
PALGRAVE STUDIES
IN DEMOCRACY,
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FOR GROWTH
ENTREPRENEURIAL
UNIVERSITIES IN
INNOVATION-SEEKING
COUNTRIES
Challenges and
Opportunities
Marina Dabić,
Jadranka Švarc &
Miguel González-Loureiro

Palgrave Studies in Democracy, Innovation, and Entrepreneurship for Growth

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The central theme of this series is to explore why some areas grow and others stagnate, and to measure the effects and implications in a transdisciplinary context that takes both historical evolution and geographical location into account. In other words, when, how, and why does the nature and dynamics of a political regime inform and shape the drivers of growth and especially innovation and entrepreneurship? In this socioeconomic and socio-technical context, how could we best achieve growth, financially and environmentally?

This series aims to address such issues as:

- How does technological advance occur, and what are the strategic processes and institutions involved?
- How are new businesses created? To what extent is intellectual property protected?
- Which cultural characteristics serve to promote or impede innovation? In what ways is wealth distributed or concentrated?

These are among the key questions framing policy and strategic decision-making at firm, industry, national, and regional levels.

A primary feature of the series is to consider the dynamics of innovation and entrepreneurship in the context of globalization, with particular respect to emerging markets, such as China, India, Russia, and Latin America. (For example, what are the implications of China's rapid transition from providing low-cost manufacturing and services to becoming an innovation powerhouse? How do the perspectives of history and geography explain this phenomenon?)

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Challenges and Opportunities

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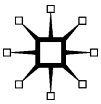

First published 2016 by
PALGRAVE MACMILLAN

Palgrave Macmillan in the UK is an imprint of Macmillan Publishers Limited, registered in England, company number 785998, of Houndmills, Basingstoke, Hampshire, RG21 6XS.

Palgrave Macmillan in the US is a division of Nature America, Inc., One New York Plaza, Suite 4500, New York, NY 10004-1562.

Palgrave Macmillan is the global academic imprint of the above companies and has companies and representatives throughout the world.

Hardback ISBN: 978–1–137–57981–2
E-PUB ISBN: 978–1–137–57983–6
E-PDF ISBN: 978–1–137–57982–9
DOI: 10.1057/9781137579829

Distribution in the UK, Europe and the rest of the world is by Palgrave Macmillan®, a division of Macmillan Publishers Limited, registered in England, company number 785998, of Houndmills, Basingstoke, Hampshire RG21 6XS.

Library of Congress Cataloging-in-Publication Data
Names: Dabić, Marina, author. | Švarc, Jadranka, author. | González-Loureiro, Miguel, 1974– author.
Title: Entrepreneurial universities in innovation-seeking countries : challenges and opportunities / Marina Dabic, Jadranka Svarc, Miguel González-Loureiro.
Description: New York, New York : Palgrave Macmillan, 2016. | Series: Palgrave studies in democracy, innovation, and entrepreneurship for growth | Includes index.
Identifiers: LCCN 2015031092 | ISBN 9781137579812 (hardback)
Subjects: LCSH: Academic-industrial collaboration—Croatia—Case studies. | Academic-industrial collaboration—Spain—Case studies. | Education, Higher—Aims and objectives—Croatia—Case studies. | Education, Higher—Aims and objectives—Spain—Case studies. | BISAC: BUSINESS & ECONOMICS / Entrepreneurship. | EDUCATION / Higher.
Classification: LCC LC1085.4.C76 D33 2016 | DDC 378.1/035—dc23 LC record available at http://lccn.loc.gov/2015031092

A catalogue record for the book is available from the British Library.

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Preface

It is paradoxical, yet true, to say, that the more we know, the more ignorant we become in the absolute sense, for it is only through enlightenment that we become conscious of our limitations. Precisely one of the most gratifying results of intellectual evolution is the continuous opening up of new and greater prospects.

—Nikola Tesla

The global financial crisis and budget cuts have brought to the forefront new models of universities dominated by the concept of an entrepreneurial university that emphasizes the market orientation of universities and their contribution to economic growth and competitiveness.

The concept is pursued regardless of the research intensity of production sectors and technological competences of the business sector within a certain country. In moderate innovation countries, the entrepreneurial role of the university is hindered by a lack of business partners, low absorption capacities for research-driven company innovation, lack of demand for research, etc., which are needed for research commercialization and science–industry cooperation.

In this context, the book analyzes the concept of an entrepreneurial university in moderate innovation countries using the example of Spain and Croatia. Although different in size, they share many similarities in terms of innovation capacities and the role of universities within the innovation system. Since the universities in these countries are also increasingly exposed to globalization and international competition they are forced to change, but these changes should correspond to the abilities of the business sector while preserving the social and cultural impacts of universities.

The university mission is linked to the value it can offer to its environment in the knowledge-based society in which we are currently embedded; that is, act as a knowledge pivot: creating, absorbing, storing, sharing, spreading, filtering, adapting, teaching, etc. valuable knowledge for progress in every plane of society. Several expressions come to mind to describe the university and its socioeconomic role in such a context: competent, innovative,

politically neutral, pro-European, defenders of the knowledge interest, multilingual, multicultural, purposeful, proactive, ambitious, focused, and, of course, entrepreneurial. A good portrait would be a mix of these adjectives.

Therefore, the entrepreneurial university is an ethos above all. Professors who support the concept do not necessarily have to share the same attitudes toward an "entrepreneurial university" by reason of their support.

These are the highlights of the theoretical and empirical work done here. A shift is needed at the university if it is to become a more entrepreneurial one, which should be based on the key drivers of change in large organizations: its human capital.

Marina, Jadranka, and Miguel
Croatia, Spain, and United Kingdom, 2015.

Acknowledgments

Writing a book is in the long run a cooperative project and throughout the process of writing this book many individuals from the universities around Europe and the world have taken time out to share their experiences, debates, cases, achievements, and thoughts. We would like to show our gratitude to all of them (listed in alphabetical order):

Angelo Riviezzo, University of Sannio, Italy
Emilio Fernández Suárez, Director of the Campus of Excellence "Campus do Mar," University of Vigo, Spain
Fernando Borrás-Rocher and **José María Gómez-Gras,** Miguel Hernández University, Spain
Francisco Liñán and **Maria Rosaria** Napolitano, University of Seville, Spain
Hans Löfsten, Chalmers University of Technology, Sweden
Jana Blažević Marcelja, STEP Rijeka, Croatia
Jean-Christophe Boisse and **Olivier Hueber**, University of Nice, Sophia Antipolis, France
José Manuel López Rodríguez, Vice Chancellor of Research and Scientific Policy, University of Valladolid, Spain
María Paz Suárez Rendueles, Vice Chancellor of Research in the University of Oviedo, Spain
Marzenna Anna Weresa, World Economy Research Institute, Warsaw School of Economics, Poland
Misericòrdia Carles, Vice Chancellor of Transfer and Innovation, University Rovira I Virgili, Spain
Nigel Culkin, Director, Centre for Innovation & Enterprise (CI&E), University of Hertfordshire, UK
Thomas Gstraunthaler and **Alexey Novoseltsev**, National Research University Higher School of Economics, Russian Federation
We thank **Silvana Brozović**, librarian from the Faculty of Economics and Business, University of Zagreb for facilitating the source research material when it seemed impossible.
We would like to thank **Vera Krnajski Hršak** and **Višnja Kabalin Borenić** for their professional acquaintances.

Special appreciation goes to **Phil Clarke** from HIVE, Nottingham Trent University, who edited the final English text.

We would like to thank **Asunción Fernández-Lorenzo** from the University of Vigo for her support in editing figures.

We are particularly grateful to Professor **Elias Carayannis** for taking the required steps at a number of levels to make the book happen, to the reviewers for their commitment and valuable comments, to the publishers for bringing the book into actual physical existence, and to you, our readers, for rendering this book a new dimension of life.

Executive Summary

Intellectual assets, human resources, and professionalism of all kinds, based on scientific research and cutting-edge technologies both in service and manufacturing, have become the essence of the new postindustrial economy. Growth in the knowledge economy largely depends on the production and transmission of new knowledge, mainly through education and training. Universities are at the center of both these processes, which has led many to assign the university a leading and strategic role in any knowledge economy. One might easily conclude that since 1990, universities have become powerful institutions that determine the fate not only of a new generation of young people thirsting for education, but also the economic development of entire regions and nations.

However, those familiar with the situation of European universities are aware that the knowledge economy puts the universities, especially in the innovation less developed countries, in somewhat ambiguous position. On the one hand it is undeniable that universities today are centers for cutting-edge research in fields from software to biotechnology and important sources of new technologies and spin-off companies. The modern economic activity has become massively dependent on up-to-date knowledge and governments throughout the world have launched numerous initiatives to link universities to innovation more closely. On the other hand, universities are faced with budget constraints, cutting down of allocated funds for research as well as growing political and social pressure to justify their efficiency. Their scientific productivity, teaching methods, and efficiency are subjected to the various methods of evaluation, measurement, accreditation, and reaccreditation. University in knowledge economy is losing its knowledge producing monopoly rather than being strengthened.

A possible reason may be that knowledge economy has brought the growing *scientification* of the economy and the mass education that has dispersed the scientific approach and its methods as well as highly educated staff throughout the economy and society. It has led,

paradoxically, to a weakening of the university. The role of universities as a pillar of the knowledge economy has come into question because they are forced to compete with many other subjects in knowledge production and diffusion that were in essence emanated from the university. As pointed out by Mode 2 of the new knowledge production, knowledge is produced in a diverse variety of organizations, resulting in a very heterogeneous practice. The range of potential sites for knowledge generation includes besides the traditional universities, institutes and industrial labs, research centers, government agencies, think-tanks, high-tech spin-off companies and consultancies. Although these sites are linked through networks of communication and research is conducted in mutual interaction, these sites also take over research that would be previously located exclusively at universities. By contrast, their "competitors," be they research consortia, private companies, or labs, are far more prepared for a knowledge economy since they are focused on the direct commercialization of knowledge, which directly contributes to innovation-driven economic growth with no regard to scientific curiosity or the public availability of scientific results.

The uncertain and ambiguous status of the university was intensified in the early 1970s when economists reconsidered the sources of economic growth and devised the concept of systems of innovation, stressing the importance of national innovation systems in the development and international competitiveness of each country. They came to the conclusion that business innovation located in companies is equally, if not more, important for economic growth as the creation of knowledge itself. The struggle for innovation-based competitiveness has transformed the crisis of the university into a global phenomenon in the 1990s.

However, neither the crisis of the university nor the concept of an entrepreneurial university is new. Universities are in a continuous transformation and reforming process since the 1970s as the rise of knowledge economy and globalization has intensified. The novelty is that both phenomena have crossed national boundaries under the pressure of globalization and become European and global phenomena driven by the European process of integration in both the sphere of research through the European Research Area (ERA) and in higher education through the Bologna process for establishing the European Higher Education Area (EHEA).

It paved the way for new concepts of the university such as entrepreneurial universities and academic entrepreneurialism as a method of transforming research into market goods and services.

Most European countries encourage universities to engage in the so-called third task and entrepreneurial activities. Besides supplying education and research, universities need to also take an active part in the diffusion of knowledge to the commercial sector. This new role implies developing new functions and structures within the universities, which are today recognized as entrepreneurial university. Universities that are not able or ready to transform are still faced with the various uncertainties and public pressures since in a knowledge economy, the creation and transmission of knowledge is a necessary but not sufficient condition for economic growth. The emphasis is on the capitalization of knowledge, its transformation into new competitive products, and processes in international markets.

This puts the university in an entirely new position, seeking a transformation from the traditional Humboldt type of university into a new type known today as the entrepreneurial university. Since the mid-1970s, scientific and university systems have been undergoing such major changes, at least in developed countries, that many have noticed a transition in research systems toward new knowledge production while the university stands on the threshold of its second revolution.

In essence, the second academic revolution involves a transition from the traditional Humboldt type of university into an entrepreneurial university. The concept owes much to the pioneering idea of a hybrid university, which is based on complementing its research and educational functions with a technological one focused on applied and industrial research. This technological function of a university soon grew into the numerous models of an entrepreneurial university closely connected to the recent concept of new knowledge production (e.g., Mode 1 and Mode 2) and science–industry interactions (e.g., triple-helix model and public–private partnership). Simultaneously, universities are faced with a crisis of identity that has emerged from the clash between the traditional concept of a university as an autonomous and self-organized institution of scientists who follow an ethic of scientific freedom, and the concept of a university as an entrepreneurial organization subjected to market needs, evaluations by policy-makers, and criticism from the wider community. Although the entrepreneurial role of a university is heavily criticized it cannot be denied that position of the university has changed due to the changed role of scientific knowledge. The university environment has changed and evolved toward a knowledge-based economy. Therefore, the university must turn into a modern knowledge-based organization that transforms the obsolete manufacturing-based model of the

industrial era. History teaches us that reverting to former practices is hardly possible. The same is true of a return to the old university paradigm.

WHAT IS THE BOOK ABOUT?

Universities are challenged today to maintain their leading role in a society of knowledge that requires strategic, structural, and organizational changes to enable them to take a greater part in technological change and economic development. In this context the European universities have undergone different reforms since 1995 mainly shaped within the Bologna process. The final aim was to strengthen their role in education, economic, social, and cultural prosperity. For example, quality assurance and accreditation systems have been one of the major reform themes while funding mechanisms based on uniform and "nondistinctive" budget funding were altered through lump sum systems with more of an emphasis on outputs. Strengthening linkages between public research and private industry to improve national economic performance is also one of the main concerns of policy-makers in many countries. However, reforms have taken place at various levels and in various policy areas in different countries.

The majority of reforms, especially regarding the orientation toward entrepreneurialism, are much more emphasized in technologically advanced countries, which are classified by the European Innovation Union Scoreboard (IUS, 2014) as innovation leaders (e.g., Sweden, Germany, Slovenia, France, and Great Britain). Less advanced innovation countries consist of modest and moderate innovator countries, which are much less involved in transitions between university and research systems. The modest innovators include mainly new European member states (Romania, Bulgaria, Latvia, and Lithuania) while moderate innovators mostly include countries from Southern Europe and the Mediterranean like Spain, Portugal, Italy, and Croatia. Those countries are not only the most affected by the global financial crisis but also share similar difficulties in their research and higher education systems such as low investment in research especially by the business sector, low patenting activity, the domination of the public sector in R&D, with universities taking a leading role in both research manpower and knowledge production but perhaps not in diffusion or transference.

At the same time, the scientific output of universities does not match their dominant position, meaning that their scientific quality is unsatisfactory. This has a negative impact on their recognition

on any international scientific and higher education map. Interactions and cooperation between universities and industry at present are also rather deficient for knowledge exchange and its subsequent successful influence on innovation. Accordingly, the concept of an entrepreneurial university has not taken deeper root in many Southern European countries. It remains an ambiguous and vague concept that so far does not have many supporters either among policy-makers or scholars themselves. For example, faculty promotion practices tend to emphasize seniority and publishing competences in current content journals, rather than innovation or cooperation with industry. The intersectoral mobility of staff between industry and academia is almost nonexistent and it is usually not well regarded among most academics. The business sector is hardly interested in cooperating with universities due to their low technological capacities and absorption of innovation, as well as the fact that universities do not clearly meet the needs of the majority of small and medium-sized enterprises (SMEs).

The purpose of the book is to shed some light on the role and success that the model of an entrepreneurial university could have for countries that are lagging behind in cutting-edge technologies and science-based innovation. The main reason is that the transformation of traditional university from the conceptual point of view is global, while its practical realization is local. The readiness of innovation following countries for radical changes toward entrepreneurial university is still doubtful since these countries have not attained the level of structural adjustment of national economies to the knowledge economy that influences the role of universities and their transformation into the entrepreneurial university. Innovation-leading countries have not only built the foundation and rationale of knowledge economy but also determine the direction and dynamic of its further development. They seek an entrepreneurial university, which could meet the requirements of accelerated knowledge production and capitalization to retain the position of global winners and innovation leaders. By contrast, innovation-seeking countries mainly follow, sometimes uncritically, the trends and directions shaped by world leaders.

To address these questions we have pointed out some historical and theoretical aspects of emerging entrepreneurial universities on a global scale, which still influence the paradoxical position of universities including the new paradigm of entrepreneurial university. The challenges and prospects of entrepreneurial university in innovation-seeking countries are analyzed using the experience of Spain and Croatia.

Although Spain and Croatia represent at best the position of entrepreneurial university in the Southern European and Mediterranean countries (Spain, Portugal, Italy, Greece, Malta, and Croatia), the conclusions could also be applied to the rest of moderate innovators (Czech Republic, Hungary, Lithuania, Serbia, and Slovakia) and modest innovators (Romania, Bulgaria, Latvia, Poland, Turkey, and FYR Macedonia) that are defined as such in the Innovation Union Scoreboard for 2013 and constitute innovation-seeking countries referred to in this book. These are all countries that belong, to a greater or lesser extent, to the European scientific and higher education periphery, with insufficient scientific merit and innovation strength to compete on the same footing with scientific core countries and innovation leaders on a large scale. They share some common features of university and research sector development such as the lack of business partners, low absorption capacities for research-driven innovation of companies, absence of the cutting-edge technologies, and low diffusion or transference of knowledge within the sectors, which are needed for research commercialization and science–industry cooperation.

Although Spain and Croatia differ significantly in many aspects relative to size, such as population (Spain has ten times more inhabitants than Croatia), GDP, their research communities, and absolute investment in R&D, some structural problems in the economy and national innovation systems, including the role of universities within the innovation system, are very similar. Furthermore, the selection of two different countries sought to reinforce the findings by discovering what such different instances have in common.

For example, both countries are severely affected by the global financial crisis, have had negative economic growth over the last few years, and high rates of unemployment among which there is an increasing share of the young and educated. Their economies are dominated by small- and medium-sized firms, oriented toward less innovative traditional sectors and with tourism accounting for a large share of their GDP. As reported by EUROSTAT, they are also similar in terms of level of exports, turnover from innovation, employment in knowledge-intensive service sectors, and other indicators regarding innovation and research capabilities.

Besides, both the countries have established rather complex systems of innovation that consist of specialized institutions and programs devoted to promoting links between public research bodies and industry. However, the achievements of these systems of innovation as

well as the levels of excellence in universities and public research organizations are far from being satisfactory.

Therefore, the main goals of the book are as follows:

1. Explain the historical roots of the conceptual ambiguity of entrepreneurial universities, which are still strong among academics and policy-makers;
2. Provide an empirically based comparative analysis of the role of entrepreneurial university in two moderately innovative countries—Croatia and Spain;
3. Draw certain conclusions about the role that an entrepreneurial university might play in the social and economic development of moderately innovative countries under circumstances of a knowledge-based economy and globalization.

The basic message of the book is that the transition from traditional to entrepreneurial university on the global scene has intensified since the 1970s due to the transition from industrial to knowledge society. Historical development of modern university coupled with the scientific revolutions showed that the knowledge industries, which ultimately lead to today's knowledge economy, are based on cutting-edge technologies, university–industry interaction, and commercialization of university research through company start-ups and licensing. However, the transition to the knowledge economy is not only incomplete but is saturated with a number of unknowns coming from globalization and the emergence of service economy. The latter blurs the insight into what sectors and activities today are the backbones of development. Knowledge economy linked with globalization creates a great uncertainty and complexity for individuals and organizations in social and economic life including universities. It is also characterized by a series of global processes with a very uncertain outcome such as shift of production to the Far East, global unemployment, the rise of creative and service economies, etc. Such global economic uncertainty, insecurity, and vagueness of the role of industrial development, technological innovation, and related higher education and scientific research leads to slowdown of the transition from traditional to entrepreneurial university.

Universities in both innovation leading and following countries are in flux, reflecting issues specific to the transition from an industrial to a knowledge society. It is certain, however, that the concept of

entrepreneurial university suits much better innovation leaders than followers. Innovation leaders need a university that is able to capitalize scientific research with the aim to preserve their position of global techno-economic leaders. By contrast, innovation followers suffer from the absence of science-based innovation, cutting-edge technologies, as well as a clear discourse about their own position in the global knowledge economy. Innovation followers have to respond not only to the challenges of transformation of universities toward entrepreneurial university but above all they are challenged to transform their economies from industrial to knowledge economies. Economy of innovation followers, especially in the Sothern European and Mediterranean countries, is still the economy of industrial societies, while world competition is growingly based on advance technologies, research-intensive innovation, and other intangibles subjected to the rules and norms of the knowledge economy. Since innovation-seeking countries are lacking the clarity of strategic goals, the policies and mechanisms to achieve the transformation from industrial to knowledge economy as well as transition from the traditional to entrepreneurial university are also lacking determination and dedication.

Our analysis revealed that, in addition to unfinished transition, innovation followers suffer from several specific factors that hinder and slow the emergence of entrepreneurship university, as follows:

- dysfunctional innovation system that lacks the business sector interested in cooperating with universities;
- poor scientific output of universities and their international visibility;
- centrally governed university system with a weak support for market-oriented activities;
- unsatisfactory level of entrepreneurship.

These factors create a specific socioeconomic environment, which is the main barrier to entrepreneurial university in innovation followers. The change toward the new university paradigm is not possible as an isolated social phenomenon but only within the relevant socioeconomic and institutional context. Innovation-seeking countries lack the sociocultural environment strongly supportive to entrepreneurial university and technologically advanced economy that would provide natural and strong incentives to it.

Although entrepreneurial activity is undoubtedly a future of university on a global scale, the following functions of the current

universities in innovation-seeking countries seem more important at the moment than the radical change of university paradigm:

Attaining excellence in education and scientific research,
Becoming internationally competitive in education and research;
Fostering entrepreneurship education;
Developing all kinds of cooperation with the business sector.

A radical change from traditional to entrepreneurial university with a lack of real ground in the innovation system can lead to a derogation of universities and further weakening of the national educational and scientific basis. Therefore, our analysis suggests that transition to entrepreneurial university must be considered with caution and critics. It should take into account the compliance between the socioeconomic environment and the mission of entrepreneurial university.

The book consists of seven chapters. The first five chapters are more theoretically oriented and discuss the concept, history, and characteristics of entrepreneurial universities, while the remaining chapters provide the empirical results of a survey about the attitudes of professors toward entrepreneurial universities in Spain and Croatia. The **first chapter** addresses the concept and definition of an entrepreneurial university and presents some criticism as well as supporting opinions. The **second chapter** provides the socioeconomic and theoretical antecedents that gave rise to the entrepreneurial university and its ambiguous position. It explains the historical roots of the interaction between science and industry and the emergence of knowledge-based industries that initiated the first and second academic revolutions and changed the university paradigm from a traditional to an entrepreneurial university. The **third chapter** addresses the critics and the change required in knowledge production toward more industry-oriented research that fosters the business and entrepreneurial component of universities. The **fourth chapter** analyzes the theories of transition in scientific systems, with particular attention paid to the triple-helix model. The **fifth chapter** discusses the wide diversity of activities that entrepreneurial universities undertake, namely cooperative research projects, commercialization of research results, academic entrepreneurship, venture capital, and facilities such as science, research, and technology parks. The key issue here is the university as a factor for regional development.

The **sixth chapter** provides empirical results about the attitudes of university professors toward entrepreneurial universities in Spain

and Croatia. It was found that faculty members in both countries have a strong desire to participate in the commercialization process. However, faltering support systems, weak incentive structures, centrally governed systems and regulations, plus the university culture, all work to make the creation of efficient links between universities and the market difficult. The main definition of entrepreneurial university applied by faculty members is analyzed, as well as their opinion regarding what the main entrepreneurial universities are worldwide. Their opinion regarding the context is analyzed by means of identifying barriers and needs at faculty level, and changes due to the Bologna Declaration. The personal attitudes toward the entrepreneurial university dimensions are also analyzed.

The **seventh chapter** presents the most relevant findings and challenges to be faced by universities in innovation-seeking countries in their path to entrepreneurialism, in their role of key agents to boost economic growth and welfare in the knowledge-based economy. Critical challenges identified are those related with the unfinished transition to the knowledge-based economy, the dysfunctional innovation system, the poor scientific output of a number of universities in each country, the centralization of university managerial system instead of faculty units of decision, and the unsatisfactory level of entrepreneurship.

Finally, the **eighth chapter** contains the outlooks and conclusions on entrepreneurial universities in innovation-seeking countries, essentially, a process-based view of the shift required at multiple levels of analysis with a view on inputs, processes, and outputs in the value creation by the university. The alignment between the three pillars of the university mission and the way how the university creates value for each of the stakeholders involved is explained. By means of an intangible-based view, university managers should devote time, effort, and resources to guide the process of value creation. This is related with how the university creates value by means of the intangible elements, namely its human, structural, and relational capital.

Chapter 1

Toward a New University Paradigm

Introduction

From its beginnings, conventionally marked by the establishment of the Humboldt University in Berlin in 1809, the modern university has faced a double challenge arising from the many conflicting objectives of research: the search for fundamentally new knowledge that tends to contribute to the quality of teaching as one of the theoretical core activities of universities; and the pursuit of applied knowledge that contributes to practical accomplishments that have a direct technological applicability and commercial usability.

In Europe this conflict in research goals and the overall scientific and educational orientation of the university remain highly topical and have brought about the current rivalry between the two chief concepts of universities: research and entrepreneurial universities. In contrast, American universities have always been oriented toward practical teaching and application. The grounds for such an orientation were established in 1862, when the US government awarded universities, through the Morrill Act, land as a form of financial support (the so-called land-grant universities) for their work. The Morrill Act required a balance between "the practical and liberal education," i.e., classical studies and the teaching of agriculture and mechanical arts that reflected a growing demand for agricultural and technical education in the United States to form a new class of engineers. Land-grant colleges developed into the large public universities of today such as Michigan and Pennsylvania State Universities. The tradition of entrepreneurship was significantly strengthened in the 1980s and 1990s by venture

capital, university science parks, technology transfer offices, spin-off companies, and other practices, which have not become fully familiar in Europe.

Contrary to America and some developed European countries like Germany, where university research "complements" the productive sphere, in transitional countries there is a 20-year-long period of institutional inertia in universities that retards the harmonization of knowledge production with the demands of the new techno-economic paradigm—the knowledge economy. There is a discrepancy between the expected central role of universities, research institutes, and scientists as "knowledge producers" regarding the fundamental resources of emerging knowledge economies on the one hand, and their marginal role in the current real-world economy on the other.

Decreasing government funds for university education and scientific research along with demands for the production of technologically applicable knowledge with commercial potential brought additional confusion as to the role of science in transition economies. The emergence of transition economies in the early 1990s coincided with the beginning of the transition of scientific systems in developed countries (Cozzens, 1989). Therefore, the transition countries have not had time to adapt their science and higher education systems to the new concepts in science and innovation that yielded such models as new knowledge production (Gibbons, 1998), the triple helix (Leydesdorff and Etzkowitz, 2000), the entrepreneurial university (Clark, 1998), innovation systems (Nelson and Winter, 1982; Freeman, 1987), etc. Unfortunately their economies have not followed the path to a knowledge economy that naturally requires changes to their science and higher education systems. There is no doubt that in developed countries both their scientific and innovation systems have undergone tremendous changes over the last 20 years, which have been incorporated in many policy and strategic documents of the European Union. The basic strategic documents—the Lisbon agenda (European Council, 2000) in the past, and the Innovation Union (European Commission, 2010) in the present—are based on the well-known concept of the research triangle that strongly suggests a connection between research (knowledge production), education (knowledge dissemination and transmission), and innovation (knowledge utilization and commercialization) in the unique cycle of knowledge production for the creation of the new (in the past) and better (at present) intellectually based jobs. There are also many other documents and projects devoted

to science–industry cooperation like the revised guidelines of the European Commission to "create modernised agenda for universities: education, research and innovation" (European Commission, 2006b); project DIfUSE (Driving Innovation from Universities into Scientific Enterprises, 2005–2008); project ECIU (European Consortium of Innovative Universities); the formation of ERA (The European Research Area, Cordis. "The EU Framework Programme for Research and Innovation". Retrieved July 14, 2015);); EIT (European Institute for Technology, http://eit.europa.eu/); etc From some more radical points of view, the traditional Humboldt-type university is facing a collapse and is no longer able to function properly (Wissema, 2009). It has grown into a complex institution overloaded with various functions such as teaching, research, and publications, providing services to society, cooperating with industry, patenting, and technology transfer. At the same time it is subject to too much administrative and bureaucratic intervention by public administrations (Decter *et al.*, 2007). Therefore, new concepts such as third-generation universities (Wissema, 2009) have also emerged. This seeks to reconcile the conflicts of present-day universities and to establish them as a center of elite education and the commercialization of research at a global level. The success of such universities depends on their international competitiveness in order to attract the best students, professors, and contracts with industry.

It seems, therefore, that the changes in science and higher education are far from complete and transition countries are slowly but surely joining the process of transforming science and higher education. The first phase of transition toward a market economy and democracy is over, and economic growth based on innovation and knowledge is becoming a necessity for transition countries too. They are starting to share with more developed countries the same difficulties of a weak transformation of science into innovation. Although political and business elites as well as mangers are not yet aware of the new role for science and higher education, there is no doubt that knowledge-based manufacturing and services will soon arise as the most important issue in development. It also means that new methods of knowledge production and the organization of university science must be developed.

It should be stressed, therefore, that countries where university scientific disciplines and curricula developed together with the industrial world, i.e., countries where economic development and science mutually supported each other (e.g., the United States and Germany), have

gained significant economic growth (Berglund and Clarke, 1999). The "crisis" of the university as well as the "transition" of scientific systems seeks for a new model of knowledge production, but also new strategies and organizational cultures. It is important to emphasize the unquestionable contribution of universities regarding technological change through their standard missions of scientific research and education. It is questionable whether these functions, in a knowledge-based economy, are sufficient for the university in order to maintain its current leading position in the production of knowledge and intellectual capital. In order to put knowledge to work, many governments in the 1990s made a shift from science to innovation policy. Innovation policy is usually defined as an "amalgam of science and technology and industrial policy" (OECD, 1997). This definition reflects, in essence, the nature of innovation as a phenomenon that integrates scientific knowledge, its technological application, as well as commercial exploitation.

The final task of innovation policy is to foster innovation by the capitalization of science through the productive use of national scientific and technological potentials. Alongside the concept of national innovation system (NIS), new concepts and approaches to science and university systems have also emerged. Among the theories on change in scientific and university systems three are the most important, and have evoked both positive and negative reactions from other scholars. However, all three theories have left their mark on the development of systems of science and scientific policy and are current today. The first theory addresses a "new model of knowledge production" (Gibbons *et al.*, 2006), which includes heterogeneity, interdisciplinarity, and networking with an emphasis on cooperation between science and industry in knowledge production. The second theory is a thesis on the "university revolution" (Etzkowitz, 1998; Etzkowitz and Viale 2010) that underpins the entrepreneurial university; and the third relates to the "triple-helix model" (Leydesdorff and Etzkowitz, 2000).

The public sector has different specific needs than the business system has. Those differences must be taken into account when developing management systems for the public sector (Serrano Cinca *et al.*, 2003; Bossi Queiroz *et al.*, 2005; Sánchez and Elena, 2006). In particular, they highlight that public sector organizations have multiple nonfinancial objectives and goals, so they must be managed by measuring and controlling adequate performance indicators (mainly nonfinancial). Although universities are not profit-oriented organizations, they have been involved in the quest for competitive