minniti 2006). Frequently younger individuals show higher levels of entrepreneurial activity (Stephan et al. 2015a; Estrin et al. 2013). The variable is the exact age of the respondent from GEM, APS, at the time of the interview.

Firm level control, industrial sector we also control for the different industrial sectors of new firms. This information also comes from GEM data that classifies entrepreneurship activities into four categories: extractive, manufacturing, business services and consumer-oriented activities.

Individual economic income This variable measure if the home annual income of the entrepreneurs is in the lowest, middle or higher third related to the average income of the country. This measure helps to control by the potential influence of socioeconomic capital of the entrepreneurs (Kwon and Arenius 2010).

Individuals educational level This variable measures the educational attainment of the entrepreneurs. The variable is taken from GEM, the respondents were asked to provide the highest degree they earned. The likelihood of being a nascent entrepreneur increases as individuals have higher education (Arenius and Minniti 2005), we expect this effect should be even higher in the case of high expectations TEA.

In Tables 4.2 and 4.3, descriptive statistics and correlation of the controls shows predictors and dependent variables. To investigate potential multicollinearity problems, we calculate variance inflation factors (VIF) for all the variables and find no evidence of multicollinearity.[4]

4.4.5 Data Analysis

We analyzed the data using the hierarchical linear modelling (HLM) method. Multilevel modelling is appropriate when data is hierarchically structured—that is, when they consist of units grouped at different levels of a hierarchy (Rabe-Hesketh

[4] VIF values not reported, but available upon request.

Table 4.2 Descriptive statistics

Level	Mean	Std. Dev.	Min	Max
Level 1				
Innovative Ambitious Entrepreneurship	2.44	1.2141	1	6
Export orientation	0.13	0.3391	0	1
Female	0.46	0.4987	0	1
Age	37.36	12.2493	18	99
Industrial Sector				
Extractive Sector	0.04	0.2010	0	1
Transforming	0.24	0.4282	0	1
Business Services	0.12	0.3251	0	1
Consumer Oriented	0.61	0.4882	0	1
Income				
Lowest 33%tile	0.25	0.4339	0	1
Middle 33%tile	0.32	0.4642	0	1
Upper 33%tile	0.43	0.4968	0	1
Education				
Non or basic primary	0.13	0.3357	0	1
Some secondary	0.16	0.3681	0	1
Secondary degree	0.39	0.4860	0	1
Post-secondary	0.27	0.4438	0	1
Grad experience	0.04	0.1972	0	1
Level 2				
Innovation and business sophistication	3.63	0.2746	2.88	4.52
R&D expenditure	0.39	0.3271	0.02	1.26
Support policies for entrepreneurship	2.60	0.5765	1.60	4.37
Efficiency of tech transfer (university to firms)	2.20	0.2495	1.67	2.91
Tech Subsidies	2.06	0.3542	1.26	2.75

and Skrondal 2006). In our research, individuals belong to a determined country by year. In the case of country-level indicators (GCI and NES) and innovative ambitious entrepreneurship, we observe the same hierarchical structure, with individuals in the first level and country-time in the second level. Following research like Amorós et al. (2019b), Autio et al. (2013), Pathak et al. (2016) and Stephan et al. (2015a, b), we take their recommendations of utility of a multilevel approach in studies of institutions and entrepreneurship. The use of HLM helps improve the estimations when compared with other multivariate procedures like OLS or logistic regressions because it reduces the risk of Type I errors when it does not acknowledge the existence of a higher level (in this case countries) and treating all variables as if they were observed at the individual level (Stephan et al. 2015b). Consequentially, the use of conventional single-level regression analysis could increase the possibility of "false positives" due to underestimation of standard errors given their non-normal distribution (Hofmann et al. 2000). For this specific case, we use a multilevel mixed-effects linear regression procedure.

Table 4.3 Correlation matrix

	Level 1	1	2	3	4	5	6	7	8
1	Innovative Ambitious Entrepreneurship	1.000							
2	Export orientation	0.109	1.000						
3	Age	0.032	0.009	1.000					
4	Extractive Sector	0.001	0.029	0.057	1.000				
5	Transforming	0.009	−0.001	0.036	−0.104	1.000			
6	Business Services	−0.045	−0.039	−0.036	−0.227	−0.700	1.000		
7	Consumer Oriented	0.120	0.041	−0.001	0.015	−0.021	−0.086	1.000	
8	Non or basic primary	−0.098	−0.052	0.177	0.040	0.001	0.053	−0.248	1.000
9	Some secondary	−0.076	−0.015	−0.006	−0.015	0.022	0.047	−0.267	−0.179
10	Secondary degree	−0.009	−0.005	−0.141	−0.035	0.009	0.035	−0.482	−0.323
11	Post-secondary	0.120	0.041	−0.001	0.015	−0.021	−0.086	−0.062	−0.248
12	Grad experience	0.069	0.040	0.049	0.010	−0.018	−0.074	−0.125	−0.084
13	Lowest 33% tile	−0.049	−0.038	0.035	0.017	−0.005	0.072	−0.193	0.201
14	Middle 33% tile	−0.027	−0.020	−0.028	−0.028	−0.007	0.045	−0.057	0.014
15	Upper 33% tile	0.067	0.052	−0.003	0.011	0.010	−0.103	0.220	−0.186
16	Female	−0.041	−0.027	0.009	−0.071	−0.138	0.222	−0.056	0.054

		9	10	11	12	13	14	15	16
9	Some secondary	1.000							
10	Secondary degree	−0.348	1.000						
11	Post-secondary	−0.267	−0.482	1.000					
12	Grad experience	−0.090	−0.163	−0.125	1.000				
13	Lowest 33% tile	0.129	−0.027	−0.193	−0.095	1.000			
14	Middle 33% tile	0.035	0.045	−0.057	−0.072	−0.382	1.000		
15	Upper 33% tile	−0.144	−0.019	0.220	0.149	−0.505	−0.605	1.000	
16	Female	0.039	0.004	−0.056	−0.053	0.132	0.037	−0.148	1.000

	Level 2	1	2	3	4	5	6
1	Innovative Ambitious Entrepreneurship	1.000					
2	Innovation and business sophistication	0.100	1.000				
3	R&D expenditure	−0.289	0.286	1.000			
4	Support policies for entrepreneurship	0.319	0.205	0.053	1.000		
5	Efficiency of tech transfer (university to firms)	−0.049	−0.043	0.101	0.156	1.000	
6	Tech Subsidies	0.277	0.232	0.354	0.511	0.324	1.000

4.5 Results

Table 4.4 shows the estimation results. The two models presented explain individual engagement in high expectation-innovative entrepreneurial activity. In model 1 we report all the individual level variables and the second model includes both individual and country level variables. The coefficients are consistent in the two estimations and do not lose consistency, this shows evidence of the robustness of the results, therefore we will analyze the coefficients presented in the more complete model (Model 2).

The coefficients associated to country level variables that are linked to policies that deepen the efficiency of technology transfers are positive and significant: innovation sophistication ($\beta = 0.113$, $p < 0.05$) and support policies towards entrepreneurial activity in general($\beta = 0.118$, $p < 0.01$). In regard to the R&D expenditure as a percentage of GDP, the coefficient results to be negative and significant($\beta = -0.113$, $p < 0.01$) . Finally, in the variables efficiency of tech transfer between universities and technology subsidies the model shows there is no significant effects in high expectation-innovative entrepreneurial activity.

In regard to the individual controls, international orientation ($\beta = 0.263$, $p < 0.01$) has, as expected, a positive impact on the likelihood an individual engaging in innovative ambitious entrepreneurship. These type of entrepreneurship activities also increase with higher levels of education ($\beta = 0.251$, $p < 0.01$). In Latin America, women have less probability than men to engage in innovative ambitious entrepreneurship ($\beta = -0.0330$, $p < 0.01$) and age has a small significant effect ($\beta = -0.00122$, $p < 0.01$). All three economic sectors identified in the analyses show a positive and significant effect, the biggest impact among them comes from business services.

4.6 Conclusions

Our study is particularly meaningful for entrepreneurship educators, policymakers, and organizations that are eager to foster innovative ambitious entrepreneurship, since the findings of this research appear to have both theoretical and practical implications. In regard to the theory, they contribute to the ongoing efforts that try to clarify the mechanisms through which macro-level variables (e.g., government intervention) influence micro-level variables (e.g., expectations of growing) which can affect firm performance (e.g., growth in revenues and employment) in LAC countries. Concretely, they indicate that although innovative ambitious entrepreneurs are influenced by the context, there is a self-selective phenomenon that occurs in highly educated individuals, with internationally oriented ventures. Our results indicate that not only individual level predictors as international orientation, increase the innovative entrepreneurs' likelihood of presenting high growth expectations.

Table 4.4 Multilevel analysis

Variables	Model 1 Innovative Ambitious Entrepreneurship	Model 2 Innovative Ambitious Entrepreneurship
Individual Level		
International orientation	0.260***	0.263***
	(0.0149)	(0.0149)
Transforming	0.0791***	0.0783***
	(0.0295)	(0.0295)
Business Services	0.0709**	0.0692**
	(0.0314)	(0.0313)
Consumer Oriented	0.0640**	0.0629**
	(0.0286)	(0.0285)
Middle Income 33%tile	−0.0346**	−0.0307**
	(0.0137)	(0.0138)
Upper Income 33%tile	0.00492	0.00595
	(0.0136)	(0.0136)
Some secondary	0.0260	0.0277
	(0.0186)	(0.0186)
Secondary degree	0.0867***	0.0867***
	(0.0165)	(0.0165)
Post-secondary	0.141***	0.140***
	(0.0184)	(0.0184)
Grad experience	0.239***	0.251***
	(0.0298)	(0.0299)
Female	−0.0339***	−0.0330***
	(0.0103)	(0.0103)
Age	−0.00115***	−0.00112***
	(0.000417)	(0.000417)
Country Level		
Innovation and business sophistication		0.113**
		(0.0483)
R&D expenditure		−0.180***
		(0.0593)
Support policies for entrepreneurship		0.118***
		(0.0165)
Efficiency of tech transfer (university to firms)		−0.0376
		(0.0317)
Tech Subsidies		0.0482
		(0.0334)
Constant	2.127***	1.453***
	(0.102)	(0.208)

(continued)

Table 4.4 (continued)

Variables	Model 1 Innovative Ambitious Entrepreneurship	Model 2 Innovative Ambitious Entrepreneurship
Observations	48,258	48,258
Number of groups	14	14

Standard errors in parentheses. Sector reference variable extractive, agriculture, fishing and related; Income reference variable low 33% income; Education reference variable basic primary
*p < 0.1
**p < 0.05
***p < 0.01

In regard to the country level contextual factors, as suggested by previous research (Shane 2009), general entrepreneurship policy is not necessarily a driver of innovative ambitious entrepreneurship rates. In other words, by itself it does not guarantee beneficial effects with respect to how many innovative ambitious entrepreneurs a country will generate. However, our findings suggest that in the case of LAC countries, support policies for entrepreneurship, do have a positive impact in this particular type of entrepreneurial activity. Furthermore, we find evidence that country level innovation and business sophistication, has a positive and significant effect. Although the R&D expenditure, suggests no impact in the decision of individuals to create more jobs in the near future in innovative ventures, this can be explained because R&D expenditure is a private and public outcome of policies that were created to stimulate the innovation ecosystem.

An interesting and probably counter intuitive result is the negative even not significant effect of "efficiency of tech transfer" from universities to firms and quality of direct subsidies for new technologies. One potential explanation is the transactional costs that a relationship between an entrepreneur and the university implies. And also the lack of good programs that link technology transfer offices with new ventures. On average universities tend to emphasize in managerial voids about the venture, which directly erodes the over expectations of the entrepreneur, in regard to the firms' potential growth.

Entrepreneurship generates substantial benefits to the economy regardless the level of analysis (individual and country). While we know that high growth entrepreneurial activity can be fostered by the influencing forces of the supply and demand side conceptually, there is little evidence about the current state of innovative ambitious entrepreneurial activity in LAC is observed. This study focused on the understanding of some features that significantly influence the likelihood of entrepreneurs to have high growth expectations in innovative ventures. Although theoretically R&D transfer, governmental intervention, and innovation sophistication influence entrepreneurship, the main aspects which explain a certain rate of entrepreneurial activity are not universal and should be carefully analyzed. In this way, we can make a major contribution to the study of entrepreneurship and practitioners in LAC and contribute to understand inhered phenomena of the region (Aguinis et al. 2020).

As in every study, there are some limitations that should be mentioned as they offer opportunities for future research. First, although our findings covered a specific contextual scenario as LAC countries to study the relationship between innovation, R&D transfer, and government intervention and entrepreneurs' expectations about their desire for growing, we did not examine the underlying mechanisms through which such effects occurred. It is important to consider that our conceptual approach is nurtured with the entrepreneurs' intention to be ambitious in terms of job creation. As we explained, this type of behaviour (be pro-growth entrepreneurs) is very relevant in terms competitiveness and strategic entrepreneurship dynamics (Levie and Autio 2011). But this measure is only related with the further perceptions of the individuals not strictly characteristics of the firm (even we control by some of them). This could represent a restriction to understand the full spectrum of dynamic entrepreneurs (or real growth). This restriction is given by the nature of GEM variables that do not capture other aspect of firm performance. Future research could explore precisely other components of entrepreneurship growth and performance or a real panel approach could be very useful in this sense. Another interesting topic to explore in future studies is the efficiency of technology transfer which has a unique behavior in the context of LAC, the reasons for this and the mechanisms that underlie the results, could increase the quality of policy design.

Acknowledgments The authors extend their gratitude to Global Entrepreneurship Monitor (GEM) Consortium and Editors -Maribel Guerrero and David Urbano- for their useful comments to this chapter.

References

Acs, Z., & Amorós, J. E. (2008). Entrepreneurship and competitive dynamics in Latin America. *Small Business Economics, 31*(3), 305–322.

Acs, Z., Desai, S., & Hessels, J. (2008). Entrepreneurship, economic development and institutions. *Small Business Economics, 31*(3), 219–234.

Acs, Z., Astebro, T., Audretsch, D., & Robinson, D. T. (2016). Public policy to promote entrepreneurship: A call to arms. *Small Business Economics, 47*(1), 35–52.

Aguinis, H., Villamor, I., Lazzarini, S. G., Vassolo, R. S., Amorós, J. E., & Allen, D. G. (2020). Conducting management research in Latin America: Why and what's in it for you? *Journal of Management, 46*(5), 615–636.

Amorós, J. E., Fernández, C., & Tapia, J. (2012). Quantifying the relationship between entrepreneurship and competitiveness development stages in Latin America. *International Entrepreneurship and Management Journal, 8*(3), 249–270.

Amorós, J. E., Borraz, F., & Veiga, L. (2016a). Entrepreneurship and socioeconomic indicators in Latin America. *Latin American Research Review, 51*(4), 186–201.

Amorós, J. E., Etchebarne, M. S., Torres-Zapata, I., & Felzenstein, C. (2016b). International entrepreneurial firms in Chile: An exploratory profile. *Journal of Business Research, 69*(6), 2052–2060.

Amorós, J. E., Poblete, C., & Mandakovic, V. (2019a). R&D transfer, policy and innovative ambitious entrepreneurship: Evidence from Latin American countries. *The Journal of Technology Transfer, 44*(5), 1396–1415.

Amorós, J. E., Ciravegna, L., Mandakovic, V., & Stenholm, P. (2019b). Necessity or opportunity? The effects of state fragility and economic development on entrepreneurial efforts. *Entrepreneurship Theory and Practice, 43*(4), 725–750.

Aparicio, S., Urbano, D., & Audretsch, D. (2016). Institutional factors, opportunity entrepreneurship and economic growth: Panel data evidence. *Technological Forecasting and Social Change, 102*, 45–61.

Arenius, P., & Minniti, M. (2005). Perceptual variables and nascent entrepreneurship. *Small Business Economics, 24*(3), 233–247.

Audretsch, D., & Caiazza, R. (2016). Technology transfer and entrepreneurship: Cross-national analysis. *The Journal of Technology Transfer, 41*(6), 1247–1259.

Audretsch, D. B., & Thurik, A. R. (2001). What's new about the new economy? Sources of growth in the managed and entrepreneurial economies. *Industrial and Corporate Change, 10*(1), 267–315.

Audretsch, D. B., & Thurik, A. R. (2004). A model of the entrepreneurial economy (No. 1204). Papers on entrepreneurship, growth and public policy.

Audretsch, D. B., Carree, M. A., & Thurik, A. R. (2001). Does entrepreneurship reduce unemployment? Tinbergen Institute Discussion Paper TI 2001-074/3, Rotterdam.

Audretsch, D. B., Carree, M. A., Van Stel, A. J., & Thurik, A. R. (2002). Impeded industrial restructuring: The growth penalty. *Kyklos, 55*(1), 81–98.

Autio, E. (2005). Creative tension: The significance of Ben Oviatt's and Patricia McDougall's article 'toward a theory of international new ventures'. *Journal of International Business Studies, 36*(1), 9–19.

Autio, E. (2007). Global entrepreneurship monitor: 2007 global report on high-growth entrepreneurship. Babson College.

Autio, E., Pathak, S., & Wennberg, K. (2013). Consequences of cultural practices for entrepreneurial behaviors. *Journal of International Business Studies, 44*(4), 334–362.

Autio, E., Kenney, M., Mustar, P., Siegel, D., & Wright, M. (2014). Entrepreneurial innovation: The importance of context. *Research Policy, 43*(7), 1097–1108.

Baumol, W. J. (1990). Entrepreneurship: Productive, unproductive, and destructive. *Journal of Political Economy, 98*(5), 893–921.

Birch, D. (1987). *The job generating process*. Cambridge, MA: MIT Press.

Bosma, N., Jones, K., Autio, E., & Levie, J. (2009). GEM executive report 2008. Babson College, Universidad del Desarrollo, and Global Entrepreneurship Research Consortium.

Bowen, H. P., & De Clercq, D. (2008). Institutional context and the allocation of entrepreneurial effort. *Journal of International Business Studies, 39*(4), 747–767.

Bruton, G. D., Ahlstrom, D., & Li, H. L. (2010). Institutional theory and entrepreneurship: Where are we now and where do we need to move in the future? *Entrepreneurship Theory and Practice, 34*(3), 421–440.

Bruton, G. D., Ketchen, D. J., & Ireland, R. D. (2013). Entrepreneurship as a solution to poverty. *Journal of Business Venturing, 28*(6), 683–689.

Capelleras, J. L., & Rabetino, R. (2008). Individual, organizational and environmental determinants of new firm employment growth: Evidence from Latin America. *International Entrepreneurship and Management Journal, 4*(1), 79–99.

Carlsson, B. (1989). The evolution of manufacturing technology and its impact on industrial structure: An international study. *Small Business Economics, 1*(1), 21–38.

Carree, M. A., & Thurik, A. R. (2005). The impact of entrepreneurship on economic growth. In *Handbook of entrepreneurship research* (pp. 437–471). Boston: Kluwer Academic Publishers.

Carree, M. A., Van Stel, A., Thurik, R., & Wennekers, S. (2002). Economic development and business ownership: An analysis using data of 23 OECD countries in the period 1976–1996. *Small Business Economics, 19*(3), 271–290.

Casson, M. (1995). *Entrepreneurship and business culture*. Aldershot: Edward Elgar Publishing.

Dau, L. A., & Cuervo-Cazurra, A. (2014). To formalize or not to formalize: Entrepreneurship and pro-market institutions. *Journal of Business Venturing, 29*(5), 668–686.

de Koning, A., & Snijders, J. (1992). Policy on small-and medium-sized enterprises in countries of the European Community. *International Small Business Journal, 10*(3), 25–39.

De Soto, H. (1989). *The other path* (p. 17133). New York: Harper & Row.

Dimov, D. (2010). Nascent entrepreneurs and venture emergence: Opportunity confidence, human capital, and early planning. *Journal of Management Studies, 47*(6), 1123–1153.

Drucker, P. F. (2006). *Innovation and entrepreneurship – practice and principles*. New York: Harper.

Estrin, S., Korosteleva, J., & Mickiewicz, T. (2013). Which institutions encourage entrepreneurial growth aspirations? *Journal of Business Venturing, 28*(4), 564–580.

Freeman, C. (1987). *Technology policy and economic performance: Lessons from Japan*. London: Pinter Publishers.

Golovko, E., & Valentini, G. (2011). Exploring the complementarity between innovation and export for SMEs' growth. *Journal of International Business Studies, 42*(3), 362–380.

Grilo, I., & Thurik, R. (2005). Latent and actual entrepreneurship in Europe and the US: Some recent developments. *The International Entrepreneurship and Management Journal, 1*(4), 441–459.

Guerrero, M., Cunningham, J. A., & Urbano, D. (2015). Economic impact of entrepreneurial universities' activities: An exploratory study of the United Kingdom. *Research Policy, 44*(3), 748–764.

Guerrero, M., & Urbano, D. (2019). Effectiveness of technology transfer policies and legislation in fostering entrepreneurial innovations across continents: an overview. *The Journal of Technology Transfer, 44*(5), 1347–1366.

Hofmann, D. A., Griffin, M. A., & Gavin, M. B. (2000). The application of hierarchical linear modelling to organizational research. In K. J. Klein & S. W. J. Kozlowski (Eds.), *Multilevel theory, research, and methods in organizations: Foundations, extensions, and new directions* (pp. 467–511). San Francisco: Jossey-Bass.

Kantis, H. (2005). The emergence of dynamic ventures in Latin America, Southern Europe and East Asia: An international comparison. *International Journal of Entrepreneurship and Small Business, 2*(1), 34–56.

Kantis, H., Angelelli, P., & Moori-Koenig, V. (2004). *Experience in Latin America and worldwide*. Washington DC: Inter–American Development Bank–Fundes International.

Kantis, H., Federico, J., & Ibarra-García, S. (2016a). *Condiciones sistémicas para el emprendimiento dinámico 2016: Novedades y tendencias para fortalecer e integrar los ecosistemas de la región*. Argentina: PRODEM/Asociación Civil Red Pymes Mercosur.

Kantis, H., Federico, J., Angelelli, P., & Ibarra-García, S. (2016b). Business performance in young Latin American firms. In *Firm innovation and productivity in Latin America and the Caribbean the engine of economic development* (pp. 167–205). New York: Palgrave Macmillan US.

Kelley, D., Bosma, N. S., & Amorós, J. E. (2011). *Global entrepreneurship monitor 2010 executive report*. London: GERA.

Kenney, M., & Patton, D. (2005). Entrepreneurial geographies: Support networks in three high-technology industries. *Economic Geography, 81*(2), 201–228.

Klepper, S. (1996). Entry, exit, growth, and innovation over the product life cycle. *The American Economic Review, 86*, 562–583.

Klepper, S., & Simons, K. L. (2000). Dominance by birthright: Entry of prior radio producers and competitive ramifications in the US television receiver industry. *Strategic Management Journal, 21*(10–11), 997–1016.

Kreiser, P. M., Marino, L. D., Kuratko, D. F., & Weaver, K. M. (2013). Disaggregating entrepreneurial orientation: The non-linear impact of innovativeness, proactiveness and risk-taking on SME performance. *Small Business Economics, 40*(2), 273–291.

Kwon, S. W., & Arenius, P. (2010). Nations of entrepreneurs: A social capital perspective. *Journal of Business Venturing, 25*(3), 315–330.

Landström, H., Åström, F., & Harirchi, G. (2015). Innovation and entrepreneurship studies: One or two fields of research? *International Entrepreneurship and Management Journal, 11*(3), 493–509.

Lederman, D., Messina, J., Pienknagura, S., & Rigolini, J. (2014). *Latin American entrepreneurs: Many firms but little innovation. World Bank Latin American and Caribbean studies*. Washington: World Bank Group.

Lehmann, E. E., & Seitz, N. (2017). Freedom and innovation: A country and state level analysis. *Journal of Technology Transfer, 42*(5), 1009–1029.

Levesque, M., & Minniti, M. (2006). The effect of aging on entrepreneurial behavior. *Journal of Business Venturing, 21*(2), 177–194.

Levie, J., & Autio, E. (2008). A theoretical grounding and test of the GEM model. *Small Business Economics, 31*(3), 235–263.

Levie, J., & Autio, E. (2011). Regulatory burden, rule of law, and entry of strategic entrepreneurs: An international panel study. *Journal of Management Studies, 48*(6), 1392–1419.

Leyden, D. P. (2016). Public-sector entrepreneurship and the creation of a sustainable innovative economy. *Small Business Economics, 46*(4), 553–564.

Loveman, G., & Sengenberger, W. (1991). The re-emergence of small-scale production: An international comparison. *Small Business Economics, 3*(1), 1–37.

Lumpkin, G. T., & Dess, G. (1996). Clarifying the entrepreneurial orientation construct and linking it to performance. *The Academy of Management Review, 21*(1), 135–172.

Malerba, F., & McKelvey, M. (2018). Knowledge-intensive innovative entrepreneurship integrating Schumpeter, evolutionary economics, and innovation systems. *Small Business Economics, 54*(2), 503–522.

Martínez-Fierro, S., Biedma-Ferrer, J. M., & Ruiz-Navarro, J. (2016). Entrepreneurship and strategies for economic development. *Small Business Economics, 47*(4), 835–851.

Mason, C., & Brown, R. (2013). Creating good public policy to support high-growth firms. *Small Business Economics, 40*(2), 211–225.

McMullen, J. S., & Dimov, D. (2013). Time and the entrepreneurial journey: The problems and promise of studying entrepreneurship as a process. *Journal of Management Studies, 50*(8), 1481–1512.

Messina, J., & Silva, J. (2017). Wage inequality in Latin America: understanding the past to prepare for the future (English). *Latin American development forum series*. Washington, D.C.: World Bank Group.

Minniti, M., Bygrave, W. D., & Autio, E. (2006). *GEM global entrepreneurship monitor: 2005 executive report*. London: London Bussiness School.

Mrożewski, M., & Kratzer, J. (2017). Entrepreneurship and country-level innovation: Investigating the role of entrepreneurial opportunities. *The Journal of Technology Transfer, 42*(5), 1125–1142.

OECD. (1996). *SMEs: Employment, innovation and growth: The Washington Workshop*. Paris: OECD.

Pathak, S., Xavier-Oliveira, E., & Laplume, A. O. (2016). Technology use and availability in entrepreneurship: Informal economy as moderator of institutions in emerging economies. *The Journal of Technology Transfer, 41*(3), 506–529.

Piore, M. J., & Sabel, C. F. (1984). *The second industrial divide: Possibilities for prosperity*. New York: Basic Books.

Poblete, C. (2018). Growth expectations through innovative entrepreneurship: The role of subjective values and duration of entrepreneurial experience. *International Journal of Entrepreneurial Behaviour & Research, 24*(1), 191–213.

Porter, M., Sachs, J., & McArthur, J. (2001). *Executive summary: Competitiveness and stages of economic development. The Global Competitiveness Report, 2002* (pp. 16–25). New York: Oxford University Press.

Rabe-Hesketh, S., & Skrondal, A. (2006). Multilevel modelling of complex survey data. *Journal of the Royal Statistical Society, 169*(4), 805–827.

Reynolds, P., Bosma, N., Autio, E., Hunt, S., De Bono, N., Servais, I., & Chin, N. (2005). Global entrepreneurship monitor: Data collection design and implementation 1998–2003. *Small Business Economics, 24*(3), 205–231.

Sala-i-Martin, X., Blanke, J., Drzeniek Hanouz, M., Geiger, T., & Mia, I. (2010). The global competitiveness index 2010—2011: Looking beyond the global economic crisis. In K. Schwab (Ed.), *The global competitiveness report 2010–2011* (pp. 3–55). Geneva: World Economic Forum.
Schumpeter, J. A. (1934). *The theory of economic development: An inquiry into profits, capital, credit, interest and the business cycle* (Vol. 55). New Brunswick: Transaction Publishers.
Shane, S. (2009). Why encouraging more people to become entrepreneurs is bad public policy. *Small Business Economics, 33*(2), 141–149.
Shane, S., & Venkataraman, S. (2000). The promise of entrepreneurship as a field of research. *Academy of Management Review, 25*(1), 217–226.
Sobel, R. S. (2008). Testing Baumol: Institutional quality and the productivity of entrepreneurship. *Journal of Business Venturing, 23*(6), 641–655.
Stam, E. (2015). Entrepreneurial ecosystems and regional policy: A sympathetic critique. *European Planning Studies, 23*(9), 1759–1769.
Stephan, U., Hart, M., & Drews, C. C. (2015a). Understanding motivations for entrepreneurship: A review of recent research evidence Enterprise Research Centre and Aston Business School Aston University, Birmingham On line: http://publications.aston.ac.uk/id/eprint/25172/1/Understanding_motivations_for_entrepreneurship.pdf Accessed 21 Apr 2017.
Stephan, U., Uhlaner, L. M., & Stride, C. (2015b). Institutions and social entrepreneurship: The role of institutional voids, institutional support and institutional configurations. *Journal of International Business Studies, 46*(3), 308–331.
Storey, D. J. (1998). Six steps to heaven: Evaluating the impact of public policies to support small businesses in developed economies Centre for Small and Medium Sized Enterprises, Warwick Business School.
Storey, D. J. (2016). *Understanding the small business sector (reedition)*. New York: Routledge.
Thai, M. T. T., & Turkina, E. (2014). Macro-level determinants of formal entrepreneurship versus informal entrepreneurship. *Journal of Business Venturing, 29*(4), 490–510.
Valdez, M. E., & Richardson, J. (2013). Institutional determinants of macro-level entrepreneurship. *Entrepreneurship Theory and Practice, 37*(5), 1149–1175.
Van Stel, A., Carree, M., & Thurik, R. (2005). The effect of entrepreneurial activity on national economic growth. *Small Business Economics, 24*(3), 311–321.
Verheul, I., Wennekers, S., Audretsch, D., & Thurik, R. (2002). An eclectic theory of entrepreneurship: Policies, institutions and culture. In *Entrepreneurship: Determinants and policy in a European-US comparison* (pp. 11–81). Boston: Springer.
Wennekers, S., & Thurik, R. (1999). Linking entrepreneurship and economic growth. *Small Business Economics, 13*(1), 27–56.
Wiklund, J., Davidsson, P., Audretsch, D. B., & Karlsson, C. (2011). The future of entrepreneurship research. *Entrepreneurship Theory and Practice, 35*(1), 1–9.
Winter, S. G. (2006). Toward a neo-Schumpeterian theory of the firm. *Industrial and Corporate Change, 15*(1), 125–141.
World Economic Forum. (2017). In C. Schwab (Ed.), *The global competitiveness report 2017–2018*. Geneva: WEF.

Chapter 5
Technology Transfer Policies and Entrepreneurial Innovations at Brazilian University-Industry Partnerships

Maribel Guerrero, Paola Rücker Schaeffer, and Bruno Brandão Fischer

5.1 Introduction

Over the past 40 years, the Bayh-Dole Act has been the most inspiring piece of legislation around the world. This policy measure has empowered organizations (i.e., universities, SMEs, and non-profit organizations) to be the owners of inventions made by federally-funded research, as well as it has ensured royalties, licensing, and spinning-off to the organizations that have made these inventions. The most consistent output of this policy measure has been the flourishment of the academic entrepreneurship phenomenon around the world (Grimaldi et al. 2011; Aldridge and Audretsch 2017; Guerrero et al. 2015; Guerrero and Urbano 2019b). This has been confirmed by the exponential rising of technology transfer and academic entrepreneurship research over the past three decades (Miranda et al. 2018; Guerrero and Urbano 2019b).

M. Guerrero
Facultad de Economía y Negocios, Universidad del Desarrollo, Santiago, Chile

Northumbria Centre for Innovation, Regional Transformation and Entrepreneurship (iNCITE), Newcastle Business School, Northumbria University, Newcastle upon Tyne, UK

Centre for Innovation Research (CIRCLE), Lund University, Lund, Sweden
e-mail: maribel.guerrero@northumbria.ac.uk

P. R. Schaeffer
Department of Science and Technology Policy (DPCT), University of Campinas (UNICAMP), Campinas, Brazil
e-mail: paolaschaeffer@ige.unicamp.br

B. B. Fischer (✉)
School of Applied Sciences (FCA), University of Campinas (UNICAMP), Campinas, Brazil

National Research University Higher School of Economics, Moscow, Russia
e-mail: bfischer@unicamp.br

M. Guerrero, D. Urbano (eds.), *Technology Transfer and Entrepreneurial Innovations*, International Studies in Entrepreneurship 51,
https://doi.org/10.1007/978-3-030-70022-5_5

Originated by public organizations (i.e., universities or national laboratories), academic entrepreneurship represents the result of technology transfer outcomes such as intellectual property rights, patents, licenses, technologies, and others radical inventions (Callan 2001; Lockett and Wright 2005; Lockett et al. 2005; Wright et al. 2006). The versatility of academic entrepreneurship has allowed the embracing of multiple academic lenses (i.e., technology transfer, entrepreneurial behaviors, academic entrepreneurship, knowledge management, strategic management, public policy, and others) (Guerrero and Urbano 2019a).

Likewise, the published literature reviews have provided relevant insights about determinants and outputs associated with this phenomenon (O'Shea et al. 2008; Sørheim et al. 2011; Miranda et al. 2018). Based on previous studies in the Latin-American context, technology transfer policies to support entrepreneurial innovations have been characterized by the strengthening of university-industry partnerships (Guerrero and Urbano 2017). However, little is known about the effectiveness of these policies implemented in the context of emerging economies. Motivated by this research gap, this chapter discussed the evolution of determinants and outcomes of technology transfer policies implemented in Brazil.

The remainder of this chapter is organized as follows. Section 5.2 introduces a review of the existing literature. In Sect. 5.3, we explain the methodology design. Then, Sect. 5.4 describes the evolution of technology transfer policies in Brazil. Section 5.5 shows the findings and discussion. Finally, we conclude by outlining policy implications.

5.2 Technology Transfer Practices and Entrepreneurial Innovations within University-Industry Partnerships

The configurations of new knowledge-intensive environments required fertile settings for innovative and entrepreneurial activities. Innovation and entrepreneurship are multidimensional processes linked to economic development. It explains why many nations, regions, and cities have implemented several policies to stimulate innovation by entrepreneurial firms to foster economic growth (Autio et al. 2014) and to promote technology-based entrepreneurship (Grimaldi et al. 2011). This phenomenon has been operationalized through the Triple or the Quadruple Helix approaches in emerging economies. This approach recognizes the interaction between universities, industries, governments, and society to achieve economic priorities.

If we paid attention to universities, literature has evidenced that a few universities in emerging economies have adopted an entrepreneurial management style with members and stakeholders who act entrepreneurially (Guerrero and Urbano 2017). This type of universities have also interacted with their outside environment in an entrepreneurial manner (Audretsch 2014) and incorporate an entrepreneurial and innovative orientation into their core activities/missions (Kirby et al. 2011). As a result, the entrepreneurial and innovative university has configured an adequate environment for nurturing innovation and entrepreneurship within their community (students, faculty, academics, and alumni) and simultaneously act as an intersection in the regional innovation systems and entrepreneurship ecosystems (Herrera et al. 2018).

Based on previous studies in emerging economies, we have learned that university core activities are oriented to transform the mindset and actions of the community (students and academics). Regarding graduate entrepreneurship, research has increased radically during the last decade in emerging economies by exploring the entrepreneurial intention of students and university support mechanisms (Guerrero and Urbano 2019a). For the case of academic entrepreneurship, research has focused on foundational elements regarding career development, resources, and evaluation of effectiveness (Guerrero and Urbano 2019b).

Following the basis of an entrepreneurial and innovation ecosystem, we observe a policy pattern to promote the relationship between university and industry for engaging entrepreneurship and innovation government's achievements in emerging economies (Perkmann et al. 2011; Guerrero and Urbano 2017). The interaction of university with external organization/stakeholders tends to generate marketable entrepreneurial innovations that have been promoted via policies (Motoyama and Knowlton 2017). It has represented a link between regulations and outcomes of intellectual property, entrepreneurship, innovation, and higher education (Oliver and Sapir 2017).

Given the lack of consensus about the effectiveness of technology transfer policies, the academic debate has evaluated the entrepreneurial and innovative results around the world (Guerrero and Urbano 2019b). Consequently, the concept of entrepreneurial innovations has emerged to explain the generation of marketable research based on policy priorities (Norbäck and Persson 2012, 488). According to Autio et al. (2014 p.1100), entrepreneurial innovation could be understood such as the development of entrepreneurial initiatives focused on radical innovations based on the co-creation among multiple actors (individuals and organizations) in a defined space/time as a result of a policy that fosters entrepreneurship and innovation ecosystems. Complementary, Guerrero and Urbano (2017, p.295) expand the definition of entrepreneurial innovations within university-industry collaborations subsidized by public policy in the context of emerging economies.

5.3 Methodology

5.3.1 Data Collection

This research is based on a two-step appraisal of the evolutionary patterns comprehending technology transfer policies, their impacts in terms of generating entrepreneurial outcomes in University-Industry connections, and the perceived levels of systemic effectiveness in these mechanisms. First, we draw information from dedicated literature to contextualize how the environment for technology transfer from academia to markets has unfolded in Brazil. This perspective follows propositions from Autio et al. (2014) and Guerrero and Urbano (2019), emphasizing the relational aspects that foster the generation of entrepreneurial innovations. In this context, technologies derived from scientific research can provide the foundations for commercial innovations, but these processes are embedded in broader regulatory environments (Guerrero and Urbano 2019). Accordingly, in this initial stage, changes in the regulatory framework are outlined, as well as pivotal agents and the overall state of affairs concerning technology transfer with a focus on flows originating from academia. Second, we dig deeper into this phenomenon by conducting an empirical exploratory assessment based on multiple cases in the State of São Paulo, Brazil. More specifically, following Fischer et al. (2018), our analytical focus resides on different agents participating in a thriving technological corridor spanning across roughly 400 kilometers and comprehending five central cities: São Paulo, Campinas, São José dos Campos, Ribeirão Preto, and São Carlos.

Data collection included interviews with technology transfer offices (TTOs), leaders of research groups, research centers, and knowledge-intensive entrepreneurial ventures. Interviews with leaders of research groups and research centers provide a complementary perspective on technology transfer processes that go beyond intellectual property commercialization – a primary function of TTOs. Also, by interviewing these researchers, it was possible to obtain a critical view of the role played by TTOs and to develop a further comprehension of the phenomenon under scrutiny. Gathering the viewpoint of knowledge-intensive entrepreneurs enhances the quality of this debate as it introduces the market-side vantage point into our empirical exercise. Hence, adopting the multiple case method, we are able to bring a more robust, generalizable, and testable perspective to our contributions (Eisenhardt and Graebner 2007). In addition to interviews covering agents' perspectives of evolutionary trends in technology transfer in the analyzed region, documents such as TTO annual reports, information available on University-Industry Collaboration, data available on universities' and funding agencies' websites, and the websites of interviewed entrepreneurial companies were analyzed.

Universities included in the study comprise the University of São Paulo (São Paulo and Ribeirão Preto campuses), University of Campinas (Campinas), Federal University of São Carlos (São Carlos), Aeronautics Institute of Technology (São José dos Campos) and the Federal University of ABC (situated in an adjacent location within the São Paulo Metropolitan Area). These higher education institutions represent some of the top academic units in Brazil concerning both scientific and technological developments (Fischer et al. 2019). Additionally, the TTO of the National Institute for Space Research (São José dos Campos) was also interviewed. Research groups and research centers were selected according to available information on levels of involvement with partners from industry. Highly interactive subjects were selected in order to obtain a clearer perspective of technology transfer dynamics. Within the business ecosystem, companies of the PIPE/FAPESP Program were interviewed.[1] Most of these companies have or had formal relationships with the universities participating in the research. Twenty-one face-to-face interviews were undertaken with different actors between September and November 2018: five TTOs, five research groups, six research centers, and five PIPE companies. Interviews were recorded and transcribed for analytical purposes.[2] The interviews lasted an average of 64 minutes.

5.3.2 Data Analysis

The content analysis method guided the empirical organization of data assessment. The coding and identification techniques of the central categories were used (following Strauss 2003). Then, the data were categorized according to each type of actor interviewed. In categorization, we sought to identify relationship patterns between the constructs proposed in the literature review and the data collected in case studies (Eisenhardt and Graebner 2007).

5.4 Evolution of the University-University Technology Transfer Scene in Brazil

The Brazilian regulatory context associated with technology transfer processes has faced significant changes over the last three decades. The first issue of interest in this debate concerns the revision of intellectual property laws in 1996 (Law 9279/96). This specific act brought stability to the patent system by aligning national policies with directives from the TRIPS agreement. In turn, this generated incentives for more robust technological activity in the country and guaranteed appropriability rights (Ryan 2010) – critical issues in defining solid grounds for innovation-driven collaboration.

However, conditions for upgrading processes of the Brazilian innovation system still faced severe challenges. In this respect, policymakers identified that a central weakness of the productive structure was lack of capacity in translating a relatively strong scientific production into actual technological capabilities (Albuquerque 1999; Ryan 2010). Trying to tackle this issue, the São Paulo Research Foundation

[1] In order to identify knowledge-intensive companies, we used data from companies participating in the PIPE/FAPESP Program, which aims to subsidize innovative small business initiatives. Created in 1997 by the São Paulo Research Foundation (FAPESP) and inspired by the U.S. Small Business Innovation Research (SBIR), the program gives support to entrepreneurial projects with a high level of knowledge intensity and innovative potential (Salles-Filho et al. 2011).

[2] This procedure follows recommendations from the Research Ethics Committee from the University of Campinas. Interviews were approved under the protocol #89010418.2.0000.8142/ Project 'Universities as Pivotal Agents in Innovation Ecosystems'.

(Fapesp), in the late 1990s, begun to subsidize projects that involved shared R&D efforts between universities and corporations (Alves et al. 2015). Even though Fapesp is a state-level institution, it functions as a pivotal agent in the most developed economy of the country, responding for roughly a third of the Brazilian GDP. But this pioneering initiative took time to mature and have more profound impacts on national policies.

In 2004, significant institutional changes took place intending to dynamize the environment for efficient technology transfer in the country. The first initiative in this regard was the 2004–2008 Industrial, Technological and Trade Policy (PITCE), which included university-industry linkages as a critical component of its strategy, a situation that has remained stable ever since - although overarching policies have suffered changes. The current federal scheme addressing these long-term orientations of the innovation system is called the National Strategy for Science, Technology, and Innovation (2016–2022).

Perhaps more importantly, 2004 was the year when the Brazilian Innovation Act was launched. Based mainly on the Bayh-Dole Act, this piece of legislation set the stage for more precise regulation in processes and products emanating from university-industry collaboration in the context of public academic institutions. Important to say, public universities in Brazil respond to most of the scientific and technological activity in the country (Fischer et al. 2019). Along these lines, the Innovation Act also encompasses the possibility of establishing research infrastructures that can be shared in collaborative projects between companies and universities (Santos and Torkomian 2013). Positive effects of this institutional change have been perceived in academic patenting (Santos and Mello 2009) and joint university-industry technological activity (Fischer et al. 2019; Dewes et al. 2015), thus leveraging competitiveness levels in incumbent firms and fostering spin-off activity in universities.

Nonetheless, some fundamental challenges remained. Literature reports governance weaknesses in TTOs related to lack of managerial capabilities (Alves et al. 2015; Silva and Guimarães 2015), as well as bureaucratic barriers that reduce companies' – particularly SMEs – propensity to engage in scientific and commercial relationships with academia (Freitas et al. 2013), leading to high levels of informal connections between individual researchers and markets (Dewes et al. 2015). In order to tackle some of these frailties, discussions involving governmental agencies, academia and industry generated an upgraded regulatory framework enacted in 2016. Known as the New Legal STI Framework (Law 13243/2016), the new legislation seeks to address existing barriers in university-industry linkages, such as the participation of scientists in R&D projects taking place in industrial facilities, as well as establishing more straightforward rules for the shared use of universities' laboratories and research infrastructure. Another critical aspect of the new institutional background concerns the provision of flexibility in the management of IP rights arising from collaborative projects.

Along similar lines – and following the strategic shift of the Brazilian innovation system that began in 2004 – several other initiatives have taken place with a primary or secondary focus on approximating academia to markets through the provision of a more efficient environment for technology transfer. For instance, Law 11196/2005 alleviates tax burdens for companies engaging in R&D projects, including collaboration with higher education institutions. In 2007, governmental efforts led to the creation of the Brazilian Technological System (Sibratec), a governance system that promotes ties between academia and markets through the provision of collaborative centers and funding for the joint development of new technologies. Complementarily, in 2013 the federal government established a public enterprise to strengthen a triple helix rationale for innovation. This organizational structure, Embrapii (Brazilian National Association for Industrial Research and Innovation), comprises 28 research centers aiming at technological development and transfer as a mechanism to enhance competitiveness levels in Brazilian firms.

But while impacts have been felt in terms of the evolution of the technology transfer process and the generation of entrepreneurial innovations deriving from scientific research, the scope of university-industry connections in Brazil has not reached maturity. It is because relationships are mostly reliant on short-term projects and involve firms from low and medium-tech sectors (Albuquerque et al. 2015; Dewes et al. 2015; Dutrénit and Arza 2015; Freitas et al. 2013). One possible explanation for this situation is the predominance of multinationals in high-tech sectors that approach the Brazilian market with exploitation strategies. It leads primarily to product adaption to the local market without encompassing commitments to long-term innovative projects in the host economy. Additional explanations include the Brazilian industrial structure, with an intense concentration in mature industries with low levels of technology upgrading and reduced propensity to perceive universities as strategic partners (Fischer et al. 2019). It is illustrated in Table 5.1, where universities seem to occupy a marginal position in terms of contributions to innovative processes in Brazilian firms. As can be gathered from data, the share of firms developing joint R&D activities has not increased over the last two decades – despite the abovementioned institutional changes. This picture is supported by the perception of the majority of firms involved in collaborative processes that universities represent partners of low or no relevance for innovative endeavors (a persistent trend over the six waves of the survey).

5.5 Results

In this section we dig deeper into the dynamics of technology transfer from academia to markets in Brazil by addressing this phenomenon through interviews with key agents in the most developed innovation area in Brazil, the technological corridor comprehending the cities of São Paulo, Campinas, São José dos Campos, São Carlos and Ribeirão Preto. To offer a comprehensive perspective, we assess issues related to the third mission as a strategic orientation in universities, the role played by TTOs, knowledge transfer through patenting activity and other scientific services, and the emergence of academic entrepreneurship.

Table 5.1 Brazilian innovation survey (PINTEC): UIC trends in Brazil from the companies' perspective

PINTEC	Total companies in the survey	Innovative companies	Companies with collaborative processes	Companies with UIC	UIC object (only companies with UIC)		UIC importance (companies with collaborative processes)		
					R&D activities	Others	High	Medium	Low/Not relevant
2003	84,262	28,036	1052	551	360	191	188	124	740
			−3.76%	−1.96%	−65.30%	−34.70%	−17.90%	−11.80%	−70.30%
2005	91,055	30,377	2194	777	341	436	432	256	1506
			−7.22%	−2.56%	−43.90%	−56.10%	−19.70%	−11.70%	−68.60%
2008	106,822	41,223	4248	1759	1028	732	829	477	2942
			−10.31%	−4.27%	−58.40%	−41.60%	−19.50%	−11.20%	−69.30%
2011	128,699	45,950	7694	3405	1850	1555	1431	826	5437
			−16.74%	−7.41%	−54.30%	−45.70%	−18.60%	−10.70%	−70.70%
2014	132,529	47,693	7299	3432	1882	1551	1098	840	5361
			−15.30%	−7.20%	−54.80%	−45.20%	−15.00%	−11.50%	−73.50%
2017	116,962	39,329	6120	2942	1717	1225	1111	585	4423
			−15.55%	−7.47%	−58.40%	−41.60%	(18.2%)	(9.6%)	−72.20%

Source: Authors

5.5.1 Third Mission as a Strategic Goal

The importance of turning universities into more efficient HUBs (Technology Transfer Centers) of knowledge diffusion has been highlighted in our assessments. The need for a more robust technology transfer activity that leads to entrepreneurial innovations and economic development is perceived as a legitimizing mechanism for academic activities in Brazil. In this regard, the director of TTO_4 mentioned the importance of industrial development based on academic research. Although training remains as the central activity and most relevant form of universities' activities to impact society, it is also observed that other elements encompassed in the third mission of universities were pinpointed as critical for academic embeddedness in innovation systems. The deputy coordinator of TTO_3 emphasized this view towards economic and social development:

> …we expect that knowledge developed within the university to reach society effectively. That is, turning knowledge into wealth. It can transform the university's knowledge into an innovation that will be used, that companies can absorb, that it then generates revenue because it is putting the product on the market, generating jobs, generating taxes to be collected. In this way, TTOs can, by transferring this knowledge that generates wealth, ultimately generate economic development…

Also, the impacts of collaboration with the industry on teaching activities can be felt in the restructuring of the curriculum of undergraduate courses. The Minor Program of the Technological Institute of Aeronautics is one example. However, other initiatives are moving in the same direction, as detailed by the leader of the Research Group_3. According to the interviewee, with the restructuring process, the undergraduate course will become less conceptual, adopting practical activities through interaction with companies. Professors hope that this change will result in students with a more applied profile in the area of innovation.

Concerning collaborative processes, research centers stand out for undertaking frontier scientific research, which ends up attracting public and private partners. Based on real problems proponed by the industry, the centers and groups seek to engage in high-quality research and are internationally competitive. It is relevant to note that the firms with which centers and research groups collaborate comprehend both indigenous and multinational enterprises. These are mostly large companies focused on innovation strategies and engaged in R&D activities. Nonetheless, small companies that interact with universities are generally knowledge-intensive entrepreneurial ventures, being highly dependent on the results of scientific and technological research developed at universities, as is the case of PIPE companies.

Regarding financial support, the importance of private funding as a source of complementary resources, notably in times of constant budget cuts, ends up being reflected in the university's view of the relevance of interaction with external actors. The leader of Research Group_1 notes that there has been a shift in the institutional perspective of the university with the creation of incentives and mechanisms that facilitate the collaboration.

5.5.2 TTOs' Missions, Structure, Activities, and Barriers

As mentioned, the Brazilian Innovation Act of 2004 instituted the requirement for public universities to have a TTO. Thus, the TTOs of the universities analyzed have, for the most part, a trajectory of more than ten years of experience. According to the Act, these TTOs have the mission to (1) support intellectual property activities; (2) promote technology transfer; (3) promote projects of collaboration between universities and the productive sector; and (4) foster entrepreneurial activity. According to TTOs' directors, the mission of TTOs is to act as intermediaries in the process of establishing links between universities and industry. However, it should be noted that several universities already carried out activities of technology transfer and protection of intellectual property rights long before the formal creation of the TTOs, although these activities were under the responsibility of other academic structures.

Except for the offices of the University of São Paulo and the University of Campinas, which have more than 30 employees each, it is noted that other TTOs have a lean structure and constant budget constraints. This situation highlights some lack of strategic perception of these offices in academic activities. Even though these institutions are following established rules, their respective TTOs do not possess sufficient resources to manage technology transfer activities in large universities. TTOs are generally directly subordinate to the universities' provost, which gives them greater autonomy and credibility. In terms of financial resources, revenues come from the universities' budgets, licenses, research contracts, and technology transfer agreements.

Among the activities performed by the TTOs, intellectual property support is the most important activity. This is evidenced by data from the Brazilian Patent Office (INPI), considering that the University of São Paulo and the University of Campinas are consistently listed among the top 10 patent applicants in the country. Also, cultivars stand out as an important asset of the universities, especially in terms of licensing and revenue generation. It is a typical feature of the national economic system in Brazil, heavily reliant on the competitiveness of agricultural activities.

Notwithstanding the patenting capabilities of their institutions, there remain difficulties for TTOs to license developed technologies. According to the deputy director of TTO_5, a way out of this situation - and that would bring universities closer to their ecosystems - would be the development of co-patents. That is, all technology would already be developed in partnership with an external agent ensuring its future application. According to Miller et al. (2016), the transformation of knowledge and its subsequent commercialization, through the exploitation of intellectual property rights, are more successful in the presence of bi-directional flows of knowledge with industrial networks.

Additionally, only recently have TTOs taken a more proactive attitude in terms of prospecting for opportunities. Participation in business events, the search for collaborations in firms engaged in R&D activities, and the creation of industrial master's and doctoral degrees are still incipient and poorly structured. The deputy director of TTO_5 mentions the need for a process that links local demands with academic competences. The need to identify external demands and connect them with research offers developed internally was also mentioned by the leader of the Research Group_1 and the coordinator of the Research Center_4. Initiatives in this regard could result in alignment between the university's scientific and technological knowledge and the productive regional specialization.

However, a major hurdle mentioned by interviewees in TTOs concerns budget constraints. It makes it nearly impossible for TTOs to participate in business acceleration programs and to hire and retain qualified people to perform the necessary tasks. It also reflects in the impossibility of protecting abroad technologies developed at Brazilian scientific institutions. The lack of budget allocation for these applications impacts activities of the National Institute for Space Research, for example. As pointed out by the TTO of this institution, agencies linked to the space area of other countries use the technologies developed in Brazil and are exempt from paying royalties, since these technologies do not have their property rights protected internationally.

In turn, these conditions impact the capacity of TTOs to develop a more proactive and prospective positioning. It generates a negative reputation of TTOs among research centers and groups, who perceive TTOs as inefficient. It is particularly critical for public universities, which must abide by specific legislation concerning technology transfer. Hence, beyond their inability to dedicate resources to networking activities with business partners, TTOs are often associated with inflexibility in the negotiation of contracts, a critique that has been recurrent in previous literature dealing with other contexts (Clarysse et al. 2014; Hayter 2016; Miller et al. 2016; Siegel et al. 2003).

5.5.3 Patenting Activity

Several examples of co-patents were observed in the collaborations established by the research centers, especially in the case of the Federal University of São Carlos and the University of Campinas. In this context, as pointed out by two interviewees, the researcher has an active role in prospecting processes that involve technological development. The development of co-patents was also cited by TTO_2 and TTO_5, which have sought to involve and encourage more researchers to participate in the process of patenting and prospecting for the technologies developed. Such a solution would also avoid excessive patent applications by university researchers who focus on this activity solely to improve their performance indicators.

Thus, there is a need to have a more careful internal analysis of universities' patent deposits, considering the market potential of academic inventions. As underscored by TTO_5, patents need to generate revenue in order not to become just a liability for the university. The need for a more detailed assessment of patent applications was also mentioned in the interview with the Research Center_4. Its coordinator mentioned that TTOs need to have specialized people capable of identifying the potential of an invention. Another solution studied by the TTOs, but not yet implemented, is the use of licensing indicators as an incentive mechanism for career promotion, which would discourage the deposit of IP that has no commercial potential.

The universities are also seeking to play a more active role in IP's portfolio management. In addition to maintaining online repositories of patented technologies, they organize events with companies aiming to disclose their patents. Another possibility opened up by the New Legal STI Framework is the possibility of licensing the technologies without having to run public bids for IP assets. This new possibility is especially relevant for patent applications filed jointly with the productive sector, given that these patents will no longer need to be publicly disclosed and will be of priority use by the co-holder company. Indeed, the leader of the Research Group_1 mentioned the challenge involved in the technology licensing processes and the application of co-patents when analyzing the relationship with the TTOs. According to the interviewee, a more explicit and more transparent policy is needed since the fees charged in the projects vary according to the partner with whom one is interacting, which ends up creating insecurity for companies interested in establishing relationships with universities in Brazil.

Furthermore, technological services, which include the provision of services through the use of infrastructure and equipment available at universities, are also gaining relevance, especially in younger universities and with a focus on interactions with other agents of the ecosystem. This type of linkage is especially frequent when analyzing the Latin American context, being these collaborations typically short-term and involving unidirectional flows of knowledge (Arocena and Sutz 2001; Cai and Liu 2015; Fernandes et al. 2010). With the institutionalization of the New Legal STI Framework, it will be possible to legitimize the offer of technological services, which is still a challenge of ideological and institutional nature in Brazil. It should be noted that the provision of services is not always an activity managed by the TTOs, and in some cases, this function is under the control of the university outreach office or is directly managed by researchers.

The PIPE Firm_2, founded based on academic research in the field of engineering, develops medical equipment and maintains research projects with universities throughout the state of São Paulo, in addition to using these institutions to carry out tests. According to the company's CEO of PIPE Firm_2,

> …the research started before the company. The company started in 2014. The company was created in 2014 as an organization to give life to scientific discovery, and it evolved until it became clear that to set up an organization, you cannot do only research…

Co-publications with industrial researchers are also usual, especially in the case of research centers and groups, following a worldwide trend of increase in recent decades, as observed by Crescenzi et al. (2016). The Research Center_3, for example, has more than 100 peer review papers co-authored with industrial partners. The firms surveyed highlight this practice as a certificate of credibility for industrial research and also as a diffusion mechanism for the technology that has been developed in collaboration with academia. This disclosure helps companies sell their products abroad according to the PIPE Firm_3.

5.5.4 Academic and Student Entrepreneurship

The promotion of academic entrepreneurship by the researchers interviewed is a particular behavior among star scientists. These are pointed out in the literature as actors who are familiar with innovation and entrepreneurship activities, being responsible for the success of new businesses coming from academia and for bringing universities closer to the productive sector (Crescenzi et al. 2017; Fuller and Rothaermel 2012). These findings were confirmed in the interviews. Besides, previous experience with the business founding is also reflected in an entrepreneurial orientation of these scientists, with a focus on characteristics such as short-term orientation, product development, and profit-making (Jain et al. 2009; Meng et al. 2019). Thus, a different normative system based on business principles becomes noticeable in researchers' behavior. The incentive for entrepreneurship on the part of those who finance the activities of the research centers was also mentioned by one director of the Research Center_2 interviewed:

> …companies are coming. This is even demanded from [...] for a more significant creation... for encouraging a bigger creation of companies. The Research Financing Law has changed a bit, so there is a possibility to invest in firms. So we can use part of this amount that would go to research, we can use it to promote companies, small companies, creation of startups, and everything. But this is still very incipient, it is a new thing, from 2015/2016. It is something that people are still trying to understand how it works…

Several firms participating in the research were born from ideas created within the university environment, which was highlighted as a meeting place between people, ideas, knowledge, and opportunities. The PIPE Firm_1 brings evidence that corroborates this conclusion: "*the university provided the place for us to meet and the knowledge base for us to set up the company*" (Partner-Founder of the PIPE Firm_1). In the example of PIPE Firm_5, after being founded, the company was established in the incubator of the *alma mater,* promoting contacts with angel investors. At the beginning of the company's activities, contact with professors and researchers was intense and frequent, which allowed them to have access to frontier knowledge. Currently, despite being located in the city's Science Park, the company still maintains intense collaborations in terms of research projects and teaching activities with the university. Additionally, the company's Product Management Director mentioned that the ecosystem formed from this university was a determining factor in choosing where the company would be based. These findings are in line with the propositions of Miller and Ács (2017), which suggest that universities are environments that lead to the recognition of opportunities and the formation of new firms.

It is essential to highlight the role that the São Paulo Research Foundation has regarding academic entrepreneurship. Research centers' coordinators and groups' leaders stressed the importance of the PIPE Program. According to interviewees, most of the new knowledge-intensive businesses, as well as academic spin-offs, were only founded with the financial support of this initiative. As these are companies that are born from research activities, these projects involve a high degree of risk, which reinforces the importance of having a public agent investing in these ventures. The evidence suggests that there are still countless factors that limit universities to perform all the activities included in the concept of the third mission according to the perspective of the interviewees. The current legislation in Brazil imposes a series of restrictions on the performance of the academic entrepreneurship on the part of professors and employees of public universities, which is a limitation of the institutional context mentioned not only by the TTOs but also by groups and research centers. The New Legal STI Framework aims to eliminate these barriers noticed, but first, it needs to be regulated internally in each university.

5.6 Conclusions

Prior literature has identified the strategic role played by universities in supporting the development and transfer of new technologies to firms in Brazil (Mazzoleni and Nelson 2007). Given the overall weakness of Brazilian firms' technological competences, the relevance of universities as critical elements of this particular innovation system becomes evident (Rapini et al. 2009). As our analysis has demonstrated, Brazil has promoted constant improvements in institutional conditions for achieving closer connections between universities and industry through technology transfer processes that enhance systemic capabilities for entrepreneurial innovations. Nonetheless, several challenges remain for these conditions to reach their potential.

A first noteworthy matter deals with the incipiency of policy initiatives. TTOs only became a widespread part of universities' organization structures in 2004. As this happened in most institutions as part of a new regulatory environment, the need for further embedding a technology transfer culture in academia remains a pending topic. On the other hand, as demonstrated with data from the Brazilian Innovation Survey, there is a lack of firms' demand for technological development arising from academic environments. This cultural disconnection among agents of the ecosystem perpetuates a chasm that negatively affects aggregate competitiveness levels. A clear example of this situation has been highlighted by one of our Deputy Director of TTO_5interviewees:

> …the productive sector demands little from the scientific system, and we see this clearly in the region of (...). Industrial plants that are copies of the headquarters of multinational companies located in the region, and small and medium-sized companies being part of global value chains of large companies whose manufacturing process is closely linked to the demands of large companies, so they are not very innovative…

The university must legitimize its missions and its role in society, especially at the local level. It is the main challenge that lays ahead in the face of imminent budgetary constraints. The university needs to restructure itself to benefit from collaborations with the industry entirely. Systemic conditions for university-industry technology transfer in Brazil have evolved (Fischer et al. 2019, 2020). A much friendlier regulatory environment has been designed over the years in order to promote further integration among agents of the ecosystem, ultimately leading to economic development through entrepreneurial innovations. However, while the country has achieved substantial improvements in this field, it is yet to unleash academic knowledge and turn it into an efficient source of competitiveness for both incumbents and entrepreneurial ventures. In this regard, the behavior of Brazilian firms seems to be a critical bottleneck for more robust technology transfer activity. Accordingly, complementary policies and initiatives that address more fundamental problems in demand for technology seem to be the missing piece of the puzzle.

Acknowledgments Maribel Guerrero acknowledges the Facultad de Economía y Negocios at the Universidad del Desarrollo (Chile), the Northumbria Centre for Innovation, Regional Transformation and Entrepreneurship based on Newcastle Business School at Northumbria University (UK), and the Centre for Innovation Research (CIRCLE) at Lund University (SE) for their invaluable support. Authors acknowledge funding from the São Paulo Research Foundation (Fapesp Grant #2016/17801-4). Bruno Fischer's contribution to this article is based on the study funded by the Basic Research Program of the National Research University Higher School of Economics (HSE) and by the Russian Academic Excellence Project '5-100'.

References

Albuquerque, E. (1999). National systems of innovation and non-OECD countries: Notes about a rudimentary and tentative typology. *Brazilian Journal of Political Economy, 19*(4), 35–52.

Albuquerque, E., Suzigan, W., Arza, V., & Dutrénit, G. (2015). Matrices of university–firm interactions in Latin America. In E. Albuquerque, W. Suzigan, G. Kruss, & K. Lee (Eds.), *Developing national systems of innovation: University–industry interactions in the global south* (pp. 194–218). Cheltenham: Edward Elgar.

Aldridge, T., & Audretsch, D. B. (2017). The Bayh-Dole act and scientist entrepreneurship. In D. B. Audretsch & A. N. Link (Eds.), *Universities and the entrepreneurial ecosystem* (pp. 57–66). Cheltenham: Edward Elgar.

Alves, A., Quelhas, O., Silva, M., & Lameira, V. (2015). On the role of university in the promotion of innovation: Exploratory evidences from a university-industry cooperation experience in Brazil. *International Journal of Innovation and Learning, 17*(1), 1–18.

Arocena, R., & Sutz, J. (2001). Changing knowledge production in Latin American universities. *Research Policy, 30*(8), 1221–1234.

Audretsch, D. B. (2014). From the entrepreneurial university to the university for the entrepreneurial society. *The Journal of Technology Transfer, 39*(3), 313–321.

Autio, E., Kenney, M., Mustar, P., Siegel, D., & Wright, M. (2014). Entrepreneurial innovation: The importance of context. *Research Policy, 43*(7), 1097–1108.

Cai, Y., & Liu, C. (2015). The roles of universities in fostering knowledge-intensive clusters in Chinese regional innovation systems. *Science and Public Policy, 42*(1), 15–29.

Callan, B. (2001). Generating spin-offs: Evidence from across the OECD. *Science Technology Industry Review, 26*, 13–55.

Clarysse, B., Wright, M., Bruneel, J., & Mahajan, A. (2014). Creating value in ecosystems: Crossing the chasm between knowledge and business ecosystems. *Research Policy, 43*(7), 1164–1176.

Crescenzi, R., Nathan, M., & Pose, A. (2016). Do inventors talk to strangers? On proximity and collaborative knowledge creation. *Research Policy, 45*(1), 177–194.

Crescenzi, R., Filippetti, A., & Iammarino, S. (2017). Academic inventors: Collaboration and proximity with industry. *Journal of Technology Transfer, 42*, 730–762.

Dewes, M., Dalmarco, G., & Padula, A. (2015). Innovation policies in Brazilian and Dutch aerospace industries: How sectors driven by national procurement are influenced by its S&T environment. *Space Policy, 34*, 32–38.

Dutrénit, G., & Arza, V. (2015). Features of interactions between public research organizations and industry in Latin America: The perspective of researchers and firms. In E. Albuquerque, W. Suzigan, G. Kruss, & K. Lee (Eds.), *Developing national systems of innovation: University–industry interactions in the global south* (pp. 93–119). Cheltenham: Edward Elgar.

Eisenhardt, K., & Graebner, M. (2007). Theory building from cases: Opportunities and challenges. *Academy of Management Journal, 50*(1), 25–32.

Fernandes, A., Souza, B., Silva, A., Suzigan, W., Chaves, C., & Albuquerque, E. (2010). Academy–industry links in Brazil: Evidence about channels and benefits for firms and researchers. *Science and Public Policy, 37*(7), 485–498.

Fischer, B., Queiroz, S., & Vonortas, N. (2018). On the location of knowledge-intensive entrepreneurship in developing countries: Lessons from São Paulo, Brazil. *Entrepreneurship and Regional Development, 30*(5–6), 612–638.

Fischer, B., Schaeffer, P., & Vonortas, N. (2019). Evolution of university-industry collaboration in Brazil from a technology upgrading perspective. *Technological Forecasting and Social Change, 145*, 330–340.

Fischer, B., Guerrero, M., Guimón, J., & Schaeffer P. R. (2020). Knowledge transfer for frugal innovation: Where do entrepreneurial universities stand? *Journal of Knowledge Management*. https://doi.org/10.1108/JKM-01-2020-0040.

Freitas, I., Marques, R., & Silva, E. (2013). University-industry collaboration and innovation in emergent and mature industries in new industrialized countries. *Research Policy, 42*(2), 443–453.

Fuller, A., & Rothaermel, F. (2012). When stars shine: The effects of faculty founders on new technology ventures. *Strategic Entrepreneurship Journal, 6*(2), 220–235.

Grimaldi, R., Kenney, M., Siegel, D. S., & Wright, M. (2011). 30 years after Bayh–Dole: Reassessing academic entrepreneurship. *Research Policy, 40*(8), 1045–1057.

Guerrero, M., & Urbano, D. (2017). The impact of Triple Helix agents on entrepreneurial innovations' performance: An inside look at enterprises located in an emerging economy. *Technological Forecasting and Social Change, 119*, 294–309.

Guerrero, M., Cunningham, J. A., & Urbano, D. (2015). Economic impact of entrepreneurial universities' activities: An exploratory study of the United Kingdom. *Research Policy, 44*(3), 748–764.

Guerrero, M., & Urbano, D. (2019). Effectiveness of technology transfer policies and legislation in fostering entrepreneurial innovations across continents: An overview. *Journal of Technology Transfer, 44*, 1347–1366.

Guerrero, M., & Urbano, D. (2019a). A research agenda for entrepreneurship and innovation: The role of entrepreneurial universities. In D. Audretch, E. Lehnman, & A. Link (Eds.), *A research agenda for entrepreneurship and innovation* (pp. 107–133). Cheltenham: Edward Elgar.

Guerrero, M., & Urbano, D. (2019b). Effectiveness of technology transfer policies and legislation in fostering entrepreneurial innovations across continents: An overview. *The Journal of Technology Transfer, 44*(5), 1347–1366.

Hayter, C. (2016). A trajectory of early-stage spin-off success: The role of knowledge intermediaries within an entrepreneurial university ecosystem. *Small Business Economics, 47*(3), 633–656.

Herrera, F., Guerrero, M., & Urbano, D. (2018). Entrepreneurship and innovation ecosystem's drivers: The role of higher education organizations. In J. Leitão, H. M. Alves, N. Krueger, & J. Park (Eds.), *Entrepreneurial, innovative and sustainable ecosystems* (pp. 109–128). Cham: Springer.

Jain, S., George, G., & Maltarich, M. (2009). Academics or entrepreneurs? Investigating role identity modification of university scientists involved in commercialization activity. *Research Policy, 38*(6), 922–935.

Kirby, D., Guerrero, M., & Urbano, D. (2011). Making universities more entrepreneurial: Development of a model. *Canadian Journal of Administrative Sciences, 28*, 302–316.

Lockett, A., & Wright, M. (2005). Resources, capabilities, risk capital and the creation of university spin-out companies. *Research Policy, 34*(7), 1043–1057.

Lockett, A., Siegel, D., Wright, M., & Ensley, M. D. (2005). The creation of spin-off firms at public research institutions: Managerial and policy implications. *Research Policy, 34*(7), 981–993.

Mazzoleni, R., & Nelson, R. (2007). The roles of research at universities and public labs in economic catch-up. *Research Policy, 36*(10), 1512–1528.

Meng, D., Li, X., & Rong, K. (2019). Industry-to-university knowledge transfer in ecosystem-based academic entrepreneurship: Case study of automotive dynamics & control group in Tsinghua University. *Technological Forecasting and Social Change, 141*, 249–262.

Miller, D., & Ács, Z. (2017). The campus as entrepreneurial ecosystem: The University of Chicago. *Small Business Economics, 49*, 75–95.

Miller, K., McAdam, R., Moffett, S., Alexander, A., & Puthusserry, P. (2016). Knowledge transfer in university quadruple helix ecosystems: An absorptive capacity perspective. *R&D Management, 46*(2), 383–399.

Miranda, F. J., Chamorro, A., & Rubio, S. (2018). Re-thinking university spin-off: A critical literature review and a research agenda. *The Journal of Technology Transfer, 43*(4), 1007–1038.

Motoyama, Y., & Knowlton, K. (2017). Examining the connections within the startup ecosystem: A case study of St. Louis. *Entrepreneurship Research Journal, 7*(1), 1–32.

Norbäck, P. J., & Persson, L. (2012). Entrepreneurial innovations, competition and competition policy. *European Economic Review, 56*(3), 488–506.

O'Shea, R. P., Chugh, H., & Allen, T. J. (2008). Determinants and consequences of university spin-off activity: A conceptual framework. *The Journal of Technology Transfer, 33*(6), 653–666.

Oliver, A. L., & Sapir, A. (2017). Shifts in the organization and profession of academic science: The impact of IPR and technology transfer. *Journal of Professions and Organization, 4*(1), 36–54.

Perkmann, M., King, Z., & Pavelin, S. (2011). Engaging excellence? Effects of faculty quality on university engagement with industry. *Research Policy, 40*(4), 539–552.

Rapini, M., Albuquerque, E., Chave, C., Silva, L., Souza, S., Righi, H., & Cruz, W. (2009). University-industry interactions in an immature system of innovation: Evidence from Minas Gerais, Brazil. *Science and Public Policy, 36*(5), 373–386.

Ryan, M. (2010). Patent incentives, technology markets, and public–private bio-medical innovation networks in Brazil. *World Development, 38*(8), 1082–1093.

Salles-Filho, S., Bonacelli, M., Carneiro, A., Castro, P., & Santos, F. (2011). Evaluation of ST&I programs: A methodological approach to the Brazilian Small Business Program and some comparisons with the SBIR program. *Research Evaluation, 20*(2), 157–169.

Santos, M., & Mello, J. (2009). IPR policy and management of university technology transfer offices in Brazil. In *Triple Helix Association: 7th biennial international conference on university, industry and government linkages*, Glasgow, Scotland, 17–19 June 2009.

Santos, M., & Torkomian, A. (2013). Technology transfer and innovation: The role of the Brazilian TTOs. *International Journal of Technology Management and Sustainable Development, 12*(1), 89–111.

Siegel, D., Waldman, D., & Link, A. (2003). Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: An exploratory study. *Research Policy, 32*(1), 27–48.

Silva, L., & Guimarães, P. (2015). Law and innovation policies: An analysis of the mismatch between innovation public policies and their results in Brazil. *Law and Development Review, 9*(1), 1–57.

Sørheim, R., Widding, L. Ø., Oust, M., & Madsen, Ø. (2011). Funding of university spin-off companies: A conceptual approach to financing challenges. *Journal of Small Business and Enterprise Development, 18*(1), 58–73.

Strauss, A. (2003). *Qualitative analysis for social scientists*. New York/Cambridge: Cambridge University Press.

Wright, M., Lockett, A., Clarysse, B., & Binks, M. (2006). University spin-out companies and venture capital. *Research Policy, 35*(4), 481–501.

Chapter 6
Technology Transfer Policy Framework in Chile

Claudia Yáñez-Valdés and Maribel Guerrero

6.1 Introduction

The advance of technology in the last decades has become an opportunity to develop complex artifacts or experimentation and give solutions to society's needs (Bercovitz and Feldman 2006). Any technology transfer process requires a strategic combination of scientific research, innovation, and entrepreneurship (Audretsch and Link 2012). This combination allows democratizing the economy by allowing new actors to enter the market with innovative solutions, proposing the replacement of obsolete technologies.

The technology transfer process represents how countries generate and transform knowledge into useful/marketable innovations or technologies within the productive system (Mowery and Oxley 1995). In the Chilean context, the main producers of knowledge are universities, research centers, and innovative companies. Over the last decades, the government has strengthened the production and commercialization of knowledge through several instruments and programs, consolidating the technology transfer policy framework. An established process of technology transfer promotes innovation, which is a determining factor in improving social welfare and the economy's competitiveness. In addition to the

C. Yáñez-Valdés (✉)
Facultad de Economía y Negocios, Universidad del Desarrollo, Santiago, Chile
e-mail: clyanezv@udd.cl

M. Guerrero
Facultad de Economía y Negocios, Universidad del Desarrollo, Santiago, Chile

Northumbria Centre for Innovation Regional Transformation and Entrepreneurship (iNCITE), Newcastle Business School, Northumbria University, Newcastle upon Tyne, UK

Centre for Innovation Research (CIRCLE), Lund University, Lund, Sweden
e-mail: maribel.guerrero@northumbria.ac.uk

M. Guerrero, D. Urbano (eds.), *Technology Transfer and Entrepreneurial Innovations*, International Studies in Entrepreneurship 51,
https://doi.org/10.1007/978-3-030-70022-5_6

community's benefits, innovations resulting from technology transfer represent a return on public investment in research and development.

In this chapter, we analyze the technology transfer policy framework's evolutionary process and its effectiveness. To doing so, the chapter adopts a retrospective longitudinal analysis of secondary sources of information. Our findings provide insights about the progress at the regulatory level and gaps in the technology transfer process from producers to enterprises.

The remainder of this chapter is organized as follows. Section 6.2 introduces a review of the existing literature on technology transfer in emerging economies. In Sect. 6.3, we explain the methodology design for collecting the information required in the analysis. Then, Sect. 6.4 describes the evolution of technology transfer policies in Chile. Finally, we conclude by outlining the main conclusions and implications.

6.2 Theoretical Framework

Technology transfer is understood as the formal/informal movements of know-how, skills, technical knowledge, procedures, methods, expertise, and technology from one organizational environment to another organizational environment (Roessner 2000). The knowledge construct includes human judgment elements, while technology tends to be more tangible and precise (Mitchell and Boyle 2010). It is restricted to using methods, techniques, and tools to transform the environment, incorporating scientific knowledge. Technology is evaluated in its capacity to generate desired results concretely, and, as such, it needs to be explicit and codifiable (Gopalakrishnan and Santoro 2004).

The complex technology transfer process involves multiple stages, actors, and disciplines (Lin and Li 2011). Technology transfer occurs through at least four means: (a) spin-offs representing a new venture formed by individuals who were employees of one scientific organization based on an essential technology generated and transferred from a parent organization (Steffensen et al. 2000); (b) licensing granting rights to make, use and sell specific innovations (product, design, or process) or to perform specific actions by the party who has the right to give such permission (Ramachandran 1993); (c) patents representing the exclusive right granted by the State for the protection of an invention and give the owner the exclusive right to sell or assign his rights to another person to commercialize it under license, or to prevent third parties from commercially exploiting the protected invention for a limited period; and (d) publications are also a means of diffusion of knowledge and not for potential users of a research-based technology (Rogers et al. 2001).

Based on these means, entrepreneurial innovations involve the disruption of existing industries and new ones through multi-level processes and stakeholders, multiple actors, and multiple contexts that constitute different entrepreneurial ecosystems (Autio et al. 2014). Specifically, concerning technology transfer from universities to industry, the promotion of these processes includes a wide range of activities involving the generation, use, application, and exploitation of knowledge.

The commercialization of the results generated in this interaction can represent a complementary funding source for universities and research centers. It is one more reason to advance in scientific research matters for the development of a country.

Technology transfer is one of the fundamental challenges that emerging economies face to advance to be a developed country. The advance of technology in the last decades has become an opportunity to develop complex artifacts or experimentation and give solutions to society's needs (Bercovitz and Feldman 2006). Technology transfer is essential for this process since it links scientific research, innovation, and entrepreneurship (Audretsch and Link 2012). This relationship democratizes the economy by allowing new actors to enter the market with innovative solutions, proposing replacement to obsolete technologies.

The role of the State in promoting technology transfer is based on the potential benefits of developing the results of scientific research so that they reach society in the form of products and services (Mowery and Oxley 1995). An established technology transfer process promotes innovation, which is a determining factor in improving social welfare and the economy's competitiveness. In addition to the community's benefits, innovations resulting from technology transfer represent a return on R&D's public investment. The State must act directly as a regulatory agent due to a series of market failures that hinder technology transfer and innovation. Among the main inefficiencies are systemic failures, financing gaps, communication gaps, and knowledge gaps (Kochenkova et al. 2015). There are major coordination failures and high transaction costs.

The effectiveness of the technology transfer process depends, to a large extent, on the interaction between different agents who have different goals, objectives, and priorities. In emerging economies, we identify three gaps: (a) the funding gap representing the insufficient investment in the early stages of technological development, therefore, derives from problems of appropriability of knowledge due to its public nature and the high uncertainty regarding the results of R&D activities (Munari et al. 2018); (b) the communication gap representing the differences in culture, language, and expertise among the different agents participating in the technology transfer process (Decter et al. 2007): and (c) the knowledge gap that represents a significant deficiency in knowledge management skills among researchers and academic entrepreneurs (Wright et al. 2004). The knowledge gap can affect the staff working in technology transfer offices, especially if they are newly established. In this sense, the lack of networks and professional experience can also affect interaction with the industrial and financial sectors.

6.3 Methodology

6.3.1 Contextualization

Over the last decade, Chile has made enormous progress in the life quality of its citizens. The country has had a record of growth and poverty reduction that has made it a strong emerging economy. On May 7, 2010, Chile became the first South

American country to join the Organization for Economic Cooperation and Development (OECD). With this milestone, it has become a necessity to incorporate better policies in various areas. Compared to other OECD members, Chile ranks below average in terms of income and wealth, civic participation, health status, jobs and income, housing, work-life balance, social connections, personal security, education and skills, and environmental quality well-being. Chile is one of the OECD member countries that invests the least in R&D, with 0.4% of GDP (OECD 2003).

In Chile, various incentive mechanisms and instruments have been used to promote transfer and foster links between knowledge-generating centers and enterprises. The latter incorporates knowledge and technology into their work to provide new or improved products and services. Therefore, companies are in charge of putting into value the research activity results by transforming the knowledge into goods or services useful for society and allowing the development of relevant innovations and solutions. However, Chile is still in debt with the growth and innovation models that have not achieved the expected results, and the necessary policies to promote research development are not yet strengthened.

According to the OECD (2003), it is the member that invests the least in R&D. Even though the State has promoted the development of Startup incubators and investment in R & D in the last few years, these efforts are still insufficient and reflected in the low figures for patenting. It seems that current policies and regulations have not stimulated the development of this area in companies or have not reached an appropriate level to allow the transmission of knowledge (Ministerio de Ciencias 2020). This institutional weakness also reflects the lack of coordination between the public and private agents involved in the process. As a member of the OECD countries, Chile should encourage advances in science and technological knowledge in the production sector by promoting intellectual property management, encouraging strategic alliances for developing applied research; and fostering new technology-based enterprises (OECD 2003). Therefore, the technology transfer policy framework's change may have to do more to raise awareness of the importance of protection, taking a new, more modern, effective, and efficient look at industrial property rights.

6.3.2 Methodological Design

We adopted the retrospective case study approach (Leonard-Barton 1990) through multiple secondary sources of information related to Chile's technology transfer policy framework. Concretely, we revised official reports from the Ministry of Economy, Development, and Tourism; the National Institute of Intellectual Property; the National Agency for Research and Development; the Ministry of Science, Technology, Knowledge and Innovation; the National Council of Innovation for Development; the Development Corporation; the Agriculture Ministry; the Ministry of Health; the National Arts Council; and the Ministry of Education. We analyzed the information by adopting the triangulation process suggested by Yin (2017).

6.4 The Chilean Technology Transfer Policy Framework

6.4.1 The Evolution of Technology Transfer and Industrial Property Policies

In Chile, the foundations' technology transfer policy framework is linked to intellectual property rights for inventions, mostly influenced by the U.S. Bayh-Dole Act (Gotkin 2012). Historically, the first trademark regulation, namely the Royal Regulations and Tariffs for Free Trade from Spain to the Indies of October 12, 1778. Then, industrial property regulation was established in 1833 to guarantee their authors' exclusive property and inventors' discoveries and production. A few years later, the registration of trademarks was in charge of the National Society of Agriculture funded by the Ministry of Finance in 1838. Then, the Decree-Law on Patents for the invention came into force, and the first patent law was approved in 1840. Andrés Blest granted the first patent for the "method for making rum in Chile" in Valparaíso.

In the Latin American context, Chile was one of the pioneers in dictating industrial property's trademark norms (1925 Decree-Law No. 588, the 1931 Decree-Law No. 291, 588, and 958). The Industrial Property Law included patents, trademarks, and industrial models. In the 1950s, the Ministry of Economics was re-organized into the Department of Commerce and the Department of Industry (including the Patent and Trademark Offices). In the 1960s, the Department of Industrial Property comprised the Patent and Industrial Model Conservator, the Trademark Conservator, and the Legal Under secretariat. In the 1970s, Chile adopts the International Classification of Goods and Services for the Registration of Trademarks, and the Agreement of Strasbourg governed the classification of Patents and Utility Models.

In the 1990s, in return to democracy, the industrial property law was enacted in 1991. The first initiatives taken by the Ministry of Economy, Development, and Reconstruction was oriented towards the modernization of the industrial property law of 1931. The industrial property law established similar procedures for processing different rights, extending prior oppositions to utility models for incremental inventions, establishing penalties for the infringement of rights, and extending the patentable subject matter to products excluded from patentability until that time in almost half of the legislations worldwide. After this reform process, Chile was part of the Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement), free trade agreements with the United States, and the European Community. Chile has adopted the Paris Convention for the Protection of Industrial Property of 1838, the Berne Convention for the Protection of Literary and Artistic Works, the Eighth Round of Multilateral Negotiations of the General Agreement on Tariffs and Trade adopted in the Marrakech Agreement, and the Annex 1C: "Agreement on Trade-Related Aspects of Intellectual Property Rights" of the World Trade Organization.

In the 2000s, Chile implemented several reforms in the Industrial Property Law and created the weekly Industrial Property Gazette. These reforms were aligned to the Marrakech Agreement about industrial designs, layout designs, geographical origin, industrial property, undisclosed information, and penalties. For instance, Law No. 20.154 standardized and reduced the 15% of additional tax rate levied on imports of software, technological consultancy, and patents from abroad. In 2007, Law No. 20.160 entered into force as the second amendment to the Industrial Property Law to adapt it to the free trade agreements with North America and Europe. It incorporates trademarks certification that clarifies the possibility of registration of sound marks, harmless disclosures, among others. At the institutional level, in 2009 was created the National Institute of Intellectual Property (INAPI). The critical milestone was given a substantial boost to intellectual property. Chile now has an institute responsible for administering and developing the national intellectual property system. This institute ensures a balance between rights holders and society and contributes to its economic and social development.

The institute follows the classic registration functions, encourages technology transfer and knowledge promotion, and advises the President of the Republic about this area and international matters. In 2012, the INAPI was recognized by the World Intellectual Property Organization (WIPO), the International Searching Authority (ISA), and the Patent Cooperation Treaty. INAPI is the 19th entity around the world and the 2nd in Latin America. In 2014, the INAPI officially started to operate as International Search Authority and Preliminary Patent Examination Authority of the Patent Cooperation Treaty. Finally, Chile launched the National Industrial Property Strategy in 2016. This strategy establishes a set of actions and measures to promote/use intellectual property as an effective economic and social development instrument. Concretely, the strategy encourages innovation and knowledge dissemination. Also, several Centers for Digital Innovation and Technology Transfer were created by the Corporation for the Promotion of Production of the Ministry of Economy, Development, and Tourism. These centers try to establish a network of digital innovation centers for prototyping and technology transfer, linked to large corporations, universities, and strategic locations. This network operates in the form of distribution centers, which act collaboratively, and centrally store the characteristics of the developed prototypes, their State of development, and level of success. Thus implemented, this network will allow the reuse of successful prototypes, whether they have been developed in different centers in the country or abroad, enabling using the same prototype in several cases in the same industry or different industries.

6.4.2 The Agencies Related to Technology Transfer

The intellectual property encourages innovation, technology transfer, and decision-making by the consumer public. In a broad sense, intellectual property relates to all creation produced by the human mind, including inventions, utility models, trademarks, literary and artistic works, among others. The industrial property's outcomes include patents, utility models, trademarks, collective marks, and certification marks (INAPI 2020). Table 6.1 shows the Chilean agencies with a complete dedication or active participation in intellectual property matters. The National Institute of

Table 6.1 Chilean agencies related to intellectual property

Types of intellectual property	INAPI	MINAGRI (FIA)	MINSAL (ISP)	MINEDUC AND MINCIENCIA	COUNCIL OF CULTURE
Patents	X				
Utility models	X				
Integrated circuit topographies	X				
Copyright				X	X
Plant varieties		X			
Brands	X				
Designations of origin	X	X			
Geographical indications	X	X			
Industrial designs	X				
Trade and business secrets	X				
Undisclosed information	X	X	X		
Genetic resources	X	X			X

Source: Authors

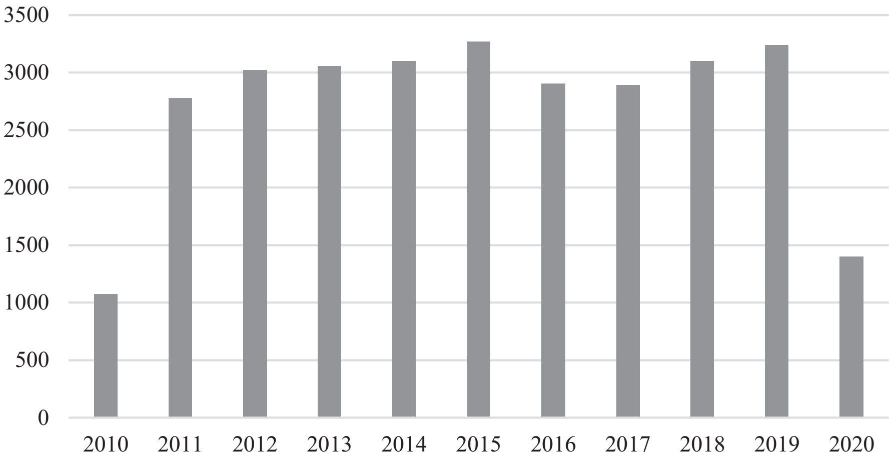
Intellectual Property (INAPI) plays a role as a patent registration office disseminating, protecting, and evaluating intangible assets. The Ministry of Agriculture (MINAGRI), through the Foundation for Agricultural Innovation (FIA), is focused on the protection of forestry and agricultural intellectual property. The Ministry of Health (MINSAL), through the Chilean Institute of Public Health (ISP), is focused on health control by surveillance, authorization, inspection, research, and technology transfer. The Ministry of Education (MINEDUC) is supporting R&D generated by the beneficiary institutions, such as technology transfer and licensing. The Ministry of Science, Technology, Knowledge, and Innovation (MINCIENCIA) is focused on designing policy frameworks/instruments for science and technology transfer. The National Council for Culture, Arts, and Heritage is focused on supporting copyrights and preservation of arts, traditional cultures, and cultural heritage.

6.4.3 *Insights about the Effectiveness of Technology Transfer Frameworks*

We found two trends that provide insights into the technology transfer framework's effectiveness are: patents and technological-based companies.

The first insight related to the policy framework's effectiveness is the number of patents that imply the protection of an invention for 20 years. The benefits derived from the patent's exploitation are the promotion of innovations and technological capabilities. Patentable advances in a given field of technology can cover both disruptive and incremental innovation. The potential patented invention must meet three requirements: must be novel, have an inventive level, and be susceptible to industrial application. Figure 6.1 shows that the number of annual patents has presented a sustained growth from 2016 to now, reaching in 2019, the best number over the last 10 years (INAPI 2020). This number dropped in 2020 due to the effects of the pandemic.

Concerning the PCT, Table 6.2 the institutions that patent more under this modality are the universities (WIPO 2020)



Source: Authors

Fig. 6.1 Applied Patents per year in Chile. (Source: Authors)

Table 6.2 PCT top applicants

Applicant	2017	2018	2019
Pontificia Universidad Católica de Chile	9	12	19
Universidad de Chile	14	11	12
Universidad de Santiago de Chile	11	10	10
Universidad Técnica Federico Santa Maria	4	4	8
Universidad de Concepcion	6	6	7
Universidad de Antofagasta		3	5
Bhp Chile Inc.			2
Compañía Minera San Geronimo			2
Envases Chiloe S.A.			2
Golden Omega S.A.			2

Source: Authors

Table 6.3 TTOs, HUBs and Spin-offs

Year	TTOs	HUBs	Spin-offs
2015	18	0	11
2016	24	0	10
2017	25	0	15
2018	29	3	14

Source: Authors

The second insight related to the policy framework's effectiveness is the number of technological-based ventures (spin-offs). According to the Ministry of Science (2020), spin-offs are understood as technological-based ventures born from ideas or scientific knowledge within research centers, university TTOs or HUBs. In this vein, CORFO (2019) had supported the creation of these scientific infrastructures that manage knowledge and technological innovations that could be transferred into local or international markets. Table 6.3 shows some insights about the evolution of Chilean TTOs, HUBs, and Spin-offs during the last 5 years (CORFO 2019). Concretely, the number of technological-based ventures reveals some advances but also several challenges given internal barriers like bureaucracy.

Indeed, the Study of Characterization of Science and Technology-Based Enterprises in Chile showed that 97% of the 299 ventures had received public funds for their operation, and the rest had received funds from the National Agency Research (ANID) related to the Ministry of Science (2020). It reveals that technology-based ventures have been supported by several programs and instruments associated with the technology transfer framework—most of these technology-based ventures are born within research laboratories and universities.

6.5 Conclusions

The development of a knowledge-based economy is strongly related to an effective technology transfer policy framework (Guerrero and Urbano 2019). The Chilean regulations, instruments, and programs implemented represent an effort but not sufficient to realize the technology transfer processes that enhance enterprises' competitiveness. The main challenges are associated with a lack of collaboration among agents involved in the innovation ecosystem and the entrepreneurship ecosystem. The weak link between knowledge generators (universities, research centers), knowledge managers (TTOs, HUBs), and industry demand new instruments that engage this relationship. Potential technological entrepreneurs have difficulties in linking their core activities with knowledge produced within universities. Entrepreneurs are neither beneficiaries nor creators of knowledge. Therefore, they lose the funding opportunities associated with technology transfer programs. Also, universities' internal regulations and bureaucratic aspects affect the process of technology transfer, which is reflected in the low number of spin-offs created per year

(Guerrero et al. 2015). The spin-offs born under the umbrella of universities can be successful or can even remain in the initial stages due to lack of support, so progress must be made to monitor these ventures.

It is important that the technology transfer policy framework takes into account these particularities and does not focus solely on financing, such as a mere loan from the State, and that its resources are returned to the State's coffers and, in some cases, even the resulting intellectual property becomes the property of the State. Innovation is an investment, not an expense. The Chilean technology transfer framework should assume a basic principle that the State must encourage innovation, transfer, and the generation of technological entrepreneurs.

The study's limitations are related to a lack of consolidation of reports and more publicly available information on the implementation of the various programs. Especially in agencies that administer a large number of programs, there are no indicators of each program's effectiveness or follow-up of the technology transfer that they seek to promote. Future research must integrate the territorial approach and the characteristics of the countries as determinants of technology transfer. Also, research should be carried out in the R&D ecosystem to support institutions as a network as a whole. On the other hand, the role of the private sector as a support agent for technology transfer is an issue that needs to be reviewed to determine its importance for technology-based firms.

Acknowledgments Claudia Yáñez-Valdés acknowledges the financial support provided by the Universidad del Desarrollo. Maribel Guerrero acknowledges the Facultad de Economía y Negocios at the Universidad del Desarrollo (Chile), the Northumbria Centre for Innovation, Regional Transformation and Entrepreneurship based on Newcastle Business School at Northumbria University (UK), and the Centre for Innovation Research (CIRCLE) at Lund University (SE) for their invaluable support.

References

Audretsch, D., & Link, A. (2012). Entrepreneurship and innovation: Public policy frameworks. *The Journal of Technology Transfer, 37*(1), 1–17.

Autio, E., Kenney, M., Mustar, P., Siegel, D., & Wright, M. (2014). Entrepreneurial innovation: The importance of context. *Research Policy, 43*(7), 1097–1108.

Bercovitz, J., & Feldman, M. (2006). Entrepreneurial universities and technology transfer: A conceptual framework for understanding knowledge-based economic development. *The Journal of Technology Transfer, 31*(1), 175–188.

Corporación de Fomento de la Producción CORFO. (2019). Transferencia Tecnológica en Chile: "Estudio de caracterización de las actividades y resultados de los procesos de transferencia tecnológica desde los centros de conocimiento en Chile." Santiago de Chile.

Decter, M., Bennett, D., & Leseure, M. (2007). University to business technology transfer—UK and USA comparisons. *Technovation, 27*(3), 145–155.

Gopalakrishnan, S., & Santoro, M. (2004). Distinguishing between knowledge transfer and technology transfer activities: The role of key organizational factors. *IEEE Transactions on Engineering Management, 51*(1), 57–69.

Gotkin, J. (2012). *The United States Bayh-Dole Act and its effect on university technology transfer*. Baden-Baden: Nomos Verlagsgesellschaft mbH & Co. KG.

Guerrero, M., Cunningham, J. A., & Urbano, D. (2015). Economic impact of entrepreneurial universities' activities: An exploratory study of the United Kingdom. *Research Policy, 44*(3), 748–764.

Guerrero, M., & Urbano, D. (2019). Effectiveness of technology transfer policies and legislation in fostering entrepreneurial innovations across continents: an overview. *The Journal of Technology Transfer, 44*(5), 1347–1366.

Instituto Nacional de Propiedad Intelectual INAPI. (2020). *Propiedad Intelectual e Industrial*. Retrieved from Instituto Nacional de Propiedad Intelectual. https://www.inapi.cl/propiedad-intelectual-e-industrial.

Kochenkova, A., Giuri, P., Grimaldi, R., & Munari, F. (2015). The effect of university-level support policies on female participation in academic patenting. Paper presened at the Druid15 Conference. https://conference.druid.dk/acc_papers/4x015n6flh5aoadklvf27tmfut8m.pdf.

Leonard-Barton, D. (1990). A dual methodology for case studies: Synergistic use of a longitudinal single site with replicated multiple sites. *Organization Science, 1*(3), 248–266.

Lin, Z., & Li, W. (2011). Technological innovation ability of normal universities from authorization of patents and transference of patents in China. Taking South China Normal University as an example. *Technology and Innovation Management, 2*.

Ministry of Science. (2020). *Caracterización de los participantes de la Transferencia Tecnológica en Chile*. Retrieved from http://ctie.economia.cl/wp-content/uploads/2020/01/20200110-Boletin-transferencia-tecnológica-1.pdf.

Mitchell, R., & Boyle, B. (2010). Knowledge creation measurement methods. *Journal of Knowledge Management, 14*(1), 67–82, Q Emerald Group Publishing Limited, ISSN 1367-3270.

Mowery, D., & Oxley, J. (1995). Inward technology transfer and competitiveness: The role of national innovation systems. *Cambridge Journal of Economics, 19*(1), 67–93.

Munari, F., Sobrero, M., & Toschi, L. (2018). The university as a venture capitalist? Gap funding instruments for technology transfer. *Technological Forecasting and Social Change, 127*, 70–84.

Organization for Economic Cooperation and Development OECD. (2003). *Organisations, turning science into Business: Patenting and licensing at public research*. Retrieved from https://www.oecd-ilibrary.org/.

Ramachandran, V. (1993). Technology transfer, firm ownership, and investment in human capital. *The Review of Economics and Statistics, 75*, 664–670.

Roessner, J. (2000). Technology transfer. In *Science and technology policy in the US. A time of change*. London: Longman.

Rogers, E., Takegami, S., & Yin, J. (2001). Lessons learned about technology transfer. *Technovation, 21*(4), 253–261.

Steffensen, M., Rogers, E., & Speakman, K. (2000). Spin-offs from research centers at a research university. *Journal of Business Venturing, 15*(1), 93–111.

World Intellectual Property Organization WIPO. (2020). *The patent cooperation treaty statistics*. https://www.wipo.int/edocs/infogdocs/en/ipfactsandfigures2019/.

Wright, M., Birley, S., & Mosey, S. (2004). Entrepreneurship and university technology transfer. *The Journal of Technology Transfer, 29*(3–4), 235–246.

Yin, R. (2017). *Case study research and applications: Design and methods*. London: Sage Publications.

Part IV
Empirical Evidence in Europe

Maribel Guerrero and David Urbano

> *"Reports from funding agents have shown inconclusive evidence regarding the effectiveness of policy frameworks and instruments that foster entrepreneurship and innovation."*
>
> – Guerrero and Urbano (2019, 1350)

Although the European countries have shown maturity in the design and implementation of policy frameworks that support entrepreneurship and innovation activities, little is still known in the academic literature about the effectiveness and impacts of this legislation, programs, or instruments (Guerrero and Urbano 2019). A big lesson after the 2008 financial situation was working on the unification and implementation of smart specialization policies by allocating the public resources considering the reinforcement of each country member's dynamic capabilities. Given the current events related to the COVID-19 pandemic, this part of the book looks back on the outcomes and benefits of technology transfer policies for fostering entrepreneurial innovations.

This part of the book then looks forward to some recommendations to protect the future and face the current challenges and opportunities by considering the learning lessons. Concretely, this part of the book is integrated by three longitudinal quantitative studies that examine the relationship between policy frameworks and

M. Guerrero (✉)
Facultad de Economía y Negocios, Universidad del Desarrollo, Santiago, Chile

Centre for Innovation Research (CIRCLE), Lund University, Lund, Sweden

Northumbria Centre for Innovation, Regional Transformation and Entrepreneurship (iNCITE), Newcastle Business School, Northumbria University, Newcastle upon Tyne, UK
e-mail: maribel.guerrero@northumbria.ac.uk

D. Urbano
Department of Business and Centre for Entrepreneurship and Social Innovation Research (CREIS), Universitat Autònoma de Barcelona, Bellaterra, Spain
e-mail: david.urbano@uab.cat

entrepreneurial innovations through interesting proxies. Chapter 7 showed relevant results related to how R&D policies and organizational factors influence entrepreneurial innovations and their effects on European firms' growth. Chapter 8 also demonstrates the positive relationship between indicators of knowledge diffusion processes (R&D expenditure at country-level and ICT usage at work by entrepreneurs at individual-level) and individual-level entrepreneurial performance, as well as the intriguing moderated role of Intellectual Property Rights (IPR). Chapter 9 shown the initial positive effect of a German legislation reform (Hochschullehrerprivileg) that fosters entrepreneurial innovation among university faculty.

Consequently, these chapters offer readers at least two provoking academic discussions. The first academic discussion is related to proxies for measuring entrepreneurial innovations through R&D activities at the firm level, entrepreneurial performance at the individual level, and start-ups and patents at the university level. The second provocative academic discussion is related to the intriguing hamper effects of strict legislation on the knowledge diffusion process created by R&D activities. In this view, the research agenda highlights the need to understand and evaluate the technology transfer policy frameworks' effectiveness. Policymakers should also need to consider the level of technology transfer protections they want to install carefully through policy frameworks and instruments.

Reference

Guerrero, M., & Urbano, D. (2019). Effectiveness of technology transfer policies and legislation in fostering entrepreneurial innovations across continents: An overview. *The Journal of Technology Transfer*, *44*(5), 1347–1366.

Chapter 7
Antecedents and Consequences of Innovation via R&D in Europe

David Urbano, Andreu Turro, and Sebastian Aparicio

7.1 Introduction

In recent decades, researchers have paid increasing attention to the role of entrepreneurship and innovation in productivity, innovation, employment and economic and social development (Acs et al. 2012; Audretsch and Keilbach 2008; Urbano and Aparicio 2016; among others). In this regard, both researchers and policymakers consider that fostering entrepreneurship and innovation means fostering the development of economies (Aparicio et al. 2020). Specifically, R&D investments have been studied extensively from an innovation perspective because they can lead to competitive advantage through the creation of new products, processes, or technologies (Barker and Mueller 2002). For this reason, a significant number of studies have examined how R&D activities are influenced by several factors, such as: a firm's industry (Scherer 1984); public policy instruments (Becker 2015); national institutions (Judge et al. 2015); access to informal networks (Reagans and McEvily 2003); corporate strategy (Baysinger & Hoskisson 1989); firm size (Revilla and Fernández 2012); access to company resources (Del Canto and Gonzalez 1999) and organizational slack (Alessandri and Pattit 2014); CEO characteristics and leadership style (Barker and Mueller 2002); and employees' absorptive capacity and knowledge (Kang and Lee 2017); among others. Although the literature is diverse,

D. Urbano (✉) · A. Turro
Department of Business and Centre for Entrepreneurship and Social Innovation Research (CREIS), Universitat Autònoma de Barcelona, Barcelona, Spain
e-mail: david.urbano@uab.cat; andreu.turro@uab.cat

S. Aparicio
Durham University, Durham University Business School, Durham, UK

Fundación ECSIM, Medellin, Colombia
e-mail: sebastian.aparicio@durham.ac.uk

M. Guerrero, D. Urbano (eds.), *Technology Transfer and Entrepreneurial Innovations*, International Studies in Entrepreneurship 51,
https://doi.org/10.1007/978-3-030-70022-5_7

two different but strong streams of research on the antecedents of R&D activity are highlighted, namely, economics and management (Griffiths and Webster 2010; Teece 2018). On the one hand, from an economic perspective, the emphasis tends to be placed on the effect of external factors such as industry characteristics or competitive environment (Wang 2007). On the other hand, the management and business literature has been more focused on companies' internal variables, such as a firm's strategy and human resource practices (Stock et al. 2014). The question that still persists for scholars, policymakers and managers is whether the amount of public and private resources invested in creating R&D activities and projects exerts profitable and successful innovations which help companies grow (Markham et al. 2010). As it is well known, innovative activities are developed under high risk and uncertainty (Branscomb et al. 2001). Auerswald and Branscomb (2003) have discussed how some costly projects do not succeed because no commercial applicability is found in the new invention, which, in turn, affects the growth goals of firms.

Extant literature recognizes the problem of progressing scientific discovery from laboratory to market (Moultrie 2015). Few research studies have made significant attempts to address this phenomenon and authors such as Markham et al. (2010) claim that even though previous research recognizes the problem, the solution is still fuzzy. For instance, there are works that have used a holistic approach to study both the determinants of R&D activity and its subsequent consequences on sales, profits, number of employees, or new product launches (Choi et al. 2016; Oura et al. 2016; Stock et al. 2014; Wang 2007; Wang and Dwi Lestari 2013); however, these studies recognize limitations and certain relevant areas could be explored further. First, previous research using a holistic approach considers mostly company- and individual-level factors (Oura et al. 2016). Therefore, from this perspective, the role of environmental antecedents for R&D has not been researched in depth (Feldman 2014). In particular, the effect of formal institutions (i.e., regulations) has not been studied quantitatively from an antecedent and consequences perspective (Martin 2016; Patriotta and Siegel 2019). This is a relevant omission because it means that the analysis of the barriers and drivers to innovation through R&D activities is not complete. Specifically, the literature suggests further analysis on factors such as labor regulations and access to highly skilled employees, because both might be relevant for R&D activities as they may foster or hamper the recruitment process of qualified workers needed for the invention process (Bornay-Barrachina et al. 2012; Kleinknecht et al. 2014). Secondly, there is limited evidence of the complementary effects that both internal and environmental determinants have on R&D activities (directly) and on firms' performance (indirectly), which limits our understanding of this phenomenon (Feldman 2014; Link 2020). A more complete picture of how various factors condition R&D activity, but also how they subsequently influence firm performance, could enhance our knowledge about the type of organizational resources, human capital practices and public policies that lead to successful R&D.

Recognizing that research on the antecedent and consequences of R&D is still separated, this chapter studies the simultaneous effects that a set of factors (at the company and environmental levels of analysis) have on R&D activity, which may explain firm growth. This study applies a two-stage probit least squares (2SPLS) estimation, using data from the EU-EFIGE/Bruegel-UniCredit. This includes a total of 14,759 different observations for seven European countries (Austria, France, Germany, Hungary, Italy, Spain, and the U.K.). Antoncic (2007) claims that there are a limited number of studies in this field which use multi-country and European data. In fact, the prevalence of datasets from the U.S. (and U.K.) could limit the development of certain researches at the international level (Antoncic 2007). The results show how a set of two different internal resources (employment of foreign executives and the percentage of fixed-term contracts among employees) and two external institutional determinants (country labor regulations and specific training outside the firm) influence R&D activities in Europe. In addition, their subsequent influence on firms' growth is also confirmed. This allows us to have a more complete understanding of innovation through R&D, which has implications, both from a theoretical and practical point of view.

Our study contributes first to the literature that explores antecedents and consequences of R&D activities as mechanisms for intrapreneurship, corporate entrepreneurship and innovative entrepreneurial behaviors (Baden-Fuller 1995; Hughes and Mustafa 2017; Turro et al. 2014). This is, our model provides an enhanced understanding about which specific R&D determinants lead to firm growth and job creation. Hence, we contribute by showing how investments in some specific R&D determinants might be particularly appropriate if companies want to grow. This is a relevant implication because previous literature does not agree about under which circumstances R&D activities lead to firm growth (Lamperti et al. 2017). Hence, although some companies spend significant amounts of resources on R&D and policymakers design policies to foster these types of activities, their efforts do not necessarily lead to better firm performance (Ahn et al. 2018; Coad and Rao 2008). Second, the evidence suggests the importance of implementing training programs for workers at all levels, who, through innovations, lead companies to higher growth levels. Precisely the implementation of certain practices such as the recruitment of foreigners and flexible contracts for all workers is highlighted as a relevant finding. Third, at the managerial and strategic levels, our results might be helpful for those managers searching for new markets at the local or international level. In this regard, drawing on the intersection between (institutional) economics and management, our results may be useful to dive into the policy discussion about gaining knowledge from immigration and international relations (Kitching et al. 2009). We show that both, external training and workers from overseas are sensitive strategies that generate innovation and, at the same time, spur firm growth. Consistent with the extant literature, the adoption of innovations may respond to both external and internal factors (Damanpour et al. 2018), preparing firms to create or enter into new markets. As Wright et al. (2016) discuss, the political environment might be harmful for the formation of financial capital, which is needed to leverage different firm strategies and outcomes.

Apart from this introduction, the chapter is structured as follows. In Section 7.2, we review the literature on innovation and entrepreneurial activities through R&D, and present the hypotheses of the research. Section 7.3 explains the methodology of the study. The findings of the study are presented in section 7.4. Finally, section 7.5 provides conclusions and suggests some limitations and future research lines.

7.2 Theoretical Framework

As explained above, the literature on the antecedents of innovation and R&D activity can be differentiated by various determinants (Stock et al. 2014). Thus, this study offers two sets of different hypotheses. The first set of hypotheses concerns determinants such as *foreign executives* and *fixed-term contracts*, which are considered to be internal factors for the company. The second set of hypotheses focuses on *labor regulations* and *external training*, which are considered to be environmental factors. Throughout the literature analysis, we have identified that both internal and environmental factors play a crucial role in explaining R&D activities which are expected to lead to the firm's growth. From an internal determinants' perspective, extant research has highlighted that human capital attributes may be viewed as a valuable company resource (Barney 1991; Riley et al. 2017). Hence, employees with higher pools of human capital should be more capable of both recognizing and exploiting new business opportunities (Davidsson and Honig 2003). In this regard, having cultural diversity and different backgrounds among managers (hence, wider and higher human capital) should have a positive effect on a firm's capacity to adapt to new changes and to innovate. For instance, prior international business experience on the part of the manager has gained increased significance and is widely recognized as a vital asset for firms (Wang 2008). International experience has been argued to embrace abilities to search for information, identify and evaluate opportunities, screen country markets, evaluate strategic partners and manage customs operations and foreign exchange (Fletcher and Harris 2012; Urbano and Turro 2013). Cultural (and knowledge) diversity can positively affect the firm's speed of absorption of external knowledge, which leads to greater R&D investments (Moreira et al. 2018). In this regard, R&D expenditure is one of the innovation indicators that is more strongly related to different forms of firm growth (Bianchini et al. 2018; Hodges and Link 2019) even when companies compete in non-high-tech sectors (Booltink and Saka-Helmhout 2018).

The role of temporary contracts on innovation outcomes represents another key internal resource (also related to human capital) whose effect remains unclear (Zhou et al. 2011). Flexibility is considered a fundamental factor if companies want to respond quickly to technological changes and to new business opportunities (Altuzarra and Serrano 2010). Therefore, companies need not only to have skilled employees but also flexibility to manage the workforce. This is, investments in innovation and R&D often require work reorganization; hence, those companies that have less firing restrictions should be more able to adapt to those changes (Saint-Paul 2002), particularly, in contexts of high uncertainty (Ghignoni et al. 2018). Overall, companies benefit from flexibility as it allows to have a more effective response to technological changes, and it increases the chances of exploiting new business opportunities more efficiently (Altuzarra and Serrano 2010). In this regard, having employees with fixed-term contracts offers the opportunity to progressively increment innovation since they allow job flexibility and better job matching (Smirnykh 2016). Based on the above, the following hypotheses are posed:

Hypothesis 1a: The employment of foreign executives in the firm makes the development of innovation via R&D more likely, this allows an increase in the firm's growth.

Hypothesis 1b: The engagement of employees using fixed-term contracts makes the development of innovation via R&D more likely, this allows an increase in the growth of the firm.

From an external determinants' perspective, the formal institutional framework (North 1990, 2005) has extensively been considered to play a fundamental role as it stimulates (or constraints) innovation in companies (Puffer et al. 2010). Hence, policymakers are aware of the importance of creating an environment that supports R&D activities (Becker 2015; von Zedtwitz et al. 2015). In this respect, the labor market is part of the formal institutional framework and it is relevant for R&D activity. Some of the most studied labor market aspects include, among others, strong trade unions, access to relevant social benefits and high minimum wages (Kleinknecht et al. 2014). Harsh employment laws and procedures have a negative effect on labour mobility hampering (or delaying) reallocation of jobs from declining sectors to growing and more dynamic ones (Nickell and Layard 1999). Hence, more labour mobility implies and enhanced supply of new employees and more (and better) new ideas for organizations, what leads to more innovative and entrepreneurial initiatives. In this context, individuals looking for a job are more likely to find one where they can work more efficiently, what could have an effect on the firm's productivity (Smirnykh 2016). Overall, investments in R&D tend to lead to different types of firm growth (Ruiqi et al. 2017; Stam and Wennberg 2009).

Research explains how a simplified labor market could serve to obtain the necessary resources needed to develop new innovative projects more easily (Begley et al. 2005). In this regard, external training and education are also part of the formal institutional environment and contribute to provide the wide range of skills needed to improve the companies' innovation capacity (Gonzalez et al. 2016). Consistent with this, private R&D benefits from geographically localized knowledge spillovers and from access to highly skilled human capital (Becker 2015). Training can increase the distribution of knowledge across employees and facilitate the development and reconfiguration of existing capabilities (Thornhill 2006). Therefore, as employees acquire specific human capital resources and skills from training programmes, experiences and learning processes (Guerrero and Peña 2013), it is considered necessary that the company offers specific training and refresher courses to their workers to implement and develop innovative projects (Hayton and Kelley 2006). Overall, the existence and intensity of this effect on performance may be different depending on various company or environmental characteristics which may simultaneously influence the likelihood of engaging with R&D activities and the effects on firm performance (Riley et al. 2017; Teirlinck 2017). Therefore, we propose the following hypotheses:

Hypothesis 2a: Higher labor market restrictions make the development of innovation via R&D less likely, which reduces firm growth.

Hypothesis 2b: Training outside the firm makes the development of innovation via R&D more likely, which reduces firm growth.

7.3 Methodology

7.3.1 Data

This chapter utilizes the EU-EFIGE/Bruegel-UniCredit dataset (Altomonte and Aquilante 2012). This survey, released in 2010, includes cross-sectional information about manufacturing companies across seven European countries (Austria, France, Germany, Hungary, Italy, Spain and the UK) for the years 2007–2009. The data collection was carried out thanks to the European project entitled European Firms in a Global Economy: Internal Policies for External Competitiveness (EFIGE), which was developed from September 2008 to August 2012. Altomonte and Aquilante (2012) assert that the support from the European Commission under the Directorate General Research was key to reach firms across Europe. Due to the common research and sample design for all countries, the EFIGE dataset provides comparable and consistent information on firms' characteristics, including ownership structure and innovation. The extrapolation of common descriptive statistics and regression analyses to the business population was based on three criteria. First, the availability of a large sample of firms; second, a response rate ranging from 85 to 90% for five to ten key questions, all of them previously agreed; and third, a proper stratification of selected firms within the sample, which enabled enough representativeness of the gathered data ex-ante and ex-post for each country. In addition to these criteria, this dataset was totally anonymized, so there is not even possible to identify firms by categorizing NACE2 industry sectors. Altomonte and Aquilante (2012) provide further details about the survey design, sampling, validity and so on.

The dataset includes information for 14,759 European firms, distributed as follows: 3,021 in Italy; 2,973 in France; 2,935 in Germany; 2,832 in Spain; 2,067 firms in the UK; 488 firms in Hungary; and 443 in Austria. The sample selected in each country has been designed to be representative of the manufacturing structure (stratification by industry, region and firm size). In this regard, the survey excludes firms smaller than 10 employees. In addition, the EFIGE dataset is fully comparable across countries, as it has been obtained from responses to the same questionnaire administered over the same time span (January to May, 2010). In general, the questions refer to 2008, although some relate to information in 2009 and the years previous to 2008. This is done to account for the effects of the crisis as well as the dynamic evolution of firms' activities. Finally, the data contain additional information that allows us to go beyond balance sheet information to address other relevant matters related to the relationship between innovation through R&D and firm performance. In this regard, the dataset also provides information on firm characteristics and activities; the variables are divided into six sections: proprietary structure of the firm; structure of the workforce; investment, technological innovation and R&D; internationalization; finance; and market and pricing. Based on this structure, we pay particular attention on those variables that enable us to capture internal characteristics often associated with human capital, and those external factors related to certain regulations and market characteristics that explain, first innovation through R&D, and second, firm performance.

Dependent variables We are interested in knowing how R&D activities and firm performance are recursively linked. Thus, our first dependent variable consists of measuring *innovation through R&D*. Although this is a limited proxy, there are studies that still use R&D to discuss innovative activities (cf. Link and Scott 2019; Patlibandla and Petersen 2002). These works explain that R&D involves staff with certain technical knowledge that are expected to innovate either methods or products. It is an investment that can bring return to the firm throughout competitiveness and new knowledge that is transferred from universities, laboratories, etc. (Amorós et al. 2019; Cunningham et al. 2019; Guerrero and Urbano 2019). On these bases, we have a binary variable which takes the value 1 if the firm has more than 1% of employees involved in R&D activities and more than 1% of Entrepreneurs/executives (included middle management) familiar or not of own firm; and 0 otherwise. Previous studies in entrepreneurship and R&D literature have used similar binary dependent variables (Altomonte et al. 2013; Arenius and Minniti 2005). Our second dependent variable comprises a traditional measure of *firm growth*, which is related to the size of the firm. Despite that there exist different alternatives to measure performance, it is suggested that sales, assets and employment are highly correlated, so they could substitute each other (Wiklund and Shepherd 2005). The dataset enables us to understand entrepreneurship and innovative behavior within the company and its possible relationship with the firm's achievements (e.g., annual turnover in 2008, number of employees, etc.).Therefore, we approach to firm growth by capturing the total number of employees of firms in the home country in 2008.

Internal factors as independent variables In order to test the first set of hypotheses, which are related to human capital variables, we have used *foreign executives*. This variable is measured through a dummy that takes the value 1 if the firm has more than 1% of Foreign Executives (included middle management); and 0 otherwise. The reasoning behind this proxy regards to the knowledge that can be shared throughout socialization processes between local and foreign workers. Hausmann (2016) explains that a way to gain competitiveness consists of recruiting people from overseas to learn different processes and ways of doing things. Indeed, Hausmann and Neffke (2019) show how workers mobility helps to expand knowledge frontiers, which is observed through new industries in the economy. In order to achieve such an expansion through foreign workers, it is also important that the firm offers appealing contracts, which match the experience and salary of the worker. In this sense, we have captured *fixed-term contract* as the percentage of employees that have worked with fixed-term contract in 2008 (variable transformed into natural logarithm). Authors such as Brown and Sessions (2005) suggest that this behavior within firms might penalize workers with same level of education compared to those having permanents contracts. However, Boockmann and Hagen (2008) and Hagen (2002) suggest that variables like this might capture a sort of incentive firms apply to increase workers' performance. These authors explain that workers are tempted to enter into permanent contracts, so a good internal competition might benefit the company through different innovations workers can come up with.

External factors as independent variables According to Teece (2007), firms should combine internal characteristics (or capabilities) with external factors that can bring opportunities or challenge, which serve firms to learn from. In order to cover some aspects that are external to the company, we have used *labor regulations*, which is measured through a binary variable that takes the value 1 if the firm has considered labor market regulations as a main factor preventing an appropriate firm performance; and 0 otherwise. Although this is a firm's perception, other authors have provided evidence on how expectations coming from certain regulations might affect firms (cf. Krasniqi and Desai 2016). Basically, firms modify their decisions according to what they think of supportive policies or barriers imposed by governments (Brown et al. 2017; Lajqi and Krasniqi 2017). Another external variable has to do with the knowledge existing out of the firm that can be acquired through strategies related to *formal training*. Acs et al. (2013) and Braunerhjelm et al. (2018) explain that knowledge can be learnt through entrepreneurs either creating new ventures or working for SMEs. We approach to this external knowledge by using a binary variable which takes the value 1 if the employees have participated in formal training programs outside the firm; and 0 otherwise. Coad et al. (2016) and Storey (2004) have used similar variables, in which the training has come from banks or other companies, respectively. Accordingly, these authors find that training is a good variable that explains entrepreneurship and firm performance.

Control variables To control for unobservable characteristics within the firm, we use *gender of CEO* (equal to 1 if male; otherwise 0); *workforce variation* (equal to 1 if the firm has perceived workforce reduction or increase; and 0 otherwise); *managerial experience* (equal to 1 if the firm has had any executive working abroad at least 1 year; and 0 otherwise); *external financing* (level of external financing dependency perceived in the industry of firm --variable transformed into natural logarithm); and *R&D investment* (average percentage of the total turnover that the firm has invested in R&D in the last 3 years (2007–2009) –variable transformed into natural logarithm). From this perspective, some previous studies have indicated that women's participation rates in entrepreneurship are lower than the rates for men (Arenius and Minniti 2005). Similarly, changes in the workforce and the number of employees have also been highlighted as potential factors influencing entrepreneurial activities (Barbosa and Eiriz 2011). In addition, different types of previous experiences might have an effect on the likelihood of engaging in R&D activities (Di Guardo and Harrigan 2016). Finally, access to external finance has been extensively considered to play a key role in the development of innovative outcomes (Chang and Shih 2004). To control for certain aspects that can also affect firm performance (Visintin and Pittino 2014; Vohora et al. 2004;), the variables analyzed were the *age* of the organization (those firms with 6–20 years of operation and those with less than 6 years are equal to 1; 0 otherwise) and *industry types* (i.e., traditional, exhibiting economies of scale, and specialized), which are represented by dummy variables as well. Regarding country-specific effects, in addition to labor regulations and workforce variation which capture regulatory and some market dynamics, we also included country fixed effects in the equations. As we are using cross-sectional data, the inclusion of other variables at the country level might be useless as their influence can be observed by the constants representing each fixed-effect. It is also important to notice that although some authors have used firm size as a control variable explaining firm performance (Baum and Wally 2003; Burghardt and Helm 2015; Coad and Rao 2008; Delmar et al. 2003; among others), we avoided this measure as some collinearity problems with the firm growth proxy occurred. Table 7.1 provides a summary of the variables used in the study.

7.3.2 Method

Bringing together antecedents and consequences of R&D requires an empirical design that considers simultaneity. Thereby, we used a two-stage probit least squares (2SPLS) estimation (Keshk et al. 2004; Maddala 1983), based on a dummy variable version of two-stage least squares (2SLS), as the estimation strategy. The set of reduced-form equations are stated as follows:

$$\mathrm{P}\left(\mathrm{RD_i} = 1\right) = f\left(\mathrm{R_i}, \mathrm{I_i}, \mathrm{CV_i}\right) \tag{7.1}$$

$$\mathrm{FGi} = f\left(\widehat{RD}_{\mathrm{i}}, \mathrm{xi}\right) \tag{7.2}$$

where RD_i corresponds to innovation through R&D, R_i refers to companies' resources and capabilities, I_i represents institutions and CV_i represents the control variables for Eq. (7.1). Regarding Eq. (7.2), FG_i is firm growth, RD_i is innovation through R&D and x_i denotes the control variables for this equation. All these variables pertain to each organization *i*. The estimation follows a two-stage process with an additional step of standard error correction to avoid heteroscedastic results. Equation (7.1) is estimated with probit and Eq. (7.2) using ordinary least squares (OLS); the predicted values ($\widehat{RD_i}$ and $\widehat{FG_i}$) from each model are obtained throughout the second stage. In this step, the original endogenous variable in Eq. (7.1) is replaced by $\widehat{RD_i}$. Finally, the procedure ends with the correction of standard errors to guarantee the efficiency of the estimated equations. Given the research objective, potential endogeneity between the dependent variables (*firm growth* and *innovation through R&D*) could exist. It is likely that innovation through R&D is driven by increasing firm performance and this type of entrepreneur contributes to higher firm growth as a result of new product and service creation. Innovation through R&D only accounts for a small percentage in most countries and this may attenuate its feedback into firm performance. To overcome this situation, we focused on instrumenting innovation by taking into account human capital as well as institutional factors.

Table 7.1 Description of variables

Eq. 7.1	Variable	Description
Dependent variables	Innovation through R&D	Dummy variable takes the value 1 if the firm has more than 1% of employees involved in R&D activities and more than 1% of Entrepreneurs/executives (included middle management) familiar or not of own firm; and 0 otherwise.
Independent variables	Foreign executives	Dummy variable takes the value 1 if the firm has more than 1% of Foreign Executives (included middle management); and 0 otherwise.
	Ln % employees with fixed-term contract	Percentage of employees that have worked with fixed-term contract in 2008.
	Labor market regulations	Dummy variable takes the value 1 if the firm has considered labor market regulations as a main preventing an appropriate firm performance; and 0 otherwise.
	External training	Dummy variable takes the value 1 if the employees have participated to formal training programs outside the firm; and 0 otherwise.
Control variables	Gender of CEO	Dummy variable takes the value 1 if male; and 0 otherwise.
	Any variation of workforce	Dummy variable takes the value 1 if the firm has perceived workforce reduction or increase; and 0 otherwise.
	Managerial experience	Dummy variable takes the value 1 if the firm has had any executive that worked abroad at least 1 year; and 0 otherwise.
	Ln Dependency of external financing of industry sector	Level of external financing dependency perceived in the industry of firm.
	Ln % of investment in R&D from total turnover	Average percentage of the total turnover that the firm has invested in R&D in the last 3 years (2007–2009)

Eq. 7.2	Variable	Description
Dependent variable	Ln Firm growth	Total number of employees of your firm in the home country in 2008.
Independent variables	Innovation through R&D	Dummy variable takes the value 1 if the firm has more than 1% of employees involved in R&D activities and more than 1% of Entrepreneurs/executives (included middle management) familiar or not of own firm; and 0 otherwise.

(continued)

Table 7.1 (continued)

Eq. 7.2	Variable	Description
Control variables	Between 20 and 6 years of operation	Dummy variable takes the value 1 if the firm has operated between 6 and 20 years since the establishment; 0 otherwise.
	Less than 6 years of operation	Dummy variable takes the value 1 if the firm has operated less than 6 years since the establishment; 0 otherwise.
	Traditional industries	Dummy variable takes the value 1 if the firm corresponds to the traditional industries according to Paviit classification on the basis of original NACE code of firm (3-digits); 0 otherwise.
	Economies of scale industries	Dummy variable takes the value 1 if the firm corresponds to the economies of scale industries according to Paviit classification on the basis of original NACE code of firm (3-digits); 0 otherwise.
	Specialized industries	Dummy variable takes the value 1 if the firm corresponds to the specialized industries according to Paviit classification on the basis of original NACE code of firm (3-digits); 0 otherwise.

7.4 Results

Table 7.2 provides a summary of the descriptive statistics for the variables we studied. Table 7.3 enables us to see that on average, 72.7% of companies devote more than 1% of their employees and executives to R&D activities. In terms of firm growth, on average, firms across the sample have 65.09 workers. Notice that European firms have about 22% foreign executives, and that only 3.9% of employees have a fixed term contract.

Table 7.3 shows several significant correlations at the 90% level for some of the variables studied, however, the subsequent multicollinearity analysis shows that this is not a problem. Specifically, we calculated the VIF value for Eq. (7.1), which is 1.02, while for Eq. (7.2) it is 1.95. Thus, excessive multicollinearity is not affecting our results significantly. Particularly, the correlation analysis displays that our variables of interest (i.e. foreign executives, fixed terms contract and external training) are positively correlated to innovation through R&D; whilst labor regulation goes in opposite direction. Table 7.3 also shows that innovation through R&D and firm growth are positively correlated. These results are consistent with our initial expectations.

Furthermore, to address the possibility of heteroscedasticity and autocorrelation among observations pertaining to the same company, corrected standard errors were estimated (Keshk 2003). The 2SPLS regression analysis is presented in Table 7.4, in which we report the estimated coefficients, the marginal effects (probit models) and corrected standard errors in parentheses for all models. All the models are highly significant ($p \leq 0.000$). Although the analysis is based on 2SPLS results, for comparison reasons, we used three additional estimation strategies: the linear

Table 7.2 Descriptive Statistics

No.	Variables	N	Mean	Std. Dev.	Min	Max
1	Innovation through R&D	14,759	0.727	0.445	0	1
2	Foreign executives	14,759	0.039	0.194	0	1
3	Fixed term contract	8,685	2.982	2.239	0	23.026
4	Labor regulations	12,444	0.190	0.392	0	1
5	External training	14,759	0.367	0.482	0	1
6	Gender of CEO	14,759	0.922	0.267	0	1
7	Workforce variation	14,759	0.584	0.493	0	1
8	Managerial experience	14,759	0.219	0.413	0	1
9	External financing	14,526	1.161	2.327	0	23.026
10	R&D investment	7,403	1.429	1.148	0	23.026
11	Firm growth	14,759	3.561	0.965	2.303	6.215
12	6–20 years	14,759	0.352	0.478	0	1
13	Less than 6 years	14,759	0.071	0.256	0	1
14	Traditional industries	14,759	0.477	0.499	0	1
15	Economies of scale industries	14,759	0.252	0.434	0	1
16	Specialized industries	14,759	0.181	0.385	0	1

Note: *N* number of observations, *Std. Dev.* standard deviation, *Min.* Minimum value, *Max.* maximum value

probability model (not accurate given the dummy nature of the dependent variable in Eq. (7.1), the probit model (appropriate for Eq. (7.1), but does not take into account the simultaneity issue), and linear regression for Eq. (7.2) only.

Model 1 presents the regression results for company and environmental factors affecting the development of innovation via R&D in a linear probability model performed through OLS Eq. (7.1). Model 2 assesses the same variables using probit estimation. Model 3 shows the results of analysis only for firm growth analysis Eq. (7.2). Model 4 displays the results for both equations using the entire set of variables analyzed in this chapter. Given that some variables have missing values, the sample varies across models.

Hypothesis 1a measures the effect of *foreign executives* on innovation through R&D. In this case, the variable exhibits significant behavior with the expected sign in all the models presented. In addition, it is the variable that has a higher impact (larger marginal effect). Overall, the results support Hypothesis 1a. Therefore, the employment of executives from different nationalities increases the likelihood of devoting a significant amount of resources to R&D activities, which in turn influences firm growth. Similarly, the results support Hypothesis 1b, as it also has a significant and positive sign in all the models presented. Therefore, the higher the percentage of employees with *fixed-term contracts*, the more likely it is that R&D activities will be developed; however, this impact is less relevant than in the case of the previous hypothesis.

Labor regulations have a significant effect with the expected sign in Models 1 and 2; hence, the stronger labor market regulations are, the less likely it is that firms will engage in R&D activities (and vice versa). In addition, having appropriate labor

Table 7.3 Correlation matrix

N	Variables	1	2	3	4	5	6	7	8
1	Innovation through R&D	1							
2	Foreign executives	0.097	1						
3	Fixed term contract	0.012	0.010	1					
4	Labor regulations	−0.087	−0.025	−0.069	1				
5	External training	0.062	−0.007	−0.011	−0.033	1			
6	Gender of CEO	0.070	0.012	0.015	−0.027	0.019	1		
7	Workforce variation	0.071	0.024	0.036	0.019	0.014	0.012	1	
8	Managerial experience	0.153	0.209	0.020	−0.040	0.031	0.042	0.060	1
9	External financing	0.037	0.029	0.056	−0.064	0.033	−0.001	0.016	0.040
10	R&D investment	−0.002	0.042	0.025	0.005	0.014	−0.013	−0.053	0.033
11	Ln Firm growth	0.251	0.259	−0.091	−0.055	−0.006	0.078	0.143	0.324
12	6–20 years	−0.006	−0.031	0.036	−0.022	0.018	−0.003	0.018	−0.033
13	Less than 6 years	0.015	−0.004	0.016	−0.022	−0.006	−0.010	0.032	0.010
14	Traditional industries	−0.137	−0.068	0.040	0.048	−0.047	−0.043	−0.014	−0.122
15	Economies of scale industries	0.072	0.029	−0.020	−0.021	−0.009	0.019	0.012	0.056
16	Specialized industries	0.061	0.034	−0.017	−0.035	0.035	0.033	0.016	0.054

N	Variables	9	10	11	12	13	14	15	16
8	International experience								
9	External financing	1							
10	R&D investment	0.027	1						
11	Ln Firm growth	0.032	−0.104	1					
12	6–20 years	−0.007	0.047	−0.129	1				
13	Less than 6 years	0.009	0.017	−0.044	−0.203	1			
14	Traditional industries	−0.028	−0.070	−0.130	0.005	0.006	1		
15	Economies of scale industries	−0.001	0.001	0.091	−0.015	−0.008	−0.555	1	
16	Specialized industries	0.044	0.025	0.035	0.005	−0.006	−0.448	−0.273	1

Correlations in bold are significant at $p < 0.10$

market regulations also has an indirect effect on firm growth, as this variable also remains significant in Model 4. Overall, we find support for Hypothesis 2a. Hypothesis 2b addresses the role of *external training* in innovation through R&D. In this case, the fact that the employee receives formal training outside the firm has a positive impact on R&D activity (Models 1 and 2). Similarly, *external training* also affects firm growth indirectly through its significant effect in Model 4. Consequently, the findings also support Hypothesis 2b.

Table 7.4 Estimation results of simultaneous equation model

	(1)	(2)		(3)	(4)	
	Innovation through R&D	Innovation through R&D			Innovation through R&D	
		Estimation	dy/dx		Estimation	dy/dx
Foreign executives	0.133*** (0.015)	0.831*** (0.155)	0.157*** (0.017)		0.381** (0.182)	0.088** (0.035)
Ln % employees with fixed-term contract	0.006***	0.028*	0.008*		0.046***	0.012***
	(0.002)	(0.016)	(0.004)		(0.013)	(0.004)
Labor market regulations	−0.079***	−0.271***	−0.078***		−0.187***	−0.053***
	(0.018)	(0.057)	(0.018)		(0.060)	(0.018)
External training	0.038***	0.136***	0.036***		0.174***	0.046***
	(0.013)	(0.051)	(0.013)		(0.052)	(0.014)
Gender of CEO	0.138***	0.431***	0.135***		0.249**	0.073**
	(0.030)	(0.088)	(0.031)		(0.096)	(0.031)
Any variation of workforce	0.057***	0.208***	0.058***		0.122**	0.033**
	(0.014)	(0.050)	(0.014)		(0.054)	(0.015)
Managerial experience	0.107*** (0.013)	0.425*** (0.057)	0.108*** (0.013)		0.089 (0.096)	0.023 (0.025)
Ln Dependency of external financing of industry sector	0.005** (0.002)	0.024+ (0.015)	0.007+ (0.004)		0.019 (0.013)	0.005 (0.003)
Ln % of investment in R&D from total turnover	−0.005	−0.021	−0.006		0.030	0.008
	(0.006)	(0.022)	(0.006)		(0.025)	(0.007)
Ln Firm growth					0.457***	
					(0.104)	
Constant	0.571***	0.086			−1.517***	
	(0.034)	(0.104)			(0.379)	
(Pseudo) R^2	0.057	0.061			0.067	
Probability		0.810			0.811	
Log likelihood		−1696.465			−1686.921	
LR X^2					241.07	
				Ln Firm growth	Ln Firm growth	
Innovation through R&D				0.515*** (0.015)	1.045*** (0.089)	
Between 20 and 6 years of operation				−0.287*** (0.016)	−0.343*** (0.061)	
Less than 6 years of operation				−0.286*** (0.029)	−0.432*** (0.112)	
Traditional industries				−0.195***	0.205*	

(continued)

Table 7.4 (continued)

	(1)	(2)		(3)	(4)	
				(0.030)	(0.107)	
Economies of scale industries				0.020	0.119	
				(0.033)	(0.106)	
Specialized industries				−0.055+	0.096	
				(0.034)	(0.110)	
Constant				3.405***	3.095***	
				(0.031)	(0.134)	
Country fixed-effects	No	No		No	Yes	
Observations	3531	3531		14759	3531	
R^2				0.095	0.274	

+p = 0.1, *p & 0.10, **p & 0.05; ***p & 0.01
Note: Model 1 is estimated through linear probability model (OLS) with robust standard errors, Models 2 and 3 are estimated through probit and OLS with robust standard errors, respectively; while model 4 is estimated using 2SPLS, which have corrected standard errors (in parentheses)

7.5 Discussion and Conclusions

7.5.1 Discussion

Using data from the EU-EFIGE/Bruegel-UniCredit dataset for seven different European countries, this chapter studied the simultaneous effects that a set of factors (at the company and environmental levels of analysis) has on R&D activity, which may explain firm growth. Particularly, the significant result of the variable *foreign executives* is in line with those studies that describe how foreign managers with different backgrounds have the potential to enhance the company's ability to adapt to changes or to identify new business opportunities (Li et al. 2012). From this perspective, Westhead et al. (2001) explain that entrepreneurial firms with diverse management know-how and international business experience may be able to undertake more promising competitive strategies and exploit opportunities than their larger counterparts. Similarly, firms with higher market knowledge are considered to have a higher propensity (or learning capability) to gather further foreign knowledge (Andersen and Bettis 2015). Overall, the literature agrees that conducting business in international markets allows managers to develop knowledge and specific business skills associated with the context in which they are developed (Glavas and Mathews 2014; Johanson and Vahlne 2003). Moreover, it has also been suggested that managers who have developed their careers in one organization can be assumed to have a relatively limited perspective when faced with an unprecedented problem (Herrman and Datta 2006).

The results for the variable *fixed-term contract* show that having a significant number of temporary jobs has a positive effect on the development of innovative activities in established companies. More flexible companies (in terms of workforce) can have more efficient responses to external shocks (Krishna Dutt et al. 2015). Those firms with less flexible labor forces might tend to focus on relatively secure goods so that they do not have to pay the costs of adjusting the labor force (Di Cintio and Grassi 2017; Saint-Paul 2002); hence, they may focus on incremental innovations rather than on launching completely new products and innovations (Aparicio et al. 2016).

From the perspective of the external formal institutional environment, the previous literature has already highlighted how regulations and certain procedural requirements can have a negative effect on innovation (Djankov et al. 2002; Johnson et al. 2015). In the case of the labor market, there is no consensus on its effect and in fact, previous literature shows opposing views. On the one hand, it has been argued that fixed-term contracts have a detrimental effect on innovation because they lead to companies investing less in training their employees (Al-Laham et al. 2011). Thus, employees tend to be less skilled and less loyal to companies (e.g. they change jobs more often), what makes the overall companies' levels of specific human capital remain low (Bentolila and Dolado 1994). On the other hand, it has also been argued that the fewer the restrictions, the more likely it is that companies will be able to attract the appropriate human capital resources for their new projects (Urbano et al. 2019b). From this perspective, companies can flexibly adjust their workforce and invest in those areas and sectors that are more emergent and dynamic (Bassanini and Ernst 2002). Our findings contribute to this view because, according to them, more simplified labor market regulations could have a direct influence on the development of R&D activities. Similarly, the simultaneous model presented shows that this could have an indirect effect on the growth of firms.

Finally, regarding the role of *external training*, the findings show that knowledge gives individuals greater cognitive capacity, making them more productive and efficient (Becker 1964). Formal education is considered to be one component of human capital that may assist in the accumulation of explicit knowledge and may provide skills useful to employees (Davidsson and Honig 2003); hence, individuals with a greater quality of human capital and education will be better able to identify and exploit business opportunities (Gonzalez-Alvarez and Solis-Rodriguez 2011). Thus, our findings are in line with those research that suggest that people who start businesses have a higher level of education than people who do not (Bowen and Hisrich 1986; Turro et al. 2016). Several previous studies have found a positive impact from training courses or programs at universities on the perceived attractiveness and feasibility of starting new innovative initiatives (Peterman and Kennedy 2003). Hence, a firm's intellectual capital is considered to be a key and rich source of the knowledge flows required to promote corporate entrepreneurship (Chandler et al. 2005; Kiss and Barr 2014; Urbano et al. 2013). If the company has qualified human resources, the implementation and development of new projects will become easier; moreover, the possibilities of success will increase.

7.5.2 Contributions to Theory

Overall, this chapter has both theoretical, practical and policy implications. The research provides a two steps model of the phenomenon of entrepreneurial innovation through R&D because it simultaneously studies both its antecedents and consequences for firm growth in terms of number of employees. This provides an enhanced understanding of the relevance of R&D determinants. This is, we contribute by showing a picture that includes not only how some key factors condition R&D investments but also how these factors lead to firm growth (Crepon et al. 1998). Hence, the importance of these specific determinants is reinforced. Our findings contribute to the research that highlights the challenges of understanding when investments in innovation and R&D actually lead to better firm performance (Markham et al. 2010). A significant part of the resources spent in R&D and innovation do not lead to better productivity or financial performance (Graddy-Reed et al. 2018), and therefore could be used more efficiently. Hence, the existence and intensity of this effect on performance may be different depending on various company or environment characteristics (which may influence simultaneously the development of R&D activities and the effect on firm performance). Overall, there is widespread agreement amongst researchers that innovation may be one of the most effective methods of achieving high levels of organizational performance (Kuratko 2009; Morris et al. 2011). Indeed, numerous real-world examples are available demonstrating how a firm's commitment to recurring R&D investments can lead to enhanced organizational performance (Bloodgood et al. 2015). Similarly, previous studies have also shown that firms that are entrepreneurially orientated develop competitive advantages that lead to better performance (Walter et al. 2006). Overall, improved organizational results, usually in terms of growth and profitability, are thought to be a result of entrepreneurship and innovation in established organizations (Covin and Slevin 1991). Indeed, most authors take the view that the growing academic interest in this field stems mainly from this positive relationship (Narayanan et al. 2009).

In addition, the results also contribute to the discussion about the role of internal and environmental factors for R&D activities (Urbano et al. 2019a). Previous research in the area of management, had rarely emphasized the importance of the formal institutional context (North 1990) what limits our understanding of the factors that enable successful R&D investments. The findings of this study show how factors external to the company (labor regulations and access to well-trained employees) play a fundamental role. Overall, this contributes to those studies that rely on institutional economics (North 1990) to explain that innovation cannot be understood without considering the effect of the external context in which it takes place (Martin 2016). In this regard, our research benefits from the fact that we use a dataset with information for seven different countries. It has been considered that in order to enhance and develop concepts and theories, some researches should be tested in different cultural settings which may allow further generalization of the results (Antoncic and Hisrich 2001). From this perspective, when studying innovation related initiatives, the international context might play an important role. In fact, it has been highlighted that new business activities cannot be studied without placing emphasis on the context in which they are performed (Hills and LaForge 1992). Similarly, the dominance of American-based (and Anglo-Saxon) research has already been stressed by some authors as a potential gap for future research (Antoncic 2007).

7.5.3 Contributions to Practice

Our findings also have practical implications, because an enhanced understanding of the effect of a set of factors on R&D activity and firm growth might be relevant, especially for those managers who are interested in implementing new innovative projects in their companies. Our results suggest that if companies want to foster successful innovation via R&D its workforce should have a wide variety of backgrounds, knowledge and previous experiences (Autio et al. 2000). These characteristics can provide companies with enhanced capabilities such as: ability to recognize and exploit new business opportunities; capacity to adapt to changes; or better understanding of foreign markets (Oura et al. 2016). In addition, workforce flexibility is also a key factor that allows an easier allocation of resources and investments in those areas and sectors that are more promising (Jones 1996).

Our results also suggest that the good performance of those who are involved not only in R&D activities but also at also at all levels of the company is beneficial for the SME's growth. In this regard, complementary to interdisciplinary backgrounds, a well-defined reward system would encourage everyone within the company to play her role in leading intrapreneurial projects. Based on our results, we particularly emphasize the importance of implementing educational programs that equip workers with practical knowledge, useful for the tasks everyone performs, as well as for her professional evolution. Shepherd and Gruber (2020) offer valuable insights into the bridge that closes the theory-practice gap. Although these authors focus on the process from starting through growing a new venture, the analysis can be also extrapolated to entrepreneurial behavior within companies. In this regard, the implementation of practical programs that increase workers' human capital may be related to entrepreneurial skills at all levels, which could bring a double benefit to employees. First, by knowing the lean startup method, they can apply practical concepts to every project they lead or work on, and learn from such an entrepreneurial process. Second, as some employees might have the intention to set up a new venture in the near future (Agarwal et al. 2016), thanks to these reward programs, they would have the initial knowledge to start off the entrepreneurial process.

7.5.4 Contributions to the Policy Debate on Entrepreneurial Innovation

The implementation of practical programs can be also derived from policy strategies that connect universities, the public sector and private firms. For example, Link (2020) discusses the relevance of public research organizations to transfer knowledge to the society through reports, academic articles and educational programs that show and explain empirical evidence, which may be an input for decision making in terms of public policies and firms' strategies. Audretsch and Link (2019) also complement this idea by suggesting that public bodies can be helpful to transfer knowledge to universities and entrepreneurial firms. Drawing on this discussion, our findings offer evidence on the importance of different training programs to encourage entrepreneurial behavior via R&D within firms, achieving a subsequent growth. Thus, in addition to conducting research and creating reports, public bodies might be motivated to organizing public events where business owners and managers can learn and exchange new knowledge, which can be applicable to firms' strategies and decision making (Davidsson and Honig 2003).

Similarly, the relevance of the formal environment implies that the results obtained thanks to these exchanges could also provide relevant information for policymakers in the areas of entrepreneurship and innovation. Specifically, governments and public bodies should promote labor regulations enabling flexibility. We show, for example, that foreign human resource is key to achieving innovative activities and firm growth. The existence of flexible rules that allow people with external knowledge coming to countries would serve to potentiate the knowledge exchange and learning experience. In fact, according to Audretsch (2019), this is one of key aspects that have characterized the Silicon Valley. He asserts that some regions and countries fail in raising new knowledge due to budget constraints and ineffective policies, so spillover effects do not meet expectations. In this regard, different policies to attract external knowledge and flexible permits for foreign workers with different backgrounds may strengthen the available labour force that can help firms innovate and grow.

7.5.5 Limitations and Avenues for Future Research

This research has some limitations and suggests some future research lines. First, more accurate proxies for both our dependent and our independent variables could be used. In addition, following previous research, we differentiated our independent variables in terms of internal and environmental conditioning factors. Future studies could use other proxies, so that the differences between both types of variables are even more evident.

Second, we used data for the years 2007–2009 but we did not take into account the effect of time. This is, although the data includes information for different years, it was collected in one single moment (cross-section), what limits the quality of the data studied. This implies that we are unable to capture how some of the companies' past actions influence the current R&D and growth practices. In addition, some European countries were affected by the economic crisis at the end of 2008, which may have influenced R&D investments in companies. However, Aristei et al. (2017) and Carboni and Medda (2018) explain that the EFIGE database works with mean values during the period spanning from 2007 through 2009. To some extent, the purpose of this treatment is to overcome possible biases due to the downturn lived in Europe. In this regard, our findings provide an enhanced understanding about how and to what extent R&D activities were affected by the economic crisis.

Third, the significant role of some of the control variables (gender, age and type of industry, or access to finance, for instance) suggests that these issues could be developed further in future studies. For instance, individual entrepreneurship literature has extensively focused on the role of gender when developing entrepreneurial activities (Bardasi et al. 2011). However, to our knowledge, this issue has been much less researched in R&D literature. Similarly, a country's financial system is widely agreed to be an important determinant of its level of new business activity (Taylor and Murphy 2004), as access to finance is considered a key feature for the development of innovation activities (Bowen and De Clercq 2008). Fourth, the literature on R&D and firm growth has introduced a distinction between different type of growth as a relevant explanatory factor (Coad and Rao 2008), however, we only focus on growth in terms of number of employees. Future studies using more varied and wide-ranging datasets should account for this.

Acknowledgment The authors acknowledge the Editors of this book for leading this initiative, as well as for all comments and suggestions to improve the chapter. David Urbano and Andreu Turro acknowledge the financial support from the project ECO2017-87885-P (Spanish Ministry of Economy & Competitiveness). In addition, David Urbano acknowledges the financial support from project 2017-SGR-1056 (Economy & Knowledge Department, Catalan Government), and ICREA under ICREA Academia programme. Sebastian Aparicio acknowledges Durham University Business School for constant support. In addition, Sebastian acknowledges financial support from Colciencias Ph.D. programme Chapter 3 (617/2013), Enlaza Mundos Municipio de Medellín (2013), and Fundación ECSIM.

References

Acs, Z., Audretsch, D. B., Braunerhjelm, P., & Carlsson, B. (2012). Growth and entrepreneurship. *Small Business Economics, 39*(2), 289–300.

Acs, Z. J., Audretsch, D. B., & Lehmann, E. E. (2013). The knowledge spillover theory of entrepreneurship. *Small Business Economics, 41*(4), 757–774.

Agarwal, R., Gambardella, A., & Olson, D. M. (2016). Employee mobility and entrepreneurship a virtual special issue. *Strategic Management Journal, 37*(13), E11–E21.

Ahn, S., Yoon, J., & Kim, Y. (2018). The innovation activities of small and medium-sized enterprises and their growth: Quantile regression analysis and structural equation modeling. *Journal of Technology Transfer, 43*(2), 316–342.

Alessandri, T. M., & Pattit, J. M. (2014). Drivers of R&D investment: The interaction of behavioral theory and managerial incentives. *Journal of Business Research, 67*, 151–158.

Al-Laham, A., Tzabbar, D., & Amburgey, T. L. (2011). The dynamics of knowledge stocks and knowledge flows: Innovation consequences of recruitment and collaboration in biotech. *Industrial and Corporate Change, 20*(2), 555–583.

Altomonte C, Aquilante T (2012) The EU-EFIGE/Bruegel-Unicredit dataset. Working Papers, Bruegel 753, Bruegel.

Altomonte, C., Aquilante, T., Békés, G., & Ottaviano, G. I. (2013). Internationalization and innovation of firms: Evidence and policy. *Economic Policy, 28*(76), 663–700.

Altuzarra, A., & Serrano, F. (2010). Firms' Innovation Activity and Numerical Flexibility. *Industrial and Labor Relations Review, 63*, 22.

Amorós, J. E., Poblete, C., & Mandakovic, V. (2019). R&D transfer, policy and innovative ambitious entrepreneurship: Evidence from Latin American countries. *Journal of Technology Transfer*. https://doi.org/10.1007/s10961-019-09728-x.

Andersen, T. J., & Bettis, R. A. (2015). Exploring longitudinal risk-return relationships. *Strategic Management Journal, 36*(8), 1135–1145.

Antoncic, B. (2007). Intrapreneurship: A comparative structural equation modeling study. *Industrial Management & Data Systems, 107*(3), 309–325.

Antoncic, B., & Hisrich, R. D. (2001). Intrapreneurship: Construct refinement and cross-cultural validation. *Journal of Business Venturing, 16*(5), 495–527.

Aparicio, S., Urbano, D., & Audretsch, D. B. (2016). Institutional factors, opportunity entrepreneurship and economic growth: Panel data evidence. *Technological Forecasting and Social Change, 102*, 45–61.

Aparicio, S., Audretsch, D., & Urbano, D. (2020). Does entrepreneurship matter for inclusive growth? The role of social progress orientation. *Entrepreneurship Research Journal*. https://doi.org/10.1515/erj-2019-0308.

Arenius, P., & Minniti, M. (2005). Perceptual variables and nascent entrepreneurship. *Small Business Economics, 24*(3), 233–247.

Aristei, D., Sterlacchini, A., & Venturini, F. (2017). Effectiveness of R&D subsidies during the crisis: Firm-level evidence across EU countries. *Economics of Innovation and New Technology, 26*(6), 554–573.

Audretsch, D. B. (2019). Have we oversold the Silicon Valley model of entrepreneurship? *Small Business Economics*. https://doi.org/10.1007/s11187-019-00272-4.

Audretsch, D. B., & Keilbach, M. (2008). Resolving the knowledge paradox: Knowledge-spillover entrepreneurship and economic growth. *Res Pol, 37*(10), 1697–1705.

Audretsch, D. B., & Link, A. N. (2019). Entrepreneurship and knowledge spillovers from the public sector. *The International Entrepreneurship and Management Journal, 15*(1), 195–208.

Auerswald, P. E., & Branscomb, L. M. (2003). Valleys of death and Darwinian seas: Financing the invention to innovation transition in the United States. *Journal of Technology Transfer, 28*, 227–239.

Autio, E., Sapienza, H. J., & Almeida, J. G. (2000). Effects of age at entry, knowledge intensity, and imitability on international growth. *The Academy of Management Journal, 43*(5), 909–924.

Barbosa, N., & Eiriz, V. (2011). Regional variation of firm size and growth: The Portuguese case. G*rowth and Change, 42*(2), 125–158.

Baden-Fuller, C. (1995). Strategic innovation, corporate entrepreneurship and matching outside-in to inside-out approaches to strategy research. *Brit J Manag, 6*, S3–S16.

Bardasi, E., Sabarwal, S., & Terrell, K. (2011). How do female entrepreneurs perform? Evidence from three developing regions. *Small Business Economics, 37*, 417–441.

Barker, I. I. I. V. L., & Mueller, G. C. (2002). CEO characteristics and firm R&D spending. *Management Science, 48*, 782–801.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99–120.

Bassanini, A., & Ernst, E. (2002). Labor market regulation, industrial relations and technological regimes: A tale of comparative advantage. *Industrial Relations, 11*, 391–426.
Baum, J. R., & Wally, S. (2003). Strategic decision speed and firm performance. *Strategic Management Journal, 24*, 1107–1129.
Baysinger, B. D., & Hoskisson, R. E. (1989). Diversification strategy and R&D intensity in multi-product firms. *The Academy of Management Journal, 32*, 310–332.
Becker, G. S. (1964). *Human capital*. Chicago: University of Chicago Press.
Becker, B. (2015). Public R&D policies and private R&D investment: A survey of the empirical evidence. *Journal of Economic Surveys, 29*, 917–942.
Begley, T. M., Tan, W. L., & Schoch, H. (2005). Politico-economic factors associated with interest in starting a business: A multi-country study. *Entrepreneurship Theory and Practice, 29*, 35–55.
Bentolila, S., & Dolado, J. (1994). Spanish labour markets. *Econ Pol, 9*(18), 53–99.
Bianchini, S., Pellegrino, G., & Tamagni, F. (2018). Innovation complementarities and firm growth. *Industrial and Corporate Change, 27*(4), 657–676.
Bloodgood, J. M., Hornsby, J. S., Burkemper, A. C., & Sarooghi, H. (2015). A system dynamics perspective of corporate entrepreneurship. *Small Business Economics, 45*(2), 383–402.
Boockmann, B., & Hagen, T. (2008). Fixed-term contracts as sorting mechanisms: Evidence from job durations in West Germany. *Labour Economics, 15*(5), 984–1005.
Booltink, L. W., & Saka-Helmhout, A. (2018). The effects of R&D intensity and internationalization on the performance of non-high-tech SMEs. *International Small Business Journal, 36*(1), 81–103.
Bornay-Barrachina, M., la Rosa Navarro, D., López Cabrales, A., & Valle Cabrera, R. (2012). Employment relationships and firm innovation: The double role of human capital. *British Journal of Management, 23*(2), 223–240.
Bowen, H. P., & De Clercq, D. (2008). Institutional context and the allocation of entrepreneurial effort. *Journal of International Business Studies, 39*(4), 747–767.
Bowen, D. D., & Hisrich, R. D. (1986). The female entrepreneur: A career development perspective. *The Academy of Management Review, 11*, 393–407.
Branscomb, L. M., Auerswald, P. E., & Chesbrough, H. (2001). *Taking technical risks: How innovators, executives, and investors manage high-tech risks*. Cambridge, MA: MIT Press.
Braunerhjelm, P., Ding, D., & Thulin, P. (2018). The knowledge spillover theory of intrapreneurship. *Small Business Economics, 51*, 1–30.
Brown, S., & Sessions, J. G. (2005). Employee attitudes, earnings and fixed-term contracts: International evidence. *Review of World Economics, 141*, 296–317.
Brown, R., Mawson, S., & Mason, C. (2017). Myth-busting and entrepreneurship policy: The case of high growth firms. *Entrepreneurship and Regional Development, 29*, 414–443.
Burghardt, D., & Helm, M. (2015). Firm growth in the course of mergers and acquisitions. *Small Business Economics, 44*, 889–904.
Carboni, O. A., & Medda, G. (2018). R&D, export and investment decision: Evidence from European firms. *Applied Economics, 50*, 187–201.
Choi, J., Jun, S., & Park, S. (2016). A patent analysis for sustainable technology management. *Sustainability, 8*(7), 1–13.
Chandler, G. N., Honig, B., & Wiklund, J. (2005). Antecedents, moderators, and performance consequences of membership change in new venture teams. *Journal of Business Venturing, 20*(5), 705–725.
Chang, P. L., & Shih, H. Y. (2004). The innovation systems of Taiwan and China: A comparative analysis. *Technovation, 24*, 529–539.
Coad, A., & Rao, R. (2008). Innovation and firm growth in high-tech sectors: A quantile regression approach. *Research Policy, 37*, 633–648.
Coad, A., Frankish, J. S., Roberts, R. G., & Storey, D. J. (2016). Why should banks provide entrepreneurship training seminars? *International Small Business Journal, 34*, 733–759.
Covin, J. G., & Slevin, D. P. (1991). A conceptual model of entrepreneurship as firm behavior. *Entrepreneurship Theory and Practice, 16*(1), 7–25.

Crepon, B., Duguet, E., & Mairesse, J. (1998). Research, innovation and productivity: An econometric analysis at the firm level. *Economics of Innovation and New Technology, 7*, 115–158.

Cunningham, J. A., Lehmann, E. E., Menter, M., & Seitz, N. (2019). The impact of university focused technology transfer policies on regional innovation and entrepreneurship. *Journal of Technology Transfer*. https://doi.org/10.1007/s10961-019-09733-0.

Damanpour, F., Sanchez-Henriquez, F., & Chiu, H. H. (2018). Internal and external sources and the adoption of innovations in organizations. *Brit J Manag, 29*, 712–730.

Davidsson, P., & Honig, B. (2003). The role of social and human capital among nascent entrepreneurs. *Journal of Business Venturing, 18*, 301–331.

Del Canto, J. G., & Gonzalez, I. S. (1999). A resource-based analysis of the factors determining a firm's R&D activities. *Res Pol, 28*, 891–905.

Delmar, F., Davidsson, P., & Gartner, W. B. (2003). Arriving at the high-growth firm. *Journal of Business Venturing, 18*, 189–216.

Di Cintio, M., & Grassi, E. (2017). Uncertainty, flexible labour relations and R&D. *Metroeconomica, 68*, 91–120.

Di Guardo, M. C., & Harrigan, K. R. (2016). Shaping the path to inventive activity: The role of past experience in R&D alliances. *Journal of Technology Transfer, 41*, 250–269.

Djankov, S., La Porta, R., Lopez-De-Silanes, F., & Shleifer, A. (2002). The regulation of entry. *The Quarterly Journal of Economics, 117*, 1–37.

Feldman, M. P. (2014). The character of innovative places: Entrepreneurial strategy, economic development, and prosperity. *Small Business Economics, 43*, 9–20.

Fletcher, M., & Harris, S. (2012). Knowledge acquisition for the internationalization of the smaller firm: Content and sources. *International Business Review, 21*(4), 631–647.

Ghignoni, E., Croce, G., & Ricci, A. (2018). Fixed term contracts and employers' human capital: The role of educational spillovers. Pap Reg. *Science, 97*, 301–322.

Glavas, C., & Mathews, S. (2014). How international entrepreneurship characteristics influence Internet capabilities for the international business processes of the firm. *International Business Review, 23*(1), 228–245.

Gonzalez, X., Miles-Touya, D., & Pazó, C. (2016). R&D, worker training and innovation: Firm-level evidence. *Industry and Innovation, 23*, 694–712.

Gonzalez-Alvarez, N., & Solis-Rodriguez, V. (2011). Discovery of entrepreneurial opportunities: A gender perspective. *Industrial Management and Data Systems, 111*, 755–775.

Graddy-Reed, A., Lanahan, L., & Ross, N. M. (2018). The Effect of R&D Investment on Graduate Student Productivity: Evidence from the Life Sciences. *Journal of Policy Analysis and Management, 37*, 809–834.

Griffiths, W., & Webster, E. (2010). What governs firm-level R&D: Internal or external factors? *Technovation, 30*, 471–481.

Guerrero, M., & Peña, I. (2013). The effect of intrapreneurial experience on corporate venturing: Evidence from developed economies. *The International Entrepreneurship and Management Journal, 9*, 1–20.

Guerrero, M., & Urbano, D. (2019). Effectiveness of technology transfer policies and legislation in fostering entrepreneurial innovations across continents: An overview. *Journal of Technology Transfer*. https://doi.org/10.1007/s10961-019-09736-x.

Hagen, T. (2002). Do temporary workers receive risk premiums? Assessing the wage effects of fixed–term contracts in west germany by a matching estimator compared with parametric approaches. *Labour, 16*, 667–705.

Hausmann, R. (2016). Economic development and the accumulation of know-how. *Welsh Economic Review, 24*, 13–16.

Hausmann, R., & Neffke, F. M. (2019). The workforce of pioneer plants: The role of worker mobility in the diffusion of industries. *Res Pol, 48*(3), 628–648.

Hayton, J. C., & Kelley, D. J. (2006). A competency-based framework for promoting corporate entrepreneurship. *Human Resource Management, 45*(3), 407–427.

Herrman, P., & Datta, D. K. (2006). CEO experiences: Effects on the choice of FDI entry mode. *Journal of Management Studies, 43*(4), 755–780.

Hills, G., & LaForge, R. (1992). Research at the marketing interface to advance entrepreneurship theory. *Entrepreneurship Theory and Practice, 16*(3), 33–59.

Hodges, N. J., & Link, A. N. (2019). Innovation by design. *Small Business Economics, 52*(2), 395–403.

Hughes, M., & Mustafa, M. (2017). Antecedents of corporate entrepreneurship in SMEs: Evidence from an emerging economy. *Journal of Small Business Management, 55*, 115–140.

Johanson, J., & Vahlne, J. E. (2003). Business relationship learning and commitment in the internationalization process. *Journal of International Entrepreneurship, 1*(1), 83–101.

Johnson, P. D., Smith, M. B., Wallace, J. C., Hill, A. D., & Baron, R. A. (2015). A review of multilevel regulatory focus in organizations. *Journal of Management, 41*(5), 1501–1529.

Jones, O. (1996). Strategic HRM: The implications for pharmaceutical R&D. *Technovation, 16*(1), 21–32.

Judge, W. Q., Liu Thompkins, Y., Brown, J. L., & Pongpatipat, C. (2015). The impact of home country institutions on corporate technological entrepreneurship via R&D investments and virtual world presence. *Entrepreneurship Theory and Practice, 39*(2), 237–266.

Kang, M., & Lee, M. J. (2017). Absorptive capacity, knowledge sharing, and innovative behaviour of R&D employees. *Technology Analysis & Strategic Management, 29*, 219–232.

Keshk, O. M. (2003). CDSIMEQ: A program to implement two-stage probit least squares. *The Stata Journal, 3*, 1–11.

Kiss, A. N., & Barr, P. S. (2014). New venture strategic adaptation: The interplay of belief structures and industry context. *Strategic Management Journal, 36*(8), 1245–1263.

Kitching, J., Smallbone, D., & Athayde, R. (2009). Ethnic diasporas and business competitiveness: Minority-owned enterprises in London. *Journal of Ethnic and Migration Studies, 35*, 689–705.

Keshk, O. M., Pollins, B. M., & Reuveny, R. (2004). Trade still follows the flag: The primacy of politics in a simultaneous model of interdependence and armed conflict. *The Journal of Politics, 66*(4), 1155–1179.

Kleinknecht, A., van Schaik, F. N., & Zhou, H. (2014). Is flexible labour good for innovation? Evidence from firm-level data. *Cambridge Journal of Economics, 38*, 1207–1219.

Krasniqi, B. A., & Desai, S. (2016). Institutional drivers of high-growth firms: Country-level evidence from 26 transition economies. *Small Business Economics, 47*(4), 1075–1094.

Krishna Dutt, A., Charles, S., & Lang, D. (2015). Employment flexibility, dual labour markets, growth, and distribution. *Metroeconomica, 66*(4), 771–807.

Kuratko, D. F. (2009). The entrepreneurial imperative of the 21st century. *Business Horizons, 52*(5), 421–428.

Lajqi, S., & Krasniqi, B. A. (2017). Entrepreneurial growth aspirations in challenging environment: The role of institutional quality, human and social capital. *Strategic Change, 26*(4), 385–401.

Lamperti, F., Mavilia, R., & Castellini, S. (2017). The role of Science Parks: A puzzle of growth, innovation and R&D investments. *Journal of Technology Transfer, 42*(1), 158–183.

Li, L., Qian, G., & Qian, Z. (2012). Early internationalization and performance of small high-tech "born-globals". *International Marketing Review, 29*(5), 536–561.

Link, A. (2020). Knowledge transfers from federally supported R&D. *The International Entrepreneurship and Management Journal*. https://doi.org/10.1007/s11365-020-00676-9.

Link, A. N., & Scott, J. T. (2019). The economic benefits of technology transfer from US federal laboratories. *Journal of Technology Transfer*. https://doi.org/10.1007/s10961-019-09734-z.

Maddala, G. S. (1983). *Limited dependent and qualitative variables in econometrics*. Cambridge: Cambridge University Press.

Markham, S. K., Ward, S. J., Aiman-Smith, L., & Kingon, A. I. (2010). The valley of death as context for role theory in product innovation. *Journal of Product Innovation Management, 27*, 402–417.

Martin, B. R. (2016). R&D policy instruments–a critical review of what we do and don't know. *Industry and Innovation, 23*, 157–176.

Moreira, S., Markus, A., & Laursen, K. (2018). Knowledge diversity and coordination: The effect of intrafirm inventor task networks on absorption speed. *Strategic Management Journal, 39*(9), 2517–2546.
Morris, M. H., Kuratko, D. F., & Covin, J. G. (2011). *Corporate entrepreneurship & innovation*. Boston: Cengage/South-Western/Publishers.
Moultrie, J. (2015). Understanding and classifying the role of design demonstrators in scientific exploration. *Technovation, 43*, 1–16.
Narayanan, V. K., Yang, Y., & Zahra, S. A. (2009). Corporate venturing and value creation: A review and proposed framework. *Research Policy, 38*(1), 58–76.
Nickell, S., & Layard, R. (1999). Labour market institutions and economic performance. In O. Ashenfelter & D. Card (Eds.), *Handbook of labour economics* (pp. 2985–3028). Amsterdam: Elsevier Science.
North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge: Cambridge University Press.
North, D. C. (2005). *Understanding the process of economic change*. Princeton: Princeton University Press.
Oura, M. M., Zilber, S. N., & Lopes, E. L. (2016). Innovation capacity, international experience and export performance of SMEs in Brazil. *International Business Review, 25*(4), 921–932.
Patlibandla, M., & Petersen, B. (2002). Role of transnational corporations in the evolution of a high-tech industry: The case of India's software industry. *World Development, 30*(9), 1561–1577.
Patriotta, G., & Siegel, D. (2019). The Context of Entrepreneurship. *Journal of Management Studies, 56*(6), 1194–1196.
Peterman, N., & Kennedy, J. (2003). Enterprise education: Influencing students' perceptions of entrepreneurship. *Entrepreneurship Theory and Practice, 28*(2), 129–144.
Puffer, S. M., McCarthy, D. J., & Boisot, M. (2010). Entrepreneurship in Russia and China: The impact of formal institutional voids. *Entrepreneurship Theory and Practice, 34*(3), 441–467.
Reagans, R., & McEvily, B. (2003). Network structure and knowledge transfer: The effects of cohesion and range. *Administrative Science Quarterly, 48*(2), 240–267.
Revilla, A. J., & Fernández, Z. (2012). The relation between firm size and R&D productivity in different technological regimes. *Technovation, 32*(11), 609–623.
Riley, S. M., Michael, S. C., & Mahoney, J. T. (2017). Human capital matters: Market valuation of firm investments in training and the role of complementary assets. *Strategic Management Journal, 38*(9), 1895–1914.
Ruiqi, W., Wang, F., Xu, L., & Yuan, C. (2017). R&D expenditures, ultimate ownership and future performance: Evidence from China. *Journal of Business Research, 71*, 47–54.
Saint-Paul, G. (2002). Employment protection, international specialization, and innovation'. *European Economic Review, 46*(2), 375–395.
Scherer, F. M. (1984). *Innovation and growth: Schumpetarian perspectives*. Cambridge, MA: MIT Press.
Shepherd, D. A., & Gruber, M. (2020). The lean startup framework: Closing the academic–practitioner divide. *Entrepreneurship Theory and Practice*. https://doi.org/10.1177/1042258719899415.
Smirnykh, L. (2016). Is flexible labor good for innovation? Evidence from Russian firm-level data. *Foresight and STI Governance, 10*(4), 60–70.
Stam, E., & Wennberg, K. (2009). The roles of R&D in new firm growth. *Small Business Economics, 33*(1), 77–89.
Stock, R. M., Totzauer, F., & Zacharias, N. A. (2014). A closer look at cross-functional R&D cooperation for innovativeness: Innovation-oriented leadership and human resource practices as driving forces. *Journal of Product Innovation Management, 31*(5), 924–938.
Storey, D. J. (2004). Exploring the link, among small firms, between management training and firm performance: A comparison between the UK and other OECD countries. *International Journal of Human Resource Management, 15*(1), 112–130.
Taylor, M., & Murphy, A. (2004). SMEs and e-business. *Journal of Small Business and Enterprise Development, 11*(3), 280–289.

Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal, 28*(13), 1319–1350.
Teece, D. J. (2018). Reply to Nelson, Helfat and Raubitschek. *Res Pol, 47*(8), 1400–1402.
Teirlinck, P. (2017). Configurations of strategic R&D decisions and financial performance in small-sized and medium-sized firms. *Journal of Business Research, 74*, 55–65.
Thornhill, S. (2006). Knowledge, innovation and firm performance in high-and low-technology regimes. *Journal of Business Venturing, 21*(5), 687–703.
Turro, A., Urbano, D., & Peris-Ortiz, M. (2014). Culture and innovation: The moderating effect of cultural values on corporate entrepreneurship. *Technological Forecasting and Social Change, 88*, 360–369.
Turro, A., Alvarez, C., & Urbano, D. (2016). Intrapreneurship in the Spanish context: A regional analysis. *Entrepreneurship and Regional Development, 28*(5–6), 380–402.
Urbano, D., & Aparicio, S. (2016). Entrepreneurship capital types and economic growth: International evidence. *Technological Forecasting and Social Change, 102*, 34–44.
Urbano, D., & Turro, A. (2013). Conditioning factors for corporate entrepreneurship: An in (ex) ternal approach. *The International Entrepreneurship and Management Journal, 9*(3), 379–396.
Urbano, D., Alvarez, C., & Turro, A. (2013). Organizational resources and intrapreneurial activities: An international study. *Management Decision, 51*(4), 854–870.
Urbano, D., Aparicio, S., & Audretsch, D. B. (2019a). *Institutions, entrepreneurship, and economic performance*. Cham: Springer.
Urbano, D., Aparicio, S., & Audretsch, D. (2019b). Twenty-five years of research on institutions, entrepreneurship, and economic growth: What has been learned? *Small Business Economics, 53*(1), 21–49.
Visintin, F., & Pittino, D. (2014). Founding team composition and early performance of university–based spin–off companies. *Technovation, 34*(1), 31–43.
Vohora, A., Wright, M., & Lockett, A. (2004). Critical junctures in the growth in university high–tech spinout companies. *Res Pol, 33*, 147–175.
Von Zedtwitz, M., Corsi, S., Soberg, P., & Frega, R. (2015). A Typology of Reverse Innovation. *Journal of Product Innovation Management, 32*(1), 12–28.
Walter, A., Auer, M., & Ritter, T. (2006). The impact of network capabilities and entrepreneurial orientation on university spin-off performance. *Journal of Business Venturing, 21*(4), 541–567.
Wang, E. C. (2007). R&D efficiency and economic performance: A cross-country analysis using the stochastic frontier approach. *Journal of Policy Modeling, 29*(2), 345–360.
Wang, C. L. (2008). Entrepreneurial orientation, learning orientation, and firm performance. *Entrepreneurship Theory and Practice, 32*(4), 635–657.
Wiklund, J., & Shepherd, D. (2005). Entrepreneurial orientation and small business performance: A configurational approach. *Journal of Business Venturing, 20*(1), 71–91.
Wright, M., Wilson, N., Gilligan, J., Bacon, N., & Amess, K. (2016). Brexit, private equity and management. *Brit J Manag, 27*(4), 682–686.
Wang, E. C. (2007). R&D efficiency and economic performance: A cross-country analysis using the stochastic frontier approach. *Journal of Policy Modelling, 29*(2), 345–360.
Wang, K. J., & Dwi Lestari, Y. (2013). Firm competencies on market entry success: Evidence from a high-tech industry in an emerging market. *Journal of Business Research, 66*(12), 2444–2450.
Westhead, P., Wright, M., & Ucbasaran, D. (2001). The internationalization of new and small firms: A resource-based view. *Journal of Business Venturing, 16*(4), 333–358.
Zhou, H., Dekker, R., & Kleinknecht, A. (2011). Flexible labor and innovation performance: Evidence from longitudinal firm-level data. *Industrial and Corporate Change, 20*(3), 941–968.

Chapter 8
How IPR Can Shape Knowledge Diffusion Processes in Europe

André van Stel, Jorge Barrientos-Marín, Serhiy Lyalkov, Ana Millán, and José María Millán

8.1 Introduction

Technological progress and innovation are generally considered the main determinants of economic progress and play a key role in theories of endogenous growth (Romer 1986, 1990; Aghion and Howitt 1998). In particular, in endogenous growth models, economic output is not only determined by physical capital and labor, but also by knowledge capital. Aggregate Research & Development (R&D) expenditures are often used as an empirical indicator of a country's or region's investments in the stock of knowledge capital. The higher R&D investments, the bigger the knowledge stock, the higher the chance of innovations taking place, the higher the rate of technological progress, and ultimately, the higher economic output and

A. van Stel
Trinity Business School, Trinity College Dublin, Dublin, Ireland

Center for Entrepreneurship, Kozminski University, Warsaw, Poland
e-mail: vanstela@tcd.ie

J. Barrientos-Marín
Department of Economics, University of Antioquia, Medellín, Colombia
e-mail: jorge.barrientos@udea.edu.co

S. Lyalkov
Department of Quantitative Analysis, International University of La Rioja, Logroño, Spain

A. Millán
Department of Economic Analysis and Political Economy, University of Sevilla, Sevilla, Spain
e-mail: amtapia@us.es

J. M. Millán (✉)
Department of Economics, University of Huelva, Huelva, Spain
e-mail: jmillan@uhu.es

M. Guerrero, D. Urbano (eds.), *Technology Transfer and Entrepreneurial Innovations*, International Studies in Entrepreneurship 51,
https://doi.org/10.1007/978-3-030-70022-5_8

growth. Unfortunately, innovation is subject to market failures (e.g., lack of full appropriability) and, therefore, firms' R&D investments may be lower than what is socially desirable (Aerts and Schmidt 2008; Takalo and Tanayama 2010). As a consequence, governments around the world have established public support programs to stimulate innovation activities of firms, where R&D subsidies and tax credits are the most common forms, along with Intellectual Property Rights (IPR) policies (Takalo 2012; Krieger et al. 2018; Guerrero and Urbano 2019).

However, even if economies succeed in reaching considerable levels of R&D, higher R&D investments and a larger stock of knowledge do not automatically translate in higher economic growth. In order for a given knowledge stock to result in high rates of economic growth, it is crucial that knowledge spillovers, including imitation (Schmitz 1989), occur. Entrepreneurs play an important role in creating such knowledge spillovers, for instance by leaving an incumbent firm and starting their own new firms, while exploiting the new knowledge obtained in the incumbent firm (Audretsch and Keilbach 2004; Acs et al. 2013; Erken et al. 2018). However, the ease with which such knowledge spillovers may occur will depend on the strictness of IPR. Hence, although strict IPR increases the incentives to innovate, as it enhances appropriation of the returns to innovation, it may restrict the amount of knowledge spillovers. If the law makes it very difficult to re-use knowledge in different firms from where the knowledge was created (e.g. imitation), knowledge will less easily be diffused, thereby hampering economic progress. This may be especially relevant in countries with high R&D levels, as a bigger knowledge stock implies a higher level of potential spillovers.

All in all, although higher levels of R&D and stricter IPR are generally considered to be benign circumstances to achieve high rates of technological and economic progress (at the macro level) as well as strong entrepreneurial performance (at the individual level), it is not straightforward that the performance of all individual entrepreneurs is positively related to R&D and IPR. This is because strict IPR may be favorable for innovative entrepreneurs but unfavorable for imitative entrepreneurs (Burke and Fraser 2012). Thus, as the quality of the entrepreneurship sector (as approximated by average entrepreneurial performance) is important for achieving economic growth (Acs 2006), it is important to know more about the relationship between these variables. However, an analysis of how country-level R&D, the strictness of IPR, and their interaction relate to the performance of individual entrepreneurs is lacking to date.

In addition, the present chapter also explores the role of ICT usage by entrepreneurs in the knowledge diffusion process. The use of ICT in business has increased spectacularly over the last two decades, and a new stream of literature studying determinants and effects of ICT usage at the workplace is emerging rapidly (Haller and Siedschlag 2011; Bayo-Moriones et al. 2013; Giotopoulos et al. 2017). As more intensive ICT usage increases efficiency and facilitates opportunity identification (Liang et al. 2010), ICT use frequency at work is a clear determinant of entrepreneurial performance (Millán et al. 2021). Moreover, ICT use frequency at work will also help (both innovative and imitative) entrepreneurs to benefit from knowledge spillovers, as many entrepreneurial opportunities require digital applications in order to be exploited. This is especially true in the current circumstances where the world is facing a pandemic, and where the way of doing business has become even more ICT-intensive than before. However, we argue that the facilitating role of ICT in realizing and exploiting business opportunities stemming from knowledge spillovers, will be smaller in Strict-IPR environments compared to Weak-IPR environments. This may be the case simply because the amount of knowledge spillovers in the former type of environment will be smaller in the first place.

Addressing this research gap is precisely the main aim of this work—that is, analyzing how the interplay between country R&D and individual-level ICT use frequency at work on the one hand, and IPR laws on the other hand, affects the performance of individual entrepreneurs by using (i) a generally accepted measure of entrepreneurial performance such as earnings; (ii) macro-level measures of R&D investments and IPR protection; (iii) a geographical coverage as wide as 32 European countries, including the EU-28 member states; and (iv) the most recent international microdata available (fifth and sixth waves of the *European Working Conditions Survey* –EWCS– for 2010 and 2015), which include a comprehensive measure of ICT usage by entrepreneurs.

The contribution of our chapter is as follows. Although it is widely recognized that entrepreneurship and innovation are strongly related (Erken et al. 2018), the two topics are still often investigated separately. This is especially true when different units of observation are concerned. In the present chapter we bring together two strongly related streams of research which are still typically investigated in isolation. These are the (macro-level) literature on national systems of innovation and the (micro-level) entrepreneurship literature focusing on the individual. Regarding the former stream, we focus on macro-level R&D (which in this chapter is used as a measure of entrepreneurial innovation), IPR (as a measure of technology transfer policy), and individual earnings from entrepreneurship. The last measure is an established indicator of the success and quality of entrepreneurship (Van Praag 2005; Millán et al. 2014). High-quality entrepreneurship is increasingly deemed important in policy circles as it becomes more and more clear that only a minority of entrepreneurs are of considerable quality in the sense of contributing significantly to macro-economic development and job creation (Acs 2006; Shane 2009; Henrekson and Sanandaji 2018). Hence, the current chapter contributes to extant literature by investigating how entrepreneurial innovations at the macro level (as measured by R&D expenditures) influence the quality of entrepreneurship at the micro level (as measured by entrepreneurial earnings), and how this relationship is moderated by a country's technology transfer policy (as measured by the strictness of IPR legislation). To the best of our knowledge, this chapter is the first to investigate this relationship. Moreover, we are the first to explore how the positive relationship between ICT usage at work by entrepreneurs and their earnings may depend on the technology transfer policy (Strict or Weak IPR regime) being in place in a certain national economy.

The following set-up is used in the chapter. In Sect. 8.2 we first show the general context of lagging R&D expenditures in Europe which call for innovation policies, including IPR policy.[1] We then discuss the impact of the strictness of IPR legislation on the economy. Finally, we derive hypotheses regarding the relationship between

[1] For a more extensive discussion on innovation and R&D policy in Europe, we refer to Van Stel et al. (2019).

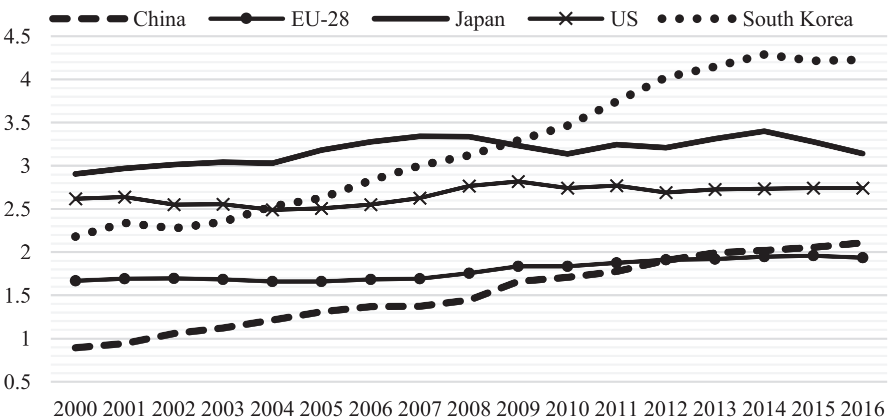
country-level expenditures on R&D, ICT use frequency by entrepreneurs, IPR legislation, and individual-level entrepreneurial performance. We then test these hypotheses making use of the 2010 and 2015 waves of the *European Working Conditions Survey*. This database and the variables that we employ from it are discussed in Sect. 8.3, as well as describes our methods of analysis. Section 8.4 describes the empirical results. Section 8.5 discusses implications for various stakeholders and concludes.

8.2 Theoretical Framework

8.2.1 R&D Expenditures in the EU and Rest of the World

Figure 8.1 below shows the international evolution of Gross Domestic Expenditure on R&D (GERD) for selected economies. We can observe that the EU lags behind its major competitors when it comes to investment in knowledge generation. Indeed, the EU-28 level of GERD accounted for only 1.9% of its GDP in 2016 (OECD 2019).[2]

In addition, productivity growth has slowed down in Europe while investment in R&D has remained relatively stable in most countries (i.e., the R&D-Productivity



Source: OECD Science, Technology and R&D Statistics: Main Science and Technology Indicators.

Fig. 8.1 GERD as % of GDP for selected economies, 2000–16. (Source: OECD Science, Technology and R&D Statistics: Main Science and Technology Indicators)

[2] This figure varies substantially across European countries and is correlated with the level of economic development of the country's economy. Thus, this figure rises above 2.5% in countries like Sweden, Austria, Germany, Denmark, and Finland. By contrast, this figure lies below 1% in countries such as Poland, Turkey, and Slovakia, Romania and Latvia (OECD 2019). This large cross-country variation can also be observed in Table 8.1.

nexus seems weaker), with a deceleration in the diffusion of innovation from productivity-leading companies to lagging companies as one of its plausible drivers (OECD 2015; European Commission 2017).

Therefore, the existing evidence on the European productivity slowdown calls for a better understanding of the knowledge diffusion processes and its potential obstacles (Elschner et al. 2011), including the existing IPR laws, as a fundamental piece of the technology transfer policy.

8.2.2 IPR and Its Effects on the Economy

Similar to what was observed for R&D investment, the strictness of IPR protection varies severely across geographies and also seems closely related to countries' levels of economic development.[3] However, although stronger levels of IPR protection should encourage technological and economic progress by stimulating the creation of knowledge, it can also limit the spread of new ideas and encourage monopoly (Falvey et al. 2006). Otherwise stated, the effect of stricter IPR on relevant economic outcomes such as growth, productivity, and innovation is not straightforward. Indeed, the impact of IPR protection on these outcomes is likely to vary with a country's income level.

Concerning economic progress, Thompson and Rushing (1996) find a positive and significant relationship between IPR protection and growth in countries with a level of GDP above a certain threshold whereas the relationship is not significant for countries below this level. In a later study, Thompson and Rushing (1999) obtain similar results when analysing the relationship between IPR and total factor productivity. However, Falvey et al. (2006) observe how stronger IPR protection significantly improves growth for high income countries and low income countries but such relationship is not found for middle-income countries. Falvey et al. consider results for high-income countries largely as expected; these countries undertake the vast majority of innovation and strong IPR protection should encourage further innovation by allowing innovators to profit from their inventions. However, technology transfer occurs through other channels for middle-income countries; strong IPR protection encourages imports and inward foreign direct investment from advanced countries that would enhance economic growth without adversely affecting domestic imitative activities.

As regards innovation, Park and Ginarte (1997) find that strictness of IPR explains only the physical and research capital investment behaviour of the top 30 economies whereas this relationship is not significant for the lower developed countries. These authors suggest that IPR affects economic growth by stimulating the accumulation of factor inputs like research and development capital and physical capital. This implies that countries not conducting innovative research or

[3] See Table 8.1

conducting a limited amount would enjoy few, if any, of the benefits of IPR protection because an innovation sector through which IPR affects economic growth is absent. The same result is obtained by Schneider (2005) for developed countries. However, the positive impact turns to a negative impact for developing countries, possibly because an innovation sector is lacking while at the same time imitation is hampered. Finally, Furman et al. (2002) and Xu and Chiang (2005) concentrate on the relationship between IPR protection and the inflow of foreign patents, which is also observed to be stronger for high-income countries.

8.2.3 Hypotheses Derivation

This section is aimed at deriving four hypotheses regarding the interrelations between country-level R&D investment (as our proxy of entrepreneurial innovation), the strictness of IPR (as a measure of technology transfer policy), individual-level ICT usage at work, and individual entrepreneurial performance in terms of earnings (as indicator of the success and quality of entrepreneurship).

In this sense, higher R&D investments at country level are associated with a higher rate of technological progress of the economy. If entrepreneurs have the possibility to work with more sophisticated technology, it will be easier for them to make profits, for instance if unit costs are lower as a result of labour-saving technological progress. In this regard, Deeds (2001) observes how the R&D intensity of a high technology venture is positively related to the amount of entrepreneurial wealth created by the venture. Similarly, Hall et al. (2010) observe how for every 100 euros a company invests in R&D, the net benefit it obtains is between 10 and 30 euros for every year the R&D investment is considered not to have become obsolete.

In addition, the rate of return on R&D investment for an economy (i.e., the social rate of return) has been estimated to be much larger (up to two to three times higher) than the return a company achieves due to positive spillover effects (Coe and Helpman 1995; Kao et al. 1999). Higher R&D levels are associated with a bigger knowledge stock entrepreneurs can draw from. The bigger knowledge stock implies a higher level of potential knowledge spillovers which also increase entrepreneurial opportunities to make profits. Venture capitalists, for instance, look out for such entrepreneurial opportunities and the concentration of knowledge in a region due to the positive effects on start-ups (Mueller 2007). In this regard, the presence of venture capital financing is associated with the acceleration of the innovation and commercialization process accompanied by better firm performance (i.e., greater growth in wages and scale; Kelly and Kim 2018). All in all, governments and policymakers are interested in building innovation clusters to attract entrepreneurial firms, due to the value added and the positive knowledge spillover effects for the regions concerned (Colombelli and Quatraro 2018; Lehmann and Menter 2018). The above arguments lead to the following hypothesis:

Hypothesis 1: *Country-level R&D expenditures are positively related to individual-level entrepreneurial earnings.*

Turning our attention to IPR, its impact on entrepreneurial earnings is twofold. Stricter IPR is positively related to innovation *creation* as it will make it easier for entrepreneurs to appropriate the returns to their innovations. This, in turn, will have a positive effect on earnings of (innovative) entrepreneurs. Previous research suggests that this positive relationship holds in particular for high-income countries (Thompson and Rushing 1996, 1999; Falvey et al. 2006).[4] On the other hand, stricter IPR is negatively related to innovation *access* as such strict legislation will make it more difficult for entrepreneurs to make use of innovations created elsewhere (Burke and Fraser 2012). This, in turn, will have a negative effect on earnings of (imitative) entrepreneurs. Policy, then, must solve a difficult trade-off between incentives for innovation and the need to encourage diffusion (Denicoliò and Franzoni 2012). In this regard, the study by Burke and Fraser (2012) is informative as they estimate the effects of various IPR-related variables on self-employment rates (as a rough indicator of entrepreneurial opportunities) across a sample of predominantly high-income countries. Although they find that patent activity has a negative effect on self-employment, overall they find that more extensive and stronger IPR laws have a net positive effect on self-employment activity. According to Burke and Fraser (2012), this indicates that "positive market opportunity creation effects outweigh negative technology cost/access effects for most of the self-employed sector" (p. 830). Based on their analysis, we expect the positive effects of IPR to dominate. Hence, we hypothesize the following:

Hypothesis 2: *Stricter IPR legislation is positively related to individual-level entrepreneurial earnings.*

Too strict IPR legislation may hamper the diffusion of knowledge created by R&D. This may be especially harmful in countries with high R&D levels, as a bigger knowledge stock implies a bigger flow of potential knowledge spillovers. In such circumstances, a lower level of IPR may be instrumental in actually realizing these potential spillovers, i.e. less strict IPR may facilitate not only (earnings from) imitative entrepreneurship but also innovative entrepreneurship that wishes to build further on the earlier innovations made in other firms (Burke and Fraser 2012). Furthermore, under these circumstances, entrepreneurs possessing valuable intellectual property are pushed to grow their ventures quickly as a way to combat misappropriation (Autio and Acs 2010). In contrast, for countries with lower R&D levels, i.e. smaller knowledge stocks, potential spillovers are also smaller and hence the amount of potential spillovers foregone by high IPR, is also smaller. Based on the foregoing reasoning, we suggest the following hypothesis:

Hypothesis 3: *The positive relationship between country-level R&D expenditures and individual-level entrepreneurial earnings is weaker in economies with strict IPR than in economies with weak IPR.*

---

[4] Note that the present chapter focuses on high-income (i.e. European) countries.

ICT may serve as an efficiency-enhancing driver of business performance by raising productivity and helping a business to identify and exploit new profit opportunities (Liang et al. 2010; Millán et al. 2021). As argued above, such profit opportunities may also stem from imitation. Thus, the rapid pace at which the worldwide diffusion of ICT has increased over the last decade may facilitate knowledge diffusion among firms. However, the role of ICT in accelerating knowledge diffusion may be much smaller in institutional contexts where the potential for knowledge spillovers is smaller in the first place. As we have seen above, such a context is formed by strict IPR regulation. Strict IPR hampers access to innovations and hence (imitative) entrepreneurship. In such a context, high ICT usage may play a more modest role in raising entrepreneurial earnings. It will still help in realizing higher efficiency, but its role in identifying and exploiting new profit opportunities, particularly those stemming from imitation, will be much smaller. Thus, because profit opportunities related to knowledge spillovers and imitation are more limited in countries with stricter IPR levels, the facilitating role of ICT in realizing and exploiting such opportunities, will also be smaller.

Hypothesis 4: *The positive relationship between ICT use frequency at work and individual-level entrepreneurial earnings is weaker in economies with strict IPR than in economies with weak IPR.*

To the best of our knowledge, a conditional analysis on the relationship between country expenditures on R&D, the country-level of IPR, individual-level ICT use frequency at work and individual entrepreneurial performance does not exist to date. Addressing this drawback of the literature is the main aim of this work—that is, filling the existing research gap by particularly analysing the moderating role of the strictness of IPR legislation on the relationships between: (a) country-level expenditures on R&D and individual-level entrepreneurial earnings; and (b) ICT use frequency at work by entrepreneurs and their earnings. To this end, we make use of (i) a generally accepted measure of performance: earnings; (ii) a wide geographical coverage of many European countries, including the EU-28; and (iii) the most recent international microdata available (fifth and sixth waves of the EWCS – EWCS 2010 and 2015).

8.3 Methodology

8.3.1 Data and Sample

We use data from the EWCS 2010 and 2015 (Eurofound 2012, 2016, 2018). This survey is carried out every 5 years by the EU Agency *Eurofound* (*European Foundation for the Improvement of Living and Working Conditions*)[5] and offers key

[5] This Foundation is an autonomous body of the European Union (EU), created to assist in the formulation of future policy on social and work-related matters. Further information can be found

work-related information on 44,000 workers (including both employees and self-employed individuals) covering 35 European countries.[6] These workers are interviewed about several working condition aspects, including physical environment, workplace design, working hours, work organization and social relationships in the workplace. Depending on country size and national arrangements, the sample ranges from 1000 to 4000 workers per country. Our final sample includes men and women aged 18 to 65 who are classified as self-employed individuals within the EU-28 territory, 2 candidate countries (Serbia and Turkey) and 2 European Free Trade Association (EFTA) countries (Norway and Switzerland). All individuals working part-time, i.e., working less than 15 hours per week, are excluded. The final dataset, after removing cases with missing data for any of the relevant variables, yields 6289 observations.

8.3.2 Dependent variable

We are interested in explaining how country-level R&D and individual-level ICT use frequency at work affect the business performance of entrepreneurs in terms of earnings (the dependent variable), and how these relationships are moderated by a country's strictness of IPR. To this end, we employ the variable 'net monthly earnings'. Workers in the EWCS are asked to refer to his/her average net earnings in recent months and, in case he/she doesn't know, are asked to give an estimate.[7] The variable is defined in PPP dollars of 2015 and converted to natural logarithms.

8.3.3 Independent Variables

Expenditure on R&D The fundamental role of technological activities, as drivers of entrepreneurial success and hence of economic development, urges countries to promote innovation in their economies (Van Stel et al. 2014). Therefore, in order to capture the presence and commitment to technological effort and innovation activities in each of the considered economies, our regressions include the Gross Domestic Expenditure on R&D (GERD) for the periods 2010 and 2015. This indicator includes expenditures by business enterprises, higher education institutions, as well as government and private non-profit organizations. In order to make fairer com-

at www.eurofound.europa.eu

[6] This set includes the EU-28 together with 5 candidate countries (Albania, the Former Yugoslav Republic of Macedonia, Montenegro, Serbia and Turkey) and 2 EFTA countries (Norway and Switzerland).

[7] The interviewer is asked to explain, if necessary, that net monthly earnings are the earnings at one's disposal after taxes and social security contributions.

parisons between countries, Eurostat provides this information expressed as *Purchasing Power Standards* –PPS– per inhabitant at constant 2005 prices.[8]

Intellectual Property Rights The quality of institutions has a strong bearing on competitiveness and growth (Easterly and Levine 1997; Acemoglu et al. 2001, 2002). Thus, it influences investment decisions and the organization of production and plays a key role in the ways in which societies distribute the benefits and bear the costs of development strategies and policies. For example, owners of land, corporate shares, or intellectual property are unwilling to invest in the improvement and upkeep of their property if their rights as owners are not protected (De Soto 2000). With the purpose of capturing the strictness of IPR protection in each economy in our sample, our specifications incorporate the *Intellectual Property Protection* indicator (IPP) for periods 2010 and 2015 from the *World Economic Forum's Executive Opinion Survey* (WEF-EOS; Browne et al. 2014).[9] IPP is evaluated on a scale of 1 to 7, from extremely weak to extremely strong protection. Furthermore, in order to test for moderating effects of IPP on the relationships between GERD and earnings from self-employment, and between ICT usage and earnings, our specifications also include a dummy equaling 1 for strict IPP (and 0 for weak IPP) and interaction terms intended to capture the differentiated effects of GERD and ICT use frequency at work (see below) on those economies with strict and weak IPP regimes.

ICT use frequency at work The information on ICT use frequency at work is captured at the micro level. Thus, respondents in the EWCS 2010 and 2015 are asked to what extent his or her main paid job involves working with computers, laptops, and smartphones, etc. (i.e. 'how often do you use … in your daily work?'). This variable is measured as a 7-point Likert scale, ranging from 1 for individuals answering *never* to 7 for individuals answering *all of the time*. This discrete ordered and frequency variable serves us to operationalize ICT usage at work.

Table 8.1 shows figures as regards our macroeconomic indicators GERD and IPP for countries and periods in our sample. This table also splits our sample of 32 countries in two groups based on an IPP threshold to distinguish weak vs. strong IPP countries. The IPP regime in which each country operates is presented under two

[8] PPS is the technical term used by Eurostat for the common (artificial) currency in which national accounts aggregates are expressed when adjusted for price level differences using PPPs. Thus, PPPs can be interpreted as the exchange rate of the PPS against the €.

[9] The WEF-EOS draws on the views of over 14,000 executives in over 140 economies and captures valuable information on a broad range of factors that are critical for a country's competitiveness and sustainable development, and for which data sources are scarce or, frequently, non-existent on a global scale. Among several examples of otherwise unavailable data are the quality of the educational system, indicators measuring business sophistication, and labor market variables such as flexibility in wage determination. The Survey results are used in the calculation of the *Global Competitiveness Index* (GCI) and other indexes of the WEF. Further information about WEF can be found at https://www.weforum.org. Further information about the GCI can be found at https://www.weforum.org/reports/the-global-competitiveness-report-2017-2018

Table 8.1 GERD and IPP indicators for 32 European countries

Country	GERD *PPS per inhabitant*				IPP				IPP regime	
	Rank#	2010	Rank#	2015	Rank#	2010	Rank#	2015	Uncorrected for GDP per capita	Corrected for GDP per capita
Austria	5	852	3	987	4	6.07	9	5.51	Strict	Strict
Belgium	9	602	9	733	13	5.27	12	5.29	Strict	Strict
Bulgaria	31	60	27	114	32	2.63	31	3.02	Weak	Weak
Croatia	27	99	28	114	28	3.51	28	3.61	Weak	Weak
Cyprus	26	108	29	103	14	4.75	17	4.35	Weak	Strict
Czech Republic	18	275	15	428	21	4.02	20	3.92	Weak	Weak
Denmark	6	838	5	880	5	5.99	13	5.28	Strict	Strict
Estonia	19	221	18	252	16	4.61	14	4.94	Strict	Strict
Finland	2	1034	8	784	2	6.09	1	6.19	Strict	Strict
France	10	574	11	597	8	5.81	6	5.60	Strict	Strict
Germany	7	790	4	929	9	5.72	11	5.41	Strict	Strict
Greece	21	126	25	171	20	4.14	21	3.86	Weak	Weak
Hungary	20	165	21	221	23	3.88	26	3.69	Weak	Weak
Ireland	12	518	12	545	11	5.57	7	5.60	Strict	Weak
Italy	17	301	16	313	22	3.91	25	3.69	Weak	Weak
Latvia	29	74	30	96	26	3.65	19	4.00	Weak	Strict
Lithuania	24	108	23	187	24	3.80	22	3.83	Weak	Weak
Luxembourg	4	911	7	798	6	5.93	2	6.08	Strict	Weak
Malta	22	124	22	191	18	4.39	16	4.52	Weak	Strict
Netherlands	11	573	10	680	7	5.84	5	5.70	Strict	Strict
Norway	8	668	6	802	10	5.66	8	5.57	Strict	Weak
Poland	25	108	24	174	27	3.58	24	3.75	Weak	Weak
Portugal	16	303	19	240	15	4.61	15	4.57	Strict	Strict
Romania	32	45	32	57	29	3.38	30	3.35	Weak	Weak
Serbia	30	64	31	78	30	2.77	32	2.88	Weak	Weak
Slovakia	23	109	20	235	25	3.73	23	3.78	Weak	Weak
Slovenia	14	446	14	482	17	4.49	18	4.06	Weak	Weak
Spain	15	315	17	282	19	4.31	29	3.58	Weak	Weak
Sweden	3	971	2	1050	1	6.11	10	5.46	Strict	Strict
Switzerland	1	1052	1	1090	3	6.08	3	6.04	Strict	Strict
Turkey	28	89	26	129	31	2.68	27	3.66	Weak	Weak
United Kingdom	13	453	13	485	12	5.33	4	5.94	Strict	Strict
EU-32 (unweighted)		405		445		4.63		4.59		

Data sources: Eurostat and World Economic Forum
Countries are ranked from higher to lower GERD and from strict to weak IPP legislation

alternatives: (i) an IPP threshold of 4.62 based on the EU-32 (unweighted) mean; and (ii) a correction of IPP for the level of GDP per capita in that country.

8.3.4 Control Variables

In order to isolate the effect of our hypotheses-related variables, the empirical models also include a set of explanatory variables that are known to influence self-employment earnings (see e.g. Hamilton 2000; Millán et al. 2014; Van Stel et al. 2018; Parker 2018; Millán et al. 2020, 2021): a distinction between self-employed with and without employees, educational attainment, job-related aspects (tenure, working hours, business sector) and some demographic indicators (gender, immigrant, age, cohabitation status, children, health status). Furthermore, in order to control for the business cycle and some structural differences between countries, the empirical models also include the national unemployment rates for periods 2010 and 2015, which we collect from Eurostat and the World Bank, and a period 2015 (vs. 2010) dummy. We refer to the Table 8.4 for all variable descriptions.

8.3.5 Methodology

Regarding earnings from self-employment, a considerable proportion of observations are zeros in some human population surveys (see Van Stel et al. 2018). In these cases the entrepreneur either only earns just enough to cover business expenses or might suffer losses (which are censored). This feature violates the linearity assumption so that the least squares method is inappropriate. As usual under these circumstances, earnings equations are estimated by means of tobit models (Tobin 1958). This feature does not occur in our sample though and, hence, OLS regressions are used in order to estimate earnings from self-employment. As explained above, in order to test for moderation effects of IPP on the relationships between country-level R&D and individual-level entrepreneurial earnings, and between individual-level ICT use frequency at work and earnings, we make use of a dummy variable indicating a strict IPP regime (versus a weak IPP regime). In particular, we include interaction terms between R&D and the Strict IPP-dummy, and between ICT usage and Strict IPP. We also estimate separate regressions for Strict versus Weak IPP regime samples.

8.4 Results

8.4.1 Descriptive Analysis

We aim to explore how self-employed workers compare depending on the country-level GERD and IPP. Table 8.2 below compares self-employed workers in countries which' GERD and IPP are above and below the unweighted average levels for the

Table 8.2 Descriptive statistics

Countries	All		High GERD		Low GERD		Strict IPP		Weak IPP	
# observations	6289		2482		3807		2408		3881	
Variables	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Dependent variable										
Net monthly earnings – PPP $ of 2015 (1–55,211)	2213	2033	2883	2459	1776	1550	2944	2465	1759	1546
ICT use										
ICT use frequency at work (1–7)	3.06	2.22	3.82	2.17	2.57	2.10	3.82	2.19	2.60	2.10
Entrepreneurship types										
Self-employed with employees[a]	0.311		0.348		0.287		0.360		0.281	
Own-account self-employed worker[a]	0.689		0.652		0.713		0.640		0.719	
Educational attainment										
Basic education[a]	0.110		0.028		0.163		0.044		0.150	
Secondary education[a]	0.608		0.584		0.623		0.557		0.639	
Tertiary education[a]	0.283		0.388		0.214		0.400		0.210	
Job aspects										
Tenure (1–53)	12.8	10.5	12.6	10.7	12.9	10.3	12.8	10.7	12.8	10.3
Working hours (15–98)	47.0	15.3	45.0	14.2	48.3	15.8	44.8	14.2	48.4	15.8
Business sector dummies										
Agriculture[a]	0.170		0.104		0.212		0.099		0.213	
Industry[a]	0.100		0.088		0.107		0.080		0.112	
Construction[a]	0.108		0.129		0.095		0.136		0.091	
Commerce and hospitality[a]	0.267		0.215		0.302		0.222		0.296	
Transport[a]	0.043		0.040		0.045		0.039		0.045	
Financial services[a]	0.029		0.038		0.024		0.038		0.024	
Public administration and defense[a]	0.002		0.003		0.002		0.002		0.002	
Education[a]	0.015		0.019		0.012		0.020		0.012	
Health[a]	0.047		0.085		0.022		0.087		0.022	
Other services[a]	0.219		0.279		0.179		0.277		0.183	
Demographic characteristics										
Female[a]	0.339		0.340		0.339		0.342		0.338	
Immigrant[a]	0.105		0.174		0.060		0.171		0.065	
Age (18–65)	44.2	11.2	45.7	10.8	43.3	11.3	46.0	10.8	43.1	11.3
Cohabiting[a]	0.729		0.726		0.731		0.730		0.728	
Children under 14[a]	0.319		0.328		0.314		0.323		0.317	
Health (1–5)	3.98	0.76	4.09	0.76	3.91	0.76	4.09	0.76	3.92	0.76

Data source: EWCS (2010 and 2015)
[a]Dummy variable

32 countries in our sample during the periods 2010 and 2015 (these benchmarks are 425 for GERD and 4.62 for IPP). We first explore earnings. We observe how earnings for self-employed are far higher in countries with high GERD than in countries with low GERD, which supports our Hypothesis 1. Similarly, earnings from self-employment are also far higher in countries with strict IPP than in countries with weak IPP, which is consistent with our Hypothesis 2.

Concerning ICT use frequency at work, entrepreneurs in countries with high GERD use ICT at work more often than those in countries with low GERD. In a similar vein, entrepreneurs in countries with strict IPP use ICT at work more often than those in countries with weak IPP. We also observe in our sample that, compared with self-employed in countries with low GERD and weak IPP, self-employed in countries with high GERD and strict IPP, respectively, have more often employees, higher levels of educational attainment, and they work shorter hours. Furthermore, they work more often in construction, financial services, education and health. Finally, they are also more often immigrants, older, with partner, and feeling healthier.

8.4.2 Multivariate Analysis

Although our univariate analysis seems to support the validity of some of our hypotheses, a conditional analysis is needed to draw robust conclusions. Table 8.3 shows the results from 5 models as regards net monthly earnings and their main predictors, with special focus on country-level GERD and IPP, and individual-level ICT use frequency at work. These results are presented as follows. Average predicted earnings are indicated at the top of each specification. These predicted earnings help to understand the relative importance of our marginal effects presented below. Thus, each specification is presented in a two-column format. The first column shows semi-elasticities in the form of [(dy/dx)/y]%., i.e., percentage changes of earnings caused by unit changes of the respective explanatory variables, whereas t-statistics associated with these effects are presented in the second column. Table 8.3 shows the estimation results from 5 specifications, Models 1 to 5, which are aimed to test our earnings-related hypotheses.

Overall, our empirical tests support most of the hypotheses advanced in this article. Model 1 serves as our baseline model and includes country dummies. Models 2 to 5 substitute country dummies by our hypotheses-related variables and some controls for aggregated conditions, i.e., the unemployment rate and a period dummy. In particular, Model 2 is aimed to test Hypotheses 1 and 2, and includes GERD and IPP as main explanatory variables. This model shows that each additional 100 PPS per inhabitant in R&D effort increases earnings from self-employment by about 5%-points, in concordance with Hypothesis 1. Furthermore, we also observe in Model 2 that each unitary increase in the IPP scale (from 1 to 7) raises earnings from self-employment by about 3.5%-points, supporting Hypothesis 2. Model 3 focuses on testing our Hypotheses 3 and 4, i.e., the moderating effect of IPP on the

Table 8.3 Determinants of net monthly earnings (OLS linear regressions)

# Model	1			2			3			4			5			Testing equality of coefficients Model 4 vs. 5		
Countries	All			All			All			Strict IPP			Weak IPP					
Average predicted earnings (y) (in PPP $ of 2015)[a]	2213			2213			2213			2944			1759					
Independent variables (x)	$\frac{dy/dx}{y}\%$	t-statistic		$\frac{dy/dx}{y}\%$	t-statistic		$\frac{dy/dx}{y}\%$	t-statistic		$\frac{dy/dx}{y}\%$	t-statistic		$\frac{dy/dx}{y}\%$	t-statistic		Difference	p-value	
Hypotheses related variables																		
GERD PPS per inhab. ('00)[b] (0.45–10.90)				4.99	8.68	***	6.83	6.40	***	1.68	2.50	**	8.00	7.57	***	−6.32	0.00	***
IPP (2.63–6.19)				3.50	2.21	**												
Strict IPP (> 4.62)[c]							41.0	6.23	***									
ICT use frequency at work (1–7)				1.63	3.46	***	2.58	4.39	***	0.72	0.96		2.62	4.35	***	−1.90	0.06	*
Interaction terms																		
GERD × Strict IPP							−3.54	−2.91	***									
ICT use frequency at work × Strict IPP							−2.57	−3.07	***									
Entrepreneurship types																		
Self-employed with employees[c]	36.0	16.6	***	34.7	15.3	***	34.1	15.1	***	33.8	9.33	***	32.0	11.2	***	1.79	0.73	

(continued)

Table 8.3 (continued)

# Model	1			2			3			4			5					
Countries	All			All			All			Strict IPP			Weak IPP					
Average predicted earnings (y) (in PPP $ of 2015)[a]	2213			2213			2213			2944			1759			Testing equality of coefficients Model 4 vs. 5		
Independent variables (x)	$\frac{dy/dx}{y}\%$	t-statistic		$\frac{dy/dx}{y}\%$		t-statistic	$\frac{dy/dx}{y}\%$		t-statistic	$\frac{dy/dx}{y}\%$		t-statistic	$\frac{dy/dx}{y}\%$		t-statistic	Difference	p-value	
Own-account self-employed worker[c] (ref.)																		
Educational attainment																		
Basic education[c] (ref.)																		
Secondary education[c]	32.9	9.06	***	18.9	5.72	***	18.1	5.49	***	72.0	7.43	***	5.52	1.62		66.5	0.00	***
Tertiary education[c]	69.1	14.7	***	48.7	11.0	***	47.2	10.8	***	110.0	9.78	***	31.4	6.36	***	78.7	0.00	***
Job aspects																		
Tenure (1–53)	1.15	4.26	***	1.57	5.56	***	1.58	5.62	***	1.09	2.40	**	1.81	5.14	***	−0.72	0.22	
Tenure (squared)	−0.02	−2.85	***	−0.02	−3.02	***	−0.02	−3.19	***	−0.01	−1.22		−0.03	−3.12	***	0.01	0.36	
Working hours (15–98)	2.96	11.75	***	2.92	11.1	***	2.94	11.2	***	3.18	6.94	***	2.99	9.29	***	0.19	0.72	
Working hours (squared)	−0.02	−9.38	***	−0.02	−8.79	***	−0.02	−8.80	***	−0.03	−5.65	***	−0.02	−7.56	***	0.00	0.53	
Demographic characteristics																		

# Model	1			2			3			4			5					
Countries	All			All			All			Strict IPP			Weak IPP					
Average predicted earnings (y) (in PPP $ of 2015)[a]	2213			2213			2213			2944			1759			Testing equality of coefficients Model 4 vs. 5		
Independent variables (x)	$\frac{dy/dx}{y}\%$	t-statistic		$\frac{dy/dx}{y}\%$	t-statistic		$\frac{dy/dx}{y}\%$	t-statistic		$\frac{dy/dx}{y}\%$	t-statistic		$\frac{dy/dx}{y}\%$	t-statistic		Difference	p-value	
Female[c]	−23.2	−13.9	***	−25.1	−14.6	***	−25.0	−14.6	***	−27.0	−9.57	***	−22.9	−10.7	***	−4.16	0.18	
Immigrant[c]	−6.08	−2.20	**	−7.73	−2.79	***	−7.84	−2.84	***	−3.62	−0.96		−11.1	−2.68	***	7.44	0.17	
Age (18–65)	2.12	3.46	***	1.33	2.08	**	1.27	1.99	**	4.30	3.86	***	0.06	0.08		4.24	0.00	***
Age (squared)	−0.02	−3.23	***	−0.02	−2.20	**	−0.02	−2.11	**	−0.04	−3.33	***	−0.01	−0.63		−0.04	0.03	**
Cohabiting[c]	6.11	2.85	***	6.15	2.74	***	6.28	2.80	***	9.97	2.74	***	4.61	1.63		5.36	0.29	
Children under 14[c]	1.28	0.61		2.79	1.25		2.52	1.13		4.47	1.21		0.41	0.15		4.05	0.36	
Health (1–5)	7.71	6.70	***	9.75	8.19	***	9.49	8.00	***	5.49	2.84	***	12.2	8.21	***	−6.76	0.01	***
Business cycle																		
Unemployment rate (3.5–24.9)				−0.41	−1.93	*	−0.26	−1.17		−2.14	−3.40	***	0.21	0.88		−2.35	0.00	***
Wave																		
2015[c]	−4.33	−2.51	**	−3.92	−2.20	**	−3.32	−1.86	*	0.93	0.30		−8.51	−3.92	***	9.44	0.01	***
Business sector dummies	Yes			Yes			Yes			Yes			Yes			--		
Country dummies	Yes			No			No			No			No			--		

Table 8.3 (continued)

Notes: N = 6289 for models 1–3; N = 2408 for model 4; N = 3881 for model 5

The maximum correlation is 0.552 (between age and tenure), and the VIF values (from model 1) range from 1.03 to 1.79. Thus, multicollinearity does not pose a concern, especially in consideration of the large size of our sample

*0.1 > $p \geq 0.05$; **0.05 > $p \geq 0.01$; *** $p < 0.01$

[a]Our dependent variable is the natural logarithm of monthly net earnings. Accordingly, we interpret the regression coefficients as semi-elasticities in the form of [(dy/dx)/y]%., i.e., they show the percentage changes of earnings caused by unit changes of the respective explanatory variables. In the context of dummy variables, these reflect the impact for a discrete change of the dummy variable from 0 to 1 and are calculated as $(e^{coef} - 1)\%$

[b]In hundreds of PPS per inhabitant at constant 2005 prices.

[c]Dummy variable

Table 8.4 Variable definitions

Variable	Description
Dependent variables	
Net monthly earnings - PPP $ of 2015 (logs)	Average net earnings in recent months. The variable is defined in PPP $ of 2015 and converted to natural logarithms.
Independent variables	
GERD PPS per inhab.	Gross Domestic Expenditure on R&D by business enterprises, higher education institutions, as well as government and private non-profit organizations. Data for periods 2010 and 2015 are used. The variable is expressed as Purchasing Power Standards –PPS– per inhabitant at constant 2005 prices (Data source: Eurostat).
IPP	Intellectual Property Protection indicator. Data for periods 2010 and 2015 are used. The variable is evaluated on a scale of 1 to 7, from extremely weak to extremely strong protection (Data source: World Economic Forum's Executive Opinion Survey).
Strict IPP	Dummy equals 1 for observations corresponding to countries which' IPP is above 4.62, this benchmark being the unweighted average IPP for the 32 countries in our sample during the periods 2010 and 2015 (Data source: World Economic Forum's Executive Opinion Survey).
ICT use frequency at work	Variable ranging from 1 to 7. The scale refers to the individual ICT (i.e., computers, laptops, smartphones, etc.) use frequency at work. It equals 1 for individuals answering 'never' and 7 for individuals answering, 'all of the time'.
Control variables	
Entrepreneurship types	
Self-employed with employees	Dummy equals 1 for workers who declare being self-employed with employees.
Own-account self-employed worker	Dummy equals 1 for individuals who declare being self-employed without employees
Educational attainment	
Basic education	Dummy equals 1 for workers with less than lower secondary education (ISCED-1997, 0–1).
Secondary education	Dummy equals 1 for workers with, at least, lower secondary education but non-tertiary education (ISCED-1997, 2–4).
Tertiary education	Dummy equals 1 for workers with tertiary education (ISCED-1997, 5–6).
Job aspects	
Tenure	Years of experience in the company or organization.
Working hours	Working hours per week.
Business sector dummies	
Agriculture	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is A = Agriculture, forestry and fishing.

(continued)

Table 8.4 (continued)

Variable	Description
Industry	Dummy equals 1 for workers whose codes of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) are B = Mining and quarrying, C = Manufacturing, D = Electricity, gas, steam and air conditioning supply, and E = Water supply; sewerage, waste management and remediation activities.
Construction	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is F = Construction.
Commerce and hospitality	Dummy equals 1 for workers whose codes of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) are G = Wholesale and retail trade; repair of motor vehicles and motorcycles, and I = Accommodation and food service activities.
Transport	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is H = Transportation and storage.
Financial services	Dummy equals 1 for workers whose codes of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) are K = Financial and insurance activities, and L = Real estate activities.
Public administration and defense	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is O = Public administration and defense; compulsory social security.
Education	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is P = Education.
Health	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is Q = Human health and social work activities.
Other services	Dummy equals 1 for workers whose codes of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) are J = Information and communication, M = Professional, scientific and technical activities, N = Administrative and support service activities, R = Arts, entertainment and recreation, S = Other service activities, T = Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U = Activities of extraterritorial organizations and bodies.
Demographic characteristics	
Female	Dummy equals 1 for females.
Immigrant	Dummy equals 1 for citizens of a different country from that of residence.
Age	Age reported by the workers.
Cohabiting	Dummy equals 1 for individuals cohabiting with spouse/partner.
Children under 14	Dummy equals 1 for individuals cohabiting with any son or daughter aged under 14.

(continued)

Table 8.4 (continued)

Variable	Description
Health	Variable ranging from 1 to 5. The scale refers to the level of health declared by the worker. It equals 1 for individuals whose health is very bad and 5 for individuals whose health is very good.
Business cycle	
Unemployment rate	National annual unemployment rate for periods 2010 and 2015 (source: Eurostat, World Bank).
Wave	
2015	Dummy equals 1 for observations corresponding to the EWCS 2015 and 0 for observations corresponding to the EWCS 2010.
Country dummies	32 dummies equaling 1 for individuals living in the named country: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Data source: EWCS

relationships between (i) GERD and earnings from self-employment and (ii) ICT use frequency at work and earnings from self-employment. Hence, the main predictors are (i) GERD; (ii) a dummy equaling 1 for strict IPP, that is, when the IPP indicator is above 4.62; (iii) an interaction term intended to capture the differentiated effect of GERD on those economies with strict and weak IPP regimes; and (iv) an interaction term aimed to test the existence of a differentiated effect of ICT usage at work on those economies with strict and weak IPP regimes. Thus, when the IPP is *below* this benchmark, we find that earnings from self-employment increases by about 6.8%-points for each additional 100 PPS per inhabitant in GERD. When the IPP is *above* this benchmark, however, we observe that each additional 100 PPS per inhabitant in GERD only increases earnings from self-employment by 3.3%-points.[10] These results are, therefore, coherent with Hypothesis 3. Furthermore, when the IPP is *below* this benchmark, we find that earnings from self-employment increases by about 2.6%-points for each advancement (step) on the ICT frequency use scale. When the IPP is *above* this benchmark, however, we observe an absence of any effect of ICT usage on self-employment earnings.[11] These results are, therefore, coherent with Hypothesis 4.

Models 4 and 5 are separate regressions for countries with strict and weak IPP regimes in order to check the robustness of the different role of GERD and ICT use frequency at work on earnings from self-employment we just identified in Model 3. In this sense, we observe how these effects are indeed stronger for countries with

[10] Results concerning the situation when the IPP indicator is above 4.62 can be achieved by adding marginal effects associated with GERD and the interaction term in Model 3 (i.e. 6.83–3.54).

[11] Results concerning the situation when the IPP indicator is above 4.62 can be achieved by adding marginal effects associated with ICT use and the interaction term in Model 3 (i.e. 2.58–2.57).

weak IPP, in accordance with Hypotheses 3 and 4. In particular, we observe how earnings from self-employment increase in countries with strict and weak IPP, respectively, by about 1.7%-points and 8.0%-points for each additional 100 PPS per inhabitant in GERD. The final column of Table 8.3 shows that this difference in estimated marginal effects of GERD between Strict and Weak IPP regimes is significant at 1% level. Note that Models 4 and 5 also support Hypothesis 2 since average predicted earnings are much higher in the strong-IPP sample (2944 $) compared to the weak-IPP sample (1759 $). Concerning the effect of ICT usage at work on self-employment earnings, each advancement (step) on the ICT frequency use scale by entrepreneurs in countries with weak IPP is observed to increase their earnings by about 2.6%-points whereas, conversely, we observe no significant effect of ICT use on earnings for entrepreneurs in countries with strict IPP. The final column of Table 8.3 shows that the difference in estimated marginal effects of ICT usage between Strict and Weak IPP regimes is significant at 10% level.

As regards the results for our control variables, having employees, education, tenure and the number of working hours increase earnings from entrepreneurship, as expected. As regards tenure, however, the quadratic term begins to dominate the linear term when self-employed reach 29 years of experience, indicating that, beyond this number of years of experience, additional experience does not report additional earnings. Similarly, results as regards working hours indicate that, beyond 64 working hours per week, additional entrepreneurial efforts are no longer productive. We also find that females and immigrants earn less than their male and native counterparts, respectively. Regarding the age of the entrepreneur, we find a nonlinear, inverted U-shaped impact on earnings where the turning point is reached when the entrepreneur is 47 years old. Cohabiting individuals report higher earnings than those living without partner whereas no effect of children on earnings is observed. Reporting good health also seems to be positively associated with earnings from entrepreneurship. Finally, higher unemployment rates are associated with lower earnings, which is also expected.

8.4.3 Robustness Checks

We performed several robustness checks. First, although we present only a few models in Table 8.3, a complete stepwise regression approach (in which models incorporate covariates one-by-one) was followed, which serves as a robustness check for the results obtained in previous models. Second, our findings are also robust to the use of alternative operationalization of hypotheses-related variables such as (i) GERD expressed as a percentage of GDP and (ii) the Protection of Property Rights indicator from the Economic Freedom of the World Index (EFW; Fraser Institute, Canada).[12] Third, we also obtain similar results when using median

[12] Further information about the EFW index can be found at https://www.fraserinstitute.org/economic-freedom/approach. Further information about the *Fraser Institute* can be found at https://www.fraserinstitute.org

(instead of mean) IPP to calculate the benchmark which distinguishes strict from weak IPP countries. Fourth, the robustness of our t-statistics was verified by re-estimating them from variance–covariance matrices of the coefficients obtained by bootstrapping. All results as regards these robustness checks are available upon request.

The fifth and final robustness test is arguably our most important one. Here we investigate whether our results for Models 4 and 5 in Table 8.3 could be affected by the exclusion of GDP per capita from our regression model. Table 8.5 shows that GDP per capita is relatively strongly correlated with both GERD and IPP. Therefore we did not include GDP per capita as a control variable so as to avoid multicollinearity. However, since GDP per capita is not part of our model, and since the correlation between IPP and GDP per capita is relatively high with 0.79, we cannot exclude beforehand the possibility that our different results for weak versus strong IPP regimes are capturing a difference in results between higher and lower developed countries within our sample of 32 European countries. To control for a possible distortion caused by exclusion of GDP per capita, we created an alternative distinction between strict versus weak IPP regimes that corrects for the influence of GDP per capita. In particular, we ran a simple regression on 64 country-level observations (32 countries for 2 waves) explaining IPP (i.e., the continuous IPP variable) from GDP per capita and a constant. The residuals from this regression can be interpreted as IPP levels that are corrected for the level of GDP per capita of each country. The natural way to distribute these corrected IPP levels over regime types is to define countries with positive residuals as Strict-IPP countries and those with negative residuals as Weak-IPP countries. The alternative distribution of countries over strict versus weak regimes can be seen in the last column of Table 8.1 (IPP regime corrected for GDP per capita). Estimation results for Models 3 to 5 using this alternative classification of strict versus weak IPP regimes are in Table 8.6. Results in Table 8.6 are qualitatively similar to those in Table 8.3. If anything, the results are even stronger as the differences in marginal effects of GERD and ICT usage between Strict-IPP and Weak-IPP regimes are larger, with the difference in marginal effects of ICT usage between the two regimes now being significant at the 1% level (compared to 10% level in Table 8.3). In summary, our results are also robust to the correction of IPP levels for the level of GDP per capita in each country.

Table 8.5 Country-level correlations

	GERD PPS per inhab.	IPP	GDP per capita in PPS Index (EU28 = 100)
GERD PPS per inhab.	1		
IPP	0.87	1	
GDP per capita in PPS Index (EU28 = 100)	0.77	0.79	1

Notes: N = 64; Data sources: Eurostat and World Economic Forum

Table 8.6 Estimation results for alternative classification of strict vs weak IPP regimes

# Model	3			4			5			Testing equality of coefficients Model 4 vs. 5		
Countries	*All*			*Strict IPP*[d]			*Weak IPP*[d]					
Average predicted earnings (y) (*in PPP $ of 2015*)[a]	2213			2610			1940					
Independent variables (*x*)	$\frac{dy/dx}{y}\%$	t-statistic		$\frac{dy/dx}{y}\%$	t-statistic		$\frac{dy/dx}{y}\%$	t-statistic		Difference	p-value	
Hypotheses related variables												
GERD PPS per inhab. ('00)[b] (*0.45–10.90*)	9.56	14.3	***	2.35	4.37	***	11.3	16.5	***	−8.92	0.00	***
Strict IPP[c, d]	26.2	5.63	***									
ICT use frequency at work (1–7)	2.70	4.52	***	0.00	0.00		2.78	4.53	***	−2.78	0.01	***
Interaction terms												
GERD × Strict IPP	−4.86	−6.21	***									
ICT use frequency at work × Strict IPP	−2.78	−3.36	***									
Entrepreneurship types												
Self-employed with employees[c]	34.3	15.2	***	33.9	9.61	***	33.9	11.7	***	−0.04	0.99	
Own-account self-employed worker[c] (*ref.*)												
Educational attainment												
Basic education[c] (*ref.*)												
Secondary education[c]	18.3	5.58	***	51.1	7.23	***	4.30	1.20		46.8	0.00	***
Tertiary education[c]	48.0	11.0	***	88.2	10.2	***	29.2	5.74	***	59.0	0.00	***
Job aspects												
Tenure (*1–53*)	1.56	5.57	***	1.35	3.04	***	1.47	4.11	***	−0.11	0.85	
Tenure (squared)	−0.02	−3.19	***	−0.02	−1.67	*	−0.02	−2.30	**	0.00	0.91	

Working hours (*15–98*)	2.86	10.9	***	3.18	7.06	***	2.86	8.80	***	0.32	0.56	
Working hours (squared)	−0.02	−8.48	***	−0.03	−5.51	***	−0.02	−7.14	***	0.00	0.49	
Demographic characteristics												
Female[c]	−25.2	−14.8	***	−24.2	−8.85	***	−24.9	−11.4	***	0.76	0.81	
Immigrant[c]	−9.77	−3.56	***	−8.97	−2.38	**	−11.5	−2.89	***	2.55	0.63	
Age (*18–65*)	1.23	1.93	*	2.96	2.82	***	0.38	0.47		2.58	0.06	*
Age (squared)	−0.01	−2.03	**	−0.03	−2.54	**	−0.01	−0.85		−0.02	0.16	
Cohabiting[c]	6.17	2.76	***	10.5	2.97	***	3.98	1.39		6.53	0.19	
Children under 14[c]	2.59	1.17		2.15	0.60		1.39	0.50		0.76	0.86	
Health (1–5)	9.77	8.27	***	7.61	4.05	***	11.0	7.33	***	−3.34	0.16	
Business cycle												
Unemployment rate (*3.5–24.9*)	−0.43	−2.01	**	−3.75	−7.34	***	0.57	2.40	**	−4.32	0.00	***
Wave												
2015[c]	−5.18	−2.96	***	0.60	0.21		−12.3	−5.67	***	12.9	0.00	***
Business sector dummies	*Yes*			*Yes*			*Yes*			–		
Country dummies	*No*			*No*			*No*			–		

Notes: N = 6289 for model 3; N = 2558 for model 4; N = 3731 for model 5
*0.1 > $p \geq 0.05$; **0.05 > $p \geq 0.01$; ***$p < 0.01$
[a]Our dependent variable is the natural logarithm of monthly net earnings. Accordingly, we interpret the regression coefficients as semi-elasticities in the form of [(dy/dx)/y]%., i.e., they show the percentage changes of earnings caused by unit changes of the respective explanatory variables. In the context of dummy variables, these reflect the impact for a discrete change of the dummy variable from 0 to 1 and are calculated as $(e^{coef} - 1)\%$
[b]In hundreds of PPS per inhabitant at constant 2005 prices
[c]Dummy variable
[d]IPP levels are corrected for the level of GDP per capita in each country

8.5 Conclusions

8.5.1 Implications

The results of our empirical analysis have implications for various stakeholders. For policymakers, it is important to strike a balance between the level of R&D in their countries and the strictness of IPR laws. If total R&D expenditures in a country (the sum of public and private R&D) is relatively low, governments may directly increase R&D by increasing public R&D. However, it may also stimulate (primarily private) R&D indirectly by installing stricter IPR laws. This will increase the incentives for private firms to conduct R&D as the strict IPR makes it easier to appropriate the returns to their R&D efforts. On the other hand, if R&D is already at a relatively high level, it may be wise to exploit such a big knowledge stock by lowering the strictness of IPR, which will in turn stimulate knowledge spillovers. As we have shown, the association of country-level R&D with average entrepreneurial income is stronger in a weak-IPR regime, hence installing less strict IPR laws will be especially beneficial to entrepreneurs in countries with high R&D investments.

For innovative entrepreneurs with an international orientation, it may be wise to consider the strictness of IPR in various countries as part of their decision in which country to locate. Nevertheless, this is not just a matter of choosing a country with a strict IPR regime: although this will help appropriating the returns to their innovations, innovative entrepreneurs will find it harder to use existing innovations on which they may wish to build further. Hence, whereas innovative entrepreneurs pursuing *radical* innovations are likely to benefit from a strict IPR regime, innovative entrepreneurs pursuing *incremental* innovations (building further on earlier innovations made in other firms) as well as imitative entrepreneurs will be better off in a country that combines high R&D levels with a low IPR regime, facilitating knowledge spillovers. In such countries entrepreneurs will have easy access to a big knowledge stock, which benefit incremental innovation and imitation. We note though that such countries are rare as the country-level correlation between R&D and IPP is high with 0.87 (see Table 8.5).

Regarding ICT usage, policymakers will be aware that digitalization becomes increasingly important in contemporary economies, and even more so in light of the current pandemic. Moreover, ICT usage by entrepreneurs facilitates exploitation of knowledge spillovers. However, the current chapter has shown that such a positive role for ICT in knowledge diffusion seems to be considerably smaller in economies with stricter IPR regimes. This is an important and, as far as we know, novel consideration that policymakers should be aware of when setting IPR levels for their economies. Finally, our work also has implications for researchers as we show that the impact of R&D, ICT usage and IPR on entrepreneurial outcomes should be considered in tandem with each other rather than in isolation.

8.5.2 Conclusions

Using recent data drawn from the European Working Conditions Survey for 32 European countries, we have explored the relationship between two indicators of knowledge diffusion processes —country-level R&D and individual-level ICT usage at work by entrepreneurs—, Intellectual Property Rights (IPR), and individual-level entrepreneurial performance as measured by earnings. Our results show that country-level expenditures on R&D, entrepreneurs' ICT use frequency at work, and IPR are all positively associated with earnings of individual entrepreneurs. However, we have also found two intriguing moderation effects in the sense that IPR reduces both the positive relationship between country R&D and entrepreneurial earnings and the positive relationship between ICT usage and earnings.

Our results suggest that too strict IPR may hamper the diffusion of knowledge created by R&D, including imitation. Current entrepreneurship research has a tendency to strongly emphasize (if not overemphasize) the role of the innovative or Schumpeterian entrepreneur (e.g., Henrekson and Sanandaji 2018). It goes without saying that these entrepreneurs are very important for achieving economic growth as they contribute strongly to increasing a country's knowledge stock, and hence technological progress. However, knowledge diffusion and imitation may be equally important for achieving high rates of economic growth, i.e. many imitative entrepreneurs are also to be considered high-quality in the sense of contributing significantly to macro-economic development and job creation (Schmitz 1989). Results of the current chapter suggest that high-R&D countries may (unintentionally) hamper economic progress by setting too strict IPR levels which discourage high-quality imitative entrepreneurship and the associated diffusion of knowledge. In addition, our results suggest that too strict IPR legislation may also limit the facilitating role of ICT usage at work by entrepreneurs in the exploitation of knowledge spillovers.

In conclusion, the present chapter has contributed to our knowledge of how country levels of R&D and IPR play out for the earnings of individual entrepreneurs, and hence, the average quality of a country's entrepreneurs. To the best of our knowledge, this chapter is the first to investigate how the level of investments in a country's knowledge stock (as measured by R&D expenditures) influences the quality of entrepreneurship at the micro level (as measured by entrepreneurial earnings), and how this relationship is moderated by a country's technology transfer policy (as measured by the strictness of IPR legislation). In addition, we are the first to explore how the positive relationship between ICT usage at work by entrepreneurs and their earnings may depend on the technology transfer policy (Strict or Weak IPR regime) being in place in a certain national economy. A limitation of this study is that we are unable to distinguish empirically between innovative and imitative entrepreneurs. It is likely that the interaction between R&D and IPR plays out differently for the earnings of these two types of entrepreneurs. We consider the identification of these two types a fruitful direction for future research. Future research may also focus on investigating the relationship between R&D, IPR, ICT usage at work and earnings outside of the European context as used in this chapter. Especially in low- and middle-income countries, the relationship might be different (Thompson and Rushing 1996, 1999; Falvey et al. 2006).

Acknowledgments All authors contributed equally to the manuscript. The authors would like to thank Andrew Burke and the book editors —Maribel Guerrero and David Urbano— for their insightful comments that contributed substantially to the development of this chapter. The current chapter is an extension of Van Stel et al. (2019), which is part of Serhiy Lyalkov's doctoral dissertation (written in the framework of the Ph.D. Program in Economics, Business, Finance and Computer Science at the University of Huelva and the International University of Andalusia, Spain). The role of ICT use frequency at work by entrepreneurs in relation to IPR and entrepreneurial performance is the main novel element relative to the original publication. At the time of writing, Ana Millán was lecturer at the Department of Financial Economics and Accounting, Pablo de Olavide University, Sevilla, Spain. This work was supported by the Spanish Ministry of Economy and Competitiveness (Ministerio de Economía y Competitividad) under research projects ECO2017-86305-C4-2-R and ECO2017-86402-C2-2-R; the Ministry of Economy and Knowledge of the Andalusian Regional Government (Junta de Andalucía-Consejería de Economía y Conocimiento) through Research Group SEJ-487 (Spanish Entrepreneurship Research Group – SERG), and Andalusia ERDF 2014–20 Operational Programme (Programa Operativo FEDER Andalucía 2014–20) under University of Huelva research project UHU-1265299; and University of Huelva through Research and Transfer Policy Strategies (Estrategias de Política de Investigación y Transferencia).

References

Acemoglu, D., Johnson, S., & Robinson, J. (2001). The colonial origins of comparative development: An empirical investigation. *The American Economic Review, 91*(5), 1369–1401. https://doi.org/10.1257/aer.91.5.1369.

Acemoglu, D., Johnson, S., & Robinson, J. (2002). Reversal of fortune: Geography and institutions in the making of the modern world income distribution. *Quarterly Journal of Economics, 117*(4), 1231–1294. https://doi.org/10.1162/003355302320935025.

Acs, Z. J. (2006). How is entrepreneurship good for economic growth? *Innovations: Technology, Governance, Globalization, 1*(1), 97–107. https://doi.org/10.1162/itgg.2006.1.1.97.

Acs, Z. J., Audretsch, D. B., & Lehmann, E. E. (2013). The knowledge spillover theory of entrepreneurship. *Small Business Economics, 41*(4), 757–774. https://doi.org/10.1007/s11187-013-9505-9.

Aerts, K., & Schmidt, T. (2008). Two for the price of one? Additionality effects of R&D subsidies: A comparison between Flanders and Germany. *Research Policy, 37*(5), 806–822. https://doi.org/10.1016/j.respol.2008.01.011.

Aghion, P., & Howitt, P. (1998). *Endogenous growth theory*. Cambridge, MA: MIT Press.

Audretsch, D. B., & Keilbach, M. (2004). Entrepreneurship capital and economic performance. *Regional Studies, 38*(8), 949–959. https://doi.org/10.1080/0034340042000280956.

Autio, E., & Acs, Z. (2010). Intellectual property protection and the formation of entrepreneurial growth aspirations. *Strategic Entrepreneurship Journal, 4*(3), 234–251. https://doi.org/10.1002/sej.93.

Bayo-Moriones, A., Billón, M., & Lera-López, F. (2013). Perceived performance effects of ICT in manufacturing SMEs. *Industrial Management & Data Systems, 113*(1), 117–135. https://doi.org/10.1108/02635571311289700.

Browne, C., Di Battista, A., Geiger, T., & Gutknecht, T. (2014). The Executive Opinion Survey: The voice of the business community. In K. Schwab (Ed.), *The global competitiveness report 2014–2015* (pp. 85–96). Geneva: World Economic Forum.

Burke, A., & Fraser, S. (2012). Self-employment: the role of intellectual property right laws. *Small Business Economics, 39*(4), 819–833. https://doi.org/10.1007/s11187-011-9336-5.
Coe, D. T., & Helpman, E. (1995). International R&D spillovers. *European Economic Review, 39*(5), 859–887. https://doi.org/10.1016/0014-2921(94)00100-E.
Colombelli, A., & Quatraro, F. (2018). New firm formation and regional knowledge production modes: Italian evidence. *Research Policy, 47*(1), 139–157. https://doi.org/10.1016/j.respol.2017.10.006.
De Soto, H. (2000). *The mystery of capital: Why capitalism triumphs in the west and fails everywhere else*. New York: Basic Books.
Deeds, D. L. (2001). The role of R&D intensity, technical development and absorptive capacity in creating entrepreneurial wealth in high technology start-ups. *Journal of Engineering and Technology Management, 18*(1), 29–47. https://doi.org/10.1016/s0923-4748(00)00032-1.
Denicoliò, V., & Franzoni, L. A. (2012). Weak intellectual property rights, research spillovers, and the incentive to innovate. *American Law and Economics Review, 14*(1), 111–140. https://doi.org/10.1093/aler/ahr017.
Easterly, W., & Levine, R. (1997). Africa's growth tragedy: Policies and ethnic divisions. *Quarterly Journal of Economics, 112*(4), 1203–1250. https://doi.org/10.1162/003355300555466.
Elschner, C., Ernst, C., Licht, G., & Spengel, C. (2011). What the design of an R&D tax incentive tells about its effectiveness: A simulation of R&D tax incentives in the European Union. *Journal of Technology Transfer, 36*(3), 233–256. https://doi.org/10.1007/s10961-009-9146-y.
Erken, H., Donselaar, P., & Thurik, R. (2018). Total factor productivity and the role of entrepreneurship. *Journal of Technology Transfer, 43*(6), 1493–1521. https://doi.org/10.1007/s10961-016-9504-5.
Eurofound. (2012). *Fifth European working conditions survey – Overview report*. Luxembourg: Publications Office of the European Union. https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1182en.pdf. Accessed 29 Oct 2020.
Eurofound. (2016). *Sixth European working conditions survey – Overview report*. Luxembourg: Publications Office of the European Union. https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1634en.pdf. Accessed 29 Oct 2020.
Eurofound. (2018) European working conditions survey integrated data file, 1991–2015. [data collection]. 7th Edition. UK Data Service. SN: 7363. https://doi.org/10.5255/UKDA-SN-7363-7
European Commission. (2017). *The economic rationale for public R&I funding and its impact*. Brussels: European Commission. https://op.europa.eu/es/publication-detail/-/publication/0635b07f-07bb-11e7-8a35-01aa75ed71a1. Accessed 29 Oct 2020.
Falvey, R., Foster, N., & Greenaway, D. (2006). Intellectual property rights and economic growth. *Review of Development Economics, 10*(4), 700–719. https://doi.org/10.1111/j.1467-9361.2006.00343.x.
Furman, J. L., Porter, M. E., & Stern, S. (2002). The determinants of national innovative capacity. *Research Policy, 31*(6), 899–933. https://doi.org/10.1016/s0048-7333(01)00152-4.
Giotopoulos, I., Kontolaimou, A., Korra, E., & Tsakanikas, A. (2017). What drives ICT adoption by SMEs? Evidence from a large-scale survey in Greece. *Journal of Business Research, 81*, 60–69. https://doi.org/10.1016/j.jbusres.2017.08.007.
Guerrero, M., & Urbano, D. (2019). Effectiveness of technology transfer policies and legislation in fostering entrepreneurial innovations across continents: an overview. *The Journal of Technology Transfer, 44*(5), 1347–1366.
Hall, B. H., Mairesse, J., & Mohnen, P. (2010). Measuring the returns to R&D. In B. H. Hall & N. Rosenberg (Eds.), *Handbook of the economics of innovation* (Vol. 2, pp. 1033–1082). Burlington: Academic. https://doi.org/10.1016/S0169-7218(10)02008-3.
Haller, S., & Siedschlag, I. (2011). Determinants of ICT adoption: Evidence from firm-level data. *Applied Economics, 43*(26), 3775–3788. https://doi.org/10.1080/00036841003724411.
Hamilton, R. T. (2000). Does entrepreneurship pay? An empirical analysis of the returns to self-employment. *Journal of Political Economy, 108*(3), 604–631. https://doi.org/10.1086/262131.

Henrekson, M., & Sanandaji, T. (2018). Schumpeterian entrepreneurship in Europe compared to other industrialized regions. *The International Review of Entrepreneurship, 16*(2), 157–182.

Kao, C., Chiang, M.-H., & Chen, B. (1999). International R&D spillovers: An application of estimation and inference in panel cointegration. *Oxford Bulletin of Economics and Statistics, 61*(4), 693–711. https://doi.org/10.1111/1468-0084.0610s1691.

Kelly, R., & Kim, H. (2018). Venture capital as a catalyst for commercialization and high growth. *Journal of Technology Transfer, 43*(6), 1466–1492. https://doi.org/10.1007/s10961-016-9540-1.

Krieger B, Licht G, & Pellens M (2018) New perspectives in European innovation policy. ZEW policy brief, No. 7/2018. Zentrum für Europäische Wirtschaftsforschung (ZEW), Mannheim. http://hdl.handle.net/10419/183222. Accessed 29 Oct 2020.

Lehmann, E. E., & Menter, M. (2018). Public cluster policy and performance. *Journal of Technology Transfer, 43*(3), 558–592. https://doi.org/10.1007/s10961-017-9626-4.

Liang, T., You, B., & Liu, C. (2010). A resource-based perspective on information technology and firm performance: A meta-analysis. *Industrial Management & Data Systems, 110*(8), 1138–1158. https://doi.org/10.1108/02635571011077807.

Millán, J. M., Congregado, E., Román, C., van Praag, M., & van Stel, A. (2014). The value of an educated population for an individual's entrepreneurship success. *Journal of Business Venturing, 29*(5), 612–632. https://doi.org/10.1016/j.jbusvent.2013.09.003.

Millán, J. M., Lyalkov, S., Burke, A., Millán, A., & van Stel, A. (2021). 'Digital divide' among European entrepreneurs: Which types benefit most from ICT implementation? *Journal of Business Research, 125*, 533–547. https://doi.org/10.1016/j.jbusres.2019.10.034.

Millán, A., Millán, J. M., & Caçador-Rodrigues, L. (2020). Disclosing 'masked employees' in Europe: job control, job demands and job outcomes of 'dependent self-employed workers'. *Small Business Economics, 55*(2), 461–474. https://doi.org/10.1007/s11187-019-00245-7.

Mueller, P. (2007). Exploiting entrepreneurial opportunities: The impact of entrepreneurship on growth. *Small Business Economics, 28*(4), 355–336. https://doi.org/10.1007/s11187-006-9035-9.

OECD. (2015). *The future of productivity*. Paris: OECD Publishing. https://doi.org/10.1787/9789264248533-en.

OECD. (2019) Gross domestic spending on R&D (indicator). https://doi.org/10.1787/d8b068b4-en. Accessed 29 Oct 2020.

Park, W. G., & Ginarte, J. C. (1997). Intellectual property rights and economic growth. *Contemporary Economic Policy, 15*(3), 51–61. https://doi.org/10.1111/j.1465-7287.1997.tb00477.x.

Parker, S. C. (2018). *The economics of entrepreneurship*. Cambridge, UK: Cambridge University Press. https://doi.org/10.1017/9781316756706.

Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of Political Economy, 94*(5), 1002–1037. https://doi.org/10.1086/261420.

Romer, P. M. (1990). Endogenous technological change. *J Polit Econ, 98*(5, Part 2), S71–S102. https://doi.org/10.1086/261725.

Schmitz, J. A., Jr. (1989). Imitation, entrepreneurship, and long-run growth. *Journal of Political Economy, 97*(3), 721–739. https://doi.org/10.1086/261624.

Schneider, P. H. (2005). International trade, economic growth and intellectual property rights: A panel data study of developed and developing countries. *Journal of Development Economics, 78*(2), 529–547. https://doi.org/10.1016/j.jdeveco.2004.09.001.

Shane, S. (2009). Why encouraging more people to become entrepreneurs is bad public policy. *Small Business Economics, 33*(2), 141–149. https://doi.org/10.1007/s11187-009-9215-5.

Takalo, T. (2012). Rationales and instruments for public innovation policies. *Journal of Reviews on Global Economics, 1*, 157–167. https://doi.org/10.6000/1929-7092.2012.01.14.

Takalo, T., & Tanayama, T. (2010). Adverse selection and financing of innovation: is there a need for R&D subsidies? *Journal of Technology Transfer, 35*(1), 16–41. https://doi.org/10.1007/s10961-009-9112-8.

Thompson, M. A., & Rushing, F. W. (1996). An empirical analysis of the impact of patent protection on economic growth. *Journal of Economic Development, 21*(2), 61–77. http://jed.or.kr/full-text/21-2/4.pdf. Accessed 29 Oct 2020.

Thompson, M. A., & Rushing, F. W. (1999). An empirical analysis of the impact of patent protection on economic growth: An Extension. *Journal of Economic Development, 24*(1), 67–76. http://jed.or.kr/full-text/24-1/thompson.PDF. Accessed 29 Oct 2020.

Tobin, J. (1958). Estimation of relationships for limited dependent variables. *Econometrica, 26*(1), 24–36. https://doi.org/10.2307/1907382.

Van Praag, C. M. (2005). *Successful entrepreneurship: Confronting economic theory with empirical practice*. Cheltenham: Edward Elgar Publishing.

Van Stel, A., Millán, J. M., & Román, C. (2014). Investigating the impact of the technological environment on survival chances of employer entrepreneurs. *Small Business Economics, 43*(4), 839–855. https://doi.org/10.1007/s11187-014-9565-5.

Van Stel, A., Millán, A., Millán, J. M., & Román, C. (2018). The relationship between start-up motive and earnings over the course of the entrepreneur's business tenure. *Journal of Evolutionary Economics, 28*(1), 103–123. https://doi.org/10.1007/s00191-017-0499-3.

Van Stel, A., Lyalkov, S., Millán, A., & Millán, J. M. (2019). The moderating role of IPR on the relationship between country-level R&D and individual-level entrepreneurial performance. *Journal of Technology Transfer, 44*(5), 1427–1450. https://doi.org/10.1007/s10961-019-09731-2.

Xu, B., & Chiang, E. P. (2005). Trade, patents and international technology diffusion. *The Journal of International Trade and Economic Development, 14*(1), 115–135. https://doi.org/10.1080/0963819042000333270.

Chapter 9
Regional Innovation, Entrepreneurship and the Reform of the Professor's Privilege in Germany

James A. Cunningham, Erik E. Lehmann, Matthias Menter, and Nikolaus Seitz

9.1 Introduction

Over the past decades, substantial research effort has gone into understanding and evaluating the contribution of knowledge-based entrepreneurship and innovation to economic growth (Wennekers and Thurik 1999; Wong et al. 2005). Within knowledge-based economies, public sector actors such as universities can be a source of new knowledge, provide supports for entrepreneurs in terms of knowledge transfer, incubation, mentorship, and consultancy thus generating more entrepreneurial and innovative outcomes within and beyond the academic sector (see Bercovitz and Feldman 2006). Consequently, universities are increasingly perceived as key actors in contributing to economic growth and fostering entrepreneurial behaviors and innovative activities, thereby being of benefit and support to private sector actors in achieving firm level growth (Salter and Martin 2001). As

J. A. Cunningham (✉)
Newcastle Business School, Northumbria University, Newcastle upon Tyne, UK
e-mail: james.cunningham@northumbria.ac.uk

E. E. Lehmann
Faculty of Business and Economics, University of Augsburg and CCSE (Augsburg/Bergamo, Italy), Augsburg, Germany
e-mail: erik.lehmann@wiwi.uni-augsburg.de

M. Menter
Faculty of Economics and Business Administration Friedrich Schiller University Jena, Jena, Germany
e-mail: matthias.menter@uni-jena.de

N. Seitz
LMU Munich School of Management, Ludwig-Maximilians-Universitaet, Munich, Germany
e-mail: seitz@bwl.lmu.de

M. Guerrero, D. Urbano (eds.), *Technology Transfer and Entrepreneurial Innovations*, International Studies in Entrepreneurship 51,
https://doi.org/10.1007/978-3-030-70022-5_9

universities are at the center of knowledge creation and exploitation, they are shaped by technology transfer policies and legislation (O'Kane et al. 2015). They are directly funded to implement a mix of innovation and entrepreneurship policy interventions, or, more often, indirectly supported through partnerships with industry (Muscio et al. 2013). Public policy funding has also been used to strengthen national technology transfer systems to then support more effective innovation and entrepreneurship outcomes for a variety of stakeholders (see Geoghegan and Pontikakis 2008; Guerrero and Urbano 2019). These policy interventions assume mutually beneficial outcomes, thus mandate interactions between universities and industry, hence promote public and private sector interaction (Cunningham and Link 2014).

Due to the increasing awareness that universities play an essential role in shaping regional competitiveness and prosperity (Audretsch et al. 2012; Valero and Van Reenen 2019), governments have tried to revise the traditional academic role of universities and integrate entrepreneurial elements into higher education systems. Leyden and Menter (2018) explicate the added value of a simultaneous focus on both basic and applied research that ultimately cross-fertilize each other, thus call for government interventions that facilitate the interactions between the public and the private sector. Etzkowitz (2014) describes this paradigm shift as the entrepreneurial university wave, which transforms universities from ivory towers into global economic engines. As a consequence, policymakers specifically target universities and set up policies or new legislations to enhance local knowledge flows, hence generate university-industry technology transfer and research collaborations (Audretsch 2014; Lehmann and Menter 2016). The Bayh-Dole Act of 1980 serves as a visible example of how entrepreneurial and innovative outcomes can be fostered within and beyond an academic setting, thus has often been taken as a role model for policy and legislative interventions how to best stimulate university and industry technology transfer (see Mowery and Sampat 2004; Shane 2004; Aldridge and Audretsch 2011).

Previous studies have addressed calls in the literature for more research on the economic roles of universities' entrepreneurial outcomes (see Cunningham et al. 2017a; Di Nauta et al. 2018) and have identified the benefits of specific and various forms of university-industry collaborations. Other studies have shown that entrepreneurial universities do have a positive impact on all three missions (Guerrero et al. 2015) and national government policy and funding does influence technology transfer behaviors (Hsu et al. 2015), TTOs (Fitzgerald and Cunningham 2016), principal investigators (Cunningham et al. 2014; Menter 2016; Kuratko and Menter 2017), and high-technology entrepreneurs (Cunningham and Menter 2020a). However, such studies have not focused on examining the simultaneous effects on entrepreneurial and innovative outcomes of university focused technology transfer policies. Our chapter seeks to address this gap by examining the innovation and entrepreneurship impacts of a university focused technology transfer policy and legislative framework.

Set in the German context, we focus on a far-reaching legislation change that reformed the old 'professor's privilege' (*Hochschullehrerprivileg*). We specifically focus on the question whether both entrepreneurial and innovative outcomes have been affected through a change in property rights on inventions made by scientists. This legislative policy change was intended to foster entrepreneurial innovation among university faculty and balance the interests between scientists and universities. Our study contributes to an ongoing discussion concerning the efficacy of replicating successful university focused technology transfer policy initiatives in different contexts. For countries that have adapted their legislation according to the Bayh-Dole Act of 1980, scholars have found mixed results (see Poyago-Theotoky et al. 2002; Siegel et al. 2003). Our study contributes and extends existing knowledge about the efficacy and effectiveness of replicated technology transfer policies and associated legal frameworks. We also derive some policy recommendations how the regional context should best be integrated in policy initiatives to ensure beneficial outcomes with regard to entrepreneurial and innovative outcomes.

Based on a unique dataset capturing both university and regional specifics within a timeframe from 1998 to 2012, the results of our study reveal that this legislative change did have an initial positive effect on universities as measured by start-ups and patents. The effect yet changed over time, leading to some unintended consequences. Our chapter argues that policymakers and legislators need to give consideration to the replication of policy and legislative instruments from other contexts along with the criteria that is used to measure success. Therefore, blind replication of university focused technology transfer policies might not be fit for purpose when implemented in another context or jurisdiction.

The remainder of this chapter is structured as follows. Section 9.2 reviews the literature on the role of entrepreneurial universities and the impact of university focused technology transfer policies. Section 9.3 details the legislative change in Germany, i.e. the German Employees' Inventions Act (*Arbeitnehmererfindungsgesetz*). Section 9.4 explains our data set and describes our methodological approach. Section 9.5 presents our results whereas Sect. 9.6 discusses potential implications for policy and practice. A final section concludes.

9.2 Theoretical Framework

Seminal work by Baumol (1990) emphasizes the essential role of the institutional environment in fostering and shaping entrepreneurial and innovative outcomes. By setting norms, i.e. 'the rules of the game', institutions direct the flow of entrepreneurial activities and therefore constitute key pillars in entrepreneurship and innovation policies. Moreover, North (1990) provides a framework linking institutions with the development of entrepreneurship and concludes that institutions function as both opportunities and constraints concerning human interaction. Thus, institutions and respective policies influence and determine entrepreneurial behavior as they encourage or discourage certain activities (Minniti 2008). The provision of adequate resources by the government, especially funding, is therefore only half the story. Financial resources constitute necessary however not sufficient prerequisites for entrepreneurial activities. The interaction of various different entities, i.e.

network dynamics, finally trigger knowledge flows within and across regions leading to innovation and economic growth (Huggins and Thompson 2015). Regulations of intellectual property rights and technology transfer thereby incentivize or impede the engagement in the commercialization of inventions (Wu et al. 2015). In the case of regions and universities, Siegel et al. (2007), based on a study of the U.S. and European universities, conclude that both regions and universities craft and implement technology transfer policies that are feasible and coherent. Hence, the institutional context and the local environment as found in entrepreneurial universities shape behaviors and determine the innovation and entrepreneurship success of university focused technology transfer policies.

9.2.1 The Role of Entrepreneurial Universities

There is a growing research focus on the role universities play in supporting industrial and economic activities (see Breznitz 2014; Pugh 2017; Smith et al. 1987). Faculty and researchers through their research endeavors and activities develop and create knowledge that has potential market applications through technology transfer (Owen-Smith and Powell 2001; Link et al. 2007). Universities have proactively sought to expand their research mission with the creation of dedicated research institutions and centers to create the critical mass that is necessary to create new knowledge on a consistent basis (see Dolan et al. 2019).

To support third missions activities, universities have created technology transfer offices (TTOs) to facilitate the exploitation of technology and knowledge created by its academic community (Cunningham et al. 2020). The creation of TTOs is partly to overcome some of the barriers that faculty experience as they attempt to commercialize their knowledge (Martyniuk et al. 2003; O'Reilly and Cunningham 2017; Smith 1998). TTOs have taken on different roles beyond intellectual property protection and their remit has been broadened to creating and promoting links with firms within their locality and beyond (Fitzgerald and Cunningham 2016). Consequently, the third mission has become a legitimate activity along with other missions of an entrepreneurial university – teaching and research. Such legitimacy and growth also has meant more of a focus on supporting graduate entrepreneurship through dedicated incubators, business plan competitions as well as mentoring through extra-curricular activities (see Sudana et al. 2019; Watson et al. 2018; Mian 1996).

Within the entrepreneurship and innovation fields, this evolution of the university is now conceptualized and theorized as an entrepreneurial university (Slaughter and Leslie 1997; Etzkowitz 2004; Audretsch 2014). Guerrero and Urbano (2012: 55) describe an entrepreneurial university as

> "an instrument that not only provides a workforce and value added with the creation or transformation of knowledge but also improves the individual's values and attitudes towards these issues."

Entrepreneurial university research thereby reflects the main activities: teaching, research and entrepreneurial innovation. There is a need to provide an adequate culture that attracts human capital and supports the exploitation of new knowledge that can have wider economic and societal impacts (Audretsch and Keilbach 2004; Guerrero et al. 2015). This entrepreneurial mission of universities occurs at the boundaries of different scientific and professional backgrounds, creating a need for partnerships and internal and external support mechanisms that help transcend those boundaries (Grimaldi et al. 2011; Audretsch and Keilbach 2004; Guerrero et al. 2014b).

Research on entrepreneurial universities has focused on a variety of issues and country settings (see Bercovitz and Feldman 2006; Carayannis et al. 2016; Chang et al. 2016; Heinonen and Hytti 2010; Cunningham et al. 2014). More recently, there has been a more concentrated empirical focus on developing economy contexts where entrepreneurial universities are in an embryonic phase (see Nkusi et al. 2020; Mustafa et al. 2016; Temel et al. 2015; Dalmarco et al. 2018; Heinonen and Hytti 2010; Chang et al. 2016). Previous research on entrepreneurial universities and regions highlights the strategic role they play in shaping, supporting and driving regions (Baldini et al. 2014). Universities are continuously challenged how best to share their expertise and knowledge – locally or globally – and how they should best support the region that they inhabit (see Kitagawa 2005). Entrepreneurial universities thereby have to balance the tensions between basic and applied research with the organizational technology transfer objective against the regional needs and demands (see Ranga et al. 2003). However, Brown (2016) cautions against exaggerating the impact of entrepreneurial university on regions. Nevertheless, Cunningham and Menter (2020a), based on German data, show that entrepreneurial universities do have a positive impact on regions. In a regional context, entrepreneurial universities' role is considered as "acquiring a crucial function as intermediaries that are able to manage and enhance local intellectual capital and to make possible the learning region growth" (Trequattrini et al. 2018: 99). Consequently, the institutional context and the absorptive capacity does influence the entrepreneurial universities' intermediary role effectiveness in implementing university focused technology transfer policies that are designed to have innovation and entrepreneurship impact on individual actors such as faculty and firms. For policymakers, the challenge thereby is how best to support entrepreneurial universities through appropriate policy instruments, taking into account regional, industrial and societal strengths and weaknesses.

9.2.2 University Focused Technology Transfer Policies: Institutional and Absorptive Considerations

Studies focusing on the Bayh-Dole Act of 1980 have examined the impact this policy and legislative intervention has had on supporting university focused technology transfer in the United States. Sampat et al. (2003) found that the quality of academic patents in the U.S. declined significantly after the implementation of this legislative change. Using data from three leading U.S. universities, Mowery et al. (2001) argue that the Bayh-Dole Act of 1980 did instigate greater patenting and licensing activities in two of these universities, yet having little impact on the content of academic research. Furthermore, in their comprehensive and in-depth review of the Bayh-Dole Act, Mowery et al. (2015: 1) note that this legislative change was “one of several factors that contributed to the growth of patenting and licensing by U.S. universities during the 1980s and 1990s”. In examining the impact of Bayh-Dole Act on basic research, Thursby and Thursby (2011) found no effect on research profiles, while Boettiger and Bennett (2006) argue the need to reform this legislation. Link et al. (2011: 1098) highlight in their study of two U.S. national laboratories that the Bayh-Dole Act “was not sufficient to accelerate the rate of technological diffusion and commercialization from national labs to the marketplace”. Despite the partially controversial assessment of the impact of the Bayh-Dole Act, this legislation still served as a role model for multiple national technology transfer policy changes (Mowery and Sampat 2004). Against the insights generated from the empirical studies of the Bayh-Dole Act, it is clear that in developing and implementing university focused technology transfer policies and the associated legislative framework support considerations are necessary with respect to capacity, capabilities and constraints of institutional actors such as entrepreneurial universities. Each entrepreneurial university mission, focus and purpose is shaped by its organizational evolution and whether technology transfer activities are organizationally and culturally deemed legitimate and appropriate (Goldstein 2010).

The existing body of literature provides some insights into the entrepreneurial transformation process of universities (e.g., the United States by Shane 2005; O’Shea et al. 2005, 2007; Europe by Clark 1998; Wright 2007; Grimaldi et al. 2011; Guerrero et al. 2014a; Guerrero and Urbano 2012; Urbano and Guerrero 2013; Cunningham and Menter 2020a). The main determinant factors of entrepreneurial universities identified in previous studies have been the university’s resources and capabilities, the role of university community and the regional innovation system, as well as the institutional context (Agrawal 2001). Responding to these changes along with the policy and legislative demands now being placed on universities resulted in the establishment of formal organization and governance structures or other support measures to foster entrepreneurship as part of the university institutional responses which can include centers of small-university businesses, research facilities, research groups or quasi-firms, liaison offices, technology transfer offices, and incubators (see Tseng and Raudensky 2014; Guerrero et al. 2011; Hülsbeck et al. 2013; Cunningham et al. 2019b; Siegel et al. 2007). Other internal factors such as leadership, talent, connections with stakeholders, traditions, and reputation are further important for promoting technology transfer and fostering the entrepreneurial and innovative capacity of universities (see Rasmussen et al. 2006; O’Shea et al. 2007; Bramwell and Wolfe 2008; Markman et al. 2005). Recently, an increasing body of empirical studies has also highlighted the role of adequate entrepreneurship educational programs for students and academics (Nabi et al. 2017). Seminars and courses that provide a wide variety of situations, aims, and methods improve students’ skills, attributes, and behaviors to develop an entrepreneurial mindset and creative thinking that support entrepreneurial and innovation outcomes (Blenker et al. 2014; Gately and Cunningham 2014a, b; Katz 2003, 2008; Matlay 2008).

The *institutional context* in which entrepreneurial universities exist also shapes how universities support entrepreneurship, innovation, and value creation within their region, nationally and even internationally (Cunningham et al. 2018). Adopting North (1990), the entrepreneurial stage of universities could be determined by the political, economic, and legal rules and codes of conduct, values, attitudes, norms of behaviors, and culture on knowledge production, transference, commercialization, and entrepreneurship in each society (Grimaldi et al. 2011; Guerrero et al. 2014a; Guerrero and Urbano 2012; Wright 2007). Audretsch and Lehmann (2005) confirm that the knowledge spillover theory of entrepreneurship holds for regions and that firms closely located to universities are significantly influenced by both the university knowledge outputs and the knowledge capacity of the region. Moreover, university spillovers and regional competitiveness are positively correlated in supporting entrepreneurial firms' innovative capabilities (Audretsch et al. 2012).

Within the institutional level, scholars analyzed different models of ownership and compensation strategies and their effect on academic and innovative research outcomes. For example, Moosa (2018) reports how a culture of "publish or perish" and publication-based compensations creates adverse effects and led researchers over-invest in publishing rather than carrying out quality research. The value of intellectual property rights has become a tension between universities and firms (see Rappert et al. 1999) as well the withholding of research results to support patent application among productive and entrepreneurial life sciences faculty (Blumenthal et al. 1997). From these and other studies it is clear that university focused technology transfer policies can have intended and unintended consequences.

The *absorptive capacities* and the role of regional ecosystems and communities for stimulating technology transfer (Cantner et al. 2020; Audretsch et al. 2019a; Etzkowitz and Leydesdorff 2000; Agrawal 2001) also influence the effectiveness of university focused technology transfer policies. Social capital – organizational bonding capital, regional bridging social capital and personal creative social capital – enhances higher absorptive capacity in regional innovation systems (see Audretsch et al. 2020; Kallio et al. 2010). The literature is vast and has focused on a variety of different factors that shape regional entrepreneurial and innovation outcomes ranging from the role of start-up milieus, industrial density, regional cluster structures, cultural diversity, labor markets, tolerance and the quality of places for attracting smart talents and talent-seeking firms (Anselin et al. 1997; Audretsch et al. 2012, 2016, 2019c; Stolarick and Florida 2006; Lehmann et al. 2017b; Lehmann and Menter 2018b; Roper and Love 2006). Strong networks and alliances attract industry funding and grants and support universities' entrepreneurship and innovation activities as well as attract human capital and prospective students and talents to the university (O'Shea et al. 2007).

9.3 Conceptualization: The German Employees' Inventions Act

Inspired partly by a belief that U.S. universities are more successful at commercializing research via innovations and academic entrepreneurship (Geuna and Rossi 2011; Hvide and Jones 2018), many European countries have also enacted new reforms that shifted the rights to university-based innovations. Since the early 2000s, countries like Austria, Denmark, Norway, Finland, or Germany moved from a policy regime where university researchers had enjoyed full rights to intellectual property to a system where the inventor typically holds only a minority of the rights and the university holds the remainder (Lach and Schankerman 2008). These reforms substantially shifted property rights to universities and constituted the end of the so-called 'professor's privilege' (*Hochschullehrerprivileg*), where academic employees held all rights of their inventions and research outcomes themselves. While the Bayh-Dole Act might have been a signal for new legislations, the reform changes across Europe have been quite different compared to the U.S. While the Bayh-Dole Act shifted ownership away from the government towards universities, in Europe the transfer came from the researchers (Hvide and Jones 2018).

The basic rationale behind this institutional change is to overcome the well-known European knowledge paradox. Accordingly, while European universities perform well in creating new knowledge and top-level research, they suffer in commercializing their research outcomes through academic spin-offs and entrepreneurship activity. Much of these shortcomings in the entrepreneurship performance of the European universities stem from misguided incentives, hence, are the unintended consequences of the old 'professor's privilege' system. Thus, high-technology research and entrepreneurial innovations are often associated with high costs, risks and uncertainty concerning the actual value of inventions or the formal patenting and licensing processes. Therefore, by shifting the property rights, i.e. sharing both the costs and risks as well as the expected benefits associated with the commercialization process (e.g. patenting, licensing), these reforms aimed at setting an incentive that encourages researchers to invest in technology transfer and entrepreneurship activity.

In Germany, the professor's privilege ended by adopting the German Employees' Inventions Act in 2002. Accordingly, academic employees need to announce all inventions to the university, hence do not possess the property rights of their own invention but need to transfer the ownership. The universities are free to use and exploit the research outcomes for technology transfer and commercializing purpose. While the universities pay all expenses related to the patent process and will search for potential licensees, in turn, they have to compensate and share at least 30 percent of the revenues with the inventor (Cuntz et al. 2012; Hülsbeck et al. 2013; Glauber et al. 2015). To date, a limited number of studies has evaluated the effects of the German Employees' Inventions Act in 2002, with a sole focus on patenting outcomes. Harhoff and Hoisl (2007) conclude that this legislation change has created substantial monetary rewards for productive inventors, while Von Proff et al.

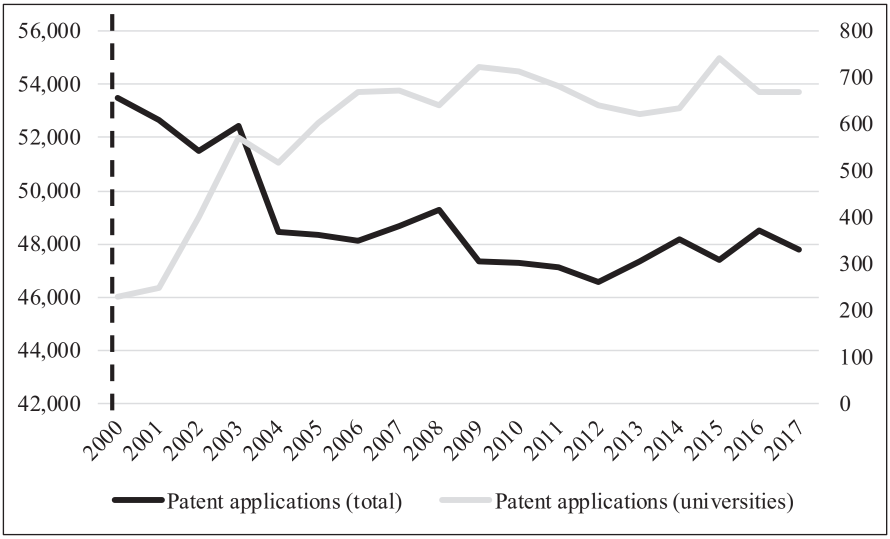
(2012) find no evidence of increased patenting activities after the reform. The study by Czarnitzki et al. (2016) reports even a negative impact of the reform on universities patenting activity. Using a difference-and-difference approach, their quasi natural experiments show that after the abolishment of the professors´ privilege both quantity and quality of universities' patenting activity decreased. Studying the Norwegian context, Hvide and Jones (2018) come to a similar result. Thus, changing the ownership of inventions had led dropped the start-up rate of university researchers to about 50 percentage. With the Bayh-Dole Act of 1980 serving as a policy and legislative technology transfer role model for the German Employees' Inventions Act in 2002, a study by Grimm (2011) shows that this public policy facilitated patent registrations, yet argues that support schemes are still deficient. Adopting a multiple country case study approach, Weckowska et al. (2018: 88) emphasize that "adopting Bayh-Dole-like legislation may trigger the development of local IP practices, which stimulate patenting. However, it is not always sufficient and definitely not always necessary". As a result, context matters, thus influences the effectiveness of technology transfer policies and legislations.

Analyzing both patenting and entrepreneurial behavior within the German context before and after 2002, the sole number of patent applications of universities drastically increased, hence suggests a great success of this public policy at first glance, especially when taking into consideration the general decreasing aspiration to patent in Germany (see Fig. 9.1). Business registrations almost follow the same trend, as the number significantly increased shortly after the implementation of the public policy in 2002, yet plateaued and declined subsequently (see Fig. 9.2). Due to those mixed results, the objective of our chapter is to empirically investigate the impact of the German Employees' Inventions Act in 2002 on patenting and entrepreneurial behaviors and outcomes.

In summary, the main empirical focus of university-based technology transfer policies and legislation to date has been U.S. centered and has generated a debate as to how successful such interventions have been in achieving the desired policy outcomes. Within regions, entrepreneurial universities play an intermediary role in supporting innovation and entrepreneurship. Technology transfer policy interventions in regions tend to rely on a single policy instrument. For university focused technology transfer policies, universities have responded with a variety of internal institutional changes designed to support innovation and entrepreneurship outcomes within and beyond the academic sector. The absorptive capacity of firms and individual actors thereby shapes the implementation as well as entrepreneurship and innovation outcomes (Lehmann et al. 2017a).

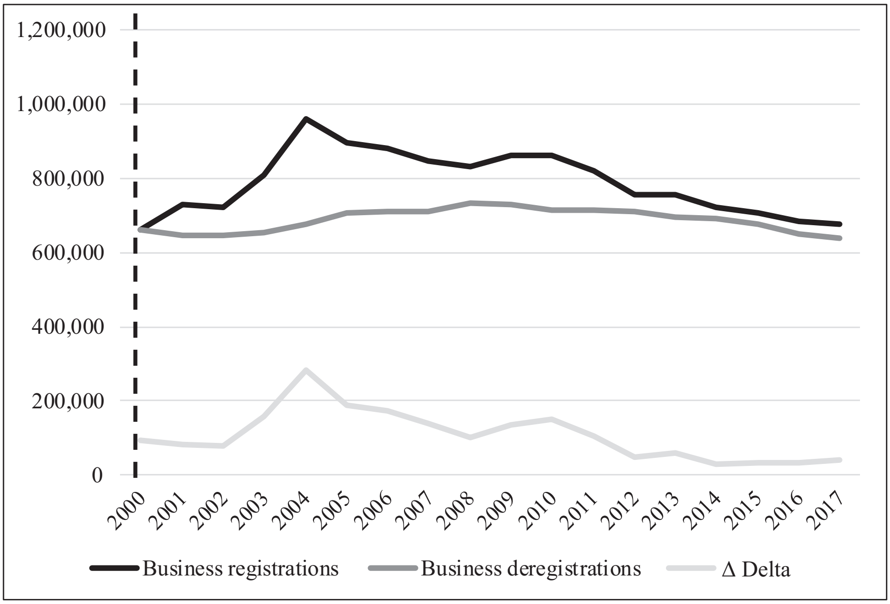
9.4 Methodology

This chapter studies the effect of the German Employees' Inventions Act of 2002 in Germany. Upon the reform of the associated 'professor's privilege', Germany moved toward the typical U.S. model, where the university holds majority rights of



Source: Authors

Fig. 9.1 Development of patent applications.



Source: Authors

Fig. 9.2 Development of business (de)registrations.

research outputs. The main rationale behind this shift in ownership was to encourage researchers to commercialize their inventions through patents and licenses, thus, driving technology transfer and innovation. It is the main goal of our study to empirically assess the impact of this legislation change in 2002 on university innovation performance and its effectiveness to create local spillovers to business innovations and regional entrepreneurship activities. Therefore, we test a hand-collected panel data set of 75 public universities in 62 regions in Germany within a 15-year time period between 1998 and 2012.

9.4.1 Data and Variables

As we are interested in the effect of the reform of the 'professor's privilege' in 2002 on technology transfer and regional innovativeness, we build a time dummy variable, coded with 0 before the years of 2002 (1998–2002) and 1 otherwise (2003–2012). For capturing universities' capacity for innovative research, we draw on two complementary and well-established performance measures, citations per publications and the number of patents applications filed by each university (Lehmann and Stockinger 2019; Hicks 2012). However, whereas the number of citations per publication are supposed to reflect basic university research activities, patents are usually associated with more "applied" research activities, such as design, engineering and technical inventions (Geuna and Nesta 2006; Link et al. 2007).

To test potential effects on regional outcomes, we use two well-established measures, regional business patents and entrepreneurship rates. An extensive body of research has outlined the importance of universities in regional innovation systems. Besides attracting talents and human capital, knowledge spillovers are created via industry-partnerships, collaborations and third party funded research (Etzkowitz 2008; Fritsch and Schwirten 1999; Audretsch et al. 2012). To capture the possible effect of university research on business innovations, we draw on the regional number of patent applications filed. Besides technological innovations, entrepreneurship is another spillover mechanism through which university research may impact regional development (Wright et al. 2004; Audretsch et al. 2019b; Lee 1996). Thus, we further use the number of new business registrations as a second proxy for measuring technology transfer.

We control for both university-level and regional characteristics. Previous studies have outlined the particular role of research universities in regional innovation and entrepreneurship ecosystems (Wright et al. 2004; Cohen et al. 2002). For capturing universities' research capacities, we included several controls. To control for financing, we take the amount of third-party funding granted by both industry and the German research society (DFG) and whether universities have been awarded an 'excellence status'. As a part of Germany's research and innovation strategy, the 'Excellence Initiative' has selected outstanding German universities and research institutions. Since 2006, institutions that have been awarded with an 'excellence status' received additional funding to improve their international competitiveness.

Additionally, we take the number of graduates per research fellow as a measure for universities' overall capacities to conduct research.

Besides funding and research intensity, previous studies also highlighted that disciplines and the type of research matter for regional technology transfer. For instance, Audretsch et al. (2004) provide evidence that academic spillovers are heterogeneous in their impact. In particular, their findings suggest that spillovers from social sciences have a different impact on regional outcomes than spillovers from natural sciences. Technical innovation spillovers are associated with natural sciences and more likely occur in close distance to technical universities. Spillovers from social sciences, however, are associated with entrepreneurship rather than technical innovations. To consider possible biases due to the technical orientation of universities, we control for the share of STEM graduates (science, technology, engineering, and mathematics) in relation to all students enrolled.

On a regional level, we consider several common and previously studied variables that have been found to consistently influence innovation spillovers and regional entrepreneurship. Prior research has outlined the essential role of density and regional networks as they facilitate the creation of social capital and interactions, and boost spillovers (Florida 1995; Lehmann and Seitz 2017). Besides social ties, thick labor markets and infrastructure are also important (Fritsch and Franke 2004). A quite recent stream in the literature has also outlined the importance of local endowments, such as cultural amenities, educational attainment and other facilities, since they attract human capital and provide platforms where people get in touch with each other and share ideas and knowledge (Audretsch et al. 2019b; Falck et al. 2011). However, all of these factors tend to occur in economic vital regions with dense labor markets, high income and productivity rates; thus, as a noisy but reliable control for regions' overall economic and infrastructural attractiveness, we include Gross Domestic Product (GDP) per capita in our empirical model. To capture the impact of regional labor markets, we draw on two separated measures, the role of workforce and regional unemployment. Innovation and technology transfer takes place in highly dynamic and competitive job markets. Flexibility and the co-location of qualified workers drives knowledge spillovers and entrepreneurship (Saxenian 2002; Storper and Scott 2009). Therefore, we control for regions' overall capacity of qualified work force (as a share of employed workers per population). Previous studies demonstrated that there is a U-shaped relationship between economic vitality and entrepreneurship rates (Faria et al. 2010; Wennekers et al. 2005). High unemployment rates and inflexible labor markets push people towards small business entrepreneurship to earn their living (Acs and Szerb 2007; Koellinger and Thurik 2012; Baptista and Preto 2007). To control for possible biases due to this necessity-driven entrepreneurship, we further include regional unemployment rates in our model.

Taking account of Germany's special political history, we further consider possible biases due to the former socialist regions constituting Eastern Germany. Various studies report that differences in technological and entrepreneurship development in East and West German regions are structural and persist over long periods, and even endures institutional shocks, such as communism or the breakdown of the Soviet Union (see Fritsch and Wyrwich 2014). Thus, we consider possible institutional effects by including an East-West dummy variable (East = 1; West = 0) in our regression model. A summary of all deployed variables and their corresponding sources is presented in Table 9.1.

Table 9.2 reports the correlation between all sampled variables. Most variables correlate very slightly to moderate ($0.009 \leq r \leq 0.53$). The correlation between the level of workforce and the regional unemployment is high ($r \leq 0.83$), suggesting additional attention. Nevertheless, testing for multi-collinearity reveals inconspicuous values of variance inflation factors along all deployed variables.

Table 9.1 Country-level correlations

Variable	Obs.	Mean	Std. Dev.	Min	Max	Description/Source
Regional innovation	1201	0.0013	0.0013	0.0001	0.0085	Number of patent applications; source: German Patent and Trademark Office
Regional entrepreneurship	1211	9.9413	1.7569	5.8801	16.5039	Number of new business registration; source: German Federal Statistical Office
Applied university research	1216	0.0033	0.0051	0.0000	0.0465	Number of patent applications filled by the university; source: German Patent and Trademark Office
Basic university research	1190	17.6917	9.1848	0.0000	168.3333	Citations per publication, source: Scopus
Private-party funding	1196	4.6646	6.3459	0.0000	123.9267	Third party funding by industry (per research fellow); source: German Patent and Trademark Office
Public-funding	1196	5.8501	4.0011	0.0000	32.3164	Third party funding public research grants (per research fellow); source: German Patent and Trademark Office
Research intensity	1196	0.9856	0.4171	0.0000	3.8669	Graduates per research fellow; source: German Patent and Trademark Office
Technical orientation	1196	0.4282	0.2354	0.0000	1.0000	Share of STEM graduates to all students enrolled; source: German Patent and Trademark Office
Workforce	1201	700,361	619,162	63,729	2,422,124	Regional labor force; source: German Patent and Trademark Office
Regional prosperity	1211	27,258	6570	14,073	49358.34	Gross domestic product; source: German Patent and Trademark Office
Unemployment	1215	62,295	68,844	2749	409,792	Regional unemployment rate; source: German Patent and Trademark Office

Table 9.2 Correlation matrix

		1	2	3	4	5	6	7	8	9	10	11
1	Regional innovation	1										
2	Regional entrepreneurship	0.3223	1									
3	Applied university research	−0.1085	−0.1015	1								
4	Basic university research	0.069	0.0288	−0.0376	1							
5	Private-party funding	0.3056	0.0511	0.1021	0.0013	1						
6	Public-funding	−0.0434	0.1279	0.2001	0.0757	0.1519	1					
7	Research intensity	−0.0679	0.0644	−0.1549	−0.3231	−0.063	−0.1615	1				
8	Technical orientation	0.0417	−0.011	0.3708	0.0667	0.2365	0.3732	−0.3992	1			
9	Workforce	0.2451	0.521	−0.0691	0.0948	0.0531	0.2384	−0.0751	0.1226	1		
10	Regional prosperity	0.5553	0.5592	−0.1853	−0.1153	0.1049	0.1565	0.1334	0.0334	0.5208	1	
11	Unemployment	−0.0888	0.3022	0.0096	0.1217	0.0277	0.1969	−0.1064	0.0601	0.8268	0.0583	1

9.4.2 Methodology and Estimation Techniques

To analyze our panel dataset, we rely on cross-region comparisons. We employ regression estimation techniques in order to investigate the interrelationship between the legislation change, universities' research outcomes and regional innovation spillovers and entrepreneurship growth. This approach enables us to provide two insights. First, we analyze the effectiveness of the reform in stimulating universities' research and innovation outputs. Second, we examine how and to what extent these reforms have effected regional innovation outcomes and entrepreneurship growth. Therefore, we provide key insights into the mechanisms of technology transfer and industry-university spillovers. We compare two core models using the following estimation:

$$\begin{aligned} Y_{rt} = {} & \beta_0 + \beta_1 Applied\ university\ research_{rt} + \\ & \beta_2 Basic\ university\ research_{rt} + \\ & \beta_3 Employees'\ Inventions\ Act_{rt} + \\ & \beta_4 Applied\ university\ research_{rt}\ x \\ & Employees'\ Inventions\ Act_{rt} + \\ & \beta_5 Basic\ university\ research_{rt}\ x \\ & Employees'\ Inventions\ Act_{rt} + \beta_6 X_{rt} + \beta_7 Z_{rt} + \varepsilon \end{aligned} \tag{9.1}$$

Our first core model analyzes the effect on regional innovation outcomes. Thus, Y_{rt} represents the patent activity of region r at time t; whereas in our second model, Y_{rt} represents the entrepreneurial activities of region r at time t. We are interested in the effect of the legislation change in 2002 on universities' innovation capacity and whether there have also been positive externalities for regions and their innovation development. The variables *Applied university research*, *Basic university research* and *Employees' Inventions Act* represent our explanatory variables. The variable *Employees' Inventions Act* is a dummy variable indicating the post-treatment period, i.e. the time period after the amendment of the Employees' Inventions Act in 2002, and then takes the value 1. The interaction between *Applied university research* and *Employees' Inventions Act*, and *Basic university research* and *Employees' Inventions Act*, represent the joint effect; thus, indicating if the reform of the 'professor's privilege' has promoted technology transfer, thus, regional innovation and entrepreneurship growth. Vector X_{rt} includes university specifics, and vector Z_{rt} represents regional specifics.

For each dependent variable, we employ two different estimation specifications in order to investigate isolated as well as comprehensive effects, enabling us to take into account different sets of variables (Model I and II: regional innovation; Model III and IV: regional entrepreneurship). Our first estimation approach (Model I and III respectively) represents our basic model. Our second estimation approach considers the interactions between *Applied university research* and the *Employees' Inventions Act* as well as *Basic university research* and the *Employees' Inventions*

Act (Model II and IV respectively). For all regression, we use cluster-robust standard errors (ε) to control for heteroscedasticity and autocorrelation. Cluster-robust standard errors correct for the tendency of conventional standard errors to underestimate the standard deviation of the estimators. We further lag all independent variables by 1 year. Conducted robustness checks confirm the validity of our depicted results which will be explained in the subsequent section.

9.5 Results and Discussion

The results of our empirical analysis are presented in Table 9.3. We are interested in the effect of the new legislation of the Employees' Inventions Act in 2002 on universities' innovation capacity and whether there have also been positive externalities for regions' innovation development and entrepreneurship activity. The variables *Applied university research*, *Basic university research* and *Employees' Inventions Act* represent our explanatory variables. The variable *Employees' Inventions Act* is a time dummy variable considering the post-treatment effect of the policy reform. The interaction between *Applied university research* and *Employees' Inventions Act*, and *Basic university research* and *Employees' Inventions Act*, represent the joint effect; thus, indicating if the reform of the 'professor's privilege' of 2002 has promoted technology transfer, thus, regional innovation and entrepreneurship growth. Model I and II test the impact of the policy reform on regional innovation outcomes (as a measure of business patents); while model III and IV compare the effects on entrepreneurial activities, measured by new business registrations.

Our results provide mixed evidence. Since the reform in 2002, across all regions there has been a decreasing number of patent applications (see Model I to II); whereas business registrations have significantly increased over time (see Model III to IV). Taking into consideration also the interaction terms between applied and basic university research and the examined legislation, we find positive and significant effects on universities' innovation activity, indicating that especially within a university context, the new legislation of the 'professor's privilege' resulted in augmented entrepreneurial and innovation outcomes. Our results thus reinforce the argumentation of Link et al. (2011) that the Bayh-Dole Act in the US context, or, in our case the Employees' Inventions Act in the German context, have not been sufficient political instruments to accelerate entrepreneurial innovations from the university to the marketplace, i.e. to the region.

From a regional perspective, these positive impacts do not seem to affect all examined regional performance dimensions equally. Whereas basic university research does not show any significant effects, applied university research seems to stimulate regional entrepreneurship, but has no or even a negative effect on regions' patent activity. These results are in line with Bergmann et al. (2016) who argue that depending on the source of the start-up idea and the stage of its development, both organizational and regional contexts play a decisive role, yet have differentiated effects. More applied university research increases the opportunities to start one's

Table 9.3 Analysis

	Regional Innovation		Regional Entrepreneurship	
Technology transfer	Model I	Model II	Model III	Model IV
Applied university research	−0.00215	−0.0136**	−14.23	20.10*
	(−0.82)	(−2.50)	(−1.41)	(2.01)
Basic university research	0.00000322	0.00000363	0.0112	−0.000428
	(1.86)	(1.65)	(1.38)	(−0.14)
Public policy				
Employees' Inventions Act	−0.000227***	−0.000232*	1.688***	0.888***
	(−5.65)	(−2.15)	(22.08)	(4.90)
Applied university research × Employees' Inventions Act		−0.00000155		0.0411***
		(−0.46)		(5.95)
Basic university research × Employees' Inventions Act		0.0144**		−42.57***
		(3.25)		(−4.24)
University				
Private-party funding	0.00000481	0.00000376	−0.0146	−0.0168
	(0.54)	(0.42)	(−0.92)	(−1. 62)
Public-funding	−0.0000199*	−0.0000198*	0.0157	0.0165
	(−2.49)	(−2.47)	(0.88)	(1.10)
German Excellence Initiative	−0.000281	−0.000287	0.273	0.296
	(−1.84)	(−1.89)	(1.12)	(1.28)
Research intensity	0.000137*	0.000126*	−0.227	−0.0655
	(2.35)	(2.21)	(−1.60)	(−0.48)
Technical orientation	0.000831*	0.000817*	−0.137	−0.0652
	(2.34)	(2.33)	(−0.21)	(−0.11)
Region				
Workforce	$1.61 * 10^{-10}$	$1.91 * 10^{-10}$	0.00000131*	0.00000131*
	(0.38)	(0.45)	(2.41)	(2.56)
Regional prosperity	$6.99 * 10^{-9}$	$6.75 * 10^{-9}$	−0.000118***	−0.0000875**
	(0.53)	(0.45)	(−4.29)	(−3.16)
Unemployment	$-1.92 * 10^{-9}$*	$-1.64 * 10^{-9}$*	0.00000435	0.00000246
	(−1.70)	(−1.51)	(1.12)	(0.70)
Number of universities (each region)	0.000194	0.000163	0.159	0.189
	(0.57)	(0.48)	(0.41)	(0.55)
East-West	−0.000596**	−0.000604**	−1.145**	−0.850*
	(−3.22)	(−3.09)	(−3.05)	(−2.22)
N	1032	1032	1032	1032
n	75	75	75	75

T-statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

own business as inventions can be realized within and beyond a university setting. Moreover, while the application of basic research results is often critical and more complex, it is the nature of applied research to be easily capitalizable and transferable to new business opportunities. Etzkowitz (1998) here also refers to "entrepreneurial science".

All control variables show robust results and findings as expected. On a university level, our findings confirm previous studies that both research and the technical orientation of universities drive especially technology-driven spillovers, while it is less associated with spin-offs and academic entrepreneurship (Audretsch et al. 2012). Receiving increased public funding or being awarded an excellence status (massive public funding for a limited time period) initially leads to augmented research performance within universities (see Cattaneo et al. 2016), yet might crowd out private sector innovations as indicated by the significant and negative signs.

On a regional level, we have considered several common and previously studied variables that have been found to consistently influence both regional innovation and entrepreneurial activities. In line with the literature, regional prosperity reduces the stimulus to become an entrepreneur and start a business, as shown by the negative and significant sign. Considering Germany's political history, we control for possible biases due to structural differences between the former socialist regions constituting East and West Germany. Our findings confirm previous studies within the economic development literature (Fritsch and Wyrwich 2014). Hence, being located in East Germany negatively affects both entrepreneurial and innovative endeavors and outcomes.

Our results show that the German Employees' Inventions Act did have a significant effect on patents as previous studies have found (see Grimm 2011), but we also find that there was an increase in start-ups as measured by business registrations. The results of our study have some similarities to those of the Bayh-Dole Act of 1980. In particular, the rate of patenting increased after the legislative introduction followed by a subsequent plateauing and declining period. This unintended consequence is to be expected given the individual rather than organization focus of this technology transfer policy and legislation. However, the question remains with respect to the quality of these academic patents and whether this has declined coupled with the overall decline in the number of patents as Sampat et al. (2003) found in their US study of the Bayh-Dole Act. Taking the findings of Von Proff et al.'s (2012) study where they found no evidence of increased patenting activities after the legislative reform this would call into the question the real effect of this legislation as measured by patents. However, a similar trend has occurred with business registrations and future research is required to assess the causality between this decline and this German legislative change. Similar to the findings of studies of the Bayh-Dole Act (see Mowery et al. 2001, 2015) other factors may have also contributed to this initial increase and subsequent decline.

Our study highlights similar to studies focusing on the Bayh-Dole Act that the initial implementation of such legislations has an initial positive impact with actors responding in different ways. The question that arises is for how long this initial impact can be sustained before further additional technology transfer policy and legislative measures are required to ensure the sustainability of the technology transfer system at the macro, meso and micro levels. Hence, our study reinforces the need for policymakers to adjust the legislative and the technology transfer policy posture more quickly to ensure it is fit for purpose, rather than continuing and elongating the status quo that is no longer adequately delivering the desired collective and individual outcomes (see Boettiger and Bennett 2006).

9.6 Policy and Practice Implications

Our study has some interesting policy and practice implications. First, our study questions the feasibility of university focused technology transfer policies and legislation to simultaneously support innovation and entrepreneurship outcomes. Our study highlights the challenge of maintaining this dual and simultaneous entrepreneurship and innovation focus that was the policy and legislative intention of the German Employees' Inventions Act. Our findings suggest that this dual focus and simultaneous innovation and entrepreneurship focus is challenging if not impossible to achieve over the long term in supporting university-based technology transfer. Therefore, it may be necessary for policymakers rather than having broad legislative and technology transfer policy responses that there is a need for more specific and tailored regional technology transfer policy and legislative responses that are designed to achieve the coherency and feasibility as argued by Siegel et al. (2007) that is necessary for regions and their entrepreneurial universities. Moreover, policymakers should be open and consider other legislative approaches such as voluntary approaches that are used extensively in environmental regulations (see Cunningham and Clinch 2004) to achieve simultaneous entrepreneurship and innovation outcomes.

Second, our study highlights the dangers of policymakers' reliance on a single university focused technology transfer policy instrument and supportive legislative framework to achieve simultaneously innovation and entrepreneurship outcomes. Such a single policy focus creates a policy lock-in effect. This then particularly forces institutions and individual actors to make strategic choices as how to respond and to behave in a manner that is predominately aligned to meeting their own specific needs. This in turn results in a misalignment between the policy intent and actual policy outcomes. Consequently, in the case of such misalignments, the danger is that policymakers maintain the policy and legislative status-quo which further reinforces the status-quo. While there might be initial signs of positive policy impact and behavioral change among actors, policymakers need to factor in the medium- and long-term policy impact when they are formulating university focused technology transfer policies that are designed to achieve both innovation and entrepreneurship outcomes. Therefore, as part of the policy planning process, policymakers need to consider and factor in the development and implementation of other policy interventions which could be required to further strengthen the effectiveness of a stand-alone university focused technology transfer policy. Within this line, we also suggest to broaden the future analysis of policy research. While, the majority of previous studies has focused on assessing the effectiveness of a single policy program, researchers should measure the 'policy mix'. It is often not only a single policy instrument that is utilized, but rather a mix of complementary initiatives, each designed to capture various aspects of a complex program (Guerzoni and Raiteri 2015; Flanagan et al. 2011). Hence, while the institutional environment is essential to stimulate R&D and new knowledge creating, translating this new knowledge into entrepreneurship takes an entire (eco-) system of various factors and conditions, where policy support may help. Thus, although the proliferation of a 'policy mix' for entrepreneurship is evident, systematic research is scarce and needed to fully understand the underlying mechanisms and guide policymakers in creating valuable initiatives.

Third, while our study extends the limited number of existing studies of the German Employees' Inventions Act to the university context and beyond patents to include start-ups as measured by new business registrations, it raises a fundamental question in relation to measures and the evaluation of technology transfer policy effectiveness. A key implication arising from our study for policymakers is what the appropriate measures that should be used to evaluate technology transfer policy and legislative interventions for entrepreneurship and innovation outcomes are. Our study highlights and questions the relevance of patents as an appropriate measure of innovation and entrepreneurship activities. As Sampat et al. (2003) noted, patent data should not be the sole measurement tool to evaluate the effect of the Bayh-Dole Act. Our study concurs with this and we suggest that policymakers and legislators need to choose a broad set of measurement tools to evaluate the success and failures of these instruments. It also suggests that policymakers need to take a broad set of measurements to assess the effectiveness of their technology transfer legislation and policies and to evaluate on a regular basis so as to further adapt existing legislations to avoid a business-as-usual scenario or a crowding out situation for individual actors. Moreover, policymakers need to be aware that initial positive evaluations based on narrow measures may mask over the medium- and long-term business-as-usual where the desired impacts are not attained compared to the policy and legislative intentions.

Fourth, our study highlights the dangers for policymakers of blindly imitating and implementing university focused technology transfer policies that seem to be successful in another country into their own national context. Context matters, thus imitating university focused technology transfer policies does not necessarily yield similar innovation and entrepreneurship outcomes. The real danger is that such policies could result in poorer outcomes and unintentionally constrain universities and regions rather than enhancing them. The national and regional context in which the imitated university focused technology transfer policies are implemented matters and ultimately determines the actual and perceived policy success. While our study has some commonality outcomes similar to empirical studies of the Bayh-Dole Act, there are also unintended consequences for various actors. To this end, policymakers need to engage and consult extensively with key stakeholders particularly in regions so that university-based technology transfer policies and the legislative frameworks will yield simultaneously the desired entrepreneurship and innovation outcomes particularly in the medium- to long-term perspective, taking into account regional and institutional variations.

Fifth, our study also illustrates the powerful signaling effect that legislation can have in initially mobilizing organizations and individual actors in directing and shaping their actions, responses, and behaviors (see Menter et al. 2018). The implementation of this legislation would suggest that over time universities and institutions adjusted their actions and responses to comply with this university focused technology transfer policy and legislation. The unanswered question stills remains whether such outputs would have occurred anyway without this policy intervention. Therefore, our study would suggest that policymakers need to be cautious in terms of policy and legislative imitation and not blindly replicate as it may be not fit for purpose to support technology transfer, and maybe counterproductive to the value creation motivations of different actors that are directly and indirectly affected by such legislative changes. For entrepreneurial universities and TTOs, our study highlights the powerful impact university focused technology transfer policies and legislation can have on shaping and influencing institutional responses. This requires entrepreneurial universities to constantly scan and anticipate such legislative changes and in doing so prepare the organizational capacity to effectively respond and gain from these changes. Moreover, given the significant intermediary role that entrepreneurial universities play in regions, it is vital that there is a coherency and alignment between the regions' strengths and needs and that of the university. If such university focused technology transfer policies constrain regionally based entrepreneurial universities then negative impacts on regional knowledge capacities, entrepreneurial firms' innovation capabilities and regional competitiveness are likely to occur. To mitigate against such effects, regional coherency is critical in terms of current and future needs. Regional social capital that Kallio et al. (2010) categorized is crucial in ensuring that university focused technology transfer policies enhance the region and the universities rather than restraining their future potential.

Sixth, our study highlights how external environmental changes, in this case a change in technology transfer policies and legislation, can rapidly change how institutions adopt new processes and practices to respond effectively, particularly when there are incentives at play. This means that entrepreneurial universities formally and informally need to have the capacity to constantly undertake environmental scanning so as to anticipate such environmental changes irrespective of whether they respond to them or not. Hence, entrepreneurial universities need to have an organizational culture, an appropriate entrepreneurial architecture, organizational structures and the human capital capacity to respond and adapt effectively that does not undermine their institutional strategic direction and culture. Preparing and responding to such changes means that organizations need to adopt an entrepreneurial culture which is one of the core features of an entrepreneurial university (see Cunningham et al. 2017a). Entrepreneurial universities need to consistently invest in human capital – academic and professional services – to possess the necessary skills and competencies that are required to effectively respond to changes and to implement effectively any changes to organizational structures and processes. This requires an ongoing evaluation of professional development needs and measuring the human capital of faculty, particularly scientists in the principal investigator role (Foncubierta-Rodríguez et al. 2020). Such an investment provides institutions with the organizational flexibility to respond to incremental as well as transformative changes that are driven by external drivers (Cunningham and Menter 2020a). This means that entrepreneurial universities implement effective strategies to address skill deficits, putting in place promotions, rewards and incentives that place a value of collegiately in supporting regional development and adapting to change in an entrepreneurial and flexible manner. It also requires that entrepreneurial universities have the appropriate organizational structures that can coherently and effectively anticipate, meet and balance current and future environmental changes. More consideration needs to be given to organizational practices, ensuring that professional development staff have the requisite skills, competencies and capabilities to support appropriately faculties, researchers and the stakeholder building that is required within and outside the university environment. Often there is a lag between resource availability and the immediate demands in responding to government policies. Professional support staff needs to add more activities on existing processes to keep pace with demand and there is little focus on changing or discarding processes and practices. This requires entrepreneurial universities to plan and anticipate the pressures and demands their professional support staff will need to meet in order for them to support the university community and for the university to fulfil its anchor role within the locality it inhabits.

9.7 Conclusion

The purpose of this chapter was to investigate whether entrepreneurial and innovative outcomes have been affected by a legislative change in intellectual property rights of inventions made by employees within entrepreneurial universities. Our study offers several contributions. First, we address the deficit of international studies of technology transfer policies. Our study of the German Employees' Invention Act of 2002 uses a unique dataset from 1998 to 2012 and addresses this deficit with our focus on patent and start-ups in an entrepreneurial university context. Our second contribution highlights that we did find that this legislative change did have an initial positive effect on entrepreneurial universities as measured by start-ups and patents. However, the effect changed over time, leading to some unintended consequences. Our third contribution is centered on the blind replication and imitation of technology transfer policies from one country to another and the appropriate use of measurement criteria. Such replication may lead to a non-fit for purpose in supporting the policy and legislative outcomes that are desired.

Our study highlights the importance of using appropriate policy instruments to support entrepreneurship and innovation and in essence that one size does not fit all. Policymakers need to have more nuanced regional approaches to policy development that attempts to meet the actual economic and social needs of regions. There is a need for future studies to focus on expanding and evaluating legislative and policy initiatives to other types of instruments that support technology transfer. In undertaking such studies there is a need to conduct studies at the micro level (see Cunningham and Menter 2020b), as the introduction of legislative changes will change the behaviors and approaches of individuals. Assumptions need to be challenged as how individuals and institutions that support them will behave in relation to incentives and legislative changes. Different scenarios need to be considered and the likely direct and indirect positive and negative impacts need to be analyzed at the policy formation stage to assess the scale and scope of the impact of such change.

Conducting comparative studies across regions and countries, also in emerging economy contexts, would provide a stronger and more coherent evidence base to support effective policy making. It would thereby be valuable to assess if such policy and legislative changes designed to support technology transfer in other jurisdictions have only yielded modest impacts as our study finds no definitive effect as with the Bayh-Dole Act in the U.S. Again, our study questions the appropriateness of patent data as an appropriate measure. Future studies should seek to broaden the evaluation measures to capture and reflect the dynamic and fluid nature of technology transfer processes irrespective of mechanisms, as well as, taking account of other factors such as cultural, organizational settings, rewards, etc. There were clear unintentional consequences resulting from the implementation of the German Employees' Inventions Act. Hence, future studies could focus on whether policymakers and legislators analyze such consequences before the legislative enactment and how this is factored into the legislative framework to mitigate against such unintentional consequences or free riding behaviors. In the policy design process, questions in relation to how policymakers plan and mitigate against unintentional consequences or free riding behaviors would be valuable. Future studies should future address the limitations of this study, i.e. investigate the effects on both internal and external technology transfer mechanisms to derive further practical recommendations how entrepreneurial and innovative outcomes can be fostered. Finally, studies that examine technology transfer policy failure would also advance theory and practice and would provide further empirical evidence and insight that would support effective technology transfer policies and legislation that dually support entrepreneurship and innovation impacts. Scholars should thereby deploy a plurality of data collection methods to capture both formal and informal technology transfer mechanisms that influence the outcomes of respective policies (see Cunningham et al. 2017b).

Acknowledgments This chapter is based on Cunningham et al. (2019a) and extends previous theoretical assumptions, provides concrete new messages in findings, extends the discussion, derives new implications and proposes new potential research lines.

References

Acs, Z. J., & Szerb, L. (2007). Entrepreneurship, economic growth and public policy. *Small Business Economics, 28*(2–3), 109–122.

Agrawal, A. K. (2001). University-to-industry knowledge transfer: Literature review and unanswered questions. *International Journal of Management Reviews, 3*(4), 285–302.

Aldridge, T. T., & Audretsch, D. B. (2011). The Bayh-Dole act and scientist entrepreneurship. *Research Policy, 40*(8), 1058–1067.

Anselin, L., Varga, A., & Acs, Z. (1997). Local geographic spillovers between university research and high technology innovations. *Journal of Urban Economics, 42*(3), 422–448.

Audretsch, D. B. (2014). From the entrepreneurial university to the university for the entrepreneurial society. *The Journal of Technology Transfer, 39*(3), 313–321.

Audretsch, D. B., & Keilbach, M. (2004). Does entrepreneurship capital matter? *Entrepreneurship Theory and Practice, 28*(5), 419–429.

Audretsch, D. B., & Lehmann, E. E. (2005). Does the knowledge spillover theory of entrepreneurship hold for regions? *Research Policy, 34*(8), 1191–1202.

Audretsch, D. B., Lehmann, E. E., & Warning, S. (2004). University spillovers: Does the kind of science matter? *Industry and Innovation, 11*(3), 193–206.

Audretsch, D. B., Hülsbeck, M., & Lehmann, E. E. (2012). Regional competitiveness, university spillovers, and entrepreneurial activity. *Small Business Economics, 39*(3), 587–601.

Audretsch, D. B., Lehmann, E. E., & Menter, M. (2016). Public cluster policy and new venture creation. *Economia e Politica Industriale, 43*(4), 357–381.

Audretsch, D. B., Cunningham, J. A., Kuratko, D. F., Lehmann, E. E., & Menter, M. (2019a). Entrepreneurial ecosystems: Economic, technological, and societal impacts. *The Journal of Technology Transfer, 44*(2), 313–325.

Audretsch, D. B., Lehmann, E. E., Menter, M., & Seitz, N. (2019b). Public cluster policy and firm performance: Evaluating spillover effects across industries. *Entrepreneurship & Regional Development, 31*(1–2), 150–165.

Audretsch, D. B., Lehmann, E. E., & Seitz, N. (2019c). Amenities, subcultures, and entrepreneurship. *Small Business Economics.* https://doi.org/10.1007/s11187-019-00190-5.

Audretsch, D. B., Lehmann, E. E., Menter, M., & Wirsching, K. (2020). Intrapreneurship and absorptive capacities: The dynamic effect of labor mobility. *Technovation*. https://doi.org/10.1016/j.technovation.2020.102129.

Baldini, N., Fini, R., & Grimaldi, R. (2014). The transition towards entrepreneurial universities: An assessment of academic entrepreneurship in Italy. In A. N. Link, D. Siegel, & M. Wright (Eds.), *Handbook of university technology transfer* (pp. 218–244). Chicago: University of Chicago Press.

Baptista, R., & Preto, M. T. (2007). The dynamics of causality between entrepreneurship and unemployment. *International Journal of Technology, Policy and Management, 7*(3), 215–224.

Baumol, W. J. (1990). Entrepreneurship: Productive, unproductive, and destructive. *The Journal of Political Economy, 98*(5), 893–921.

Bercovitz, J., & Feldman, M. (2006). Entpreprenerial universities and technology transfer: A conceptual framework for understanding knowledge-based economic development. *The Journal of Technology Transfer, 31*(1), 175–188.

Bergmann, H., Hundt, C., & Sternberg, R. (2016). What makes student entrepreneurs? On the relevance (and irrelevance) of the university and the regional context for student start-ups. *Small Business Economics, 47*(1), 53–76.

Blenker, P., Trolle Elmholdt, S., Hedeboe Frederiksen, S., Korsgaard, S., & Wagner, K. (2014). Methods in entrepreneurship education research: A review and integrative framework. *Education+ Training, 56*(8/9), 697–715.

Blumenthal, D., Campbell, E. G., Anderson, M. S., Causino, N., & Louis, K. S. (1997). Withholding research results in academic life science: Evidence from a national survey of faculty. *JAMA, 277*(15), 1224–1228.

Boettiger, S., & Bennett, A. B. (2006). Bayh-Dole: If we knew then what we know now. *Nature Biotechnology, 24*(3), 320–323.
Bramwell, A., & Wolfe, D. A. (2008). Universities and regional economic development: The entrepreneurial University of Waterloo. *Research Policy, 37*(8), 1175–1187.
Breznitz, S. M. (2014). *The Fountain of knowledge: The role of universities in economic development*. Stanford: Stanford University Press.
Brown, R. (2016). Mission impossible? Entrepreneurial universities and peripheral regional innovation systems. *Industry and Innovation, 23*(2), 189–205.
Cantner, U., Cunningham, J. A., Lehmann, E. E., & Menter, M. (2020). Entrepreneurial ecosystems: A dynamic lifecycle model. *Small Business Economics*. https://doi.org/10.1007/s11187-020-00316-0.
Carayannis, E. G., Cherepovitsyn, A. Y., & Ilinova, A. A. (2016). Technology commercialization in entrepreneurial universities: The US and Russian experience. *The Journal of Technology Transfer, 41*(5), 1135–1147.
Cattaneo, M., Meoli, M., & Signori, A. (2016). Performance-based funding and university research productivity: The moderating effect of university legitimacy. *The Journal of Technology Transfer, 41*(1), 85–104.
Chang, Y. C., Yang, P. Y., Martin, B. R., Chi, H. R., & Tsai-Lin, T. F. (2016). Entrepreneurial universities and research ambidexterity: A multilevel analysis. *Technovation, 54*, 7–21.
Clark, B. R. (1998). *Creating entrepreneurial universities*. Oxford: Pergamon Press.
Cohen, W. M., Nelson, R. R., & Walsh, J. P. (2002). Links and impacts: The influence of public research on industrial R&D. *Management Science, 48*(1), 1–23.
Cunningham, J. A., & Clinch, J. P. (2004). An organizing framework for the implementation of environmental voluntary approaches. *European Environment, 14*(1), 30–39.
Cunningham, J. A., & Link, A. N. (2014). Fostering university-industry R&D collaborations in European Union countries. *International Entrepreneurship and Management Journal, 11*(4), 849–860.
Cunningham, J. A., & Menter, M. (2020a). Transformative change in higher education: Entrepreneurial universities and high-technology entrepreneurship. *Industry and Innovation*. https://doi.org/10.1080/13662716.2020.1763263.
Cunningham, J. A., & Menter, M. (2020b). Micro-level academic entrepreneurship: A research agenda. *Journal of Management Development*. https://doi.org/10.1108/JMD-04-2020-0129.
Cunningham, J. A., O'Reilly, P., O'Kane, C., & Mangematin, V. (2014). The inhibiting factors that principal investigators experience in leading publicly funded research. *The Journal of Technology Transfer, 39*(1), 93–110.
Cunningham, J. A., Guerrero, M., & Urbano, D. (2017a). Entrepreneurial universities — Overview, reflections, and future research agendas. In J. A. Cunningham, M. Guerrero, & D. Urbano (Eds.), *The world scientific reference on entrepreneurship* (pp. 3–19). Singapore: World Scientific Publishing.
Cunningham, J. A., Menter, M., & Young, C. (2017b). A review of qualitative case methods trends and themes used in technology transfer research. *The Journal of Technology Transfer, 42*(4), 923–956.
Cunningham, J. A., Menter, M., & O'Kane, C. (2018). Value creation in the quadruple helix: A micro level conceptual model of principal investigators as value creators. *R&D Management, 48*(1), 136–147.
Cunningham, J. A., Lehmann, E. E., Menter, M., & Seitz, N. (2019a). The impact of university focused technology transfer policies on regional innovation and entrepreneurship. *The Journal of Technology Transfer, 44*(5), 1451–1475.
Cunningham, J. A., Menter, M., & Wirsching, K. (2019b). Entrepreneurial ecosystem governance: A principal investigator-centered governance framework. *Small Business Economics, 52*(2), 545–562.
Cunningham, J. A., Harney, B., & Fitzgerald, C. (2020). *Effective technology transfer offices: A business model framework*. Berlin: Springer.

Cuntz A, Dauchert H, Meurer P, Philipps A (2012) Hochschulpatente zehn Jahre nach Abschaffung des Hochschullehrerprivilegs. Studien zum deutschen Innovationssystem 13-2012, Expertenkommission Forschung und Innovation (EFI) - Commission of Experts for Research and Innovation, Berlin.

Czarnitzki, D., Doherr, T., Hussinger, K., Schliessler, P., & Toole, A. A. (2016). Knowledge creates markets: The influence of entrepreneurial support and patent rights on academic entrepreneurship. *European Economic Review, 86*, 131–146.

Dalmarco, G., Hulsink, W., & Blois, G. V. (2018). Creating entrepreneurial universities in an emerging economy: Evidence from Brazil. *Technological Forecasting and Social Change, 135*, 99–111.

Di Nauta, P., Merola, B., Caputo, F., & Evangelista, F. (2018). Reflections on the role of university to face the challenges of knowledge society for the local economic development. *Journal of the Knowledge Economy, 9*(1), 180–198.

Dolan, B., Cunningham, J. A., Menter, M., & McGregor, C. (2019). The role and function of cooperative research centers in entrepreneurial universities. *Management Decision, 57*(12), 3406–3425.

Etzkowitz, H. (1998). The norms of entrepreneurial science: Cognitive effects of the new university–industry linkages. *Research Policy, 27*(8), 823–833.

Etzkowitz, H. (2004). The evolution of the entrepreneurial university. *International Journal of Technology and Globalisation, 1*(1), 64–77.

Etzkowitz, H. (2008). *The triple helix: University-industry-government innovation in action*. London: Routledge.

Etzkowitz, H. (2014). The entrepreneurial university wave: From ivory tower to global economic engine. *Industry and Higher Education, 28*(4), 223–232.

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: From National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. *Research Policy, 29*(2), 109–123.

Falck, O., Fritsch, M., & Heblich, S. (2011). The phantom of the opera: Cultural amenities, human capital, and regional economic growth. *Labour Economics, 18*(6), 755–766.

Faria, J. R., Cuestas, J. C., & Mourelle, E. (2010). Entrepreneurship and unemployment: A nonlinear bidirectional causality? *Economic Modelling, 27*(5), 1282–1291.

Fitzgerald, C., & Cunningham, J. A. (2016). Inside the university technology transfer office: Mission statement analysis. *The Journal of Technology Transfer, 41*(5), 1235–1246.

Flanagan, K., Uyarra, E., & Laranja, M. (2011). Reconceptualising the 'policy mix' for innovation. *Research Policy, 40*(5), 702–713.

Florida, R. (1995). Toward the learning region. *Futures, 27*(5), 527–536.

Foncubierta-Rodríguez, M. J., Martín-Alcázar, F., & Perea-Vicente, J. L. (2020). Measuring the human capital of scientists in the principal investigator role. *Journal of Management Development*. https://doi.org/10.1108/JMD-08-2019-0362.

Fritsch, M., & Franke, G. (2004). Innovation, regional knowledge spillovers and R&D cooperation. *Research Policy, 33*(2), 245–255.

Fritsch, M., & Schwirten, C. (1999). Enterprise-university co-operation and the role of public research institutions in regional innovation systems. *Industry and Innovation, 6*(1), 69–83.

Fritsch, M., & Wyrwich, M. (2014). The long persistence of regional levels of entrepreneurship: Germany, 1925–2005. *Regional Studies, 48*(6), 955–973.

Gately, C., & Cunningham, J. A. (2014a). The contributions and disconnections between writing a business plan and the start-up process for incubator technology entrepreneurs. In A. C. Corbett, D. S. Siegel, & J. A. Katz (Eds.), *Academic entrepreneurship: Creating an entrepreneurial ecosystem* (pp. 197–241). Bingley: Emerald Group Publishing.

Gately, C., & Cunningham, J. A. (2014b). Building intellectual capital in incubated technology firms. *Journal of Intellectual Capital, 15*(4), 516–536.

Geoghegan, W., & Pontikakis, D. (2008). From ivory tower to factory floor? How universities are changing to meet the needs of industry. *Science and Public Policy, 35*(7), 462–474.

Geuna, A., & Nesta, L. J. (2006). University patenting and its effects on academic research: The emerging European evidence. *Research Policy, 35*(6), 790–807.

Geuna, A., & Rossi, F. (2011). Changes to university IPR regulations in Europe and the impact on academic patenting. *Research Policy, 40*(8), 1068–1076.

Glauber, J., Wollersheim, J., Sandner, P., & Welpe, I. M. (2015). The patenting activity of German universities. *Journal of Business Economics, 85*(7), 719–757.

Goldstein, H. A. (2010). The 'entrepreneurial turn' and regional economic development mission of universities. *The Annals of Regional Science, 44*(1), 83–109.

Grimaldi, R., Kenney, M., Siegel, D. S., & Wright, M. (2011). 30 years after Bayh–Dole: Reassessing academic entrepreneurship. *Research Policy, 40*(8), 1045–1057.

Grimm, H. M. (2011). The diffusion of Bayh-Dole to Germany: Did new public policy facilitate university patenting and commercialisation? *International Journal of Entrepreneurship and Small Business, 12*(4), 459–478.

Guerrero, M., & Urbano, D. (2012). The development of an entrepreneurial university. *The Journal of Technology Transfer, 37*(1), 43–74.

Guerrero, M., Toledano, N., & Urbano, D. (2011). Entrepreneurial universities and support mechanisms: A Spanish case study. *International Journal of Entrepreneurship and Innovation Management, 13*(2), 144–160.

Guerrero, M., Urbano, D., Cunningham, J. A., & Organ, D. (2014a). Entrepreneurial universities in two European regions: A case study comparison. *The Journal of Technology Transfer, 39*(3), 415–434.

Guerrero M, Urbano D, Salamzadeh A (2014b) Evolving entrepreneurial universities: Experiences and challenges in the Middle Eastern context. In: Fayolle A (ad.) Handbook of research in entrepreneurship education: Entrepreneurial university handbook. Edward Elgar Publishing, Cheltenham, p 163–187.

Guerrero, M., Cunningham, J. A., & Urbano, D. (2015). Economic impact of entrepreneurial universities' activities: An exploratory study of the United Kingdom. *Research Policy, 44*(3), 748–764.

Guerrero, M., & Urbano, D. (2019). Effectiveness of technology transfer policies and legislation in fostering entrepreneurial innovations across continents: an overview. *The Journal of Technology Transfer, 44*(5), 1347–1366.

Guerzoni, M., & Raiteri, E. (2015). Demand-side vs. supply-side technology policies: Hidden treatment and new empirical evidence on the policy mix. *Research Policy, 44*(3), 726–747.

Harhoff, D., & Hoisl, K. (2007). Institutionalized incentives for ingenuity—Patent value and the German Employees' Inventions Act. *Research Policy, 36*(8), 1143–1162.

Heinonen, J., & Hytti, U. (2010). Back to basics: The role of teaching in developing the entrepreneurial university. *The International Journal of Entrepreneurship and Innovation, 11*(4), 283–292.

Hicks, D. (2012). Performance-based university research funding systems. *Research Policy, 41*(2), 251–261.

Hsu, D. W., Shen, Y. C., Yuan, B. J., & Chou, C. J. (2015). Toward successful commercialization of university technology: Performance drivers of university technology transfer in Taiwan. *Technological Forecasting and Social Change, 92*, 25–39.

Huggins, R., & Thompson, P. (2015). Entrepreneurship, innovation and regional growth: A network theory. *Small Business Economics, 45*(1), 103–128.

Hülsbeck, M., Lehmann, E. E., & Starnecker, A. (2013). Performance of technology transfer offices in Germany. *The Journal of Technology Transfer, 38*(3), 199–215.

Hvide, H. K., & Jones, B. F. (2018). University innovation and the professor's privilege. *American Economic Review, 108*(7), 1860–1898.

Kallio, A., Harmaakorpi, V., & Pihkala, T. (2010). Absorptive capacity and social capital in regional innovation systems: The case of the Lahti region in Finland. *Urban Studies, 47*(2), 303–319.

Katz, J. A. (2003). The chronology and intellectual trajectory of American entrepreneurship education: 1876–1999. *Journal of Business Venturing, 18*(2), 283–300.

Katz, J. A. (2008). Fully mature but not fully legitimate: A different perspective on the state of entrepreneurship education. *Journal of Small Business Management, 46*(4), 550–566.

Kitagawa, F. (2005). Entrepreneurial universities and the development of regional societies: A spatial view of the Europe of knowledge. *Higher Education Management and Policy, 17*(3), 65–89.

Koellinger, P. D., & Thurik, R. A. (2012). Entrepreneurship and the business cycle. *Review of Economics and Statistics, 94*(4), 1143–1156.

Kuratko, D. F., & Menter, M. (2017). The role of public policy in fostering technology-based nascent entrepreneurship. In J. A. Cunningham & C. O'Kane (Eds.), *Technology-based nascent entrepreneurship technology-based nascent entrepreneurship* (pp. 19–52). New York: Palgrave Macmillan.

Lach, S., & Schankerman, M. (2008). Incentives and invention in universities. *The Rand Journal of Economics, 39*(2), 403–433.

Lee, Y. S. (1996). 'Technology transfer' and the research university: A search for the boundaries of university-industry collaboration. *Research Policy, 25*(6), 843–863.

Lehmann, E. E., & Menter, M. (2016). University–industry collaboration and regional wealth. *The Journal of Technology Transfer, 41*(6), 1284–1307.

Lehmann, E. E., & Menter, M. (2018a). Public cluster policy and performance. *The Journal of Technology Transfer, 43*(3), 558–592.

Lehmann, E. E., & Menter, M. (2018b). Public cluster policy and neighboring regions: Beggar-thy-neighbor? *Economics of Innovation and New Technology, 27*(5–6), 420–437.

Lehmann, E. E., & Seitz, N. (2017). Freedom and innovation: A country and state level analysis. *The Journal of Technology Transfer, 42*(5), 1009–1029.

Lehmann, E. E., & Stockinger, S. A. (2019). Entrepreneurship in higher education: The impact of competition-based policy programmes exemplified by the German excellence initiative. *Higher Education Quarterly, 73*(1), 70–84.

Lehmann, E. E., Menter, M., & Wirsching, K. (2017a). Firm performance and regional innovation mechanisms: The moderating role of absorptive capacities. *Frontiers of Entrepreneurship Research, 37*(11), 243–248.

Lehmann, E. E., Seitz, N., & Wirsching, K. (2017b). Smart finance for smart places to foster new venture creation. *Economia e Politica Industriale, 44*(1), 51–75.

Leyden, D. P., & Menter, M. (2018). The legacy and promise of Vannevar Bush: Rethinking the model of innovation and the role of public policy. *Economics of Innovation and New Technology, 27*(3), 225–242.

Link, A. N., Siegel, D. S., & Bozeman, B. (2007). An empirical analysis of the propensity of academics to engage in informal university technology transfer. *Industrial and Corporate Change, 16*(4), 641–655.

Link, A. N., Siegel, D. S., & Van Fleet, D. D. (2011). Public science and public innovation: Assessing the relationship between patenting at US National Laboratories and the Bayh-Dole Act. *Research Policy, 40*(8), 1094–1099.

Markman, G. D., Phan, P. H., Balkin, D. B., & Gianiodis, P. T. (2005). Entrepreneurship and university-based technology transfer. *Journal of Business Venturing, 20*(2), 241–263.

Martyniuk, A. O., Jain, R. K., & Stone, H. J. (2003). Critical success factors and barriers to technology transfer: Case studies and implications. *International Journal of Technology Transfer and Commercialisation, 2*(3), 306–327.

Matlay, H. (2008). The impact of entrepreneurship education on entrepreneurial outcomes. *Journal of Small Business and Enterprise Development, 15*(2), 382–396.

Menter, M. (2016). Principal investigators and the commercialization of knowledge. In D. B. Audretsch, E. E. Lehmann, S. Vismara, & M. Meoli (Eds.), *University evolution entrepreneurial activity and regional competitiveness* (pp. 193–203). Heidelberg: Springer.

Menter, M., Lehmann, E. E., & Klarl, T. (2018). In search of excellence: A case study of the first excellence initiative of Germany. *Journal of Business Economics, 88*(9), 1105–1132.

Mian, S. A. (1996). Assessing value-added contributions of university technology business incubators to tenant firms. *Research Policy, 25*(3), 325–335.

Minniti, M. (2008). The role of government policy on entrepreneurial activity: Productive, unproductive, or destructive? *Entrepreneurship Theory and Practice, 32*(5), 779–790.
Moosa, I. A. (2018). *Publish or perish: Perceived benefits versus unintended consequences*. Cheltenham: Edward Elgar Publishing.
Mowery, D. C., & Sampat, B. N. (2004). The Bayh-Dole Act of 1980 and university–industry technology transfer: A model for other OECD governments? *The Journal of Technology Transfer, 30*(1–2), 115–127.
Mowery, D. C., Nelson, R. R., Sampat, B. N., & Ziedonis, A. A. (2001). The growth of patenting and licensing by US universities: An assessment of the effects of the Bayh–Dole act of 1980. *Research Policy, 30*(1), 99–119.
Mowery, D. C., Nelson, R. R., Sampat, B. N., & Ziedonis, A. A. (2015). *Ivory tower and industrial innovation: University-industry technology transfer before and after the Bayh-Dole Act*. Stanford: Stanford University Press.
Muscio, A., Quaglione, D., & Vallanti, G. (2013). Does government funding complement or substitute private research funding to universities? *Research Policy, 42*(1), 63–75.
Mustafa, M. J., Hernandez, E., Mahon, C., & Chee, L. K. (2016). Entrepreneurial intentions of university students in an emerging economy. *Journal of Entrepreneurship in Emerging Economies, 8*(2), 162–179.
Nabi, G., Liñán, F., Fayolle, A., Krueger, N., & Walmsley, A. (2017). The impact of entrepreneurship education in higher education: A systematic review and research agenda. *Academy of Management Learning & Education, 16*(2), 277–299.
Nkusi, A. C., Cunningham, J. A., Nyuur, R., & Pattinson, S. (2020). The role of the entrepreneurial university in building an entrepreneurial ecosystem in a post conflict economy: An exploratory study of Rwanda. *Thunderbird International Business Review.* https://doi.org/10.1002/tie.22165.
North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge: Cambridge university press.
O'Kane, C., Mangematin, V., Geoghegan, W., & Fitzgerald, C. (2015). University technology transfer offices: The search for identity to build legitimacy. *Research Policy, 44*(2), 421–437.
O'Reilly, P., & Cunningham, J. A. (2017). Enablers and barriers to university technology transfer engagements with small-and medium-sized enterprises: Perspectives of principal investigators. *Small Enterprise Research, 24*(3), 274–289.
O'Shea, R. P., Allen, T. J., Chevalier, A., & Roche, F. (2005). Entrepreneurial orientation, technology transfer and spinoff performance of US universities. *Research Policy, 34*(7), 994–1009.
O'Shea, R. P., Allen, T. J., Morse, K. P., O'Gorman, C., & Roche, F. (2007). Delineating the anatomy of an entrepreneurial university: The Massachusetts Institute of Technology experience. *R&D Management, 37*(1), 1–16.
Owen-Smith, J., & Powell, W. W. (2001). To patent or not: Faculty decisions and institutional success at technology transfer. *The Journal of Technology Transfer, 26*(1–2), 99–114.
Poyago-Theotoky, J., Beath, J., & Siegel, D. S. (2002). Universities and fundamental research: Reflections on the growth of university–industry partnerships. *Oxford Review of Economic Policy, 18*(1), 10–21.
Pugh, R. (2017). Universities and economic development in lagging regions: 'Triple helix' policy in Wales. *Regional Studies, 51*(7), 982–993.
Ranga, L., Debackere, K., & Tunzelmann, N. (2003). Entrepreneurial universities and the dynamics of academic knowledge production: A case study of basic vs. applied research in Belgium. *Scientometrics, 58*(2), 301–320.
Rappert, B., Webster, A., & Charles, D. (1999). Making sense of diversity and reluctance: Academic–industrial relations and intellectual property. *Research Policy, 28*(8), 873–890.
Rasmussen, E., Moen, Ø., & Gulbrandsen, M. (2006). Initiatives to promote commercialization of university knowledge. *Technovation, 26*(4), 518–533.
Roper, S., & Love, J. H. (2006). Innovation and regional absorptive capacity: The labour market dimension. *The Annals of Regional Science, 40*(2), 437–447.

Salter, A. J., & Martin, B. R. (2001). The economic benefits of publicly funded basic research: A critical review. *Research Policy, 30*(3), 509–532.

Sampat, B. N., Mowery, D. C., & Ziedonis, A. A. (2003). Changes in university patent quality after the Bayh–Dole act: A re-examination. *International Journal of Industrial Organization, 21*(9), 1371–1390.

Saxenian, A. (2002). Silicon Valley's new immigrant high-growth entrepreneurs. *Economic Development Quarterly, 16*(1), 20–31.

Shane, S. A. (2004). Encouraging university entrepreneurship? The effect of the Bayh-Dole Act on university patenting in the United States. *Journal of Business Venturing, 19*(1), 127–151.

Shane, S. A. (2005). *Academic entrepreneurship: University spinoffs and wealth creation*. Cheltenham: Edward Elgar Publishing.

Siegel, D. S., Wessner, C., Binks, M., & Lockett, A. (2003). Policies promoting innovation in small firms: Evidence from the US and UK. *Small Business Economics, 20*(2), 121–127.

Siegel, D. S., Veugelers, R., & Wright, M. (2007). Technology transfer offices and commercialization of university intellectual property: Performance and policy implications. *Oxford Review of Economic Policy, 23*(4), 640–660.

Slaughter, S., & Leslie, L. L. (1997). *Academic capitalism: Politics, policies, and the entrepreneurial university*. Baltimore: Johns Hopkins University Press.

Smith, H. L. (1998). Barriers to technology transfer: Local impediments in Oxfordshire. *Environment and Planning C: Government and Policy, 16*(4), 433–448.

Smith, T. R., Drabenstott, M., & Gibson, L. (1987). The role of universities in economic development. *Economic Review, 72*(9), 3–21.

Stolarick, K., & Florida, R. (2006). Creativity, connections and innovation: A study of linkages in the Montréal Region. *Environment and Planning A, 38*(10), 1799–1817.

Storper, M., & Scott, A. J. (2009). Rethinking human capital, creativity and urban growth. *Journal of Economic Geography, 9*(2), 147–167.

Sudana, I. M., Apriyani, D., Supraptono, E., & Kamis, A. (2019). Business incubator training management model to increase graduate competency. *Benchmarking: An International Journal, 26*(3), 773–787.

Temel, S., Durst, S., Yesilay, R. B., Hinteregger, C., Sukan, F. V., & Uzkurt, C. (2015). The drivers of entrepreneurial universities in emerging economies: A Turkish case study. In L. M. Carmo Farinha (Ed.), *Handbook of research on global competitive advantage through innovation and entrepreneurship* (pp. 569–588). Hershey: IGI Global.

Thursby, J. G., & Thursby, M. C. (2011). Has the Bayh-Dole act compromised basic research? *Research Policy, 40*(8), 1077–1083.

Trequattrini, R., Lombardi, R., Lardo, A., & Cuozzo, B. (2018). The impact of entrepreneurial universities on regional growth: A local intellectual capital perspective. *Journal of the Knowledge Economy, 9*(1), 199–211.

Tseng, A. A., & Raudensky, M. (2014). Performance evaluations of technology transfer offices of major US research universities. *Journal of Technology Management & Innovation, 9*(1), 93–102.

Urbano, D., & Guerrero, M. (2013). Entrepreneurial universities: Socioeconomic impacts of academic entrepreneurship in a European region. *Economic Development Quarterly, 27*(1), 40–55.

Valero, A., & Van Reenen, J. (2019). The economic impact of universities: Evidence from across the globe. *Economics of Education Review, 68*, 53–67.

Von Proff, S., Buenstorf, G., & Hummel, M. (2012). University patenting in Germany before and after 2002: What role did the professors' privilege play? *Industry and Innovation, 19*(1), 23–44.

Watson, K., McGowan, P., & Cunningham, J. A. (2018). An exploration of the business plan competition as a methodology for effective nascent entrepreneurial learning. *International Journal of Entrepreneurial Behavior & Research, 24*(1), 121–146.

Weckowska, D. M., Molas-Gallart, J., Tang, P., et al. (2018). University patenting and technology commercialization–legal frameworks and the importance of local practice. *R&D Management, 48*(1), 88–108.

Wennekers, S., & Thurik, R. (1999). Linking entrepreneurship and economic growth. *Small Business Economics, 13*(1), 27–56.

Wennekers, S., Van Wennekers, A., Thurik, R., & Reynolds, P. (2005). Nascent entrepreneurship and the level of economic development. *Small Business Economics, 24*(3), 293–309.

Wong, P. K., Ho, Y. P., & Autio, E. (2005). Entrepreneurship, innovation and economic growth: Evidence from GEM data. *Small Business Economics, 24*(3), 335–350.

Wright, M. (2007). *Academic entrepreneurship in Europe*. Cheltenham: Edward Elgar Publishing.

Wright, M., Birley, S., & Mosey, S. (2004). Entrepreneurship and university technology transfer. *The Journal of Technology Transfer, 29*(3–4), 235–246.

Wu, Y., Welch, E. W., & Huang, W. L. (2015). Commercialization of university inventions: Individual and institutional factors affecting licensing of university patents. *Technovation, 36*, 12–25.

Part V
Empirical Evidence in Africa

Maribel Guerrero and David Urbano

"The academic effort for analyzing technology transfer policy in low-income economies has increased in the last decade but not their representativeness."

– Guerrero and Urbano (2019, 1360)

Little is known about the establishment of a technology transfer policy framework in African countries. According to Reichelt (2007), the implementation of these policies has been incorporated in the current decade in the South African economy that is strongest than the Southern African region. Indeed, South Africa is adjusting its innovation system to allow greater flexibility for publicly-funded research institutions to transfer technological innovations to the private sector. Given the lack of evidence about the evolution of technology transfer policies and the effects on the development of entrepreneurial innovations in the African context, this part of the book focuses on exploring Egypt's case. Concretely, Chap. 10 provides an in-depth analysis of the factors impeding technology transfer's adoption and effectiveness within the Egyptian Higher Education system. In this vein, readers will understand the particularities of this context and the research gaps for continuing the conversation and discussing novel methods that could be replicated to examine the link between technology transfer policies and entrepreneurial innovations in the African context.

M. Guerrero (✉)
Facultad de Economía y Negocios, Universidad del Desarrollo, Santiago, Chile

Centre for Innovation Research (CIRCLE), Lund University, Lund, Sweden

Northumbria Centre for Innovation, Regional Transformation and Entrepreneurship (iNCITE), Newcastle Business School, Northumbria University, Newcastle upon Tyne, UK
e-mail: maribel.guerrero@northumbria.ac.uk

D. Urbano
Department of Business and Centre for Entrepreneurship and Social Innovation Research (CREIS), Universitat Autònoma de Barcelona, Bellaterra, Spain
e-mail: david.urbano@uab.cat

References

Guerrero, M., & Urbano, D. (2019). Effectiveness of technology transfer policies and legislation in fostering entrepreneurial innovations across continents: An overview. *The Journal of Technology Transfer*, *44*(5), 1347–1366.

Reichelt, K. M. (2007). University technology transfer and national innovation policy: Success stories from Brazil, Colombia and South Africa. International Intellectual Property Institute. http://iipi.org/wp-content/uploads/2010/07/UniversityTechTransfer_072507.pdf.

Chapter 10
University Technology Transfer and Innovation: The Need for Policy in Egypt

David A. Kirby and Hala El Hadidi

10.1 Introduction

Universities are playing an increasingly important role in economic development through the transfer of technology and/ the formation of innovation-led entrepreneurial new ventures. As Gonzalez-Pernía et al. (2013, p. 6) have observed

> "encouraged by the rise of scientific breakthroughs and technological innovations universities around the world have become increasingly involved in the transfer of knowledge to the marketplace, thereby enhancing economic growth and regional development".

This has led to what has become known as the University "Third Mission", something that often takes time to be accepted and implemented (Guerrero et al. 2015). In an attempt to expedite the process, reduce public expenditure and meet public budget constraints, many Governments have introduced, therefore,

> "measures necessary to encourage and facilitate knowledge transfer from university to industry and other institutions" (Muscio et al. 2014, p.1048).

Accordingly, there has emerged the Triple Helix of university-industry-government interactions (Etzkowitz 2003). In the factor-driven economies, which compete on basic factor conditions such as low-cost labor and unprocessed natural resources, university technology transfer is not as developed as it is in either the efficiency - or innovation – driven economies. This does not mean that it does not exist or is not needed. Indeed, in Egypt, the Government has recognized the need for innovation and has introduced measures to encourage its universities to engage in technology transfer (Science Technology and Development Fund 2012). The policy

D. A. Kirby (✉) · H. El Hadidi
Department of Business Administration, The British University in Egypt,
El Sherouk City, Egypt
e-mail: hala.elhadidi@bue.edu.eg

M. Guerrero, D. Urbano (eds.), *Technology Transfer and Entrepreneurial Innovations*,
International Studies in Entrepreneurship 51,
https://doi.org/10.1007/978-3-030-70022-5_10

measures have not been especially effective (Kirby and El Hadidi 2019), however, and the purpose of this chapter is to understand the factors impeding its adoption and make more effective policy recommendations.

Within the Arab World[1], university-industry links and technology transfer activities are only weakly developed. This is because only a minority of the academic staff (22%) are scientists and the scientific research that is undertaken is "weak and modest", with the result that there is low awareness of the importance and impact of good scientific research (Abu-Orabi 2016). Traditionally Egypt has been the leading nation, within the region, in terms of the number of scientific articles published, but none of its 43 public and private sector universities (with over two million students) is ranked highly in the leading global university league tables. Likewise, with the possible exception of the American University in Cairo,[2] none has strongly developed industry links or a tradition of either technology transfer or technology commercialization. This is despite the various national mechanisms to support, directly, university-industry collaboration and technology transfer. As a result of such limitations the Egyptian system of Higher Education has been held responsible for the decline in the country's capacity for innovation which, in turn, has resulted in its declining economic competitiveness. Essentially, the system is highly centralized, and "regulated" by the Ministry of Higher Education and the Egyptian Supreme Council for Universities. The institutions have little autonomy, little interaction with "the market" and little involvement in the innovation process (El Hadidi and Kirby 2015a, b, 2016, 2017). Accordingly, only one non-state foreign university, might be regarded as being entrepreneurial (Kirby and Ibrahim 2016), and Egypt was ranked last for entrepreneurial education in the 2017/18 Global Entrepreneurship Monitor project (Ismail et al. 2018), as it has been since 2008.

According to the 2012 report of the Egyptian Science, Technology and Development Fund (STDF), there are six entities concerned with facilitating university technology transfer from/to established firms[3], while the Egyptian Academy of Scientific Research and Technology provides grants to fund TICOs [Technology Innovation Commercialization Offices] in all Egyptian Universities[4], and the STDF

[1] The Arab World includes 22 countries, 10 in Africa and 12 in Asia. It is sometimes referred to as the Middle East and North Africa (MENA) region. The Arab World includes 22 countries, 10 in Africa and 12 in Asia. It is sometimes referred to as the MENA region.

[2] The American University in Cairo was founded in 1919. It is an international university offering 37 undergraduate degrees, 44 masters degrees and 2 doctoral degrees. It has some 6453 students and 453 fulltime staff. In the 2018 QS World University Ranking it was ranked 420th globally and 1st in Egypt. In 2013 it opened its Venture Lab, the first university-based incubator in Egypt.

[3] These include the Academy of Scientific Research and Technology (Invention and Innovation Development Agency), Ministry of Industry and Foreign Trade Technology and Innovation Centers, National Research Centre Business and Investors Service Office, Technology Innovation and Entrepreneurship Centre, Technology Transfer Offices at Alexandria University, American University in Cairo, Assuit University, Cairo University and Helwan University and a virtual Incubator for Science Based Business.

[4] As of 2018, 43 TICOS had been established by ASRT since 2013/14 at a cost of 30.1 million Egyptian pounds. ($1.74 m).

supports university-industry research. However, there is no coherent, coordinated strategy and despite these initiatives and mechanisms, the STDF (2012, p. 13) concluded that Industry/Academia Collaboration activity is *“missing to a great extent in Egypt”*. It explained this in terms of

- The lack of collaboration between the different initiatives
- The shortage of Technology Transfer Offices
- The lack of support from senior university management
- The lack of commercial and professional awareness
- The lack of support for inventions that solve national problems
- The lack of any formal course on technology transfer and commercialization.

The chapter is structured as follows: the theoretical framework is described in Sect. 10.2. Then, the methodological design is described in Sect. 10.3. The findings are shown in Sect. 10.4. Then, discussion and implications in Sect. 10.5 and concluding remarks in Sect. 10.6.

10.2 Theoretical Framework

Egypt has policies and mechanisms to promote technology transfer and foster entrepreneurial innovation, but they have been largely ineffective, as in much of the Arab world. The Government has recognized this and, despite public spending on education having declined (Reda 2012), has acknowledged the need to modernize its universities and have them engage more directly in the technology transfer process. In November 2015, as part of this modernization process, an intergovernmental MOU on research, innovation and education was signed with the U.K., followed, in January 2018, by a U.K.-Egypt bilateral MOU on the establishment of international branch campuses that would deliver academic “programs, research and innovation which contribute to Egypt’s national priorities”. Subsequently, on 2nd August, Law No.162 of 2018 was passed permitting the establishment and organization of international university branch campuses in the country, the intention being to open eight international universities from Canada, France, Hungary, Sweden, U.K. and US by 2020.

While policy intervention has often been responsible for the involvement of universities in technology transfer (Perkmann et al. 2013) its effectiveness has been variable, as Hewitt-Dundas (2012) discovered in the U.K. Apart from universities often having different technology transfer strategies, requiring different support structures and incentive mechanisms (Phan and Siegal 2006; Perkmann et al. 2013), the Egyptian policies have addressed the symptoms rather than the cause of the problem – the trappings rather than the substance (De Lourdes Machado et al. 2004). While the research literature on university-industry technology transfer is both voluminous and multi-disciplinary (Bozeman 2000; Link 2015; Perkmann et al. 2013) it is focused predominantly on the advanced innovation-driven economies of North America and Europe, and the university response to knowledge transfer. As Bercovitz and Feldmann (2006, pp. 180–1) have recognized

> "unfortunately, there are few studies that consider the firm, rather than the university, as the focal actor".

The research on the former demonstrates the broad range of factors involved. For example, Galan-Muros et al. (2017) show that while university structures/offices are important, as the Egyptian policy has recognized, of more significance are funding and incentives, communication of the mission and, in particular, senior management support. Indeed, the earlier research of Friedman and Silberman (2003) specifically concludes that it is not the presence of a technology transfer office that is important but the experience of its staff, the university's location in a region with a concentration of high technology firms, its mission in support of technology and the way it rewards its staff. Moreover, Markman et al. (2005a, b) and Phan and Siegal (2006) suggest that formal technology transfer mechanisms, such as Technology Transfer Offices, are more related to technology commercialization than the broader concept of university-industry collaboration. Inter-organizational trust, prior experience of collaborative research and the breadth of the interaction are identified as further important factors by Bruneel et al. (2010), while D'Este and Patel (2007) conclude that previous experience with industrial collaborators affects, positively, the attitudes and behavior of academics towards industry. Similarly Perkmann et al. (2013, p. 427) conclude that

> "the best and most successful scientists are also those who engage most with industrial partners",

while the research of Chukumba and Jensen (2005) stresses the importance of research quality. It is not just the quality and volume of research being undertaken that is important, however, but the type, as Vinig and Lips (2015) recognize. Their research demonstrates that in Holland only the more applied technical and medical universities perform well on technology transfer, a conclusion that is similar to the earlier finding of Avanitis et al. (2008) who discovered that the scientific institutes in Switzerland, with a stronger orientation to applied research, are also stronger in terms of technology transfer. Meanwhile, the research of Bercovitz and Feldmann (2006) has stressed the importance of multi-disciplinary research and concludes that a system that adheres to rigid disciplinary boundaries, as in Egypt, is likely to inhibit university-industry interaction and restrict the opportunities for technology transfer. This is because

> "knowledge production increasingly is trans-disciplinary and depends on the ability of researchers to work with others across a broad spectrum of disciplines" (op cit. p. 184).

For many academics this is a new experience as are the concepts of technology transfer and commercialization and, as Bruneel et al. (2010) demonstrate, it is not something for which they have been trained or with which they are necessarily comfortable (Boehm and Hogan 2014) and many are reluctant to engage in the process and resist so doing. Accordingly universities have introduced policies on technology transfer and the rewarding of staff, leading Siegel et al. (2004) to argue that reward systems for university technology transfer and staffing competences are critical, not least as such measures also signal the significance of the transfer activity. As Debackere and Veugelers (2005) have recognized, universities do need to develop a clear strategy that manages the transfer process and does not impact negatively on teaching and research, though, there is no consensus on the impact of university policies and governance systems (Muscio et al. 2014).

Research on the industry perspective shows (Herman 2013) that in countries where the commitment to R & D is low, there is little incentive for firms to collaborate with universities and that the firms that do pursue collaboration are often larger (Fontana et al. 2006) and possess innovation strategies. When university-industry collaboration does occur, often there are clashes of culture (Siegel et al. 2003a) as the primary industry motive is financial gain, whereas publication is more important to the university scientist. Accordingly to Siegel et al. (2003b, p. 127),

> "firms typically do not want researchers to publish their results and share information with colleagues and the general public".

This creates tensions between the two, compounded further by the bureaucracy and inflexibility that often typifies universities and slows the transfer process. Additionally, firms perceive universities to have unrealistic expectations and complain that (Siegel et al. 2003b, p. 120)

> "university scientists and administrators do not understand or appreciate industry goals/culture/constraints".

Thus, there are numerous constraints on university – industry involvement in technology transfer and to overcome them, policy has to be multi-faceted. As the law of requisite variety (Ashby 1968) implies it is not possible to resolve a problem by addressing, as the Egyptian policy appears to have done, just one facet. The solution must be equal to or greater than the number of factors involved. Thus policy to promote university-industry technology and encourage universities to participate has to address the broad range of factors involved. To facilitate entrepreneurial innovation, through the transfer of technology between universities and industry, therefore, policy needs to be coherent and to address the fundamental problems that discourage such activity.

10.3 Methodology

Accordingly the study adopted a four-phase investigative strategy whereby each phase contributes to greater understanding (Kirby 2007).

Phase 1 was a qualitative analysis of the views of a panel of 18 experts drawn from senior university administration and relevant Government Departments/Ministries. It was based on unstructured in-depth interviews to scope the subject and identify the key issues. A panel of 10 experts evaluated the content of the intended interview questions and agreed (70–100%) that they were consistent with the theoretical and operational definitions of the variables of interest. A test-retest procedure was used to estimate the reliability of the interview (with a 7–10 days gap), the results indicating reliability of 0.7–0.95.

Phase 2 was a contextual investigation based on a self-administered questionnaire survey of 560 Science, Engineering Technology (SET) academics in 8 private and public Egyptian universities. The questionnaire (Kirby and El Hadidi 2019) comprises 99 statements where the respondents were required to indicate the strength of their agreement/disagreement with each statement on a 5-point Likert-type scale where 5 means strongly agree. A score of 4 or 2 would mean that the respondents either agreed or disagreed with the statement, respectively. The Research on the industry perspective shows statements on technology transfer and commercialization reveal that these sub-components have acceptable reliability. The questionnaire was distributed in 3/20 state universities and 5/23 private universities. In total, these 8 universities engaged some 2890 SET academics (2059 in the public sector and 831 in the private sector). The participants were selected randomly and in total 400 responded, representing a 13.8% response rate. However, only 240 responses (11.7% of the population) were from the state sector, compared with 160 (19.2%) from the private sector. The reasons for this are unclear but it means that the state universities are somewhat under-represented in the study, as they appear to be in the technology transfer and entrepreneurial innovation process, nationally. The data were processed and analyzed using SPSS and the differences in the responses between the public and private universities analyzed using a T-Test.

Phase 3 was based on a set of semi-structured in-depth interviews (Kirby and El Hadidi 2019) that form the basis for three different Technology Transfer Office (TTO) case studies selected purposively from the Phase II survey to illustrate the issues involved. The intention was to provide concrete examples of the problems that have been encountered when efforts have been made to promote technology transfer and facilitate university-industry collaboration to foster innovation.

Phase 4 examined the issue from the perspective of industry. For this a structured questionnaire survey (Kirby and El Hadidi 2019) of 300 Egyptian businesses located in different industrial zones in Greater Cairo was used. It comprised open and closed questions developed from the relevant theoretical and empirical literature. The validity of the instrument was reviewed by a panel of 5 economic experts and tested using a pilot (n = 30). The test-retest reliability method was used to assess the stability and reliability of the instrument over time and proved to be high (0.78–0.95). The questionnaire was written initially in English before being translated into Arabic and independently back-translated into English. Of the 300 firms contacted, 237 usable responses were received yielding a 79% response rate. The results show that 5% could be classified as small or medium sized firms (fewer than 50 employees) and 95% as large (50+ employees). This compares with the results of the official 2012/13 Economic Census that shows that 99.7% of the 2.4 million establishments in the formal sector could be classified as SMEs and only 0.4% as large. Thus the sample is biased heavily towards the larger firm, though some 86.5% of the sample are Egyptian businesses with only 13.5% being multinational organizations. Ten industrial sectors are represented including Manufacturing and Production (30%), Retail and Distribution (16%) and Healthcare and Pharmaceuticals

(12%) but there is only weak representation of the knowledge/technology-based sectors (Information Technology – 4%; Telecommunication – 6%), reflecting the structure of a factor-driven economy. However, some 35% of the sample claimed to be engaged in R & D.

10.4 Results

10.4.1 First Phase: The Views of the Expert Panel

The majority of the interviewees believed that universities have a role to play in stimulating innovation and according to one respondent, an Engineer,

> “Universities are the main actor, since they gather skills and proficiencies that are well fitted to push ahead innovation”.

The experts recognized that Universities have both a direct and an indirect role to play in stimulating innovation, the former role by establishing university incubators and bringing ideas to the market, the latter by transferring knowledge to society, and equipping students with the skills to innovate and create new commercial opportunities. Also, they recognized that universities ought to teach innovation and entrepreneurship as part of their curriculum, to undertake innovative research and to transfer their (new) knowledge by linking academia and industry. They recognized, also, that research should impact on society and there should be collaboration with both Government and industry – the Triple Helix. Most interviewees were familiar with the concept of the Triple Helix University and at least one of the country’s private universities was developed on the concept. The experts acknowledged that, at present, the Egyptian universities make only a minor contribution to innovation compared with other countries. The majority argued, also, that Egypt’s universities are not producing creative graduates who can innovate. This was attributed to the curricula, the emphasis on rote memorization and obsolete teaching methods. As one interviewee recognized, there is no

> “critical thinking in the education system. Not only is it not encouraged but culturally it is discouraged. No risk taking allowed. No safe space for trial. Also the curricula and the methods of teaching and the exposure that universities provide is not very good.”

Two of the respondents did contend, though, that:

> “There are examples of outstanding students starting their companies, and others who innovate in specific technological disciplines”.

Thus suggesting that Egypt’s universities can and do produce creative graduates who can innovate but not in all specialties and on a very small scale. The experts also recognized that there are too few university startups and spin out companies as

> “The business word is considered to be a shameful word by most of the universities’ staff members”.

However, it was believed, also, that the majority of Egypt's universities were not involved in knowledge commercialization and transfer because they do not produce knowledge to an influential extent. According to one expert, though, there are

> "Very few patents due to ignorance of the patents law. Weak information about IP which leads to no encouragement for inventive ideas and no Governmental regulations to govern knowledge commercialization".

Perhaps of most importance though was the fact that

> "…The current universities law does not allow commercialization. State university staff are not allowed to become part or full partners in enterprises (spin-offs). No mechanism and no management. Egypt's universities are not involved in knowledge commercialization, as they shouldn't be. It is the role of start-up firms and entrepreneurs, that's why collaboration with industry is important" (Ms. Zeinab El Sadr, Executive Director of the RDI Program).

It was believed that Egypt's universities are working with industry but to a limited extent only. There is lack of trust between university and industry and universities lack the organizing mechanisms for the proper management of formal relationships with industry.

> "Traditionally, university and industry are in a different wave lands. However, the solution for this has been through R&D departments."

The interviewees recognized that the Egyptian government has a policy towards increasing the capacity for innovation and university-industry research but believed that more support was needed. They recognized that there are mechanisms that have been in place for several years that support university industry collaboration, but that they need to be supported by the beneficiaries - industry.

Despite these initiatives to increase the capacity for innovation and university-industry research, the experts believed that within the Egyptian government there is more room for collaboration, clarity and transparency, in setting policies. The Ministry of Industry is currently developing a national innovation strategy, while the Ministry of Research and Development has developed the Science and Technology Indicators for measuring the country's performance in this field (RDI program).

However, more clear mechanisms are believed to be needed to link industry with the research community which needs further focus and coordination between the concerned ministries and entities. The experts believed that much more needs to be done if the universities are to fulfil their potential in the innovation process. For example, a larger fund was proposed that should be directed to applied scientific research and innovatory projects, together with a widely publicized nation-wide project with announced priorities for research and innovation in all fields. At the same time, it was felt that specific topics of interest should be identified, for example in the field of Medicine.

The majority view, however, was that the Egyptian Government does not have a coherent policy towards increasing the capacity for innovation and university-industry research. For example, university staff were believed to be undertaking research only for promotion purposes. However, if the promotion laws required applied research and patent applications, the situation would improve. Again, the panel questioned why an enterprise should seek research if it is costly and not perceived to be of relevance/value. From the perspective of Business, it was suggested there must be incentives in the form of tax breaks and new legislation to enhance university-industry cooperation.

In summary, the experts believed that Egypt lags behind other countries in terms of both the capacity to innovate and university-industry research and that although there are numerous initiatives there is a need for a more coherent mechanism and formal management However, they believed that much could be done to improve this situation. First, it was suggested, the fund directed to research and innovatory projects should be increased. Second, part or complete tax exemptions should be introduced for innovatory projects in order to motivate industry to activate their R&D departments or/and link with universities. Third, the bureaucratic rules that discourage the registration of IPR should be reduced. Fourth, the innovators should be supported. Fifth, the universities should be encouraged to solve problems relevant to the needs of the market - both their research and teaching needs to be more market led.

10.4.2 Second Phase: The Survey of Egyptian Science, Engineering and Technology Academics

The survey revealed that the academics neither agreed nor disagreed with any of the statements relating to innovation and the role of the country's universities – they neither supported nor refuted the idea that universities are the creators of new ideas, have a major or minor role to play in innovation or promote innovation through their teaching, research or community service activities (the third mission). Similarly, they neither agreed nor disagreed with the view that the quality of higher education in Egypt was conducive to innovation, which is in contrast to the views of Egyptian experts (El Hadidi and Kirby 2015a). Possibly this indecision reflects the fact that innovation is not something that the universities (whether public or private) have been required to engage with previously, suggesting a need to raise awareness. A statistically significant difference of opinion (significant at the 0.001 significance level) appeared to exist, however, between the country's private and public universities with respect to Research and R & D. Essentially, the respondents from the private universities disagreed that universities have R & D activities, University R & D impacts strongly on innovation, that there is collaboration between universities and industry, that university budgets allow for R & D or that universities have strong R & D environments. In contrast the public university respondents, on average, neither agreed nor disagreed with these statements, suggesting that there is a difference between the two types of institutions and the roles they play with respect to R & D.

According to the earlier experts' survey the concept of Universities commercializing the knowledge generated from their academic research is somewhat not permitted by law. Hence, it is not surprising, perhaps, that both samples neither agree nor disagree with any of the statements relating to knowledge commercialization. It is not something that is widely considered in Egyptian academia, nor is it seen as an important role for the country's universities. If the country is to benefit from the new knowledge created by the research of its universities, particularly in the state sector, this needs to change. Academics, their managers and Government need to recognize the importance of knowledge commercialization to the functioning of a modern university and the economy. While the state universities in Egypt have traditionally had a role in Community Service, the formal transfer of knowledge and technology between university and industry has not been extensive. This may well explain why the average response, in both sectors, to all of the statements relating to technology transfer was neither agree nor disagree. The respondents, on average, are insufficiently well informed to reach a decision. Again, as with technology commercialization, this needs to change if the country's universities are to help Egypt to compete more effectively in the global market place.

Critical to the successful transformation of a country's universities is a supportive ecosystem and, as the literature demonstrates, the Triple Helix of university-industry- government is important in this respect. In Egypt, though, either the respondents were not aware of the support available from industry and government, or it is not readily available. The respondents from both the state and the private universities were agreed that

> "there needs to be a national policy that encourages universities to get involved with the, third mission", while there was recognition, particularly in the private sector, that "Co-operation between universities and industry promotes innovation".

This needs to be capitalized on and encouraged. If the Egyptian "government has a policy towards increasing the capacity for innovation and university-industry research" it would seem that, with an average score of 3.54, the respondents in both sectors were not aware of it. However, the infrastructure of universities does not appear to encourage innovation, particularly in the private sector, and the respondents agreed that support was needed. Perhaps somewhat surprisingly, though, given the control exerted by the Government, the state universities did not agree that universities should be more autonomous. This not only contrasts with the views of those from the private sector but it contradicts the view expressed by Naghizadeh et al. (2015) and others that to optimize their entrepreneurial capability universities need to move away from close government regulation and sector standardization. However, both sectors recognized the need to capacity build (4.37) and to reward those academics who innovate (4.38).

10.4.3 Third Phase: Case Studies

As the following case studies illustrate several Egyptian universities are attempting to participate in the innovation process and collaborate with industry in accordance with the Triple Helix model. Accordingly the cases demonstrate what is being achieved, and the challenges such institutions face when attempting to bring about change and make a significant contribution.

Case 1. Cairo University Innovation Support Office[5] Founded in 2009 by Professor Dr. Galal Hassan Galal-Edeen, a Computer Scientist with a Ph.D. from Brunel University in the U.K., the Cairo University Innovation Support and Patent Registration Facilitation Office (CUISO) is the outcome of two European Tempus projects[6]. It was intended as the first "port of call" for academic innovators in Cairo University wishing to commercialize their innovative ideas and for members of Egyptian industry who wish to collaborate with the University. A year later, in 2010, a Technology Transfer Office was opened in Cairo University, also with funding from the European Union Tempus program and with similar objectives (see case 3 below). According to Galal-Eldeen (2015), the mission of CUISO is:

> "… to give the best possible institutional support to innovators based in, or collaborating with, Cairo University, and to the transfer of university-generated research and technology to the wider community".

According to its Director it has five strategic aims, namely to: create an effective contact point between the university and industry; initiate and systematize innovation licensing and exploitation; spread awareness within the University about innovation, industry collaboration and technology transfer; support University's faculties and research centers in adopting effective measures to liaise and collaborate with industry; and establish and publicize the relative importance of the various technology transfer options available. To achieve its mission and aims, the Centre has introduced, or supported, a variety of initiatives, including staff (e.g., Creativity and Innovation training; Awareness and dissemination events; Cairo University Innovation Support Strategy; University IP policy), students (e.g., Awareness sessions; Competitions; Innovators Club in the Faculty of Computers and Information), and industry (e.g., Professional training and seminars; Template representing successful university-industry collaboration). Since its foundation, it has been responsible for 5 disclosures and bringing 2 patents to market, generated a better understanding of the value of problem-oriented research and developed greater awareness of the value of open innovation and the benefits of in-depth analysis of both the problem and the market. Meanwhile, the research of some of the University's students has benefitted and their problem-solving skills have improved as has their enthusiasm to innovate and become entrepreneurs. However, ever since its foundation, the Center has faced challenges, mainly in the form of funding and space. When the shared Tempus and University funding expired in 2011, there were no mechanisms within the University that enabled the Centre to charge for its services, while the lack of suitable space meant that the Centre's equipment resource, valued at approximately 50,000 Euro, could not be utilized. This is seen, by the Director, as a transition phase as the Centre has been designated as a Special Unit within the

[5] Cairo University is a state university founded in 1908. It has some 280,000 students and 12,158 staff in 17 Faculties plus Schools of Law and Medicine. QS ranked it 481–490 in the world in 2017 and second in Egypt, 11th in the Arab world

[6] Tempus was, from 2007–2013, the European Union's program supporting the modernization of higher education in the EU's surrounding area including the Mediterranean region.

University, which should enable it to provide its planned income-generating consultancy and training activities. However, it will still need around 150 square meters of space, plus funding for administrative staff.

On the basis of his experience since 2009, the Director believes there needs to be more long-term strategic co-ordination and planning at the institution level in higher education, plus a change in the mindset of senior managers, enabling them to appreciate the importance of the role of universities in the innovation process. At the same time, he suggests, there needs to be a change in the Egyptian University law so that universities and academics can take ownership of university spinout companies based on the intellectual property stemming from their research. He also advocates the creation of a national entity, operating at a level higher than individual ministries, to coordinate various innovation and exploitation-related actions more effectively. He believes that the current activities are very weakly coordinated, leading to inefficiencies and wasted opportunities.

Case 2.Technology Innovation and Commercialization Office (TICO) at Zagazig University[7] In accordance with its mission to contribute to the technological and economic development of Egypt, Zagazig University opened its Technology Innovation and Commercialization Office in July 2013, in response to a call for bids from the Academy of Scientific Research and Technology (ASRT). In total, 30 such offices were created around the country and the University received a grant of 600,000 EGP to establish the office over a period of two years. Apart from paying for the facilities, which are housed on the University's main campus, the grant is used, together with a further 300,00 EGP from the University, to employ a Director and 6 part-time staff, plus three administrators. The vision of the Office is very much that of a Triple Helix institution whereby the University, Industry and Government work in partnership. Its aim was, and is, to channel University outputs (from Science, Technology and Research) to industry and to promote innovation both within and outside the University. The TICO operating model sees the office as a bridge transferring expertise, problem solutions, student training, pilot projects, consultation and product invention and development to industry, while industry transfers experience, needs analysis, worker training, project application, joint supervision and product evaluation and implementation to academia. To do this, the TICO has three departments, namely GICO (an office for Grants and International Collaboration), TTO (Technology Transfer Office) and TISC (Technology Innovation and Support Centre). Together these three departments: Promote knowledge and awareness on patent processing; Facilitate patent applications; Create intellectual property agreements between the University and Industry; Encourage connections between the University's research laboratories and industrial production units; Enable technology transfer between the University and industry; Map the University's competence in technological and scientific research; Help transform

[7] Zagazig University was established in 1974 as a state university. It has ove170,000 students and some 7000-academic staff in 17 Faculties and 2 Institutes. It is ranked by QS as 8th in Egypt and 43rd in the Arab World.

innovative ideas into products, and Bring new ideas and products to market. Since its formation, the Office has created 26 innovative student ventures (13 innovations for school pupils age 13–18 years and 13 innovations for university students) and 12 staff projects. The office has also raised awareness on campus of the importance of innovation, so that academics, students and graduates now come to the TICO for help and promotion, Despite this, the TICO has faced numerous challenges, most notably: Lack of confidence in the capabilities of the University and its ability to deliver solutions or products; Conflicts of interest and potential disengagement; Licensing complications; Incompatibility between the needs of industry and research interests; Lack of appropriate expertise; Political and economic instability; and Lack of a spirit of innovation and entrepreneurship. To overcome these challenges the Office has acted primarily as a broker/arbitrator between the University and industry and has run training programs for the academics to help raise their awareness and equip them with the requisite skills. According to the Director of TICO, Professor Mahmoud Sitohy, a Biochemistry specialist, Egyptian

> "economic development cannot happen without systematic innovative applied research that reaches the market".

This is what the TICO is attempting to do and its future plans include: Greater penetration of the industry market, particularly the pharmaceutical, food and handicrafts industry sectors; National and international university collaboration; Building a Science Park; Offering student training programs on innovation and entrepreneurship; and Working with schools to encourage pupils (10–18-year-old) to produce innovations. In 2015 the ASRT funding ceased. An extension to the contract was negotiated but the TICO is not yet sustainable. Therefore, further funding is required and the University will look to external funding sources, such as aid from the European Commission under Horizon 2020 and Erasmus as well as the Newton Mosharafa Fund. It has not done so, previously, in part because it has not been fully aware of the support available and in part because of the time needed to apply. The staff members of TICO recognize that they have learned a great deal and suggest that if universities are to play a significant role in the innovation and economic development process, Government Policy is required to encourage them and industry to collaborate more. Among their various suggestions were that the law on staff spinout companies needs to change, the Supreme Council should require entrepreneurship and innovation modules to be introduced into all degree programs, the criteria for staff promotion needs to be changed to include research application not just publication and firms should be required to work with the country's universities.

Case 3. American University in Cairo (AUC) Technology Transfer Office The idea to establish a Technology Transfer Office (TTO) at AUC was that of Professor Ehab Abdel Rahman, based on his experience at the University of Utah. It was one of four TTOs established in Egypt in 2010 as part of an Enterprise - University Partnership (EUPART) project funded under the European Union Tempus program. AUC was the lead partner in the project, which included Cairo. Assuit and Helwan universities in Egypt and the Freie Universitat in Berlin, the Polytechnic University of Turin, Linkoping University in Sweden, and the Technical University of Vienna. Other partners included the European Patent Office, the Egyptian Patent Office, the Science and Technology Development Fund and sixth of October City Investors Association. The mission of the TTO is

> "to benefit the global public by creating opportunities for AUC's innovators to maximize the impact of AUC innovative technologies, breakthrough and discoveries through licensing to companies or spinouts while generating revenue to support research and education".

Its purpose is to serve the AUC community by helping those Faculty, staff or students to protect, then commercialize their creative and/or innovative ideas. To achieve its mission the TTO undertakes a number of activities including: Managing the University's patent portfolio; Developing the University's IP management policies, strategies and procedures; Scouting University technologies to find high potential projects; Evaluating patentable ideas and assessing their commercial value; Providing advice and consultation; Raising awareness of AUC innovative technologies; Liaising with industry and fostering confidence and trust between them; Licensing AUC Intellectual Property to companies or entrepreneurial teams; Helping incubate technology and facilitate the growth, development and success of new technologies; and Promoting entrepreneurship. As a result of its activities, the TTO concluded its first deal in 2013, with what was Egypt's first University spinout, D-Kimia, a start-up company that develops novel and affordable diagnostic solutions to detect a broad range of diseases, initially focusing on the identification of hepatitis C. Its cofounders are Professor Hassan Azzazy, Professor of Chemistry at AUC, and Karim Hussein, a serial entrepreneur. Under the agreement between the AUC and D-Kimia, the company has the exclusive license for 4 patent pending technologies developed at the AUC Novel Diagnostics and Therapeutics Laboratory and, through a separate agreement, can access laboratories and equipment in the University's School of Sciences and Engineering. Since this early activity, the TTO, which employs 4 staff including a Director, an administrator and two licensing officers, has filed 78 patents in 32 patent families. Its activities, now that the Tempus funding has ceased, have been funded by the University, though, in 2013, it was one of the 30 universities and research centers that successfully bid for TICO funding. Apart from funding, the lack of industry interest/ support is seen as a challenge, as is the relatively low level of funded, cutting-edge research, together with the Egyptian university labor, commercial and intellectual property regulatory framework. While the AUC is not directly subject to the Egyptian Supreme Council, it is sensitive to the country's regulations with respect to those hindering university and industry innovation. Hence, its Director, Ahmed El Laithy, suggests that for Egyptian universities to participate more effectively in the innovation process there needs to be greater understanding on the part of industry of the need to collaborate with universities, a change in a number of laws and implementation mechanisms to better manage IP prosecution and permit universities to take equity in ventures resulting from their research and an update of the relationship/contract between the university and the academic at public universities. Among the aspirations that the TTO Director has for the future is the creation of a national association of university technology managers similar to those already existing, such as AUTM (Association of University Technology Managers) and the Japanese University Technology Transfer Association.

10.4.4 *Fourth Phase: View of Industry*

The findings reveal that only 6% of the sample (n = 14) had a partnership with an Egyptian university and only one-third (n = 79) claimed to have knowledge of the concept of the Triple Helix University (Etzkowitz 2003). Of these 79, however, only 36% (n = 28) identified correctly that it was a university that works in partnership with industry and government, indicating a clear lack of real understanding of the concept among the business community. Of the 14 businesses that have links with a university, almost three quarters had a knowledge/technology transfer partnership involving consultancy and training, while some 68% partnered on research and 60% on teaching and learning. Such partnerships were perceived to create benefits for the industrial partners of which the most important were a reduction in costs (35%) and access to new knowledge (25%). However, the partnerships were not without their challenges. Chief among them were the mismatch between the universities and industry in terms of relevance, time horizons and expectations which was cited by 37% of the respondents and, when coupled with focus conflicts (7%), accounted for almost half of the sample (44%). The second most frequently cited challenge related to the industrial partner's knowledge of the university and what it can offer. Some 23% of the respondents claimed not to know what the university could offer because of a lack of information, while a further 14% complained about the quality of the information provided.

When asked why they did not partner with universities in Egypt, over one third (35%) of the 213 respondents claimed it was because they were too theoretical while 22% percent pointed to the conflict that occurs between academia and industry resulting from universities wishing to publish their findings while industry wants to keep them confidential. A further 13% also pointed to the different objectives of academia and industry – to the fact that universities wish to create knowledge whereas industry wishes to create competitive advantage. When taken together, this would suggest that over one third of the sample (35%) do not collaborate with higher education because of the conflicting interests and objectives. However some 15% percent also claimed that universities are too expensive and 7% percent suggested that the research undertaken in Egyptian universities is not leading edge.

In order to encourage University-Industry partnerships, the industrialists put forward a range of suggestions. These included university – industry collaboration becoming a national strategic priority (19%) and a core/priority activity for universities (17%). To facilitate collaboration joint steering groups were proposed by 18% of the sample and a further 13% suggested that the goals and benefits of partnering need to be made clear for both parties. At the same time it was recognized by 11%

of the sample that the reward system in universities does not encourage partnerships with industry and it was proposed that if the academic staff are to develop and engage in such partnerships, they will need to be incentivized and rewarded. Linked to this is the issue relating to intellectual property ownership and the concern of the academic to publish the results of his/her research. This was recognized by a further 5% of the sample as an issue that needs to be resolved, presumably as part of the academic staff incentive and reward process. Finally the industrialists recognized that the role of universities needs to change so that they become more strongly oriented to helping solve the scientific and technological challenges companies encounter (8%) and match their strengths with the core research competence of the company in order to identify promising opportunities for collaboration (9%).

10.5 Discussion and Implications

The results from the four research phases confirmed the limited effectiveness of the measures introduced to support technology transfer and supported the proposition that to promote it and facilitate entrepreneurial innovation, policy needs to be both comprehensive and coherent. The findings also suggest that these initiatives have had some success in raising internal awareness, amongst both university staff and students, but also reinforce the further need to raise awareness and understanding both within universities and the external business community. Neither community fully acknowledged the role the modern university can play in innovation, appearing unaware of, in particular, the benefits that can be derived from research collaboration. Hence, there remains only limited collaboration between the two. Finally, all four phases of the study demonstrated the constraints imposed by the laws and regulations governing Egypt's universities, in particular the criteria for the promotion of university academics and the constraints on entrepreneurial spin-out activity. As a consequence, the modern third mission of universities, embracing both technology transfer and entrepreneurial innovations, remains underdeveloped. In detail the research demonstrated.

Phase 1 Although Government support is being provided there is no coherent strategy that co-ordinates the activity and includes Higher Education (Kirby and Ibrahim 2013). Clearly, it is important not to over-estimate the role of Government and what is achievable (Henry 2013) and might be expected from the Triple Helix model, but as elsewhere (Kirby 2006; Mock 2005), the role of Government is important. The need is for a clear research and innovation strategy where all the stakeholders (universities- industry- government) have a clear role and mandate to achieve a common goal, increase the country's innovativeness and, thereby, its competitiveness. Long-term, however, the universities themselves need to be freed from both external and internal bureaucracy, allowing them to be more innovative and flexible than at present. At the same time, they should be encouraged to interact with their external environments through both the transfer and commercialization of technology and to move away from close government regulation and sector standardization. They need to search for their own special organizational identities, believing

> "that the risks of experimental change...should be chosen over the risks of simply maintaining traditional forms and practices" (Clark 1998, p. xiv).

Phase 2 This second phase suggested there is little apparent understanding of the contribution of the modern university to the innovation process on the part of academia, indicating the need for raising awareness through capacity building and staff development. As one respondent put it, however

"The most important [thing] is that staff with industrial research achievements should be recognized and selected for leadership positions".

This is important. Those academics that do innovate and commercialize their innovations need to be rewarded and recognized. Recognition should not be solely for research publication, but for its application, implementation and commercialization. Indeed, to protect the intellectual property, it the researchers may necessarily need to be prevent journal and/or conference publication of the research. This will certainly require changes in university policy both at the level of the institution and, probably, nationally, a point recognized in phase one which suggested that

> "if the promotion laws recognized applied research and patent applications, the situation would improve" (El Hadidi and Kirby 2015a, p.156).

Additionally, and importantly, policies will need to be introduced that enable and support the transfer and commercialization of technology by the universities and their academic staff.

Phase 3 The three cases triangulate and complement the findings of the earlier research by El Hadidi and Kirby (2015a and b) and demonstrate the sort of activities being undertaken to involve universities in the innovation process. While acknowledging the achievements, they also illustrate the limitations and difficulties involved. They reinforce the need to raise awareness and understanding of the process both internally and externally. They suggest some success in raising internal awareness amongst both university staff and students, but that the Egyptian business community still does not acknowledge the role the modern university can play in innovation, appearing unaware of the benefits that can be derived from research collaboration. Second although TICOs have been established in 43 of the country's universities, the cases suggest an often piecemeal and un-coordinated program of activity, frequently the result of individuals and institutions taking advantage of external funding programs. While such programs are intended to bring about change, and modernization, their effectiveness is often relatively limited. First they are usually short- or fixed- term and tend not to be sustainable, lasting only for the duration of the project. Second, they tend to be "bolt on" and not regarded as an institutional core activity. Accordingly, there is often no sense of corporate ownership and it is not, therefore, something in which all academics engage. Third, on occasions, they actually conflict or compete with, rather than reinforce or complement, other, similar initiatives within the institution. This is not unique to Egypt and in part results from the initiatives not being integrated into the institution's core strategic planning framework. As a consequence, there is often little coherence and institutional change is thereby limited. Accordingly the focus remains mainly on the two traditional missions of research and teaching and learning. All three cases demonstrate, also, the constraints imposed by the criteria for the promotion of university academics and the constraints on new venture spin-out activity.

Phase 4 Having shown that no more than 6% of the sample population collaborated with academia despite the various government interventions intended to encourage it, this phase of the research confirmed the 2012 Egyptian Science and Technology Development Fund (STDF) finding that industry/academic collaboration activity is "missing to a great extent in Egypt" (op.cit, p.13). It also demonstrated the limited effectiveness of the existing policies and measures. Given the structure of the sample and its bias towards large firms, it is probable that even this estimate is somewhat high as it is known that Egyptian SMEs, which constitute some 99.7% of the industrial population, are known to lack the knowledge, desire and understanding to carry out research, especially with universities. This lack of SME collaboration with Higher Education is not unique to Egypt (Bonner et al. 2015) but it is one that needs to be addressed, as elsewhere, if the country's SMEs are to contribute fully to the innovation process (OECD 2010a). Where university – industry collaboration does occur, numerous benefits may be identified together with challenges. Primarily the latter relate to the different objectives of the two sectors and/or the industrialist's knowledge of what services the universities can offer. Such findings not only corroborate the literature on the topic but suggest the need for closer dialogue between the two sectors to better understand each other's needs, modus operandi and the mutual benefits to be gained from collaboration as well as how to manage the relationship. In the majority of cases, however, industry does not collaborate with Higher Education in Egypt either because of the conflicting interests and objectives of the two sectors or because the research is too theoretical or not leading edge. Clearly changes need to be made in both sectors but Egyptian industry does need to recognize that while collaboration with universities can be problematic, the benefits can be significant for all parties, including the national/regional economy. Overcoming such challenges requires effort on their part. Not only do they need convincing of the benefits by success stories but, certainly the larger firms need to employ academic liaison officers who understand academia and can work with academics, building a relationship of trust. However, it is not just the larger firms that need to collaborate with academia but the SMEs, not least as it has been found in Japan, for example, that smaller firms achieve higher productivity through university-industry collaboration than large firms (Motohashi 2005). Accessing the SME sector is notoriously difficult, though it might be possible using the local large organization supply chain or via designated programs intended to link SMEs with Higher Education and stimulate Innovation.[8]

---

[8] Such as the U.K.'s Knowledge Transfer Partnerships (ktp.innovateuk.org).

The study findings have considerable implications for the promotion of technology transfer in Egypt as well as the factor-driven economies. They suggest that a comprehensive, coherent national strategy is required that addresses the various issues impeding university-industry technology transfer and coordinates the various support measures. Clearly, it is important not to over-estimate what is achievable (Henry 2013) but as might be expected from the Triple Helix model, and has been witnessed elsewhere (Kirby 2006; Mock 2005), the role of Government is important. The need is for a strategy where all of the stakeholders (universities- industry-government) have a clear role and mandate to achieve the common goal, and the universities need a clear set of policies to help them achieve this. Long term, however, they need to be freed from both external and internal bureaucracy, allowing them to be more innovative and flexible than at present. At the same time, their funding base needs to be diversified and they should be encouraged to interact with their external environments through both technology transfer and commercialization. According to Zhao et al. (2020, p.327),

> "organizational-level mission and policy affect academics' industrial engagement"

the Government needs to require its universities, to incorporate the "third mission" into their core activities but permit them, also, to be more autonomous and responsive to their markets. The senior management needs to be committed to the concept (Galan-Muros et al. 2017) and to building capacity while the promotion criteria for academics need to be addressed and the value of research exploitation, not just publication, needs to be recognized. Equally, the law regulating the ownership of university spinouts needs to be amended to permit both the individual researchers and their employers to take equity in the ventures.

Industry also needs to be encouraged/incentivized to collaborate with the country's universities. As in Norway (Rasmussen and Rice 2012) for example, this might include fiscal incentives such as tax breaks and/or innovation vouchers (OECD 2010b). However, this implies there is no benefit to industry from collaboration – that the benefit is to academia only. This is not the case as many of the multinationals, represented in Egypt, appreciate. Firms like BG, BP, Google, Shell, Siemens and Vodafone all have, at least in their home environments, extensive university-industry programs that go beyond graduate recruitment and include collaborative research and corporate venturing. These organizations may be used both to demonstrate the benefit of collaboration and to introduce the concept through their local activities as well as their supply chains, thereby extending the concept to indigenous domestic firms including SMEs. The Government might also consider creating a permanent national forum in which academic –industrial and government representatives can explore areas of mutual interest and benefit, together with opportunities for collaboration[9]. Finally, the country and its universities need to continue availing themselves of the support being made available from external sources such as the

[9] The U.S. Business-Higher Education Forum (http://bhef.com) is an example of such an initiative as is AURIL (Association for University Research and Industry Links) in the U.K. (auril.org.uk).

European Union[10] and the U.K. Newton – Mosharafa fund[11]. However, when so doing, such projects need to fit into coherent institutional frameworks that promote and enable increased sustainable technology transfer and commercialization, innovation and economic and social competitiveness.

10.6 Conclusions

The aim of this research was to examine university technology transfer in Egypt in an attempt to extend the body of understanding and help formulate effective policy. From the extant body of understanding it is evident that even in the innovation-led economies, university-technology transfer does not occur naturally (Galan-Muros et al. 2017) and policies need to be introduced to help promote and facilitate its development. Hence, in accordance with the concept of the Triple Helix (Etzkowitz 2003) there is an important role for Government. As has occurred in Saudi Arabia (Alshumaimri et al. 2010), the Egyptian Government should set the strategy. It needs to require the modernization of the economy by encouraging university – industry collaboration and the creation of new growth-oriented knowledge/technology-based businesses as a national priority. The role of its universities needs to be addressed, requiring them to become more entrepreneurial (Kirby and Ibrahim 2016). This appears to be beginning. Not only did the first Egyptian university-linked science park[12] open in December 2018, at The British University in Egypt, but several universities have responded entrepreneurially to the COVID-19 pandemic and, according to Mowafy (2020) have metamorphosed to play an effective role as incubators of scientific and technology-based entrepreneurship. However, there is no evidence that technology transfer and the Third Mission have been adopted formally by the institutions (Siegel and Guerrero 2021). This has to occur for, as Galan-Muros et al. (2017) have recognized, those HEIs successfully engaged with industry put in place a series of mechanisms simultaneously at strategic and operational levels and change or adapt their organizational structure, culture and mission. In this context, the recently introduced international university branch campus program is important. Not only does it introduce universities that have

[10] The EU is working to develop closer scientific ties between Egypt and the European Research Area particularly through increased Egyptian participation in Horizon 2020, the on-going 80 billion Euro EU Framework Program for Research and Technological Development.

[11] The U.K.'s Newton-Mosharafa Fund is a 20-million-pound sterling fund over 5 years intended to bring together the British and Egyptian scientific research and innovation sectors to find solutions to the challenges facing Egypt in economic development and social welfare.

[12] A 14,000 square meter Science and Innovation Park operated in co-operation with China's Tus-Holdings Co Ltd, the arm of Tsinghua University with responsibility for the University's Science Park (TusPark).

experience of the Third Mission and Technology Transfer[13] but it provides an opportunity to monitor the impact of these universities on the technology transfer process and the way universities and industry interact and collaborate. As Guimon (2013) and Guerrero and Urbano (2019) have recognized, though, it is not just education policy that needs to be investigated but the success of [all] specific policy programs to support university-industry collaborations in developing countries, and not just in Egypt.

Acknowledgments The authors would like to acknowledge the funding that Dr. El Hadidi received for her research from the Emerald/EFMD MENA Management Research Fund Award, together with all those who participated in the project. Without them the research would not have been possible.

References

Abu-Orabi, S. T. (2016, November 13–16). Higher Education and Scientific Research in the Arab World. Paper presented at the 15th IAU General Conference. Chulalongkorn University, Bangkok.

Alshumaimri, A., Aldridge, T., & Audretsch, D. B. (2010). The university technology transfer revolution in Saudi Arabia. *The Journal of Technology Transfer, 35*, 585–596.

Ashby, W. R. (1968). Variety, constraint, and the law of requisite variety. In J. Buckley (Ed.), *Modern systems research for the behavioral scientist*. Chicago: Aldine Publishing Co.

Avanitis, S., Kubli, U., & Woerter, M. (2008). University-industry knowledge and technology transfer in Switzerland: What university scientists think about co-operation with private enterprises. *Research Policy, 37*(10), 1865–1883.

Bercovitz, J., & Feldmann, M. (2006). Entrepreneurial universities and technology transfer: A conceptual framework for understanding knowledge-based economic development. *Journal of Technology Transfer, 31*, 175–188.

Boehm, S. N., & Hogan, T. (2014). 'A jack of all trades': The role of PIs in the establishment and management of collaborative networks in scientific knowledge commercialization. *The Journal of Technology Transfer., 39*(1), 134–149.

Bonner, K., Hewitt-Dundas, N., & Roper, S. (2015). *Collaboration between SMEs and universities – Local population, growth and innovation metrics*. Bristol: Higher Education Funding Council for England.

Bozeman, B. (2000). Technology transfer and public policy: A review of research and theory. *Research Policy, 29*, 627–655.

Bruneel, J., D'Este, P., & Salter, A. (2010). Investigating the factors that diminish the barriers to university-industry collaboration. *Research Policy, 39*(7), 858–868.

Chukumba, C., & Jensen, R. (2005). University invention, entrepreneurship and startups. NBER working paper series 11475. Cambridge, MA.

Clark, B. R. (1998). *Creating entrepreneurial universities: Organisational pathways of transformation*. Oxford: Elsevier Science.

[13] In September 2019 a branch of Coventry University, the winner of the UK's Entrepreneurial University of the Year Award (2011) and The Duke of York Award for University Entrepreneurship (2017), was opened in Elsewedy's Knowledge Hub University, located on a 50-acre site in the new administrative capital.

D'Este, P. D., & Patel, P. (2007). University-industry linkages in the UK: What are the factors underlying the variety of interactions with industry? *Research Policy, 36*(9), 1295–1313.

De Lourdes Machado, M., Farhangmehr, M., & Stover Taylor, J. (2004). The status of strategic planning in Portuguese higher education institutions: Trappings or substance. *Higher Education Policy., 17*(4), 383–404.

Debackere, K., & Veugelers, R. (2005). The role of academic technology transfer organizations in improving industry science links. *Research Policy, 34*(3), 321–342.

El Hadidi, H., & Kirby, D. A. (2015a). Universities and innovation in a factor-driven economy; the Egyptian case. *Industry and Higher Education, 29*(2), 151–160.

El Hadidi, H., & Kirby, D. A. (2015b). The attitude of Egyptian SET academics towards innovation: Universities and innovation in a factor-driven economy. *Industry and Higher Education, 29*(4), 1–11.

El Hadidi, H., & Kirby, D. A. (2016). Universities and innovation in a factor-driven economy: The performance of universities in Egypt. *Industry and Higher Education, 30*(2), 140–148.

El Hadidi, H., & Kirby, D. A. (2017). University-industry collaboration in a factor-driven economy; the perspective of Egyptian industry. *Industry and Higher Education., 31*(3), 195–203.

Etzkowitz, H. (2003). Innovation in innovation: The Triple Helix of university-industry-government relations. *Social Science Information., 42*(2), 151–160.

Fontana, R., Guena, A., & Matt, M. (2006). Factors affecting university-industry R & D projects: The importance of searching, screening and signalling. *Research Policy, 35*(2), 309–323.

Friedman, J., & Silberman, J. (2003). University technology transfer: Do incentives, management and location matter? *The Journal of Technology Transfer, 28*(1), 17–30.

Galan-Muros, V., Van der Sijde, P., Groenewegen, P., & Baaken, T., (2017). Nurture over Nature: How do European universities support their collaboration with business? *The Journal of Technology Transfer, 42*(1), 184–205.

Gonzalez-Pernia, J. L., Kuechie, G., & Pena-Legazkue, I. (2013). An assessment of the determinants of university technology transfer. *Economic Development Quarterly, 27*(1), 6–17.

Guerrero, M., Cunningham, J. A., & Urbano, D. (2015). Economic impact of entrepreneurial universities' activities: An exploratory study of the United Kingdom. *Research Policy, 44*(3), 748–764.

Guerrero, M., & Urbano, D. (2019). Effectiveness of technology transfer policies and legislation in fostering entrepreneurial innovations across continents: an overview. The *Journal of Technology Transfer, 44*(5), 1347–1366.

Guimon, J. (2013). Promoting university-industry collaboration in developing countries. The Innovation Policy Platform: Policy Brief, 1–11.

Henry, C. (2013). Entrepreneurship education in HE: are policymakers expecting too much? *Education+Training, 55*(8/9), 836–848.

Herman, C. (2013). Industry perceptions of industry-university partnerships related to doctoral education in South Africa. *Industry and Higher Education, 27*(3), 214–222.

Hewitt-Dundas, N. (2012). Research intensity and knowledge transfer activity in UK universities. *Research Policy, 41*(2), 262–275.

Ismail, A., Tolba, A., Barakat, S., & Meshreki, H. (2018). *Global entrepreneurship monitor: Egypt National Report, 2017–2018*. Cairo: American University in Cairo.

Kirby, D. A. (2006). Creating entrepreneurial universities in the UK: Applying entrepreneurial theory to practice. *The Journal of Technology Transfer, 31*, 599–603.

Kirby, D. A. (2007). The contextual stepwise approach to enterprise research and the use of undisguised stories and focus groups. In D. Hine & D. Carson (Eds.), *Innovative methodologies in enterprise research*. Cheltenham: Edward Elgar.

Kirby, D. A., & El Hadidi, H. (2019). University technology transfer efficiency in a factor-driven economy: The need for a coherent policy in Egypt. *The Journal of Technology Transfer, 44*(5), 1367–1395.

Kirby, D. A., & Ibrahim, N. (2013). Entrepreneurship education policies in the MENA region: Challenges and opportunities. *American Journal of Entrepreneurship, 6*(2), 1–15.

Kirby, D. A., & Ibrahim, N. (2016). Entrepreneurial universities in Egypt: Opportunities and challenges. In N. Rizk & H. Azzazy (Eds.), *Entrepreneurship+innovation in Egypt*. Cairo: The American University in Cairo Press.

Link, A. N. (2015). Capturing knowledge: Private gains and public gains from university research partnerships. *Foundations and Trends in Entrepreneurship, 11*(3), 139–206.

Markman, G. D., Glaniodis, P. T., Phan, P. H., & Balkin, D. B. (2005a). Innovation speed: Transferring university technology to market. *Research Policy, 34*(7), 1058–1075.

Markman, G. D., Phan, P. H., Balkin, D. B., & Glaniodis, P. T. (2005b). Entrepreneurship and university-based technology transfer. *Journal of Business Venturing., 20*(2), 241–263.

Mock, K. H. (2005). Fostering entrepreneurship: Changing role of government and higher education governance in Hong Kong. *Research Policy, 34*(4), 537–554.

Motohashi, K. (2005). University-industry collaborations in Japan: The role of new technology-based firms in transforming the National Innovation System. *Research Policy, 34*(5), 583–594.

Mowafy, A. (2020, April 8). How "entrepreneurial universities" are tackling the effects of COVID-19 in Egypt. AUC Business Forward Digest.

Muscio, A., Quaglione, D., & Vallanti, G. (2014). University regulation and university-industry interaction: A performance analysis of Italian academic departments. *Industrial and Corporate Change., 24*(5), 1047–1079.

Naghizadeh, R., Elahi, S., Manteghi, M., Ghazinoory, S., & Ranga, M. (2015). Through the magnifying glass: An analysis of regional innovation models based on co-word and meta-synthesis methods. *Quality & Quantity., 49*(6), 2481–2505.

OECD. (2010a). *SMEs, entrepreneurship and innovation*. Paris: OECD.

OECD. (2010b). *Innovation vouchers*. Paris: OECD.

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Brostrom, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., Krabel, S., Kitson, M., Llerena, P., Lissoni, F., Salter, A., & Sobrero, M. (2013). Academic engagement and commercialisation: A review of the literature on university-industry relations. *Research Policy, 42*(2), 423–442.

Phan, P. H., & Siegal, D. S. (2006). The effectiveness of university technology transfer. *Foundations and Trends in Entrepreneurship., 2*(2), 77–144.

Rasmussen, E., & Rice, M. P. (2012). A framework for government support mechanisms aimed at enhancing university technology transfer: The Norwegian case. *International Journal of Technology Transfer and Commercialisation., 11*(1/2), 1–25.

Reda, M. (2012). *Enhancing Egypt's competitiveness: Education, innovation and labor*. Cairo: Egyptian Centre for Economic Studies.

Science and Technology Development Fund. (2012). *Egypt's innovation ecosystem*. Cairo: Innovation Support Department, Science and Technology Development Fund.

Siegel, D. S., Waldman, D., & Link, A. (2003a). Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: An exploratory study. *Research Policy, 32*, 27–48.

Siegel, D. S., Waldman, D. A., Atwater, L. E., & Link, A. (2003b). Commercial knowledge transfers from universities to firms: Improving the effectiveness of university-industry collaboration. *Journal of High Technology Management Research, 14*(1), 11–133.

Siegel, D. S., Waldman, D. A., Atwater, L. E., & Link, A. (2004). Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: Qualitative evidence from the commercialization of university technologies. *Journal of Engineering and Technology Management., 21*(1–2), 115–142.

Siegel, D. S., & Guerrero, M. (2021). The impact of quarantines, lockdowns, and 'reopenings' on the commercialization of science: micro and macro issues. *Journal of Management Studies*. https://doi.org/10.1111/joms.12692

Vinig, T., & Lips, D. (2015). Measuring the performance of university technology transfer using meta data approach: The case of Dutch universities. *The Journal of Technology Transfer, 40*(6), 1034–1049.

Zhao, Z., Brostrom, A., & Cai, J. (2020). Promoting academic engagement: University context and individual characteristics. *The Journal of Technology Transfer, 45*(1), 304–337.

Part VI
Empirical Evidence in/post-Socialist Economies

Maribel Guerrero and David Urbano

"Despite the institutional disparities, university authorities, policymakers, and academics are focusing their attention on the potential of universities to create innovative environments to transit to the knowledge-based economies."

– Marozau, Guerrero and Urbano (2016, 1)

Since the fall of the Berlin wall, Eastern European Socialist regimes have transited into capitalism, and the rest of the Socialist regimes have been enrolled in new innovation paradigms (Švarc et al. 2020). The 1990s has represented a strategic challenge for all these countries in recovering from the drastic decline of their technological capabilities and their adjustment to entrepreneurial capabilities (Marozau et al. 2016, 2019; Cruz-Amarán et al. 2020). It also explains the recent establishment of regulatory frameworks that protecting intellectual property and commercialization of knowledge (e.g., intellectual property law, university technology transfer).

Inspired by these challenges, this part of the book shows qualitative and quantitative evidence about the evolution of technology transfer policies and entrepreneurial innovations in/post-Socialist economies. Chapter 10 discusses the phases of the

M. Guerrero (✉)
Facultad de Economía y Negocios, Universidad del Desarrollo, Santiago, Chile

Centre for Innovation Research (CIRCLE), Lund University, Lund, Sweden

Northumbria Centre for Innovation, Regional Transformation and Entrepreneurship (iNCITE), Newcastle Business School, Northumbria University, Newcastle upon Tyne, UK
e-mail: maribel.guerrero@northumbria.ac.uk

D. Urbano
Department of Business and Centre for Entrepreneurship and Social Innovation Research (CREIS), Universitat Autònoma de Barcelona, Bellaterra, Spain
e-mail: david.urbano@uab.cat

evolution of university technology transfer legislation and outcomes in Croatia. Chapter 11 demonstrates the marginal effect of the Belarusian government's science and technology interventions on SMEs' entrepreneurial innovations and the strong support to large state-owned enterprises to preserve their manufacturing potential. Chapter 12 shows the Cuban technology transfer policy framework's evolutionary process, as well as the need for consistent management that proactively promotes the interrelation among all innovation ecosystem's agents and productive actors.

This part of the book offers readers relevant drivers/barriers in the technology transfer evolutionary process, the European Union's supports to European post-Socialist economies, and the current challenges to transit towards knowledge-based economies. We encourage researchers to continue exploring technology policy frameworks' effectiveness and the emergence of entrepreneurial innovations in/post-Socialist economies.

References

Cruz-Amarán, D., Guerrero, M., & Hernández-Ruiz, A. D. (2020). Changing times at Cuban universities: looking into the transition towards a social, entrepreneurial and innovative organization. *Sustainability, 12*(6), 2536. https://doi.org/10.3390/su12062536.

Marozau, R., Guerrero, M., & Urbano, D. (2016). Impacts of universities in different stages of economic development. *Journal of the Knowledge Economy*. https://doi.org/10.1007/s13132-016-0359-7.

Marozau, R., Guerrero, M., Urbano, D., & Ibañez, A. (2019). Evolving entrepreneurial activities at post-soviet universities. In J. Maxwell (Ed.), *Higher education institutions: Perspectives, opportunities and challenges* (pp. 201–246). New York: Nova Science Publishers.

Švarc, J., Dabić, M., & Tugrul, D. (2020). A new innovation paradigm: European cohesion policy and the retreat of public science in countries in Europe's scientific periphery, accepted for publication in the *Thunderbird International Business Review*, *62*(5), 531–547. https://doi.org/10.1002/tie.22166.

Chapter 11
Socialism to Capitalism: Technology Transfer and Entrepreneurship in the Republic of Croatia

Jadranka Švarc and Marina Dabić

11.1 Introduction

The future development of contemporary economies, including those in post-socialist countries, is highly dependent on their capacity to generate and exploit various types of innovation and their ability to transfer knowledge and new technologies from the scientific sphere to production, and vice versa (Švarc et al. 2019; Dabić et al. 2019). Stojčić (2020) assessed the impact of a range of innovation policies in eight Central and Eastern European countries in terms of both the financial incentivization of R&D and the public procurement of innovation. The conclusions of this research exposed the positive results of both of these policy instruments. Companies with public procurement for innovation contracts or those receiving monetary support for innovation were more likely to innovate and attain high sales figures when selling new products. The push channel, in this instance, appears to be the driving force behind this innovation. Stojčić (2020) pointed out that this is especially evident in instances in which public procurement has not been created in such a way that companies are required to think of new products and processes. When

The original version of this chapter was revised. The correction to this chapter is available at https://doi.org/10.1007/978-3-030-70022-5_14

J. Švarc
Institute Ivo Pilar, Zagreb, Croatia
e-mail: jadranka.svarc@pilar.hr

M. Dabić (✉)
Faculty of Economics and Business, University of Zagreb, Zagreb, Croatia

Management Division, Nottingham Business School, Nottingham Trent University, Nottingham, UK
e-mail: mdabic@net.efzg.hr; marina.dabic@ntu.ac.uk

Corrected Publication 2021
M. Guerrero, D. Urbano (eds.), *Technology Transfer and Entrepreneurial Innovations*, International Studies in Entrepreneurship 51,
https://doi.org/10.1007/978-3-030-70022-5_11

this happens, these two policy channels often have less of an impact in comparison to those attained via push policies exclusively.

Technology transfer has many different meanings and there is an abundance of multidisciplinary literature on this topic (Wahab et al. 2012; Bozeman et al. 2015). Scholars' understanding of what is important in the management of knowledge and technology transfer has evolved continuously, but scientific research, innovation and, recently, entrepreneurship are considered to be inseparably intertwined with technology transfer (Audretsch et al. 2012). While some think that technology transfer is all about technological and managerial learning in companies, growing numbers of scholars since the 1990s have become increasingly more preoccupied with university technology transfer (UTT) (Allen and O'Shea 2014; López Mendoza and Mauricio Sanchez 2018; Breznitz and Etzkowitz 2016), which usually involves the commercialization of research results, different models of science/industry cooperation, and academic entrepreneurship. This approach has resulted in a large expansion of literature in this area, and this was mainly inspired by the ideas of the third university mission, initiated by the third university revolution (Etzkowitz and Viale 2010), the model of the triple helix (Etzkowitz 2008), academic capitalism (Slaughter and Leslie 2001; Rhoades and Slaughter 1997), and entrepreneurial university (Gibb and Hannon 2006; Silva et al. 2018). These theories and ideas have found fruitful grounds for policy applications in European development strategies; firstly within the Lisbon agenda (European Commission 2000) and most recently within the smart specialization strategy (S3) (Foray et al. 2009; Radošević et al. 2018), which established the concept of entrepreneurial university and figured university technology transfer as a fundamental mechanism to spur regional economic growth.

Following this, technology transfer in this study addresses the processes of knowledge transfer from the scientific to the business sector, and all types of academic engagement involving the cooperation of the science with industry (Perkmann et al. 2013; Breznitz and Feldman 2010). It goes beyond the pure commercialization of research results and involves both formal and informal channels of knowledge transfer between academics and stakeholders within an innovation system. Miller et al. (2018) identified, for example, 13 types of modes of engagement to encourage academics to participate in knowledge transfer ranging from the level of formality, to networking, to spin-outs; while (Dabić et al. 2016) identified the eight basic functions of an entrepreneurial university, of which technology transfer was one of the most prominent. The key research questions addressed in this article are whether or not the transition to capitalism and membership in the EU changed the university technology transfer model practiced in the socialist era and, if so, in what direction; whether the academic knowledge and research was infused into valuable economic activity and marketable innovation that would foster entrepreneurial innovation, or not; and whether knowledge transfer and the propensity to engage in entrepreneurship following capitalism were enhanced and, if not, why?

This research was conducted using Croatia as its subject: the newest, 28th EU member state as of 2013, and a country with controversial outcomes of the transition process in comparison to its peers. This controversy stems from the fact that Croatia was much more prepared for market economy in 1990s, and had numerous advantages over countries from socialistic blocks, in terms of price liberalization, foreign trade liberalization, and reformation of the banking system (Uvalić 2018), leaving other Eastern European countries, at that time, behind. Nowadays, by contrast, Croatia is one of the least developed EU member states, lagging behind its eastern peers in growth rates of GDP and competitiveness of economy. It remains an upper middle-income country, with a GDP per capita of 11.806 EUR in 2017[1] which achieved around 60% of the EU-28 average, however future economic prospects are ambiguous. This research is conceptual, using the case study of Croatia to better understand how technology transfer and entrepreneurial innovation are determined by the political economy in a national context. The arguments in this article are three-fold. Firstly, we argue that UTT has not essentially changed today in comparison to socialism, as the socio-economic context remains adverse to innovation and entrepreneurialism, despite its transformation to capitalism. Secondly, we argue that UTT has evolved through three models since socialism: the science-based model practiced in socialism; the innovation-based model in transition; and the bureaucratic model of today. Thirdly, we argue that the current bureaucratic UTT model is driven by the Europeanization of national research and innovation policies, embodied in the smart specialization strategy, and in certain aspects of regression with regards to the two previous phases of UTT.

The chapter is structured as follows: in the next four sections the historical evolution and the main features of UTT are described, following on from socialism (Sect. 11.2), over the first (Sect. 11.3) and second (Sect. 11.4) phase of transition, to the present state of Europeanization of UTT (Sect. 11.5). Discussion of the results of the research is given in Sect. 11.6, leading on to some concluding remarks in Sect. 11.7.

11.2 Theoretical Framework

Schumpeter (1942) and Drucker (1985) posited entrepreneurial innovation as the source of productivity growth. This approach cultivated a view in which innovation and entrepreneurship were virtual synonyms which could be used interchangeably (Acs and Audretsch 2005), which had a negative collateral effect on the entrepreneurship. The term ‘entrepreneurship’ almost disappeared from the European scholarly agenda from the early twentieth century to the 1980s. The focus, in this period, was orientated towards science-based innovation and high technology sectors, carried out by large corporations and research institutes. The analytical framework used to study innovation was the national system of innovation (Nelson 1993); a concept conceived within the evolutionary economy (Nelson and Winter 1982) which focused on the institutions and structures that would foster research based innovation (Edquist and Lundvall 1993) in which an entrepreneur was absent or personified in big industries and large corporations (Autio et al. 2014; Acs et al.

[1] Review: http://www.hnb.hr/en/statistics/main-macroeconomic-indicators

2014). This concept of entrepreneurship was productive in the post-war economic regimes of the managed economy, but significantly changed with the massive downsizing and restructuring of many large firms, which gave rise to entrepreneurial economy (Thurik et al. 2013) and brought individual entrepreneurs to the center of the innovation system (Acs et al. 2017; Gibson, et al. 2019). Scholars gathered around the GEDI project (Global Entrepreneurship and Development Index) (Szerb et al. 2013a, b), established the theoretical foundation of entrepreneurship capital (Audretsch 2007); entrepreneurship society and economy (Thurik et al. 2013); and the national system of entrepreneurship (Szerb et al. 2013a, b; Acs et al. 2014), which essentially replaced the national innovation system. These concepts, along with the construction of entrepreneurship as a separate research field (Carlsson et al. 2013; Landström and Harirchi 2018), marked the rise of a new era of entrepreneurial economy in which entrepreneurship re-emerged as a key agenda of economic policy.

However, a gap between entrepreneurship based on the narrow types of science-based innovation, which take place at technological frontiers (Autio et al. 2014, p. 1099), and traditional entrepreneurship simply based on new ventures neglecting technological innovation, still persists. According to Thurik et al. (2013) and Audretsch and Thurik (2000), the first type of entrepreneurship was inherent to a managed economy, while the latter is implicit in entrepreneurial economy. Traditional entrepreneurialism, which is often likened to just “another shop around the corner” (Block et al. 2013, p. 713), lacks the innovation dimension and has previously been seen to threaten technological progress and economic growth in the long run (Shane 2009). Discussions concerning the exploitation of new knowledge within the knowledge spill-over theory of entrepreneurship (KBST) (Audretsch and Caiazza 2016) and knowledge-driven entrepreneurial economy (Audretsch and Link 2018) definitely have a place within this context. On the other hand, it seems that a concept of entrepreneurial innovation that has recently entered the academic fora (González-Cruz and Devece 2018) could bridge the aforementioned gap, as entrepreneurial innovation assumes opportunity driven businesses (Mrozewski and Kratzer 2017) with a high potential for growth (Guerrero and Urbano 2017, 2019). Entrepreneurial innovation is focused, as concisely summarized by Autio et al. (2014, p. 1105), on radical innovation, and can generate growth without necessarily involving scientific research and infrastructures, which is a rather illusive feat for many entrepreneurs. Its nature and performance is determined by the different contexts of entrepreneurial innovation ecosystems (industrial, organizational, temporal, etc.), which generate different types of entrepreneurial innovation. However, it seems that the concept of entrepreneurial innovation is still theoretically and analytically vague and remains insufficiently distinctive from other forms of entrepreneurship. This entrepreneurship innovation is discussed from many angles such as: the narrative perspective of contextualizing innovation through relational, temporal, and performative efforts (Garud et al. 2014); its role for emerging economics within the model of the triple helix (Guerrero and Urbano 2017); interaction between opportunity and necessity entrepreneurship (Mrozewski and Kratzer 2017); its role in regional competitiveness and entrepreneurial university (Guerrero et al. 2015, 2016); the intelligence of the intellectual class (Burhan et al. 2017); and governance quality and economic freedom in the EU (Ignatov 2017), to name but a few of the theoretical approaches.

Following the ideas of Guerrero and Urbano (2017) and (Guerrero et al. 2016), entrepreneurial innovation can be understood to be a new technology entrepreneurship initiative which involves different kinds of university technology transfer (cooperative search, business incubation, etc.) and cooperative knowledge generation, through models such as that of the triple helix (Etzkowitz 2008). When it comes to transition economies, it could be argued that the entrepreneurial innovation or commercial exploitation of knowledge hardly exists (Kornai 2010; Švarc 2014; Krammer 2009). Croatia suffers from the same shortcomings in terms of innovation and entrepreneurship regardless of its transition to capitalism and irrespective of its embracing of the principle of entrepreneurial economy (Thurik et al. 2013). These reasons can be found in the inheritance of socialism and, on the other hand, in the particular processes of entrepreneurship development in the transition period. During socialism, private ownership was largely discouraged because it signified alienation from "social ownership" and compromised the principals of self-managing socialism (see the next section). When the planned economy collapsed, the population inherited slacked entrepreneurship capital (Audretsch 2007, 2018) and lacked entrepreneurial experience, skills, and institutions (Estrin and Mickiewicz 2011), which made the transition a nightmare (Ignatov 2017).

While the practice of university technological transfer largely relied on the legacy, practice, and scientific technological resources of ex-Yugoslavia, the development of entrepreneurship was rather uncharted territory. With no historical foundation, entrepreneurship has been developing according to two different plans. The first plan involved a new type of "political entrepreneurship" (Kshetri 2009) driven by tycoons' non-transparent privatization of state enterprises, which led to today's crony capitalism (Franičević and Bićanić 2007). Crony capitalism has had a disastrous impact on innovation dynamism and pro-innovation culture as it is considered to be a speculative (often criminal) form of entrepreneurship which displaces productive and innovation-based businesses. Innovation has lost its plausibility, social value and, economical effectiveness (Švarc 2017).

The second plan was developed quite separately from the privatization process and included the development of new small and medium-sized enterprises (SMEs). This new sector was encouraged by public policies, strategies, laws, and regulations, and through the state supporting programs where integration with the European Union played a key role. The process started with the adoption of the European Charter for Small Enterprises in 2003, which recommended ten key policy areas of action to support SMEs. The implementation of this was subjected to regular monitoring and evaluations (Švarc 2014). Owing to the Europeanization of entrepreneurship policy, Croatia put in place the basic legal and regulatory frameworks for SMEs rather quickly. The government started the nationwide "Business impulse" program to develop business capacities and support primarily traditional types of businesses. However, the technological and innovation capacities of the firms were rather neglected (mainly limited in terms of their acquisition of the new equipment) and involved quite limited relationships with universities as a source of business competitiveness. Therefore, neither crony or "political" entrepreneurship nor the new SMEs sector nurtured entrepreneurial innovation. University technology transfer has developed along its own path, which is presented in the next sections with reference to entrepreneurship innovation where appropriate.

11.3 University Technology Transfer in Socialism and the Position of Croatia in ex-Yugoslavia

There is a vast amount of literature concerning the rise and fall of eastern socialistic economies, including Croatia and ex-Yugoslavia (Bartllet 2003; Dyker 2011; Dyker and Vejvoda 2014), as well as numerous case studies on particular countries' transitions of research and innovation systems following socialism, which are well summarized in Meske (Meske 2000a, b) and Dyker and Radošević (1999). It is commonly perceived that industries in Croatia within ex-Yugoslavia have grown very quickly following the Second World War, when large industrial corporations were extended or founded, such as Podravka (food), Pliva (pharmacy), Rade Končar (electrical equipment), RIZ (electronics), Nikola Tesla (telecommunications), and Đuro Đaković (machinery), to mention only a few. In some technological sectors, ex-Yugoslavia has kept pace with developed western countries, and even exported technical services to Arab countries (Radosević 1994). Croatia was one of the six republics of Yugoslavia and, with the exception of Slovenia, was the most developed republic, boasting a relatively strong industrial base. According to some estimations (Stipetić 2012), Croatia had its greatest GDP growth between 1950 and 1973 and, at the end of this period, even surpassed countries within Central Europe, such as Hungary and Poland, and was only eclipsed by Czechoslovakia and Slovenia.

Most large corporations had in-house research institutes, which cooperated with different faculties and with the largest Croatian institute for natural sciences—Institute Ruđer Bošković—which was established in the 1950s for nuclear research. However, the knowledge-orientated basis for the development of proprietary technologies was insufficient, and thus the import of foreign technologies was the basis of technological development. The type of imported technology depended on the technological maturity of the sector and varied from low technological loan jobs in the textile industry, to various license contracts, consultations, and know-how, to the acquisition of complete "turn-key" services.

Nevertheless, it is important to stress the specific role that science plays in ideology and in the politics of socialistic economies, including those within Croatia. It is considered to be an important condition for economic development and is the main element of historical competition with the West (Meske 2000a). Science thus receives a lot of support from the government, including in-house industrial institutes, which sometimes result in the over-extension of research staff. When it comes to science-industry cooperation and knowledge transfer, it is commonly agreed that the East and West have developed according to radically different logics (Hanson and Pavitt 1987; Högselius 2003). The main difference between the East and West is that innovation in the East was not spontaneously driven by the interest of stakeholders, but was centrally coordinated by the state, limiting the mutual co-evolution of industry and science in creating technical change. This substantial difference is a logical consequence of the political economy of socialism and capitalism, as a socialistic economy is based on the central planning of economy and state paternalism (the paternalistic relationship between the state and the firm) rather than market competition and private initiatives. This considerably reduced the willingness of companies and research institutes to respond to market incentives through innovation and marketable research. The central planning of innovation resulted in the fragmentation of the innovation system, which prevented the integration of R&D and production and inter-organizational learning.

Another essential fault of technological policy in socialism was the supposedly linear model of innovation (in which innovation takes place in consecutive phases from research to invention and innovation) or the science-push approach, which established science as the primary instigator of innovation and technological change. It is often forgotten that the science-based model of innovation was not only a dominant theoretical model in the West, in the period from the Second World War to the 1970s, but was also practiced by companies (Balconi et al. 2010, p. 3). The remaining shortcomings include the absence of small firms or "specialized suppliers", very few technological trajectories, and a lack of appropriate selection environments (Hanson and Pavitt 1987); as well as imbalances between production capacities and absorptive capacities, technological obsolescence of equipment, imbalances in the production chain, and others (Radosević 1994).

Although Croatia shared the majority of these shortcomings with other countries of the Soviet bloc, its system of innovation had certain advantages compared to the Soviet system. Croatia, as a part of ex-Yugoslavia, developed a network of relatively strong mission oriented public and industrial research institutes, this was a stark contrast to the Soviet model, in which the Academy of Sciences was a superior scientific institution and the main producer of basic research. Besides. Yugoslavia developed specific workers' self-managing socialism and, within it, a specific institutional set-up for science-industry cooperation— "the self-managing interest communities for science"—whose purpose was to lead science policy from a republic level, and mediate the "labor exchange" between suppliers (research organizations) and recipients of science (industry). In this way, research organizations in Croatia were funded from the state and from the production sector in two ways: via the "direct exchange of work" (direct contract with industry), or via "indirect exchange of work" mediated by the self-managed interest communities for science. Regardless of the efficiency of this funding, this shows that the government of ex-Yugoslavia has been aware, since the 1970s, of the importance of supporting the "links between knowledge and economic development" (IDIS 1980, p. 12), and has sought to encourage the "exchange of work" between research and industry. According to some estimations (Pisk 2001), "Institute Rudjer Boskovic" in 1989 accounted for 40% of its funds from the production sector, including the army, but these funds were reduced in 1999 to only 13%. As we shall illustrate, such levels of science/industry cooperation would not be achieved in later periods, even up to the present.

11.4 Methodology

A longitudinal case study approach is used in this research to analyze the evolution of university technology transfer and its relation to entrepreneurial innovation over the last 30 years, during the transition from socialism to capitalism. It offers a discussion of the evolution of the UTT and entrepreneurial innovation from socialism to the current Europeanization of the technology transfer policies, through the historical overview of the three phases of UTT evolution, exemplified by Croatia. The research includes the analysis of a number of strategic documents, laws, programs, regulations, and reports on scientific and innovation policies in Croatia, from the mid-1990s to the most recent S3 strategy, supported by statistical data (e.g. Eurostat) and other relevant data from international resources (e.g. GEM, Doing Business Indictors) to capture main actors, funding trends, and policies regarding technology transfer and innovation challenges. This approach provides a theoretical insight and a critical reflection concerning the meaning of technology transfer and entrepreneurial innovation in different socio-economic contexts over time. Important resources include the country reports of OECD, World Bank, and the European Union (such as Erawatch/RIO reports) since their commencement in 2006,[2] as well as the recent HEInnovate background report carried out in 2018 by Dabić for the OECD/EC.

11.5 Results

11.5.1 First Phase of Transition: Policy Learning and Establishing Initial Infrastructures

Croatia became an independent state of ex-Yugoslavia in 1991, at which point it begun its journey towards a modern capitalist economy. During the first turbulent decade of its independence, Croatia laid the foundations for new state institutions, exchanged its single-party system for parliamentary democracy, created its own new currency, repaired large-scale homeland war damages, and initiated reforms for its transition to a market economy.

The Croatian R&D sector has undergone, like all post-socialist countries, a similar process of restructuring, ranging from "shock without therapy" (Radosević 1996) to a gradual restructuring of research infrastructures and the organization of

[2] Further details, visit https://rio.jrc.ec.europa.eu/en/country-analysis/Croatia/country-report

science activities. The science base in Croatia, in terms of both human/resource capacities and investment in R&D, has shrank significantly (Prpić 2003) but the old socialist elitist approach to science, along with the linear model of innovation, helped to preserve the national knowledge base of public R&D during this turbulent transition period while the national economy was brought to ruin. In contrast, industrial R&D has undergone serious deterioration, corresponding with low-levels of absorption capacity in firms in terms of research and technology transfer. In line with the tremendous loss of industrial production during the 1990s, mainly due to the breakdown of export markets during the process of the privatization of state-owned companies, many leading technological companies (with 50 years of accumulated knowledge and technological competences) collapsed or were absorbed by foreign companies. These losses in industrial production in sectors with higher levels of technology content can be considered as one of the most severe transformations, with devastating consequences on technological development and transfer. Supply and demand for R&D and technological development either vanished or was greatly reduced. This process is perceived by sociologists as the "empty-shell model" of privatization (Županov 2001), which denotes the extraction of the company's substance by tycoons and corrupt managers, usually culminating in the devastation of a company's fixed assets and technological competences.

Similar devastation processes were also present in other post-socialist countries (Poland, Hungary, Slovenia, etc.) but these were mitigated by the countries' membership in the EU and through their integration into the European techno-economic networks. Unlike these countries, Croatia was disabled by this process due to homeland war and the subsequent isolation of the European integration process until 2013. R&D and innovation were not the focus of the governmental agenda, as it was expected that innovation and technology development would be generated spontaneously as the result of companies' privatization, macroeconomic stabilization, and trade liberalization (the holy trinity of transition). The fact that technology transfer was not an automatic and spontaneous process, which would follow from foreign direct investments and market liberalization, was overlooked. Instead, endogenous research and technological capacities, together with private initiative and entrepreneurial activities (which were suppressed during socialism) were needed.

Policies concerning the theory and practice of innovation and knowledge-based growth became a significant objective for policy-makers in the early 1990s (Mytelka and Smith 2002), and Croatia was no exception to this, particularly with regard to the evolutionary theory of technological change (Nelson and Winter 1982) and the concept of the national system of innovation (Freeman 1988). Both of these concepts perceive innovation as a phenomenon endogenous to society and economy, a social construct (OECD 1992) which requires an appropriate institutional support and deliberate policy actions to facilitate the smooth flow of knowledge between different sectors, primarily industries and universities. The most attractive of these was the concept for an innovation system in which the competitiveness of a nation does not depend on the scale of R&D, but rather "[…] upon the way in which the available resources are managed and organized" (OECD 1992:80). It provides a hope that even a small country with limited resources, like Croatia, could make rapid progress and technologically leapfrog. South Korea, Ireland, and Finland serve as examples of this.

The learning of policies and the beginning of the Croatian innovation system can be traced back to the mid-1990s, when the Ministry of Science and Technology (today Ministry of Science and Education) made efforts to transfer advanced "Western" models of science/industry cooperation and financial support to innovative small and medium-sized enterprises. Technical assistance projects with Germany and Italy provided necessary expert knowledge for the modernization of Croatia's technological policies and technology transfer (Lange and Švarc 1994).[3] This first phase of launching the Croatian innovation system, which lasted until 2000, was focused mainly on technological infrastructures and resulted in the establishment of the first technology innovation centers in three university cities, Zagreb, Split, and Rijeka, closely followed by Osijek and Dubrovnik. These centers are still in function but now operate on more commercial principles.

Importantly, cooperation with Italy resulted in the establishment of the Business Innovation Centre of Croatia (BICRO), the pillar institution of the whole innovation system, with a mission to create financial models and instruments to support innovative or research based entrepreneurship and allow for possible evolution into the national development agency (like, for example, the IDA in Ireland). This has, unfortunately, never happened. BICRO passed many organizational and structural transformations, however it ceased to be in 2014 when it was merged with the Croatian Agency for Small Business, Innovation, and Investment (HAMAG). This large agency had little over a hundred employees, whose main task was to implement programs funded by the ESIF within the cohesion policy of the EU.

HAMAG-BICRO also provided support to Technology Transfer Offices in Croatia (TTO programs). The programs was focused on strengthening the role of TTOs in universities and public research institutions, as these represent central locations for encouraging and conducting technology transfer activities. The programs was funded from the budget for STP II, which was funded by the WB loan. Currently there are five TTOs in Croatia, all with the main objective of providing support to researchers in public science organizations in every phase of technology implementation, including the identification of ideas, market potential, the processes of protection and commercialization of IP, and the establishment of spin-off/spin-out companies.

[3] The projects were made within bilateral cooperation of the Ministry and the German Federal Ministry of Research, Science, Education and Technology using the expertise of FhG-ISI, Karlsruhe and VDI/VDE-IT, Berlin and with the Business Innovation Centre Friuli -Venezia Giulia, Trieste

11.5.2 Second Phase: The "Golden Age" of the Innovation-Driven Mode of UTT

The second phase of establishing the Croatian innovation system was marked by the launch of a programs called HITRA in 2001 (MoST 2002). This was the first nationwide government programs in innovation policy-making. It was a reflection of the desire of the new left-oriented government, who won power in the 2000 elections, to give momentum to innovation and technology development. HITRA was "a sort of diversion among the elitist-type oriented scientist while, for entrepreneurs, it was just a new trendy initiative of public administration with no significance for the real business" (Švarc 2011, p. 145). HITRA treats the national innovation system as a complex dynamic structure, wherein a system's efficiency can be anticipated by its three constitutive parts: policy measures and programs; technological institutional infrastructure; and control mechanisms for monitoring system performance. The first HITRA programs included the development of commercially promising products and services from research organizations, prior to their commercial stage, and a programs for the development of knowledge-based companies, aimed at both entrepreneurs and scientists. These programs were subsequently upgraded and extended by a number of other innovation supporting programs, of which the Proof of Concept (PoC), introduced in 2010 with the aim of programs pre-commercial capital for the technical and commercial testing of innovation concepts, was the most successful.

Public administration designed HITRA rather ambitiously, tasking it with motivating scientific research to foster science-industry cooperation, reviving industrial R&D, and encouraging the commercialization of research results in order to support competition within the economy (Švarc 2011). This phase of UTT development can therefore be treated as innovation-driven technological policy—at least, when "good intentions" are considered. However, the reality of HITRA's programs in practice presented many obstacles which prevented this innovation-based model of UTT from achieving its full potential. First of all, HITRA was faced rather early on with a lack of "systemic" innovation policy (Kuhlmann 2001). Many projects are obstructed by the deficiencies of the remaining parts of the innovation system, which are beyond the sphere of research and beyond the scope of HITRA itself; for example the lack of a sound policy concerning intellectual property protection, lack of venture and risk capital, absorption capacities of companies, etc. The Croatian government has not undertaken sufficient efforts to promote innovation policy at a national level, nor coordinated and harmonized the different ministries' efforts towards technological development. Nonetheless, the "division of work" and competences between the line ministry of science and the economy have persisted. The fact that technology transfer processes imply that functional, organizational, disciplinary, or national and cultural boundaries need to be spanned was overlooked.

On the other hand, the mind-set of leading politicians and intellectuals did not change much in terms of understanding innovation as an interactive process, embedded primarily in firms. However, the linear process, which has been the dominant approach since the 1970s, persisted as they failed to understand that technology transfer is based on a multichannel interactive model which does not necessarily involve R&D, and that innovation is primarily linked to firm-based learning and knowledge acquisition in the production process (engineering, testing, marketing, organization), while explicit R&D and links to research institutions is only a small part of these activities, if any (OECD 1998). Innovation systems and policies have thus developed within the wide framework of science policy, and yet have only occupied a peripheral position due to the strong resistance of the scientific community towards the "commodification of science", and their efforts to preserve the traditional role of science as an "ivory tower". The majority of scientists have resisted change, particularly with regards to scientific commercialization rather than to scientific ethos and principles. Studies of science-industry cooperation in Croatia have revealed rather weak connections between these sectors (Vehovec and Radas 2006; Radas 2006; Jelеč Raguž and Mujić Mehičić 2017) as well as weak entrepreneurialism in Croatian universities (Dabić et al. 2016). The elitist approach to science and the focus of industrial policies on privatization and FDI, which ignored engineering, applied sciences, and technologies, has hampered the recognition of innovation and technological transfer as the driving force of economic growth. For these reasons, HITRA remained fragmented initially, unable to spur knowledge-based growth as its main task. By 2013, when the government initiated major reforms of the research and science development (R&SD) system, all HITRA programs were terminated or substituted with ESIF programs. Despite its termination, HITRA had an irreversible influence on the management of research projects, and brought socio-cultural changes with it, enabling a shift from conventional science policies towards policies that promoted entrepreneurial spirit and knowledge transfer activities in the academic community.

This second phase of innovation policy, which lasted from 2001 to 2010, despite deficiencies, marks the "golden age" of the innovation system. During this decade, the national innovation system (NIS) had become a relatively complex system of supporting programs, infrastructures, and policy documents for improving innovation dynamics and technology transfer (Švarc 2011). New institutions, such as the Croatian Institute for Technology which develops technology forecasts and strategies, and the Technological Council of the Ministry of Science and Education which provides grants for applied research and technological projects, were established by the mid-2000s. New funds to support knowledge and technology transfer were founded in the period between 2005 and 2009, such as "the Unity Through Knowledge Fund (UKF)", "the Science and Innovation Investment Fund", and "the Partnership programs for the science/industry cooperation of the Croatian Science Foundation". The landscape of interface institutions for technology transfer and innovation development was significantly extended in the coming years, with new centers for technology transfer emerging at universities, as well as technology and innovation centers and parks supported by local communities. Thanks to the EU Instrument for Pre-Accession Assistance (IPA), activated in Croatia in 2007, the large infrastructure—the Biosciences technology commercialization and incubation center (BIOCentre)—was supported with over €18 million, and the Centre began operation in September 2015. The first (and, to this day, only) Science and Technology park at a university was established by the University of Rijeka (StepRi)[4] in 2008, with the support of the then BICRO's programs for technological infrastructure development (TEHCRO). The Science Park and the engagement of the University of Rijeka with the local economy made this university almost the ideal entrepreneurial university: striving to implement a triple helix model of the industry-science-government relationship in practice. Seeking to increase entrepreneurship in the Faculties of Economics and Business in Zagreb, Faculty of Economics and Tourism "Dr. Mijo Mirković" in Pula and Faculty of Economic in Split, Croatia jointly with partners form Austria, Poland, France, Israel, Slovenia and Lithuania implemented project "Fostering Entrepreneurship in Higher Education" (FoSentHE), which was granted by the European Commission. The FoSentHE project was dedicated to the promotion of entrepreneurship amongst students and to the generation of interest in scientific commercialization (Dabić et al. 2012).

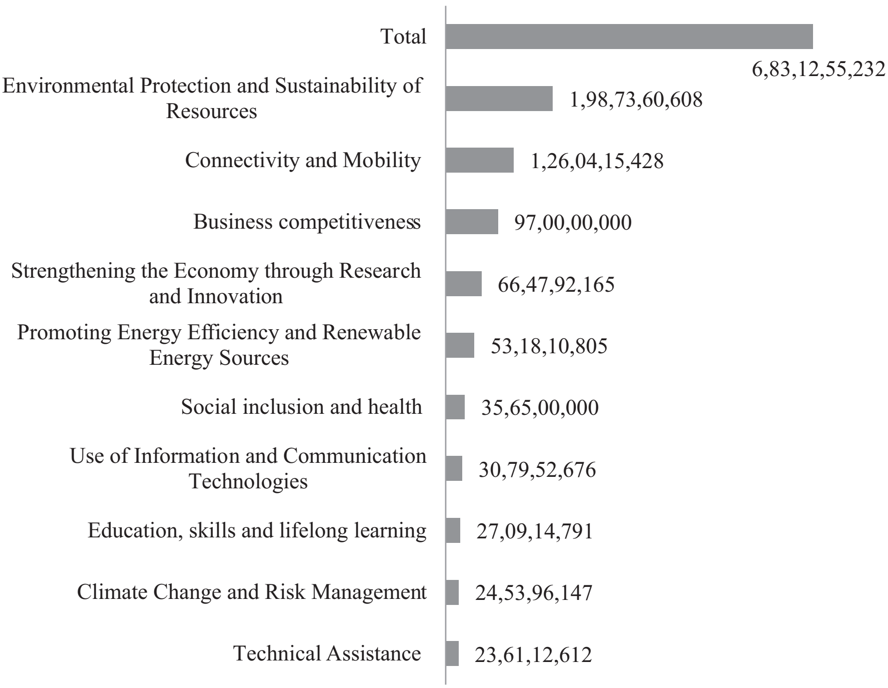
11.5.3 Present State: Europeanization of Technology Transfer and Entrepreneurship Policies

From 2010 onwards, the innovation system landscape was gradually reshuffled and, by 2013, almost all institutions and programs launched during the "golden age" were terminated or transformed. The Ministry of Economy took over programs for technology transfer in place of the Ministry of Science and Technology, marking a new era in innovation policy and UTT, which were traditionally under the auspices of the Ministry of Science and Education. In 2013, the government initiated major reforms of the R&SD system with regards to funding, organizing, and evaluating scientific work to improve scientific excellence. The reform marked the end of Croatia's innovation system, which had been building since the mid-1990s from a grounding focus on research activities and the supply-side of the innovation process. As a result of the budget austerity policy, the reform included serious cut-offs of the funds for scientific projects between 2013 and 2016. The reforms coincided with Croatia's entry into the EU in July 2013, which granted access to the European Structural and Investment Funds (ESIF) and allowed for the adoption of Smart Specialization Strategy (S3) as a pre-conditionality for using ESIF. Policymakers believed ESIF would serve to substitute a large portion of the scarce budget resources. Innovation policy and technological transfer in Croatia has become, like in other EU countries, largely determined by the common European strategy of research and innovation (Dabić et al. 2015a, b). ESIF, as a critical source of funds for R&D in Croatia, which significantly surpasses the national funding abilities for research activities, brought not only money but also its scientific policy (research priorities, goals and purpose of research, and financial priorities) as pre-determined

[4] For further details, visit http://www.step.uniri.hr/o-nama

by the S3 (Švarc et al. 2019). It led, as Kuhlmann (2001) expected, to the "post-national" innovation systems striving towards centrally mediated policy-making. S3 has not only made dramatic changes, but has significantly affected both innovation policy previously determined by the National Innovation Strategy, 2014–2020, and science policy, which was defined in the Strategy for Education, Science, and Technology, 2014–2020. S3 was primarily developed as a central mechanism of the new European cohesion policy which should have enabled all EU countries, especially those less developed, to follow their own path of development (Foray et al. 2009). S3 was launched by the European Union as a new approach to economic development, based on the targeted support of R&D activities and innovation. It set the strategic directions for the development of R&D activities in the forthcoming period. The cohesion policy within the S3 is no longer based only on inclusion into the ERA (European Research Area) framework programs, which is featured by the frustratingly low participation of innovation followers and mainly serves the interest of the most developed countries (Bečić and Švarc 2015). Innovation followers are also no longer supposed to impartially copy innovation supporting instruments, which usually achieve weak or negligible success in the recipient country.

S3 preserved the basic idea of science/industry/government cooperation but on different premises which allowed countries to specialize in their own specific sectors, depending on their capabilities. In contrast to previous innovation policies, which followed a centralized top-down approach, the S3 strives to identify research and technology areas for public interventions based on the analysis of the strengths and potential of the local economy through the Entrepreneurial Discovery Process (EDP), which is led by local entrepreneurs. This "strengthening of the strengths" policy focused on entrepreneurs and designed cohesive policies that would encourage regional development and SMEs in technologically peripheral countries in the EU. This has evolved over time into a new industrial and innovation policy for regional development all over the EU (Radošević 2018). The S3 in Croatia is coordinated by the Ministry of Economy, Entrepreneurship, and Crafts (MEEC), who drafted the analytical background for the S3 with the support of an EU cofounded expert team. The Smart Specialization Strategy was adopted by the Croatian government on 30th March 2016. The implementation of S3 in Croatia is funded under the European Regional Development Fund (ERDF) within Operational Programs "Competitiveness and Cohesion 2014–2020" (OPCC) through two priority axis: Priority Axis 1— Strengthening the economy through the application of research and innovation, which will focus on research, technological development, and innovation; and Priority Axis 3—Business Competitiveness, which will provide support for small and medium-sized businesses (SMEs). In parallel, through the ESF-OP Efficient Human Resources (OP EHR), a significant contribution will be provided for S3 implementation in the field of smart skills. It seems that the implementation of S3 has finally pointed UTT in the right direction, after 15 turbulent years of "national" innovation policy, with a modest impact on technology development. The S3 policy marks two important milestones: firstly, the beginning of a new innovation ecosystem with a stronger focus on companies' needs and regional development, complemented by entrepreneurial culture and spirit; and secondly, the scientific community's efforts to embrace cooperation with companies through knowledge and technology transfer, something that was avoided for almost 20 years. It is commonly perceived that the EU Structural and Investment Funds (ESIF), with a fund of €10.68 billion for the period 2014–2020, provided Croatia with the remarkable opportunity to address their needs in research, innovation, and skills. It makes €1.5 billion per year (World Bank 2012), over 3% of GDP on an annual basis, and about ten times as much as it did from 2007 to 2013 (European Commission 2015). Of these funds, €664.79 m is used with the intention of strengthening the economy by applying research and innovation, as determined by the budget of the Operational Program "Competitiveness and Cohesion", 2014–2020. The majority of resources (€4.321b) come from the European Regional Development (ERDF) which seeks to form cohesion policies through balanced regional development. An overview of the ESIF in Croatia between 2014 and 2020 is provided in Fig. 11.1. The ESIF budget for research and innovation significantly outweighs national budgets, allowing S3 to have a significant impact on national R&D and technology transfer policies. In Croatia, the total national budget funds for competitive research projects in basic sciences in the five year period between 2013 and 2017 was around €108 million (Martinović Klarić 2019), compared to ESIF's contribution towards for strengthening the economy through research and innovation,



Source: Authors

Fig. 11.1 ESIF allocation (€) by OPCC 2014–2020. (Source: Authors) which reached around €95 m per year (€664 m in total between the 2014 to 2020 programming period[5]) (see Fig. 11.1).

Table 11.1 shows a provisional public overview of the ERD funds between 2014 and 2020.

Classified under "entrepreneurship, research and innovation" reveals that ERDF programs can be divided in three groups according to their targets: (1) entrepreneurship development; (2) cooperation between research and business sectors (conditionally: university technology transfer); and (3) scientific research and infrastructures. Although this overview is only provisional, it clearly demonstrates that the majority of ERDF resources are geared towards entrepreneurship development and business-supporting institutions (over €550 m), which do not include technology development or technology transfer activities conducted in cooperation with the research sector. Financially, the most generous programs for entrepreneurship aim to: (1). upgrade business development and improve the technological readiness of SMEs through new production capacities, constructions, and business units (SME competence and development); and (2) commercialize innovative products or services that are new to the markets (innovation in S3 areas) (Table 11.1).

The next group of activities funded by the ERDF can be considered technology transfer activities devoted to new products/services and the technological upgrading of companies through cooperation with public research organizations or universities. Following the principles of EDP, the projects' goals and activities are shaped by the interests and needs of companies and strive to tailor technological development according to the capabilities of local firms. Currently, these projects are orientated around three large programs, worth over €100 m each, geared towards the development of new products and services emerging from R&D activities and the Centers of Competence (Table 11.1). Unfortunately, only a segment of the research community can take advantage of these funds: those which have research fields that are close to their industrial application. Researchers in other disciplines (natural, medical, social, etc.) are, for the most part, not eligible for ERDF funding. However, ERDF has earmarked, within the third group of activities, generous resources for the revitalization of public research infrastructures which could not be financed otherwise; for example, from the scarce state budget. This is a crucial contribution that the ESI provides to public science.

The European Union encourages entrepreneurship in Croatia in other ways, too. For example, the Croatian Venture Capital Initiative was established in June 2018 with a €35 million injection from the European Investment Fund (EIF) and has already raised €12.2 million of private-sector funding. In January 2019, the EIF and the Croatian Bank for Reconstruction and Development launched the Croatian growth investment program: a €70 million co-investment program to support fast-growing SMEs (European Commission 2020). ESIF has significantly increased Croatia's state aid for SMES and regional development. However, most programs

[5] Further details, visit: https://strukturnifondovi.hr/en/eu-fondovi/esi-fondovi-2014-2020/op-konkurentnost-i-kohezija/

Table 11.1 A tentative overview of ERDF public calls related entrepreneurship, research, and innovation in Croatia within the OPCC 2014–2020 (data extracted on 26 February 2020)

Content of call	Status	Budget in million €
Entrepreneurship Development		
Development of a Network of Entrepreneurial Supporting Institutions (PPIs) through HAMAG-BICRO - Phase 2	Open mid 2020	6,7
SMEs Internationalization of Business - Phase 2	Open mid 2020	18
Quality signs	Open mid 2020	1
From product certification to market	Open mid 2020	4
Innovation Vouchers for SMEs	Open mid 2020	6,7
Innovation in S3 areas	Closed 2019	85,7
Innovation of newly established SMEs - Phase 2	Closed 2019	20
Promotion of entrepreneurship	Closed 2019	5,1
Improving the competitiveness and efficiency of SMEs through ICT	Closed 2019	7,2
From product certification to market	Closed 2018	5,1
Building and equipping SME production facilities	Closed 2018	27
Internationalization of SME business	Closed 2017	5,1
Entrepreneurship Promotion 2017 to 2019	Closed 2017	5,1
Commercialization of innovation in entrepreneurship	Closed 2017	15
E-impulse	Closed 2016	34
Innovation of newly established SMEs	Closed 2016	8,7
SME Competence and Development	Closed 2017	117
Improving the competitiveness and efficiency of SMEs through ICT (phase 2)	Closed 2018	49
Construction and equipment of SME production capacities	Closed 2018	69
WWW Vouchers for SMEs	Closed 2020	4
Introduction of business process and quality management systems (ISO and similar standards)	Closed 2020	5,1
Entrepreneurial Supporting Institutions (PPIs) (13 projects)		46
Development of entrepreneurship in five cities		9
Total		553,5
Cooperation Between Business Companies And Research Organizations (UTT)		
Development of new products and services resulting from R&D activities (IRI II)	Open by mid-2020	105
Development of new products and services resulting from R&D activities (IRI I)	Closed in 2018	100
Centers of competence	Closed in 2017	105
Total		310
Scientific Research and Infrastructures		

(continued)

Table 11.1 (continued)

Content of call	Status	Budget in million €
Preparation of R&D infrastructures	Closed in 2017	6
Synergies between Horizon 2020, Twinning, and ERA Chairs	Closed in 2018	7
Capacity building for research, development, and innovation	Closed in 2018	25
Croatian Science and Education Cloud	Closed in 2018	26
Centre for Advanced Laser Techniques	Closed in 2017	17
Organizational reform and infrastructure in the public R&D org.	Closed in 2017	102
Research centers of excellence	Closed in 2017	50
Children's center for translational medicine at Srebrnjak hospital	Closed in 2018	58
Total		291

Notes: Interreg programs are not included. Source: https://strukturnifondovi.hr/natjecaji/

lack adequate monitoring and evaluation mechanisms (World Bank 2018) and the evidence of the effectiveness and absorption of these funds is inconclusive. Although the latest reports (European Commission 2020) estimate that funds have been allocated to a specific projects in their entirety, only a small portion (around €2.8b) is spent on the selected projects, revealing that the level of implementation is well below the EU average (European Commission 2020). The Centers of Competences and Centers of Excellence are still in their formative stages, delivering no clear results. On the other hand, it is estimated that ESIF contributes towards the mobilization of important private investments of around €553 million of additional capital in the form of loans, guarantees, and equity, which is 5.6% of all of the decided allocations of the ESIF (European Commission 2020). A review of 150 successful entrepreneurial projects (MEEC 2018), such as Rimac Automobili, Microblink, Olival, etc., illustrate that ESI funds positively influence entrepreneurship and regional economies through investments in new production technologies, new products and services, production capacities, and so on.

There is also another problem when it comes to implementation of S3 as the process of building S3 in Croatia saw the principles of EDP adhered to only in part. The participation of stakeholders, especially those from science and business backgrounds, in the formulation of priorities for the technology transfer from universities to local businesses is rather formal (Mršić 2018). This simply means that organic links between stakeholders in formulating regional technological needs, and the subsequent submission of cooperative projects for ESIF funding based on common interest and importance for the local economy, are harder to find. On the contrary, project activities are mainly driven by the bureaucratic requirements of ESIF operative programs and the "rules of the game" with regards to project submission, evaluation, and funding. Moreover, initiatives for project submissions regularly come from research organizations as companies are more focused on simply surviving and are less interested in knowledge transfer from universities. It is presupposed that "isomorphic mimicry" (Radošević 2018) will occur, in which EDP only imitates the interaction between the business and research community with the aim to "collect the free money".

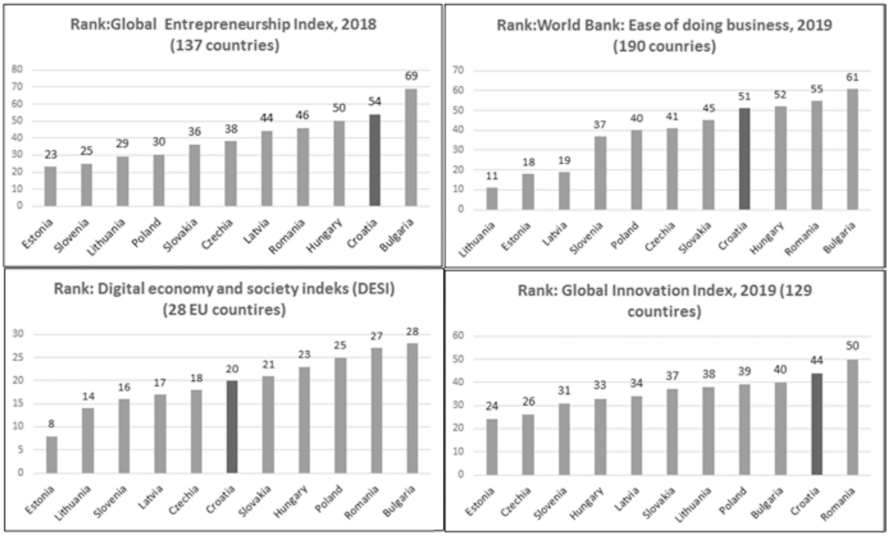
The fundamental question is not whether such imitations will occur, but in what proportion in relation to projects driven by authentic mutual interests. It seems that, at the moment, technology transfer within ESIF operational programs is just another top-down "bureaucratic" incentive (this time coming from the EU and not from the national administration) for science-industry cooperation. The only difference this has in comparison to previous government initiatives is access to larger amounts of ESIF resources, which can support bigger projects which may have greater potential impact on the economy if cooperation is efficient. Besides, low technological capacities of companies and the structure of the industry could yield little convergence with the EU (Bonaccorsi 2016; Muscio et al. 2015; Archibugi and Filippetti 2011). Such sub-optimal use of ESIF has already been seen in Greece (Liargovas et al. 2016), while the effects of EU transfers to Romania and Bulgaria are estimated as ambiguous and limited (Surubaru 2020). These are countries with which Croatia shares many obstacles when using ESIF, such as inefficient administration, corruption, and the declining competitiveness of economy.

Despite these potential threats to the implementation of S3 and the weak partnerships between business, research, and governance institutions, S3 reshuffled dormant innovation systems, policies, and institutional landscapes, increasing interest in certain sectors of business and research for advanced technologies. S3 also provides significant funds for technology transfer activities, innovation, and entrepreneurship when compared to the scarce national resources available. The absorption of funds and the contribution towards growth are expected to be higher in 2020 and 2021 when most projects will reach their maturity.

11.6 Discussion

Despite almost 20 years of practicing innovation policies, many indictors reveal that Croatia has not progressed much in the economy, in technology, or in innovation during the last decade. According to the latest report of the European Commission (2020), Croatia's GDP per capita – relative to the EU average – was still at the same level as it was 10 years earlier. This suggests that Croatia has experienced a lost decade in terms of economic catch-up when compared to the rest of the EU. The position of Croatia, in terms of its international rankings for innovation, business, and competitiveness, is rather low in spite of its investments over the past few years, its efforts in creating more friendly business environments (e.g., lower minimum capital for start-up companies, reducing notary fees, etc.), and its environment for innovation. The performance of Croatian research and innovation systems is considered suboptimal and inferior when compared to the most of its Central and Eastern European peers (CEE: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak, Slovenia) and has been seen to deteriorate in recent years (European Commission 2019; World Bank 2018, p.33). The most common international comparisons, such as the Global Entrepreneurship Report, Ease of doing business, the Digital Economy and Society Index, and the Global Innovation Index (Fig. 11.2), show that the Croatian economy is less competitive than its peers. There is a worrying trend which shows a general “lagging behind” of the countries of the former Soviet Union, which were behind Croatia in the era of socialism. In the last couple of years, Croatia can be seen to lag behind not only Hungary, Poland, the Czech Republic, and Slovenia, which used to be Croatia’s peers, but also behind countries such as Bulgaria and Romania, which have always been behind the rest of Europe. It seems that these countries too will soon leave Croatia behind.

The summary innovation index of the European Innovation Scoreboard 2019 (EIS 2019) places Croatia at the bottom of the group of so-called moderate innovators, ranking 26th out of 28 European countries (only Romania and Bulgaria are behind). This reveals that Croatia has made no progress in improving its innovation performance in the last decade. It performs below the EU average in all innovation dimensions except non-R&D innovation expenditure by firms, companies with marketing/organizational innovation, and companies that provide ICT training (EIS 2019). It is worth mentioning that a rich landscape of over 350 business-supporting institutions (e.g. business incubations, entrepreneurial zones, etc.), complemented

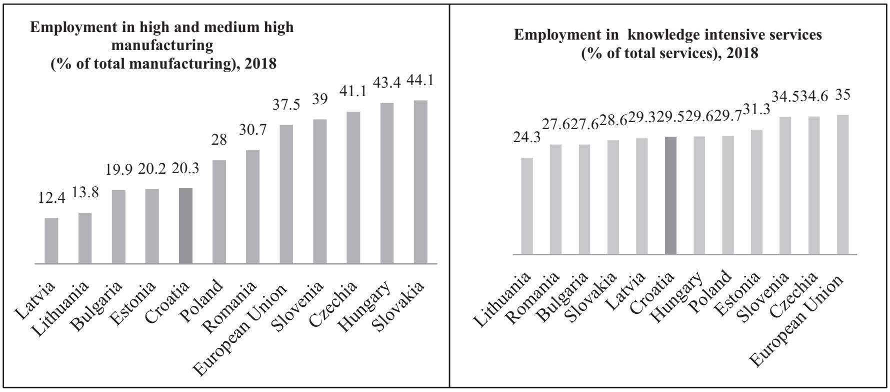


Source: Authors

Fig. 11.2 Rank of croatia among CEEC by the select international composite indicators. (Source: Authors) by a number of supporting programs intended to increase the innovation capacities of SMEs, turned out to be of modest efficiency. According to the latest GEM report (Singer et al. 2018), Croatian companies mainly invested in technological infrastructure (e.g. machinery), while new product investments were scarce: 72% of newly established companies and 83% of "old" companies did not produce "new to the market products" in 2017. This means that Croatian companies belong to the "red ocean", in which competitors fight for dominance in the markets of known products, as opposed to the "blue ocean", where demand is created by new products. This pattern of entrepreneurial activity (technological readiness without new products), when combined with the lowest motivational index (opportunity-based business) among the European countries, proves to be a significant factor when it comes to low business and innovation competitiveness.

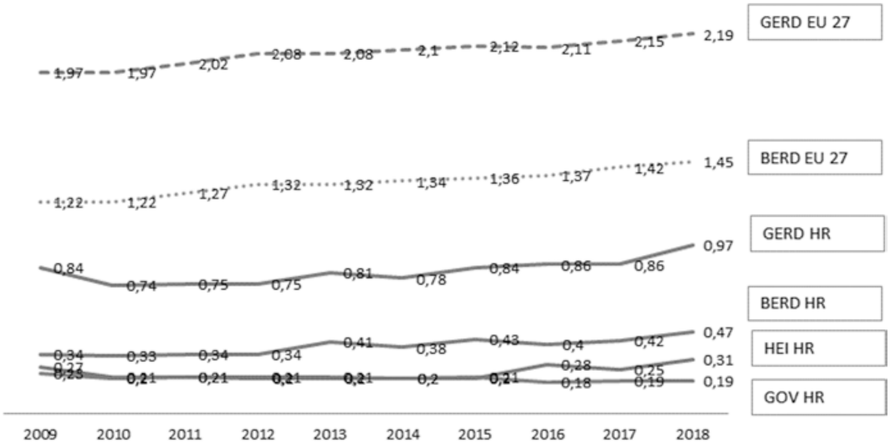
Low investment in R&D is a result of the structure of the economy, which has remained relatively unchanged over the last 15 years, with no shift towards more knowledge-intensive sectors (EC, 2018b, p. 275). Croatia is lagging in terms of its development of medium and high manufacturing and its knowledge-intensive services in comparison to its CEEC peers (Fig. 11.3). A high promotion of tourism and trade is averse to investments in R&D, innovation, and the stronger integration of Croatian companies in global value chains. Croatian expenditures on R&D are stagnant and low (below 1% of GDP), showing signs of recovery only in 2018, when it reached 0.97% of GDP (49% from private resources and 51% from public resources) (Fig. 11.4), but this is still insufficient in reaching Croatia's national 2020 R&D target of 1.4 of GDP. Per capita investment in research achieved only 18% of the EU-27 average (€661.5 vs. €122.2 per inhabitant) (Fig. 11.4) R&D expenditures by sectors of performance, 2009–2018.

This increase in funding is usually attributed to ESIF, but data shows that the public research sector (government and higher education institutions) did not significantly increase funding from ESIF between 2016 and 2018, when the more



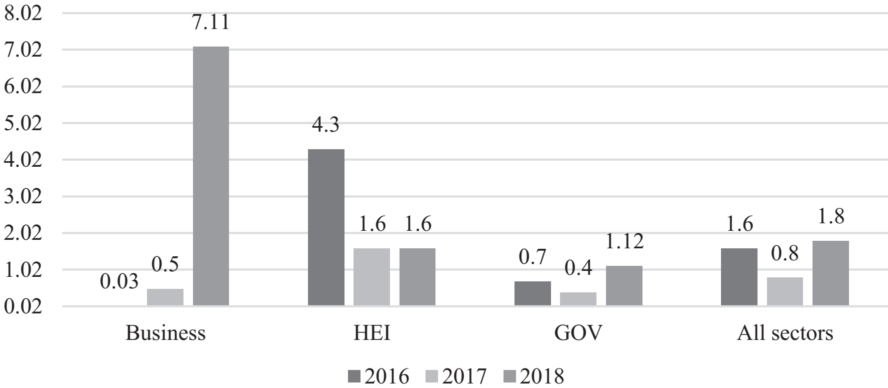
Source: Authors

Fig. 11.3 Employment in medium-high tech manufacturing and knowledge intensive services % of total manufacturing (service), 2018. (Source: Authors)



Source: Authors

Fig. 11.4 Employment in medium-high tech manufacturing and knowledge intensive services % of total manufacturing (service), 2018. (Source: Authors)



Source: Authors

Fig. 11.5 Share of ESIF in total funds for R&D, 2016–2018, by sectors. (Source: Authors)

intensive implementation of ESIF begins. Significant increases were recorded only by companies that increased ESIF funding from €47 thousand to over €five million (CBS 2019) (Fig. 11.5). It is reasonable to assume that the funds have come from the science-industry (technology transfer) programs (Table 11.1). At 0.47% of GDP in 2018, business R&D expenditure is among the lowest in the EU and reaches around one third of the EU average of 1.45% of GDP (Fig. 11.4). In 2017, a few large firms invested over 53% of the total funds (e.g. telecommunication, pharmaceutical, and food industry), medium-sized companies with up to 250 employees accounted for around 40% (e.g. chemical, metal, electrical products, motor vehicles, computer programming), and small companies invested only 7% of their total business expenditures on R&D (CBS 2019, p. 20).

Table 11.2 Key Data on Human Resources, 2013–2018

	Croatia 2013	Croatia 2018	EU27 2018[a]
HRST - human resources in science and technology (% of active population)	13.8	17.6	29.7
Persons with tertiary education aged 25–34 (% of active population	29.6	37.5	40.9
Scientists and engineers (% of active population)	1.0	1.4	4.0
Researchers (FTE)	6529	7985	–
Researchers (FTE) (% of active population)	0.36	0.45	0.85
Students	164,623	165,197	–
Graduates % per 1000 population aged 20–29	56.2	57.8	71.2
Doctoral graduates per 1000 population aged 25–34	0,8	0,6	1.3

Source: Authors
[a]EU27 countries since 2020

Croatia performs significantly below the EU average in human resources, particularly in terms of its number of researchers, human resources in science and technology (HRST), and scientists and engineers (Table 11.2). Since 2013, the number of students has been seen to stagnate at around 165 thousand, while the number of researchers (FTE) has been oscillating between 6500 and 7500 for a decade. Researchers in the business sector are at low levels, accounting for around 20% of the total number of researchers. It is particularly worrying that the number of doctorates awarded has been decreasing since 2013, when doctoral studies were reformed and funding was transferred from the Ministry of Science and technology (MSE) to the Croatian Science Foundation (CSF).

Skill shortages, low R&D investment, rigidities in the business environment, and weaknesses in public administration are the key drivers of Croatia's productivity gap (World Bank 2018). This suggests that Croatian innovation policies have not been efficient in spurring on the economic development and competences of entrepreneurs. The Croatian innovation system is widely perceived to be inefficient, characterized by fragmentation, subscale investments, and poorly defined policies (European Commission 2015). The development of the Croatian innovation system, from its foundation in 2001 up until today, clearly shows that, in countries with economies of low technological capacity, UTT is challenged by the lack of business partners and the low absorption capacities when it comes to companies' research-driven innovation (Dabić et al. 2016). Technology transfer polices and policies for fostering entrepreneurship have followed a different evolutionary path, both from an institutional and conceptual point of view. Entrepreneurship has developed, as described in Sect. 11.2 according to two plans (tycoon privatization and creation of traditional SME sector), which both followed their internal development logic and dynamics and largely ignored entrepreneurial innovation and new technologies. On the other hand, technology transfer has manly focused on the capitalization of science and research-based innovation, not taking into account the real needs of entrepreneurs. An attempt to merge these sectors into a single process took place rather recently through the Europeanization of research and technology transfer policy, determined by the concept of S3 and implemented through the bureaucratic rules and requirements of the ESIF Operational programs.

Liberalization of economy, market competition, privatization of companies, EU membership, and other benefits resulting from the collapse of socialism have not brought with them the expected socio-economic progress anticipated in the first enthusiastic decade of the transition to capitalism. The reasons behind this sluggish economic development, in which technological transfer was largely absent, are still the subject of bitter disputes. Economists mainly blame the wrong (neoliberal) growth model, based on financialization and excessive sovietization of the economy (Radošević 2013), as well as classic obstructive elements, such as lack of managerial and strategic competences and entrepreneurial skills, strong national currency, or enormous bureaucracy and red tape. An important element is the large share of tourism in the economy (the indirect contribution of tourism to GDP was estimated to reach over 25% in 2017 (World Bank 2018), which is based on rents and creates an economic culture in which technological entrepreneurship and innovation play no role. Another reason for locking into the low and medium technological growth model is the strong role of the state–owned companies in national economy which contribute a fifth of total turnover and possess a third of total assets (World Bank 2018). Such companies (around 74) and hundreds of others which are under the state shield, management or interest are lacking genuine incentives for competition through innovation and research.

Sociologists believe that inherited cultural factors, such as egalitarianism (Vuković et al. 2017), and socio-political trajectories known as the state of semi-modernism. Processes of de-industrialization, re-traditionalization, de-scientization, and irrational administration (Županov 2001) have resulted in the cognitive, social, and political inability of political elites to accept global transformations as necessary for global innovation- driven growth (Švarc 2006, 2017). Industrial and technological policies have largely been associated with the mere transition to market economy and the privatization of companies, while technological developments have not been taken into account (Švarc 2017). Finally, political economists are more prone to finding obstacles in incorrect political systems, such as the "dependent market capitalism" (Nölke and Vliegenthart 2009) of the less developed countries in the European periphery. In Croatia, this specific type of crony capitalism was established during the first decade of transition. The characteristics of crony capitalism were described in a seminal article by Franičević and Bićanić (2007) and were extended by younger authors such as Čepo (2020), Šimić-Banović (2018), and Mačkić (2019). Crony capitalism essentially consists of systemic corruption and clientelism, which permeate all segments of economy and society, and divert companies' focus from innovation and export-oriented businesses towards political protection and support from interest groups to help sustain their business and their own prosperity.

11.7 Conclusions

11.7.1 Implications

The implications of the given analysis are rather straightforward. Croatia urgently needs to recover its economy and to accelerate its integration with the EU. The entrepreneurial innovation and UTT are essential components of this process but are not sufficient and self-sustained. They are currently well supported within the framework of S3 and ESIF funds and both sides (scientific community and entrepreneurs) should take advantage of this European support and assistance. Seeking to increase the proper use of funds, the policy- maker should understand how the system of cooperation operates and how it functions in practice to avoid bureaucratic implementation of the ESIF programs and administrative allocation of the funds. The organic interest among stakeholders should be found and exchanged for formal implementation of the programs involving only administrative "business as usual" procedures (calls, evaluation, funding). In this line, more effort is needed from the local, regional, and national authorities to coordinate the entrepreneurial discovery process and to spur entrepreneurial innovation. More coordination is required in order to identify and implement ambitious joint projects and the strategic entrepreneurial innovation of broader economic interests or grand challenges. The inclusion of Croatia in the global value chains is wholly neglected in the innovation policies; however, other countries, such as those of Visegrad (Slovakia, Poland Hungary, Czech Republic), based their success precisely on their inclusion in the global value chains (GVC) (Grodzicki 2014). Research into the policy mix for technology and innovation upgrades through the variety of forms for GVC could be a fruitful future policy orientation (Kergroach 2018).

The benchmark analyses of the Croatian economy provide clear evidence that supporting programs, either for science/industry cooperation or for the business competitiveness of traditional SME, have not delivered the desired economic growth. Therefore, it is necessary to look beyond European programs to diagnose the roots of slow growth. Many analyses, including this one, point out that economic recovery requires complex socio-economic transformations, which have been slowed down in Croatia by the lack of action taken towards "economic hygiene", or "getting the fundamentals right" (OECD 2001). The research implies that fundamentals, such as well-functioning markets, institutions, governance, and favorable macroeconomic conditions, as described in the World Bank report (2013) and European semester (European Commission 2015), should be established to raise Croatian competitiveness from last place in the EU.

The next policy actions involve fostering entrepreneurs, technology development, innovation, and scientific research, which is needed to re-affirm Croatia on international competitiveness and business scales. Because of the low technological capacities of firms, it would be useful to consider the unorthodox idea of the division of labor between public research and private businesses (Dosi et al. 2006) to allow both spheres to develop through their inherent logic and dynamics. The mastery of productive entrepreneurship, and its ability to create demand for R&D (Radošević 2006) and the entrepreneurship abilities of the population in general, should be strengthened on the entrepreneurial pole" of the process. The prerequisite is the completion of the privatization process of the state companies, as well as intensive efforts against crony capitalism as a phenomenon adverse to entrepreneurial innovation and technology development. On the "science pole," it is necessary to assure the sustainability of the scientific research system and the national knowledge base, which is a distinct process not crucially related to entrepreneurship (Švarc et al. 2020). The concepts of entrepreneurial economy and the national entrepreneurial system point out that entrepreneurship and science can develop separately. Entrepreneurial innovation does not necessarily involve R&D, while academics should be required to develop their "islands of excellence," cutting-edge research, and technological frontiers to fulfil their social and economic role, which is a prerequisite for developing research-based entrepreneurial innovation.

UTT fills a structural void in terms of its lack of advanced technologies and is therefore an important but non-crucial part of the innovation system. Given that science-based technology development is often unpredictable and can produce unexpected commercial effects, these activities can give rise to new industries and therefore deserve full public support, as carried out under S3. Bio-medical research and robotization are examples of such prospective areas. Given the low investment in R&D, the low technology levels of companies, and the focus on tourism, another unorthodox idea worth considering would be to substitute the lack of R&D with a new sector of ICT companies. With a revenue growth of 4% and an employment rate of 8.5% per year, the ICT sector is one of the fastest growing in Croatia. It has created an income of around €4.2 billion and 1300 new jobs and has become one of the 12 largest export branches (Eurofast 2017). ICT companies operate with foreign capital and work in global markets, changing the landscape of traditional businesses that share weak and non-transparent state-based business models. In contrast to industrial innovation, which requires large R&D infrastructures and heavy investments, the ICT sector "democratizes innovation" as it is mainly based on software development, which drastically reduces entry barriers and learning costs for new companies (Paunov and Planes-Satorra 2019). As such, it should be considered as an alternative to hard-to-reach high technologies.

11.7.2 Limitations and Future Research

This research analyses the evolution path of the UTT in post-socialist countries, using Croatia as an example of this, with the aim of establishing whether or not the transition to capitalism and membership in the EU has enhanced UTT practices and related entrepreneurial innovation, and whether academic knowledge and research has filtered down to cultivate valuable economic activities and marketable innovation under these new circumstances. The main contribution of the research is the identification of three models of UTT in transition countries using the longitudinal case study of Croatia: the science based model, which was practiced in socialism; endeavors towards an innovation based model during the transition period; and a bureaucratic UTT model, driven by the EU cohesion policy and access to the European Structural Funds. Insights into the evolution of these models suggests the following three relevant conclusions.

Firstly, the sluggish economic growth and technological stagnancy of the country suggest that there is no substantial difference in the efficiency of the different UTT models, which were in operation in different socio-political regimes. The proficiency of UTT was not improved during the switch from socialism to capitalism, nor through Croatia's membership in the EU, and is thus shown to have little influence on entrepreneurial innovation. UTT continues to suffer from almost the same shortcomings nowadays as it did in the era of socialism and in its transitional period. Fragmentation of the innovation system, poor connections between science and business sectors, low technology and innovation capacities of companies, low business investments in R&D, technological obsolescence of equipment, narrow technological trajectories, and the low interest of companies in innovation and cooperation within research sectors have all largely remained the same. Secondly, the suppression of innovativeness, entrepreneurship, and competition, which would otherwise stimulate UTT, is still strongly present, although it is based on different premises—primarily on the wrong growth model and crony capitalism. Sources of growth throughout a significant part of the transition were based on domestic consumption, defensive inter-sectoral restructuring (dismissal of workers or early retirement), and low technology foreign direct investments (FDI) (Lovrinčević and Teodorović 1998), instead of market competition, innovation, and technological upgrading. This model was not sustainable in the long run, and it led to poor market dynamism and a business environment that needed stimulation in the later stages of the development of its national competitiveness. This has contributed to the structural deficiencies of the R&D business sector in terms of low business investment in R&D and insufficient human resources for innovation dynamics within firms. Governance of innovations is often reduced to the buying of new machinery, incremental modifications, and products/processes which exclude risk taking and lead to low economic effect and non-export orientation. Negative effects also stem from the lack of transparency of corporate practices, and a close connection to state and authoritarian corporate management, which characterizes all periods of economic development, from socialism to the present day. Thirdly, the difficulties experienced throughout socialism, in terms of the practical application of research results and technological development, have not improved. The national innovation policy was launched in 2001 during the country's transition into capitalism and, as a result of a lack of entrepreneurial innovation, the inability of businesses to bridge the gap between scientific research and its commercial application, narrow-minded policy-makers, and incorrect growth models, it has never come to function as it was hoped it would. This confirms the results of previous research (Staehr 2011), which state that, while EU membership has advanced democratic reforms, the effect on market-economic reforms has been either non-existent or negative. The overall results suggest that, despite the dramatic change from socialism to capitalism, the basic mechanisms of economic functioning, such as state paternalism, lack of competition, private initiatives, and weak entrepreneurship, remain constant and produce modest improvements in the practices of UTT. Subsequently, sound action of the national government is needed to overcome economic and technological stagnation, and to exploit the benefits of the EU integration policies and ESIF.

The main limitation of this research refers to the qualitative methodology approach due to a lack of objective and systematized data for discussing the performance of technology transfer and entrepreneurship policy. Although the longitudinal case study and qualitative interpretive approach is an excellent method for critical analyses and understudying how the national socio-economic and political context determines technology transfer and entrepreneurial innovation, a lack of statistical data and empirical information about R&D, innovation, and entrepreneurship limit the achievements and scope of this research. It mainly concerns a lack of systemized data about ESIF operational programs (projects, stakeholders, beneficiaries, the share in national funds for R&D, etc.) and the technology complexity of the economy in general. The available international benchmarks and reports are not sufficient for efficient governance and the strategic coordination of innovation and entrepreneurship. A system of data collection, evaluation methods, and indicators should be established for diagnostic analyses (Edquist 2011), evidence-based innovation policy (Gault 2018), and better leverage of European funds. Therefore, future research should be focused on comprehensive empirical research and data collection concerning UTT, entrepreneurial innovation, and performance of the ESIF operational programs, with a view to explore their influence on national entrepreneurship, innovation, and scientific potential, along with their inclusion into the global value chains.

References

Acs, J. Z., & Audretsch, B. D. (2005). Entrepreneurship, innovation and technological change. *Foundations and Trends in Entrepreneurship., 1*(4), 149–195. https://doi.org/10.1561/0300000004.

Acs, J. Z., Audretsch, D. B., & Lehmann, E. E. (2017). National system of innovation. *Journal of Technology Transfer, 42*(5), 997–1008. https://doi.org/10.1007/s10961-016-9481-8.

Acs, Z., Autio, E., & Szerb, L. (2014). National systems of entrepreneurship: Measurement issues and policy implications. *Research Policy, 43*(3), 476–494. https://doi.org/10.1016/j.respol.2013.08.016.

Allen, T., & O'Shea, R. (Eds.). (2014). *Building technology transfer within research universities: An entrepreneurial approach*. Cambridge: Cambridge University Press.

Archibugi, D., & Filippetti, A. (2011). Is the economic crisis impairing convergence in innovation performance across Europe? *Jcms-J Common Mark S, 49*, 1153–1182. https://doi.org/10.1111/j.1468-5965.2011.02191.x.

Audretsch, D. B., & Thurik, A. R. (2000). Capitalism and democracy in the 21st century: From the managed to the entrepreneurial economy. *Journal of Evolutionary Economics, 10*(1), 17–34. https://doi.org/10.1007/s001910050003.

Audretsch, D. B. (2007). Entrepreneurship capital and economic growth. *Oxford Rev Econ Pol, 23*(1), 63–78.

Audretsch, D. B. (2018). Entrepreneurship, economic growth, and geography. *Oxford Rev Econ Pol, 34*(4), 637–651.

Audretsch, D. B., & Caiazza, R. (2016). Technology transfer and entrepreneurship: Cross-national analysis. *Journal of Technology Transfer, 41*, 1247–1259. https://doi.org/10.1007/s1096.1-015-9441-8.

Audretsch, D. B., Lehmann, E., & Wright, M. (2012). Technology transfer in a global economy. *Journal of Technology Transfer, 39*(3), 301–312. https://doi.org/10.1007/s10961-012-9283-6.

Audretsch, D. B., & Link, A. N. (2018). Innovation capital. *Journal of Technology Transfer, 43*, 1760–1767. https://doi.org/10.1007/s1096.1-018-9700-6.

Autio, E., Kenney, M., Mustar, P., Siegel, D., & Wright, M. (2014). Entrepreneurial innovation: The importance of context. *Research Policy, 43*(7), 1097–1108.

Balconi, M., Brusoni, S., & Orsenigo, L. (2010). In defence of the linear model: An essay. *Research Policy, 39*(1), 1–13.

Bartllet, W. (2003). *Croatia between Europe and the Balkans*. London: Routledge.

Bečić, E., Švarc, J. (2015) Smart specialisation in Croatia: between the cluster and technological specialisation, *Journal of the Knowledge Economy, 6*(2), 270–295, https://doi.org/10.1007/s13132-015-0238-7.

Block, J. H., Thurik, R., & Zhou, H. (2013). What turns knowledge into innovative products? The role of entrepreneurship and knowledge spillovers. *Journal of Evolutionary Economics, 23*(4), 693–718. https://doi.org/10.1007/s0019.1-012-0265-5.

Bonaccorsi, A. (2016). Addressing the disenchantment: Universities and regional development in peripheral regions. *Journal of Economic Policy Reform, 20*, 293. https://doi.org/10.1080/17487.870.2016.1212711.

Bozeman, B., Rimes, H., & Youtiem, J. (2015). The evolving state-of-the-art in technology transfer research: Revisiting the contingent effectiveness model. *Research Policy, 44*, 34–49.

Breznitz, S. M., & Etzkowitz, H. (Eds.). (2016). *University technology transfer: The globalization of academic innovation*. New York: Routledge.

Breznitz, S. M., & Feldman, M. P. (2010). The engaged university. *Journal of Technology Transfer, 37*(2), 139–157. https://doi.org/10.1007/10961-010-9183-6.

Burhan, N. A. S., Razak, R. C., Salleh, F., Labastida, M. E., & Tovar, M. E. L. (2017). The higher intelligence of the 'creative minority' provides the infrastructure for entrepreneurial innovation. *Intelligence, 65*, 93–106. https://doi.org/10.1016/j.intell.2017.09.007.

Carlsson, B., Braunerhjelm, P., McKelvey, M., Olofsson, C., Persson, L., & Ylinenpaa, H. (2013). The evolving domain of entrepreneurship research. *Small Business Economics, 42*, 913–930. https://doi.org/10.1007/s11187-013-9503-y.

CBS. (2019). *Statistical reports: Research and development, 2017*. Zagreb: Croatian Bureau of Statistics.

Čepo, D. (2020). Structural weaknesses and the role of the dominant political party: democratic backsliding in Croatia since EU accession. *Southeast European and Black Sea Studies*, 1–19, https://doi.org/10.1080/14683857.2020.1709721.

Dabić, M., Daim, T., Bayraktaroglu, E., Novak, I., & Bašić, M. (2012). Exploring gender differences in attitudes of university students towards entrepreneurship. *International Journal of Gender and Entrepreneurship, 4*(3), 316–336.

Dabić, M., Gonzalez-Loureiro, M., & Daim, T. U. (2015a). Unraveling the attitudes on entrepreneurial universities: The case of Croatian and Spanish universities. *Technology in Society, 42*, 167–178.

Dabić, M., Švarc, J., & Bečić, E. (2015b). A multidimensional approach to the environment for entrepreneurship in selected CE countries. *International Journal of Transitions and Innovation Systems, 3–4*(3), 295–328.

Dabić, M., Švarc, J., & González-Loureiro, M. (2016). *Entrepreneurial universities in innovation-seeking countries: Challenges and opportunities*. New York: Palgrave Macmillan.

Dabić, M., Lažnjak, J., Smallbone, D., & Švarc, J. (2019). Intellectual capital, organisational climate, innovation culture, and SME performance: Evidence from Croatia. *Journal of Small Business and Enterprise Development. 26*(4), 522–544. https://doi.org/10.1108/JSBED-04-2018-0117.

Dosi, G., Llerena, P., & Labini, M. S. (2006). The relationship between science, technologies and their industrial exploitation: An illustration through the myths and realities of the so-called "European paradox". *Research Policy, 35*, 1450–1464.

Drucker, P. F. (1985). *Innovation and entrepreneurship*. New York: Harper and Row.

Dyker, D. A. (2011). *Yugoslavia: Socialism, development, and debt*. New York: Routledge.

Dyker, D. A., & Radošević, S. (Eds.). (1999). *Innovation and structural change in post-socialist countries: A quantitative approach*. Dordrecht: Kluwer Academic Publishers.

Dyker, D. A., & Vejvoda, I. (Eds.). (2014). *Yugoslavia and after: A study in fragmentation, despair and rebirth*. London: Routledge.

Edquist, C. (2011). Design of innovation policy through diagnostic analysis: Identification of systemic problems (or failures). *Industrial and Corporate Change, 20*, 1725. https://doi.org/10.1093/icc/dtr06.0.

Edquist, C., & Lundvall, B. A. (1993). Comparing the Danish and Swedish systems of innovation. In R. R. Nelson (Ed.), *National innovation systems: A comparative analysis* (pp. 265–298). New York: Oxford University Press.

EIS. (2019). *European innovation scoreboard 2019*. European Union, Luxembourg. https://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards/. Accessed 5 Mart 2020.

Estrin, S., & Mickiewicz, T. (2011). Entrepreneurship in transition economies: The role of institutions and generational change. In M. Minniti (Ed.), *The dynamics of entrepreneurship: Evidence from global entrepreneurship* (pp. 181–209). Oxford: Oxford University Press.

Etzkowitz, H. (2008). *The triple helix: University-industry-government innovation in action*. London: Taylor and Francis Group.

Etzkowitz, H., & Viale, R. (2010). Polyvalent knowledge and the entrepreneurial university: A third academic revolution? *Critical Sociology, 36*(4), 595–609.

Eurofast. (2017). *Croatian tech companies drive economic growth and development*. Post available at: https://eurofast.eu/2017/11/01/croatian-tech-companies-drive-economic-growth-and-development/#. Accessed 4 March 2020.

European Commission. (2000). *Towards a European research area, Brussels, 18 January 2000*, [COM(2000), (Lisbon agenda)], European Commission, Brussels.

European Commission. (2015). *Country report Croatia 2015*, (European Semester), SWD (2015) 30 final, Brussels. http://ec.europa.eu/europe2020/pdf/csr2015/cr2015_croatia_en.pdf. Accessed 29 May 2017.

European Commission. (2019). *Country Report Croatia 2019, European Semester, SWD(2019) 1010 final*, European Commission, Brussels. https://ec.europa.eu/info/sites/info/files/file_import/2019-european-semester-country-report-croatia_en.pdf. Accessed 25 Mart 2020.

European Commission. (2020). *Country report Croatia 2020: 2020 European Semester, SWD(2020) 510 final*, Brussels. https://ec.europa.eu/info/sites/info/files/2020-european_semester_country-report-croatia_en.pdf. Accessed 25 Mart 2020.

Foray, D., David, P. A., & Hall, B. (2009). *Smart specialisation—The concept, knowledge economists*. Policy Brief No. 9. http://ec.europa.eu/invest-in-research/pdf/download_en/kfg_policy_brief_no9.pdf. Accessed 15th Sept 2018.

Franičević, V., & Bićanić, I. (2007). EU accession and Croatia's two economic goals: Modern economic growth and modern regulated capitalism. *Southeast European and Black Sea Studies, 7*, 637–663.

Freeman, C. (1988). Japan: A new national system of innovation? In G. Dosi et al. (Eds.), *Technical change and economic theory* (pp. 330–349). London: Pinter Publisher Limited.

Garud, R., Gehman, J., & Giuliani, A. P. (2014). Contextualizing entrepreneurial innovation: A narrative perspective. *Research Policy, 43*(7), 1177–1188.

Gault, F. (2018). Defining and measuring innovation in all sectors of the economy. *Research Policy, 47*, 617–622.

Gibb, A., & Hannon, P. (2006). Towards the entrepreneurial university. *International Journal of Entrepreneurship Education, 4*(1), 73–110.
Gibson, E., Daim, T. U., & Dabic, M. (2019). Evaluating university industry collaborative research centers. *Technological Forecasting and Social Change, 146*, 181–202.
González-Cruz, T., & Devece, C. (2018). Entrepreneurial innovation, judgment, and decision-making as a virtuous process. *The International Entrepreneurship and Management Journal, 14*(2), 245–248.
Grodzicki, M. J. (2014). Global value chain and competitiveness of V4 economies (chapter 1). In D. Kiendl-Wendner & K. Wach (Eds.), *International competitiveness in Visegrad countries: Macro and micro perspectives* (pp. 13–31). Gratz: Fachhochschule Joanneum.
Guerrero, M., & Urbano, D. (2017). The impact of Triple Helix agents on entrepreneurial innovations' performance: An inside look at enterprises located in an emerging economy. *Technological Forecasting and Social, 119*, 294–309.
Guerrero, M., Urbano, D., & Fayolle, A. (2016). Entrepreneurial activity and regional competitiveness: Evidence from European entrepreneurial universities. *Journal of Technology Transfer, 41*(1), 105–131.
Guerrero, M., Cunningham, J. A., & Urbano, D. (2015). Economic impact of entrepreneurial universities' activities: An exploratory study of the United Kingdom. *Research Policy, 44*(3), 748–764.
Guerrero, M., & Urbano, D. (2019). Effectiveness of technology transfer policies and legislation in fostering entrepreneurial innovations across continents: an overview. The *Journal of Technology Transfer, 44*(5), 1347–1366.
Hanson, P., & Pavitt, K. (1987). *The comparative economics of research development and innovation in east and west: A survey*. Chur: Harwood Academic Publishers.
Högselius, P. (2003). *Can east European countries innovate?* Paper prepared for the DRUID winter conference, Aalborg, 16–18 January.
IDIS. (1980). *Science in Yugoslavia*. Zagreb: Institute of Social Research (IDIS). (in Croatian).
Ignatov, A. (2017). Entrepreneurial innovation: The European Union perspective. *Review of Economic Perspectives, 18*(2), 137–154. https://doi.org/10.2478/revecp-2018-0008.
Jelač Raguž, M., & Mujić Mehičić, N. (2017). The influence of science–industry collaboration on firms' innovative performance—Evidence from the Republic of Croatia. *Economic Research-Ekonomska Istraživanja, 30*(1), 992–1002. https://doi.org/10.1080/1331677X.2017.1314819. Accessed 15th Aug 2018.
Kergroach, S. (2018). National innovation policies for technology upgrading through GVCs: A crosscountry comparison. *Technol Forecast Soc*. https://doi.org/10.1016/j.techfore.2018.04.033.
Kornai, J. (2010). Innovation and dynamism: Interaction between systems and technical progress. *The Economics of Transition, 18*, 629–670. https://doi.org/10.1111/j.1468-0351.2010.00396.x.
Krammer, S. M. S. (2009). Drivers of national innovation in transition: Evidence from a panel of eastern European countries. *Research Policy, 38*(5), 845–860. https://doi.org/10.1016/j.respol.2009.01.022.
Kshetri, N. (2009). Entrepreneurship in post-socialist economies: A typology and institutional contexts for market entrepreneurship. *Journal of International Entrepreneurship, 7*(3), 236–259.
Kuhlmann, S. (2001). Future governance of innovation policy in Europe—Three scenarios. *Research Policy, 30*(6), 953–976.
Landström, H., & Harirchi, G. (2018). The social structure of entrepreneurship as a scientific field. *Research Policy, 47*, 650–662.
Lange, S., & Švarc, J. (Eds.). (1994). *Conceptual approaches for an industry-related promotion of R&D in croatia*. Julich: Workshop proceedings. Forschungszentrum Julich GmbH.
Liargovas, P., Petropoulos, S., Tzifakis, N., & Huliaras, A. (Eds.). (2016). *Beyond "absorption": The impact of EU structural funds on Greece*. Athens: Konrad-Adenauer Stiftung.
López Mendoza, X. P., & Mauricio Sanchez, D. S. (2018). A systematic literature review on technology transfer from university to industry. *International Journal of Business and Systems Research, 2*(2), 197. https://doi.org/10.1504/ijbsr.2018.10010090.

Lovrinčević, Ž., & Teodorović, I. (1998). Condition and tendencies of the Croatian economy in the period1994 to 1998. *Ekonomski pregled, 49*(7–8), 699–717. (in Croatian).

Mačkić, V. (2019). *Budgetary effects of clientelism, lecture at the conference Clientelism in Croatia*, Centre for Democracy and Law Miko Tripalo, 14 February 2019, Zagreb (In Croatian).

Martinović Klarić, I. (2019). *Croatian Science Foundation*. Presentation of the Croatian Science Foundation at the Ivo Pilar Institute, Zagreb, 25 April, 2019.

MEEC. (2018). *150 successful entrepreneurial projects*, Ministry of economy, Entrepreneurship and Crafts, Zagreb. https://www.mingo.hr/public/documents/MGPO_Brosura_150_projekata.pdf. [22 June 2019]. Accessed Oct 2020.

Meske, W. (Ed.). (2000a). *From system transformation to European integration: Science and technology in Central and Eastern Europe at the beginning of the 21st century*. Piscataway: Transaction Publishers.

Meske, W. (2000b). Science and technology in CEECs in the socialist era. In W. Meske (Ed.), *From systemtransformation to European integration: Science and technology in Central and Eastern Europe at the beginning of the 21st century* (pp. 7–27). Piscataway: Transaction Publishers.

Miller, K., Alexander, A., Cunningham, J. A., & Albats, E. (2018). Entrepreneurial academics and academic entrepreneurs: A systematic literature review. *The International Entrepreneurship and Management Journal, 77*(1–3), 9–38.

MoST. (2002). *Croatian program for innovative technological development (HITRA): Collected programmatic papers*. Zagreb: Ministry of Science and Technology.

Mrozewski, M., & Kratzer, J. (2017). Entrepreneurship and country-level innovation: Investigating the role of entrepreneurial opportunities. *Journal of Technology Transfer, 42*(5), 1125–1142. https://doi.org/10.1007/s10961-016-9479-2.

Mršić, A. (2018). *The processes of defining the problems and priorities in innovation policy making in Croatia from the perspective of discursive institutionalism*. University of Zagreb, Faculty of Political Sciences, Doctoral Dissertation (in Croatian).

Muscio, A., Reid, A., & Rivera Leon, L. (2015). An empirical test of the regional innovation paradox: Can smart specialisation overcome the paradox in central and Eastern Europe? *Journal of Economic Policy Reform, 18*(2), 153–171. https://doi.org/10.1080/17487870.2015.1013545.

Mytelka, L. K., & Smith, K. (2002). Policy learning and innovation theory: An interactive and co-evolving process. *Research Policy, 31*, 1467–1479.

Nelson, R. (Ed.). (1993). *National innovation systems. A comparative analysis*. New York: Oxford University Press.

Nelson, R. R., & Winter, S. G. (1982). *An evolutionary theory of economic change*. Cambridge: The Belknap Press of Harvard University Press.

Nölke, A., & Vliegenthart, A. (2009). Enlarging the varieties of capitalism: The emergence of dependent market economies in East Central Europe. *World Polit, 61*, 670–702. https://doi.org/10.1080/1468385070.17261.04.

OECD. (1992). *Technology and economy: The key relationships*. Paris: OECD.

OECD. (1998). *Science, technology and industry outlook*. Paris: OECD.

OECD. (2001). *The new economy: Beyond the hype*. Paris: OECD.

Paunov, C., & Planes-Satorra, S. (2019). *How are digital technologies changing innovation?: Evidence from agriculture, the automotive industry and retail*. OECD Science, Technology and Industry Policy Papers, No. 74, OECD Publishing, Paris, https://doi.org/10.1787/67bbcafe-en.

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Brostrom, A., D'Este, P., et al. (2013). Academic engagement and commercialisation: A review of the literature on university-industry relations. *Research Policy, 42*(2), 423–442.

Pisk, K. (2001). *Cooperation of science and industry, presentation at the fifth multidisciplinary conference: crhr for the Croatian economy*. Zagreb: Croatian Academy of Engineering and Croatian Systems Society. (in Croatian).

Prpić, K. (2003). Social marginalization of science and development of the Croatian research potentials. *Drustvena istrazivanja, 12*(1–2), 45–68. (in Croatian).
Radas, S. (2006). Collaboration between industry and science: Motivation factors, collaboration intensity and collaboration outcome. *Croatian Economic Survey, 8*(1), 11–31.
Radosević, S. (1994). Strategic technology policy for Eastern Europe. *Economic Systems, 18*(2), 87–116.
Radosević, S. (1996). Restructuring of R&D institutes in post-socialistic economies: Emerging patterns andissues. In A. Webster (Ed.), *Building new bases for innovation: The transformation of the R&D systemin post-socialist states* (pp. 8–31). Cambridge: Anglia Polytechnic University.
Radošević, S. (2006). Research and development, competitiveness and European integration of South Eastern Europe. *Europe–Asia Stud, 61*(4), 621–650.
Radošević, D. (2013). Development strategy for Croatia 2014–2020. *Ekonomski pregled, 64*(3), 187–212. (in Croatian).
Radošević, S. (2018). Assessing EU smart specialization policy in a comparative perspective. In S. Radosevic et al. (Eds.), *Advances in the theory and practice of smart specialization* (pp. 2–31). Amsterdam: Elsevier Academic Press.
Radošević, S., Curaj, A., Gheorghiu, R., Andreescu, L., & Wade, I. (Eds.). (2018). *Advances in the theory and practice of smart specialization*. Amsterdam: Elsevier Academic Press.
Rhoades, G., & Slaughter, S. (1997). Academic capitalism, managed professionals, and supply-side higher education. *Social Text, 51*, 9–38.
Schumpeter, J. A. (1942). *Capitalism, socialism and democracy*. New York: Harper & Brothers.
Shane, S. (2009). Why encouraging more people to become entrepreneurs is bad public policy. *Small Business Economics, 33*(2), 141–149.
Silva, C. E., Esteves, F., Narcizo, R. B., & Cardoso, R. (2018). Concepts and criteria for the characterization of the entrepreneurial university: A systematic literature review. *Journal of Economics, Business and Management, 6*(3), 65–71.
Singer, S., Šarlija, N., Pfeifer, S., & Oberman, P. S. (2018). *Global entrepreneurship monitor Croatia 2016: What makes Croatia a (non-)entrepreneurial country?* Zagreb: CEPOR. (in Croatian).
Slaughter, S., & Leslie, L. L. (2001). Expanding and elaborating the concept of academic capitalism. *Organization, 8*(2), 154–161.
Staehr, K. (2011). Democratic and market-economic reforms in the post-communist countries. *Eastern European Economics, 49*(5), 5–28. https://doi.org/10.2753/eee00.12-87754.90501.
Šimić-Banović, R. (2018). Uhljeb – A post-socialist homo croaticus: A personification of the economy of favours in Croatia? *Post-Communist Economies, 31*(3), 279–300. https://doi.org/10.1080/14631377.2018.1537708.
Surubaru, N. C. (2020). *European funds in central and Eastern Europe: Drivers of change or mere funding transfers?* Evaluating the impact of European aid on national and local development in Bulgaria and Romania, European Politics and Society, online. https://doi.org/10.1080/23745118.2020.1729049.
Stipetić, V. (2012). *Two centuries of the Croatian economy (1820–2005)*. Zagreb: HAZU. (in Croatian).
Stojčić, N. (2020). Collaborative innovation in emerging innovation systems: Evidence from Central and Eastern Europe. *The Journal of Technology Transfer,* 1–32. https://doi.org/10.1007/s10961-020-09792-8.
Švarc, J. (2006). Socio-political factors and the failure of innovation policy in Croatia as a country in transition. *Research Policy, 35*(1), 144–159.
Švarc, J. (2011). Does Croatian national innovation system (NIS) follow the path towards knowledge economy? *International Journal of Technology Transfer and Commercialisation, 10*(2), 131–151.

Švarc, J. (2014). A triple helix systems approach to strengthening the innovation potential of the Western Balkan countries. *International Journal of Transitions and Innovation Systems, 3*(3), 169–188. https://doi.org/10.1504/IJTIS.2014.06569.8.

Švarc, J. (2017). Socio-political approach in exploring the innovation culture in post-socialist countries: The case of Croatia. *Post-Communist Economies, 29*(3), 359–374. https://doi.org/10.1080/14631377.2017.13150.01.

Švarc, J., Čengić, D., Poljanec-Borić, S., & Lažnjak, J. (2019). Scientists' attitudes about 2013 science reforms: A critical analysis. *Politička Misao, 56*(1), 7–38. https://doi.org/10.20901/pm.56.1.01. (In Croatian).

Švarc, J., Dabić, M., & Tugrul, D. (2020). A new innovation paradigm: European cohesion policy and the retreat of public science in countries in Europe's scientific periphery. *Thunderbird International Business Review, 62*(5), 531–547. https://doi.org/10.1002/tie.22166.

Szerb, L. A., Acs, Z., & Autio, E. (2013a). Entrepreneurship and policy: The national system of entrepreneurship in the European Union and in its member countries. *Entrepreneurship Research Journal, 3*(1), 9–34.

Szerb, L., Aidis, R., & Acs, J. Z. (2013b). The comparison of the global entrepreneurship monitor and the global entrepreneurship and development index methodologies. *Foundations and Trend in Entrepreneurship, 9*, 1–142. https://doi.org/10.1561/03000.00046.

Thurik, A. R., Stam, E., & Audretsch, D. B. (2013). The rise of the entrepreneurial economy and the future of dynamic capitalism. *Technovation, 33*(8–9), 302–310. https://doi.org/10.1016/j.technovati.on.2013.07.003.

Uvalić, M. (2018). *The rise and fall of market socialism in Yugoslavia DOC Research Institute, special report*. https://doc-research.org/2018/03/rise-fall-market-socialism-yugoslavia/. Accessed 23 Sept 2018.

Vehovec, M., & Radas, S. (2006). Industry science collaboration in Croatia: Academics' view. *Drustvena Istrazivanja, 3*(83), 345–369.

Vuković, V., Štulhofer, A., & Burić, I. (2017). Was Županov right? Testing the origin and persistence of the egalitarian syndrome. *Drustvena Istrazivanja, 26*(2), 207–225. https://doi.org/10.5559/di.26.2.04. (in Croatian).

Wahab, S. A., Rose, R., & Osman, S. I. W. (2012). Defining the concepts of technology and technology transfer: A literature analysis. *International Business Research, 5*(1), 61–71. https://doi.org/10.5539/ibr.v5n1p.61.

World Bank. (2013). *Country papers series: Croatia, technical assistance project (P123211)*, World Bank. https://www.worldbank.org/content/dam/Worldbank/document/eca/Western-Balkans-R&D-Croatia.pdf. Accessed 12 Apr 2020.

World Bank. (2012). *Croatia partnership country program snapshot*, World Bank, April 2012. https://www.worldbank.org/content/dam/Worldbank/document/CroatiaSnapshotApril2012.pdf. Accessed 12 Apr 2020.

World Bank. (2018). *Croatia – systematic country diagnostic*. World Bank. http://documents.worldbank.org/curated/en/452231526559636808/Croatia-Systematic-Country-Diagnostic. Accessed 28 Feb 2020.

Županov, J. (2001). The industrializing and de-industrializing elite in Croatia in the second half of the 20th century. In D. Čengić & I. Rogić (Eds.), *Ruling elites within an analytic perspective* (pp. 11–37). Zagreb: Institute of Social Sciences Ivo Pilar. (in Croatian).

Chapter 12
Evolution of Technology Transfer in Belarus: Two Parallel Dimensions in a Post-Soviet Country

Radzivon Marozau, Natalja Apanasovich, and Maribel Guerrero

12.1 Introduction

Effective knowledge transfer and exchange between the scientific and industrial sectors is considered as an important way to speed up innovation worldwide (Perkmann and Walsh 2007; Harryson et al. 2008; Radas and Božić 2009). Since there is a strong correlation between the level of income and national commitments to innovation even in transition (Krammer 2009), the transformation of knowledge and technology into valuable economic activity has become a high priority in many policy agendas in post-soviet countries. At the same time, even innovation-driven economies face difficulties in transforming great R&D results into the technological development of industries and their competitiveness in the global market (Debackere and Veugelers 2005; Dosi et al. 2006; Audretsch et al. 2012; Guerrero et al. 2020).

Post-soviet transition economies inherited to a different extent a modernized version of the linear model of the technological upgrade based on the extramural R&D

R. Marozau (✉)
BEROC Economic Research Center, Minsk, Republic of Belarus
e-mail: marozau@beroc.by

N. Apanasovich
BEROC Economic Research Center, Minsk, Republic of Belarus

School of Business of BSU, Minsk, Republic of Belarus

M. Guerrero
Facultad de Economía y Negocios, Universidad del Desarrollo, Santiago, Chile

Northumbria Centre for Innovation, Regional Transformation and Entrepreneurship (iNCITE), Newcastle Business School, Northumbria University, Newcastle upon Tyne, UK

Centre for Innovation Research (CIRCLE), Lund University, Lund, Sweden
e-mail: maribel.guerrero@northumbria.ac.uk

M. Guerrero, D. Urbano (eds.), *Technology Transfer and Entrepreneurial Innovations*, International Studies in Entrepreneurship 51,
https://doi.org/10.1007/978-3-030-70022-5_12

(Radosevic 1996). In the early 1990s, re-organization of the Science and Technology (S&T) system was not among the government officials' priorities, while two obvious diametrically opposed ways were to adjust the soviet model gradually or to raze it to the ground and to adopt good western practices and best-of-breed tools. Regardless of the chosen way, the links needed to be re-established but within a narrower boundary of independent countries.

The Republic of Belarus, arguably, appeared the most sluggish in its movement towards the market economy and western-like institutions. The country was unique among its peers because of or despite this institutional choice because it has preserved the organizational capabilities of ex-soviet large industrial enterprises that were pillars of socioeconomic development in certain periods. In this regard, public funding of extramural R&D for such enterprises became a cornerstone of the Belarusian S&T and innovation system that enabled technology upgrading and stimulated the Total Factor Productivity (Radosevic 2017). Mesmerized by certain success, Belarusian policymakers overestimated the role of R&D in innovation systems and economic development. This caused the incline towards the allocation of resources and commercialization of research output, while such areas as promoting the science-business-education links, as well management, marketing and engineering practices remained underdeveloped or neglected (Marozau and Guerrero 2016). Moreover, multinational enterprises have not become the major actors in technology transfer and business R&D, unlike in other Central Eastern European economies (Lengyel and Cadil 2009).

Whether by accident or on purpose, the state policy has contributed to the parallel development of two paths: the 'traditional' soviet-style economy and the 'new' entrepreneurship-driven economy. This segregation has permeated different policy spheres including the S&T and innovation system, where this gap might be more evidential, engendering crucial challenges for policymakers and main actors. In this regard, the purpose of this chapter is to demonstrate how the state policy shaped paths of knowledge and technology transfer activities of different types of actors. In general, comparable and relevant data on knowledge transfer is scarce in Belarus. The official surveys on R&D are filled by an organization that reflects such activities in accounting. For taxation purposes, private enterprises tend not to report about R&D activities, recording them as current expenditures and not contributing to intangible assets. Having no stimuli and avoiding additional reporting issues, many innovative enterprises stay beyond the survey's scope. According to Belarusian classification, the survey on innovation covers only medium- and large-sized enterprises (>100 employees) in certain sectors. These circumstances may substantially distort the official statistics and consequently mislead policymakers. In this regard, to triangulate our findings, we capitalized on primary data at the enterprise level gathered by the National Statistical Committee, by the World Bank within the framework of Business Environment and Enterprise Performance Surveys (BEEPS) and by the Association of Advanced Instrument Manufacturers.

We provide evidence of how a general policy towards socio-economic development rather than certain policy measures has generated two parallel dimensions of the knowledge and technology transfer related to the 'traditional' and 'new' economies. Our main arguments are that state policy in knowledge generation and transfer appeared timely and opportune that enabled the preservation of industrial potential and output until the 2010s. At the same time, policy attempts to integrate foreign best practices of innovation-based development have not resulted due to the irrelevance of institutions in Belarus as a country gradually transitioning to the market economy. In this regard, the main pressing policy challenge is to reconcile the 'traditional' industrial and 'new' entrepreneurship-driven economies.

The remainder of the chapter is structured as follows: In Sect. 12.2, we provide a brief overview of the soviet science and technology sphere that became a template for Belarusian authorities and describes the knowledge and technology transfer processes triggered by the dissolution of the Soviet Union. Section 12.3 discusses the evolution of the state policy related to the technology transfer in Belarus, while Section 12.4 illustrates how the 'traditional' and 'new' economies co-exist. Section 12.5 provides main implications and a general conclusion.

12.2 Antecedents

12.2.1 Soviet Science and Technology System

It is widely documented and acknowledged that the Soviet Union had a well-developed science and technology-fueled system with a high level of expenditures and many qualified engineers and researchers, especially in natural sciences (Martinsons and Valdemars 1992; Egorov and Carayannis 1999). At the same time, judging by traditional indicators, such as patents and research papers in international journals, does not reflect the Soviet science achievements because of its main focus on the military and 'the Iron Curtain' between the Western world and the USSR. The arms race with the U.S. preconditioned the advances in military weapons development and the aerospace sector that had a multiplier effect on many related research fields (Martinsons and Valdemars 1992). In these conditions, research institutes and enterprises located on Belarus' territory developed and manufactured 'brains' (automated control systems, computers) and 'eyes'(radiolocation, optics, electronics) for the Soviet weapon and aerospace sector. As for civilian manufacturing, it did not require any breakthrough in science and technologies because it was characterized by rather a catching-up development based in many cases on copying or re-invention. This, however, enabled to develop of engineering potential, particularly in Belarus that was often regarded as the 'assembly line' of the Soviet Union due to the relatively high concentration of manufacturing enterprises represented among others by BelAZ currently taking 27%[1] of the world market of haul

[1] For further details, visit http://www.gki.gov.by/upload/new%20structure/info%20for%20investors/oao_more/600038906.doc

trucks over 90 tons; Minsk Tractor Plant that manufactured about 10% of wheel tractors in the world.[2]

The hierarchical and centralized organization of the whole economy led to two remarkable and apparent peculiarities of the soviet science and technology system. First, the dominating linear model of innovation with exaggerated overestimation of the role of R&D and the lack of interaction among actors and users impeded quick technological advance, especially in the civilian sector (Hanson and Pavitt 1987). One of the reasons for that was the centralized economy with a stovepipe pattern and dysfunctionalities stemmed from actors' location in different hierarchy branches (Egorov and Carayannis 1999). Second, the general perception of technology as a commodity that could be transferred to and implemented at any enterprise in a certain industry, in the same way, diminished the importance of doing-using-interacting processes (Jensen et al. 2007) in new product development. Weak bottom-up and horizontal links made research organizations and researchers unresponsive to the industry needs. As a result, the R&D, manufacturing processes and customer needs appeared separated from each other (Radosevic 2011), while all channels of the knowledge and technology transfer and the end product distribution were planned and pre-defined by the state. The extramural nature of R&D and a passive role of enterprises that were not a business but production units in the complex enterprise "Soviet economy" (Radosevic 1996), were propagated to post-soviet economies and created a daunting challenge to policymakers. As a result, the civilian R&D sector entered the transitional process of the 1990s, being mostly uncompetitive in the market economy's context compared to foreign knowledge and technology producers. At the same time, the end of the Cold War gave rise to the flow of military and dual-use technologies that were quite advanced to the market through different channels.

12.2.2 Post-soviet Science and Technology System

The disintegration of the Soviet Union in 1991 was marked by the serious decline in output in all the former soviet countries due to disruption of existed production chains and new market reality in general. From the very beginning of the transition period, Belarusian authorities adhered to the gradual movement towards the market economy, retaining substantial control over the economy and restricting the privatization of large enterprises (Palacin and Radosevic 2011). This was mirrored in Radosevic's (1996) approaches as 'gradualism without therapy' to dealing with the S&T sphere that continued being financed and coordinated by the state and having the Academy of Sciences as a key actor without any substantial restructuring. It was based on the assumption that the Belarusian R&D sector, whose only customers were large laggard soviet enterprises, was not capable of adapting to these drastic

[2] For further details, visit https://neg.by/novosti/otkrytj/traktor-s-dalnim-pricelom

changes, and the industrial sector was not able to compete in market conditions (Djarova 2011). Moreover, the S&T system's re-organization was not among the government officials' priorities who concentrated on economic stabilization and development of market institutions while redirecting the soviet S&T potential and human capital to marketable civilian R&D was suspended in many countries, including Belarus (Egorov and Carayannis 1999). To a large extent, this preconditioned the replication of soviet-style knowledge and technology transfer mechanisms. Thus, the Belarusian S&T system adopted the organizational model and its drawbacks of the Soviet civilian R&D sector, not the military one. One of the inherited instruments to bring knowledge and technologies from research organizations to the industry were also inherited from the Soviet Union – State science and technology programs (SSTPs). This instrument has remained the most important channel to transfer and commercialize knowledge and technologies from state research organizations to the public sector. However, the volume of public expenditures – the dominant source of R&D funding – was not comparable to budgets allocated in the Soviet Union. Without compensating market institutions, these cuts switched research organizations into 'survival mode' (Grudzinskii 2005) and forced them to study how to commercialize 'free-for-the-taking' knowledge and technologies. Simultaneously, many high-skilled scientists and engineers left research organizations and universities seeking job opportunities in Western countries or for another occupation (low-skilled jobs or entrepreneurial activities) (Pobol 2011).

As a response to these trends, two phenomena in R&D institutes were observed: (1) diversification of the activities in terms of products, services, and markets; (2) spontaneous privatization and (3) related to this phenomenon of quasi-spin-offs (Radosevic 1996). While diversifying their activities, many research institutes and research departments at universities were forced to expand into services (testing, quality control, measurement and standardizing) and production activities (Radosevic 1998), thereby commercializing the stock of knowledge and technologies. And since that time and public funds, they have been more oriented towards short-term fundraising than towards a strategic development of strong relationships within the innovation system (Marozau and Guerrero 2016). This approach resembled the Chinese path of universities' and research organizations' transformation that assumed that this would allow gaining experience and learning and cultivating the entrepreneurial culture and raising capital to develop research capacity for future high-tech entrepreneurial activities (Zhou and Peng 2008). But in the case of post-soviet economies, this was not a general policy but an issue of survival. The necessity of researchers and engineers to survive, combined with the poor property rights protection, engendered many spin-outs or spontaneous privatization when employees used the stock of knowledge and technology created at Soviet research organizations and commercialize it on an individual basis (Radosevic 1996). Arguably, this process became the most important channel of knowledge and technology transfer to the Belarusian private sector, giving rise to the development of new technology-based innovative enterprises – so-called "Belarusian Hidden Champions" (Marozau et al. 2021).

Many research organizations and universities span off small commercial organizations to commercialize knowledge and technologies to preserve the R&D potential of a parental organization. However, as Radosevic (1996) pointedly noted, these were rather quasi spin-offs that could be only a ‘packaging’ for knowledge- and technology-based products, or more often, services. A quasi-spin-off person might be employed full-time at a parental organization and use its equipment to manufacture spin-off products or deliver services. In the chaos of the 1990s, some quasi spin-offs managed to pump out substantial human and physical resources and intellectual property from the public sector to the private one. Some research organizations and universities, for example, Belarusian State University, continued spinning off new wholly-owned new ventures till the 2000s. Such spin-offs usually had a certain degree of autonomy in decision making and strategy implementing and separate bank accounts and property rights (Marozau et al. 2019). However, with the development of the market of R&D services as well international cooperation, spin-offs from public organizations started losing their competitiveness due to mismanagement as well as the lack of flexibility of start-ups and bureaucracy inherent in state-controlled organizations. As a result, no role models of Belarusian public organizations’ spin-offs competitive in international markets can be identified. They became ‘suitcases without a handle’, causing additional disturbances to many parent organizations and, consequently, the number of such spin-offs is steadily decreasing.

12.3 The Belarusian Technology Transfer Framework

In the Republic of Belarus, the departure point of challenges related to the technology and technology transfer to the industry is arguably the establishment of the Committee on Science and Technology under the Council of Ministers in 1993. In this year, the government adopted the approach of implementing State science and technology programs and State programs for scientific research that existed in the Soviet past. After some re-subordination and re-organization of governing bodies, in 2004, it received its current name, “State Committee for Science and Technology” (SCST) that is the same as the main state body responsible for the S&T policy in the Soviet Union. This succession was not occasional, but it reflected the policymakers’ adherence to the soviet approaches to coordinating science and technology. In the 1990s, there were hot debates in Russia whether to stipulate ‘privatization’ of the R&D results or keep them public ownership. Belarusian authorities were contemplating the discussion in the neighboring country, while processes of transfer and commercialization of publicly funded knowledge were regulated by the Civil Code of the Republic of Belarus. However, the creation of the Union State of Russia and Belarus in 1999 raised a question on harmonizing the legislation in many spheres, particularly in science and technology. As a result, Belarus followed Russia’s path in 2003 and assigned to the state the intellectual property rights arisen from state-funded research, i.e. SSTPs and State programs for scientific research. The implementation of these programs conserved the Soviet linear model of innovation with extramural R&D activities while introducing some new practices.

12.3.1 Science and Technology Instruments

State science and technology programs are formulated by SCST based on Priority areas of scientific and technical activities invigorated by President's edicts for 5 years; while no general clear-cut industrial policy has been developed SSTPs yet consist of subprograms that in turn consist of tasks (projects) that have three main actors: (a) a state customer – a governing body (including the National Academy of Sciences) that by default is an owner of R&D results; (b) executors – mostly state research organizations that conduct R&D; and (c) a manufacturer – state-controlled enterprises that produce R&D-based goods or services. The development and implementation of SSTPs leave very little room for newcomers, especially from the private sectors, and for new initiatives even in the R&D directions that SSTPs prescribe (Dobrinsky and Stahlecker 2017). However, officially, a single task is an executor initiative that develops an application for funding based on its expertise and proposes certain research to a manufacturer. In many cases, such tandems are decided ex-ante, have long-lasting relationships and trust because both bear responsibility for innovative output. If a manufacturer can fund the implementation and manufacturing stage (at least 50% of the whole task budget), a joint bid is sent to a state customer for expertise and approval and, later on, to SCST that compiles subprograms and programs from approved tasks. Possibly, manufacturers can initiate tasks, while state customers' role is always passive. The main and evident drawbacks of the implementation of this instrument of knowledge and technology transfer are the lack of cutting-edge innovations as output due to the legislative absence of right for risk; the cliquishness of all actors that are not conducive to new horizontal and vertical links necessary for innovation system development (Lundvall 1999); and traditionally, low involvement of the private sector resulting from two previous limitations as well as of bureaucratic issues and excessive state control. In these circumstances, the formal transfer of knowledge and technology has been substantially limited – in many cases, state-controlled organizations refrain from collaborating with the private sector, being afraid of accused of corruption.

However, in the low demand for R&D combined with lack of intramural R&D capabilities and financial resources at state-controlled enterprises for technological upgrade, SSTP played the decisive role in preserving the R&D and engineering potential in the Belarusian public sector. In this context, the state compensated for the incipient actions of market actors (Radosevic 2011). For most state research organizations, the funding received within the SSTP remains the main source allowing them to survive and compels them to initiate new R&D activities. It should be acknowledged that while implementing the S&T policy in Belarus, the emphasis has been made on strengthening control over the progress of state-funded R&D activities rather than on creating a competitive environment favorable for the

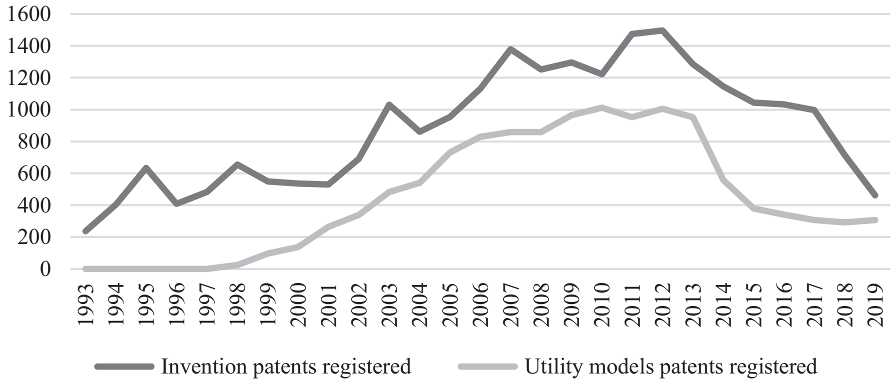


Fig. 12.1 Number of patents registered in Belarusian. (Source: Authors)

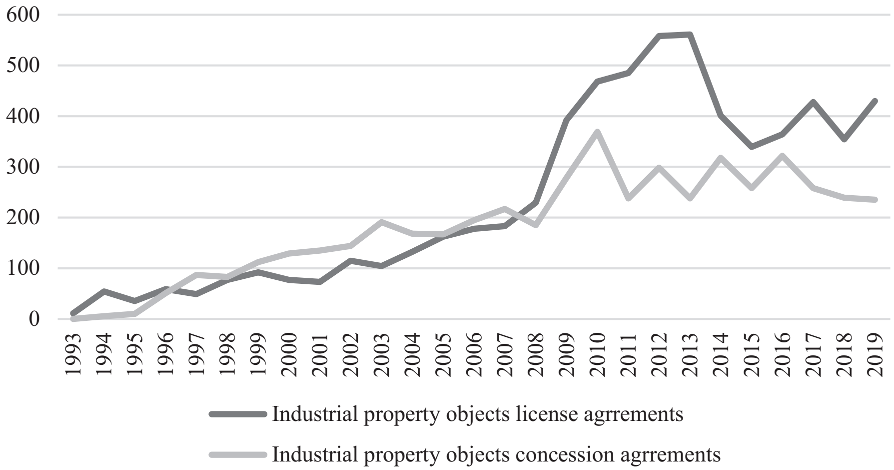


Fig. 12.2 Number of license agreements concluded. (Source: Author)

innovative organic development of industries and the country. In 2006 (Decree of Council of Ministers #1103), 2009 (Edict of President #432), 2013 (Edict of President #59), 2018 (Edict of President #240) gradually elaborated and liberalized transfer of R&D results obtained from state-funded activities but mostly among state customer, executors and manufacturers. Concurrently, the legislation enforced these organizations, enterprises and universities to commercialize the results of R&D activities, except fundamental research, within 3 years. To commercialize 'un-commercialize' R&D results created for budget money, when a state customer, executor, or manufacturer failed to transform them into products or services, the State register of rights for scientific and technological activities results was created in 2013. The extent of the problem with mandatory commercialization can be illustrated with the number of entries in this register – 2.700 as of June 30, 2019.

12.3.2 Intellectual Property Market

The market of intellectual property started developing in parallel to the market economy in the early 1990s. This process was moderated with the demand growth for R&D results and incremental changes in the state policy (Figs. 12.1 and 12.2).

One may observe that steady growth of the number of registered patents and license agreements abrupted in 2014. This might be attributed to two separate policy measures: the considerable increase of the patent registration fees and enactment of the Edict of the President #59 in 2013. Thus, in 2014, the patent registration fee grew on average by 1000% and reached 500 USD[3] Evidentially, this increase hit individuals and organizations that registered patents for their own sake without commercialization intention. Before this change, national patent registration was treated as a valuable scientific output. As for the Edict of President #59, it stipulated mandatory commercialization of IPRs arisen from state-funded research by their owner. This circumstance was a stimulus not to register IPR not to bear responsibility for commercial output.

Since the early 2000s, replicating the Western path of the industry-science links (Debackere and Veugelers 2005) and innovation ecosystem development, Belarusian authorities were concerned about creating the infrastructure for knowledge and technology transfer (Lenchuk 2006). Thus, to organize a communication platform and regulate the process of technology transfer and facilitate cooperation between researchers, entrepreneurs and investors, the Republican Center for Technology Transfer (RCTT) was established in 2003 with support from UNIDO. However, this agency could not ensure financial sustainability earning on its core functions as a technology transfer intermediary without state support. The gap between the supply and demand sides of the knowledge and technology market was not closed or narrowed. State research organizations seamlessly cooperated and transferred knowledge and technologies to state-owned enterprises within SSTPs, while ‘the rest’ of the research output, in most cases, did not fit the market. Consequently, RCTT was incorporated in the Center of System Analysis and Strategic Research of the National Academy of Sciences.

Similarly, technology transfer centers and offices have not become drivers of the knowledge transfer but due to inherent bureaucracy, while focusing mainly on documenting and administering the intellectual property and creating additional knowledge filters (Marozau et al. 2016; Marozau and Guerrero 2016; Belitski et al. 2019). Technological parks appeared ‘renting agencies’ (Radosevic 1996), providing favorable tax regimes rather than entrepreneurship and innovation ecosystems connecting technologies with business experts, entrepreneurs, venture capitalists. These examples demonstrate that transferring organizational models into a different institutional context of transition economies have not provided similar outputs and, in some cases, deviated from original missions (Radosevic 1996).

In general, most of the substantial changes in legislation related to knowledge and technology transfer were related to regulating intellectual property rights stemming from state-funded research relevant to the state-owned organization or fiscal stimuli for manufacturers of innovative products that appeared quite attractive to

[3] For further details, visit: http://www.belmarket.by/slishkom-dorogie-patenty

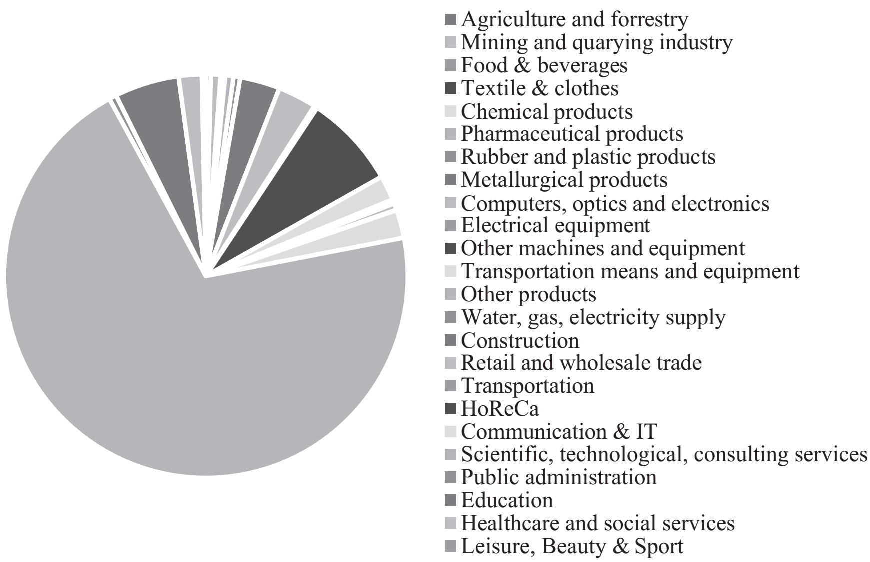
private enterprises. These fiscal stimuli were provided to residents of Free economic zones (exemption/reduction of profit tax, exemption from import tax), the Hi-Tech Park (exemption from income tax, import VAT), technological parks (50% reduction of income tax), manufacturers of innovative products defined by the council of Ministers (exemption from income tax). Another noteworthy policy measure that affected the public sector and was mostly disregarded by the innovative private sector was the Resolution of the Ministry of Finance #75 on the accounting of S&T activities that allowed accounting recognition and amortization R&D results in the form of intangible assets. Before this resolution, all R&D expenditures were treated as current ones increasing production costs. This was considerable support for loss-making and low-margin state-controlled enterprises competing on prices in the former Soviet Union market. To innovative private enterprises operating on the global market and relying on know-hows rather than patents (Inzelt and Apanasovich 2017) this legal action did not matter. They continued conducting R&D activities without reporting the creation of intangible assets and thereby decreasing income tax and avoiding bureaucracy and additional statistical reporting on science and technologies. About 60 legislative acts and norms regulate knowledge transfer and commercialization, intellectual property and respective infrastructure.

12.4 Co-existence of Two Parallel Economies in the Twenty-First Century

The Belarusian authorities' implicit institutional policy has been distinguishing between 'two economies' having different functions. The traditional part of the economy represented by state-owned enterprises ensures employment and gross output, while private enterprises dominate the new part is expected to provide dynamism and be a long-term driver of economic growth (Kruk 2019). This initially unthought concept permeated among different areas, including the S&T and innovation systems, where this gap might be more evidential, engendering crucial challenges for policymakers and main actors. The situation was also regarded as the dual path of technology upgrading driven by either large state-owned, technology-push enterprises relying on extramural R&D activities or flexible demand-pull, small- and medium-sized private enterprises (Inzelt and Apanasovich 2017).

12.4.1 Technology Transfer in the 'Traditional' Economy

The Republic of Belarus appeared one of the very few post-soviet countries that choose the path of keeping large and medium industrial enterprises under the state's roof. This guaranteed a certain degree of employment and industrial output stability in the 1990s and, most importantly, enabled preserving organizational resources (mostly human and physical ones) and capabilities (reputation, networks, business processes). Till the mid-2000s, such enterprises, enjoying financial and organizational state support and the vacuum on the market of the Commonwealth of Independent States (CIS), had been drivers of the socio-economic development. It is not surprising that the state policy in the area of S&T as well as budgetary resources was concentrated on supporting a small group of industrial giants. A high level of vertical integration and engineering potential, fueled with R&D results from state research organizations and universities, enabled to produce and upgrade quite complex but standardized products (haul truck, tractors, harvesters) or develop efficient manufacturing processes (oil processing, metallurgy, chemical industry). The National Academy of Sciences of Belarus (NAS) is part and parcel of the state-controlled S&T system still takes the dominant position in the area of knowledge creation that has about 7800 employees involved in R&D activities – about 28 percent of the total number of personnel involved in R&D in Belarus).[4] The NAS's organizational structure includes more than 100 organizations (research institutes and centers, design bureaus and manufacturing enterprises) established to commercialize R&D results. There are many cases of tasks within SSTP when a state customer is NAS, while executors and manufacturers create a subsystem within a state-controlled R&D system. In general, this application-oriented profile substantially contrasts with the antecedents and peers (Mayntz 1998). The extramural nature of R&D makes such enterprises more rigid and clunky, while they face strong competition in their target markets of the CIS countries. Figure 12.3 demonstrates that the dominating role in knowledge production is played by organizations whose main



Source: Author

Fig. 12.3 Share of intramural R&D expenditures by main sector of activity, as a percentage of total intramural R&D expenditures 2019. (Source: Authors)

[4] Analytical report on situation and development perspectives of science and technologies in the Republic of Belarus. Access mode: http://belisa.org.by/ru/print/?brief=analytical_publ Access date: 25.05.2020.

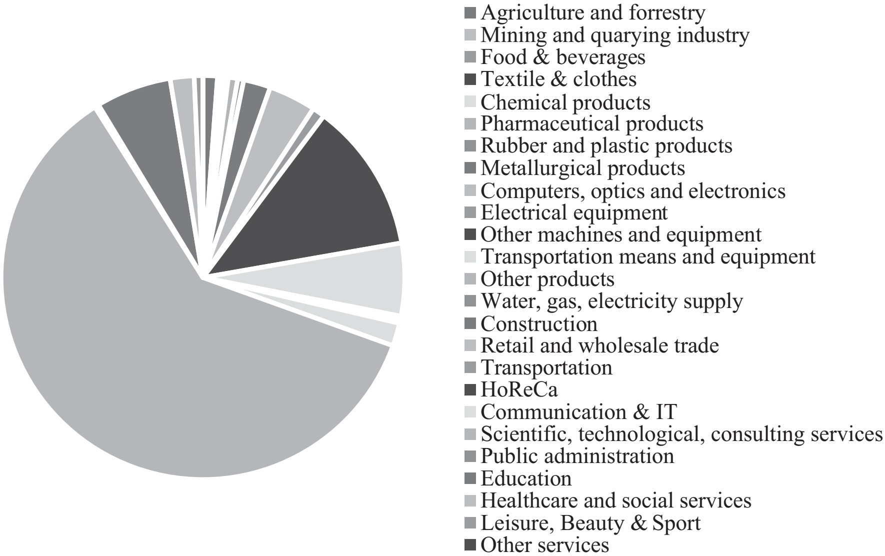
sectors are ‘Scientific, technological, consulting services’ and ‘Education’.[5] Such extramural organizations account for ¾ of total intramural R&D expenditures, of which 52 percent are financed from the state budget and non-budgetary funds (Belstat 2020).

A very similar situation is observed when considering the number of personnel involved in R&D – 2/3 are employed in ‘Scientific, technological, consulting services’ and ‘Education’ (Fig. 12.4). Meanwhile, innovative activities of Belarusian industrial enterprises are largely driven by installation and effective use of new equipment (Palacin and Radosevic 2011). In 2019, 67.5 percent of total expenditures on technological innovations were related to acquisition and installation of equipment and only 11.1% - to R&D activities. Moreover, notwithstanding the positioning of the Belarusian innovation performance as R&D-driven, ‘learning-by-doing’ and ‘learning-by-using’ were more important predictors of the innovation output (Apanasovich et al. 2016). This is another argument questioning the legitimacy of the created heavy-weight extramural and state-funded R&D system. In general, a formalistic approach to implementation of the corporate governance complemented with vague stimuli and conflicting performance indicators set by the state (Ivy 2013) at both state-owned enterprises and research organizations creates an unfavorable environment for radical technological and organizational innovations as well as involvement in global value chains (Apanasovich et al. 2016). Being vertically integrated and driven by maintenance of the employment level and output indicators, large industrial enterprises have no need and motivation to establish links and collaboration with non-affiliated SMEs. Evidentially, this deteriorates the clustering potential of regions and monotowns (Arias et al. 2014). In these locked-in settings, the impact of the state or universities’ innovation support infrastructure (technological parks, centers for technology transfers) is with some exceptions quite limited. As for privately established infrastructure such as accelerators, venture funds, business angels communities, technology incubators, they look extraneous for the ‘traditional’ economy.

In contrast to developed Western countries, universities in post-soviet economies such as Belarus do not have the pretension to be key actors in cutting-edge knowledge and technologies. They remain mostly teaching institutions satisfying a high domestic demand for higher education (Kwiek 2012; Marozau and Guerrero 2016), while R&D activities are concentrated in incorporated centers and institutes at universities that operate in the same conditions and regulatory framework as other state research organizations. Consequently, they have similar focus, structure and target customers. The share of budget funding in intramural R&D expenditures in the higher education sector is even higher (65%) than at research organizations (51.1%) (Belstat 2020) that makes their R&D capabilities more dependent on public money.

Notwithstanding weak entrepreneurial and innovation capabilities and the unreadiness of the institutional environment (Marozau et al. 2019; Guerrero and

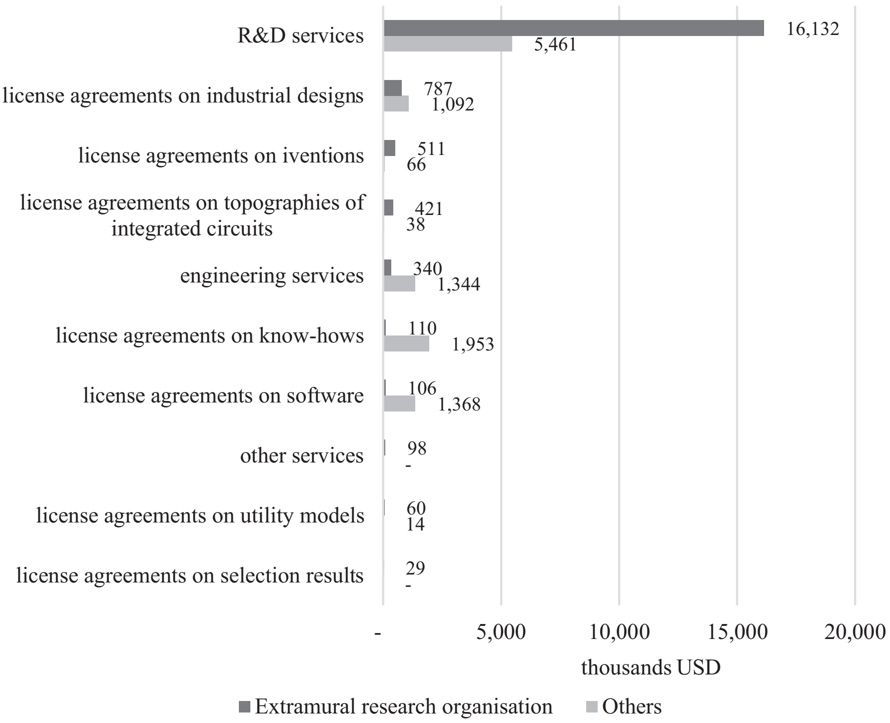
[5] When deciding on the dominating R&D system (extramural vs. enterprise-based), we argue that in case of Belarus it is reasonable to consider these distributions by sectors rather than looking on broad sectors (public, business enterprise, education) because of quite complicated structure of organizational forms and subordination.



Source: Author

Fig. 12.4 Employees involved in R&D expenditures by main sector of activity as a percentage of total employees involved in R&D, 2019. (Source: Authors)

Urbano 2012, 2019), policymakers in Belarus tried to replicate the success of Western Universities in the development of the entrepreneurial mission. In 2018, the Ministry of Education initiated the Experimental project on implementing the "University 3.0" model aimed at the development of research, innovation, and entrepreneurial infrastructure for the creation of innovative products and commercialization of intellectual activities. An important concern related to this project is whether not-for-a-show measures relevant to the current stance of the universities' resources and capabilities and, most importantly, institutional environments can be adopted (Marozau and Guerrero 2019). We argue that the overestimation of the linear path of innovation inherited from the Soviet time combined with the strong commercialization pressures put on the state-owned sector creates a deleterious mixture. Firstly, this withdraws financial resources and policy efforts from a general institutional environment for innovation development. Secondly, excessive pressure has deformed the structure of R&D activities towards development and services (Fig. 12.5) at the expense of the relative decline of basic and applied research activities (Radosevic 2011). Thirdly, this combination stimulates R&D activities to pick low-hanging-fruits and, consequently, orients towards marginal innovation. These circumstances prevent the building of enterprises' innovation capacity from competing on developed high-margin markets, while the undeveloped CIS market for technological knowledge and innovative products allows to some extent to keep the S&T system as it is. Simultaneously, in this extramural R&D system, state research organizations, especially the National Academy of Sciences, and universities have an untapped innovation potential that could repeat the role played 30 years ago in possible new shock therapy.



Source: Authors

Fig. 12.5 Total revenues by activities, 2012 ($N = 531$). (Source: Authors)

12.4.2 Technology Transfer in the 'New Economy'

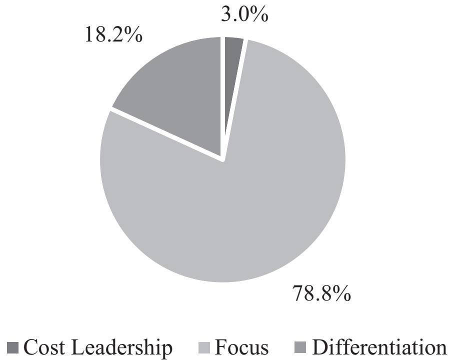
Paradoxically, but the 'new economy' and innovative private enterprises in particular, due to the absence of institutional reforms such as privatization and liberalization of economic activities and general chaos of the late 1980s and early 1990s (Daneyko and Golenchenko 2013). Thousands of researchers and engineers faced the choice: to have 2–3 parallel jobs sometimes unrelated to their competencies, to immigrate, or to try to start up a business using relatively 'free-for-the-taking' knowledge and technologies even from the military sector. As a result, thousands of legally independent companies were established in this period based on engineering competencies obtained at large industrial enterprises or R&D results from research institutes and university laboratories. The latter engendered the most intensive and avalanche-like flow of R&D-based knowledge and technologies to the manufacturing sector. During the 1990s, such new enterprises lured away or absorbed hundreds of high-skilled researchers and engineers and therefore acquire the intramural nature of R&D from their establishment. The collaboration with research organizations and universities were continued rather on an individual basis and appeared marginal.

Evidentially, the stagnant and small domestic market of R&D-based products and services, many of which stemmed from military technologies, appeared only a testbed for Belarusian small innovative firms (Marozau et al. 2021). Since 1998, Belarusian authorities started establishing free economic zones to create a preferential tax and customs regime for export-oriented manufacturing enterprises. Even the CIS market became only a launchpad for further expansion by most competitive knowledge-based enterprises to the global technological market that in many cases were entered with original equipment manufacturing model (OEM-model) or job-lot manufacturing. As a result, the soviet R&D potential was complemented with learning-by-exporting and by interacting within global value chains and preconditioned the success of Belarusian enterprises in the Business to Business (B2B) sector with irradiation, electrooptical, measuring laser equipment. Starting with the low-price strategy, 'no-name' Belarusian enterprises understand their real competitive advantages – their capability to be nimble, flexible, and ready for customization as opposed to foreign industrial giants (Fig. 12.6) (Marozau et al. 2021). In this context, the knowledge and technology transfer contribution from domestic research organizations and universities was marginal since they are considered slippage and lagging behind. SSTP financed from the state budget seemed both risky due to excessive control combined with tough punishment for failure and unreasonably time-consuming. There still is a mutual fear of collaboration and knowledge and technology transfer when it is somehow related to public money since the borders between formal and informal regulations are blurred (Egorov and Carayannis 1999). Also, low awareness and skepticism exist among businesses about state-provided opportunities in science and technology. Technology transfer centers and offices rarely address this challenge (Belitski et al. 2019) due to the lack of market understanding and experience in working with globally competitive private enterprises.

For enterprises that have crossed the formidable developed markets' threshold, the channel of knowledge transfer from foreign end-users (Fig. 12.7) still enables them to generate incremental innovations, increase market shares and take positions among top-5 in certain niches. This required the development of intellectual property rights at international patenting bodies, but the protection of know-hows appeared even greater important and more appropriate to many knowledge-intensive enterprises (Inzelt and Apanasovich 2017). This is arguable, another demarcation line between the public and private sectors. In the public sector cultivating the technology-push model, it is necessary to protect the intellectual property with patents to report on spending budget money and transfer to the industry as intangible assets.

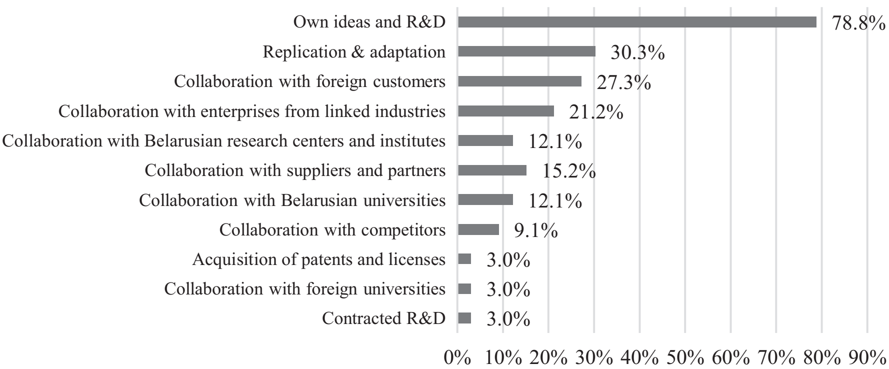
While considering the whole population of manufacturing enterprises (Fig. 12.8), intramural ideas and R&D were also the dominant source of innovative products, followed by redevelopment or replication of competitors' products. The contribution of extramural knowledge and technology producers was inconsiderable.

Moreover, the trend to rely more on intramural R&D instead of acquiring external knowledge can be observed when comparing Belarusian enterprises' responses



Source: Authors

Fig. 12.6 Dominant strategy of private enterprises of the advanced instrument manufacturing and electronics sectors. (Source: Authors)

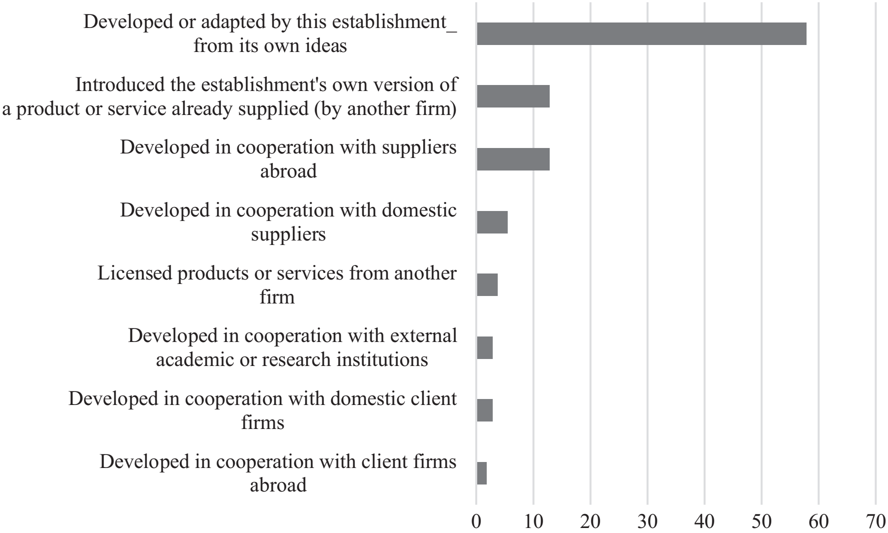


Source: Author

Fig. 12.7 Ways how private enterprises develop innovative products. (Source: Authors)

to the same question with the 5-year differences (Fig. 12.9). In both samples of 2013 and 2018, dominated private enterprises (without state share) – 86.3% and 75.6%, respectively. The basis of the Belarusian BEEPS survey 2018 additionally demonstrates the decisive role of intramural R&D expenditures in the development of new-to-market products or services, while spending on extramural R&D was also found to be related to the innovative output.

Acknowledging the ecosystem's role in the competitiveness of particular entities, innovative private enterprises, including those in the ICT-sector, are becoming key actors of the innovation support infrastructure, establishing or coordinating accelerators, venture funds, sponsored laboratories in universities, fab labs, and mentorship programs. This compensates for the state's passive role and creates prerequisites that do not lose the momentum based on the soviet scientific and technological potential.



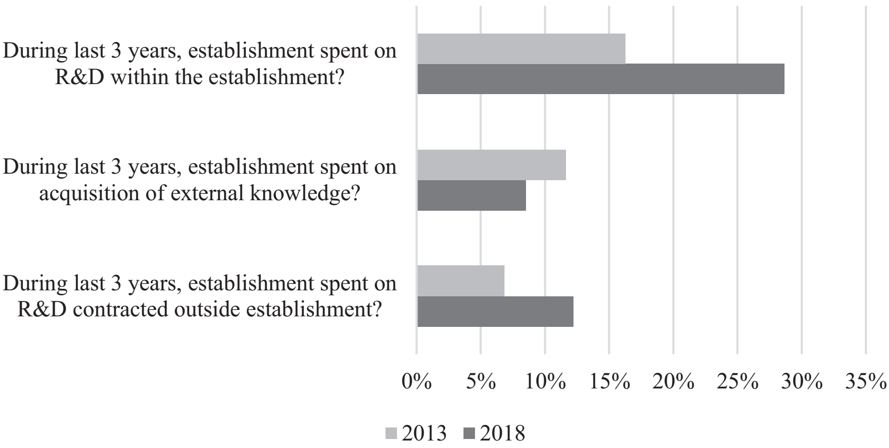
Source: Authors

Fig. 12.8 Ways how manufacturing enterprises develop innovative products, 2012. (Source: Authors)

12.5 Conclusions

The main implication of the present study for policymakers is that the co-existence of two separate technological development paths can last as long as the state has financial resources and willingness to support state-owned enterprises. In the current situation and at least in the short term, this dualism does not significantly extend the development of innovative private businesses due to their inherent distancing from the state S&T system and mostly different market niches. Belarusian knowledge-intensive enterprises are more amenable to fiscal stimuli (custom fees, taxes) than to direct state financing and participation in state programs due to the excessive state control and long bureaucratic processes that do not stimulate any flexibility in the R&D and manufacturing activities. A quite simplified understanding of how R&D activities are designed, transferred to the manufacturing sector and drive technology upgrading is at odds with what private export-oriented enterprises learned from the market. Simultaneously, a potential hotbed for future knowledge-based enterprises could be the state-controlled military industry that is still competitive and effective (Marozau et al. 2021). A certain degree of liberalization of enterprises in this sector, combined with the development of the corporate governance systems are necessary for their expansion and diversification.

However, in pursuit of innovation-driven socioeconomic development, the key long-term policy challenge is to reconcile the ‘traditional’ and ‘new’ economies,



Source: Authors

Fig. 12.9 Expenditures on R&D, 2013–2018. (Source: Authors)

particularly in the area of knowledge and technology generation and transfer. In the hardest and fastest scenario, Belarusian authorities could ‘repeat’ the financial shock of the early 1990s, enforcing research organizations and individual researchers to act more entrepreneurially. The first step in this direction could be the abolishment of widely used practices when most of a budget of state research organizations consist of budgetary funding within the framework of SPSRs or SSTPs. The new wave of potential academic entrepreneurs would find a substantially more developed entrepreneurship- and innovation support ecosystem than it was in the 1990s, including access to financing, training in business management, support infrastructure. However, markets have become more globalized and highly competitive. In general, the development of spin-offs and spin-outs may promote stronger links between the ‘new’ industry and science and bridge the gap between the extramural R&D sector and the market (Parhankangas and Arenius 2003; Steffensen et al. 2000; Treibich et al. 2013). In a soft scenario, risk-acceptation and flexibility of agenda-setting and implementation in state-funded programs and projects combined with securing equal access to funding for private enterprises would at least help to start building trust between representatives of the ‘traditional’ and ‘new’ economies. As a possible measure to raise awareness of businesses on capabilities of research organizations, universities and individual scientists could be providing abundant documented but uncommercialized R&D results (about 2.700 as of June 30, 2019) to enterprises for a nominal fee. With a promotion campaign of the measure and its outcomes, this will probably increase the interest in further collaboration with researchers or organizations. Taking into account many failures in commercializing state-funded R&D activities, policymakers should consider abandoning excessive commercialization pressures. Since the 1990s, such a policy approach to the S&T sphere, on the one hand, has taken a toll on fundamental research and scientific excellence and, on the other hand, has supported the competitiveness of traditional enterprises and sectors. For the current stance, it looks inappropriate due to substantial changes in domestic and international markets. In the future, the allocation of R&D-related rights and profits results should be clear-cut and irrevocably assigned to executors or co-financing enterprises whose relationships should be regulated by the Civil Code. Moreover, special state-funded programs or reconfigured SPSRs should support individual researchers and engineers from state-owned organizations and universities by assigning them intellectual property rights.

The incompleteness of market reforms (slow-footed privatization, underdeveloped stock-market, massive financial support to inefficient state-owned enterprises and even whole sectors) remains the main impediment on the declared way towards an innovation-based economy (Lenchuk 2006). Simultaneously, arbitrary state intervention is not aimed at establishing mechanisms of transferring both financial and knowledge flow from the 'traditional' economy to the 'new' one but rather aimed at preserving the 'traditional' enterprises with marginal upgrades. In this context, policy attempts to integrate foreign best practices of innovation-based development have not resulted in similar outcomes since they have appeared irrelevant to formal and informal institutions in Belarus as a country gradually transitioning to the market economy. Since the process of knowledge and technology transfer depends on the entrepreneurial behavior of scientists and engineers (Guerrero and Urbano 2014; Belitski et al. 2019) as well as the entrepreneurial orientation of research organizations and universities (Lockett et al. 2003; Bozeman et al. 2013; Guerrero et al. 2015), the vibrant entrepreneurial sector and general entrepreneurial culture should be developed in the first instance (McMillan and Woodruff 2002; Guerrero et al. 2008; Krammer 2009; Urbano and Guerrero 2013). In Belarus, cultural and social norms such as lack of trust, fear of failure, paternalism at the individual, organizational and state levels are still barriers to entrepreneurship development (Akulava et al. 2020). Therefore, recent advances in creating a favorable normative and regulatory environment have not given rise to an upsurge of technology-based entrepreneurial activity (Guerrero et al. 2020). In this regard, we argue that till the Global financial crisis, the state policy in the area of knowledge generation and transfer appeared timely and opportune that enabled to preserve the industrial potential and output and consequently to secure socio-economic development. However, substantial reconfiguration of markets, value chains and business models and international relations in the recent decade has challenged the Belarusian economy's structure and is steadily inclining it to the 'new' one.

Acknowledgments The authors acknowledge the support from the Belarusian Economic Research and Outreach Center (BEROC). Radzivon Marozau acknowledges the financial support by SIDA. Natalja Apanasovich expresses gratitude to the Belarusian Republican Foundation for Fundamental Research for the support provided within the framework of the project Developing and re-evaluating STI Policy Instruments and Models for Fostering Academia-Industry Cooperation. Maribel Guerrero acknowledges the Facultad de Economía y Negocios at the Universidad del Desarrollo (Chile), the Northumbria Centre for Innovation, Regional Transformation and Entrepreneurship based on Newcastle Business School at Northumbria University (UK), and the Centre for Innovation Research (CIRCLE) at Lund University (SE) for their invaluable support.

References

Akulava, M., Marozau, R., Abrashkevich. A., & Guerrero, M. (2020). *Global Entrepreneurship Monitor*. GEM Report Belarus 2019/2020. https://www.gemconsortium.org/file/open?fileId=50500. Accessed Oct 27 2020.

Apanasovich, N., Heras, H. A., & Parrilli, M. D. (2016). The impact of business innovation modes on SME innovation performance in post-soviet transition economies: The case of Belarus. *Technovation, 57*, 30–40.

Arias, M., Atienza, M., & Cademartori, J. (2014). Large mining enterprises and regional development in Chile: Between the enclave and cluster. *Journal of Economic Geography, 14*(1), 73–95.

Audretsch, D. B., Lehmann, E. E., & Wright, M. (2012). Technology transfer in a global economy. *The Journal of Technology Transfer, 39*(3), 301–312.

Belitski, M., Aginskaja, A., & Marozau, R. (2019). Commercializing university research in transition economies: Technology transfer offices or direct industrial funding? *Research Policy, 48*(3), 601–615.

Belstat. (2020). *On scientific and innovation activity in 2019*. Statistical bulletin by State Statistical Committee of the Republic of Belarus.

Bozeman, B., Fay, D., & Slade, C. P. (2013). Research collaboration in universities and academic entrepreneurship: The-state-of-the-art. *The Journal of Technology Transfer, 38*(1), 1–67.

Daneyko, P., & Golenchenko, P. (2013). Hidden champions of Belarus. In P. McKiernan & D. Purg (Eds.), *Hidden champions in CEE and Turkey* (pp. 127–140). Berlin, Heidelberg: Springer.

Debackere, K., & Veugelers, R. (2005). The role of academic technology transfer organizations in improving industry science links. *Research Policy, 34*(3), 321–342.

Djarova, J. (2011). National innovation system and innovation governance. In *UN Innovation performance review of Belarus* (pp. 21–42). Geneva: United Nations.

Dobrinsky, R., & Stahlecker, T. (2017). Policy frameworks, programming and initiatives. In *Innovation for sustainable development – Review of Belarus* (pp. 19–64). New York and Geneva: United Nations.

Dosi, G., Llerena, P., & Labini, M. S. (2006). The relationships between science, technologies and their industrial exploitation: An illustration through the myths and realities of the so-called 'European Paradox'. *Research Policy, 35*(10), 1450–1464.

Egorov, I., & Carayannis, E. G. (1999). Transforming the post-soviet research systems through incubating technological entrepreneurship. *The Journal of Technology Transfer, 24*(2–3), 159–172.

Grudzinskii, A. (2005). The University as an entrepreneurial organization. *Russian Education and Society, 47*(1), 7–25.

Guerrero, M., Rialp, J., & Urbano, D. (2008). The impact of desirability and feasibility on entrepreneurial intentions: A structural equation model. *International Entrepreneurship and Management Journal,* 4(1), 35-50.

Guerrero, M., & Urbano, D. (2012). The development of an entrepreneurial university. *The journal of technology transfer*, 37(1), 43–74.

Guerrero, M., & Urbano, D. (2014). Academics' start-up intentions and knowledge filters: An individual perspective of the knowledge spillover theory of entrepreneurship. *Small Business Economics, 43*(1), 57–74.

Guerrero, M., Cunningham, J. A., & Urbano, D. (2015). Economic impact of entrepreneurial universities' activities: An exploratory study of the United Kingdom. *Research Policy,* 44(3), 748–764.

Guerrero, M., & Urbano, D. (2019). Effectiveness of technology transfer policies and legislation in fostering entrepreneurial innovations across continents: An overview. *The Journal of Technology Transfer, 44*, 1347–1366.

Guerrero, M., Liñán, F., & Cáceres-Carrasco, F. R. (2020). The influence of ecosystems on the entrepreneurship process: a comparison across developed and developing economies. *Small Business Economics*, https://doi.org/10.1007/s11187-020-00392-2

Hanson, P., & Pavitt, K. (1987). *The comparative economics of research development and innovation in East and West: A survey*. Chur: Harwood Academic Publishers.
Harryson, S., Kliknaite, S., & von Zedtwitz, M. (2008). How technology-based university research drives innovation in Europe and China: Leveraging the power of proximity. *Journal of Technology Management in China, 3*(1), 12–46.
Inzelt, A., & Apanasovich, N. (2017). Innovation in the enterprise sector. In *Innovation for sustainable development – Review of Belarus* (pp. 107–144). New York and Geneva: United Nations.
Ivy, J. (2013). State-controlled economies vs. rent-seeking states: Why small and medium enterprises might support state officials. *Entrepreneurship and Regional Development, 25*(3–4), 195–221.
Jensen, M. B., Johnson, B., et al. (2007). Forms of knowledge and modes of innovation. *Research Policy, 36*(5), 680–693.
Krammer, S. M. (2009). Drivers of national innovation in transition: Evidence from a panel of Eastern European countries. *Research Policy, 38*(5), 845–860.
Kruk, D. (2019). *Belarusian Economy in mid-2019: The aftermath of recovery growth period*. BEROC Policy Paper Series, PP no.69 http://www.beroc.by/upload/iblock/251/2519dc1eb2a5355d3172413e91ced8d1.pdf. Accessed Oct 27 2020.
Kwiek, M. (2012). Universities and knowledge production in Central Europe. *European Educational Research Journal, 11*(1), 111–126.
Lenchuk, E. B. (2006). Problems of transition to an innovative development model in post-soviet states. *Studies on Russian Economic Development, 17*(4), 427–438.
Lengyel, B., & Cadil, V. (2009). Innovation policy challenges in transition countries: Foreign business R&D in the Czech Republic and Hungary. *Transition Studies Review, 16*(1), 174–188.
Lockett, A., Wright, M., & Franklin, S. (2003). Technology transfer and universities' spin-out strategies. *Small Business Economics, 20*(2), 185–200.
Lundvall, B. A. (1999). National business systems and national systems of innovation. *International Studies of Management and Organization, 29*(2), 60–77.
Marozau, R., Guerrero, M., Urbano, D., & Ibañez, A. (2019). Evolving entrepreneurial activities at post-soviet universities. In J. Maxwell (Ed.), *Higher education institutions: Perspectives, opportunities and challenges* (pp. 201–246). New York: Nova Science Publishers.
Marozau, R, & Guerrero, M. (2019). *Development of the entrepreneurial university (University 3.0) in Belarus: An overview of determinants and challenges*. BEROC Policy Paper Series, PP no.74 http://www.beroc.by/upload/iblock/799/79924eea6ca4d6f6163255463845de5f.pdf. Accessed Oct 27 2020.
Marozau, R., Guerrero, M., & Urbano, D. (2016). Impacts of universities in different stages of economic development. *Journal of the Knowledge Economy*. https://doi.org/10.1007/s13132-016-0359-7.
Marozau, R., & Guerrero, M. (2016). Conditioning factors of knowledge transfer and commercialisation in the context of post-socialist economies: The case of Belarusian higher education institutions. *International Journal of Entrepreneurship and Small Business, 27*(4), 441–462.
Marozau, R., Aginskaja, A., et al. (2021). Hidden champions of Belarus. In A. Braček Lalić and D. Purg (Eds.), *Hidden Champions in dynamically changing societies: Critical success factors for market leadership*. Springer. (in press).
Martinsons, M. G., & Valdemars, K. (1992). Technology and innovation mismanagement in the Soviet enterprise. *International Journal of Technology Management, 7*(4–5), 359–369.
Mayntz, R. (1998). Socialist academies of sciences: The enforced orientation of basic research at user needs. *Research Policy, 27*(8), 781–791.
McMillan, J., & Woodruff, C. (2002). The central role of entrepreneurs in transition economies. *Journal of Economic Perspectives, 16*(3), 153–170.
Palacín, J., & Radosevic, S. (2011). Recent economic and innovation performance. In *UN Innovation performance review of Belarus* (pp. 1–18). Geneva: United Nations.
Parhankangas, A., & Arenius, P. (2003). From a corporate venture to an independent company: A base for a taxonomy for corporate spin-off firms. *Research Policy, 32*(3), 463–481.

Perkmann, M., & Walsh, K. (2007). University–industry relationships and open innovation: Towards a research agenda. *International Journal of Management Reviews, 9*(4), 259–280.
Pobol, A. (2011). Innovation and international economic integration. In *UN Innovation performance review of Belarus* (pp. 113–132). Geneva: United Nations.
Radas, S., & Božić, L. (2009). The antecedents of SME innovativeness in an emerging transition economy. *Technovation, 29*(6), 438–450.
Radosevic, S. (1998). The transformation of national systems of innovation in Eastern Europe: between restructuring and erosion. *Industrial and Corporate Change,* 7(1), 77–108.
Radosevic. (2017). Measuring innovation performance. In *Innovation for sustainable development – Review of Belarus* (pp. 65–106). New York and Geneva: United Nations.
Radosevic, S. (1996). Restructuring of R&D institutes in post-socialist economies: Emerging patterns and issues. In A. Webster (Ed.), *Building new bases for innovation: The transformation of the R&D system in post-socialist states* (pp. 8–30). Cambridge: Anglia Polytechnic University.
Radosevic, S. (2011). Knowledge generation and transfer. In *UN Innovation performance review of Belarus* (pp. 61–78). Geneva: United Nations.
Steffensen, M., Rogers, E. M., & Speakman, K. (2000). Spin-offs from research centers at a research university. *Journal of Business Venturing, 15*(1), 93–111.
Treibich, T., Konrad, K., & Truffer, B. (2013). A dynamic view on interactions between academic spin-offs and their parent organizations. *Technovation, 33*(12), 450–462.
Urbano, D., & Guerrero, M. (2013). Entrepreneurial universities: Socioeconomic impacts of academic entrepreneurship in a European region. *Economic development quarterly*, 27(1), 40–55.
Zhou, C., & Peng, X. (2008). The entrepreneurial university in China: Nonlinear paths. *Science and Public Policy, 35*(9), 637–646.

Chapter 13
Technology Transfer Policy Framework at Cuban Universities

Damaris Cruz-Amarán and Maribel Guerrero

13.1 Introduction

Universities have evolved traditional forms of links with the state, business, and society (Brunner 1993; Didriksson 2012; Audretsch 2014; Guerrero and Urbano 2019b). All economic systems that have established technology transfer frameworks activity have also promoted the linkage between entrepreneurial innovations and economic development (Nelles and Vorley 2010; Guerrero et al. 2015, 2016; Reyes 2017; Papa 2018) through the creation, delivery, and capture of value (Clark 2001; Mets 2010; Gibson and Foss 2017). As a result, universities have become managers and suppliers of technologies. In this respect, Díaz-Canel and Núñez (2020, p.e884) state:

> Science stopped being an almost exclusive matter of scientists (...), to become a matter of State (...)

The government's regulatory, mediating, and funding roles are exerted through effective policy frameworks to develop science and the transfer and exploit its results for social and economic purposes. The design and implementation of

D. Cruz-Amarán (✉)
Departamento de Ciencias Empresariales, Universidad de las Ciencias Informáticas (UCI), La Habana, Cuba
e-mail: damaris@uci.cu

M. Guerrero
Facultad de Economía y Negocios, Universidad del Desarrollo, Santiago, Chile

Northumbria Centre for Innovation, Regional Transformation and Entrepreneurship (iNCITE), Newcastle Business School, Northumbria University, Newcastle upon Tyne, UK

Centre for Innovation Research (CIRCLE), Lund University, Lund, Sweden
e-mail: maribel.guerrero@northumbria.ac.uk

M. Guerrero, D. Urbano (eds.), *Technology Transfer and Entrepreneurial Innovations*, International Studies in Entrepreneurship 51,
https://doi.org/10.1007/978-3-030-70022-5_13

technology transfer policies must respond to specific economic models at the national level based on resources and capacities (Alpizar 2019). However, public policies' conceptualization matters in terms of decisions, strategies, actions, and instruments (Marinetto 1999; Hugh 1972; Kraft and Furlong 2007). In this chapter, we adopted the conceptualization proposed by May (2003, p. 226):

> Public policies establish the courses of action to address problems or to provide goods and services to segments of society. Policies do more than simply announce a course of action. They typically contain a set of objective intentions, a mix of instruments or means for achieving the intentions, a designation of governmental or non-governmental entities responsible for carrying out the intentions and allocating resources for the required tasks and goals. The intention is then characterized by the name of the policy, by the language used to communicate the objectives of the policy and the particular combination of policy instruments.

Technology transfer policies have been shaped by historical-economic-social contexts, public policies, and endogenous transformations (Guerrero and Urbano 2019a). Indeed, technology transfer policy frameworks are part of a broader legislative framework for science, technology, and innovation (Ferreira et al. 2018), and it explains why the literature shows a lack of consensus about the effectiveness of these policies (Etzkowitz and Zhou 2008; Marozau and Guerrero 2016), especially in emerging economies. Inspired by this gap, this chapter analyzes the technology transfer policy framework's evolutionary process in Cuba. This chapter reviews the technology transfer policies framework, the university technology transfer, and the socio-economic transformation during the last three decades (1990–2020) by adopting a retrospective longitudinal (Leonard-Barton 1990) and triangulation analysis (Yin 2017).

In 1960, President Fidel Castro implemented a strategic vision related to science in Cuba (Castro 1960). Firstly, the Cuban policy framework focused on the Science, Technology, and Innovation System (STIS) configuration, the development of qualified human capital, and funding (Cuban Academy of Sciences 2013). Then, in the 1990s, the STIS established a strong cohesion with the Higher Education System and socio-economic actors. Consequently, the university should adapt its structures/functions to become a key educational, social, and economic actor agent within the SCTI. From 1994 to 2020, the policy framework was gradually transforming into an open and pluralistic system to legitimize and institutionalize how to commercialize the technology, how to establish incentives and instruments applied in other countries (i.e., technology transfer offices, scientific/technological parks), and how to incentivize researchers.

Over the last three decades, influenced by this policy framework, the Cuban university had shaped its identity through an internal transformation (new organizational structures) motivated by the government's demands, the peripherical development, and the essential interrelations with socio-economic agents for sustainability (Clark 1998). The first university identity was adopting a non-profit orientation and a social logic in its operation. Then, identity evolves into a hybrid social innovation orientation until configuring a social, innovative, and entrepreneurial identity (Cruz-Amarán et al. 2020).

Following this introduction, the chapter is structured as follows: Section 13.2 describes the evolutionary phases of the science, technology, and innovation policy framework in Cuba. Section 13.3 shows the new governance framework related to the consolidation of the Science, Technology, and Innovation System. Section 13.4 highlights the current challenges and concluding remarks.

13.2 The Configuration of Science and Technology Framework

The former socialist bloc constituted a group that functioned cohesively in policy, international cooperation, and trade. Although socialist countries had similar patterns in socio-economic and political issues, since its insertion, Cuba had unique characteristics given its context (an economic blockade and underdeveloped economy), its productive factors (an exodus of talent and professionals), and its low developed infrastructures (an inherited from the republican period and the dependency to the US economy). Cuba and the former European socialist economies shared common aspects regarding the science and innovation policy frameworks. For example, imported foreign technologies that slowed down the development of endogenous technologies and a planned centralization of the economy (Teo and Ren 2019).

In the 1990s, European socialist economies moved towards a capitalist economy representing infrastructural and organizational changes in research, technology, innovation processes, capacities, and resources (Svarc and Dabić 2019). Afterward, Cuba stopped the importation of technologies as well as strategic scientific and industrial projects. Under advantageous conditions, previous commercial relations diminished technological capabilities and infrastructure (Brito et al. 1998). Cuba faced a pronounced economic crisis period maintaining socialism as a way of sustainability. Consequently, Cuba implemented several transformations to strengthen its internal scientific and technological capabilities, focusing on innovation and a socialist market economy.

The development of the Cuban Science, Technology, and Innovation System was oriented to convert the science/research outcomes into strategic sectors that transform the productive matrix (García Capote 2015). According to President Castro (1960) projections and García Capote (2015) considerations,

> Making Cuba a producer of strategic knowledge and an exporter of professional services has involved the establishment of channels of communication, distribution, market, and feedback between the different actors, the design of mechanisms of interaction (and structures) for the use of science and its results in the production, transfer, and absorption of goods, services, and knowledge for its equitable-social distribution and appropriation for the country's overall growth and development.

Over the last three decades, literature related to the Cuban science, technology, and innovation has been oriented to study the university-industry relationship (Dutrénit

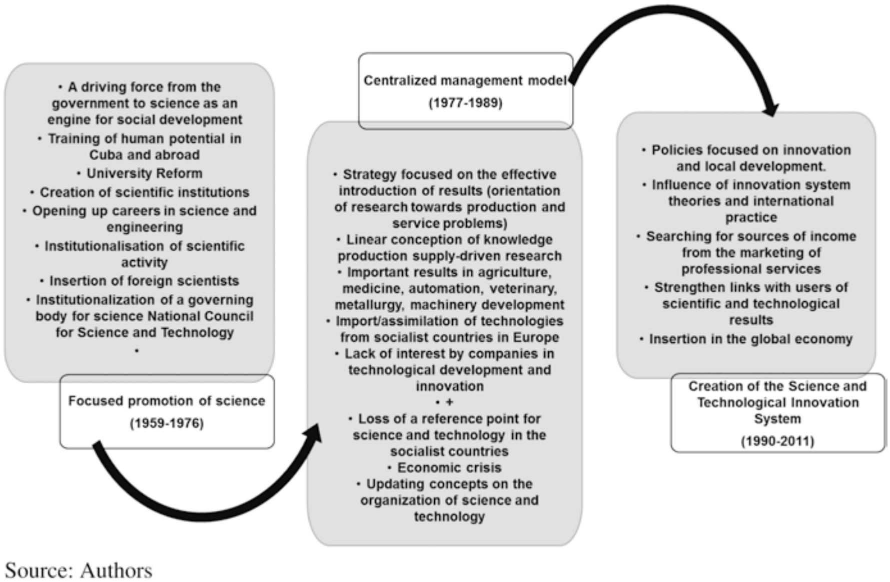


Fig. 13.1 Phases of Science, Technology, and Innovation Policy Framework in Cuba. (Source: Authors)

and Núñez 2017; Alpizar et al. 2018), the role of the university on local development (Núñez and Alcázar 2018), and public policy analysis (García Capote 2015; Enamorado et al. 2018; Alpízar 2019). According to previous studies (García 2007; García Capote 2015; Núñez and Montalvo 2015), the development of Cuban science, technology, and innovation policies had three phases: (1) the promotion of science, (2) the centralized management model, and (3) the construction of the Science and Technological Innovation System (see Fig. 13.1).

The policy framework was driven by the U.S. economic and political legislation blockage against Cuba, the country's insertion in the socialist bloc, and the fall of the socialist bloc. The policy framework established how to manage science and technology, assimilate technologies from abroad, insert into the international market, and generate new income (García Capote 2015).

13.2.1 Promotion of Science

The first phase (1959–1976) was enactment by the Agrarian Reform Law, the Nationalization Law led the departure of foreign/national professionals, and critical educational system (García del Portal et al. 1993). Consequently, the public policies that emerged in this phase addressed higher education's transformation according to the social project's needs to build an inclusive/equitable society and develop scientific/technical capacities. This phase was characterized by top-bottom intervention, control, and implementation from the President and Minister of Industries (García Capote 2015). The centralization favored the distribution of resources, the social configuration, and science decision-making. The active intervention of different actors favored the transformation process, autochthonous economic, and social development (Almuiñas et al. 1993).

The 1962 Reform of Higher Education was the major organizational innovation during the Revolutionary period because it initiated the institutionalization of research and defined the university's primary role as a social and scientific organization. In this respect, states:

> The university in Cuban society today is the vehicle through which modern science and technology, in their highest manifestations, must be placed at the service of the people of Cuba (González 1993, p.28).

> This reform transforms the relations of the university with society into (...) a phenomenon of constant adaptation and influence of the former to the changes of the latter and of reciprocal influence (García del Portal et al. 1993, p. 27).

This phase generated good results in developing scientific capabilities and in two strategic sectors related to health (creation of the National Health System) and education (eradicating illiteracy, improving the educational system, and the university's transformation and contribution to social change). This phase also showed deficiencies in science and technology management (Rojas 1978, p.428):

> (...) lack of planning and control of scientific activity, duplication of research efforts, the existence of priority aspects that have not been addressed with sufficient impact, the underutilization of available resources (both material and human), the limited application of research results to social practice, the relative absence of scientific rigor in research, and deficient scientific-technical information.

The resolutions from the First Congress of the Communist Party of Cuba (PCC) and the First Republic Constitution of the Republic after 1959 represented the bridge between the first and the second evolutionary phases. According to Rojas (1978, p.426), the PCC resolutions evaluated the advances in the National Scientific Policy Framework as follows:

> (a) …the workforce qualification plans to generate new organizational forms and technical infrastructure…(b)… the establishment of scientific degrees, teaching and research categories… (c)… expanding the sphere of action of universities to production centers … linking teaching to production and research… and the interaction of workplaces and study centers… (d)… people dedicated to research and development grouped in research organizations and scientific/technical services integrated into the Academy of Sciences, universities, and state agencies…. (e) … the establishment of the National Council for Science and Technology, the governing and regulatory body for science and technology activity…

Contradictory to the speeches and scientific policy desired, the PCC Resolutions include the technology transfer principle that favors foreign technologies' assimilation. Although the valid/timely learning process during assimilation, the technology transfer principle made the country dependent on foreign technology transfer, especially from countries in the socialist field, and limited national technologies. In this regard, the Constitution establishes (Constitución de la República de Cuba 1976, p.32):

> education is a function of the State and is free of charge. It is based on the conclusions and contributions of science and the closer relationship of study with life, work, and production.

In this vein, the new Constitution provided the legal framework to the Cuban reality and generated great interaction among actors involved in education, science, and technology.

13.2.2 Centralized Management

The second phase (1977–1989) occurred within the new constitutional environment and a centralized policy approach. The centralized management model attempts to solve the problems of the first phase: the ordering of research, the establishment of priorities, and implementing technology transfer in line with the results obtained in the research centers (García 2007). The Cuban scientific potential, the capacities achieved, and the results from research centers experienced a limited transference. Without an evaluation of the effectiveness, it is difficult to understand the value creation process.

The biotechnology sector emerged from the government's strategic vision and management of resources/capacities within research centers in biology, chemistry, and medicine. Consequently, the policy framework stimulates the creation of the Biological Front, as well as the Center for Biological Research (CIB) turned into the Center for Genetic Engineering and Biotechnology (CIGB) (García 2007). These institutions were decisive in developing Cuba's Biotechnology and Pharmacology Industry. In this regard, Pérez (2018, p.30) describes the instruments and incentives that characterized this period:

> ... strong state investment, directly attended by the Council of State and with special attributions, which allowed recovery of the investment through the export of goods and services, through government agreements, fundamentally, and the creation of a high technology industrial sector, capable of valuing in its transactions not only the products but also its intangible assets…

Regarding the knowledge/technology transfer process, the generation of knowledge was disseminated through publications and transferred into the teaching-learning process by updating contents/methodologies in medicine, biology, and pharmaceutical. The university absorbed the knowledge transference and formed a qualified human capital for its insertion in the job market (García Capote 2015, p.8):

> "…national scientific-technical program" (research) projects the necessary relations between the bank of fundamental problems to be investigated in the production and service sectors with the scientific centers and those responsible for transferring the results, provides "greater integrality and better recognition of the role of producers and users, and (...) the incorporation of these and other agents of technological change…"

The implementation lies in the fact that it manages to promote the development of the economy's sectors in an integral and relevant manner.

13.2.3 The Science, Technological and Innovation System

The economic crisis influenced the third phase (1990–2011), and all productive sectors were transformed (Marquetti 2003, pp. 14–15):

> …the development of the crisis imposed on the different ministerial and business institutions to explore new options in terms of revenue collection, mainly denominated in foreign currency. This objective situation made it possible, in many cases, to "spontaneously" start using the potential available in terms of technical advice, the offer of specialized design, and engineering services...

All efforts were focused on build a Science, Technology, and Innovation System (SCTI) (Núñez and Montalvo 2015). New policies and organizational forms emerged during this phase. Specifically, cooperation networks (called Poles) were integrated by universities, research centers, and companies to generate scientific results. The Ministry of Science, Technology, and Environment (CITMA) played an essential role in defining policy frameworks and constructing the SCTI. As a result, the Ministry of Higher Education (MES) introduced important changes into universities based on the new requirements (Marquetti 2003), such as expanding relations with productive/social actors, establishing channels with them, diversifying sources of income through technology transfer activities, and linking technology transfer and new academic degrees/programs through the International Center of Havana (CIH). In this respect, the Minister of Higher Education stated (Vecino 1996, p.4):

> ... our faculty and students have assumed the need to promote and diversify the acquisition of foreign currency in their respective universities...

The original idea was to apply a complementary self-financing system in which all the centers would participate (Santos et al. 2004), and limits were set to not deviate from their essential missions (Martín et al. 1996). The most transcendental transformation was full access to higher education in all country municipalities through the Municipal University Centers (SUM). A greater change was the use of universities' scientific/technological capacities and resources to pursue local development. The University Management of Knowledge and Innovation for Development (GUCID) promoted technology transfer among local actors. This experience established the SCIT at its micro level, placed local development on the State's public agenda, and promoted the local development variable's incorporation in the Higher Education System (Fernández and Núñez 2020). Another transcendental transformation was the creation of the University of Informatics Science (UCI). The UCI represented a disruptive new business innovation model (born with a social, innovative, and entrepreneurial identity) promoted by the Government through the Ministry of Education and the Ministry of Communications, as well as conceived as a university of excellence for introducing the computerization policy in the Cuban society, the training of computer's capacities, and promoting the computer industry (Cruz-Amarán et al. 2020). The Latin America Higher Education Report recognized the UCI as a technology park for computer science and software generation(Macaya and Herrera 2015).

This evolutionary review shows that the government centralized the three initial phases that configured the technology transfer policy framework based on strategic sectors (Biotechnology, Health, Education, Culture, Sports, and Information Technology) and looking to improve capabilities, resources, and infrastructures, and networks. The aims were equitable access, distribution, and appropriation of scientific knowledge, technologies, and innovations among productive and social actors. In this respect, Núñez and Montalvo (2015, p.6) argued:

> …the Cuban Science and Technology System received extensive state support in human resources, expenditures, and short/long-term investments for its development and strengthening. Despite this, the system worked as a kind of "black box" in which significant amounts of resources were allocated, without the expected results…

In this vein, the most challenging areas were related to the learning process, the dependence on foreign technology, the discrete development of endogenous technology, the weak interaction between the productive sector and the knowledge producers, the dependence on public funds, and the inertia to change. However, the effectiveness of policy frameworks is not shown at the country level (scientific capacity, human talent, the value-added included) (Enamorado et al. 2018).

13.3 Technology Transfer Policy Framework at Cuban Universities

13.3.1 Legitimization of University Technology Transfer

The evolution in the technology transfer policy framework also determined four transformation pathways at the Cuban university: the development of the social link, development of the socio-economic link, the impulse to innovation, and the promotion of technology transfer. By adopting a stakeholder orientation (Freeman 1984), a new university business innovation model emerged to respond to societal demands, environmental challenges, and new core activities (Miller et al. 2014). Consequently, the Cuban university has assumed a new social identity and an entrepreneurial innovation identity (Cruz-Amaran et al. 2020).

The fourth phase in the evolution of the technology transfer policy framework was related to the legitimization of the university technology transfer in the most updated social and economic policy guidelines of the Communist Party of Cuba in 2011. The guidelines integrated the Cuban university into the new mechanisms and the forms of organization of science. Specifically, Chapter V and Guideline 129 determine (Cuban Communist Party 2016, p.21):

> … to design an integral policy of science, technology, innovation, and environment that takes into consideration the acceleration of its processes of change and growing interrelationship in order to respond to the needs of the development of the economy and society in the short, medium and long term; oriented to increase economic efficiency, expand exports of high added value, substitute imports, satisfy the needs of the population and encourage their participation in the socialist construction, protecting the environment, the national heritage and culture…

This updated regulatory framework establishes a new "social contract" between the government (regulator) and universities (producer) regarding science, technology, and innovation (Brunner 1993). In this view, government controls the quality of processes and economic-social impacts inside/outside the country, while the university should provide diverse sources of income (with certain autonomy) and engage relationships with productive and social actors (Alpízar and Ramos 2016). As a result, universities should establish internal mechanisms to adapt/comply with new roles: the generation of sustained socio-economic contributions, knowledge/technology transfer to society and productive actors, and updating teaching programs. Regarding the periphery development, Noda (2016, p.15) argues:

> ... universities are actively working on how to guarantee the connection of scientific results with economic and social development [closing the cycle], looking for the most appropriate and effective ways of transferring knowledge, creating interface structures and improving their management, as well as stimulating the teachers and researchers involved, generating better training for research and promoting a culture of closing research…

In sum, the updated policy framework legitimizes the linkage between university models and innovation systems for achieving inclusive and sustainable development (Saborido Loidi and Alarcón 2018). These trends are quite similar to international experiences with unique insights related to a socialist economy (Friedman and Silberman 2003; Calcagnini and Favaretto 2015; Choudhry and Ponzio 2019; Cruz-Amarán et al. 2020). The most marked difference is the absence of policy frameworks that fostering universities' spin-offs or universities' technology-based ventures. Table 13.1 summarizes the internal/external effects of the Technology Transfer Policy Framework at the Cuban university.

13.3.2 The Future of the Technology Transfer Policy Framework

The policy framework's most updated evolution phase is related to the university technology transfer's institutionalization due to the new constitutional and governance established in the Council of Ministers (2019). This update is focused on developing the domestic industry to satisfy the country's needs through the substitution of importations using the national scientific/technological capabilities achieved during the last six decades, the exportation of professional services, and the attraction of foreign investment (Council of Ministers 2019). These actions are conceived as a continuity of the National Plan for Economic and Social Development until

Table 13.1 The influence of technology transfer framework at the Cuban University

Key elements	Policy framework effects
Externs	State and Party Economic and Social Policy Guidelines Knowledge-technology transfer regulations (Decreto) No. 363/2019/ Resolution 286/2019/ Resolution 287/2019/ Resolution 434/2019) Change labor market conditions Policy for the computerization of Cuban society Indicators of evaluation of the university-business link University quality accreditations Science and Technology Parks Strategic projection of the Ministry of Higher Education (MES) Havana International Center
Interns	Different types of transfer infrastructure: DTT, OTRI, marketing offices, Transfer and Marketing Department, Incubator. University resolutions on Science and Innovation. Undergraduate and postgraduate thesis Lack of financing Incentives and incentives for researchers and producers Teacher evaluation

Source: Authors

2030, which looked for updating its economic development model and its sustainability through scientific/technological outcomes (Cuban Communist Party 2016).

In this new phase, policy transparency will be gathered through multiple agents (government bodies, scientists, academics, professionals, technologists, and representatives of the National Assembly of People's Power) and will be endorsed through the society's participation surveys. According to the Council of Ministers (2019), the STIS will assume a proactive, integrated, and sustained role to achieve all actors' involvement. According to the Ministry of Science, Technology, Innovation, and Environment (2020), the 2017 innovation survey[1] showed no substantial variations or significant progress/changes in priorities regarding the 2006 innovation survey. A continuous prevalence of incremental innovations and barriers related to the lack of knowledge/business/innovation management, the lack of technological resources and capabilities, and the lack of articulation between the academic-scientific sector and interfaces (Ministry of Science, Technology, Innovation, and Environment 2020). Enamorado et al. (2018) founded similar findings in the province of Santiago de Cuba.

The Ministry of Higher Education (2017) has implemented several policy instruments applicable/evaluated until 2021 related to the scientific council for universities, the awards system within STIS, the set of efficiency research indicators, intellectual property resolutions, the scientific publications' registrations, and the

[1] The survey covers the period from January 2015 to December 2017 to a sample of 477 national companies, including state-owned socialist companies, commercial companies with Cuban capital, companies with mixed capital, and companies with totally foreign capital (Ministry of Science, Technology, Innovation, and Environment 2020).

doctoral training. The new policy framework's priorities have legitimized/updated universities' missions (Fernández et al. 2018) and expanded universities' visions to achieve the 2021 indicators (Alpízar 2019). Universities have also gained autonomy in knowledge management and sources of funding.

The Ministry of Finance and Prices' resolution 128 (Ministry of Finance and Prices 2020) represents an unprecedented policy regarding the STIs' management by establishing science as a self-financed activity from which the university benefits directly. In the past, universities generated income from transfers without using the income in its reproductive cycle, while in the new resolution, universities can establish funds to self-finance its management and support a circular process (Montero 2020).

Nowadays, the technology transfer policy framework allows the reorganization of Science, Technology and Innovation Entities (and their transition into companies), the reorganization of the STIS, the creation of Science-Technology Parks, the achievement of the triad University-ECTI-Enterprises, and the constitution of high-technology based companies (see Table 13.2). In this sense, the policy framework also establishes the preparation of an outcome statement associated with each project under development and its implication related to intellectual property rights.

Then, the most urgent questions for the university would be how to transform itself in organizational, structural, and economic terms to integrate the new forms of interface organizations? what is the institutional and instrumental framework necessary to make the new policies effective and to take advantage of this impulse towards the creation, delivery, and capture of value according to the beneficiaries and stakeholders? How to align the changes with the interests, motivations, and actions of the researchers and producers? What metrics and instruments contribute to the transversal evaluation of the transfer process throughout its cycle, its effectiveness in the different organizational environments, and improved informed decision-making?

13.4 Conclusions

The chapter described and highlighted the advances and challenges associated with the evolutionary stages of Cuba's technology transfer policy framework. Since 1959, Cuba has implemented several efforts to improve technology/knowledge transfer among producers, productive and social actors. The institutionalization of the STIS has catalyzed sustained economic and societal progress as the main priority. Unfortunately, over the last six decades, the technology transfer process has not generated robust insights about the policy framework's effectiveness and the assimilation of technological/innovative outcomes (see Ministry of Science, Technology, Innovation, and Environment 2020). It explains why the updated policy resolution focused on transparency, metrics, and specific outcomes. Along this evolutionary process, the Cuban university has gained a critical role in the national innovation system and its socio-economic actors' interactions. Indeed, the university has internally transformed its identity into social, innovative, and entrepreneurial

Table 13.2 Policy framework that promotes technology transfer

Focus	Policy instrument	Objective	University involvement
Reference framework for science, technology and innovation policies	Guidelines and updating of the Guidelines (Cuban Communist Party 2016)	Establish the lines for the design of the Science, Technology, Innovation and Environment Policy	Closed cycle with marketing Transfer structures Strategic Management Training of doctors in the productive sector
Digital environments	Policy for the informatization of society in Cuba (Ministry of Communications 2017)	Improve the informatization of society in Cuba in a safe and sustainable way	Transforming training environments Transformation of the organization's business model Use of technologies for research and production Transfer of IT products and services Building digital skills in human capital
Organizational forms - interrelationships - incentives	Decreto Ley 363/2019 (Council of Ministers 2019)	Establish science and technology parks and science and technology companies as an interface between the academic-scientific sector and the productive and service sector	Key Activities Alliances Incentives for those involved Transfer structures Capacity building in entrepreneurship and innovation Property rights Assimilation of advanced technologies Establish incubators
Institutionality	Resolution 286/2019 (Council of Ministers 2019)	Regulate the organization and operation of the National Registry of Science, Technology and Innovation Entities	Institutional frameworks for action
Organizational forms	Resolution 287/2019 (Council of Ministers 2019)	Regulate the System of programs and projects of Science, Technology, and Innovation	Institutional Legal Frameworks Transfer process Formation of research groups Knowledge and Innovation Management
Tax measures	Resolution 434/2019 (Council of Ministers 2019)	Establishing a Special Taxation Regime	Limited to the finances of the companies of the Marta Abreu University of Las Villas and the Technological University of Havana and the parks of Havana and Matanzas

(continued)

Table 13.2 (continued)

Focus	Policy instrument	Objective	University involvement
Financial incentives	Resolution 286/2019 (Ministry of Finance and Prices 2020)	Establishing the self-financing of science and its form	Change in the business model from total financial dependence on the State to the diversification of sources for the financing of science
Institutionalism	Decree-Law No. 7.	To institutionalize the Cuban Science, Technology and Innovation System	Establishes the Science, Technology, and Innovation System, its fundamental components, principles, functions, and organization

Source: Authors

organizations. Nowadays, the Cuban university is legitimized as the bridge between generation and transference processes with a certain autonomy. However, the university's and the STIS's sustainability depends on public/private investment in science, technology, and innovation. The investment process is centralized by the government but should be decentralized to open to new foreign investments to ensure social distribution and equality in the country. Similarly, the generation of information is needed to monitor the effectiveness of policy frameworks and instruments linked to strategic sectors. The government's speeches highlighted the need for effective links between science producers and companies (Díaz-Canel 2019, p. 2). It remains to develop a context that minimizes the prevailing supply model and encourages enterprises to establish research demands, absorb and assimilate scientific and technological results, and innovate.

Acknowledgments The authors acknowledge the financial support provided by the Universidad de las Ciencias Informáticas (UCI), as well as by the Centro de Estudios de Técnicas de Dirección (CETED) at the Universidad de La Habana. Maribel Guerrero acknowledges the Facultad de Economía y Negocios at the Universidad del Desarrollo (Chile), the Northumbria Centre for Innovation, Regional Transformation and Entrepreneurship based on Newcastle Business School at Northumbria University (UK), and the Centre for Innovation Research (CIRCLE) at Lund University (SE) for their invaluable support.

References

Academia de Ciencias de Cuba. (2013). Análisis del estado de la ciencia en Cuba de cara al cumplimiento de Los Lineamientos de la Política Económica y Social del Partido y la Revolución. Avalaible via internet. http://www.academiaciencias.cu/sites/default/files/adjuntonoticias/ACC.%20Estado%20de%20la%20Ciencia%20en%20Cuba.%20Enero%202013..pdf. Accessed 3 Jan 2020.

Almuiñas, J. L., Arrechavaleta, N., Corral, R., Crespo, G., De Armas, R., Faxas, Y., & Velásquez, A. R. (Eds.). (1993). *Cuba: La Educación Superior y el alcance de una Reforma*. La Habana: Editorial Universitaria Félix Varela.

Alpízar, M., & Ramos, F. (2016). La financiación como soporte de la educación superior cubana. *Revista Cubana de Educación Superior*, (3), 119–134.

Alpízar, M. Á. (2019). Impacto de las políticas públicas en la Educación Superior en Cuba. *Estudios del Desarrollo Social: Cuba y América Latina, 7*(2), e9.

Alpízar, M. Á. (2019). *La gestión de la transferencia de los resultados de la investigación científica en el vínculo universidad-empresa*. Ph.D. Thesis, Universidad de Oriente, p. 227.

Alpízar, M. Á., León, R., & Dentchev, N. (2018). Barreras para la comercialización de resultados en la relación universidad-sector empresarial en Cuba. *Retos de La Dirección, 12*(2), 111–132.

Audretsch, D. B. (2014). From the entrepreneurial university to the university for the entrepreneurial society. *The Journal of Technology Transfer, 39*(3), 313–321. https://doi.org/10.1007/s10961-012-9288-1.

Brito, B. C., Hernández, G., & Álvarez, A. (1998). Gestión tecnológica y desarrollo sostenible y solidario en los países latinoamericanos: experiencia cubana. *Espacios*, *19*(2). http://www.revistaespacios.com/a98v19n02/40981902.html

Brunner, J. J. (1993). Evaluación y financiamiento de la Educación Superior en América Latina: bases para un nuevo contrato. In H. Courard (Ed.), *Políticas comparadas de Educación Superior en América Latina* (pp. 44–59). Flacso: Santiago de Chile.

Calcagnini, G., & Favaretto, I. (2015). Models of university technology transfer: Analyses and policies. *The Journal of Technology Transfer, 41*(4), 655–660. https://doi.org/10.1007/s10961-015-9427-6.

Castro, F. (1960). Discurso del 15 de enero de 1960 en la Sociedad Espeleológica de Cuba. In *Academia de Ciencias de Cuba*. Avalaible via internet. http://www.academiaciencias.cu/es/node/906. Accessed 13 Nov 2019.

Choudhry, V., & Ponzio, T. A. (2019). Modernizing federal technology transfer metrics. *The Journal of Technology Transfer, 45*, 544–559. https://doi.org/10.1007/s10961-018-09713-w.

Clark, B. R. (1998). The entrepreneurial university: Demand and response. *Tertiary Education and Management, 4*(1), 5–16. https://doi.org/10.1007/BF02679392.

Clark, B. R. (2001). The entrepreneurial university: New foundations for collegiality, autonomy, and achievement. *Higher Education Management*, 13(2), 9–24.

Constitución de la República de Cuba (1976). *Constitución de la República de Cuba.* La Habana: Gaceta Oficial de la República de Cuba.

Council of Ministers. (2019). Decreto No. 363/2019 (GOC-2019-998-O86). In Gaceta Oficial de La República de Cuba, 86, 1923–1954. Avalaible via internet. http://www.gacetaoficial.gob.cu/es.

Cruz-Amarán, D., Guerrero, M., & Hernández-Ruiz, A. D. (2020). Changing times at Cuban universities: Looking into the transition towards a social, entrepreneurial and innovative organization. *Sustainability, 12*(6), 2536. https://doi.org/10.3390/su12062536.

Cuban Communist Party (PCC). (2016). Actualización de los Lineamientos de la Política Económica y Social del Partido y la Revolución para el periodo 2016–2021. In *Documentos PCC*. Avalaible via internet. https://www.pcc.cu/es/lineamientos. Accessed 5 Nov 2019.

Díaz-Canel, M. (2019). Acudir siempre a la Universidad cubana en busca de respuestas. In *Presidencia de la República de Cuba*. Avalaible via internet. https://www.presidencia.gob.

cu/es/noticias/acudir-siempre-a-la-universidad-cubana-en-busca-de-respuestas/. Accessed 10 Feb 2020.
Díaz-Canel, M., & Núñez, J. (2020). Gestión gubernamental y ciencia cubana en el enfrentamiento a la COVID-19. *Anales de la Academia de Ciencias de Cuba, 10*(2), e881.
Didriksson, A. (2012). La nueva agenda de transformación de la educación superior en América Latina. *Perfiles Educativos, 34*(138), 184–203.
Dutrénit, G., & Núñez, J. (2017). Vinculación universidad-sector productivo para fortalecer los sistemas nacionales de innovación: experiencias de Cuba. In *México y Costa Rica*. La Habana: Editorial UH.
Enamorado, M., León, R., & Fong, H. (2018). La transferencia de los resultados de la actividad de Ciencia e Innovación Tecnológica en el desarrollo empresarial de Santiago de Cuba. Paper presented at the XV Congreso Internacional de Información Info'2018. http://www.congreso-info.cu/index.php/info/info2018/paper/view/884/624. Palacio de Convenciones de La Habana, La Habana, 5–8 March 2018.
Etzkowitz, H., & Zhou, C. (2008). Building the entrepreneurial university: A global perspective. *Science and Public Policy, 35*(9), 627–635.
Fernández, A., Cruz, I., & Morales, M. (2018). El diseño de políticas de ciencia, tecnología e innovación en la educación superior cubana. Una propuesta desde la Universidad de Cienfuegos. Revista Iberoamericana de Ciencia. *Tecnología y Sociedad - CTS, 13*(39), 22.
Fernández, A., & Núñez, J. (2020). *Creación de capacidades y desarrollo local: el papel de los centros universitarios municipales*. La Habana: Editorial Universitaria Félix Varela.
Ferreira, J. J., Fayolle, A., & Ratten, V. (2018). Introduction: The role of entrepreneurial universities in society. In *Entrepreneurial universities: Collaboration, education and policies* (p. 288). London: Routledge.
Freeman, R. E. (1984). *Stakeholder management: A strategic approach*. New York: Pitman.
Friedman, J., & Silberman, J. (2003). University technology transfer: Do incentives, management, and location matter? *The Journal of Technology Transfer, 28*(1), 17–30.
García, R. (2007). *Cien figuras de la Ciencia en Cuba*. La Habana: Editorial Científico-Técnica.
García, E. (2015). La idea de un sistema de ciencia, tecnología e innovación en Cuba: orígenes, vicisitudes, futuros. *Anales de la Academia de Ciencias de Cuba, 5*(1), 1–38.
García del Portal, J., Crespo, G., & Rojas, A. R. (1993). Reforma universitaria y sociedad. In *Cuba: La Educación Superior y el alcance de una Reforma* (pp. 16–27). La Habana: Editorial Félix Varela.
Gibson, D. V., & Foss, L. (2017). Developing the entrepreneurial university: Architecture and institutional theory. *World Technopolis Review, 2*, 1–15.
González, O. (1993). El proyecto pedagógico de la Reforma de 1962: su materialización en la ensenanza. In *Cuba: La Educación Superior y el alcance de una Reforma* (pp. 28–52). La Habana: Editorial Félix Varela.
Guerrero, M., Cunningham, J. A., & Urbano, D. (2015). Economic impact of entrepreneurial universities' activities: An exploratory study of the United Kingdom. *Research Policy, 44*(3), 748–764.
Guerrero, M., & Urbano, D. (2019a). A research agenda for entrepreneurship and innovation: the role of entrepreneurial universities. In *A research agenda for entrepreneurship and innovation*. Edward Elgar Publishing. https://doi.org/10.4337/9781788116015.00012.
Guerrero, M., & Urbano, D. (2019b). Effectiveness of technology transfer policies and legislation in fostering entrepreneurial innovations across continents: An overview. *The Journal of Technology Transfer*. https://doi.org/10.1007/s10961-019-09736-x.
Guerrero, M., Urbano, D., Alain, F., Klofsten, M., & Mian, S. (2016). Entrepreneurial universities: Emerging models in the new social and economic landscape. *Small Business Economics, 47*, 551–563. https://doi.org/10.1007/s11187-016-9755-4.
Hugh, H. (1972). Policy analysis. *British Journal of Political Science, 2*(1), 83–108.
Kraft, M. E., & Furlong, S. R. (Eds.). (2007). *Public policy: Politics, analysis, and alternatives*. Washington, DC: CQ Press.

Leonard-Barton, D. (1990). A dual methodology for case studies: Synergistic use of a longitudinal single site with replicated multiple sites. *Organization Science, 1*(3), 248–266.

Macaya, G., & Herrera, R. (2015). Grupo 1: Costa Rica, Cuba, Ecuador, Panamá, Perú y Uruguay. In Centro Interuniversitario de Desarrollo (Ed.), *La transferencia de I+D, la innovación y el emprendimiento en las universidades* (pp. 405–403). Santiago de Chile: RIL editors.

Marinetto, M. (1999). *Studies of the policy process: A case analysis*. Prentice-Hall: Hemel Hempstead.

Martín, E., González, V., & González, M. (1996). *Experiencias en la gestión y el financiamiento de la educación superior en Cuba*. In Conferencia regional sobre políticas y estrategias para la transformación de la educación superior en América Latina y el Caribe. (p. 10). La Habana: UNESCO, CRESALC.

Marquetti, H. (2003). Cuba: Situación actual y perspectivas de las exportaciones de servicios. *Cuba Siglo XXI XXXIII*, 154–156. https://www.nodo50.org/cubasigloXXI/economia/marquetti5_310803.pdf.

May, P. J. (2003). Policy design and implementation. In B. Peters & J. Guy Pierre (Eds.), *Handbook of public administration* (pp. 223–233). London: Sage.

Mets, T. (2010). Entrepreneurial business model for classical research university. *Engineering Economics, 21*(1), 80–90.

Miller, K., Mcadam, M., & Mcadam, R. (2014). The changing university business model: A stakeholder perspective. *R&D Management, 44*(3), 265–287.

Ministry of Communications (MinCOM). (2017). Política Integral para el perfeccionamiento de la informatización de la sociedad en Cuba. Available via internet. https://www.mincom.gob.cu/es/node/2469. Accessed 18 Nov 2019.

Ministry of Higher Education (MES). (2017) *Documentos metodológicos para la organización de la CTI en las universidades del MES 2017-2021*. La Habana: Dirección de Ciencia y Técnica.

Ministry of Finance and Prices (MFP). (2020). Resolución No. 128/2020 In Gaceta Oficial No. 27 Ordinaria de 2020: 960–962. Avalaible via internet. https://www.gacetaoficial.gob.cu/es. Accessed 15 Apr 2020.

Ministry of Science, Technology, Innovation, and Environment (CITMA). (2020). Tercera Encuesta Nacional de Innovación. Informe de los resultados. La Habana.

Montero, L. A. (2020). Se aprueban e implantan nuevas medidas financieras para favorecer la ciencia y la innovación. http://www.cubadebate.cu/noticias/2020/05/28. Accessed 28 May 2020.

Marozau, R., & Guerrero, M. (2016). Conditioning factors of knowledge transfer and commercialisation in the context of post-socialist economies: The case of Belarusian higher education institutions. *International Journal of Entrepreneurship and Small Business , 27*(4), 441–462.

Nelles, J., & Vorley, T. (2010). Entrepreneurial by design: Theorizing the entrepreneurial transformation of contemporary universities. *Industry and Higher Education, 24*(3), 157–164. https://doi.org/10.5367/000000010791657482.

Noda, M. (2016). *Educación Superior en Iberoamérica Informe 2016.* Informe Nacional: Cuba. https://cinda.cl/wp-content/uploads/2019/01/educacion-superior-en-iberoamerica-informe-2016-informe-nacional-cuba.pdf

Núñez, J., & Alcázar, A. (2018). *La educación superior como agente del desarrollo local. Experiencias, avances, obstáculos*. La Habana: Editorial Universitaria Félix Varela.

Núñez, J., & Montalvo, L. F. (2015). La política de ciencia, tecnología e innovación en Cuba y el papel de las universidades. *Rev Cubana de Edu Superior, 34*(1), 29–43.

Papa, B. (2018). Entrepreneurial university concept: Case of a developing country, Albania. In *Cbu International Conference on Innovations in Science and Education vol 6 Praga*, 374–380. https://doi.org/10.12955/cbup.v6.1185.

Pérez, R. (2018). Ciencia e innovación: ¿dos caras de la misma moneda? Revista Temas enero-junio (93–94):27–34.

Reyes, C. N. (2017). Framing the entrepreneurial university: The case of the National University of Singapore. *Journal of Entrepreneurship in Emerging Economies, 8*(2), 162–179. https://doi.org/10.1108/JEEE-09-2015-0046.

Rojas, E. A. (1978). Tesis y Resoluciones. In *Primer Congreso del Partido Comunista de Cuba* (pp. 425–463). Editorial Ciencias Sociales: Ciudad de La Habana.

Saborido, J. R., & Alarcón, R. (2018). La integración de la Universidad: experiencias de Cuba. *Revista Cubana de Educación Superior, 37*(3), e17.

Santos, S., Alpízar, M., & León, M. (2004). *Estudio sobre el financiamiento de la educación superior de Cuba.* La Habana: IESALC.

Švarc, J., & Dabić, M. (2019). The Croatian path from socialism to European membership through the lens of technology transfer policies. *The Journal of Technology Transfer, 44*, 1476–1504. https://doi.org/10.1007/s10961-019-09732-1.

Teo, P., & Ren, S. (2019). The marketization of universities in China: A critical discourse analysis of the university president's message. *Discourse & Communication, 00*(0), 1–23. https://doi.org/10.1177/1750481319856203.

Vecino, F. (1996). Conferencia inaugural. In *Conferencia regional sobre políticas y estrategias para la transformación de la educación superior en América Latina y el Caribe*. UNESCO, CRESALC, La Habana.

Yin, R. K. (2017). *Case study research and applications: Design and methods*. London: SAGE Publications, Inc.

Correction to: technology transfer and entrepreneurial innovations policies across continents

Maribel Guerrero and David Urbano

Correction to: M. Guerrero, D. Urbano (eds.), *Technology Transfer and Entrepreneurial Innovations*, International Studies in Entrepreneurship 51, https://doi.org/10.1007/978-3-030-70022-5

Please note that the original (printed and online) version of this book, unfortunately, contained some errors. The corrections are:

Front Matter (second editor affiliation, p. iv)

David Urbano
ORCID 0000-0001-7600-8656
Department of Business and Centre for Entrepreneurship and Social Innovation Research (CREIS) Universitat Autònoma de Barcelona Barcelona, Spain

Preface (last sentence paragraph 3, p. vi)

Contents (chapter 11, first author last name, p. xii)

Jadranka Švarc and Marina Dabić

Contributors (author last name, p. xv)

Jadranka Švarc Institute Ivo Pilar, Zagreb, Croatia

The updated online version of the book can be found at
https://doi.org/10.1007/978-3-030-70022-5
https://doi.org/10.1007/978-3-030-70022-5_11

M. Guerrero, D. Urbano (eds.), *Technology Transfer and Entrepreneurial Innovations*, International Studies in Entrepreneurship 51,
https://doi.org/10.1007/978-3-030-70022-5_14

Chapter 11 (first author last name, p. 235)

Jadranka Švarc and Marina Dabić

List of chapters linked to the JOTT SI

A preliminary version of some chapters (1, 4, 7, 8, 9, 10, 11) was part of the Special Issue: "Effectiveness of Technology Transfer Policies and Legislation in Fostering Entrepreneurial Innovations across Continents" published in October 2019 (volume 44, issue 5) in the Journal of Technology Transfer. Following Springer copyright rules, the contributors of the mentioned chapters included at least 30% of new content (e.g., extending new theoretical assumptions, analyzing new data that provide new/extended findings, implications, and potential research lines).