INNOVATION GOVERNANCE: LEADING THE WINNERS

Editors

Polona Domadenik, Matjaž Koman, Tjaša Redek

Published by

Časnik Finance, d. o. o.

Ljubljana, November 2019

CIP - Kataložni zapis o publikaciji
Narodna in univerzitetna knjižnica, Ljubljana

005.591.1(082)

INNOVATION governance: leading the winners / editors Polona Domadenik, Matjaž Koman, Tjaša Redek. - 1st printing. - Ljubljana : Časnik Finance, 2019

ISBN 978-961-6541-59-6
1. Domadenik, Polona
COBISS.SI-ID 302413568

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Authors

School of Economics and Business, University of Ljubljana

Andreja Cirman
Barbara Čater
Tomaž Čater
Polona Domadenik
Daša Farčnik
Matjaž Koman
Mitja Kovač
Denis Marinšek
Irena Ograjenšek
Marko Pahor
Tjaša Redek
Vesna Žabkar

Giacomelli Media

Jurij Giacomelli

Zavarovalnica Triglav d.d.

Bojana Markovska Klepec

Students of International Full Time Master Programme in Business and Organisation - IMB, School of Economics and Business, University of Ljubljana

Matea Bezić
Aljuška Bonča
Teja Breskvar
Tine Burja
Guillaume Cavallari
Iva Drvarič
Valeska Gaber
Andreja Gradišek
Rok Hribšek
Vid Janša
Tilen Kalan
Nika Marija Kavšek
Ula Kočevar
Jan Kolar
Jaka Koščak
Karmen Krvina
Zala Logar
Raya Mammadova
Žiga Matjašec
Katja Mencigar
Karin Mohar
Thyme F. Nord
Urban Orehek
Taja Pečnik
Luka Pevec
Barbara Pikl
Anja Plaznik
Miha Povšin
Rok Primožič
Lucija Remic
Fati Sadikaj
Anastasia Stoliarova
Ana Temeljotov
Bojan Tomšič
Žan Tratar
Špela Ušaj
Jaka Velikonja

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PREFACE

"Innovation Governance: Leading the Winners" is the result of an entire year's work of a selected research team *(Andreja Cirman, Barbara Čater, Tomaž Čater, Polona Domadenik, Daša Farčnik, Jurij Giacomelli, Matjaž Koman, Mitja Kovač, Denis Marinšek, Bojana Markovska Klepec, Marko Pahor, Irena Ograjenšek, Tjaša Redek and Vesna Žabkar)*, and the students of the XXVIth generation of the International Master in Business and Organisation Programme (IMB) at the School of Economics and Business, University of Ljubljana.

The book consists of four parts. The first part discusses the role of innovations and R&D activities around the world. The second section presents selected case studies, focusing on the innovation governance conducted in multinational companies. The third part highlights the innovation governance and R&D activities in large Slovenian companies. The final section studies the innovation policy in Slovenia and identifies critical determinants of a supportive environment for innovation-led growth in EU.

Students from the XXVIth IMB generation dedicated their hard work, knowledge and time to the writing of this book. Their contributions and the committed mentorship of our aforementioned colleagues were invaluable in the book's production. We acknowledge the excellent mentorship of J*anez Prašnikar.* We would also like to thank *Mojca Mele, Armin Messerer, Roy Tondock, Jana Jovanovska* and *Jadranka Jezeršek Turnes* for their support in the process of survey design and data collection. Many thanks to *Thyme Nord* for proofreading the work, and *Ciril Hrovatin* for the technical editing and graphic design, as well as *Laura Pompe Sterle* for the cover design. *Barbara Pikl* provided us with invaluable technical assistance. Many thanks also to colleagues from the newspaper *Finance* for handling the final execution of the book.

Ljubljana, November 2019

Editors

I.

INNOVATIONS AND R&D ACTIVITIES ACROSS THE WORLD

Mitja Kovač, Jan Kolar, Rok Primožič, Tine Burja

CURRENT AND FUTURE CHALLENGES DRIVING INNOVATION PERFORMANCE

Introduction

Technological progress is a vital source of economic growth, and R&D is a critical means of technological progress (Borrus and Stowsky, 1997). Innovation is considered to be one of the main avenues for economic well-being, growth, and productivity worldwide. The most innovative countries tend to be the most competitive and economically prosperous. Paul Krugman, Nobel Prize winner, perfectly summed up the importance of productivity, which is fuelled by innovation: "productivity is not everything, but in the long run it is almost everything" (Krugman, 1994). For example, the United States, Switzerland, Sweden, South Korea, and other countries are considered to be the most innovative; however, emerging countries such as China are continuously developing and closing the gap between themselves and innovation leaders (Global Innovation Index, 2019).

Innovation is instrumental, as it benefits and improves the well-being of future generations. Biological innovation mitigates diseases, while innovation in communication and organization of information fosters educational, political, economic, and social development. With the help of technological innovation, countries can use all of the previously emphasized factors to push the efficient frontier out and therefore increase their productivity (Ernst and Young, 2018).

This chapter discusses the main trends of innovation and factors that affect innovation and R&D to better understand the dynamics and the role of innovation in the global economy. The first part of this chapter explores the key factors of innovation, such as education, public and private R&D spending, and the patent count. The second section offers an overview of mega trends, ranging

from urbanization to human well-being and artificial intelligence. Finally, the impact of these disruptive trends on innovation is discussed, and the conclusion summarizes our key findings.

1 Current global situation

When it comes to innovation around the world, an abundance of literature provides many different factors that vary between countries, companies, industries, etc. (Griffith et al., 2006). We will use a top-down approach (Corporate Finance Institute, 2019) to provide a better overview of the current situation, starting with the R&D spending on a national level and followed by a focus on different sectors and peculiarities around the world.

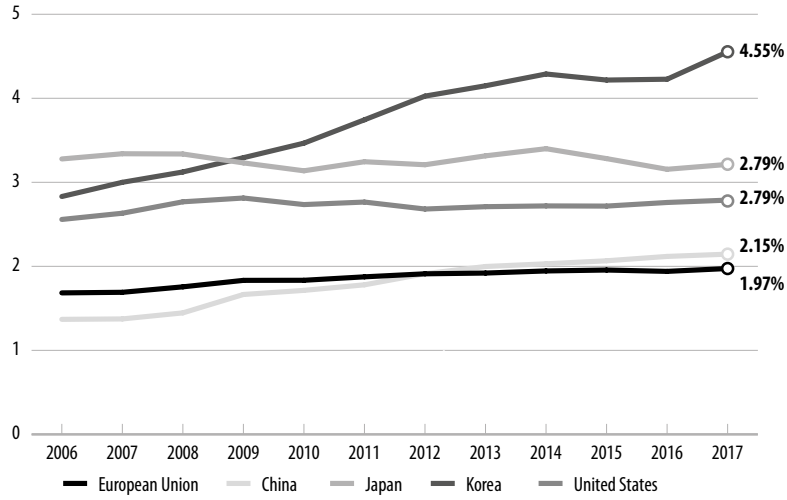
When comparing the spending on R&D as a percentage of GDP between some of the largest countries, the gap has increased.[1] Korea has been the best performer in recent years, increasing its R&D spending to over 4.5 percent of GDP. Japan follows with 3.2 percent, even though its R&D spending as percentage of GDP has slightly decreased in recent years and will be surpassed by the US if this decline continues. The United States currently invests 2.79 percent of GDP into R&D activities (OECD, 2019). China was able to overtake the EU due to a major increase in R&D spending, currently at 2.15 percent of total GDP (OECD, 2019). The EU has been continuously increasing their spending but at a slow pace. Even though the R&D spending as percentage of GDP is constantly increasing in the EU, it has gone up by less than 0.3 percentage points (OECD, 2019) in the past 12 years, reaching around 1.97 percent in 2017 (OECD, 2019).

In addition to increased human capital and education, employing more educated people enables companies to have workers who are adopting more advanced technologies, which increases the productivity of the firm itself (Loeser et al., 2016). When comparing the government expenditure on education as a percentage of GDP, the US and EU-28 are leading with around five percent of GDP spent in 2014 (The World Bank, 2019). Japan is lagging behind at around 3.6 percent (The World Bank, 2019).

One must also emphasize the significant contribution of young, leading innovators, or "yollies", to the R&D patterns (Veugelers, 2010). Even though they are typically smaller in size based on employment and R&D budget in absolute

1 This chapter only highlights a selection of countries. If all countries were included into the analysis, Sweden, Finland, and other countries would be ahead of China.

Figure 1. Gross domestic spending on R&D, as percentage of GDP between 2006 and 2018



Source: OECD, 2019.

terms, they are still the major innovators when compared to old firms. Their high R&D intensity (measured as a share of R&D expenditure in sales), which is almost twice as high on average compared to more senior firms, allows them to be more R&D-oriented. "Yollies" are typically present in younger sectors, ranging from the internet, software, biotechnology, etc. "Yollies" also support fast sales and R&D growth which consequently affects the employment growth and overall economy (Veugelers, 2010). The U.S. has a much higher percentage of "yollies" in the economy when compared to other countries. This might be one of the key drivers of the successful R&D sector in the United States (Veugelers, 2010).

2 Mega trends

Mega trends are powerful, transformative forces that could change the global economy, business, and society, and have been changing the way we live for centuries (BlackRock, 2019).

Table 1 summarizes the most important mega trends at the moment (TrendOne, 2019). To identify the relevant top global trends and needs for innovation, we must start asking questions about world's greatest challenges. Those questions need to be related to demographics, technology, lifestyle expectations, and basic needs (TrendOne, 2019).

Table 1. A summary of current Mega trends

Mega trend	Impact on Society and Business
Urbanization	Cities are growing and merging with each other, which leads to increased urbanization. These mega cities will be targeted as hubs of investment opportunities in industries such as mobility.
E-Mobility	E-Mobility will redefine the future of personal mobility, with electric cars becoming more common, as well as electric scooters, bicycles, and skateboards.
Sustainable energy production	The world is slowly moving away from traditional fuels and toward more sustainable and efficient energy sources, which is supported by the deployment of smart energy management.
Smart is the New Green	Smart products with sensor technology are being integrated into cities in order to become more sustainable.
Health, Ageing, Wellness and Well-being	With the ageing population, the healthcare industry is moving towards the forefront in research and development, diagnostic, and monitoring. Wellness and well-being are also the future of value propositions for companies.
Smart data	The future of business decision-making will be based on data, along with the development of new business models and products.
Artificial Intelligence	Artificial intelligence presents the future of innovative solutions. Companies invest in AI to develop solutions to resemble the human brain.
Open Innovation	Open innovation reaches beyond company boundaries using their own innovation process, as well as looking for strategic use of the environment's innovation potential.

2.1 Urbanization

In 2018, 55 percent of the global population lived in urban areas and the number is expected to increase to 68 percent by 2050 (UN, 2018). This mass migration to urban areas is transforming cities into enormous economic hubs and creating the phenomenon of mega-cities. Core city centres are merging and combining with suburbs and daughter cities. After 2020, more than 35 cities will grow to become mega-cities, with Asia containing nearly half of them (Frost & Sullivan, 2014).

In the future, these mega-cities will be targeted as hubs of investment, with each city transforming into a unique customer with untapped opportunities in key industries such as mobility. Partnerships between city governments, solution providers, and researchers will become working models for most future city projects (Frost and Sullivan, 2014).

2.2 E-Mobility

Companies that perceive cities as customers and position themselves as partners and solution providers will benefit from new business and investment opportunities. Concepts like bike and car sharing, integrated door-to-door

transport, inter-modality, and smart phone-based urban mobility solutions will become a common sight on the roads (Frost and Sullivan, 2017).

To make the future of connected living as seamless as possible, we will have more intelligent transport networks which integrate fare structures directed toward personal credit cards and even mobile phones. Future intelligent platforms will connect the car to numerous functions and devices at home and the office (Miller, 2017).

In near future, high speed rail will connect not only cities and countries but also continents. In roughly 15 to 20 years, one could travel effortlessly from London to Beijing using the global high-speed rail network (EESI, 2018).

2.3 Sustainable energy production

Urbanization will cause cities to consume 3/4 of current global energy. Combined with an increasing desire for energy security at the national level, a global dash to find the energy sources and business models of the future has already been triggered (The Ecologist, 2019).

The future of global energy will not be entirely dominated by fuel choices. Rising energy costs and an increasing focus on environmental performance have drawn attention to the need to manage energy efficiently through technologies such as smart grids. This has increased the world's capacity to handle energy challenges, as energy through smart grids offers more control and visibility to integrate distributed generation (wind turbines, waste-to-energy, solar panels etc.) and manage demand more effectively. This results in cleaner, more reliable, and smarter energy. With these possibilities in mind, the European Union is currently considering an energy efficiency target reduction of 40 percent for Europe by 2030 (Rosenkranz, 2015).

2.4 Smart is the new green

Green products and services will be increasingly enhanced or even replaced by smart products and services, with intelligent sensing technology and internet connectivity driving stronger optimization. Enabled by the internet of things (IoT), machine to machine communication (M2M) and over 90 billion con-

nected devices globally, digital intelligence will be the key driver of efficiency and sustainability across a vast array of applications (Singh, 2015).

Smart concepts will have a huge part also in developing smart and sustainable cities. Using the latest intelligent and green initiatives to reduce energy consumption and improve efficiency in all facets of human life, Smart Cities will be built upon eight parameters: Smart energy, Smart Mobility, Smart Healthcare, Smart Technology, Smart Infrastructure, Smart Governance, Smart Buildings, and Smart Citizens (Frost and Sullivan, 2017).

2.5 Health, ageing, wellness and well-being

The world is aging rapidly and most countries are not prepared to support their growing number of elderly people. In 2010, individuals above the age of 65 accounted for eight percent of the total population, and this number is expected to reach ten percent by 2025 (UN, 2015). The population aged 65 years or more represents 40 to 50 percent of total healthcare spending and incurs three to five times the healthcare costs per capita than those under the age of 65. Access to healthcare, insurance coverage, pension reforms, retirement policies, and adequate income for people above the age of 65 will form the basis of future government policy. The share of the healthcare budget, spent on the treatment of various diseases, in total healthcare costs will be reduced from 70 percent in 2007 to 53 percent in 2021 while spending on prevention, early diagnosis, and monitoring will increase (OECD, 2019). Nanobots, combination devices, electroceuticals, and genome sequencing are poised to transform the global field of patient care by providing complex and tailored treatments to meet patients' needs, even on a microscopic level (Frost and Sullivan, 2014).

The key to this healthcare paradigm shift will be innovation targeted toward so-called power patients, who will rely on Google and other search engines to self-diagnose and obtain the best available healthcare information (Trend Watching, 2019). While patients in the developed world grow increasingly dissatisfied with slow-moving regulatory and healthcare provision environments, the developing regions will present new business models tailored to meet specific patient needs in novel and cost-effective ways (Trend Watching, 2019).

2.6 Smart data

Data is most important resource of the digital world. The daily amount of data gathered is growing exponentially, with data from customer cards, browser searches, smartphones, and the Internet of Things devices all being collected. Companies are increasingly reliant on data to support decision-making, rather than relying on vague statements and "gut feeling". By analysing data, companies are also able to understand their customers and the market more fully and improve their processes. With a better understanding of who their customers are, they can innovate and develop new business models and products to fit their needs. This is crucial, as this method is the only way to stay competitive in our ever-changing business environment (Grow, 2017).

2.7 Artificial Intelligence

Artificial intelligence is one of the most trending topics in tech companies. Some supporters of AI predict that it will solve the existential problems of 21st century. Critics, however, fear that AI could gain the potential takeover humankind; but regardless of one's stance, AI is undeniably shaping the future. AI continues to be integrated within the Internet of Things and machine learning as tech companies chase high potential (Dang, 2019).

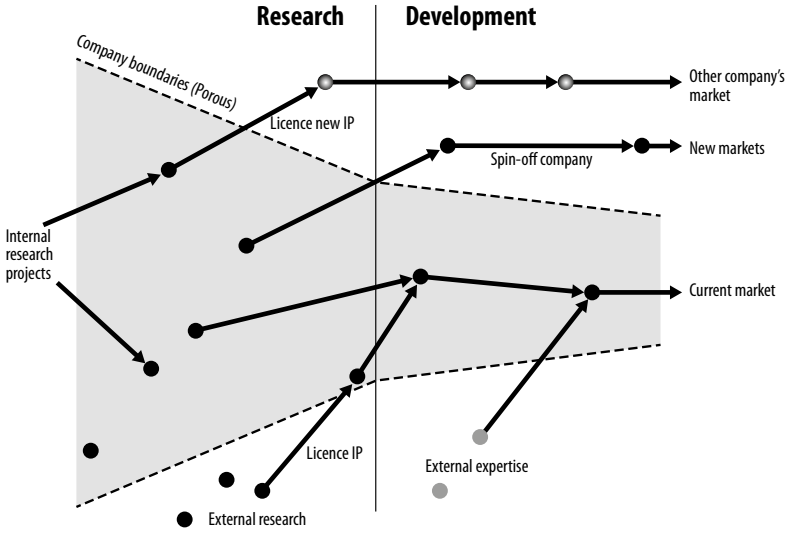
AI has an impact across many industries. Transportation will one day become autonomous, and AI-powered robots will work alongside humans in manufacturing (to some extent they already do). Healthcare will also benefit greatly from AI, as diagnoses will become faster and more accurate (Dang, 2019). The goals for AI are high, and technology companies are looking for AI solutions that are not just independently intelligent, but that can also learn from their big data. The driving reason for companies to innovate both in machine learning and AI is to develop solutions that resemble the human brain (Thomas, 2019), and thus remain competitive globally.

2.8 Open Innovation

Innovation has changed significantly in recent years, and approaches to innovation have moved increasingly toward "open innovation" (Chesbrough, 2003). In traditional innovation processes, organizations remain within their boundaries, researching and developing prospects that are close to firm-original

products with their focus solely on in-house R&D. Open innovation, on the other hand, reaches beyond company boundaries (Figure 2), using their own innovation processes as well as looking for the strategic use of their environment's innovation potential (Zapfl, 2018).

Figure 2. Open Innovation Process



Source: Wimalarante, 2017.

In recent years, there have been more and more companies using open innovation in the form of strategic partners, joint ventures, and academic collaboration. Pharmaceutical, chemical, and IT industries especially show a high tendency toward open innovation, as they are able use each other's resources in a collaborative manner (Ernst and Young, 2018).

3 The impact of mega trends on innovation

Mega trends are today the driving forces of innovation. Many of these trends are inter-connected and are working simultaneously in different aspects. The mega trends mentioned previously are thus expected to heavily impact innovation, primarily through the shaping of the direction of innovation trends. These mega trends will dictate the needs and preferences of consumers and create markets for new products or solutions to new challenges. A short summary of their expected impacts is provided in Table 2.

Table 2. The impact of megatrends on innovation

Mega trend	Impact on Innovation
Urbanization	• Increased need for products/methods to improve air quality, improve traffic, lack of water, and housing insecurity (Murali, Clummings, Feyertag, Gelb, Hart, Khan, Langdown, and Lucci, 2018).
Health, Ageing, Wellness and Well-being	• Complex issue that requires multi-disciplinary collaboration, requiring a number of new products and services to address new consumer needs (health, well-being) as well as tackle age-related problems (use of robots, automated transport, etc.) (United Nations Development Programme, 2019).
E-Mobility	• E-mobility cases also needed for improved connectivity between different systems; • Development of real-time optimization providing better vehicle performance; • New development will require use of new materials, improved software and hardware (BOSCH, 2019).
Sustainable Energy Production	• Sustainable sources are not currently reliable enough or are producing insufficient output; • Need for innovative solutions in terms of storing the power for later usage (Vyas, 2019).
Smart is the New Green	• Smart products expected to drive other game-changing innovation; • Smart products enrich the consumer experience; • Improve the efficiency in general (Cognizant, 2015).
Smart Data	• Companies are becoming more efficient in decision-making; • Companies become more innovative, with improved systems and cost effectiveness; • Satisfying consumer needs better and faster by developing better-suited products and services that relying on data analysis (Foote, 2016).
Artificial Intelligence	• Artificial Intelligence expected to reshape the nature of innovation the process and the organization of R&D; • Deep learning will contribute to innovation (Cocburn, Henderson and Stern, 2018).
Open Innovation	• Increased interaction between industries and innovation of "out of the box" products will increase; • Improved knowledge transfer and cooperation fosters more innovation in all fields (Zapfl, 2018).

The pressure of urbanization and population concentration will require new solutions that will improve air quality, rationalize and improve traffic, deal with potential water and energy distribution (even in the case of a shortage), and find new innovative ways to solve housing problems (e.g. 3D printed homes) (Murali et al., 2018). E-Mobility, which is closely related to the ageing population and urbanization, will require new solutions to allow efficient, accessible, and clean transportation. Innovations or needs in this field will also drive changes in the generation of new materials, as well as new digital solutions, including both software and hardware (Bosch, 2019). Increased population, e-mobility, urbanization, and population structure changes will require more energy, but this energy will have to be green. The trend of sustainable energy production and its relevance to urbanization, ageing, and e-mobility will require new

solutions to find, develop, and store alternative energy sources (Vyas, 2019). Optimization will be required in a number of capacities, primarily to push economies to develop more sustainably. Smart products combined with smart data and AI will help companies become more efficient, more innovative, and focused on the end-user.

The processes of production and innovation will be supported by AI, which will reshape the innovation process but also hopefully allow for a more efficient innovation and better results (Cocburn et al., 2018). Openness in general, not just increasing trends toward knowledge sharing, improved cooperation, and exchange of information will lead to more innovations which will accommodate more types of consumers (Zapfl, 2018).

Conclusion

Innovation is one of the key aspects of well-being on a company, state, or even country level. Commanders of innovation are also the economic leaders of the world, such as the United States, Switzerland, and Japan; although emerging markets such as China are catching up at a rapid pace. Leading countries in innovation are especially focused on mega trends: powerful, transformative forces that can change the global economy. There are not many mega trends, and they are all interconnected. Urbanization has triggered the need for "Future of Mobility", while "Artificial Intelligence" and "Smart Data" are needed to support the "Smart is the New Green" mega trend. Mega trends define a path in innovation, and are always evolving as the world brings new challenges. The ageing population and increased importance of human well-being inspires different academic disciplines to collaborate to achieve better results. Smart data enables companies to cut costs, be more effective and efficient, predict future trends, create consumer needs, and at the same time satisfy them through data analysis.

Changes are also happening in the way companies innovate. Companies are shying away from traditional innovation strategies, where they innovate only within their boundaries. Companies are now choosing open innovation, where barriers between internal and external sources are minimized. Although uncertainty about the future is rising, innovation will continue to play a crucial role. This is why it is important to be aware of it, embrace it, and use it effectively to build a better tomorrow.

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Tjaša Redek, Teja Breskvar, Lucija Remic, Bojan Tomšič

TECHNOLOGY LEADERS, INNOVATORS AND COPYCATS

Introduction

As Steve Jobs said, "Innovation distinguishes between a leader and a follower" (Jobs, 2005). In the past 250 years, 63 percent of productivity growth was the result of technological progress (Chadha, 2019), meaning that 2/3 of the increase in our prosperity resulted from innovative activities. Innovative property continues to be a key source of growth around the world (Piekkola, 2006), but becoming a successful innovator requires more than just increasing R&D expenditure. The nature of innovation differs significantly between the highly developed technology leaders, who push the technological frontier out at higher risk and cost, and less developed technology followers, who aim to close the gap between them and the leaders. Consequently, the amount invested in R&D differs enormously along with the processes and goals of innovative efforts. For example, in India, around 600 million dollars of total private sector R&D is split between more than 1300 individual firms, while firms such as General Motors, IBM, HP, Google, Apple, and Tesla each spend this amount multiple times over (Forbes and Wield, 2000). This obvious difference in inputs results in much different outcomes.

The purpose of this chapter is to identify the differences in the innovation processes and performances between the innovation leaders and catch-up economies, with a focus on studying the characteristics of the processes of innovation leaders and followers in order to identify successful strategies.

The chapter is divided into three main sections. First we discuss the differences between some of the least and most innovative countries, their innovation inputs, and innovation performance. The identified gaps are then discussed to understand their sources, as well as why may be advantageous for there to be a

disparity in countries' technological progression. Finally, we examine strategies of countries that invest most in R&D (technology leaders) and alternative approaches to innovation for a developing country that can devote less resources to research and development (technology followers).

1 Innovation inputs and performance among leaders and followers

The Global Innovation Index (GII)[1] is a composite measure that captures innovative inputs and performances of countries used to provide a comprehensive picture of innovative characteristics of economies. Switzerland has been on top of the *innovation scoreboard* for nine consecutive years, followed by Sweden and the US (Figure 1, Figure 2 for detailed structure by sub-index). Switzerland performed best in several innovation indicators, such as the annual number of new patent applications or imports of information and communication equipment and components. It is also a leading country in environmental performance. Sweden improved from third to second place in 2019, primarily due to increasing productivity and remarkable improvements in knowledge absorption. The US was third, mainly due to its global economic role and the quality of their innovation performance. Germany, with strong research but a slightly weaker output, has remained ninth for the third consecutive year. Slovenia was 31st and is the most innovative country in South-eastern Europe (Cornell University et al., 2019).

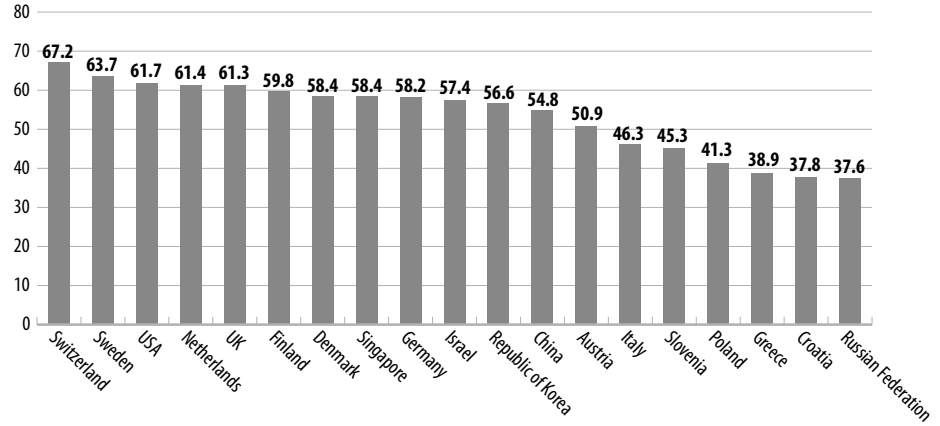
Several emerging economies have been losing in the global innovation race. Among such underperforming countries are Poland, Greece, Croatia, the Russian Federation, etc., which performed worse in education, had low investments in technology and science, and contain business environments which do not support innovation activities (Cornell University et al., 2019).

The GII measures innovativeness of countries using several indicators of *innovation output*. High-income countries such as Switzerland perform well in areas such as intellectual property receipts, creative outputs, human capital and research, high-tech exports, etc.; but in the segment of high-tech exports, China outperforms all the high-income countries, which pushes it to the top

1 GII is prepared by Cornell University, INSEAD, and the World Intellectual Property Organization (specialized agency of the United Nations). GII measures five dimensions that enable innovative activities: (1) Institutions, (2) Human capital and research, (3) Infrastructure, (4) Market sophistication, and (5) Business sophistication, and two for innovation outputs: (6) Knowledge and technology outputs and (7) Creative outputs. In total 80 individual indicators are used. The index is calculated for 129 countries (Cornell University et al., 2019).

most innovative economies in the world. Greece, Croatia, Russia, and Poland are at the bottom of the list with significantly less intellectual property recordings.

Figure 1. Global Innovation Index 2019 in a selection of countries (global top ten and selected European economies)

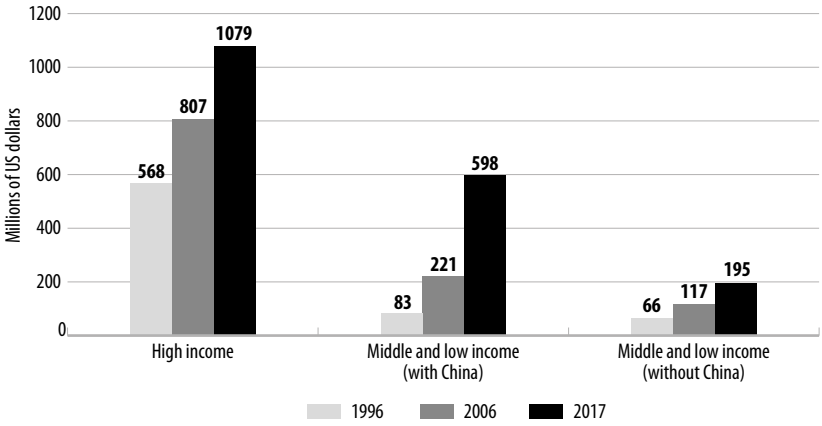


Source: Cornell University et al., 2019.

As a key *innovation* input, global R&D expenditures have been growing rapidly in the past 20 years in both developed and developing countries. Investments in technology, education, and human capital have almost doubled between 1996 and 2017. While high-income countries contributed 87 percent of total global R&D expenditures in 1996, their share declined to 64 percent in 2017, the lowest point in 30 years. China, India, and other middle-income economies represented 35 percent of global R&D expenditure. China alone contributed 24 percent of the world's R&D in 2017, which is especially massive when compared to their contribution of only 2.6 percent in 1996. Less developed economies lag significantly behind (Figure 2).

The R&D expenditure in high-income countries grew by 90 percent from 1996 to 2017. The middle and low-income countries grew investment in innovative activities by 195 percent without China, and by 620 percent including China. This level of growth suggests that they are quickly catching up with developed countries (Figure 2). R&D resources are much greater in developed economies, while the developing countries spend fewer resources and also perform worse in terms of innovation outputs; but the relationship between innovation inputs and outputs is not linear or straightforward, and the success of the leaders or the fast catch-up of some countries can only be explained by the systematic differences in R&D and innovation activities.

Figure 2. Average R&D expenditures by income groups by countries, 1996, 2006, 2017 in millions of 2005 dollars in purchasing power parity



Note: R&D data refers to gross domestic expenditure on R&D. The high-income group includes 54 developed economies (such as Switzerland, Sweden, the USA, the Netherlands, the UK, etc.), and the middle- and low-income groups include 97 economies (such as Vietnam, Ukraine, Georgia, Rwanda, Tanzania, etc.).

Source: Cornell University et al., 2019.

2 The differences in innovation characteristics between technology leaders and followers

There are many differences between the world's leading economies and those who are trying to catch up with them, be it in innovation inputs, management of innovation activities, characteristics, or outputs (Forbes and Wield, 2000). These differences do not imply that one group is better than the other, but that nature and logic of innovation requires a unique approach in order to ensure efficiency and success. Such differences are discussed at the country level, but similar findings apply also to the firm level. Table 1 summarizes the main differences.

2.1 The innovation leader shapes the future, but for the follower the future is shaped

Technology leaders shape the future with their successful innovations whether or not they understand what the impact will be. The leaders create the technological frontier and subsequently shift it forward. They systematically encourage innovation activities and invest vast resources into R&D, although they cannot be entirely certain whether the market will accept their new products or not. In-house R&D is essential for technology leaders, although its importance should not be underestimated in the case of the technology follower (Forbes and Wield, 2000).

Table 1. Differences between technology leaders and followers

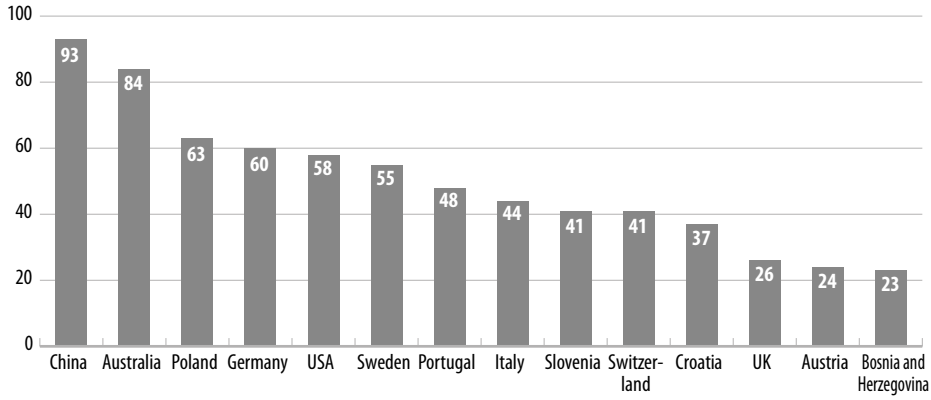
TECHNOLOGY-LEADERS	TECHNOLOGY-FOLLOWERS
Basic characteristics	
Representatives: USA, China, Germany, South Korea	Representatives: Finland, Slovenia, Spain, Croatia, Brazil
Shape the future.	Future is already shaped for the follower (by leaders).
R&D characteristics	
R&D focus: Research and Development	R&D focus: Development and Design
Key issue: *how much research and how much development?*	Key issue: *not how much R&D, but what to research and develop?*
Key role of R&D: *research expands the base knowledge on which existing industries develop new products.*	Key role of R&D: *build independent design capabilities for the firm.*
Innovation characteristics	
Leaders discover new products. In the research phase, they are not sure if the product is possible to be made - more uncertainty.	If they know that some product can be done and is marketable, they make its production more efficient - less uncertainty.
Around 50% of R&D projects made by technology leaders are unsuccessful.	• Incremental innovation is key; • Process innovation often before product innovation; • Shop-floor innovation; • Organisational, cultural & managerial innovation.

Source: Based on Forbes and Wield, 2000.

Alternatively, *technology followers* are either below or very close to the frontier but do not move it forward. Their growth and innovation strategies rely on less expensive and less risky technology transfers. Often, this transfer is accompanied by R&D expenditures financed by foreign-owned firms (Figure 3).

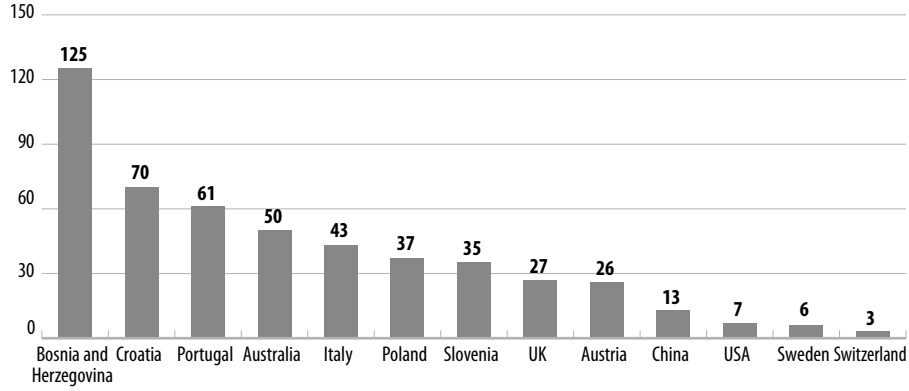
According to Forbes and Wield (2000), one of the key differences between leaders and followers is that the follower can already observe which products are commercially successful. They learn how to make those existing products efficiently, possibly adapt them, and launch them onto the market. Catching up is in many ways easier than moving ahead (Arnold and Bell, 2001). Nevertheless, the imitation process involves a great deal of innovation, like adopting products and processes which are new to the firm, upgrading them, finding local alternatives to the original inputs, adding a technical, design, or other improvement to existing products, etc. (Arnold and Bell, 2001). Knowledge absorption is the highest among technology followers. Some of the countries which were most successful in knowledge absorption are BiH, Croatia, and Portugal (Figure 4).

Figure 3. Country rank by gross domestic expenditure on research and development financed by foreign sources (among 129 economies)



Source: Cornell University et al., 2019.

Figure 4. Knowledge absorption ranking of selected countries among 129 economies



Note: Knowledge absorption is measured as intellectual property payments, High-tech imports, ICT services imports, Foreign direct investment, net inflows, and Research talent in business enterprise.

Source: Cornell University et al., 2019.

Consequently, to be able to adopt, adapt, and upgrade existing processes or products from the frontier, the followers must also engage in R&D activities. These activities are done in firm labs, as this allows them to be immediately responsive to the shop-floor problems of the firm. Moreover, imitation requires skills very similar to those required for invention (Arnold and Bell, 2001), although the qualification level might differ. Aghion (2009) determines that leading and following countries are looking for workforces with different knowledge and skills. In general, catch-up economies require slightly less educated

people. They are instead looking for a technical staff capable of implementing the transferred knowledge. As a country approaches the technological frontier, the demand for better-educated workers increases.

From this standpoint we can see that imitation may in fact be underappreciated. Imitation can be even more important for business growth than innovation is. 97.8 percent of the value of innovations goes to imitators (Shenkar, 2010).

2.2 Innovation types: Research vs. development and design

It is important to emphasize that the innovation activities of technology followers are not less difficult than the leaders', but rather completely different (Arnold and Bell, 2001). They are both trying to launch the same/similar product but with a completely different business strategy and timing. While the technology leader invests its resources in new ideas and findings, the follower focuses more on the transformation of knowledge to suit the local environment. In order to keep their leading positions, the leaders must constantly invest significant efforts into novel technologies and products. To catch up with those at the technology frontier, followers would have to progress faster than the leader.

While the technology leaders' R&D resources are more focused on research and development of the product, technology-followers put more R&D effort in development and design. The follower usually doesn't have research projects due to higher costs and significantly higher uncertainty of research outcomes. (Forbes and Wield, 2000).

Based on the OECD (2005), there are four types of innovations: product, process, marketing, and organizational. Technology leaders are mostly focused on product and process innovations, while technology followers do organizational and marketing innovations because it is cheaper, less risky, and easier to do. As the follower gradually implements innovations and moves toward the frontier, the value added in the firm increases and they can consequently embark on more complex and costlier innovation efforts. If we look at the life cycle of technology or an industry, we can see that designing takes place in the early stages to experiment and create technological innovation. In later stages of the cycle, designing is done with the purpose of technical improvement and lowering costs of production (Forbes and Wield, 2000). The last stage of the cycle is the most market-driven, since new design variations included fashionable styles and redesigns to attract more customers who have relatively old technology.

Later stages of the life cycle are performed by the *technology follower*, while the first stages are done by *technology leader*.

The Chinese use the term "shanzhai" to refer to copying market-proven products and adapting them for the local market with minor modifications. While "shanzhai" is common across a range of products and services, it is particularly prevalent in the internet sector. Chinese internet companies are often compared to their Western counterparts based on the similarity of their business models. For example, Baidu is known as the "Google of China", Alibaba as the "Amazon of China", and Xiaomi as the "Apple of China", just to name a few (Tse and Gervasi, 2017).

2.3 Basic, applied, and commercial R&D

2.3.1 The role of basic and applied R&D

Generally, R&D activities are divided into three broad categories. *Basic scientific research* generates new ideas, principles, and theories which may not be immediately utilized but nonetheless form the basis of progress and development in different fields. *Applied research* extends that knowledge to answer specific real-world questions or solve specific real-world problems. Research objectives are usually set by clients or sponsors. *Commercial R&D* focuses on finding marketable solutions.

Technology leaders focus more on initial product development. Stiglitz (2015) stresses that ultimately all innovation rests on the foundation of *basic* research, which is overwhelmingly financed by the government; however, the government also plays a crucial role in financing *applied* research due to the short-run focus of firms on direct financial rewards and consequently on *commercial* R&D. According to Pisano and Willy (2012), firms focus on specific challenges for their customers, while the government should fund basic and groundwork applied research, which in the past laid the foundation for creation of the internet. On the other hand, Arnold and Bell (2001) stress that most of the now-famous military projects, like the Manhattan project, which developed the atomic bomb, were *user-oriented* (based in applied and commercial research) and not *"science push" (basic research).*

The trend to build on existing knowledge rather than blindly investing in basic research is not observed only in followers but also in *leaders.* Many in-

dustrialized countries use measures that support firms in acquiring, incrementally developing, and applying existing knowledge and practices. The concept of open-source innovation – building on ideas and technologies from third parties – is now pervading most businesses (Deschamps and Nelson, 2014).

Research institutions are encouraged to work in a user-focused way. It is important to understand that a policy that focuses on basic science and ignores the innovation process will result in more science, not more wealth; but once at the frontier, the need for basic research from the research sector and, especially, a significant increase in internal R&D becomes more important, and it is rational to spend much more on science and public research than is the case of catch-up countries (De Vries et al., 2015).

The *technology follower* is better off when focused on incremental innovation. Research (especially basic research) does not play an important role during the catch-up process. Unfocused investment in the basic research phase results in creating capabilities disconnected from the economy. Stiglitz (2015) argues that follower countries can invest less money in R&D but still benefit from the knowledge that results from the investment of leaders. Furthermore, even if profits are higher for a leader, there is still a cost to catch up and this cost may exceed the benefits of doing so.

Countries like Ireland, Japan, and Norway focus on applied research and intermediary institutions before heavily investing into basic research. In contrast, Thailand and Morocco have historically built up their science base without paying much attention to the linkage with the private sector. This resulted in industrial development which is largely autonomous of the national R&D infrastructure (Arnold and Bell, 2001).

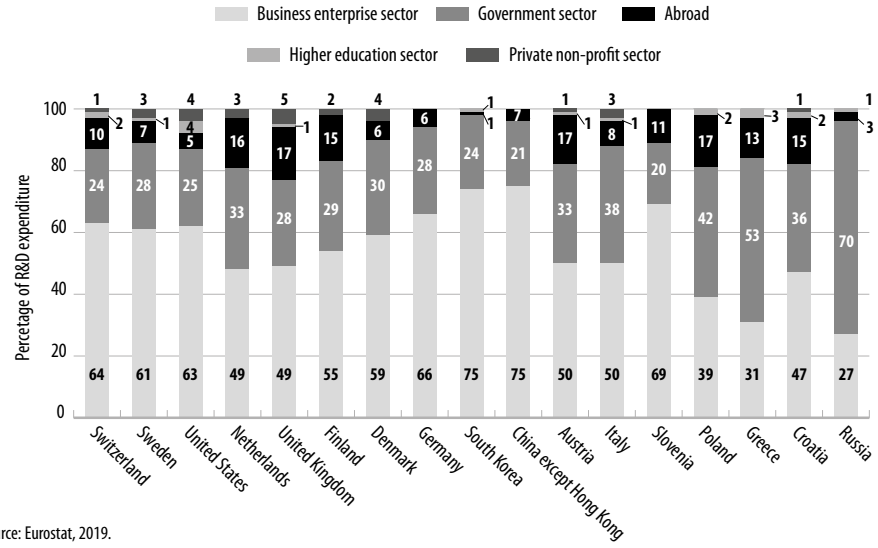
2.3.2 Government vs. business sector funding

In most OECD countries, the majority of R&D is financed by the *business sector* (60-70 percent, with Germany being a good example). On the other hand, business sector R&D investment in developing countries is lower. In Russia, 70 percent of R&D is financed by the national government (Figure 5).

Worryingly, countries where the *business sector* has a low investment in R&D also have problems absorbing knowledge from the research sector and elsewhere. Additionally, they cannot attract research-trained workers, as talented workers are not attracted to companies with weak R&D. This creates a

vicious cycle as the company without research-trained workers is then not able to specify its research and technology needs. According to Xing (2019), the linear model of innovation showed that an increase in science would lead to an increase in business activity. The truth, however, is that increased funding leads to increased science and well-educated researchers who cannot spillover into the national innovation system, because the business sector is underdeveloped. This encourages "brain drain", This is in line with a study by Forbes and Wield (2000), who argue that follower firms should conduct R&D because the nature of technology requires considerable innovation on the part of the receiver so they can keep up with the technological frontier. To sum it all up, business sector investment is of great importance for innovation.

Figure 5. Sources of R&D expenditure in 2016 (or last available year) in different countries

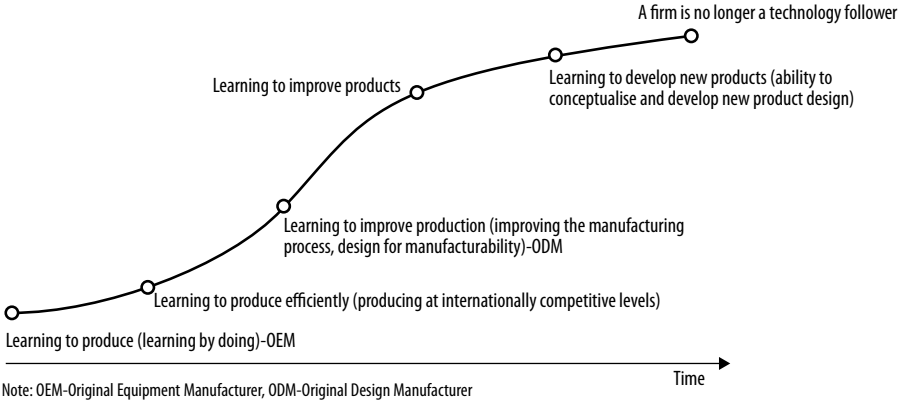


Source: Eurostat, 2019.

3 From a follower to a leader

In advanced countries, technologies go through three typical stages of development: emergence, consolidation, and maturity. Developing nations typically take the opposite route. They begin with mature technologies and gradually move to emerging ones. If this strategy is successful, the catch-up country acquires the capability to conduct domestic development and research activities. According to Forbes and Wield (2000), there is a *learning hierarchy in technology followers*, which is shown in Figure 6.

Figure 6. Learning hierarchy in technology followers



Note: OEM-Original Equipment Manufacturer, ODM-Original Design Manufacturer

Source: OECD, 2005.

Similar to the learning hierarchy, Fatas and Mihov (2009) also explored characteristics of productivity growth and explained the process of innovation convergence on the national level. When a country is poor, the labour is cheap. This country can take a blueprint for a factory from a more productive economy and offer the product at a lower price. The further behind the country is, the larger are possibilities for copying and importing knowledge. Once the country catches up there is no possibility for rapid growth, and growth must now be driven by innovation. This process seems rather simple, but for productivity to grow other criteria needs to be met. First, a country must *invest* in infrastructure, human capital, knowledge, equipment, etc. Second, countries must have a *good institution framework*. Return and risk are determined by the quality of political, legal, economic institutions, social norms, and culture.

For example, the personal computer industry used to be a crown jewel of the US economy. The company sought cost reduction and found its solution in outsourcing to Asia in 1980. This led to Asian contractors seeking higher value-added work and eventually they moved into complete product assembly. After that, they took over supply chain management, then the low-level design, and finally high-level conceptual design and specifications. The result was these "original design manufacturers" (ODMs) ending up designing and manufacturing virtually all Windows notebook PCs. After a contractor has evolved into an ODM, it can develop its own brand and become a competitor. Such activities may lead to tensions between leaders and (past) followers.

There is another reason for a follower to invest in its own product innovation besides higher profit margins. In Korea, firms initially grew based on foreign

technologies; but later foreign firms began to refuse the sharing of their technologies. For example, Mitsubishi, which provided the core technology to Hyundai Motors, suddenly refused to renew the contract in the mid-1980s. Similarly, LG Electronics found that no foreign colour TV maker was willing to license to Korean producers in the mid-1970s. It was only when these external crises occurred that Korean firms began heavily investing in domestic R&D (Kim, 1997). A more recent example of a country refusing to share its technologies is the US. As China pursues its own tech ambitions, a threatened US is cutting Chinese firms off from American scientific know-how. By putting Huawei on a US government blacklist, they have effectively limited Huawei's access to critical chips and software from American companies (Jing and Soo, 2019).

Conclusion

We have developed an idea about how technology followers and technology leaders should handle innovation. *Technology leaders* are the ones who are moving the technology frontier forward by investing in new product innovations. This is risky and expensive because of the uncertainty of whether the market will accept this product or not. When the risks are high, so are the rewards, meaning profits at the technological frontier are the highest. *The follower* can be near or even at the technology frontier, but isn't pushing it forward. Innovation is still immensely important to the follower, but they are focused more on incremental innovation, process innovation, design for manufacturability, and optimizing the supply chain. Working with and reworking the stock of knowledge is the dominant activity in innovation; however, once a country reaches the technological frontier, the way forward is no longer so clear. Therefore, more investment in research is necessary. There is another reason why a follower could find investment in research necessary, as opposed to just building on existing knowledge. A licensor might be reluctant to share its technology because of fear that a licensee could become a competitor.

Whatever the reason behind it may be in both cases, a developing nation that begins with mature technologies gradually moves to emerging ones. If this is successful, the catch-up country becomes a technology leader.

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Marko Pahor, Tilen Kalan, Špela Ušaj, Jaka Velikonja

TRENDS IN THE EU

Introduction

High investment in technology development, disruptive innovation, and R&D intensity are the main characteristics of the most progressive countries and their firms. Of the top ten firms by global market share in 2018, the majority were the hi-tech and characterized by large investments in innovation activities; but none of them are from the European Union (European Commission, 2018a). While the EU is home to a number of the world's most innovative firms and countries with ambitious goals for the future, the Union also experiences the "Innovator's Dilemma", as some large, outstanding firms fail due to the lag in the adoption of new technologies or have a slower pace of innovation. This lag is accentuated when compared to the US and even China. Nonetheless, in the EU, the number of start-up incubators, accelerators, and co-working hubs has increased in recent years, which in turn positively impacts regional entrepreneurial activities and financing initiatives (European Commission, 2018a).

The purpose of this chapter is to present the determinants of innovation as well as innovation trends in the EU, including the role of the broader policy framework. It is comprised of three main parts: first, we focus on presenting trends in innovation performance by different countries in the EU. Second, we discuss the innovation inputs, followed by governance and key European policy agendas such as Horizon 2020 and the European Research Area. Finally, we examine future initiatives aimed at improving research and innovation conditions in the European Union.

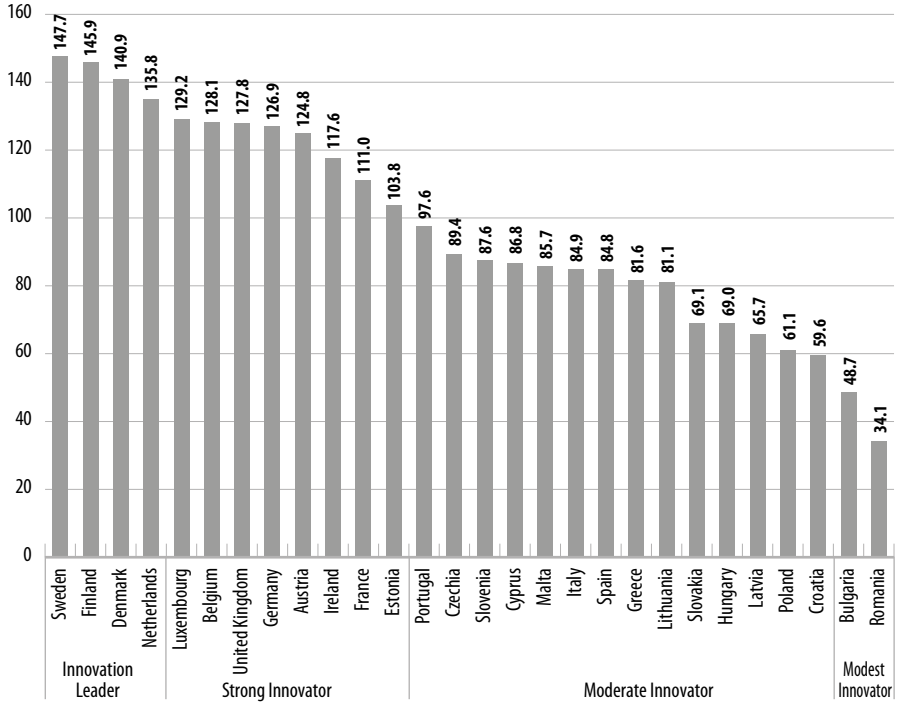
1 Innovation performance

Innovation performance in the EU is measured with the European Innovation Scoreboard (EIS). The EIS is a combination of 21 contextual indicators that

provide a comparative assessment of research and innovation. The scoreboard is comprised of nine indicators that measure the performance and structure of the economy, five that measure business and entrepreneurship, four pertaining to governance and policy framework, and three to measure demography.

According to the European Commission and its European Innovation Scoreboard, countries in the European Union can be divided into four performance groups: innovation leaders, strong innovators, moderate innovators, and modest innovators (Figure 1).

Figure 1. Summary Innovation Index in 2018: Performance of a country relative to the EU in 2010



Source: European Innovation Scoreboard, 2019.

Denmark, Finland, the Netherlands, and Sweden are Innovation Leaders with performances well above the EU average. Since 2011, the average overall EU innovation performance, as measured by ESI, has increased by 8.8 percent. The ESI increased in 25 countries and most significantly in Lithuania, Greece,

and Latvia (European Commission, 2019b). In the last eight years, the greatest improvements were made by Sweden, Finland, and Denmark (Figure 1).

Slovenia, with its performance below the EU average, falls under the category of Moderate Innovators. Between 2011 and 2018 Slovenia's innovation performance decreased by more than ten percentage points (-10.6 percent). The most severe drops were recorded in Romania (-10.7 percent) and Slovenia (-10.6 percent), whereas Germany's decrease was not so drastic (-0.9 percent). Although the formula to succeed in innovation is complex, the most common traits that distinguish innovation leaders from the rest of the countries seem to be excellent human resources, attractive research systems, and an innovation-friendly environment (European Commission, 2019c).

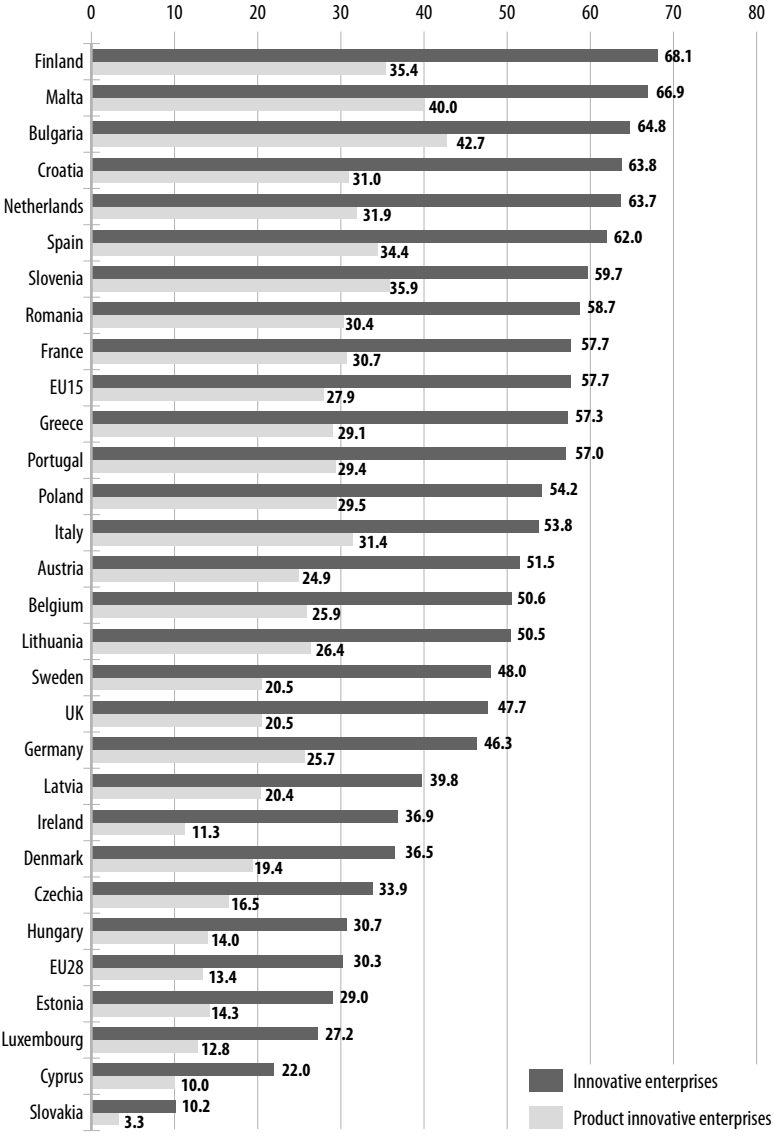
The detailed characteristics of innovation in the majority of EU countries are captured with the Community Innovation Survey (CIS) and are reported nationally by Eurostat. On average, 51 percent of EU enterprises with ten or more employees stated that they were involved in an innovation activity during 2014-2016, meaning that they introduced either product, process, organizational, or marketing innovation or performed any other kind of innovation activity (Eurostat, 2019, Figure 2). The highest percentage of actively innovative enterprises was recorded in Belgium (68 percent) and in Portugal (67 percent). Slovenia's share of innovation-active enterprises is 40 percent below the European average of 51 percent (Eurostat, 2019). Despite this, Slovenia performed better than the EU15 average by share of product-innovative enterprises, since almost 36 percent of businesses introduced some type of product innovation. The top performer in this regard was Bulgaria (Figure 2). Less innovative economies might have a higher intensity of product innovation due to the catch-up process, but the data does not control for the differing types of product innovation.

Based on the CIS, only 27.1 percent of European innovative companies received public funding. National governments on average helped 17.9 percent of such companies. The percentage of firms that obtained government support was highest in France where the national government supported 43.3 percent of innovative companies. Only 11 percent of innovation-oriented companies were funded by the European Union. Furthermore, only 2.6 percent of companies on average received funds from FP7 and the Horizon 2020 initiative (Eurostat, 2019).

Looking at the number of high-tech exports as a portion of total exports (Table 1), we can observe the positive affect of EU strategies. The most significant increase in the percentage of such exports occurred in 2014, when the

Horizon 2020 initiative was introduced, and the positive growth continues presently. Granted patents from the EPO were constantly growing from 2009 and on with only a slight decrease in 2014 (Eurostat, 2019a).

Figure 2. Share of enterprises that introduced any kind of innovation, and product innovative enterprises



Source: Eurostat, 2019.

In terms of scientific output, the number of scientific articles is high; but the question is how this knowledge transfers into economic activity given that the number of hi-tech firms and service exports is low. The number of patents is showing a positive trend over the years, whereas the movement of R&D investments is experiencing a decline in the EU. Slovenia is showing a deficiency in turning findings into technological innovations.

Table 1. Exports of high technology products and granted EPO patents

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Exports of high technology products as a percentage share of total exports										
EU28	17.10	16.10	15.40	15.70	15.30	15.60	17.00	17.80	17.80	17.90
Slovenia	5.50	5.30	5.30	5.20	5.50	5.40	5.90	5.70	5.60	5.80
Number of granted patents form European patent office - EPO (2009-2018)										
EU28	25,038	27,903	29,593	29,573	30,425	29,775	32,893	44,041	45,888	52,460
Slovenia	28	33	42	38	52	51	65	80	92	76

Source: Eurostat, 2019a.

Slovenia's high-tech exports represented only 5.8 percent of total exports in 2018 (Table 1), which is significantly lower than the European Union average. Despite an increase of 5.5 percent over the last ten years, the Slovenian economy still does not put enough emphasis on increasing its high-tech export share. The same problems arise with the number of granted patents. Slovenia on average produces 37 patents per one million inhabitants while the European Union average is almost four times higher (102 patents per one million inhabitants).

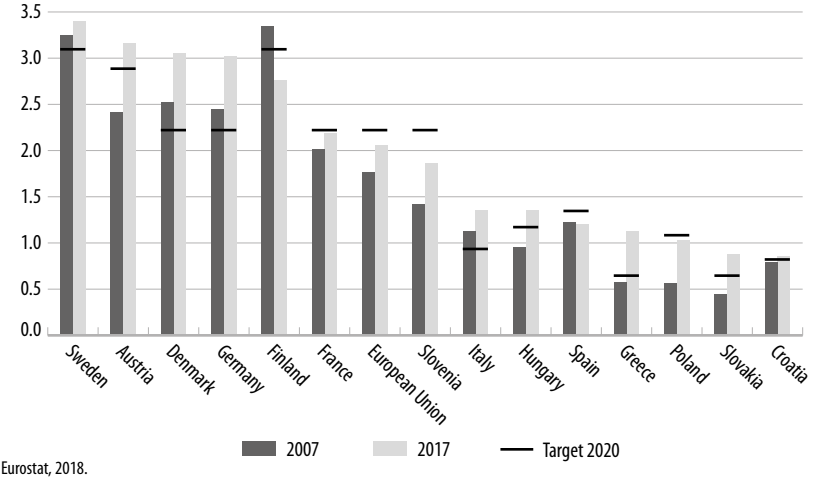
2 Innovation inputs

2.1 Gross domestic expenditure on R&D

Gross domestic expenditure on research and development (GERD) in the EU was 317 billion euros in 2017, which is roughly 7.5 times the GDP of Slovenia and almost 40 percent more than in 2007. But GERD still only makes up a mere 2.06 percent of total European GDP, far below the EU goal for 2020 of 3 percent. Countries such as Sweden and Finland have higher goals of 4 percent, while Austria has a national goal of 3.75 percent (Figure 3). In 2017, Sweden (with GERD as 3.4 percent of total GDP) and Austria (3.16 percent) had the

highest percentages of R&D expenditures among EU member states in 2017, while Denmark and Germany were the only states that had already reached their 2020 targets. Slovenia is far from reaching their goal as they currently allocate only 1.86 percent of GDP to R&D (Eurostat, 2018, Figure 3).

Figure 3. Gross domestic expenditure on R&D in 2007 and 2017 as a percent of GDP and 2020 target



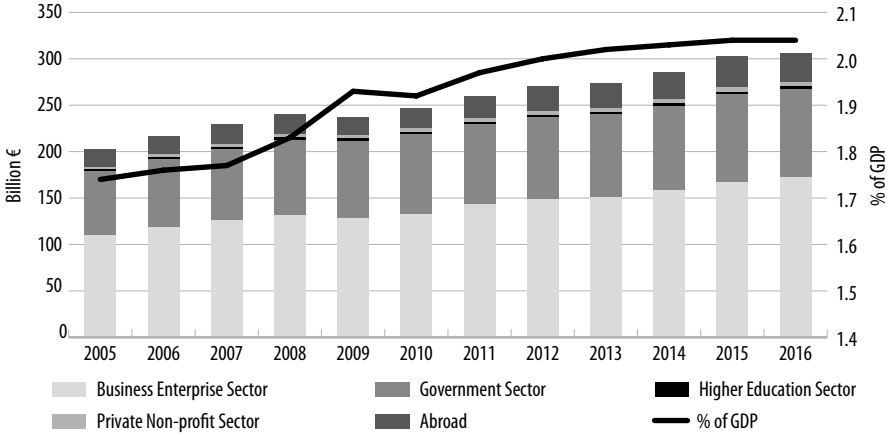
Source: Eurostat, 2018.

The expenditure on R&D has been constantly increasing since 2005 (Figure 4). The percentage of GDP allocated to R&D (black line, Figure 4) increased sharply before the financial crisis in 2009, while after the crisis the rate of growth slowed (Eurostat, 2018). More than half of total R&D spending is financed by the private sector. Funds invested from the Business Enterprise sector increased by almost 60 percent since 2005 to 173 billion euros in 2016. In the same period, relative Government sector contribution decreased by three percentage points to 31 percent of the total contribution to R&D. The importance of the "Abroad sector," funding from international organizations, the European Commission, and the foreign business sector, has increased and now contributes to more than one-tenth of all investments (Eurostat, 2018).

Slovenian investment in R&D in 2016 was 811 million euros. This amounts to less than 0.3 percent of total EU Member investments, or approximately the same as is its share of the European Union GDP in 2016 (Eurostat, 2019a). In Slovenia, the Business Enterprise sector financed almost 70 percent of all R&D investments. On the other hand, the Government sec-

tor investments represented only 20 percent in 2016, and the trend has been declining since 2005. The contribution of the "Abroad" sector is similar to the EU's input at about 10 percent of total GERD (Eurostat, 2018).

Figure 4. Intramural R&D expenditure (GERD) by source of funds and as a percent of GDP in EU28



Source: Eurostat, 2019a.

3 Innovation governance and policies in the EU

3.1 Innovation governance

Based on the number of published documents, the European Union is a global leader in the production of scientific knowledge; however, it has difficulties in marketing said knowledge. To promote the translation of science into marketable or socially valuable solutions, the European Commission is attempting to stimulate cooperation between the public sector, businesses, academia, and financial sectors through three main pillars: reforming the regulatory environment in the EU, boosting private investment in R&D, and maximising impacts.

Pillar 1 receives 32 percent of the total initiative funds and focuses on reforming the regulatory environment. The European Commission enforces favourable regulatory conditions to support innovations through institutions such as the Joint Research Centre and Scientific Advice Mechanism (SAM), which provide scientific advisement for policy-making decisions. More favourable

framework conditions in the EU could increase both private and public investments as well as the benefits received from a single market. Moreover, Innovation Deals, voluntary cooperation agreements between the EU, innovators and national, regional and local authorities, are addressing existing regulatory obstacles to innovation in the form of cooperation between developers, local and national authorities, and the European Commission. In 2015 the European Commission established the Horizon 2020 Support Facility (PSF) to create, apply, and evaluate policy reforms meant to support R&D investments and the links between science and business (European Commission, 2016).

Pillar 2 seeks to boost private investment in research and innovation and receives around 22 percent of available programme funding. There is a significant equity gap between the EU and the US in 2016 which suggests that innovation financing in the EU needs to be boosted. In the same year, the EU in total raised about 6.5 billion euros compared to the US's 39.4 billion euros. Also in 2016, venture capital in the EU was valued at 56 million euros, only one third of VC size in the United States. Venture EU, a European Union venture capital fund, aims to boost private investment in innovation and scale-ups. It is valued at approximately 410 million euros, from which 200 million euros are sourced from the Horizon 2020 initiative, around 105 million euros come from the European fund for Strategic Investments, and the remainder is taken from the COSME Programme for SMEs (European Commission, 2019d).

The European Fund for Strategic Investments (EFSI) provides funding for higher-risk projects which would otherwise be rejected by the EIB (EIF, 2019). The funding goal for 2020 is set for half a trillion euros. The EFSI has to components to support the projects with wide sector eligibility: Infrastructure and Innovation Window (IIW) to be deployed through EIB and an SME Window (SMEW) to be deployed through the EIF to support SMEs and mid-caps. One of the main sectors targeted by the EFSI is research, development, and innovation, an area where the Horizon 2020 strategy contributed around 2.2 billion euros from its budget (EIF, 2019).

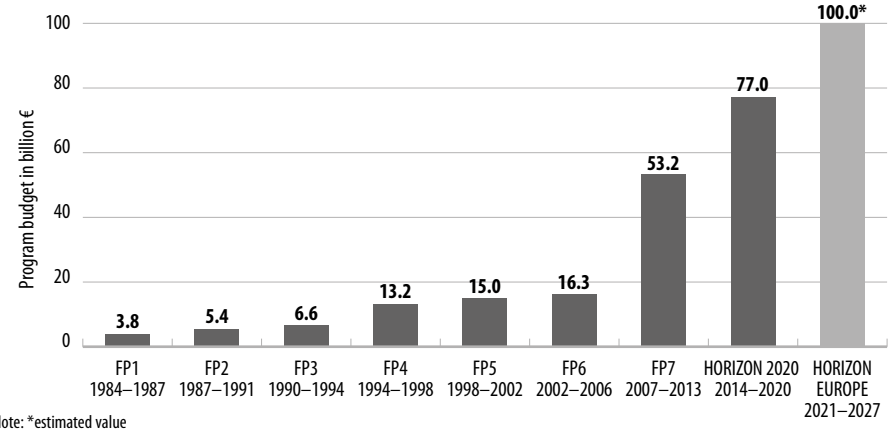
Another initiative to stimulate private R&D investment in the EU has been set by the European Commission and the EIB Group in 2014 through the launching of InnovFin, an EU Finance for Innovators Programme. The purpose of the initiative, which is supported by more than 24 billion euros, is to offer a new generation of financial instruments and advisory services to help innovative firms access research and product innovation financing more easily (European Commission, 2016).

Pillar 3 holds 39 percent of the total programme budget and focuses on maximising impacts. In order to create the most powerful impact and ease access to funding, the European Commission needs to create synergies between its strategies. Projects which were judged to deserve funding under the Horizon 2020 programme but didn't receive it due to a limited budget could receive it under the initiative *Seal of excellence,* a program aimed at recommending such projects to alternative funding sources such as the public, private, national, European, and international sectors (European Commission, 2016).

3.2 Framework programmes for research and innovation

One limitation of the EU's progression in research and innovation is a culture of risk-aversion and non-protective laws. Strategies such as Horizon 2020 are hoping to improve such disadvantages. The strategies implemented by the EU have significantly increased VC investments. Although these investments grew by three times between 2012 and 2017, the EU is still experiencing a large lag behind Asia and the United States. Growth of available capital continues to be a problem as the EU fails to provide financing for promising, high-growth companies to scale up and grow internationally. In terms of building new hi-tech companies, Sweden is the most productive country in the EU and only second behind the US globally. Despite this, successful EU unicorns had to turn to foreign capital investments to scale up and improve global competitiveness, and were thus acquired by non-EU venture funds (European Commission, 2018a).

Figure 5. Framework Programme (FP) funding from 1984 to 2027



Note: *estimated value

Source: European Commission, 2019.

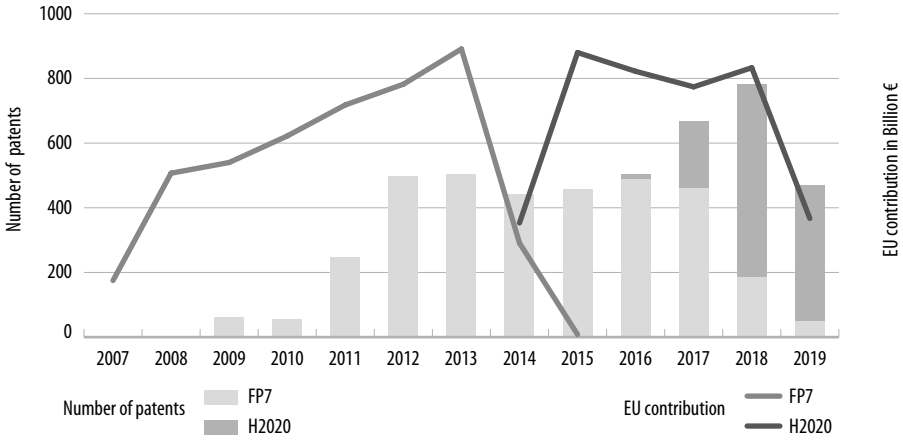
The European Union made a significant change in innovation activities with the Seventh Framework Program (FP7) and spent more than 50 billion euros on research and innovation. Since the FP7 launch, each initiative has received greater funding and experts expect the new initiative to receive more than 100 billion euros. The increase in funding (Figure 5) shows that the EU has recognised the importance of innovation in a fight against international trade competition (European Commission, 2019).

Horizon 2020 is single-handedly the largest EU Research and Innovation programme implemented in the EU between 2014 and 2020, with a goal of implementing the Innovation Union, a Europe 2020 flagship initiative aimed at securing Europe's global competitiveness. The total funding available over seven years is estimated at approximately 80 billion euros. The programme emphasizes research and innovation activities in order to increase the competitiveness of the EU, improve collaboration between public and private R&D activities, and simplify the transfer of breakthroughs from the lab to the market, which could positively affect economic growth and job creation. Its activities are based in three main areas: excellent science, industrial leadership, and societal challenges (European Commission, 2019e). The majority of the Horizon 2020 budget is aimed at Societal Challenges programmes (29.7 billion euros), followed by Excellent Science initiatives (24.4 billion euros). The Industrial Leadership initiative offers funding in the amount of 17 billion euros. The European Institute of Innovation and Technology receives 2.7 billion euros, and Euratom, a programme for nuclear research and training, received around 1.6 billion euros between 2014 and 2018 (European Commission, 2013). The EU initiative Horizon 2020 so far founded 22,655 projects involving EU member states. Within those projects more than 100 thousand researchers were involved and more than 40 billion euros were spent (European Commission, 2019g).

Figure 6 presents the relationship between financial investments from the two most important EU initiatives, Horizon 2020 and FP7, and the number of patents produced by each initiative in the EU. Here the inputs and outputs are depicted with lines, and number of patents is presented with stacked bars.

The data reveals a 3-year lag on average before investments in research start to pay off. We can especially see this in the case of the FP7 initiative, which began in 2007. The most significant funding was first allocated in 2008, though the resulting patents were not issued until 2012.

Figure 6. FP7 and Horizon 2020 initiative funding (line), and number of patents each initiative produced (stacked bar) by year



Source: Eurostat, 2019a.

3.3 Innovation Union and European Research Area

The EU market is one of the largest in the world, but it is simultaneously one of the most fragmented. The High-Level Strategy Group on Industrial Technologies in 2018 addressed significant fragmentation between EU members concerning GDP growth (from 0.4 to 4.4 percent), unemployment (4.6 to 15.5 percent) and youth unemployment (8.3 to 35.7 percent). As stated, such division could be resolved through the implementation of technological innovation and coherent alignment between national research and EU policies (European Commission, 2018d).

One key strategy of Europe 2020 is the Innovation Union, a programme agreed upon by the member states in June of 2010 and aimed at improving conditions and financing for research and innovation in the EU regarding climate change, health, and energy efficiency. It focuses on public and commercial sector innovations by including all actors from different EU regions with the aim of technological and business model innovation to achieve higher efficiency and value added. Three main program areas are: enhancing the EU's science performance, better connectivity of public and private sectors through Innovation Partnerships, and removal of obstacles from market-ready innovations (European Commission, 2019b).

The initiative's target R&D funding is three percent of GDP by 2020, which is significantly less than the US and Japan but could nonetheless create 3.7 mil-

lion jobs and, by 2025, a 795 billion euro increase in annual GDP. The R&D expenditures will be financed by both public and private investment (1/3 and 2/3 of total investment, respectively) (European Commission, 2019b).

Conclusion

The European Union is actively developing strategies to stimulate research and innovation activities in the member states. The main document shaping the future of the European Union budget is the multiannual financial framework (MFF), a seven-year framework regulating the EU's annual budget. The framework for the period 2021-2027 is in its final phase of negotiations as the European Commission proposes a modern budget for a Union that protects, empowers, and defends (European Commission, 2018b). One of the key points regarding the new financial perspective is research and innovation as investments in Europe's future, with the intention of helping the European society compete globally and preserve its unique social model. The framework's proposed budget is 100 billion euros for two main programmes: Horizon Europe (97.6 percent of funds) and the Euratom Research and Training Programme (2.4 percent of funds) (European Commission, 2018c).

The European Commission claims Horizon Europe to be the most ambitious research and innovation funding programme ever, as it intends to strengthen EU science and technology, foster the EU's industrial competitiveness and its innovation performance, and deliver on the EU's strategic priorities. Compared to previous initiatives, it will offer more support of breakthrough innovation with the establishment of the European Innovation Council (EIC) to deepen its innovation and risk-taking capability and compete on a market increasingly defined by new technologies. Furthermore, the European Commission plans to shift the EU budget toward areas with higher added value.

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Daša Farčnik, Matea Bezić, Iva Drvarič, Thyme Nord

TRENDS IN THE US

Introduction

The United States has for decades been at the forefront of global innovation. The country has previously ranked number one in categories such as patent activity and high-tech density and is among the top ten in R&D spending and productivity (Tanzi, 2019). US companies such as IBM, Canon, Intel, Microsoft, Qualcomm, Apple, Ford, Google, and Amazon are the world leaders in terms of patent grants (IFI Claims, 2019). However, the catalyst for innovation has been the federal government through their funding of both basic research and more applied development in the field of medical science, digital computers (both hardware and software), jet aircraft, satellites, improved telecommunications, and much more (Gruber and Johnson, 2019).

In this chapter, we are interested in exploring the trends and factors that have made the United States a success. First, we will present the expenditure on research and development over time, and examine the country's innovative performance through patents, intellectual property rights, etc., and the impact of innovation on the national economy. Lastly, we will discuss some of the US's transformative history in becoming a pro-innovation government, as well as the federal government's modern role in R&D.

1 Innovation Performance

1.1 The US Remains the World Leader in Patent Applications

With patents often being the measure of innovation output (Kalanje, 2005), The World Intellectual Property Organization ranks the US as number one in the

world by the number of patent applications in 2018 (World Intellectual Property Organization, 2018). At the company level, the companies with the most patent grants in 2018 were IBM (9,100 grants), Canon (3,056), Intel (2,735), Microsoft (2,353), Qualcomm (2,300), Apple (2,160), Ford (2,123), Google (2,070), and Amazon (2,035) (IFI Claims, 2019).

Looking at some additional indicators, the Global Innovation Index (GII) (2019) ranks the US as the third most innovative economy in the world in 2019, an improvement from 6th place in 2018. GII has seven input pillars, five of which discuss the degree to which the environment of the national economy enables innovative activities (institutions, human capital and research, infrastructure, market sophistication, and business sophistication) and the other two directly measure the innovation outputs (knowledge, technology, and creative outputs).

The US is ranked among the top ten in the world in providing a sound business environment, ICT infrastructure, access to venture capital, university/industry research collaboration with high R&D expenditures, ease of access to credit, trade, competition and market scale, and knowledge creation and impact. However, there is a lag in ecological sustainability, percentage of graduates in science and engineering, FDI net inflows, and productivity growth (Global Innovation Index, 2019).

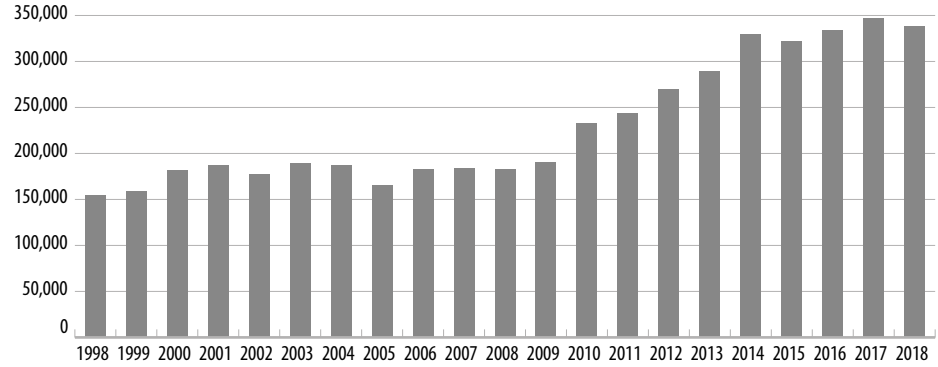
Coming to similar conclusions in many categories, the Bloomberg 2019 Innovation Index ranks the US as the eighth most innovative country in the world according to seven equally weighted metrics (South Korea and Germany being the number one and two, respectively) (Jamrisko et al., 2019). Despite the country's dominance in the fields of patent activity, high-tech density, R&D spending, and productivity, the US ranked lower than in previous years (third in 2014) due to lower scores in categories such as tertiary education efficiency and researcher concentration (Tanzi, 2019).

One of the leading tools driving innovation in the private and public sector is a heavy reliance on intellectual property (IP) (US Patent and Trademark Office, 2016). Figure 1 shows that in the period from 2000 to 2009, between 180,000 and 190,000 patents per year were granted. However, in the period from 2010 to 2018, the number increased by 85 percent to around 338,000 per year (US Patent and Trademark Office, 2018).

In 2018, 91 percent of patents were utility patents, followed by design patents (US Patent and Trademark Office, 2018). The reason for the increase in patent grants may be at least partially due to favourable legislation, such as

The American Recovery and Reinvestment Act of 2009 or The Leahy-Smith America Invents Act of 2011 (Markovich, 2012). Fleming et al. (2019) demonstrate high dependence and involvement of the government in patent grants, whereby *one-third of US patents rely on government investments* in R&D, and this number has been increasing since the 1970s.

Figure 1. Number of patents issued in the US per year (1998 - 2018)



Source: US Patent and Trademark Office, 2018.

Regardless of US governmental support, companies in the US are extremely innovative. The Business R&D and Innovation Survey (BRDIS) with 1.14 million participating companies shows that the most innovative players are companies with more than 10,000 employees. Out of those, 41 percent have introduced one or more products or process innovations between 2014 and 2016 (compared to only 17 percent of companies with 50 to 250 employees) (National Science Foundation, 2016). There is a strong relationship between funding R&D activities and innovation since 70 percent of companies that fund R&D activities reported product or process innovation, compared to only 15 percent of companies with a reported product or process innovation without investments in R&D activities (National Science Foundation, 2016).

1.2 Innovative Industries drive the US Economy

Intellectual Property and the US Economy report of 2016 identifies 81 IP-intensive industries[1] and marks them as a *"major, integral, and growing part*

1 IP-intensity states to what extend a certain industry relies on intellectual property rights and demonstrates their level of innovation. Examples of such industries are computer equipment, semiconductors, basic chemicals, pharmaceuticals, and industrial machinery (US Patent and Trademark Office, 2017).

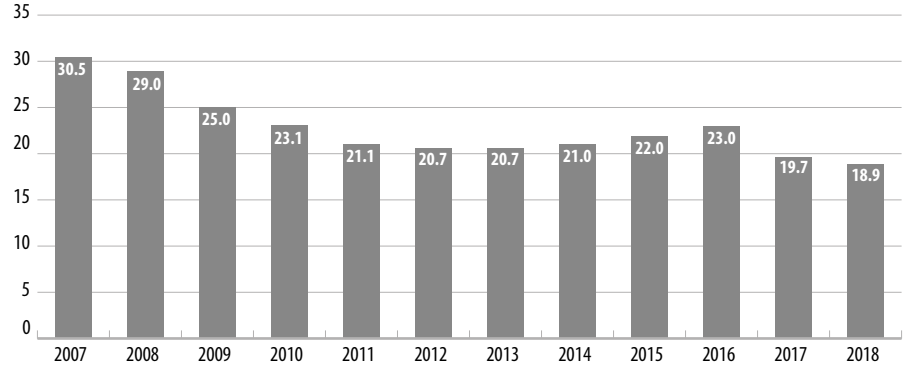
of the US economy" (US Patent and Trademark Office, 2016). Between 2010 and 2014, the value added by these industries increased by 30 percent, from 5.06 trillion dollars in 2010 to 6.6 trillion dollars in 2014, and they contributed to 38.2 percent of the US GDP in 2014 (a 3.4 percentage point increase from 2010) (US Patent and Trademark Office, 2016).

IP-intensive industries accounted for about 30 percent of the employment in the US (directly or indirectly) in 2014, and they paid a significant wage premium of 46 percent over wages in non-IP-intensive industries (up from 42 percent in 2010) (US Patent and Trademark Office, 2016). From 2008-2015, IP-intensive industries accounted for over 35 percent of the total sales of manufacturing industries while also investing 11.5 times more into R&D per employee (Pham, 2017).

The merchandise exports of IP-intensive industries increased in the 2010-2014 period to 842 billion dollars; but since the exports of non-IP-intensive industries increased at a faster pace, the share of the exports of IP-intensive industries of the total merchandise exports fell to 52 percent in 2014 (from 60 percent in 2010) (US Patent and Trademark Office, 2016). Accounting for the number of employees between these two categories, exports per employee in IP-intensive industries were 2.6 times higher than in the non-IP-intensive industries in the period 2008-2015 (Pham, 2017).

A different classification, used by the OECD, looks at the different levels of technological intensity of exports (from high to low-tech), defined with the importance of R&D expenditures relative to the gross output and value-added of different exporting industries (World Bank, 2018). Looking at high-tech industries, such as aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery, the World Bank (2018) reports a *decline in high-tech exports* as a share of manufactured exports from 30.51 percent in 2007 to 18.90 percent in 2018 (Figure 2). Pisano and Shih (2012) argue that many American firms do not see manufacturing of high-tech products as one of the important parts in the innovation process. As a result, they are outsourcing it for cost purposes and are therefore losing an important source of innovative ideas, because many product and process innovations are derived from directly working with the product. Pisano and Shih (2009) also highlight the fact that outsourcing cost the US "critical knowledge, skills, and suppliers of advanced materials, tools, production equipment, and components" and due to this, many US firms lost the ability to produce high-tech products in America.

Figure 2. High-technology exports in the US (% of manufactured exports)



Source: World Bank, 2018.

2 Innovation Inputs

In 2017, R&D expenditures amounted to 543 trillion dollars or 2.79 percent of GDP and placed the US among the world leaders in R&D expenditure, with the main drivers being the federal government and private businesses.

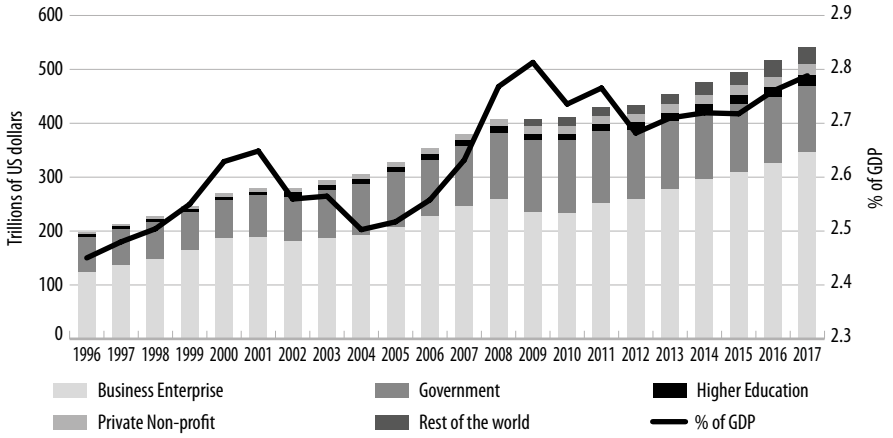
2.1 The US Expenditure on R&D throughout the years

The R&D expenditures as a percent of GDP exhibit a pro-cyclical pattern with a stable increase and a minor setback in 2000 followed by a three-year period of stagnation (mainly due to the Dotcom bubble, Figure 3). This was followed by another increase until the 2008 financial crisis that again resulted in a moderate stagnation of R&D expenditure. In the last 21 years, the average yearly growth rate of the overall dollar investment in R&D was almost five percent (4.93 percent). R&D expenditures as a share of GDP, which is one of the indicators of R&D intensity, represented 2.78 percent of GDP in 2017 and were increasing with peaks in 2001 and 2009. This was due to a lower GDP as a denominator as well as increased spending in biomedical and national security R&D, in addition to one-time funding from the American Recovery and Reinvestment Act of 2009 (National Science Foundation, 2018).

The main drivers of R&D funding are private businesses and the federal government (Figure 3), with the stable increase of investment in R&D being, to some extent, attributed to a constant increase of business R&D intensity. In 2017, R&D expenditure by companies represented 63.6 percent of total R&D

funding in the US, which is an equivalent of 1.94 percent of GDP (Foote and Atkinson, 2019). In the last two decades, businesses increased their investments in R&D by five percent every year on average as a response to decreasing federal government expenditures, especially on defence, which declined in the late '90s (Sargent Jr., 2018). Large companies with more than 25,000 employees, especially in the manufacturing of computer and electronic products, are the main drivers of R&D spending in the US (National Science Foundation, 2016).

Figure 3. The US Expenditure on R&D as a percent of GDP and in Trillions of US dollars by the channel of funding (1996 - 2017)



Source: UNESCO, 2019; own calculations.

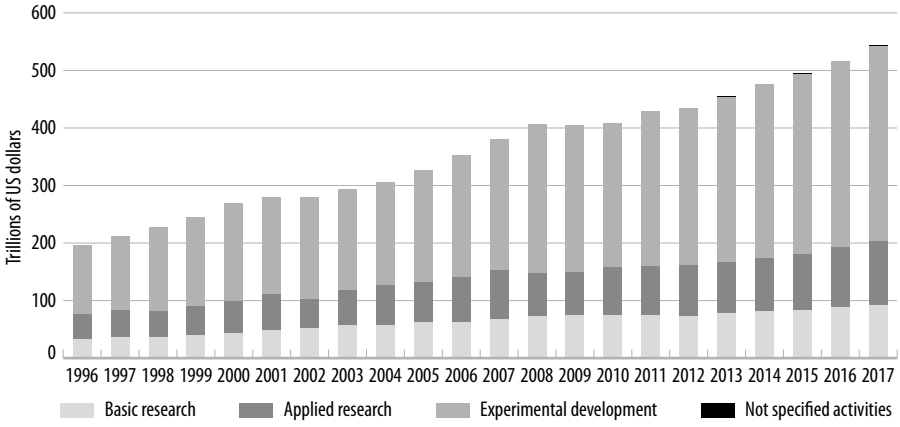
The federal government was the funding source of 22.8 percent of all R&D spending, followed by private non-profits and higher education institutions (UNESCO, 2019). The majority of governmental money for R&D is invested in transportation equipment, mainly in aerospace products and parts. The government supports R&D investments predominantly in large companies with more than 25,000 employees; however, small companies with 20 to 50 employees received substantial governmental support in 2016 when they received more funding in total than medium companies, and almost the same amount as larger companies with 1,000 to 5,000 employees (NSF, 2016).

2.2 Experimental development is leading the US R&D

R&D activities in the US can be divided into three major parts: *basic research,* which is either experimental or theoretical work that primarily deals

with acquiring new knowledge without any specific use or application; *applied research,* which is a targeted search for new knowledge and information, usually mission-driven, and seeks to reach a specific aim; and *experimental development,* which is the last stage of R&D activities that draws on knowledge acquired from research and practical experience, and subsequently produces additional knowledge (UNESCO, 2019). Experimental development is particularly important because it combines relevant business, scientific, and technological knowledge to produce plans or designs for improved processes, products, and services. Most R&D funds (62.5 percent) are spent on experimental development. This spending increased on average by 5.02 percent in the last 21 years (Figure 4). Applied research accounted for 20.3 percent or 110 billion dollars in 2017, followed by basic research (16.9 percent or 92 billion dollars) (UNESCO, 2019).

Figure 4. The US R&D by type of activity (1996 - 2017)



Source: UNESCO, 2019; own calculations.

Experimental development and applied research were mostly funded by the businesses themselves, with 88.2 percent of all experimental development expenditures and 58.1 percent of applied research expenditures in 2015, respectively. The remaining grants were mainly funded by the government, with defence spending still playing an important part (National Science Foundation, 2017). The US federal government funded 42 percent of all basic research, followed by private firms which funded 30 percent, and the remaining 29 percent being supplied by universities, non-federal governments, and other non-profit organizations (Sargent Jr., 2019).

Fiscal year 2020 will most likely bring changes in government funding, with a decline in funds for basic and applied research and an increase in experimental development due to proposed increase in the budget of the US Department of Defence (Sargent Jr., 2019).

3 Innovation Governance

The trends in the US innovation system and their impacts demonstrate the influence of innovation and R&D on the US economy. Driving this progress are many highly interdependent factors, including corporate innovation governance, the business environment, and the regulatory environment.

3.1 Successful Environments

Several aspects contribute to the success of innovation activities concerning corporate innovation, including keen management. Bloom et al. (2011) concluded that *"when it comes to overall management, American firms outperform all others"* and list high competition and flexible labour markets as main advantages. US managers are prone to ICT adaptation, with the US ranked eighth in ICT investment as a percentage of GDP in 2015, having invested 3.1 percent of GDP into software, IT, and communications equipment (OECD, 2017a).

The business financing system plays a crucial role in the business environment. Pioneered in the US, the venture capital (VC) industry is key in financing innovations. VC investments in the US in 2016 amounted to 66.6 billion dollars, representing 86 percent of all VC investments in the OECD countries (compared to the EU at 4.7 billion dollars) (OECD, 2017b). VC investment more than doubled in the US from 2010 to 2016 (OECD, 2017b), largely due to extensive financing of "unicorn" start-ups with valuations over 1 billion dollars (Clark, 2018). With VC financing, firms also benefit from management guidance in leadership and strategy (Atkinson, 2014).

The cultural environment of individualism, acceptance of failure, and constant improvement also stimulate innovation. Demanding customers pressure firms to regularly innovate. Interestingly, both competition and cooperation are crucial drivers of innovation (Atkinson, 2014). Analysing the R&D Magazine's Top 100 innovations of the Year from 1970 to 2006, Block and Keller (2008)

found "that while in the 1970s almost all winners came from corporations acting on their own, more recently over two-thirds of the winners have come from partnerships involving business and government."

The federal government of the United States has cultivated a regulatory environment in which innovation thrives. The US utilizes policy instruments to enhance the public production of knowledge, subsidize R&D in private firms, and strengthen intellectual property rights; however, it remains that "there is no central administration exclusively in charge of innovation" (OECD, 2012). R&D activity is often characterized by substantial fixed costs that can take the form of labs, labour, research, starting costs, etc. When the federal government assumes the burden of these costs, firms have less pressure on their investments to yield immediate results. Therefore, the US government continues to incentivize the "public production of knowledge," as firms are less fixated on capturing the full social returns on their investments (Carey et al., 2012).

The US market has few barriers to entry compared to other nations, as well as the allowance of e-commerce competitors to disrupt markets (Information Technology and Innovation Foundation, 2014). Different from traditional EU policy, the US's approach to competition is based on maximizing consumer welfare (Information Technology and Innovation Foundation, 2014), meaning that there is a higher focus on anti-competitive behaviour than on pro-producer policy creation. Anti-trust policies and a universal rule of law create a market that is more favourable to consumers rather than producers.

3.2 The National Innovation System

Since World War II, strong federal involvement and public support for R&D in science and technology increased massively (Information Technology and Innovation Foundation, 2014; Gruber and Johnson, 2019), and new, goal-oriented organizations emerged. The US made a notable shift away from investing in system-oriented projects and toward funding *mission-oriented agencies* (Mazzucato, 2017).

A number of federally-funded organizations make up the US National Innovation System both in terms of spending and innovative practices across all industries (National Science Foundation, 2016). The National Science Foundation (NSF) and the National Institute of Standards and Technology (NIST), with a combined budget of 17 billion dollars (CBO, 2016), disseminate fund-

ing to other labs and universities to invest in new technologies and promote R&D throughout the country (National Science Foundation, 2018). National Institutes of Health (NIH) also receives and distributes alone more than 30 billion dollars annually into health research and is the largest public funder of biomedical research in the world (NIH, 2015). The Small Business Innovation and Research program (SBIR) encourages innovation-based start-ups and is financed by governmental agencies such as the DoD, DoE, NASA, NSF, and NIH[2] and is the first place that many entrepreneurs refer to for funding (Block and Keller, 2011; Carey et al., 2012).

The Defense Advanced Research Projects Agency (DARPA) and its modern extension, the Advanced Research Projects Agency-Energy (ARPA), have been key players in developing cutting-edge technologies (Information Technology and Innovation Foundation, 2014). Both DARPA and the National Aeronautics and Space Administration (NASA) focus on "blue-sky" experimentation, which allows researchers to explore ground-breaking concepts and projects to accelerate the development of innovative technologies (Block and Keller, 2011). DARPA has been involved specifically in the development of technologies such as the internet, touch screen, voice recognition, and GPS (Bender, 2014).

3.3 The Modern Role of Government in Innovation

Although the US claimed dominance in innovation over the latter half of the 20th century, concerns arose that it would soon be surpassed (CRS, 2015). These fears were based on a perceived under-investment in physical sciences, engineering, and research combined with underperformance in STEM education[3] (CRS, 2015). Globalization also pressured countries "to move up the value chain and engage in a continuous process of adjustment and innovation", creating a significant R&D uptick in several economies (OECD, 2007).

Established in 1980, the Stevenson-Wydler Technology Innovation Act was a foundational piece of legislation that facilitated "the transfer of technology from federal laboratories to commercial use" (Information Technology and Innovation Foundation, 2014)". This took the form of increased funding to the experimental or product development phase of the innovation chain (Mazzucato, 2017). Later legislation focused on the completion and commercialization

2 Agencies allocate 2.6 percent of their budgets to grant the SBIR over 2 billion dollars annually (Block and Keller, 2011; Carey et al., 2012).
3 STEM is a curriculum based on the idea of educating students in four specific disciplines — science, technology, engineering and mathematics — in an interdisciplinary and applied approach (CRS, 2015).

of research endeavours, as well as increased patent and IPR for government inventors (EPA, 2018).

Following the recession of 2008, the Recovery Act (ARRA) of 2009 approved R&D funding of 18 billion dollars for new discoveries in energy, climate, and future technologies (OECD, 2012). The Act marks an unprecedented expansion of government efforts to shape innovation (Block and Keller, 2011). Following the boost of government R&D spending in 2009, the Budget Control Act (BCA) of 2011 limited defence and non-defence spending over the following ten years and marked a sudden decrease in federal R&D spending. The American Innovation and Competitiveness Act of 2017 is another attempt to stimulate future innovation by authorizing about 17.3 billion dollars to the NSF and NIST from 2017 to 2018 (CBO, 2016).

3.4 The Spillover Effect

The US government's regular support of the R&D industry has yielded a wide variety of results. A 2016 Berkeley University study found evidence of "crowding in" when it comes to government R&D expenditure, suggesting that a ten percent increase in federally funded R&D translates to an increase in private R&D expenditure of three percent (Moretti et al., 2016). This may be connected to the fact that R&D is associated with high fixed costs that result in long-term, multi-use benefits (Carey et al., 2012).

Additionally, firms that receive government funding for R&D may indirectly benefit other firms within the same industry because of technology spillover. The same is true on a global scale, as nations generally benefit from tech innovation that occurs abroad (Moretti et al., 2016). For example, the US funded the early development of semiconductors and the human-computer interface through DARPA. Some scientists and engineers from this agency then went on to form the company Intel, which produces technology that has been implemented into countless firms around the world (Block and Keller, 2011).

Conclusion

America, home to the world's leading universities, favourable conditions to start new businesses, an abundance of venture capital, and risk willingness along with a creative, inventive, and individualistic culture (Atkinson, 2014),

has created a "scientific and practical basis for almost everything that characterizes our modern economy" (Gruber and Johnson, 2019).

Marking a five percent average annual increase in the funds invested into R&D, businesses and the federal government remain the two most important players driving innovation in the US, representing 64 and 23 percent of total R&D expenditures respectively.

These investments place the US in the top 10 most innovative countries worldwide, leading especially in the field of patent grants, where we observe a two-fold increase of grants in the last 20 years and researchers show that over 30 percent were developed with the help of the federal funds (Fleming et al., 2019). Contributing to the country's overall success, the federal government has actively tried to create an innovation-stimulating environment by investing heavily into defence, energy, and health through world-renowned institutions such as DARPA, NASA, NIH, etc.

Finally, strong spillover effects can be witnessed both domestically and internationally. Results of R&D investment do not only benefit the single institution, but many others can thrive and grow by implementing these same innovations. All of this sums up to create a vivid environment of competition and cooperation which further drives innovation.

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Vesna Žabkar, Jaka Koščak, Karin Mohar, Žan Tratar

CHINA: FROM COPYCAT TO INNOVATOR

Introduction

China is one of the largest economies in the world and has recently become one of the key players in the field of innovation. The Chinese government in the last 30 years efficiently combined a series of measures in their five-year plans (their national development strategies which resulted in the country's extraordinary growth). Today, China is home to some of the most thriving technological innovation hubs and international enterprises in the world. It does not seem that China's momentum will stop any time soon, as they have made extensive strategic plans that reach out to 2050.

The purpose of this chapter is to present Chinese success in the field of innovation, present the role of the government, and discuss how innovation influenced the economy as a whole. Starting with China's innovation performance and followed by innovation inputs, we will take a closer look at patents and regulation to delve into how China became the leader in patent applications. Finally, we will present the China 2025 plan and conclude with innovation governance to see what exactly were the causes and effects of China's extraordinary economic and social growth.

1 Innovation performance

Based on the Global Innovation Index (GII) report in 2019 (Cornell, 2019), China was ranked 17th and jumped up three places from the previous year, with an overall score of 54.82 out of 100. When China made its first entry in 2007, the country was ranked 29th; however, things changed in the recent decade (Radu, 2018). The country scored the most points in patents, industrial designs, and

trademarks all by origin, as well as in high-tech and creative goods exports. They are in 3rd place in terms of patent ranking, right behind South Korea and Japan. Countries with many patents have a better chance to be the leaders of science and technology (S&T) in the future (Jamrisko et al., 2019).

This ranking represents strong progress for a society that is witnessing a rapid economic transformation, while the US is slipping in its ranking despite having many globally leading hi-tech companies and revolutionary innovations (Coy, 2019). Due to the transformation from backroom producers to global leaders in innovation, multinational companies from the US and Western Europe, which are present China, must reshape their R&D and human resource (HR) strategies, as well as speed up the time to market (TTM) of innovative products. All of this is necessary in order to keep track of newly innovative Chinese companies, which have been accelerating in innovation between 2014 and 2018 like never before. Many critics have made the mistake of underestimating China's rise, but years of FDI gave them the capability to become a manufacturing and a self-sufficient powerhouse. To operate in the world's largest single market, companies needed to share their expertise with local producers, who had now become "creators". The best example is the construction of a high-speed train, where the Chinese learned from foreign partners and improved their technology. China is becoming a leader in internet business models, artificial intelligence, telecommunications, and fin-tech. Firms like Alibaba, Huawei, and Baidu are penetrating into other markets, and foreign companies are starting to recognize it (Prud'homme and Zedtwitz, 2018).

1.1 Intellectual property rights

In 2016, more than three million patent applications were submitted worldwide at an increase of 8.3 percent from the year before. This growth was largely caused by the 236,000 Chinese applications, which is 98 percent more than in 2015. Without China, global growth of patent applications would be just 0.2 percent. The State intellectual property office (SIPO) of China received 1.3 million files in 2016, more than combined patent applications in the United States (USPTO, 605,571) and Japan (JPO, 208,830). Chinese patent applications are mainly filed in China (96 percent). They last on average for 7.2 years (WIPO, 2017).

However, despite the significant number of intellectual property rights applications made by Chinese entities, most of them are cancelled due to the high license fees, which are escalating every year. Among all patent applications in

2017, 23 percent were inventions, 54 percent were utility models, and 24 percent were design patents. The cost for registering an invention in 2017 was 900 yuan (131 US dollars), which rose to 8,000 yuan the following year while the other patent applications rose in price from 600 to 2,000 yuan. Because of a weak approval process for less innovative products, applicants started to copy US patents and were seeking approval in China with the intention of earning a settlement fee. Moreover, Chinese companies were filling fraudulent patent applications in order to get tax and residency benefits for their workers. Although China is growing rapidly, it still has a long way to go in establishing itself as the legitimate global leader in innovation (Chen, 2018).

1.2 The impact of innovation on China's economy

China appears to be successful as an innovator, but if we consider how many Chinese companies are successful on the global market, the picture is different. In industries where constant innovations and high-tech solutions are required, the global market share of Chinese companies is still relatively small. On the other hand, in some other industries, China is surpassing expectations. For example, in e-commerce and consumer electronics, Chinese companies like Alibaba, Baidu, and Xiaomi are the top players. Innovation transformation will be crucial for the creation of higher value-added and high-paying jobs. Continuous development is forecasted to bring an additional one hundred million people to large cities by 2020, which means that ten million new jobs will be needed every year (Woetzel, 2015).

The massive domestic consumer market, which is also highly dynamic and fast-moving, is a considerable advantage for Chinese firms. In the last decade, the average disposable income has risen by 10 percent per year, from 17,080 dollars to 36,900 dollars annually (CEIC, 2019). The Chinese mobile giant WeChat has gained one hundred million users in just 1.2 years, whereas Facebook needed 4.5 years to gather the same number of users. Additionally, Chinese customers are more prone to try out new products, so customer-facing enterprises continuously launch new models and test them on the market to receive fast feedback (Woetzel, 2015).

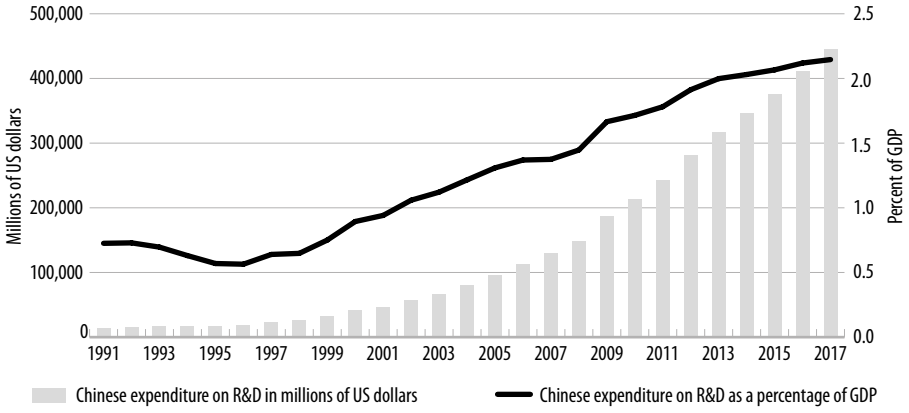
China is also the world's largest exporter overall, placing ahead of the United States and Germany. In 2017, they exported 2.41 trillion dollars worth of goods and imported 1.54 trillion dollars, which resulted in a positive trade balance of 873 billion dollars (19.5 percent of the Chinese GDP). Between 2012 and 2017,

the annual growth rate of exports was 2.5 percent. Despite the variety of products, "Broadcasting Equipment" represents the largest share of Chinese exports at 9.6 percent, followed by "Computers" which holds 6.1 percent of the total. The most important export countries for China are the US with 476 billion dollars (20 percent of all Chinese exports), Hong Kong at 255 billion dollars (11 percent), Japan at 157 billion dollars (6.1 percent), and Germany with 109 billion dollars (4.5 percent) annually. This data is particularly relevant when we talk about the current trade dispute between China and the United States. On the one hand, the ban hurts China significantly due to the size exports to the US; but alternatively, China is also the second most valuable importer of American cars (25 percent) after Canada, which represents an essential portion of their GDP (OEC, 2019; Mauldin, 2018).

2 Innovation inputs

Expenditure on R&D in China has fluctuated significantly over time. Between 2000 and 2016, *Chinese expenditure on R&D* systematically increased on average by 19.6 percent annually (Figure 1) to reach 2.1 percent of GDP in 2016. This is a divergence from the trend in 1991, where total R&D expenditure in China was a modest 0.72 percent of GDP. This increase was a result of a systematic Chinese aim to be an innovation-driven country by 2020. Such ambitions were first listed in the national strategic 5-year plans prepared by the Chinese government (UNESCO, 2019a).

Figure 1. The Chinese expenditure on R&D as a percent of GDP and in millions of US dollars between 1991 and 2017 (constant 2010 prices)

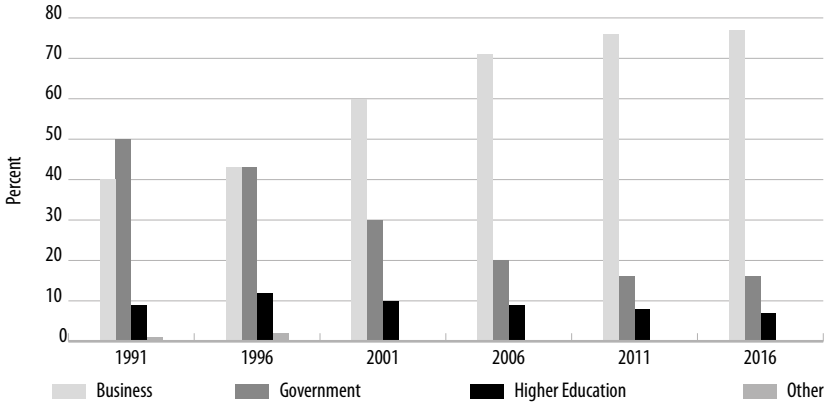


Source: OECD, 2019.

2.1 Financing R&D

R&D in China is funded through two main channels: *government* and *businesses*. In the 1990s, China made a significant transition in innovation policy and financing. The country set up high-tech parks where preferential policies on taxes, subsidies, and loans were allowed in order to stimulate economic development. This has incentivized companies to take interest in innovation, and the government started investing heavily (Figure 2) to become the leading financer of R&D in 1996. Since 2011, China's federal government has financed more than 75 percent of Chinese innovation. State-owned enterprises accounted for around 52 percent of R&D spending by domestically listed companies in 2016. This is a clear indication that the government continues to play an important role in R&D (Caixin, 2019).

Figure 2. Sources of R&D financing in China between 1991 and 2016 in percent



Source: UNESCO, 2019b.

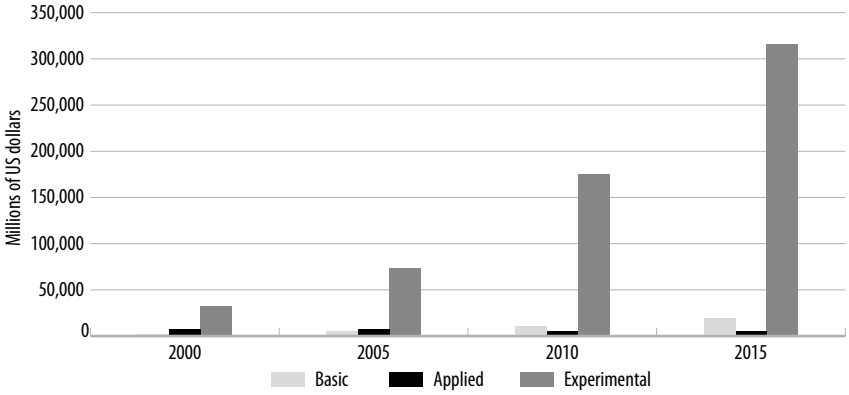
2.2 Type of R&D activity in China

China has consistently allocated the largest share of its R&D resources to experimental development, averaging roughly 80 percent from 2000 to 2016. China's preference for *experimental research* (using acquired knowledge to improve products and processes) development far outweighs that of other leading economies. Innovation powerhouses, like the United States and Japan, devoted just over 62 percent of R&D funding to experimental development research. However, China's R&D spending on basic and applied research, which is critical to the development of new scientific ideas and cutting-edge technologies,

proportionally lags behind that of other major powers. Between 2000 to 2016, *basic research* (expanding scientific knowledge without immediate application) in China averaged around five percent of total R&D expenditure, while the share of *applied research* (solving practical problems that improve human condition) dropped from 16.9 percent to 10.3 percent (Chinapower, 2019).

The importance of experimental and basic research in China is noticeable (Figure 3), with a significant increase in their funds over 15 years. However, applied research seems to have become somewhat stagnant in terms of funds allocated to it.

Figure 3. China's R&D by type of activity (2000-2015)



Source: OECD, 2019; UNESCO, 2019b.

Human resources are another critical input concerning innovation in China. Already in 2012, China had more than two million researchers, which represented approximately 0.15 percent of the population. Approximately 340,000 of them are government researchers. The massive market of skilled labor contributes heavily to the success of China (OECD, 2019). Chinese policy more than a decade ago encouraged citizens to go abroad to the top educational institutions and return with a new perspective and the knowledge to build the best educational system in the world (OECD, 2008). China had more than 4.7 million STEM (Science, Technology, Engineering & Mathematics) graduates in 2016 (Baker, 2018). Moreover, a recent study showed that approximately 24 percent of scientific papers globally had a Chinese co-author. The percentage climbs to 37 percent if combined with the papers written in Mandarin Chinese (Rathi, 2018).

3 Innovation governance

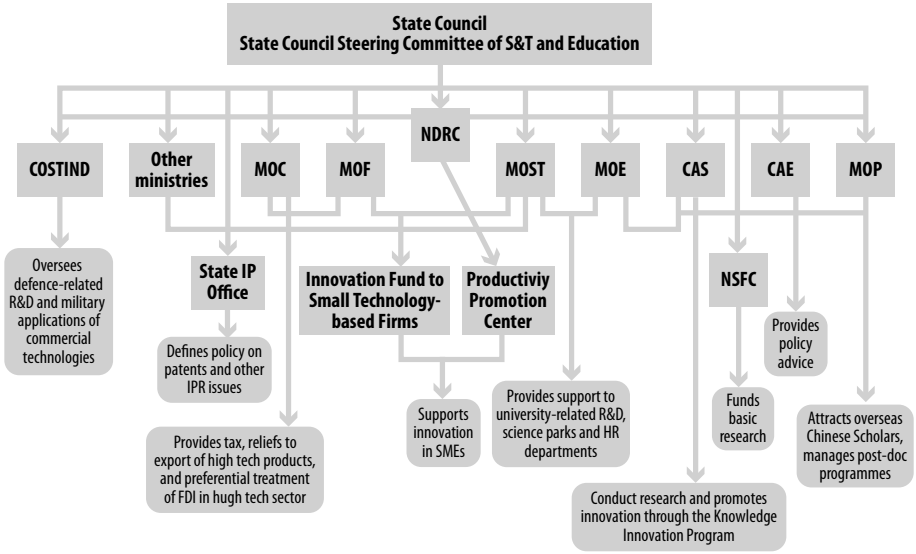
The Chinese have experienced a *state-led innovation development* push for the past three decades. Since the 1970s, the government developed numerous innovation policies (comprised of industrial, financial, and fiscal policies) designed to reform the science and technology (S&T) system to stimulate innovation and economic development in China.

The government created a set of laws, regulations, strategies, and five-year plans for S&T activities to promote technological progress and increase industrial competitiveness through regulation of markets, preferential tax treatment, R&D subsidies, and infrastructural development (Liu et al., 2011).

3.1 Key players in federal R&D

The Chinese innovation policy is largely governed by three central bodies (Figure 4). *The State Council* is the highest innovation policy coordination body for national innovation strategies. The *Ministry of Science and Technology (MOST)* participates in the design and implementation of innovation plans

Figure 4. China's S&T institutions



Legend: CAE (Chinese Academy of Engineering), COSTIND (Commission for Science, Technology, and Industry for National Defense), MOC (Ministry of Commerce), MOE (Ministry of Education), MOF (Ministry of Finance), MOP (Ministry of Personnel), NSFC (National Natural Science Foundation of China)

Source: Huang et al., 2004; OECD; 2008.

to fund basic and applied R&D, aid enterprises, manage science incubators, and develop human resources in the S&T area. The *Chinese Academy of Science (CAS)* played a vital role in developing China's S&T system in the planned economy by conducting research and promoting innovation. The *National Development and Reform Commission (NDRC)* is the economic planning body of the State Council (Huang et al., 2004; OECD, 2008).

3.2 Development of innovation policies

The evolution of China's market-oriented S&T policies commenced in the 1970s when Deng Xiaoping laid the foundation for future policy reforms. China, at the time, was mostly rural and among the least developed countries. It was of vital importance for China's economic and social development to adopt *market-based principles* and open its market to trade and foreign direct investment (FDI). The development can be broadly described in four stages (Table 1) (Hofman, 2018).

Table 1. Development stages of China's S&T policy (1975 - 2020)

Stage	Description
Pre-reform (1975-1978)	Deng Xiaoping's theory was the ideological foundation. Policy focus on S&T development, economic modernization, and industrialization.
Systemic reform (1979-1994)	General renewal of S&T systems such as research institutions, technological capabilities, facilities, and infrastructure. Focus was on industrial policies and creating a macroeconomic environment favorable to S&T development.
Deepening reform (1995-2005)	Period of expanding innovation policies beyond industrial policies and S&T.
Innovation-driven nation (2006-2020)	Decisions to implement new strategic five-year plans, such as the Medium- and Long-term Strategic Plan for the Development of S&T (2006-20) and Made in China (2025).

Source: OECD, 2008; Liu et al., 2011; Springut, 2011.

During the first stage (occurring in the years 1975-1978), several policy documents were drafted that dealt with S&T development, economic modernization, and industrialization. In the second stage (1979-1994), the focus was on industrial policies and creating a macroeconomic environment favorable to S&T development, which was also reflected in the passing of various laws for patent protection and anti-unfair competition. China commenced the implementation of numerous strategic plans, such as the Key Technologies Program and the National High Technology Program (863 Program). In 1988, the Torch Program was passed to set up high-tech parks and incubators, which significantly con-

tributed to the creation of many start-ups. China set up many high-tech parks, where they allowed preferential policies on taxes, subsidies, and loans in order to stimulate business development. Furthermore, in the 1980s, China focused on technological development by importing goods and opening its market to FDI.

During the deepening reform stage (1995-2005), the focus was on innovation policies beyond industrial policies and S&T. The government has passed a series of laws in the area of financial and fiscal policies that stimulated the business environment. The government also passed several financial and preferential tax treatment policies to benefit newly transitioned R&D enterprises. A large number of policies were associated with achievements in the S&T field. Policies that supported private enterprises were permitted to shift their innovative practices away from the primary reliance on the federal government. Newly implemented policies supported venture capital within the software industry. In 2001, China joined the World Trade Organization (WTO). CAS initiated new programs in order to have their institutes internationally acknowledged for research. MOE established policies that encouraged student exchange programmes in order to transfer knowledge and capabilities from abroad back to China.

The last stage (1995-2005) focuses on China becoming an innovation-driven nation. In this stage they decided to implement new strategic five-year plans (Medium- and Long-term Strategic Plan for the Development, Made in China, etc.). The State Council accelerated the growth of strategic emerging industries by funding investments in key technology areas. China is actively establishing a national innovation system and taking further measures regarding fiscal policies, intellectual property rights, and military collaboration. Emphasis is placed on S&T infrastructure and human resources for S&T. China funded more than 200 new programs in the fields of IT, manufacturing, transportation, biology, energy, agriculture, environment, and resources. CAS also launched new innovation strategies which will further stimulate research and cooperation with local governments (OECD, 2008; Liu et al., 2011; Springut, 2011).

3.3 Innovation-driven nation

The government reforms helped China to achieve unprecedented economic growth over the past 30 years and become one of the leading innovation-oriented nations. FDI and international trade allowed China to become the leading export country and the largest trading platform in the world. China has a huge number of national projects planned for the future.

The main objectives are an improvement in innovation competency to stimulate economic and social development and protect national security, participation with the innovation-driven countries to become the leading S&T country, and to substantially increase the overall strength of China's S&T research. The objectives are spread across many segments, including agriculture, industry, energy, aerospace industry, medical, pharmaceutical, automotive industry, semiconductors, national defense, R&D, and human resources. Some of the critical tasks of the policy reforms are to support corporations in becoming the leading players in technological advancements, to establish a national innovation system (NIS) and to facilitate linkages between universities, industry, and public research as well as civil and military research.

China has prepared efficient strategic plans which combine macroeconomic and structural policies that insist on self-reliance and international collaboration to make China the leading innovation-driven nation (OECD, 2008). Chinese President Xi Jinping announced in 2013 the start of an investment initiative in *the Silk Road Economic Belt and the 21st Century Maritime Silk Road.* Before the announcement, China was already building the China-Pakistan Economic Corridor that leads to the Arabian Sea. The investments abroad are a collection of long-term projects that China has planned in order to maintain their status as the leading export platform (CFR, 2019).

3.4 Intellectual property rights

In 1980, China joined the *World Intellectual Property Organization (WIPO).* This enabled the country to form an intellectual property rights system that corresponds to international rules as well as China's economic development needs. During the late 1990s, China established several legislative acts, such as the Law Against Unfair Competition of the PRC and the Advertising Law of the PRC and the Regulations on Customs Protection of IPR, in order to stimulate innovation in the nation.

The number of patents issued in China increased in the years after the legislation was passed (WIPO, 2010). In 1998, the *European Union - China S&T Agreement* was signed in 2004 and renewed in 2009. It is an international framework for S&T R&D cooperation between the European Union (EU) and the People's Republic of China (PRC). The central government body responsible for intellectual property is the *State Intellectual Property Office (SIPO)*, and it has a dual-track enforcement system. There is the administrative process,

where one can file a complaint to the administrative IPR authority. The process does not involve court proceedings. Alternatively, there is the judicial process, where one can report to a civil judicial court. This process is more complex than the administrative route and lasts for two years on average.

China has some compulsory technology transfer by foreign companies in exchange for market access, which can result in legal requirements to enter a joint venture with a Chinese entity in order to be permitted to do business in China (EU Delegation to China, 2019).

3.5 China's Innovation Zones

The massive manufacturing ecosystem of China enables them to develop and implement prototypes at a rapid pace. Overnight development of prototypes is the result of an efficient system, which also leads to economies of scale, followed by a cost advantage of 50 to 60 percent while maintaining optimal quality (McKinsey Quarterly, 2013). Furthermore, due to the country's large population of 1.3 billion, there is a remarkable base of high and medium-skilled workers from which large companies and start-ups recruit their workforce (Lewin et al., 2016).

Three significant cities represent the core of innovation growth in China. First, *Shanghai* committed to supporting entrepreneurs financially, especially the ones who are inclined to tech innovations in the Yangpu district. Foreign professionals, who work for those companies, are promised a permanent residence so they can have a clear focus on S&T innovation activities. The Chinese government also offers up to 60 percent of loss compensation to the start-up investors, depending on how positively they contribute to the province and the city (Ren, 2016). Because of these factors many new companies were established. A key company to mention is the car manufacturer called NIO, which can be seen as the Chinese imitation of Tesla. The company manufactures and sells electric cars and is forecasted to be a significant global player in the future of e-mobility (Bosideng, 2018). They mainly focus on thoughtful design, innovative services, and cutting-edge technology. It was also ranked 5th on the "Most Innovative Companies in China" list for 2019 (NIO, 2019).

Second, *Beijing* is China's cultural, political, and educational center. Because of high government investment, the city is home to most companies in China, which makes Beijing one of the most innovative cities in the world. Based

on a report from global real estate consulting firm Jones Lang LaSalle (JLL), Beijing was ranked as the 4th most innovative city worldwide, before Shanghai (11th place) and Shenzhen (14th place). The capital is a magnet for venture capital (VC) funding due to the thriving start-up scene. This is a consequence of big telecommunication and internet companies, as well as the number of top universities in the country in the fields of engineering and social science (JLL, 2019). Out of this environment the biggest internet giant was born and named Baidu. Since China has 731 million internet users, the company is among the leaders in areas where massive amounts of data is needed, such as artificial intelligence and machine learning (Marr, 2018).

Shenzhen was a tiny fishing village but has become a magnet for ambitious, young entrepreneurs who want to take advantage of the city. Shenzhen is the heart of the global tech supply chain, making it the new Silicon Valley of Asia (Rivers, 2018). Steven Yang, CEO of battery technology company Anker Innovations stated: "If you really want to develop products in a fast pace, I think you have to be in China – and practically have to be in Shenzhen. Ten years ago, Shenzhen was 90 percent about copycatting and 10 percent innovation; now it is 70 percent innovation and 30 percent copycatting." It was ranked as the most livable city in China, according to the Chinese Academy of Social Sciences (Hopkins, 2018). The result of the city's success was a jump in population from five million to 20 million in the past 20 years. Successful companies that operate in Shenzhen best represent all of this. Some companies include the biggest producer of non-military drones, DJI, China's largest telecom equipment company, ZTE, the dominant smartphone manufacturer, Huawei, and Tencent, the messaging platform with a billion monthly users across China (better known as WeChat) (Huifeng, 2015).

3.6 Future trends

Concerning the future, the Chinese government leaves nothing to fate and prefers to stick to a thorough plan. In 2015, China launched their new plan "Made in China 2025", which seeks to make the country dominant in global high-tech manufacturing. The idea is to use subsidies, mobilize state-owned enterprises, and acquire intellectual property (IP) to catch up to and then surpass advanced Western technology. The ten-year plan focuses on different high-tech industries like electric cars and other new energy vehicles, the next generation of IT and telecommunication services, as well as artificial intelligence and advanced robotics. All of these sectors make up the ground floor for China's

fourth industrial revolution, which refers to the integration of cloud computing, big data, and other emerging technologies into global manufacturing supply chains (McBride and Chatzky, 2019).

In order to achieve these goals, China needs to take several steps. First, they need to build the right talent pool. In recent years they invested heavily into training and education. Between 2002 and 2014 the number of graduated students in engineering and science almost quadrupled; but besides quantity, quality is also a key factor, and for now the US maintains the lead in scientific breakthroughs and industrial applications. Second, China needs to build their technological know-how. They have doubled their R&D investment between 2000 and 2016, yet the country's attainment of new knowledge still depends on foreign investment and international trade. This is because foreign companies operating in China are obligated to form a joint venture with a domestic company, which gives the Chinese access to global technology and information. Third, they need to ensure the right mix of competition and collaboration in the idea marketplace, especially when it comes to IP protection. Fourth, China must become tolerant of failure and creative destruction, which means they need to follow their plan but also be spontaneous when it comes to disruptive innovation. Fifth, a stable legal and economic situation is of high importance, since institutions need clear and predictable rules that apply to everyone. Lastly, it is important to establish the right partnership and create a balanced division of responsibilities between the public and private sector (Annuziata, 2018).

Conclusion

China has experienced remarkable economic growth, innovation development, and made the most out of their geopolitics. The state-led innovation S&T reforms established a macroeconomic environment favorable to the S&T system. The government started construction of technological parks while endorsing preferential policies on taxes, subsidies, and loans in order to stimulate the innovative environment. Businesses became interested in the government's initiatives and began investing heavily in innovation, resulting in an increase in FDI and Chinese investment abroad. Disposable income has risen, and the need for human resources is predicted to increase further. Furthermore, due to a sprawling population, they have all the labor they need to become a global powerhouse of innovation. Companies like Alibaba, DJI, Huawei, and Tencent are set to take over the global marketplace.

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II.

INNOVATION GOVERNANCE IN SELECTED MULTINATIONAL COMPANIES

Matjaž Koman, Rok Hribšek, Miha Povšin, Ana Temeljotov

DUAL STRATEGY AND INNOVATION IN MAHLE

Introduction

In the current era of e-mobility, the automotive industry is witnessing many changes and many more are expected to come in the following decade (Miller, 2017). One of the important players involved in this shift are suppliers in the automobile industry, such as Bosch, Continental, and MAHLE. These companies are not only component providers but developmental partners to car manufacturers. By providing innovative solutions, automotive suppliers co-create the future of the automotive industry.

MAHLE is the fourth largest car parts supplier in Germany, with headquarters in Stuttgart. Like many other top automotive suppliers, they focus on lightweight construction, software and networking, driver assistance systems, and combustion engines. Rising environmental awareness accompanied by environmental regulation changes are rapidly redesigning the automotive industry. In this time of change, MAHLE, as well as their competitors, are investing generously into R&D to sustain or improve their market positions (Bergmann and Tiwari, 2017).

This chapter presents innovation activities conducted at MAHLE in light of these changes, and their consequent firm performance based on information from secondary sources and in-depth interviews with employees from Corporate Planning Innovations (CPI) at MAHLE.

To begin this chapter, the company MAHLE is presented. Next, we focus on mega trends that are shaping MAHLE's operating environment, as well as their dual strategy, which was developed based on the mega trends with the aim to adjust to and take advantage of new opportunities arising from the changing

environment. In the final section, innovation life-cycle management as well as innovation initiatives at MAHLE are discussed.

1 About MAHLE

MAHLE was founded in 1920 in a small test workshop in Germany. It was established by the Mahle brothers, who had the innovative idea of replacing heavy iron pistons with light-alloy pistons, which revolutionized the automobile industry. Since then, MAHLE has expanded internationally to become a company known around the world. Throughout the years, their business shifted from being a component manufacturer to more of the development partner and module supplier role that they play currently (MAHLE, 2019a).

Today, every second automobile produced worldwide includes a part produced by MAHLE. In 2018 MAHLE had 12.6 billion euros in sales and employed almost 80,000 people worldwide, which places them amongst the top 20 automotive suppliers in the world (Berylls, 2018). The leading automotive suppliers worldwide are Bosch and Continental, which are also based in Germany. In 2018 Bosch and Continental had three to five times more employees than MAHLE, and four to seven times higher sales (Table 1).

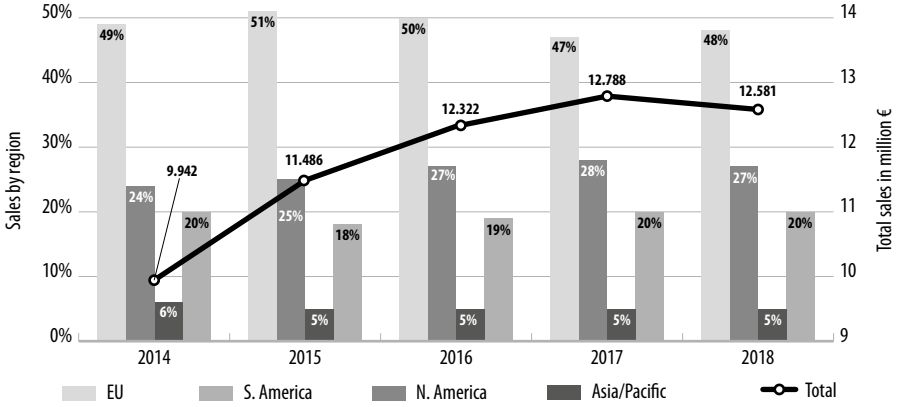
Table 1. Comparison of Bosch, Continental and MAHLE key financial figures for 2018

	MAHLE	Bosch	Continental
Sales (in millions of euros)	12,581	78,465	44,404
EBIT (in millions of euros)	773	5,502	4,028
Equity (in millions of euros)	3,014	39,176	18,333
Employees	79,564	409,881	243,226

Source: MAHLE, 2018; Bosch, 2018; Continental, 2018.

From 2014 to 2018, MAHLE's sales increased by 26.5 percent, although the sales in the last three years did not change much and even slightly decreased in 2018. Through many years of operation, MAHLE developed a robust business and sales network around the world. Most of MAHLE's sales are made in Europe, followed by North America and Asia (Figure 1).

Figure 1. Growth of MAHLE sales in total and by regions from 2014 to 2018



Note: Africa represented 1 percent in the period between 2014 and 2015, now it is below 1 percent, thus excluded from picture.

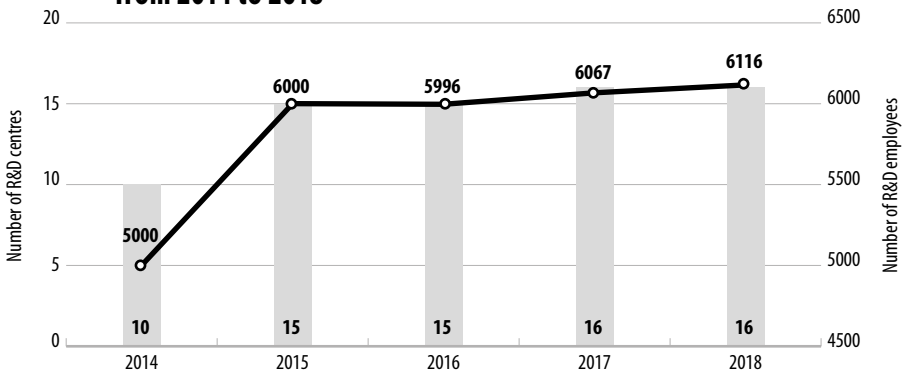
Source: MAHLE 2018.

The company has 170 production locations and 16 research and development centres worldwide. Many of these research centres were acquired in recent years and have added new knowledge and development potential to the company. Research and development are of great significance to the company, which is demonstrated by their investment in R&D of 751 million euros (six percent of sales) in 2018. At the end of the same year, MAHLE employed more than 6,000 R&D staff (7.5 percent of employees) and recorded about 550 new inventions. New solutions are expected to result in more efficient, comfortable, and environmentally friendly modes of transportation. MAHLE is focused on the future and developing solutions in electric mobility, while at the same time they continue to optimize the internal combustion engine to maintain their current strategic position (MAHLE, 2018).

Their focus on developing new technologies to be competitive in the future is reflected in their R&D activity. In the last five years, their number of R&D centres increased from ten to 16, while the number of employees in R&D increased by roughly 900 from 2014 to 2018 (Marklines, 2019, Figure 2).

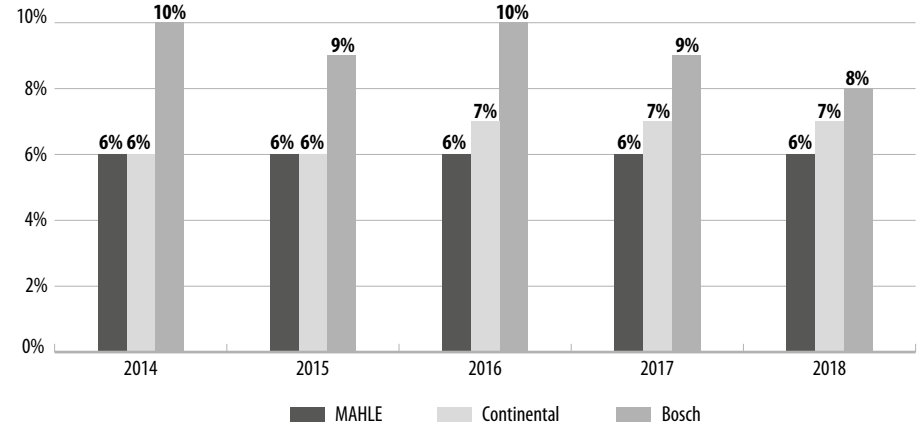
Despite the increase of investment in absolute terms in the last five years, MAHLE maintained investment in R&D of about six percent of their sales revenue (Figure 3). This is less compared to Bosch and Continental, who invested more than seven percent of sales into R&D in 2018 (Bergmann and Tiwari, 2017).

Figure 2. Number of R&D centers and employees in R&D in MAHLE from 2014 to 2018



Source: Marklines, 2019.

Figure 3. Comparison of R&D expenditure as a percentage of sales revenue for MAHLE, Continental and Bosch



Source: Statista, 2019.

Table 2. The number of new patents in Bosch, Continental and MAHLE between 2016 and 2018

	Bosch	Continental	MAHLE
2016	1122	149	122
2017	1158	189	167
2018	1053	191	123

Source: IPO, 2017, 2018, 2019.

R&D spending can be also demonstrated through the number of new patents each company has at the end of the year (Table 2). MAHLE in general is keeping up with Continental, but Bosch has many more patents than Continental and MAHLE combined.

MAHLE is highly aware of the innovations that will be needed to maintain and evolve its position as one of the top automotive suppliers worldwide, and the company is actively moving forward by constantly investing in and expanding their R&D.

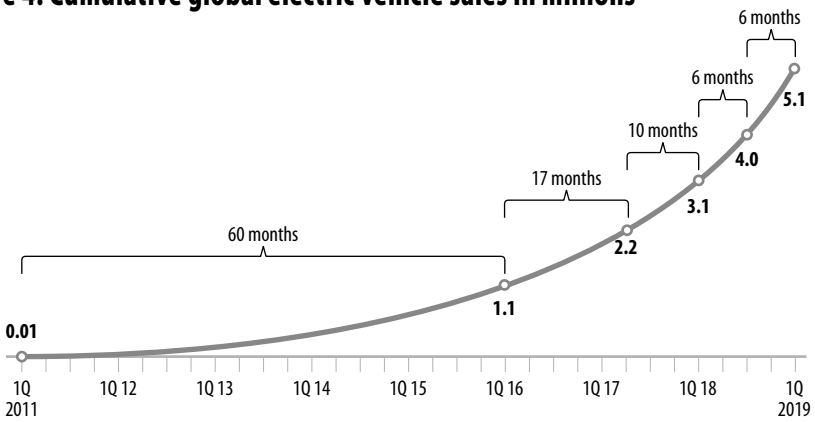
2 Mega trends shaping MAHLE's dual strategy

Mega trends are sustained global and macroeconomic forces that impact businesses, societies, economies, cultures, and personal lives. As such, they also shape a company's future strategy, development, and innovation processes, including those at MAHLE.

World population growth and economic gravity shift. Currently, the world population is rapidly increasing and is projected to rise by a staggering one billion people by the year 2030. Most of this growth will take place in African and Asian countries with rapid urbanization placing huge demands on infrastructure, services, and transportation (PWC, 2019). By 2030 Asia will represent 66 percent of the global middle-class population and 59 percent of middle-class consumption, up from 28 percent and 23 percent, respectively, in 2009. This is a great opportunity for automakers and car parts suppliers like MAHLE, as with a growing population, especially the middle-class population, the demand for cars will also increase. In India, there were about 18 cars per 1,000 people in 2016, and in China there were about 60 cars per 1,000 people. To compare, there were 765 cars per 1,000 people in the US in the same year (PWC, 2016). Furthermore, this increase in demand is currently one of the main reasons for the growth of sales at MAHLE, with the other factor being acquisitions. Like the population, the economies of BRIC (Brazil, Russia, India, and China) are also growing rapidly and transitioning from centres of production and labour to economies oriented in consumption (PWC, 2016). It is predicted that already by the late 2020s, the size of China's economy could surpass that of the US. Furthermore, by the early 2030s, the combined economic power of BRIC could overtake that of major advanced countries. In addition, Asia is slowly taking an increased share of global vehicle sales and is the only major market expected to have significant long-term growth (Steinbock, 2017).

Climate change and e-mobility. Climate change has been a popular topic for the last two decades. The growing environmental concern is the primary motivator of over half of the current electric vehicle users in Europe. In 2018, the global sales of electric vehicles surpassed four million. While it took 60 months to reach the first million (Figure 4), it only took six months to reach the four million mark (Bloomberg NEF, 2018).

Figure 4. Cumulative global electric vehicle sales in millions



Source: Bloomberg NEF, 2018.

The next major reason for the growth of the e-mobility market is the continued governmental support of eco-friendly options along with higher taxes on fuel. Society is also changing its preferences and becoming more environmentally conscious. Additionally, the technological progress in battery performance and fast-charging technologies has contributed to more and more people opting for electric vehicles; however, we must not forget about the challenges that e-mobility will have to face in the upcoming years. Electric vehicles still have a limited range and charging times remain quite long compared to other vehicles. Adding more range will demand heavier batteries, which could reduce vehicle capacity and may cause more damage to the roads. Another key issue is the poor coverage of battery-charging infrastructure. Currently, this is more advanced in the Baltic countries, barely acceptable in central Europe, and insufficient in the southern European countries. Governmental support for the relevant infrastructure is fragmented around the globe. This e-mobility transformation will take time, as it takes people anywhere from one to 15 years to change their vehicle (EU Commission, 2018). Nevertheless, 2018 was the year when traditional vehicle manufacturers strongly stood behind this e-mobility trend. Many of them announced their plan to manufacture only vehicles with

electric powertrain in the near future (Jaguar, Porsche, and Mini are some of these companies).

Besides the many new models on the market, car manufacturers have begun to implement new e-mobility services. Daimler and BMW joined forces by merging their car sharing services DriveNow and car2go. Volvo has started a new car subscription service and VW announced its own car sharing service called We Share (Bloomberg, 2018). On one hand, car sharing will lead to less cars being used; but on the other hand, the cars will be used more often. The mechanical parts will have to endure the increase in mileage and car parts suppliers will have to take this into consideration as well.

Due to the aforementioned mega trends, MAHLE has decided to shift part of their strategic focus to e-mobility. Turning this threat into an opportunity was their base for the decision to form a dual strategy, which was first implemented in 2016 to ensure the long-term growth of the company. One aim of the dual strategy is to maintain their position in the existing market of conventional vehicles while the other goal is to simultaneously increase their market share in new markets such as electric vehicle components. This means that they are still intensively working on additional optimization of combustion engines, increasing their efficiency, and lowering the emissions of these engines because they will nevertheless remain an important element of the drive mix in the future. MAHLE is also focusing on the development of alternative drive concepts, such as battery-based e-mobility and fuel cells to make electric vehicles affordable and suitable for everyday use. They are pursuing both approaches out of conviction and with one goal in mind: to make individual mobility more sustainable while continuing to strengthen the position of MAHLE as one of the world's leading development partners and suppliers of the automotive industry (MAHLE, 2018; MAHLE, 2019b).

3 Innovation at MAHLE

At MAHLE they are aware that the rapidly changing automotive industry demands responsive and agile suppliers. Furthermore, automotive producers need to build partnerships with innovative solution providers. To keep up with this pace, MAHLE developed different innovation initiatives, which are presented in Figure 5. Aside from internal initiatives, they established external cooperation and knowledge sharing with other companies. Internal innovation initiatives are

the MAHLE Incubator, MAHLE Innovation hub[1], MAHLE Top Thinkers Circle, and MAHLE Piloting, while external initiatives include investing in start-ups, cooperative agreement with other companies, and acquisitions (MAHLE, 2018).

Figure 5. Innovation activities at MAHLE.

Source: MAHLE, 2018.

Innovation life cycle management. Depending on the type of innovation activity (internal or external), the innovation processes at MAHLE differ in detail from one another but generally can be divided into four main steps: idea, concept, solution, and market. In the first phase, potentially innovative ideas are collected, evaluated, and released via different IT tools or during workshops. Then an extensive analysis and derivation of concepts is done to see if the idea is implementable and ready to be introduced to the market. In the third step, solutions are tested and developed with the help of advanced engineering until the final product is rendered. At the end of the process, customers are targeted with the help of the marketing department.

Internal initiatives. At MAHLE they believe that the key to successful innovation is interdivisional cooperation, networking, and a strong flow of information. For that reason, they developed the MAHLE Innovation Hub platform, which is an initiative that promotes channelling good ideas through the corporation. This platform enables idea sharing for innovative business models, processes, products, and services across the company (MAHLE, 2018; MAHLE, 2019b).

To speed up the innovation, they decided to include start-up principles into their business and combine them with established processes. This was put into action with the *MAHLE Incubator*, which was established in 2017. The MAHLE Incubator is an innovation program where employees can submit

1 MAHLE Innovation hub is, strictly speaking, a collaborative software platform which supports the innovation process by managing ideas.

ideas for new solutions and work in a start-up-like atmosphere. The Incubator began in Stuttgart, followed by China in 2018, and is now being expanded to other parts in Europe. The aim is that in near future the Incubators will be established worldwide. The incubator process is divided into six phases. Phases one to four are considered the pre-incubation phase. In phase one, anyone can submit ideas, which are then filtered and selected in the second step. In phase two, selected ideas are presented. The selected concepts are then presented in a way that the presenters try to impress other co-workers and inspire them to join in and help develop the idea further. In the third phase, the top ideas are invited to Concept Day, where they are presented to a MAHLE jury to assess the projects and decide on their future. The jury selects six teams that qualify for the bootcamp, which marks phase four. Bootcamp takes place in a creative space away from regular offices and lasts for about a week. This week is dedicated to building and working on the selected ideas. The ideas are then presented to the MAHLE management board. At the end of this phase, best ideas are selected. In phase five, selected teams devote the next three to six months fully to developing their ideas. The refined concept is then presented again to the MAHLE management board, which makes the final decision. If the board approves it, phase six commences. This is the so-called corporate start-up phase, where teams work on their ideas by functioning as a corporate start-up (MAHLE, 2018).

The *MAHLE Top Thinkers Circle* is a global appreciation program for employees who are particularly dedicated to innovation. It encourages all employees to actively shape the innovation culture at MAHLE and offers Top Thinkers a networking opportunity to work together with people across business units worldwide. Every year about 15 to 20 employees across all business units are nominated as Top Thinkers. They are mostly employees from development departments who are nominated by their supervisors or are recommended via their activity in Innovation Hub. Top Thinkers get an award and a certificate, and most importantly they get the chance to work in teams on a strategic topic and to present the results at a "final event" attended by management.

External cooperation and knowledge sharing. MAHLE is cooperating with many other companies and is at the same time building networks with different professionals all over the world. Through external cooperation, they share and receive new knowledge, which enables them to innovate faster. Activities that support external cooperation in MAHLE are the creation of their own corporate start-ups, cooperation with external start-ups, and acquisitions. Corporate start-ups are developed by different programs. One such program is the already

mentioned MAHLE Incubator and another was the ACTIVATR program, active until 2017. ACTIVATR was an external start-up platform where MAHLE was one of the partners. The platform allowed professionals create start-ups and corporations to form interdisciplinary teams to develop and explore new market opportunities (MAHLE, 2018). In 2017, MAHLE launched two start-ups: Retromotion, an online spare parts platform, and Mood Corp., a lifestyle brand that offers mobile scent diffusors (Yizhen Yin, 2017). While Mood Corp is no longer active, Retromotion represents a successful case of the ACTIVATR program. Today, Retromotion is an independent company with MAHLE being a minority shareholder. In order to focus on the Incubator, MAHLE stopped activities within the ACTIVATR program in 2017.

Another activity that promotes innovation through knowledge sharing is *investing in start-ups* that focus on issues that support MAHLE's dual strategy. This is managed by corporate venture capital department (CVC). CVC investigates the market and searches for start-ups that develop and offer technologies required by MAHLE, or are seen as an attractive addition to MAHLE's business in the future. In 2018, they screened about 2,000 start-ups and internally forwarded about 250 of them to different departments to check whether they are interesting to the company. Cooperation with start-ups is beneficial to both sides. Start-ups get funding, know-how, and valuable connections to penetrate the market, while MAHLE gets to be involved with the newest technologies and at the same time follow the trends more easily. In exchange, MAHLE usually gets a share in the start-up or acquires the entire company (MAHLE, 2017). One such example is cooperation with Inspekto, a start-up which built software for autonomous machine vision quality insurance for industrial plants. MAHLE was cooperating with Inspekto during their R&D phase and offered them valuable information on what is needed from such software, and in later phases enabled them to conduct the beta tests in MAHLE's plants (Brune, 2019). During their cooperation, MAHLE saw huge potential in Inspekto and decided to invest in it. Today, Inspekto's software is used in 40 percent of MAHLE's European plants, helping to prevent defects and thus saving time and money in the long-run (MAHLE, 2019b).

In the last few years, MAHLE did not acquire only start-ups, but also many developed companies. *Acquisitions* bring new knowledge and technologies to the company, which leads to growth and faster innovation. In the last eight years, MAHLE revenue has grown by a staggering 100 percent and the majority of this growth was due to their strategy of acquiring new companies. In June of 2014, MAHLE acquired a majority share in the Slovenian group Letrika d.d.

This was of great importance to them as it fit their strategy and allowed them to complement their mechatronic activities with components such as eDrives. They then added additional expertise in mechatronics in 2015 with the acquisition of Kokusan Denki, a Japanese electric DC motor specialist. Additionally, a second major division of Kokusan includes alternators, ignition components, and fuel injection systems for small engines. The market for these is already extremely large and shall continue to grow in the next years. Therefore, Kokusan Denki perfectly complemented the activities of Letrika. In the same year the acquisition of Delphi, a US tier 1 supplier, also greatly benefited the company. It supported the strategic expansion of their thermal management sector, which will play an increasingly significant role in all potential drive systems including combustion engines, electric drives, and fuel cells. Two years later they acquired Nagares, a Spanish electronics specialist, and strengthened their competency in e-mobility systems. One of the latest plans is the acquisition of Hella's shares in the joint venture Behr Hella Service, which specializes in the distribution and marketing of automotive air conditioning and cooling products. MAHLE will therefore be able to offer wholesalers the full spectrum of thermal management from a single source. All these acquisitions are key pillars in order to grow the business in this new world with a focus on electric vehicles and thermal management (MAHLE, 2019a).

Conclusion

MAHLE is aware that in order to be successful in this ever-changing mobility market, they need to be fast and impactful in their innovations. That is why they established many new innovation initiatives which are already being used and further developed. To add to this, they reformed their corporate strategy into a dual strategy, of which one half is devoted entirely toward achieving a larger share in the e-mobility market. Innovation is key in order to reach this goal. MAHLE's company culture strongly supports and promotes innovation. The initiatives are supported by the CEO as well as top management, who are all regularly involved and updated on the innovation processes. Aside from the CEO and top management, the IT, HR, workers' council, controlling and development departments are important innovation enablers within the company. MAHLE's innovative strength is based on cooperation, creativity, and acquisitions (MAHLE, 2017). In the near future, MAHLE will proceed with their dual strategy and strong innovation policy; however, in terms of R&D investments, they are lagging behind competitors. If they don't improve in this area they might not be as competitive in the future. They intend to

continue to expand and broaden their cooperation with other companies and start-ups. Therefore, MAHLE currently seems to be on the right track toward becoming a global leader in the automotive industry, although for now they lag behind top suppliers in terms of number of patents, R&D centres, and financial figures.

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Barbara Čater, Jurij Giacomelli, Barbara Pikl, Zala Logar Anja Plaznik, Anastasia Stoliarova

INTESA SANPAOLO'S CUSTOMER EXPERIENCE IN THE CENTRE OF THE GROUP'S INNOVATION STRATEGY

Introduction

New technologies are placing an increasing strain on traditional industries and challenging existing business models. Platform companies such as Google (Alphabet), Amazon, and Alibaba are expected to offer customers full banking services in upcoming years, which will influence customers' habits, banks' strategies, and significantly change one of the most traditional service industries. Over time, customers develop a stronger emotional connection with tech brands compared to the connection they have with their primary banks (Beyond Banking, 2019). Therefore, if traditional banks want to survive in the long-run, they will need to innovate their business models. Intesa Sanpaolo Group adopted this path by developing services that deliver a new customer experience. They do this through the implementation and adaptation of the Group's innovation concepts and competencies, namely DigiCal and the Adoption of the Group Distribution Model (AGDM) (Intesa Sanpaolo, 2018c).

The purpose of this chapter is to analyse the process of ongoing digital transformations at Intesa Sanpaolo Group and its Slovenian subsidiary. The chapter first provides a general overview of Intesa Sanpaolo Group, their strategy and structure, and highlights aspects of their innovation strategy relevant to the Slovenian market. Section two presents the Group's innovation strategy, its drivers, changes in customer preferences due to the digitalisation, and disruptive business models, taking into account the severe regulatory environment of the

European banking industry. The last section focuses on the customer-centric model and its delivery in the context of Intesa Sanpaolo Bank.

1 Intesa Sanpaolo Group

1.1 Key facts and figures

The leading Italian banking group, Intesa Sanpaolo, was created on January 1, 2007, with the merger of two Italian banking groups, Banca Intesa and Sanpaolo IMI, with a purpose of becoming a European-scale bank. Currently, Intesa Sanpaolo has 4,967 branches, 19 million customers and a market capitalisation of 38.1 billion euros. The Group's identity is built upon strong shared values, such as equality, integrity, transparency, respect of the individual and responsibility for the use of resources (Intesa Sanpaolo, 2019c).

In terms of market capitalisation, Intesa Sanpaolo is Italy's largest bank. It is third most sizeable bank in the Eurozone (Intesa Sanpaolo, 2018c) and 35th in the World (Relbanks, 2018). Table 1 summarises financial performance indicators of the Group.

Table 1. Financial performance indicators of Intesa Sanpaolo Group

	2016	2017	2018
Net income (in millions of euros)	3,111	3,816	4,050
Net interest income (in millions of euros)	7,293	7,265	7,276
Operating income (in millions of euros)	16,975	17,177	17,875
Total capital ratio (in percentage)	17.0	17.9	17.7
Cost to income ratio (in percentage)	51.3	55.1	53.0
Cash dividends (in millions of euros)	2,999	3,419	3,449
Leverage ratio (in percentage)	6.3	6.4	6.3
Number of branches	5,163	5,843	5,302
Number of employees	88,884	97,004	92,117

Source: Intesa Sanpaolo, 2017, 2018a,d, 2019a.

The Group has the following market shares in Italy: 17.7 percent for loans, 18.1 percent for deposits, 17.7 percent for life premiums, 20.9 percent for asset

management, 22.6 percent for pension funds and 25.6 percent for factoring (Intesa Sanpaolo, 2018a).

Banka Koper had been the subsidiary of the Intesa Sanpaolo Group in the Slovenian market for over 20 years. In year 2016 it adopted the name of its parent bank. To date, Intesa Sanpaolo has 49 branches in Slovenia with the market share of 5.7 percent, a bit more than 190,000 customers and their total assets amounting to 2,6 billion euros (Intesa Sanpaolo, 2019c). In Slovenia, Intesa Sanpaolo's aim is to increase market share by expanding nation-wide and by focusing on areas that are generally underserved by other banks in the market, typically by delivering services that are easier and simpler for customers to use through digitalisation (Cox, 2019).

1.2 Intesa Sanpaolo Group strategy

Intesa Sanpaolo Group pursues a conservative strategy. The overall goals are to provide solid and sustainable value creation for all stakeholders, a strong increase in profitability and efficiency, a low-risk profile, strategic flexibility, and a positive contribution to the economy and society. For their clients, they want to provide simple yet innovative bank services based on the real economy. Moreover, the bank has a strong policy to reward their shareholders. In 2018, 3.4 billion euros of dividends were paid out. To reach profitability and higher efficiency, employees have to go through many trainings, job reallocations, and flexibility programs. A low-risk profile is derived from solid revenue creation, continuous cost management, and dynamic credit and risk management with the efficient use of capital and liquidity. Considerable excess capital and high-value on a European-wide scale enables the bank's strategic flexibility. Sanpaolo Group is also dedicated to contributing to the growth and development of the economy and society (Intesa Sanpaolo, 2019d).

1.3 Intesa Sanpaolo Group structure

Intesa Sanpaolo Group is roughly divided into six business units operating around the globe, controlled and coordinated by the Corporate Centre. *Banca dei Territori* represents over half of the Group's consolidated operating income. It serves in retail, personal, and small and medium-sized enterprises. This division is divided into three legal entities: Banca Prossima, which focuses on charities and other non-profit organisations, Banca 5, which today focuses on

instant banking, and Mediocredito Italiano, which supports the investment, development, and innovation of SMEs at the regional and local level. The second largest division is *Corporate and Investment Banking*, which contributes 20 percent to the Group's consolidated total operating income (Intesa Sanpaolo, 2018c).

The third segment is *International Subsidiary Banks Division*, through which commercial bank subsidiaries and associates connect activities of eleven banks in eleven foreign markets: South-Eastern Europe (Albania, Bosnia and Herzegovina, Croatia, Romania, and Serbia), Central-Eastern Europe (Slovakia, Slovenia, and Hungary), and Commonwealth of Independent States and South Mediterranean (Egypt, Ukraine and Moldova). In order to leverage the transfer of best practices from larger to smaller banks, two service hubs were created to aggregate one or more challenger banks around one incumbent bank with a strong share in its home market. The first one is the Slovakian VUB Banka, and the second one is the Croatian Privredna banka. The division headquarters delegates activities to the hubs, which are then responsible for further implementation. Knowledge transfer is therefore facilitated and organised at different levels and adapted to market circumstances and the position of each specific bank in their respective market, whether the bank is an incumbent or a challenger (Intesa Sanpaolo, 2018c).

The fourth division is *Private Banking*, with four entities that serve private customers and high net-worth individuals. The fifth is *Asset Management Division* with Eurozone funds, seated in Luxemburg, while the sixth division is *Insurance Division* (Intesa Sanpaolo, 2018c).

2 Intesa Sanpaolo' innovation strategy

2.1 The Group's innovation governance

Strategic innovation currently represents the greatest challenge for Intesa Sanpaolo's corporate strategy. It is overseen by the Innovation Center and subdivided into several main areas. It is sponsored, monitored, and supervised by the top management of the Group. Benefits of innovation are monitored and transferred throughout the whole Group with the help of the previously mentioned hubs. Innovations are based on the needs of specific banks, concepts and projects such as DigiCal or AGDM, and carried out by dedicated experts

to achieve specific competencies. Table 2 presents a summary of innovation goals set by Intesa Sanpaolo, methods on how to achieve those goals, and the desired timeline of the bank's achievements.

Table 2. Innovation goals and how the company wants to achieve them

GOAL	HOW	UNTIL WHEN
Multi-channel client platform	• Extension of multi-channel platform to the full suite of ISP Retail/Personal client products (e.g., insurance wallet) • Strengthening of digitalisation in payments ecosystem by: – Launch of digital wallet, also enabling P2P transactions – Scale-up of instant payments through contactless technology • Development of a multi-channel platform for SMEs with a new digital Customer Journey • Launch of a digital transformation for C&IB clients, through a new digital platform, processes and tools • Strong digitalisation of sales force, through an upgrade to the equipment and client-interfacing tools • Progressive upgrade of back-end platform	2021
Digital processes	• Full digitalisation of high-impact processes with focus on Corporate credit and NPL • Launch of new digital products and services (e.g., Wealth Management) to reduce time to market • Full application of digital HR to streamline administrative activities and enable smart working • Progressive use of robotics and AI to optimise processes	2021
Data management and cyber security	• Evolution of a cutting-edge data infrastructure/platform • enabling the implementation of regulatory and business projects • Scale-up of robust data governance and new data quality processes • Full digitalisation of all core finance and operational reports • Strengthening of cyber security practices, with focus on high impact areas (e.g., advanced identity, predictive cyber security) • Rollout of technological, regulatory and organisational upgrades to comply with the new European regulation on Data protection (GDPR)	2021
Advanced analytics	• Scale-up of the Data Scientist team and diffusion of a "data culture" via learning, on the job training and community building • Partnership with start-ups on Machine Learning and AI • Full rollout of the use cases already developed and activation of approximately ten new use cases per year	2021
Innovation	• Focus on ISP's priorities (e.g., P&C Insurance with InsureTechs) • Scale-up of venture investment managed through Neva Finventures • Open dialogue with industry leaders and use of FinTechs to learn emerging technologies and continuously incubate new ideas	2021

Source: Intesa Sanpaolo, 2018b.

Innovation funding is centrally allocated and innovation strategy is monitored from the top, while the competencies are autonomously generated in the Intesa Sanpaolo's Innovation Center and other labs, such as the circular economy lab. The Group's innovation strategy stretches across all four essential value-creating aspects of a banking service: (1) managing clients' savings, (2) servicing transactions, (3) supporting them to reach their objectives by financing their investment (a mortgage loan or a long-term loan for the capital expenditure of a firm are examples) and development projects, and (4) ensuring clients' futures through long-term savings and insurance related to retirement (Intesa Sanpaolo, 2018c).

Digital platforms represent the core technologies to successfully manage such relationships, simultaneously supporting the workforce's need to know more about the client while preserving the secrecy of clients' information and supporting the seamless delivery of a wide range of services.

Innovation competencies are gained through the Intesa Sanpaolo Group Innovation Centre, established in 2014. One part of the Innovation Centre continues to focus on core banking. Here, DigiCal and Adoption of the Group Distribution Model (AGDM) are core concepts supporting customer-centric digitalisation and a multi-channel approach. Another part of the Innovation Centre pursues a *"blue ocean"* approach, a disruptive type of innovation which includes Fintech start-ups, the circular economy, and many partnerships.

Core banking innovation continues in Intesa under a new name, Chief IT Digital and Innovation Governance Area (CITDIO). CITDIO is Intesa's innovation centre that was reorganized and renamed in 2018 to support the digital transformation of Intesa Sanpaolo Group. The structure of CITDIO covers three areas. The Transformation Centre deals with architecture and digitalisation issues, Digital Business Partners connect the ICT department with Business and Governance Functions, while the Innovation Department focuses on internal innovation. To support a common vision and high transparency, IT, Operations, Data Office, and Cyber Security functions were also created. To provide a smoother transfer of ideas, dedicated experts from the Group cycle from one bank to another to ensure implementation quality and efficient collection of new ideas.

2.2 Drivers of innovation strategy

Intesa Sanpaolo's innovation strategy is determined by several external factors, that influence the industry and market dynamics, including customer preferences and expectations.

Disruptive business models. Currently, digital banks are rapidly gaining a substantial market share and recognition, and present serious competition to traditional banks. Due to the ease of opening an account, little to no fees, and full online service, many customers are switching from traditional banks to experience an enhanced, digital banking service. Clients are able to open accounts online and their card is delivered by post. Some of the online banks such as N26 and Revolut offer the possibility of making payments in various currencies and little to no fees for online transactions or money withdrawal at an ATM (Say, 2019). This substantially increases the cost efficiency of the new competitors[1].

Change of customer preferences due to the digitalisation. With such rapid technological development, users have access to more sources of information and are now able to perform any transaction in a matter of minutes using only their mobile devices. Online banking is enabling clients to access their bank accounts online, perform any payment transaction online without coming to the physical branch, and even take loans (Meola, 2019). Due to the increasing customer preference to interact with banks only through digital channels, the number of branches across the EU fell by five percent during 2017, mostly in Germany, Italy, Hungary, and Austria (EBF, 2018). Moreover, more than half of EU citizens (51 percent) were using internet banking. With such a change on the demand side, the supply side has to adapt.

Regulatory environment. After the financial crisis of 2008, the European banking system underwent a number of changes to regulate banking processes, resulting in the creation of the European Banking Union with the Single Supervisory Mechanism (SSM). The European Central Bank has sole licensing authority to supervise banks of the 19 member states of the European Union and administrate monetary policy throughout the Eurozone. The Single Reso-

1 An interesting case is made by new market players, neobanks, that only operate digitally and are using innovative technologies to provide solutions to customer needs. N26 and Revolut are currently leaders in this segment. N26 claims to have 3.5 million customers (Dillet, 2019), while Revolut says it has six million customers and claims that an average of 12,000 current accounts are opened every day (Smith, 2019). Revolut is a banking app, i.e. electronic money institution, which means that an individuals' money is being stored at one of the UK-based banks. Individuals' money is protected under the FSCS regulations for up to 100,000 euros. N26 has a banking license and is regulated by the European Central Bank. Individuals' money is protected by the European Deposit and guarantees up to 100,000 euros (Irish Examiner, 2019). The main benefit of such neobanks and in particular Revolut and N26 is that no fees are applied to transactions, and customers are able to open an account online in a few minutes without having to come to the branch (Say, 2019).

lution Mechanism (SRM) is one of the pillars of the EU Banking Union and is applied to banks that are covered by the Single Supervisory Mechanism. Under these terms, the European Central Bank (ECB) regulates the work of banks operating in the European Union to maintain stability and the euro's purchasing power. These regulatory trends result in the convergence and consolidation of the European banking industry and have encouraged banking groups to adapt their business models accordingly. This has been done by centralising regulatory and external compliance-related competencies to effectively align with the new regulatory framework and keep costs under control (European Commission, 2019).

Banks are encouraged to innovate and collaborate with digital companies to provide better customer service. According to Capgemini (2018), the EU's Revised Payment Services Directive (PSD2) requires banks to provide Account Information Service Providers (AISPs) access to bank account information and to allow Payment Initiation Service Providers (PISPs) to initiate payment transactions. By doing so, PSD2 removes monopolies from the banking industry. Moreover, access to the customer account information allows monitoring that could detect issues and create solutions on a top of the existing bank infrastructure.

Competition. The relative competitive position of Intesa Sanpaolo in the local market and its corporate strategy determines the implementation of the innovation strategy in that market. Today, Intesa Sanpaolo Bank is a challenger in Slovenia with a market share of less than six percent, while the market leader (incumbent) is NLB (NLB, 2018) with a market share of 23.5 percent. Nova Kreditna Banka Maribor has a strong position in the market with a share of 10.97 percent, along with ABANKA (8.2 percent), SKB (6.8 percent), and Unicredit (5.7 percent) (TheBanks.eu, 2018).

2.3 Innovation partnerships and social engagements in Intesa Sanpaolo

Innovation is made possible through numerous *partnerships* and social engagements, recognising that innovation is a social phenomenon. An example would be Intesa's strategic partnership with "The Floor", a technology platform that is sourcing and developing technologies for banks with the main goal of enabling the development of innovations in the banking industry (The Floor Hub, n.d). The aim of such a partnership is to accelerate the scale-up of

Italian companies in Asia, enable knowledge sharing, and provide Italian bank management relevant training programs to ensure that cultural differences are taken into account and are not preventing efficient market communication (Intesa Sanpaolo, 2019e).

Another example is the partnership of two Turin-based foundations, Compagnia di San Paolo and Fondazione CRT, with the Intesa Sanpaolo Innovation Center. The aim of this partnership is to enable knowledge sharing to create new opportunities for Italian and non-Italian entrepreneurs (Finextra, 2019). Furthermore, Intesa Sanpaolo is one of the leading actors in the transition toward the circular economy as an active member of the Ellen MacArthur Foundation and a lead contributor to the Italian roadmap toward the circular economy (Ellen MacArthur Foundation, 2019).

2.4 Distributing benefits of innovation across the Group

Traditionally, the main testing market for the Group's innovative solutions is in Italy. Other markets are used to test new solutions, depending on their level of sophistication and type of innovation tested; or, as in the case of the International banking division, deciding whether a company is in an incumbent or challenger position in a specific market is tested. If the market share of the bank in one particular market is more than ten percent, then the bank is an *incumbent*. The Group's innovation competencies are used to successfully defend their current market share by offering superior services over their competitors', while at the same time cutting costs and operating more efficiently. If a bank's market share is less than ten percent, than bank is a *challenger*, and innovation is needed to reach out to new customers (De Magalhaes and Hirvonen, 2019). Innovation is thus not implemented only from the top-down, but in a collaborative way through service hubs, where large incumbents lead the process and undertake some coordinative tasks that are delegated by the headquarters. Since every bank formally responds to headquarters, every hub participant can contribute to the exchange of best practices, creating a separate layer of innovation governance.

How Intesa Sanpaolo implements its innovation strategy in the International banking division depends on their market position. The market position is defined by the target market segment, or the bank's market share; but the market position depends also on external market drivers that Intesa Sanpaolo cannot influence, such as changing customer needs and expectations regarding services. For example,

ongoing investment in the Slovenian market associated with the implementation of Intesa Sanpaolo Bank's new business strategy is adapted to the level of a customer's sophistication. Slovenia is considered to have a technologically advanced consumer market, ranked 30th by the Global Innovation Index in 2018 (WIPO, 2019).

3 Innovation delivery: the case of retail in Intesa Sanpaolo Bank

3.1 Customer-centric model

Due to the digitalisation, customers changed their priorities and set of expectations towards the bank services. In the modern era, customers would often rather engage in online transactions than visit a bank branch. That is why financial institutions need to change their primary focus to what their new customer actually needs and what type of services they would like to use (Srinivas and Wadhvani, 2018). The standard for online experiences has been set high by "Earth's most customer-centric company", Amazon (Coleman, 2018). The main idea behind the customer-centric approach is that any touchpoint with the customer throughout their journey is simplified and fashioned in a consumer-oriented way. The focus is on creating a long-term relationship with the customer and to build loyalty and trust.

CRM (customer relationship management) is a crucial element of the customer-centric model, which enables banks to track what propositions their customers are interested in and what was refused, so that offers will be personalized and customers will be given only relevant offers. Such techniques eliminate information that is not interesting to the individual and thus increase the possibility that a customer would decide to take an offer about which he/she previously had doubts. CRM also enables bank managers to track what transactions were performed by the customer and, in case of any issues such as a transaction failure, they are able to immediately assist the customer with a relevant solution (Intesa Sanpaolo, 2018c).

In terms of competition, Intesa Sanpaolo is not the only bank that is implementing a customer-centric approach, as having this focus is now considered a crucial element that customers expect from banks automatically. For Intesa Sanpaolo, the customer-centric model is oriented toward creating long-term relationships by gaining trust and offering a relevant value proposition. As we

mentioned earlier, Revolut and N26 are also using customer-centric models to define how to improve the customer journey.

Two autonomous customer-centric projects with common features are DigiCal and AGDM, run by ISBD (International Subsidiaries Bank Division) (Intesa Sanpaolo,2018c). The main focus of these projects is to create cohesion between all bank services, track feedback provided by the user, and build a long-term, trustworthy relationship with their customers.

3.2 DigiCal

DigiCal is a project that uses innovative digital technologies to create solutions to customer needs. The name "DigiCal" stands for digital and physical, implying that all routine activities can be performed through digital channels, while physical branches build relationships and offer support, such as education on the use of their online platform (Intesa Sanpaolo, 2018c).

Though the strategy of Intesa Sanpaolo depends on their market share in a particular country (incumbent or challenger), the DigiCal program allows the bank to target markets in any condition. If Intesa Sanpaolo is an incumbent in the market, the DigiCal program is expected to help them improve the service level, be efficient in terms of operating costs, and focus on further innovation development and increasing their market share. If the bank is a challenger in the market or the number of branches is limited, Intesa Sanpaolo can implement a fully digital experience, which means the bank will operate as an online bank without a physical presence and cut operation costs, leverage technologies, and gain market share more rapidly (W.UP, 2019). Moreover, with the help of DigiCal, Intesa Sanpaolo can reach customers who are located in peripheral and rural areas and do not have consistent access to a branch (Intesa Sanpaolo, 2018c).

The concept of operating synergistically between the physical and digital space is not new. Many companies have their physical space and still offer services online to increase market share by appropriately serving different customer groups. This concept is also called "Phygital", and it is focused on creating a connection between online and offline worlds to create a closer, more efficient customer experience. Despite the differences between the retail industry (Phygital) and the conservative banking industry (DigiCal), customers are generally looking for connected experiences with a focus on the simplification of processes and the strengthening of relationships (Machuca, 2019).

3.3 Adopting Group Distribution Model

To be the best in digital innovation, having the perfect mix of products and services is still not adequate. To stay competitive and reach the goals of their business plan in 2018-2021, Intesa also introduced the Adopting Group Distribution Model (AGDM). To date, this project is ongoing in larger branches such as Banca Intesa Beograd (Serbia), CIB Bank (Hungary), Privredna Banka Zagreb-PBZ (Croatia), VUB Banka (Slovakia), and Intesa Sanpaolo Bank (Slovenia). The goal of this model is for customers in each Intesa Sanpaolo branch across the world to feel they are at home. To upgrade the consumer experience, improving customers' touchpoint interactions is a must. This is why AGDM already introduced a new generation of ATMs and Money Transmitter Acts (Intesa Sanpaolo, 2019b). These machines remain some of the most crucial customer touchpoints and will be present also in the future, because Intesa Sanpaolo's DigiCal project demands that the physical and digital worlds both stay relevant.

Conclusion

Intesa Sanpaolo is one of the leading banking groups in the field of innovation. Innovation enables them to offer a fast and painless customer journey to create a unique customer experience and maintain trust with their clients. In this way, they remain their client's first choice and are able to compete with emerging digital banks in the disruptive landscape of the banking industry. Intesa created its own innovation centre to accumulate innovation competencies and ensure that best practices are being spread through the entire Group, notably in the International banking division with the help of two hubs created around the Slovakian and Croatian incumbent banks. Collaboration is ensured, the specifics of each market can be considered, and adaptations based on the bank's position (incumbent or challenger) can be made. To create an omnichannel approach and connect each market with digital banking, projects DigiCal and AGDM were recently established. Innovative tools developed by those projects have allowed Intesa to create a unique consumer experience, build an emotional connection with clients, and overcome threats of digital banks and platform companies to become the number one bank in Europe.

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Andreja Cirman, Nika Marija Kavšek, Karmen Krvina, Raya Mammadova

INNOVATION AND BUSINESS TRANSFORMATION IN PHILIP MORRIS INTERNATIONAL

Introduction

Philip Morris International (PMI), a leading tobacco company, was facing a fast-changing and highly regulated environment in the early 21st century. In order to stay ahead of the competition and prepare the company for forthcoming disruptions, PMI needed to innovate; however, their business model was mainly driven by cost optimization and cost efficiency objectives, which strongly impacted their year-to-year potential to innovate as well as develop skills in innovation (Qmarkets, 2015). In order to increase innovations they needed to redesign their business model to bring forth innovation as the key driver of corporate goals (Qmarkets, 2015). Through the introduction of more mission-oriented innovation policies they were able to move from a B2B to a more consumer-centric business model.

The purpose of this chapter is to showcase how an existing and already successful company had to, due to more health-concerned consumers and stricter government regulations, engage in business model innovation by redesigning their existing business model.

The paper is comprised of two parts. PMI's history and the steps the company needed to take to become a leading tobacco company outside the traditional cigarette market will be discussed first. The second section discusses the innovation aspect at PMI by looking at innovation organization and culture, and innovation life-cycle management. The paper will be concluded with a short discussion about further challenges that the company will have to face.

1 About PMI

1.1 PMI history and key facts

The company's history began in 1847 as a London shop selling tobacco and ready-made cigarettes. "Philip Morris & Company and Grunebaum Ltd." was established in 1881 by Philip Morris' son, Leopard Morris, and Joseph Grunebaum and renamed to "Philip Morris & Co. Ltd." in 1885 (PMI, 2019c). In March of 2008, due to constraints of U.S. corporate ownership and their legislative restrictions, PMI split from Philip Morris U.S. With this split, PMI gained more freedom and the ability to pursue their new goal: to design a smoke-free future.

In 2009 PMI introduced their new R&D department in Switzerland and took a step-by-step approach to develop a revolutionary product that reduces the risk of harm caused to smokers (PMI, 2018a). Through the development of the reduce-risk tobacco products, they were able to offer a new and less detrimental option to smokers who are not willing to give up their smoking. With the release of IQOS, an electronic device that heats specially designed tobacco units just enough to release a flavourful nicotine-containing tobacco vapor without actually burning the tobacco, PMI completely transformed their business (PMI, 2019d).

Although PMI went through many changes in its history, they remain one of the world's leading tobacco and cigarette producing companies. In 2018, PMI employed around 77,000 people across the world and generated USD 79.82 billion in revenue. In last decade, the company spent more than USD 6 billion on R&D and 90 percent of budget was allocated to smoke-free products. They have more than 400 people employed in R&D in facilities in Switzerland and Singapore. Currently, they have a portfolio of over 4,600 granted patents, making them the only tobacco company among European Patent Office's top 45 patent filers (PMI, 2018b).

They are present in more than 180 markets and in many of those they have the largest market share. Their most recognizable cigarette brand is Marlboro, which is the number one cigarette brand on the market since 1972 (PMI, 2019d).

Even though PMI revenue is still mainly generated by cigarettes, as seen in the Table 1, the net revenues of smoke-free products are increasing from 2015 onwards. In fact, they have grown by 77.5 percent CAGR from 2015 to 2018 (PMI, 2018a).

Table 1. Overview of important KPIs

	2016	2017	2018
Net revenue (in millions of dollars)	26,685	28,748	29,625
Net revenue (smoke-free/total, in percentage)	2.7	12.7	13.8
R&D expenditure (in millions of dollars), in net revenue* (in percentage)	450 (1.7)	450 (1.6)	383 (1.3)
R&D expenditure (smoke-free/total, in percentage)	72	74	92
Patents generated relating to smoke-free products (cumulative)	1,800	2,900	4,600
Number of production facilities	48	46	44
Number of factories producing smoke-free products	2	3	7

Note: *The share of R&D expenditure in net revenues for years 2016 and 2017 were calculated proportionally based on the total amount spend from year 2008 up to year 2017, which was 4.5 billion dollars, found in Sustainability Report 2017.

Source: PMI, 2018a; PMI, 2018b, PMI, 2017.

In 2014, PMI developed a new and revolutionary product called IQOS, their first heat-not-burn platform. They launched it in two test markets, Japan and Italy. Now IQOS is present in 44 different countries and is one out of four of their smoke-free products. In their portfolio, they have two types of heated tobacco products (including IQOS) and two different nicotine-containing e-vapor products (PMI Science, 2018a). A brief overview of the four platforms can be found in the Table 2.

Table 2. The four IQOS platforms

	Platform1	Platform 2	Platform 3	Platform 4
Technology	Heated Tobacco Product Also referred to as EHTP or THS	Heated Tobacco Product Also referred to as CHTP	E-Vapor	E-Vapor
Nicotine Source	Tobacco	Tobacco	Nicotine Salt	E-liquid
Heat Source & Battery	Electronically controlled ceramic heat-blade Li-ion	Charcoal None	Electronically controlled heater Li-ion	Electronically controlled MESH heater Li-ion
Commercialization	Yes	Yes	No	Yes

Source: PMI Science, 2019b.

1.2 The Corporate Strategy, Vision and Mission

PMI created its corporate strategy, vision, and mission in a way that carefully addresses seven megatrends that PMI believes to be relevant to their sustainable development. They are based on the UN Sustainable Development Goals (SDGs) and include Good Health and Well-being, Decent Work and Economic Growth, Responsible Consumption and Production, Climate Action, Life below Water, and Life on Land. According to PMI (2018b), these are the core SDGs that they plan to make a reality by successfully exercising their business strategy. It is important to note that these megatrends stimulate as well as place boundaries for innovation in the company.

With these megatrends, PMI tries to tackle one of the main concerns of the modern tobacco consumer – health. 52 percent of smokers developed a regular smoking habit before they turned 18, and 81 percent of them started with boxed cigarettes. In this phase of growing up, young people often neglect the negative effects their actions have on their health (European Commission, 2018). In Table 3, megatrends are briefly described before proceeding to the discussion of the strategy itself.

At this stage, despite all the information young people have, smoking is often still viewed as a cool or rebellious act. But by the time one is middle-aged or at a point where health has become a higher priority, 54 percent of smokers at least tried to quit smoking (European Commission, 2018). Many smokers are aware of the disadvantages of smoking and are not willing to quit or are not successful in their attempt, so they are looking for alternatives with a reduced negative health impact. This is where PMI plays a vital role.

PMI's vision reflects how the company addresses the aforementioned megatrends: *"40 million adult smokers who would have otherwise continued to smoke will have switched to smoke-free products by 2025."* Their vision statement reflects how the company addresses megatrends linked to consumer expectations, sustainability, and technological progress (PMI, 2019b).

When it comes to their mission, PMI's statement is as follows: *"Our ambition is to convince all current adult smokers that intend to continue smoking to switch to smoke-free products as soon as possible."* Moreover, as current CEO of PMI, Andre Calantzopoulos stated on an Annual Shareholder Meeting in 2017 that PMI had set a new course for the company and is leading an effort to ensure that less damaging products replace cigarettes to the

benefit of adult smokers, society, the PMI company, and their shareholders. The company's efforts in this direction are supported by science and steadfast organizational and resource commitment (PMI, 2019b).

Table 3. Mega trends and PMI's strategic response to them

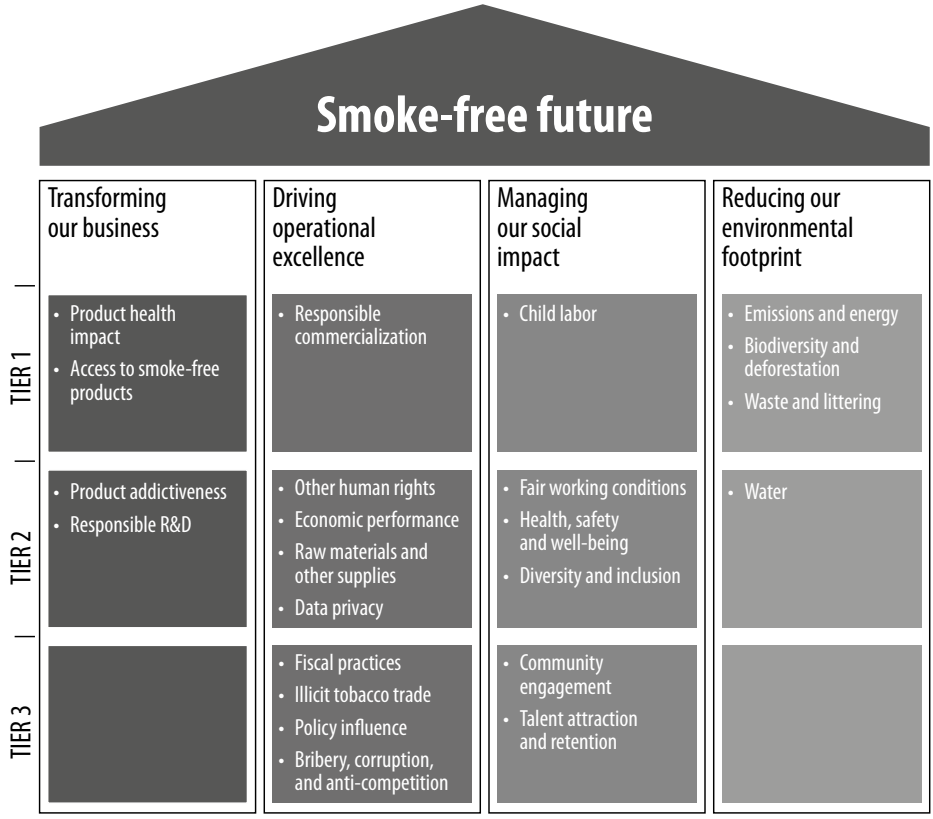
Mega trend	Brief description of megatrend	Strategic response
Changing consumer expectations	Consumers' preferences and behaviours are evolving, requiring companies to constantly adapt their products and commercialization mechanisms.	Changing their business model from B2B to B2C by introducing smoke-free alternatives.
Demographic change	Companies need to adapt to significant migrant flows and aging populations. While each has a huge impact on society and its values, they are also changing society's habits and affect the workforce.	Striving to achieve gender balance and ensuring equal pay.
Inequality	Income inequality threatens social cohesion and economic growth. Since smoking is more popular among people with lower income, it presents a health inequality.	Making smoke-free products more accessible and affordable.
Climate change	Modern society is alarmed about climate change and governments are establishing various regulatory mechanisms. to lower emissions and improve energy efficiency.	Promoting waste reduction and decreasing littering by designing products that can be recyclable or reused.
Sustainability	With responsible and transparent operations, businesses become sustainable as well as gain long-term value and foster their longevity.	Development of the four pillars of business strategy that aim to make PMI a sustainable company taking part in the circular economy.
Technological progress	Rapid development of new technologies is enhancing productivity and opening up new opportunities for interactions with customers. At the same time, it represents risks in relation to new employment patterns, data privacy, brand safety and human rights.	Opening two R&D research centres that follow pharmaceutical industry standards.
Erosion of trust	People have lost faith in traditional institutions because of overwhelming amounts of available information. Corporations have to pick the right information and distribute it through channels that people trust and perceive to be transparent.	Focusing on transparency by sharing their research on specific web platforms and engaging external scientists in a dialogue.

Furthermore, to outline and support their intentions drawn in the vision and mission, PMI developed a business strategy for creating a smoke-free future consisting of four pillars: transforming their business, driving operational excellence, managing the social impact, and reducing the environmental footprint. Each pillar consists of three levels based on the importance and ambition of the goal (PMI, 2018b). All four pillars and levels are illustrated in detail in Figure 1.

The first pillar, transforming their business, is one that reflects the innovation activity of PMI most vividly. It is focused on shifting the organization's core business model from business-to-business to a consumer-centric model.

PMI has changed their former distribution model. Previously, every gas station or kiosk was able to sell cigarettes, but now only professionally trained salespeople and stores have the right to distribute IQOS. Furthermore, the IQOS product presented the challenge of dealing with warranties. As such, the company needed to ensure proper training for the distributors and build trust among their customers.

Figure 1. Four pillars of business strategy



Source: PMI, 2018b.

It is not surprising that part of the new business model is a focus on transparency and responsible R&D, and by emphasizing those two aspects, PMI has tapped into open innovation universe that leverages their R&D. In 2018, PMI introduced new scientific platforms and opened its research studies to be re-examined by other scientists. On platforms SBV Improver and Intervals, their

scientists are posting completed and preliminary research studies and encouraging other scientists around the world to verify the quality of PMI's system of biology methods and processes (PMI, 2018b). Furthermore, in the past year, the company has made a substantial investment in converting existing cigarette factories into production facilities for smoke-free products in order to accommodate the expansion of product distribution to more countries (PMI, 2018b).

In the remaining three pillars, the connection to innovation gets weaker as the elements included there only indirectly impact the innovation process at PMI. To illustrate, the third pillar, managing their social impact, focuses on diversity and inclusion, which are key elements in fostering innovation as they create a diverse and collaborative environment. PMI also strives to achieve gender balance and ensure equal pay (PMI, 2018b). In March of 2019, they received the Global EQUAL-SALARY certification (PMI, 2019c).

Within these four pillars PMI has embedded their seven core strategies, which are closely tied with the megatrends described in Table 3. The first strategy, called "smoke-free", highlights one of the goals of PMI to develop, market, and sell smoke-free alternatives in order to make adult smokers all over the world switch to those alternatives as soon as possible. This strategy addresses "Changing Consumer Expectations" and "Technological Progress" megatrends described before in Table 3. "Regulation" reflects PMI's plans to propose regulatory policies that encourage the replacement of cigarettes by smoke-free alternatives. In doing so, PMI is trying to reduce the "Erosion of Trust" present in today's society. "Talent" emphasizes PMI's strive to become the employer of choice for their global workforce and their tireless effort to attract the best talent. This reflects PMI's attempt to address the "Demographic Change" megatrend. The strategy for "growth" is about PMI's desire to provide superior returns for their shareholders, which can be achieved by successfully addressing all megatrends. The "Transition" strategy outlines PMI's aim to transition their resources from cigarettes to smoke-free alternatives and tackles the "Changing Consumer Expectations" issue as well as the "Inequality" challenge in society. "Sustainability" focuses on driving world-class sustainability programs across PMI's entire value chain, addressing the megatrends aimed at "Sustainability" and "Climate Change". The last core strategy is about "transparency", which aims to share the company's progress, invite dialogue, and conduct independent verification (PMI, 2019a). All of these strategies work together to address the "Erosion of Trust" megatrend.

3 Innovation at Philip Morris International

3.1 Innovation organization and culture

The PMI organizational culture is designed to foster innovation and creativity. The company is organized in a non-hierarchical structure. Each business function has a top manager who oversees projects. These projects are assigned to diverse teams from various fields and a different team leader or project manager is chosen for each project depending on the challenge it presents. Additionally, the open space style offices are designed to optimize collaboration beyond the immediate team members to deliver value for the business, and challenge the behaviours that could create silos (Jovanovska, 2019). Furthermore, PMI has stirring committees that approve the innovation projects by taking into account the needs of every stakeholder (scientists, marketing, finance, consumer etc.) (Emmett, 2019).

As such, PMI is creating a collaborative environment where innovation can flourish because of five factors: Associations, Speed, Connections, Energy, and Implementation. An open workspace like PMI's gets more people involved in the innovation process and can pool a larger number of ideas (associations) from different perspectives. Furthermore, it speeds up creative production, which is a chain of connected ideas, that results in something innovative. Additionally, collaboration can help build important connections that will push the idea forward (Dance, 2008). Steerring committees at PMI can be seen as one of the tools for building connections through collaboration. Moreover, they can help overcome resistances to change, which is always included in the process of innovation, as the committees can set the right tone and smooth transitions through collaboration with different stakeholders. Finally, collaboration helps ideas reach implementation. Despite cooperation being the key to innovation, convergent thinking might hinder it. Hence, corporations need to incorporate diversity into their environment (Dance, 2008). Diversity is one of the main drivers of innovation. When it is present in the workspace, it creates an environment in which employees feel welcome, accepted, and, most importantly, respected and appreciated (Powers, 2018).

PMI strives to incorporate diversity in their environment by attempting to achieve gender balance and ensure equal pay. By putting in place practices that remove potential gender bias from the recruitment process, PMI was able

to improve their gender balance in management roles by 6 percentage points since 2014 (PMI, 2018b).

Even though diversity is critical when creating an innovative environment, companies should do their best to combine diversity with equality and collaboration, since it will only help to maximize innovation. If all people are treated equally and they feel valued for their differences, they are empowered to contribute even more by sharing their point of view and participating in problem-solving (Powers, 2018). PMI understands this is necessary for equality, diversity, and collaboration. "We think about diversity very broadly at PMI, including gender, gender identity, ethnicity, nationality, age, sexual orientation, religious background, physical ability, education, technical skills, life experiences, and more. "Inclusion is the behavior that welcomes and embraces diversity so that each person can bring the full range of their background, experience, and perspective to work with them – and share that diversity with peers and in the work, they do every day." PMI (2018b).

PMI created this type of environment by striving to become the employer of choice for a global workforce. In March of 2019, PMI received the Global EQUAL-SALARY certification, proving that they understand the importance of equality in innovation (PMI, 2019c).

3.2 Innovation life-cycle management

PMI's transformation required an efficient approach to innovation governance as the company was previously focused on cost optimization and effectiveness. FastForward ecosystem was introduced at PMI to trigger a deep and sustainable mindset shift in the corporate way of thinking and working, moving from a usual business/brand-centric approach to a customer-centric approach. FastForward (FFWD) is today embedded into several major corporate programs including corporate innovation framework and model, by combining Design Thinking, Lean Startup, and Agile principles or/and methodologies in one integrated framework (Lean Ventures International, 2018; Qmarkets Webcast, 2015). FastForward ecosystem has four main pillars:

1. *Framework and Principles:* Through a Double Infinite made up of three distinct moments, Empathize, Explore, and Execute, FFWD continuously brings teams to a point where they have to systemically de-risk their project and validate that they are doing the right thing before doing the thing

right. Additionally, FFWD Framework equips project teams with tools and a canvas to know better customer and needs, to identify solutions addressing their needs, and to de-risk those solutions through an approach of rapid iteration and experimentation;

2. *Education:* Provide employees with different learning offers to develop their knowledge, skills, and attitude to work in a customer-centric way;
3. *Services:* Offer a series of various internal consulting services to markets and central functions to support them on strategic projects and initiatives;
4. *Communities:* Communities of diverse and passionate employees contribute to the sustainability of FFWD ecosystem across regions, markets, and functions (Ducret, 2019).

Within FFWD, the NOVA framework provides employees with opportunities to share through a central web platform their possible ideas in response to corporate challenges while helping them establish their thinking through a methodology called CO-STAR. Furthermore, NOVA framework supports them in the development of their pitch required by the several FFWD Growth Boards, organized monthly in markets and central functions (Ducret, 2019). FFWD is the most crucial aspect of the innovation governance at PMI as it encourages employees to develop their ideas and help foster the ideas of others. It creates a highly collaborative environment, which is perfect for innovation.

The FFWD approach played an essential role in the business transformation of PMI as it nurtured the idea of smoke-free products and cultivated the new mission and vision of PMI. However, to truly transform their business, PMI had to take a step forward from idea creation to the actual development and distribution of their first smoke-free products. As such, PMI developed a five-step approach in product management that covers initial development, assessment, perception, and impacts over the life span of their smoke-free products (PMI, 2018b).

Step one is the product design and aerosol chemistry that focuses on designing products that lead to an overall and significant reduction in harmful and potentially harmful constituents in the aerosol, in comparison with cigarette smoke (PMI Science, 2019). The second step, the toxicological assessment, focuses on measuring the reduction in toxicity and risk of PMI smoke-free products by using laboratory models. If results show that the toxicity and risk levels are reduced significantly, the research moves to clinical studies (PMI Science, 2019). The clinical assessment tries to understand whether switching to smoke-free products reduces the exposure of adult smokers to harmful

compounds (PMI Science, 2019). These three steps support the business model by making sure that the customer is always at the center of PMI research and development. Innovation is at the core of these steps, as each requires an out-of-the-box approach in order to provide new and less harmful ways of smoking to customers who decide to continue smoking in the future.

The last two steps are perception and behavior assessment and long-term assessment. Through extensive studies, PMI tries to understand a smoke-free product's potential to benefit public health. They need to understand how different groups of people perceive the risk profile of a given smoke-free product and the likelihood they will switch to smoke-free products from cigarettes. Additionally, PMI puts significant effort into monitoring and research on the use of their smoke-free products in order to asses the product's contribution to harm reduction. Thus, this helps to establish a higher quality assessment over the long-term (PMI Science, 2019). The last two steps ensure that the business remains customer-centric even after the product has been sold to the consumer. This represents a significant change from their old business model, where everything ended with the sale. Now, PMI tries to sustain customer satisfaction in the long-run and attempts to focus on the well-being of their customers.

Conclusion

Throughout this chapter, we have witnessed how a company with an existing successful business model had to resort to innovative solutions to cater to changing regulatory environment and needs and demands of a modern customer. It is important to note that innovation within PMI does not just stop at the product level, but rather focuses on a "customer journey" as well as on maintaining an innovation-friendly environment within the company (focus on diversity, teamwork, open space offices etc.), so that the everyone can contribute to the implementation of core strategies established in the company.

It is undeniable that PMI has come a long way through their path to innovation, despite the fact that their R&D expenditures represent only around 1.5 percent of net revenue; however, the challenges that the company continues to face (such as concerns about usage of e-vapor cigarettes and possible health consequences) will constantly push the company's innovation cycle forward to address societal expectations and restrictions directed at their business.

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Tomaž Čater, Bojana Markovska Klepec, Aljuška Bonča, Katja Mencigar, Urban Orehek

DIGITALIZATION AND INNOVATION IN ZAVAROVALNICA TRIGLAV

Introduction

Emerging technologies are transforming the insurance landscape, which is one of the most complex and conservative industries. Start-ups have started to shake up the industry, transforming the business models of otherwise strictly regulated insurance companies. However, while InsurTech start-ups, or start-ups that use insurance technology, are disrupting the industry, legacy insurers have not been idle. High barriers to entry have allowed them to maintain strong market positions, but in order to offer new solutions, they have been adopting and incorporating InsurTech, for example, into their highly regulated businesses. Zavarovalnica Triglav[1] (hereafter ZT) as a legacy insurer acts as a good example of how a traditional company can adapt its strategy and structure to compete in this dynamic environment.

The purpose of this chapter is to analyse innovations and their strategic implications in the insurance industry, and more specifically in ZT, to get a general overview of how the smaller players have evolved compared to industry giants worldwide. The goals of this chapter are (1) to analyse ZT's innovation strategy (2) to examine ZT's innovation life-cycle and innovation-oriented culture, and (3) to discuss the implications of innovation strategy for ZT and other companies. The chapter is built primarily on qualitative research methods and combines the use of secondary (existing documents on innovation in ZT and the insurance industry) and primary (two interviews with relevant middle managers in ZT[2]) data from ZT and the insurance industry.

1 Even though ZT is predominately used, this chapter refers to the innovation management of not only Zavarovalnica Triglav but also the rest of the Triglav Group.

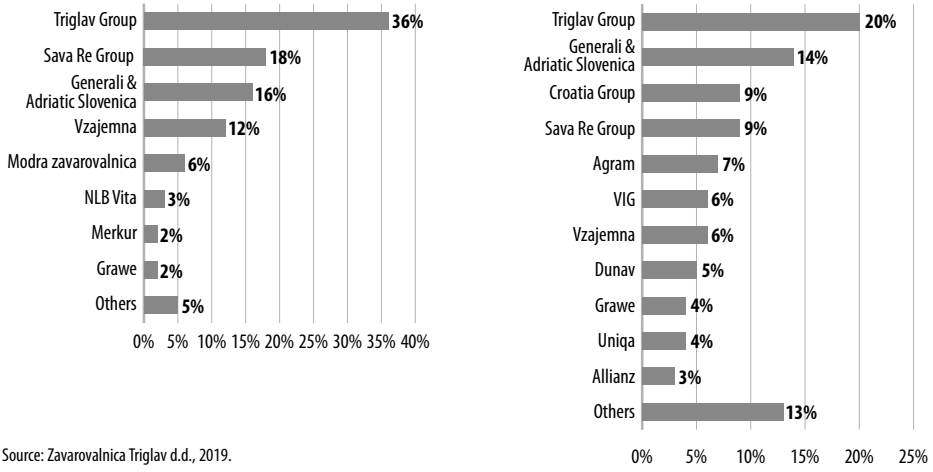
2 The interviews have been conducted with Ms. Metoda Debeljak, HR manager, and Mr. Zoran Miloševič, Chief Innovation and Digital Officer.

The chapter is comprised of five parts. The first part briefly discusses ZT and its history, part two examines major innovations in the insurance industry and ZT, while the following sections focus on innovation strategy in ZT, corporate culture and structure as enablers of innovation strategy implementation, and the process of the innovation life-cycle in ZT respectively.

1 About Zavarovalnica Triglav

ZT evolved from Vzajemna Zavarovalnica in 1900 and has in the past 120 years become one of the most important players in the insurance industry of Southeastern Europe. Triglav Group is the leading insurance/finance group in Slovenia and the Adria region[3].

Figure 1. Triglav market share in Slovenia and Adria regions



Source: Zavarovalnica Triglav d.d., 2019.

The group operates in six countries: Slovenia, Croatia, Serbia, Montenegro, Bosnia and Herzegovina, and North Macedonia and is internationally present through reinsurance. ZT is by far the largest player in Slovenia and the Adria region with 36 percent and 20 percent market shares respectively (Figure 1).

The company's core business encompasses insurance (life, non-life, health, pension, and reinsurance), and asset management (Zavarovalnica Triglav d.d., 2019). The key financial figures of ZT and the Triglav Group are presented in Table 1.

3 The Adria region is comprised of the following countries: Slovenia, Croatia, Bosnia and Hercegovina, Serbia, Montenegro and North Macedonia.

Table 1. Key financial figures in Zavarovalnica Triglav and Triglav Group in 2016-2018

	Zavarovalnica Triglav			Triglav Group		
Key financial figures	2018	2017	2016	2018	2017	2016
Profit before tax (in millions of EUR)	78.5	73.8	83.4	97.5	84.4	95.1
Net profit (in millions of EUR)	65.5	62.5	75.3	80.8	69.7	82.3
Return on equity (in %)	11.6	11.0	13.8	10.8	9.3	11.4
Book value per share (in EUR)	24.64	25.13	24.78	32.75	32.98	32.28
Net earnings per share (in EUR)	2.88	2.75	3.31	3.56	3.07	3.62
Number of employees as of 31 December	2,290	2,285	2,335	5,166	5,151	5,046

Source: Zavarovalnica Triglav d.d., 2019.

2 Recent Innovations in the Insurance Industry and Zavarovalnica Triglav

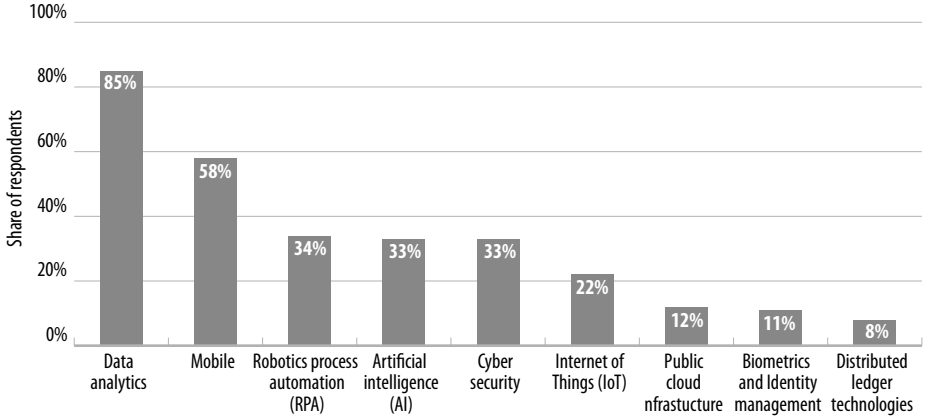
2.1 The impact of technological mega trends on the insurance industry

The insurance industry is known for its traditional and regimented practices. As a complex industry which requires large capital investments and is subjected to rigorous regulations, insurance has remained much the same for decades; however, the emerging trends of digitalization and the sharing economy are expected to disrupt the industry, with many experts holding the opinion that InsurTech is the next big opportunity after FinTech. Key insurance players in the market are thus investing heavily into their technology and innovation departments to ensure their relevance in the modern world (Statista, 2017).

Three main technologies – *Internet of Things (IoT), blockchain,* and *artificial intelligence (AI)* – are transforming the industry by enabling new methods of assessing and controlling risk, preventing fraud, improving efficiency, and improving customer experience through personalization and customization (Statista, 2019). Insurance companies globally have started to invest large portions of their funds into these new technologies, as indicated by the share of insurance investors planning to invest into a

specific technology in 2017 (Statista, 2017; Figure 2). Three mega trends in the insurance industry are: (1) *behavioural policy pricing,* (2) *customer experience and customization*, and (3) *optimization of claims settlements* (Zagorin, 2019).

Figure 2. Share of insurance companies planning to invest in selected innovations in the next 12 months worldwide in 2017



Source: Statista, 2017.

At the core of their business, the majority of successful customer-centric companies increasingly rely on the data collected from their clients to create an enriched customer experience. Insurance companies are moving toward leveraging the rise of IoT to shift their business models from the classical insurance company model of post-accident operations to accident-preventing operations. Companies thus aim to leverage real-time data to provide help to their customers, improving their customer experience as well as generating an additional customer surplus by expanding the need for their services (MacIver, 2016). Furthermore, the data collected from all IoT devices enables companies to prepare different pricing models for different customers based on their behaviour. This is best demonstrated with the use of IoT in car insurance, where safer drivers pay less for their policies. In health insurance, companies provide cheaper coverage for people with healthier lifestyles (Zagorin, 2019). Three sectors where IoT devices are already transforming the industry are wearables, connected cars, and smart homes. IoT devices are on the rise and are expected to have by far the most significant implications for the insurance business, with the overall global economic impact of IoT estimated to reach 3.9 trillion to 11.1 trillion dollars by 2025 (Statista, 2019).

The blockchain technology trend, alternatively, could revolutionize the insurance value chain by providing a more secure environment with a clear audit trail. The use of blockchain thus lowers operational costs related to transaction processing, increases trust between two parties, or even eliminates the need or concept of trust entirely. For example, smart contracts execute automatically when a certain contractual criterion is met. This is best illustrated in the case of Fizzy, an automated insurance platform for delayed flights launched by AXA in 2017. The platform monitors flight statuses and, in case of a delayed flight, executes the payment to the policyholder automatically. This eliminates the need of the customer to file a claim form and decreases time spent on processing the claim (Brenchley, 2018).

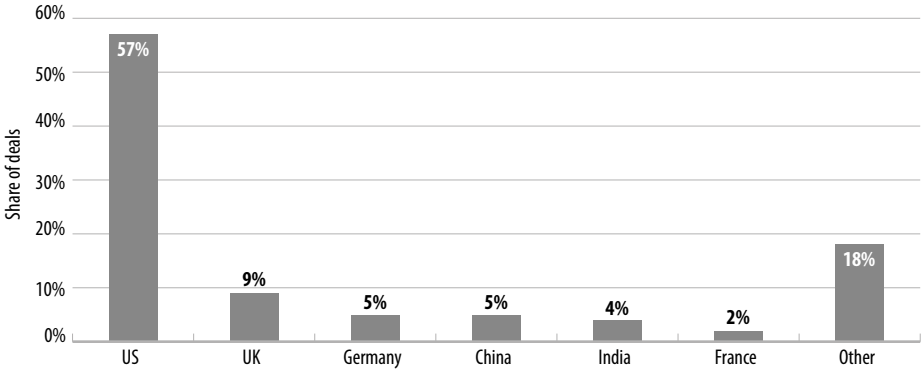
One of the most important emerging technologies is AI, which facilitates the use of IoT and blockchain. The utilization of AI is best witnessed in improved customer experience and personalization. Chatbots are increasingly popular in the verification process, where facial recognition acts as a substitute for other forms of verification. They allow an instantaneous response to the customer while, at the same time, making the identification process more efficient and cost-effective for the company. In addition, AI can be applied in the settlement of claims by speeding up the process immensely and decreasing fraud at the same time (Zagorin, 2019).

2.2 Innovation strategies of major global insurance companies

Insurance companies around the globe realize how emerging technologies are transforming the industry and are thus focusing on their own progress by placing technology at the core of their strategies. Leading legacy insurers are resorting to a wide variety of tactics to keep their competitive advantage. Some companies are setting up their own accelerators and innovation hubs, while most seek help through smart partnerships with start-ups from various industries. *The investment into InsurTech startups has increased from 0.3 billion dollars in 2013 to 2.2 billion dollars in 2017 at a CAGR of 69.2 percent.* While these start-ups are increasingly expanding their market share in the insurance industry, they are seen more as enablers of change and not disruptors per se. One of the main reasons for this is the fact that the industry is complex and has high barriers to entry. Start-ups thus recognize the need for collaboration with large legacy insurers.

While the effects of digitalization on the insurance industry are global, the leading innovators are still by far located in the US (Figure 3). The start-ups which have received the most attention as well as funds in the segment of direct insurance, where insurance policies are offered directly to the customer (thereby *disintermediating the agent*) are: Bima, Clover, Collective health, Metromile, Zhong An, and Oscar. Oscar has received the highest amount of funding raised by any InsurTech company with 1.3 billion dollars. The leading name behind the transformation toward *peer-to-peer insurance*, where customers can form groups and share premiums, is a New York-based start-up called Lemonade. CloverHound, a San Francisco based start-up, has disrupted the market entirely by creating an *insurance marketplace* where the start-up acts only as a distributor of products of many insurance companies and does not do any underwriting of its own (Statista, 2019).

Figure 3. InsurTech deals by geography from Q1 2013 to Q3 2018



Source: Statista, 2019.

The heaviest investors in the industry are insurance companies with their own *corporate venture capital* (CVC) such as Liberty Mutual, Mass Mutual Financial Group, AXA XL Insurance, Aegon, American Family Insurance, and PingAn (Statista, 2019). Two of world's global players, Allianz and Generali, have listed innovation and digital transformation as key pillars of their global long-term strategy. A large part of Allianz's innovation quest is Allianz X, a unit dedicated solely to digital investments in the future. Companies funded by the unit include Lemonade, N26, and C2FO. These companies provide customers with digital solutions to traditional problems. Allianz owns various innovation centres focused on testing and implementing innovative processes, products, and business models by cooperating with digital players, start-ups, and industry

business partners. The innovation centres cover travel, healthcare, smart home solutions, and modern automotive solutions (Allianz, 2019).

Generali's goal is to become a life-long partner of customers, enable a digital transformation of their distribution model, and transform and digitize their operating model through simplification, automation, and artificial intelligence. To achieve this, they have adopted both internal and external sources. Internally, they have structured their processes and methodologies for knowledge sharing among different functions and business units. Externally, they cooperate with start-ups as well as with established technology companies. Some of their innovations are EuropAssistance MyClinic, LINGS, and MyDrive (Generali, 2019).

3 Innovation in Zavarovalnica Triglav

3.1 Innovation strategy and governance

With its mission of building a safer future, the Triglav Group's strategy focuses on the needs of their customers. ZT's core values, responsiveness, simplicity, and reliability form the essence of their strategy. Triglav Group, like its global competitors, holds innovation at the heart of its strategy, which is mainly *driven by the company's customer-centricity.* All the company's innovations thus stem from its desire to tailor their business as closely as possible to the customer's needs. There is a fine line between optimization and innovation, and ZT's innovation always starts off as optimization due to a specific need that eventually, through formal and informal internal processes, catches life and transforms into innovation. Triglav Group is the leader in the Adria region, with its innovation strategy always being customer-oriented and technology-driven.

With several successful innovations in its business in recent years, Triglav Group, together with their strategic partners and several start-ups, introduced novelties that have changed their business conduct. One such novelty is Triglav Lab: a digital centre where customers have access to the whole range of digital insurance-assistance services and can test new technologies and experience different forms of virtual reality, like ski jumping in Planica and rescue operations following a traffic accident or an earthquake. With the new Triglav Lab digital centre in Ljubljana, Zavarovalnica Triglav is being promoted as an in-

novative, digital-centric company, addressing all generations including young people (Zavarovalnica Triglav d.d., 2019).

Combining innovative digital technology and memorable experiences, *ZT follows the major trends by providing more personalized products, more customization options, and flexible behavioural pricing models.* The effectiveness of the behavioural pricing model can be observed in the application *DRAJV*, one of ZT's most successful projects, which has proven to be a useful tool in the retention and attainment of new customers. The application records the driving style of the user and bases the insurance premium on their driving score. The better the user's driving score, the safer the ride, and with that comes a higher discount on their car insurance. The app has also had a positive impact on the driving style of users, as they have realized that the difference in travel time is negligible if they drive by the rules, as opposed to driving quickly and aggressively.

As all activities continue to be consistently client-centric, the Group continually seeks to optimize customer experiences and implement new ways to access ZT's services by developing client-tailored products upgraded with assistance services and advice for users. This can be seen in the *Triglav Health App*, an app that enables users to access all of their health policies and documents in one place. These are just a few examples of the comprehensive insurance service products, asset management services, and other innovative solutions that the Group has to offer. Other ZT innovations include *Remote Advisor, Visual Damage Detection, i.Triglav App,* and *Weather App* (Zavarovalnica Triglav d.d., 2019).

These innovations are led by the board members and managed by the Chief Innovation and Digital Officer, who aims to continually improve existing products with an emphasis on better client-oriented services and the simplification of complex products. With the goal of implementing lean business, cost-effectiveness, and more efficient performance, improvements and innovations were made in subsidiaries at an accelerated pace to unify the best practices at the Group level. Thus, Triglav Group's strategic objectives in process organisation and implementation include a high degree of automation, optimisation and cost-effectiveness of business processes, digitalisation of operations, exploitation of synergies within the Group, efficient use of data (internal and external) to support correct business decisions, developed multi-matrix organisation, and business productivity growth. Key Performance Indicators (KPIs) that are used to determine the successfulness of the innovations involve new customer attainment and retention of existing clients, revenue growth, and consequential profit increases. All activities and effects are systematically assessed in terms

of responsibility and sustainable development (the three-level balance: 3P – people, planet, profit).

To further improve innovation management, ZT is currently in the process of establishing an Innovation Committee that will handle project selection and implementation together with the Department of digitalization and innovation.

In recent years, ZT has collaborated with various young companies and start-ups, demonstrating cooperative and supportive innovation management which benefits both parties involved. ZT thus follows the strategies of global players, as all of the group's applications are developed in cooperation with external InsurTech partners. The DRAJV safe driving simulator and its positive effects on the driving culture of users as well as the impact it has had on retention and attainment of new customers is a positive example of such collaborations with external companies. Although in most cases ZT is approached by start-ups, the group also actively seeks potential external partners in accelerators.

3.2 Innovation-oriented culture and structure in Zavarovalnica Triglav

ZT has approached new transformational challenges in a highly systematic way. In 2011, when the HR department noticed the need for an initiative that would encourage the participation of every employee, a special rule book for identification and further treatment of valuable ideas was created. The new rule book meant that the employees started to actively think about how their processes and practices could be optimized. This proved to be a challenge, since insurance companies are by nature more conservative and people do not usually feel they can think outside of the box. The conservative paradigm began to change with the new rule book, which was aimed at encouraging people to start thinking about what could be done differently and what could be done better.

The project implemented a *systemic approach to gathering and evaluating ideas*. The response from the employees was satisfactory, and each year more and more ideas were presented. Whether or not the specific changes were of strategic importance, the shift in the mindset of the employees was visible and provided a foundation for future innovation.

In addition to a system of gathering good ideas, the HR department is constantly making sure that the *culture is open to innovation* in all aspects. One

of their key strategies for creating an environment that supports innovation is the promotion of cooperation as their core competency. The results of the analysis of their organizational climate show that ZT enjoys a friendly culture where people cooperate more than they compete, while employees have stated that they would not withhold information from others just for the sake of being perceived better in the eyes of their superiors.

There is *no knowledge hiding* in their company, according to the HR department, which is a result of the meticulously structured onboarding process, rotational program, and knowledge platform. Each new employee is given a mentor who organizes a program for the mentee to follow. This program lasts up to six months. That is why the mentee is encouraged to learn as much as possible from her or his field of work, as well as from other positions in the company. A rotational program has also been put in place to improve the cooperation between subsidiaries and the parent company, allowing for the values of the group to be successfully implemented throughout the region.

The HR department sees the company's *knowledge management platform* as crucial to maintain a culture where knowledge hiding has no place. The platform is designed by professionals, updated regularly, and open to every employee.

ZT's culture is set to stimulate innovation. The company distinguishes internal process innovation and improvements from actual product or service innovations. Valuable ideas which are gathered from employees are included in the domain of internal process improvement. The company then holds another *separate unit in its organizational structure responsible solely for innovation management.* The stand-alone unit is comprised of a small number of employees who are responsible for innovations that are introduced to the customer. The fact that the company holds its own stand-alone innovation department indicates that a holistic approach to innovation is an important part of the company's overall business strategy.

3.3 Innovation Life-Cycle in Zavarovalnica Triglav

ZT's management realizes that today's thriving businesses are customer-driven as well as technology-driven. They follow a three-step procedure: the idea management phase, process development phase, and the testing, launch, and continuous improvement stage. The company's innovation life-cycle management is integrated into their everyday business conduct. Having consider-

ably stricter and more formalized procedures would, in the opinion of upper management, prevent or slow down rapid idea development, which plays a substantial role in the field of technological advancements. Currently, there is hardly a distinguishable barrier between innovation management and project management, as the innovation team receives a project and then tries to introduce innovations to it.

Another point of distinction between ZT and global players is the fact that the company does not have fixed budgeting guidelines for different segments of business investments. This is due to the fact that there is no solid division between a project and an investment. In case an idea is recognized as more promising, there is always the possibility for financing, which makes ZT more flexible in terms of their innovation management. On average, *ZT annually examines approximately 10 ideas brought to their attention by external partners, and around 10 to 15 ideas sourced from the internal system*.

ZT's stand-alone innovation units uses various methods with the purpose of identifying promising ideas. The specialized division conducts analyses of consumer trends in various areas regularly, which then serve as guidelines or as a basis for prioritization, evaluation, and idea selection. Additionally, the company has substantial databases used to better understand their customer needs and expectations. In recent years, the company also organized different hackathons and design thinking workshops that yielded several interesting ideas.

Their idea management usually stems from a simple procedure that enables everyone on the team to share their opinions and insights. At this stage, the evaluation of ideas is done in a simple manner, i.e. by focusing on those ideas that add value for the customers. The team focuses their attention on the questions of how many customers require this type of innovation/product enhancement and how much are they prepared to pay for it. In addition to the cost and revenue impact of every single project, the primary criteria used for idea selection are the project's impact on brand awareness, the project's impact on the introduction of new customer channels, ZT's potential of entering new markets, and others.

The innovation team is aware that they are limited in time and resources and not all ideas are worth implementing. Sometimes, in the early stages of idea consideration, it becomes clear that the given project would not be lucrative enough, so they might abandon the idea implementation altogether. Moreover, the strict industry regulations of foreign markets can substantially impact the difficulty of integration, taking some ideas off the table from the get-go.

In the next stage, when an idea has been selected and is now in the process of development, the team transforms the idea into a viable project. This project is later processed by several teams at different stages of product development. Typically, three to five projects are in the process of development at the same time. Projects encounter the majority of obstacles in this transitory stage and teams have to come up with an answer to the questions of how to finish the project without substantial complications, and how to handle multiple projects at different stages of development simultaneously.

The last stage, testing and launching, does not normally bring about significant difficulties. Ideas are tested using methods of field testing and focus groups. Launches of new products are supported by marketing teams which highlight the customer benefits of the newly-introduced offerings.

Conclusion

ZT's case study shows that the company follows the global industry trends and has adapted well to the growing influence of insurance technology. Their apps and services are a testament to the fact that ZT has managed to develop its technological abilities to match that of the global market, while their strategy demonstrates the company's understanding of the need for innovation. The company's aim for the future is to become recognized as innovative, comprehensive, client-centric, and dynamic as an insurance group as well as financial group – a feasible goal given their current status.

ZT's innovation management system is deeply intertwined in everyday processes, but the company has yet to establish a more formal structure as observed in other global market players. ZT's next anticipated steps are, therefore, to make the innovation process more structured and transparent while also retaining enough flexibility to ensure better identification, faster evaluation, and shorter time-to-market of relevant opportunities arising from ZT's strategic innovation management process. Additionally, the company would benefit from following the global trends of innovation management in terms of innovation performance indicators by incorporating them into their daily activity.

What might hinder ZT in the future is their fixation on customer-centricity? While the customer is indubitably important, their imagination is limited. It is thus imperative that ZT focuses even more on the technological aspects of innovation management to follow the lead of the largest insurance players worldwide,

who recognize technology as one of the core strategic imperatives and one of the largest opportunities apart from FinTech. Moreover, the company should continue to actively seek partnerships with InsurTechs, which will enable the company to leverage their technologies. Smart partnerships would enable ZT to develop better methods of risk assessment, controlling, fraud prevention, optimization their processes, and enhanced personalization of service.

Emerging technologies are transforming the insurance landscape worldwide, but the Balkan region lags behind. The big insurance players in the region cannot be assessed as followers of global trends, and their products and services have remained much the same as before InsurTech started to transform the industry. ZT, however, has not stayed idle and has embraced the new challenges and adapted well to the growing role of technology in insurance. It is therefore of no surprise that ZT is the regional leader in insurance innovations, chasing emerging technology trends and carefully transitioning to a digital business model.

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III.

INNOVATION GOVERNANCE AND R&D ACTIVITIES IN BIG COMPANIES IN SLOVENIA

Polona Domadenik, Matjaž Koman, Tjaša Redek, Guillaume Cavallari,
Žiga Matjašec, Luka Pevec

INNOVATION GOVERNANCE IN LARGE SLOVENIAN FIRMS

Introduction

Global competition is intensifying and success increasingly depends on innovation capabilities and openness to change, making innovation one of management's top priorities (Deschamps and Nelson, 2014). Innovation stimulates growth and provides companies with a competitive edge (Andersen et al., 2018), and to succeed in the innovation-driven corporate world, efficient innovation governance is essential. In order to stay competitive, companies must become innovators or become obsolete and be overtaken by competitors, as was the experience of Kodak, once a leader in their field (Ringel et al., 2018).

This chapter presents the characteristics of innovation governance and its impact on innovation performance in Slovenian companies, using data from a survey conducted on large companies. To motivate the discussion, the chapter first provides a theoretical background on the characteristics and importance of innovation governance. This is followed by a description of the methodology and data. Innovation governance characteristics and their impacts on innovation performance in Slovenian firms represent the core part of the chapter, while the conclusion summarizes our main findings.

1 Innovation governance: a conceptual framework

Innovation Governance as a holistic approach to steering, promoting, and sustaining innovation at the firm level and is conceptually defined as a framework for all activities related to innovation (Deschamps, 2009). At the core of

innovation governance are the following questions: how to boost innovation, what approaches to adopt, how to mobilize the organization to strive for innovation objectives, how to foster a climate that supports creativity and discipline, and how to organize processes that help organizations market their innovations. Stimulating, directing, and sustaining innovation cannot be delegated to any single function or lower levels of an organization, rather it has to be the top management's responsibility. Innovation governance starts with a management commitment to promote different types of innovations, i.e. to encourage everyone in the organization to consider opportunities for innovation in every part of the firm and in all its internal and external processes (Deschamps and Nelson, 2014).

In an *innovative organisation*, processes are designed in such a way that they support innovation in all aspects and innovation governance processes are clearly defined. Innovative organisations often have a horizontal organizational structure, which allows them to have a different approach to change-making. Small cross-functional teams with empowered leaders have access to all resources needed to lead a project to success. According to Ringel et al. (2018), 80 percent of Strong Innovators include all relevant functional groups in these team projects. These disruptive changes in the way we do business combined with new technologies have also sparked the need for new business models. In fact, they have become a major threat to traditional ones, due to their design (Andersen et al., 2018).

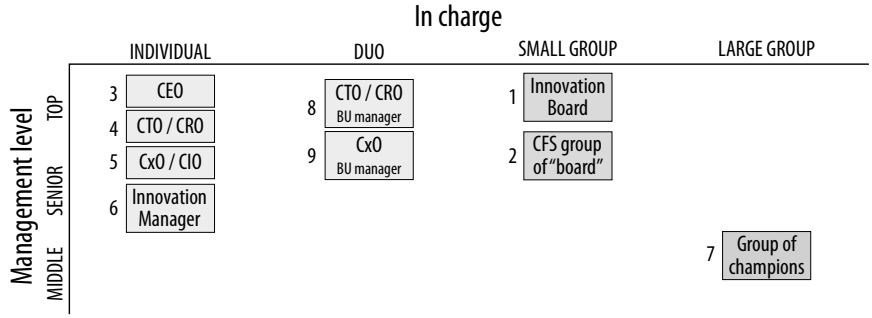
Organising the innovation process entails three basic questions. "Why Innovate?" is a question that relates to the benefits of successful innovations and potential penalties if the innovation is a failure. "Where to Innovate?" addresses the area of innovation. "How much to innovate?" is a question related to financial resources and risk. Models of innovation governance that stimulate and orchestrate all innovation activities in the company differ in four aspects: roles played by different stakeholders in the innovation process (key responsibilities and limitations)[1], existence of goals to monitor the efficiency of the innovation process, solutions for conflict resolution, and benefits the innovation process provides to different stakeholders.

According to a survey on more than 100 of the largest multinational corporations worldwide (Deschamps and Nelson, 2014), we identified nine different

1 The issue deals with defining and allocating specific innovation management responsibilities at all levels and identifying the owners of each step of the innovation process. A decision should be made whether to allocate innovation management responsibilities to a dedicated group of managers, as opposed to current business and functional managers. If dedicated innovation managers are appointed, management will have to define their roles, reporting levels, resources, and degree of empowerment in relation to line organization and other established staff functions (Deschamps and Nelson, 2014).

innovation governance models. The models differ primarily in the size of the group (single, pair, or more) and the authority level of the managers who are accountable for the innovation process (Figure 1).

Figure 1. Different models of innovation governance



Legend: CTO - Chief Technology Officer; CRO - Chief Research Officer; BU - Business Unit; CxO - Chief Experience Officer; CIO - Chief Innovation Officer; CFS - Crossfunctional steering.

Source: Adapted by Deschamps and Nelson, 2014.

In Model 1, the top management team as a group shares the duties of governance, although often members of the board who are directly involved in innovation (business leaders, marketing, and R&D) are more likely to participate. This model is often referred to as the *Innovation Board* model. In Model 2, the CEO or president of a company is accountable for innovation and the message of innovation as a top priority is clearly communicated to others[2]. Model 3 relies on a high-level, cross-functional innovation steering group or board with members selected based on functional responsibilities. The group is usually chaired by the Chief Technology Officer (CTO) or Chief Research Officer (CRO).

In Model 4, usually adopted by technology-intensive companies or companies with strong engineering traditions, the CTO and/or the CRO is accountable for innovation content (promoting technology-based initiatives) but rarely participates in the non-technical aspect of innovation. Models 5 and 6 are quite similar in having one person being accountable for innovation, but in model 6 the responsibility is entrusted to a single, dedicated manager (Chief Innovation Officer) who focuses more on the process than the content side. On the other hand, in Model 5, innovation responsibility is entrusted to a preoccupied member of the management team who also has other operational duties (such as the CTO or CRO).

2 The model of the CEO as the leader of innovation activities within the company can be found in many of the most innovative companies around the globe (e.g. Apple, Amazon, P&G, Toyota).

The next three models more heavily involve people in lower management positions, and innovation governance mostly serves as a supporting governance mechanism. Model 7 is found in companies where innovation governance is supported by a group of innovation champions, who are typically a group of innovation enthusiasts within the company focusing either on specific projects or sharing innovation practices. In Models 8 and 9 innovation governance is typically entrusted to a duo, or a two-person team. One member of the team might be the CTO, who shares innovation responsibility with a business unit manager, a functional manager, or chief experience officer.

The choice of the innovation governance model depends on the size of the company, competitiveness of the industry, innovation ambitions, competencies of the top management team, and many other historical and cultural factors[3]. If the CEO is a visionary-type (e.g. Steve Jobs or Elon Musk), the company's innovation governance model will be evolving as the innovation leader decides. If there are many strong innovation leaders among middle-management, a company usually utilizes Model 7 (a group of innovation champions).

An IMD survey on 113 multinational companies revealed that all nine models are used by companies today, although some of them are used more commonly than others (Deschamps and Nelson, 2014). Almost half of the companies implemented models with significant involvement of the CEO or top management team. 29 percent of companies developed their innovation governance model in line with Model l[4], ffollowed by 16 percent of those who adopted Model 2 (CEO as the innovation leader). The high-level *Cross-functional steering group* as a primary innovation governance model has been applied in 14 percent of companies, followed by 10 percent of companies that applied a *CTO or CRO as the main person accountable for innovation processes* within the company. Slightly fewer companies (9 percent) have a *dedicated Innovation Manager or CIO*, while 6 percent of companies do not have any person assigned to innovation specifically[5]. Only 5 percent of companies applied Model 7 *(group of innovation champions)*, and the remaining 7 percent used either models 8 or 9 *(middle management in different positions)*. The distribution of these different governance models according to the

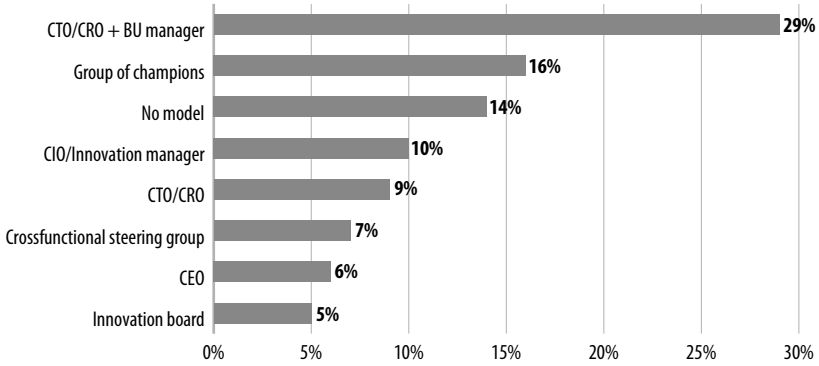
3 Different cultural and historical factors impact the perception of innovation of employees and management in the company, shape the core competencies of employees (a lack of competencies restricts the company from conducting major innovations), and determine how the different functions work together.

4 Sometimes they refer to the top management team or the subset of it also as »innovation board«. Among multinationals that incorporate this model are Coming, Nestle Waters, Lego Systems.

5 According to survey responses, the reason for that is that innovation is embodied in organisation so much that everyone feels responsible and acts to support it (Deschamps and Nelson, 2014).

international survey is presented in Figure 2. In the next section, we present innovation governance models in the largest Slovene companies.

Figure 2. Innovation models in multinational companies (in percent)



Source: Adapted by Deschamps and Nelson, 2014.

2 Methodology and sample description

2.1 Methodology

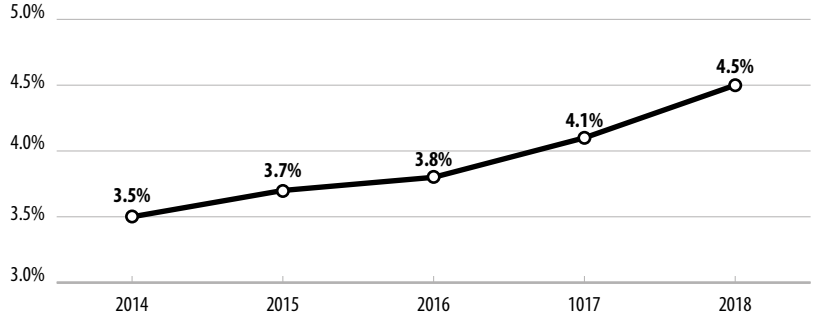
To analyse innovation governance and innovation activity in Slovenia, a survey was launched to the largest Slovenian companies with at least 250 employees. Companies from the financial and insurance sectors and employment agencies were excluded. The survey was conducted through an online survey service 1ka between July and September of 2019. 62 out of the 198 invited companies returned responses that were used in the analysis. The survey comprised 50 questions, covering the following topics:

- Corporate strategy (market presence, strategic activities),
- Innovation activities (type and level of innovation activity, level of novelty, barriers),
- Innovation governance (involvement of corporate boards, organisational structure of innovation units and their role, external cooperation),
- Costs and financing of innovation activities (distribution of costs in the innovation process, innovation budgeting, sources of financing),
- Human resources (issues regarding the labour market).

2.2 Innovation activities in Slovenian companies

The respondents on average generated the majority of their sales revenues on the domestic market (51.1 percent of sales) followed by the EU-15, where they on average generated 28.9 percent of revenues. The remaining 20 percent of revenues were gathered in markets of other EU countries (7.9 percent), other developed economies (3.8 percent), Balkan countries (3.8 percent), and others (4.8 percent).

Figure 3. Average R&D expenses (in percent of revenues)



Source: Own survey, 2019.

The average company in our sample has been increasing their share of revenues invested into R&D[6] over the last 5 years (Figure 3). In 2018, companies invested on average 4.5 percent of revenues into R&D (one percentage point more than 5 years earlier). Moreover, 52 percent of companies expect the budget for R&D will increase, while 45 percent expect the share to stay the same (at 46 percent) in the next two years.

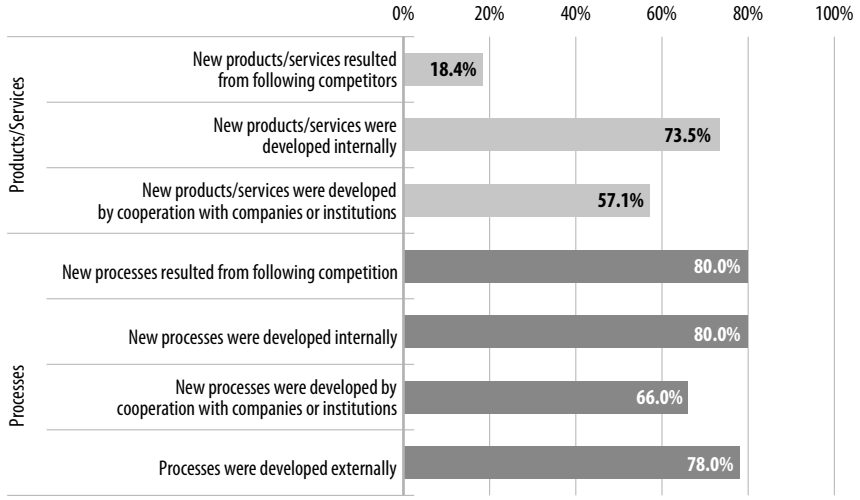
On average, in the last five years, companies developed 24 new products and 20 of them were commercially successful (previously or continue to sell at a profit), representing one-fourth of their sales. 75 percent of companies identified improving or upgrading existing products/services as the most important innovation activity, while slightly less than 20 percent prioritize new products/services on a domestic or global market[7]. Repositioning is "very important" to 13 percent of respondents, while almost one-third of respondents think that "new products/services in the global market" are "not important" or only "a little important", indicating their preference for the domestic market.

6 In our sample all companies except one in period 2014-2018 engaged in some type of innovation activities.

7 In our sample slightly more firms (34.8 percent) marked new products in global market as important, while importance on domestic market is relevant for 28.3 percent of companies.

With respect to process innovations, more than 80 percent of respondents enforced some important process innovation (process of production or customer service, maintenance, sales, accounting, IT) in the last five years. Processes of logistics, delivery, and distribution were improved by 65 percent of the respondents.

Figure 4. The prevalence of internal and external cooperation in developing new products and processes



Note: The figure show the share of respondents who agree with the statements.

Source: European Commission, 2019a.

Figure 4 summarizes an important issue on how companies organise the innovation process. In our sample, over half of the respondents (57 percent) developed new products or services in cooperation with third parties, while external cooperation is more evident in the case of process innovation. 76 percent of respondents at some point in time relied completely on third parties to develop new processes for them, while two-thirds of respondents report cooperation. 73 percent of new products and 90 percent of new processes are developed internally. Development of new processes is often inspired by competition (80 percent), but this is less evident in the case of new products or services (18 percent).

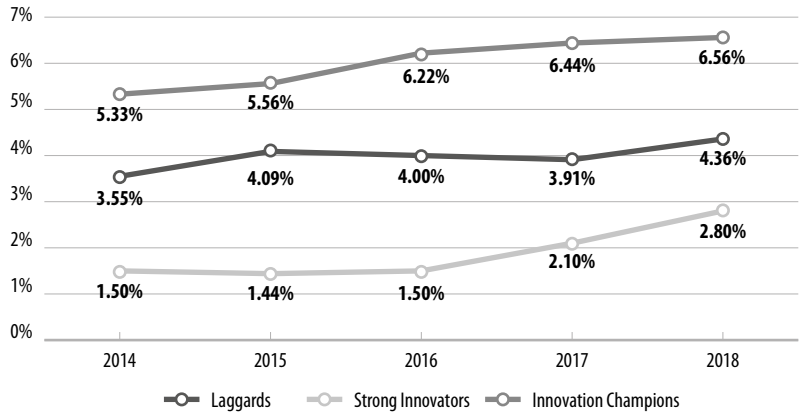
The increasing importance of external cooperation has been evidenced globally, as research on innovation activities conducted by BCG and Deloitte emphasise that large corporations often involve third parties to enhance their innovation processes (Ringel et al., 2018; Andersen et al., 2018). Also, the idea of open innovation builds on the notion that in-house innovation activities could flourish if innovators incorporated and built on ideas and technologies from third party companies (Chesbrough, 2007).

According to our survey, innovation activities will most likely have the highest impact on overall company reputation (39 percent of respondents agree), return on sales (22 percent of respondents), and customer loyalty (19 percent).

3 The characteristics of innovation governance: Champions, Innovators and Laggards

Companies differ also in how innovative their products are domestically or globally. The respondents were, based on the questionnaire[8], divided into three groups: Innovation Champions (34 percent), whose innovation was a novelty on a global scale, Strong Innovators (24 percent), who introduce novelties to the markets they are already competing in, and lastly the Laggards (42 percent), who did not introduce any meaningful innovation to their products/services or have partaken only in incremental innovation.

Figure 5. Percentage of revenues invested into R&D by different groups of companies



Source: Own survey, 2019.

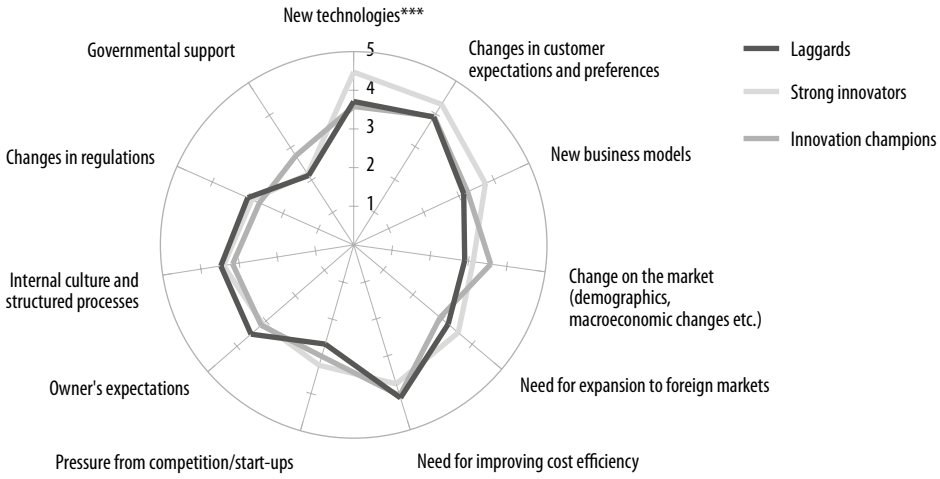
Innovation Champions have been investing the most in R&D (measured as a percentage of sales) (Figure 5), with a five-year average of around six percent, followed by Laggards, whose average was around four percent. The differences have been significant in all years except in 2018. Strong Innovators have been

8 The particular question used for the formation of the groups consisted of three sub-questions: 1. Did your company partake in improving the product/service or increasing the product's/service's customer value? 2. Did your company introduce a product/service that was a novelty on the market? 3. Did your company introduce a product/service that was a novelty on a global level?

investing the least, with their five-year average being a bit below 2 percent; however, in the last two years they almost doubled their innovation expenses and spent 2.8 percent of sales in 2018.

Respondents also differ in their motivations and triggers for performing innovation activities (Figure 6). For Innovation Champions, the strongest triggers are new technologies[9], changes in customer expectations, and new business models, while the weakest incentive is government support. Interestingly, respondents from this group receive more subsidies on average when compared to other respondents[10]. Both Strong Innovators and Laggards identify changes in customer expectations and the need to improve cost efficiency as the strongest pushes for innovation activity. Not utilizing new technologies is a major pitfall for these companies, as this would allow them to leverage different aspects of innovation and their businesses (market trends, potential innovations, strategy, efficiency, sales) (Ringel et al., 2018, Andersen et al., 2018).

Figure 6. Innovation triggers



Note: Likert scale type questions; 1-Very weak effect, 5-Very strong effect . Level of significance (One-way ANOVA) between the three groups; *=significant at 10 percent; **=significant at 5 percent; ***=significant at 1 percent.

Source: Own survey, 2019.

For all three groups of companies, creating tailored/customized solutions, increasing work productivity, and lowering costs of manufacturing are highly

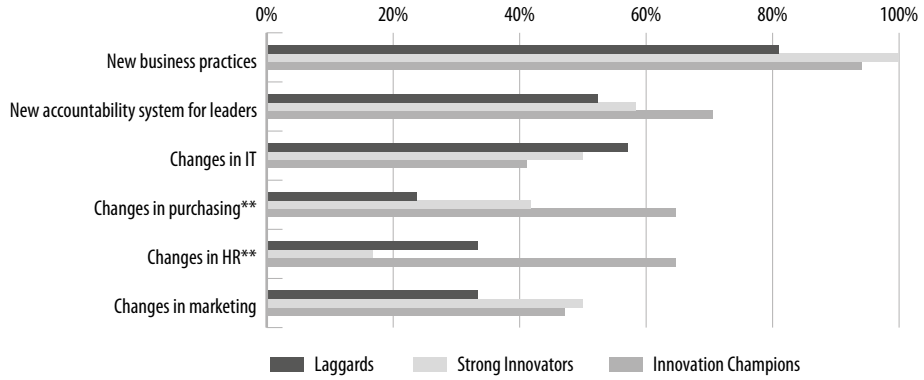
9 Similarly, European companies believe one of the main triggers for their innovation is advancements in new technologies, in fact, 92 percent believe that this is the primary trigger for innovation (Andersen et al., 2018).

10 More about sources of financing can be found in the next chapter, *Productivity, Access to Finance and Innovation.*

important innovation activities from a strategic perspective. For Innovation Champions, fast development of new products or services is crucial.

The vast majority of respondents have been implementing new business practices in order to foster innovation (Figure 7). More than 81 percent of Laggards, 100 percent of Strong Innovators, and 94 percent of Innovation Champions report having done so. Changes in IT was the second most common implemented change by Laggards (57 percent) and the third most common for Strong Innovators (50 percent).

Figure 7. Important changes implemented over the last 5 years



Note: Level of significance (One-way ANOVA) between the three groups; *=significant at 10 percent; **=significant at 5 percent; ***=significant at 1 percent
Source: Own survey, 2019.

Creating a new liability and decision-making system for leaders was the second most common change for Strong Innovators (58 percent) and Innovation Champions (71 percent). In addition to this, 65 percent of Innovation Champions have implemented changes within purchasing and HR. The vast majority of respondents (76 percent of Laggards, 67 percent of Strong Innovators, and 94 percent of Innovation Champions) developed new processes internally, while cooperation with external parties is most evident in the group of Strong Innovators and Innovation Champions.

The preferred option for developing new products/services is in-house development (66.7 percent of Laggards, 64 percent of Strong Innovators, and 88 percent of Innovation Champions), though external cooperation is common in 62 percent of Laggards[11], 50 percent of Strong Innovators, and 56 percent of

11 High share of external cooperation in the case of laggard could be related with the fact that significant portion of them (almost 30 percent) report that new products or processes are based on imitating competition.

Innovation Champions. The latter are more likely to develop connections with universities and higher education institutions, start-ups, and incubators, while Laggards and Strong Innovators rely more on internal cooperation with companies from their own groups (67 percent and 92 percent, respectively) as well as their stakeholders (86 percent and 92 percent).

The most common form of organization of innovation activities across all three groups is Centralized R&D with around 50 percent of all sampled companies having such a department. Innovation Champions surpassed traditional organizations by having their own innovation incubators (53 percent), new business development departments (44 percent), new business opportunity groups (47 percent), and emerging technologies business groups (47 percent). A substantially lower percentage of firms from the other two groups reported those forms of organisation.

Table 1. Innovation Governance Models in large Slovene companies

Person(s) in charge	Innovation Champions (in %)	Strong Innovators (in %)	Laggards (in %)
Innovation board	35	42	45
CEO	0	8	10
CTO/CRO with passive management team	6	17	20
CTO/ CRO with proactive management team	24	17	5
CTO/CRO + BU manager	18	0	5
CIO + CXO/BU manager	12	17	10
No one in charge	6	0	5

Source: Own survey, 2019.

Based on the classification by Deschamps and Nelson (2014), we can identify 6 different innovation governance models in large Slovene companies. The results are reported in Table 1. Interestingly, around 6 percent of Innovation Champions and slightly less of Laggards have no one in charge of innovation governance. The figure is similar to the one from the Deschamps and Nelson (2014) report on their studies of large multinationals. In this case, companies claim that innovation is built in a company's DNA and all employees feel responsible for innovation. While this might be true for Innovation Champions, it is less likely to be true for Laggards. The most prevalent form of innovation governance is the *Innovation Board* model with a subset of the top management team being held accountable for innovation processes. Strong research

departments in the case of Innovation Champions naturally develops the innovation governance model, involving the Chief Research Officer as responsible for innovation. On a global scale this model is prevalent especially in companies with long engineering traditions or companies operating in a fast-changing technological environment. Moreover, according to a global study on innovation governance, this model corresponded to the highest level of satisfaction by board members (Deschamps and Nelson, 2014).

Two-thirds of firms report that C-level management is actively engaged in the innovation process, from idea generation to commercialization. More than 70 percent of Laggards report that executives evaluate and make proposals on major decisions related to innovation, strategic priorities, and investments. More than 40 percent of Innovation Champions and one-third of others report that management is actively involved in innovation boards, while a passive management role in the innovation process was reported in 25 percent of companies. Interestingly, in Innovation Champions, the top management team is more involved in the innovation process even when the Chief Research Officer is responsible for innovation. Half of the surveyed companies that belong to the Strong Innovators category report a more passive top management role in the case of the CRO/CTO innovation governance model.

Interestingly, we can observe that Models 8 and 9 (Chief Research or Innovation Officer and Business Unit manager) are more widespread in Slovene companies than the rest of the world, indicating that governing innovation is more likely the task of a middle management pair or group. On the other hand, the fact that the CEO acts as an innovation leader only in few companies could be explained by the fact that most of the sampled companies do not develop radical innovations.

The time engagement of a company's board is similar in the case of Innovation Champions and Laggards but substantially lower in the case of Strong Innovators. On average, Management and Supervisory Boards of Innovation Champions spent 16 and 15 percent of their meeting time discussing topics related to innovation, while in the case of Strong Innovators, Management and Supervisory Boards spent less time discussing innovation topics (14 and 9 percent, respectively). The Management Group in Laggard companies spent more than 20 percent of their time on innovations, while their Supervisory Board spent 13 percent; however, 90 percent of firms (slight differences among groups) report that the top management team is accountable for the success of innovation activities. 70 percent of Supervisory Boards in Innovation Champions are

regularly updated with innovation activities, while only 50 percent of Laggards inform them regularly. An average CEO spent one-fifth of his/her time on innovation topics (almost 30 percent in Laggard companies, 18 percent in Strong Innovators, and 23 percent in Innovation Champions).

In general, strategic activities are better planned and managed in the case of Innovation Champions, as 75 percent of respondents from this group have an innovation strategy and have defined key performance indicators (KPIs). Alternatively, less than one half of Strong Innovators and Laggards have an innovation strategy and slightly more of them have KPIs (between 50 and 60 percent). More than half of the Innovation Champions have well-defined strategic priorities either at the level of the company or at the level of business units (or brands). More than half of Laggards and Strong Innovators report generally harmonised strategic innovation priorities, but they are not formalized (Table 2).

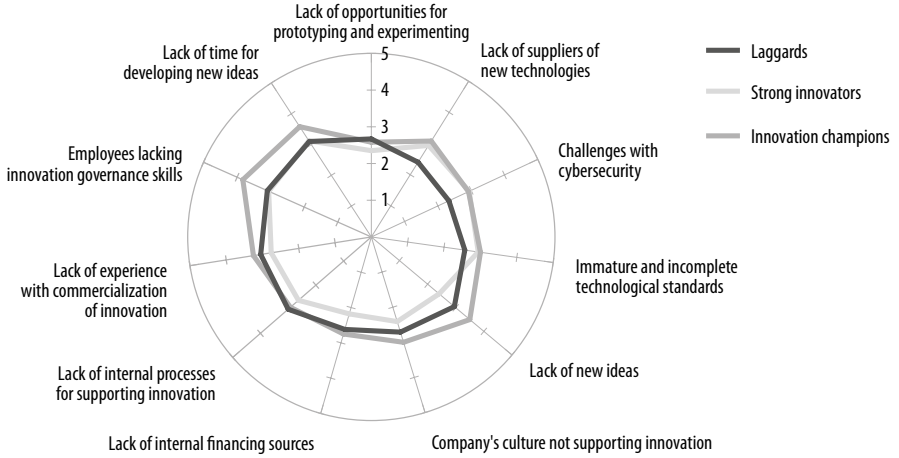
Table 2. The characteristics of innovation strategies and priorities by innovation performance group

	Laggards (in %)	Strong Innovators (in %)	Innovation Champions (in %)
Well defined strategic priorities in the field of innovation across, all aspects of the business.	33	25	29
Well defined strategic priorities in the field of innovation, across business units, product categories or brand, but not on the company level.	0	8	24
Well defined strategic priorities in the field of innovation, on the company level and business units, but not on a product category level.	5	8	29
Generally harmonised strategic innovation priorities, but not formalized.	57	50	18
Currently, there are no strategic innovation priorities, however, there are plans for their development.	5	0	0
Currently, there are no strategic innovation priorities and there no plans for their development.	0	8	0

Source: Own survey, 2019.

Figure 8 presents the importance of internal barriers to innovation, as perceived by the three groups. Innovation Champions identified immature and incomplete technological standards, cybersecurity, and lack of new technology suppliers as the most important internal barriers.

Figure 8. Internal barriers to innovation

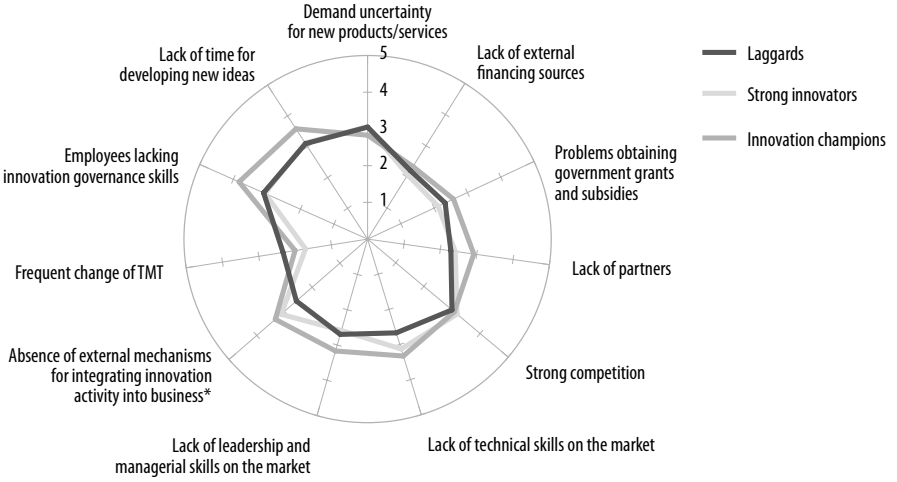


Note: Likert scale type questions; 1-Very weak effect, 5-Very strong effect . Level of significance (One-way ANOVA) between the three groups; *=significant at 10 percent; **=significant at 5 percent; ***=significant at 1 percent.

Source: Own survey, 2019.

Lack of new ideas, employees, and lack of time for developing new ideas are the most important barriers for Strong Innovators and Laggards. Lack of internal financial resources has not been identified as an important obstacle for innovation activities.

Figure 9. External barriers to innovation



Note: Likert scale type questions; 1-Very weak effect, 5-Very strong effect . Level of significance (One-way ANOVA) between the three groups; *=significant at 10 percent; **=significant at 5 percent; ***=significant at 1 percent.

Source: Own survey, 2019.

Strong Innovators and Innovation Champions perceive the absence of external mechanisms to incorporate innovation activity into the core business and demand uncertainty for new products/services as the most evident external barriers for innovation activities (Figure 9). Additionally, Strong Innovators find a lack of technical, leadership, and managerial skills on the market and a lack of partners as barriers, while none of the respondents highlighted the lack of external financial resources or change of the top management team as significant barriers.

Discussion and conclusion

According to different innovation surveys, two-thirds of CEOs recognize innovation as a top priority in their companies; but the gap between talking about innovation and delivering it is wider than ever. Executives should demonstrate their commitment through their engagement, communication, investments, and actions (Hobcraft and Phillips, 2012).

Global multinational companies spend more than ten percent of revenues on innovation every year and there is an upward trend of resources being used for innovation activities around the world (Vrontis and Christofi, 2019). Also, the investment in R&D in our sample of the largest Slovene corporations has been increasing over the last five years, with global innovators (Innovation Champions) investing around six percent of sales, on average. The other two groups of respondents were lagging behind, with Laggards investing around four percent of sales and Strong Innovators, which mostly focus on new products on domestic market, investing around 3 percent of sales per year.

The Deschamps and Nelson (2014) global study on innovation governance reports that overall responsibility for innovation is most frequently allocated either to the Innovation Boards (a subset of the top management team) or the CEO; or, in diversified and decentralized corporations, to a division president acting as CEO of a business unit. The same pattern could be identified in the case of Slovenian respondents[12].

12 However, the level of satisfaction with the Innovation Board model is perceived problematic for a significant proportion of companies that have adopted them. The most evident reason for that were lack of formality in implementation of the innovation process, insufficient customer orientation in the process, leading to missed opportunities to create real value in the market, difficulty in emerging from the old vertically integrated model and migrating toward a more networked approach., functionally oriented organization, leading to a lack of coordination and understanding between functions and lack of consistency in the project prioritization process across divisions and business units.

Many engineering-based companies or companies that operate in technology-driven industries, where technology choices and deployment issues are complex and critical, entrust innovation governance to the head of their technical function, usually the Chief of Research (Deschamps and Nelson, 2014). The success of this model is highly dependent on the credibility and leadership talents of the specific high-level individual, who must develop also a strong sensitivity to innovation commercialization and adoption issues to avoid sterile "technology-push" initiatives. Most of the Slovene Innovation Champions developed this type of innovation governance model.

In the last decade, innovation has become a highly complex corporate activity, which crosses many of the boundaries that exist in large corporations and is not based on a lack of financial resources. In order to escape from inefficient forms of corporate tribalism, where each group possess its own rules and judgments, the company should make its model of innovation governance explicit. This is the only way for large corporations in the digitised world not to be disrupted by innovative start-ups.

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Polona Domadenik, Matjaž Koman, Tjaša Redek, Valeska Gaber,
Andreja Gradišek, Taja Pečnik

PRODUCTIVITY, ACCESS TO FINANCE, AND INNOVATION

Introduction

Innovation and productivity represent key engines that drive competitiveness forward in modern economies (Carayannis and Grigoroudis, 2014). Although determining the factors which influence productivity is rather difficult, Hall (2011) shows that innovation in firms enhances their productivity. Literature shows that high-productivity firms on average invest more resources in R&D related activities, which have a decisive role in productivity growth (European Investment Bank, 2017). However, innovation projects are risky, uncertain, and more likely to be subject to opportunistic behaviour, moral hazards, and adverse selection[1]. As such, R&D investment is less likely to be financed by owners (in the form of equity financing) or loans (debt financing)[2] and must instead rely either on other internal sources or state subsidies. Highly productive firms are more likely to generate excessive cash flow, which can be used as an internal funding source to support risky innovation projects (Domadenik et al, 2008).

This chapter studies whether more productive firms are also more innovative, as those firms have more internal resources to finance their innovation projects. The analysis relies on a combination of survey and firm-level balance sheets' data of large Slovene firms, and investigates the relationship between a firm's productivity level and R&D investment.

1 The mentioned problems are the result of contract incompleteness and information asymmetry between firms and investors as described in Hall (2010) or Hall and Lerner (2010).

2 It is a well-known fact that in the absence of collateralisation, it is difficult to obtain debt financing (see Hall et al., 2016 for a recent debate on this issue).

Chapter is divided into three sections. Part one identifies recent trends in productivity growth and innovation in Slovenia and compares them to other member states of the European Union. The second part discusses the theoretical and empirical literature about the determinants of innovation and their influence on innovative activity. Lastly we present our empirical findings.

1 Productivity growth and innovation performance in Slovenia and in the European Union

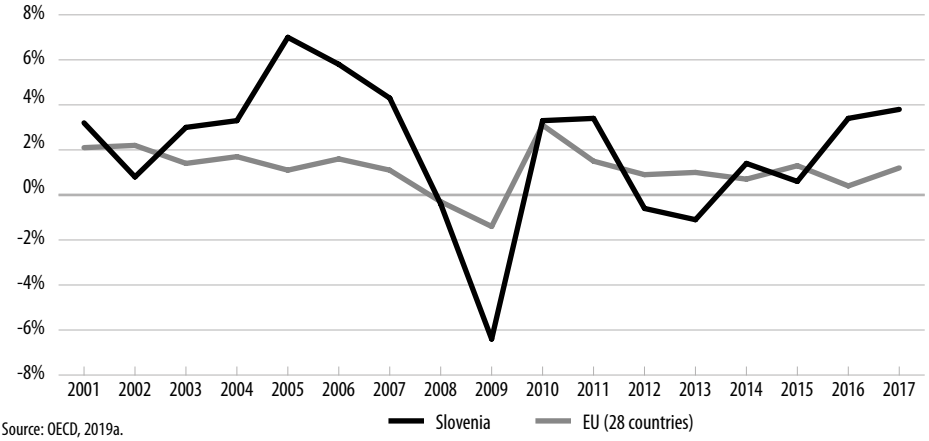
Slovenia experienced major productivity growth after 1991, as measured by GDP per hour worked. Performance was further improved after Slovenia joined the EU in 2004. In 2005, productivity growth was seven percent annually, while in the EU productivity grew by 1.1 percent (Figure 1). This increase was largely due to capital deepening, which explained half of the productivity growth in Slovenia and was recorded in almost all sectors (UMAR, 2019). By 2007, productivity growth slowed down, and by 2009 Slovenia's productivity suffered severe consequences from the financial crisis. In 2009, productivity growth declined by 6.4 percent from the previous year and the drop in output was one of the highest in the EU. In the EU as a whole, the decline was only 1.4 percent from the previous year (OECD, 2019a).

In recent years, productivity in most EU countries has been improving. Although Slovenian productivity growth has increased in the past two years and its productivity gap with the EU average has decreased, it remains wide (World Economic Forum, 2019). In 2017, Slovenia produced 23.3 percent less GDP per hour worked in comparison to the EU on average, and in 2018 the disparity decreased slightly to 20.8 percent (OECD, 2019a).

The literature provides robust evidence of a positive and significant impact of R&D on productivity (Castellani et al., 2016). What is less clear is whether higher productivity causes also an increase in innovation. At the country level, a short comparison of the research and innovation performance in the EU and Slovenia is based on the European Innovation Index (in continuing EII, Figure 2). The EII is a composite indicator measuring performance of national innovation systems in EU member states using 27 indicators[3] (European Commission, 2019a).

3 Indicators are grouped into the ten following areas: human resources, attractive research systems, innovation-friendly environments, financing and support, firm investments, innovators, linkages, intellectual assets, employment impacts, and sales impacts (European Commission, 2019a).

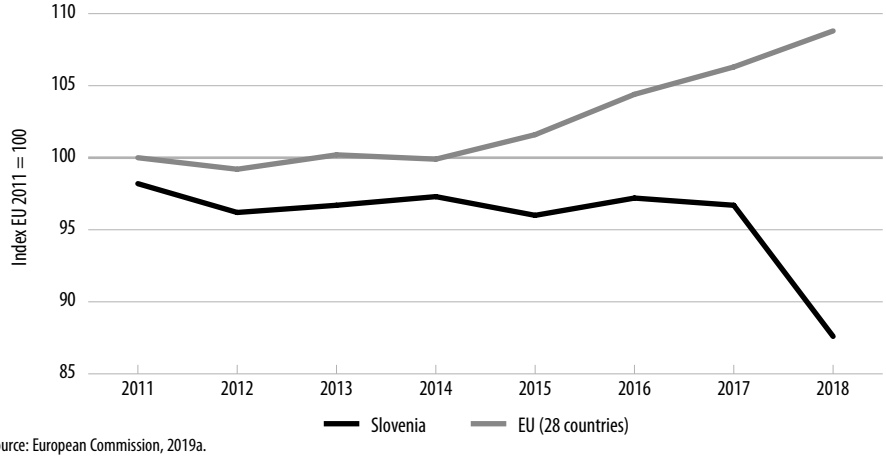
Figure 1. GDP per hour worked, percent change based on previous year



Source: OECD, 2019a.

During the past two decades, the EU has been transforming into a knowledge-based society and an innovation leader. While the innovation performance of Slovenia has deteriorated or stagnated compared to the EU average, between the years 2011 and 2018, the EU innovation performance improved by 8.8 index points (Figure 2). Slovenia's decline in 2018 was mainly caused by the declining performance of the country in the number of doctorate graduates and the indicators using CIS[4] data. Slovenia otherwise belongs to the moderate innovators group, with EII values between 50 and 90 percent of the EU average.

Figure 2. Comparison of European Innovation Index (EII) between EU and Slovenia



Source: European Commission, 2019a.

4 CIS - Community innovation survey. Survey conducted in EU member states to collect data on innovation activities in enterprises (Eurostat, 2019).

According to the EII, Slovenia's strongest innovation dimensions are firm investments, human resources, and linkages, while its weakest dimensions are financing and support for innovators (European Commission, 2019b). In the case of less developed mechanisms to finance innovation projects, internal resources become even more important. R&D expenditures as a percentage of GDP were declining in Slovenia between 2012 and 2018, while expenditures at the EU level slowly increased. Although Slovenia had a higher R&D expenditure as a percentage of GDP throughout the whole period, it has decreased by 0.71 percentage points and fell below the average R&D expenditure of the EU, which has grown by 0.06 percentage points (OECD, 2019b). Insufficient improvement in the areas of R&D, innovation capacity, and digitalization limits the potential of Slovenia to attain high productivity growth and an improvement in standard of living (UMAR, 2018).

2 Theoretical background: The determinants of innovation and the role of internal financial sources for innovation and R&D

The literature reveals several determinants of innovation activities in firms. Selected empirical studies (Table 1) point out that innovation activities at the firm level are influenced by a number of external factors, such as business cycles, the degree of competition in the market, established linkages with other firms, and institutions. Many European firms reported that they severely limited their innovation activities after the 2008 financial crisis. Another determinant driving a firm's innovative activity is related to market structure. Firms in more competitive business environments report higher innovation activity.

Among internal factors, organizational structure plays an important role as a precondition to the development of innovative capabilities. While traditional organizations are effective in static organizational frameworks, traditional structures in innovative companies often cannot provide the flexibility and agility needed to maintain an innovative and competitive stance in such environments. Regarding size, large companies with strong market power are better at innovating compared to small companies; however, small companies can be more innovative due to flexibility, adjustment of employees in innovation projects, and less complex management structures. Key to internal innovation are the technological capabilities that affect a firm's absorptive capacity. Firms that have more advanced technology are more innovative than their competitors.

Obviously, innovations would not be possible without the necessary financial resources. There is a positive relationship between internal financing and R&D spending. Internal funds are the most important and widely used source of R&D financing in advanced economies, due to the risks of opportunistic behaviour, moral hazards, and adverse selection that are more associated with innovative projects than other capital investments. The well-grounded theoretical argument that there is a link between financial constraints, R&D investment, and innovation has been tested in several empirical studies recently, but the empirical evidence remains inconclusive.

Table 1. Determinants of Innovation

Determinant of innovation	Selected references	Main linkages to innovation
Business cycle	Tomaszewski and Swiadek, 2017	Economic cycles in general influence companies' incentives to innovate.
Market Structure	Arrow, 1972, Artés, 2009; Gabsi, M'henni & Koouba, 2008; Schumpeter, 1942	Competition stimulates R&D and innovation. Market structure has impact on long-run strategic R&D decisions.
Size of a firm	Schumpeter, 1942; Bhattacharya & Bloch, 2001	Size of a firm linked to market power and innovation activities.
Ownership structure	Minetti, Murro & Paiella, 2015	Role of dispersed and concentrated ownership structure.
Orientation to foreign markets	Zemplinerová & Hromádková, 2012	Directly linked to innovation activities and innovation investments.
Linkages	Joshi, 2017	Linkages have a positive effect on the innovation performance.
Human capital	Joshi, 2017; Palacios et al., 2009	Impact of highly educated and skilled people on innovation activity.
Organizational structure	de Mello, Marx & Salerno, 2012; Menguc & Auh, 2010	Organizational structure improves general nature of how companies operate, stimulate innovation, impact knowledge sharing, and interact.
Strategy	Terziovski, 2010	Implementation of formal strategies contributes to effectiveness and better performance of a firm.
Technological capabilities	Lee, 2009; Alder, 2010	A firm's innovation performance depends primarily on its level of technological competence.
R&D expenditure	Joshi, 2017	R&D expenditure is expected to increase innovation.
R&D subsidies	Santos, 2019	Subsidies have a positive effect on investment, sales, technological progress, and job creation.
Internal sources of financing	Hall, 2002; Brown et. al, 2009; Bougheas, 2004; Ugghetto, 2008; Himmelberg & Petersen, 1994; Hall and Lerner, 2010	There is a positive relationship between increased internal funds and innovation activity performed.
External sources of financing	Arrow, 1972; Bougheas, 2004; Hall, 2002; Hall & Lerner, 2010	Equity financing and debt financing are both relevant.

Hottenrott and Peters (2009) point to a possible positive impact of financing constraints on the selection of more efficient innovative projects, and to a possible reverse impact of innovation on financing constraints due to the riskiness and information asymmetry innovation projects entail (Hajivassiliou and Savignac, 2007), leading to "more innovation, less money".

3 Empirical analysis

3.1 Data and methodology

As we have demonstrated, the theory hypothesizes a positive relationship between a firm's productivity and its R&D investment, since more productive firms have more internal sources to support innovation activities. The principal objective of our analysis was to examine the productivity performance of large Slovenian enterprises in order to determine whether there is a correlation between productivity, internal financial sources and R&D investment. Additionally, we investigated whether external sources of financing (i.e. state subsidies) have any impact on R&D activities. Data used in this study were drawn from the survey described in the previous chapter, AJPES, and state aid databases[5].

The sampling frame of this study involved only large Slovenian enterprises with more than 250 employees. In the survey, participating firms were asked about their innovation-related activities and sources of financing in the period from 2014 to 2018. A final sample consisted of a total of 49 respondents who participated in the survey.

3.2 Empirical findings

3.2.1 Productivity performance

Productivity is measured by the value added per employee (VAL) which corresponds to a firm's gross value added divided by the total number of employees. The 49 participating firms were divided into three main sectors: (1) manufacturing, which comprises 24 firms, (2) energy, which comprises 6 firms, and (3) services, which comprises 19 firms. An average company in manufac-

5 The database on state aid for R&D projects was obtained from Ministry of Finance, Republic of Slovenia.

turing employs 1,016 employees, while an average service sector company was somewhat smaller with 976 employees. Companies from the energy sector employ 439 employees, on average. Average sales growth data by sector (Table 2) in the period from 2014 to 2018 show that the companies in the service sector experienced the highest average growth of 7.3 percent, followed by companies in the manufacturing sector at 3.3 percent. Firms in the energy sector experienced a drop in sales by 0.1 percent in this timeframe. The service sector companies also experienced the highest employment growth.

The highest VAL in the period under study was observed in the case of respondents from the energy sector. The corresponding productivity in service or manufacturing sectors was lower by 45 and 60 percent, respectively, when compared to the average productivity in the energy sector. Although we might suspect that the differences are driven by industry characteristics, we observed that two thirds of surveyed firms in the energy sector were above the industry average, while only one third of service sector companies and 45 percent of manufacturing firms performed better than the average company in their industries. On average, companies in the energy sector exhibited ten percent higher productivity when compared to the industry average, while productivity in manufacturing companies does not deviate much from the industry average. Companies in the service sector performed worse than an average company in their sectors. Their average productivity was lower by almost 3.5 percent when compared to the industry average.

Table 2. Average productivity and employment in surveyed companies by sector in the period 2014-2018

	Manufacturing	Services	Energy
Number of companies	24	19	6
Number of employees	1016	976	439
Growth in employment (in percent)	2.80	5.33	0.32
Sales growth (in percent)	3.30	7.30	-0.10
Value added per employee (VAL) (in EUR)	49,179.15	64,137.12	116,428.24
Deviation of value added per employee from industry average (in percent)	0.86	-3.48	9.70
Share of firms with VAL above industry average (in percent)	45.83	36.84	66.66

Source: Own analysis, data collected from Ajpes and Gvin, 2019.

3.2.2 "More money, more innovation"?

Since only 65 percent of the respondents disclosed information about their sources of financing and R&D expenditures, we continued our analysis with a sample of 32 firms. In order to determine the relationship between productivity and innovation activity, we carried out various correlation analyses. First, we tested the strength of the relationship between VAL and R&D expenditures as percentage of sales on the firm level. Then this correlation was tested also in three groups of surveyed companies that differ in their innovation activities: Innovation Champions, Strong Innovators, and Laggards[6]. When asking firms about the distribution of costs for innovation activities, we observed that the first group (Innovation Champions) spends most on financing internal R&D activities, whereas the other two groups (Strong Innovators and Laggards) spend most on equipment modernization.

Table 3. Correlation Analysis – Value added per employee (in EUR) and R&D expenditure (percentage of sales)

	Coefficient	Spearman's rho
Whole sample	-0.059	0.524
Laggards	-0.474	0.001**
Strong Innovators	-0.207	0.282
Innovation Champions	0.526	0.000**

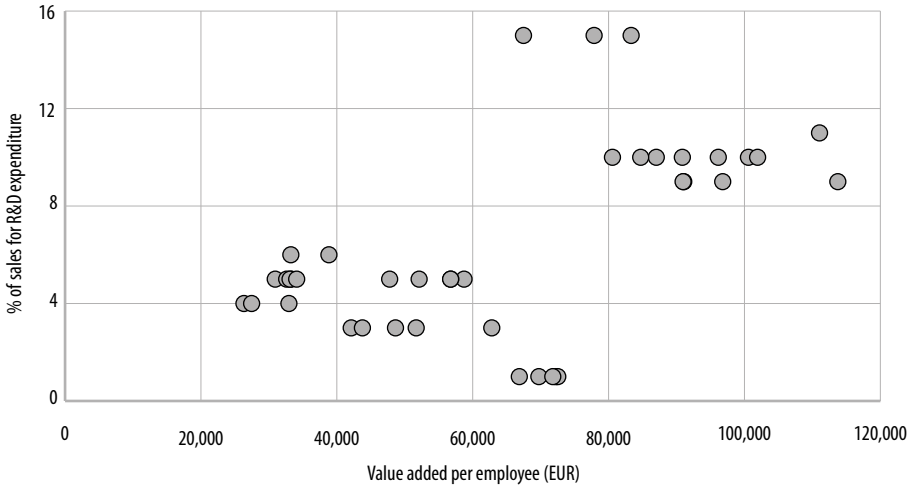
Note: ** Correlation is significant at the 0.01 level (2-tailed).

Source: Own analysis, data collected from Ajpes and Gvin, 2019.

The correlation analysis for the full sample was not statistically significant (Table 3), but the results partially confirm the hypothesis that more productive companies invest more in innovation in the case of Innovation Champions (Table 3 and Figure 3). Interestingly, the correlation coefficient was negative and insignificant in the case of Strong Innovators (Table 3 and Figure 4) but significant in the case of Laggards, indicating that less productive respondents invest more in R&D (Table 3 and Figure 5); however, this finding might be driven by the fact that there are substantial differences in productivity among firms due to industry specifics.

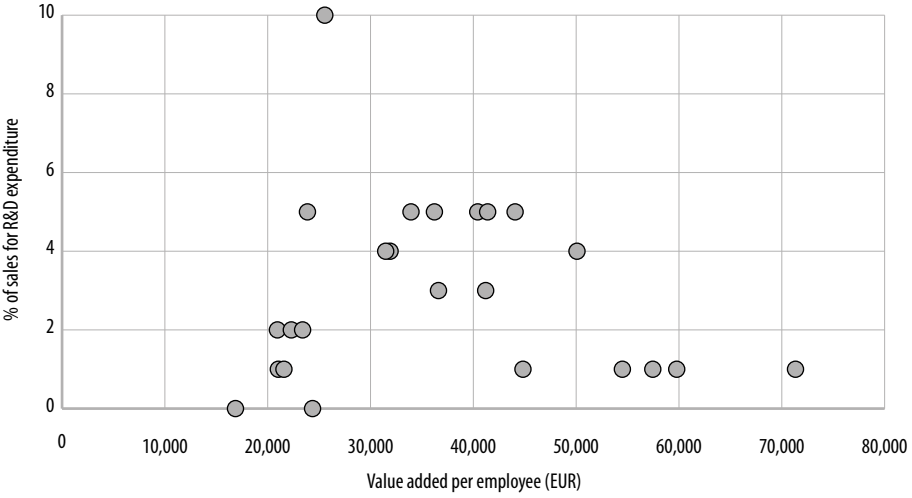
6 The distinction between respondents was made according to the type of innovation they pursued. Innovation Champions are those respondents whose innovation was a novelty on a global scale, Strong Innovators introduced novelty to the markets they are competing in, while the Laggards didn't introduce any meaningful innovation to their products/service or have contributed to the incremental innovation of their products/services. For more details see Chapter *Innovation Governance in Large Slovenian Firms*.

Figure 3. Relationship between value added per employee (in EUR) and R&D expenditure as a percent of sales for Innovation Champions.



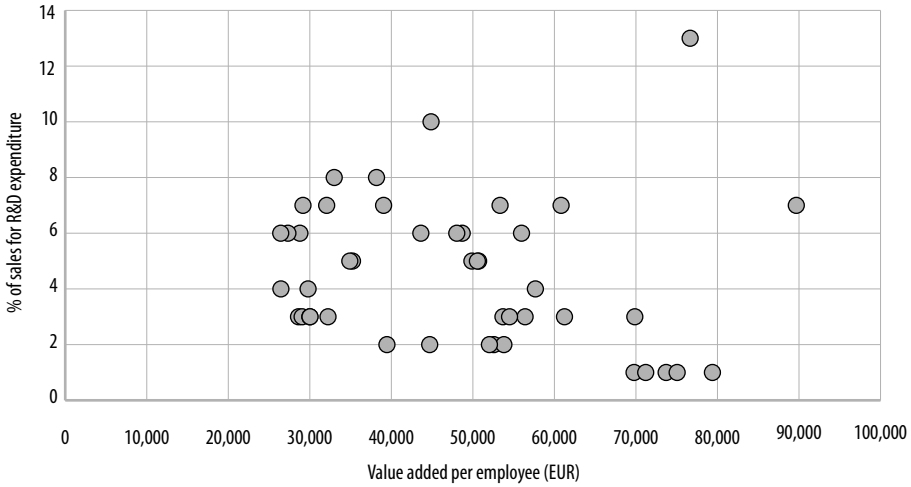
Source: Own analysis, data collected from Ajpes and Gvin, 2019.

Figure 4. Relationship between value added per employee (in EUR) and R&D expenditure as a percent of sales for Strong Innovators



Source: Own analysis, data collected from Ajpes and Gvin, 2019.

Figure 5. Relationship between value added per employee (in EUR) and R&D expenditure as a percent of sales for Laggards



Source: Own analysis, data collected from Ajpes and Gvin, 2019.

To continue, we investigated potential differences in the correlation between R&D expenditure as a percent of sales and productivity of respondents relative to their industry averages. All correlations are negative for all three groups and significant in the case of Innovation Champions (Table 4). More productive companies (when compared to an average productive company in the same industry) in general generate more internal funds for innovation activities; but internal sources could be either substituted or complemented by external sources of R&D investment. Many innovation projects at the company level are supported by different types of state schemes for supporting innovation activities. Our results therefore indicate that more productive firms in all three groups are less dependent on internal sources to finance innovation activities. This finding is also supported by the survey, as the majority (64 percent) of Innovation Champions stated that in the next two years they will increase their

Table 4. Correlation analysis – value added per employee (index) and R&D expenditure as a percentage of sales

	Coefficient	Spearman's rho
Laggards	-0.214	0.136
Strong Innovators	-0.170	0.379
Innovation Champions	-0.485	0.002**

Note: **. Correlation is significant at the 0.01 level (2-tailed).

Source: Own analysis, data collected from Ajpes and Gvin, 2019.

budget for R&D, while the rest of the group will keep it at the same level. In the Strong Innovators and Laggards groups, one half of respondents intend to increase their R&D budget, while the other half will not change it.

Table 5 reveals the differences in productivity between two groups of firms: those that received subsidies for innovation activities in the period of 2014-2018, and those that received nothing. If we compare the average productivity of firms that received state subsidies with those that didn't, we might conclude that the latter are more productive; however, the productivity gaps are driven by industry differences, as some industries (energy or pharmaceutical sectors, for example) exhibit higher productivity than others. If differences between industries are controlled for, the results show that recipients of R&D subsidies were on average more productive than their peers operating in the same industry without any state R&D support. More productive companies (when compared to the industry average) are possibly more likely to obtain state subsidies and are therefore less constrained by internal sources during innovation investment.

Table 5. Value added per employee for respondents with and without any state subsidies

	Value added per employee (EUR)		Value added per employee (index)	
	Subsidies	No subsidies	Subsidies	No subsidies
Whole sample	57,687.68*	73,555.96	110.38**	97.47
Laggards	48,099.28*	85,304.29	102.85	99.84
Strong Innovators	68,749.43	35,323.27	104,97	90.91
Innovation Champions	56,214.35	73,596.46	123.32*	96.55

Note: **, * Denotes that the difference is significant at the 0.05 and 0.01 level (2-tailed).

Source: Own analysis, data collected from Ajpes and Gvin, 2019.

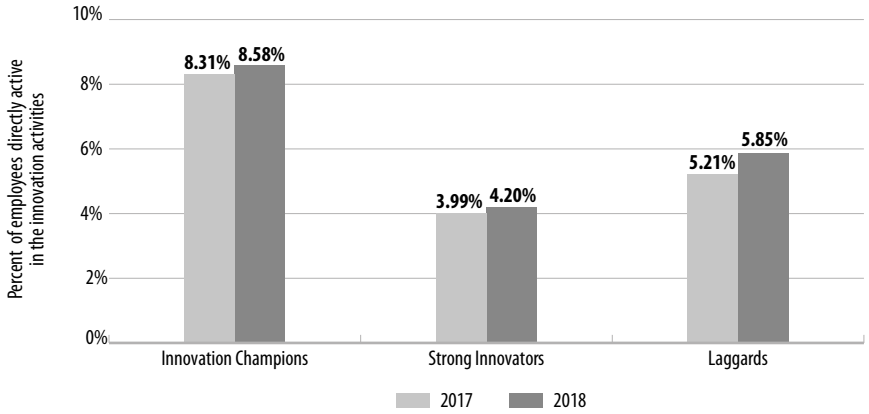
This finding is supported also by the survey, in which only 24 percent of respondents perceived financial sources as an important internal barrier for the innovation process in the last five years. For 56 percent of respondents, financial resources didn't represent any barrier for innovation. On the other hand, a lack of new ideas, commercialization, and lack of competencies related to innovation governance were identified as important internal barriers in almost 50 percent of companies.

3.2.3 Human resources and innovation activities

Since human resources are one of the main factors impacting firm innovation activity and have been identified as one of the most important internal

barriers in companies, the survey questionnaire also addressed issues related to the role of people in creating innovation. The respondents reported that 60.1 percent of their employees engaged in innovation activities in 2017, and this number increased to 65.8 employees (9 percent increase) in 2018, on average. In 2017, Innovation Champions on average had 8.31 percent of employees working on innovation, and in the following year, the percentage increased slightly to 8.58 percent (Figure 6). Interestingly, Laggards typically employed more people to work on innovation activities compared to Strong Innovators. This could have resulted from their desire to improve their innovation performance, as they report the highest growth of employees working on innovations (0.64 percent), followed by Innovation Champions (0.27 percent), and lastly Strong Innovators (0.21 percent).

Figure 6. The share of R&D personnel among the three groups



Source: Own analysis, data collected from Ajpes and Gvin, 2019.

The majority of firms that belong to the group Innovation Champions reported that they are having difficulties with retaining qualified people, because they cannot afford them. Consequently, they are dealing with the challenge of having to import high-skilled human resources. The other two groups mainly expressed a problem with their inability to attract the right personnel from abroad.

Conclusion

Innovation-driven competitiveness is crucial for long-run performance in in today's knowledge-based global economies. The ability of a country to develop

its innovative potential is a key factor. This chapter tries to explain the role of financing constraints in developing innovative activities in companies. Our findings suggest that the most innovative companies are not constrained by internal sources, as they are able to receive external financing (state subsidies). Generating internal resources with higher productivity is therefore important, especially for companies that are lagging behind in their innovation activities. The respondents to our survey indicate that attracting and retaining employees for R&D activities is more challenging than securing financial resources.

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IV.

INNOVATION POLICY IN SLOVENIA AND EU

Polona Domadenik, Matjaž Koman, Tjaša Redek

INNOVATION IN SLOVENIA

Introduction

Slovenia was in 2019 ranked as a moderate innovator by the European Innovation Scoreboard, with a summary innovation index value of 87.6 (where the EU average in 2010 was 100). This indicates a significant, modern-day gap with the EU average, as well as a significant lag between Slovenia and the EU average from almost 10 years ago. Slovenia is currently ranked behind Estonia, Portugal, and Czechia, and the majority of the EU15 (with the exception of Italy, Greece, and Spain). Sweden, Finland, and Denmark were all at least 40 percent above the EU average in 2010 (European Innovation Scoreboard, 2019). While the data on the position of Slovenia are reflecting the relative development of Slovenia within the EU (in purchasing power parity) (Eurostat, 2019b), the trend in innovation scoreboard values for Slovenia are more worrying. In 2011, Slovenia reached 98 percent of the 2010 European average but then declined, especially between 2017 and 2018, and fell far below its 2011 level. The most recent data show that both Estonia and Czechia have surpassed Slovenia in innovation (European Innovation Scoreboard, 2019). While Slovenia is at the moment still achieving positive economic growth results, it has lagged behind Czechia in GDP per capita in purchasing power parity since 2013 (Eurostat, 2019b). Knowing that competitiveness, growth, and development in more advanced economies are primarily dependent on innovation, the position of Slovenia compared to EU trends is not the most promising for the country's future, especially when considering that certain EU economies used to lag significantly behind Slovenia. While some companies are dedicated to innovation and keeping up with the best firms in the global marketplace, the average Slovenian company lags behind.

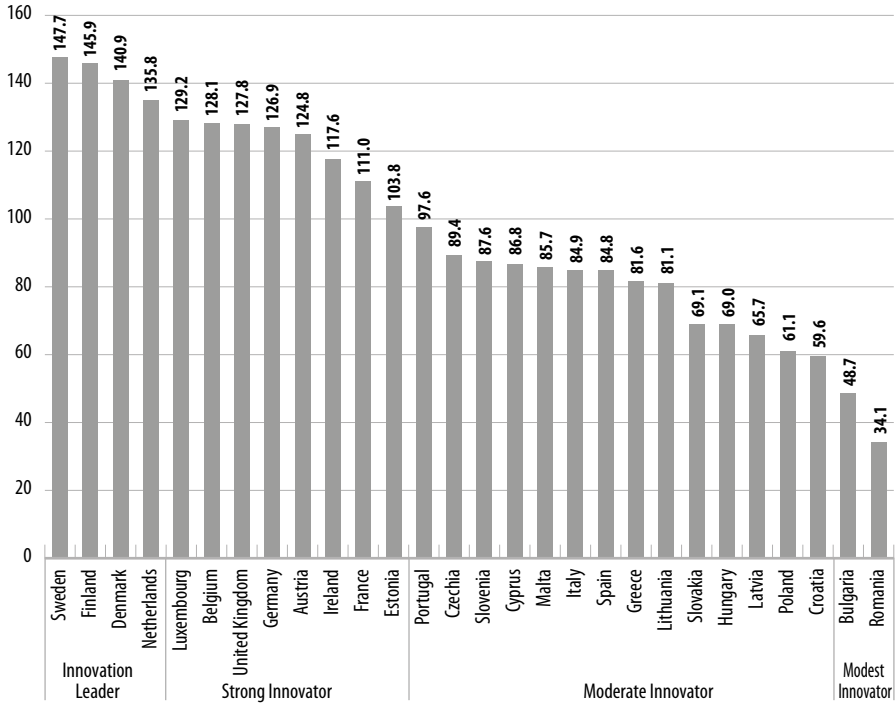
The purpose of this chapter is first to present the trends in innovation in Slovenia compared to the EU in detail, and second to identify the causes of the existing gap. The analysis will rely primarily on two data sources, the European Innovation Scoreboard and the Community Innovation Survey (Eurostat), to

identify the strengths and weaknesses of both the Slovenian innovation environment as well as corporate investment in different innovation activities.

To continue, the data for Slovenia are presented in detail with an emphasis on the relative position of Slovenia compared to the EU average. The next section is devoted to policies designed to support the innovative process in Slovenia, examining primarily whether the policies do in fact address the identified challenges of the Slovenian innovation system and performance. The conclusion summarizes our main results.

1 Innovativeness in Slovenia in comparison to the EU

Figure 1. Summary Innovation Index in 2018 in European countries (EU28 in 2011=100)



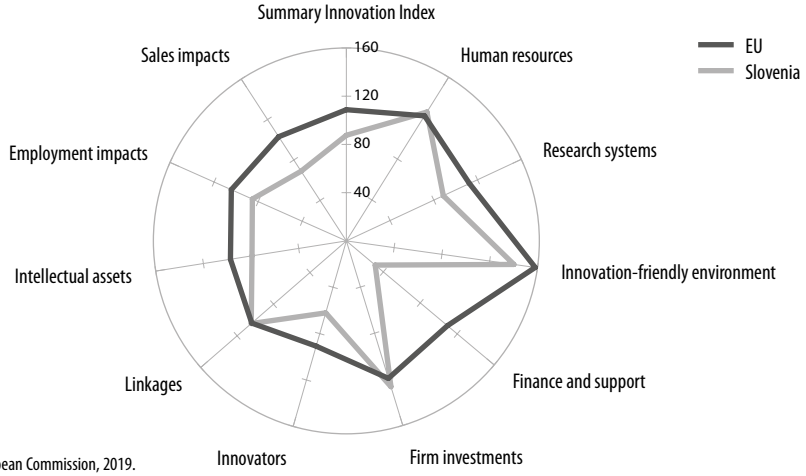
Source: European Commission, 2019.

Slovenia is ranked 15th among the 28 European economies by the European Commission's 2018 innovation index (Figure 1), and is placed in the category of *moderate innovators* according to the 2019 European Innovation Scoreboard

(European Innovation Scoreboard, 2019). The European Innovation Scoreboard captures the characteristics of innovation activity by measuring four key dimensions with sub-dimensions (in parenthesis) using a total of 27 indicators (see also Tables 1 and 2): *framework conditions* (human resources, attractive research systems, innovation-friendly environment), *investments* (finance and supports, firm investments), *innovation activities* (share of innovators, collaboration efforts, intellectual assets such as patents), and *impacts* (employment and sales impacts, including high-tech exports) (European Commission, 2019). Minimum and maximum values for each indicator are reference values that are set from highest to lowest (1 and 0 after being normalized) and all individual values are compared to them. The value of the Summary index is calculated as an unweighted average of the indicators. The European average is calculated as a mean score. Countries are divided into four groups: *innovation leaders*, which are 20 percent or more above the EU average, *strong innovators,* which are between 90 and 120 percent of the EU average, *moderate innovators,* between 50 and 90 percent of the EU average, and *modest innovators,* below 50 percent of EU average (European Commission, 2019).

Slovenia was in 2018 lagging behind the EU average primarily in three dimensions: sales effects, employment effects, and innovation-friendly environments (Figure 2). A more detailed analysis of the indicators reveals that Slovenia is achieving extremely mixed results in all areas. For example, in *framework conditions*, Slovenia is performing better than the EU average in human resources, especially in tertiary education (with over 40 percent of the population between ages 25 and 34 having completed tertiary education) and new doctorate graduates.

Figure 2. Relative performance of Slovenia to EU in 2018 (EU28 in 2011=100)



Source: European Commission, 2019.

Table 1. Summary Innovation Index and its components in Slovenia relative to EU28 in 2018 (index EU28 in 2011=100)

	EU28	SI	Change in index relative to EU 28 in 2011
FRAMEWORK CONDITIONS			
Human resources			
1.1.1 New doctorate graduates per 1000 population aged 25-34	2.1	1.9	34.0
1.1.2 Percentage population aged 25-34 having completed tertiary education	39.8	41.2	23.9
1.1.3 Percentage population aged 25-64 involved in lifelong learning	10.9	12.0	-45.8
Attractive research systems			
1.2.1 International scientific co-publications per million population	1070	1492	67
1.2.2 Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	11.5	7.8	17.8
1.2.3 Foreign doctorate students as a % of all doctorate students	20.3	8.9	2.1
Innovation-friendly environment			
1.3.1 Broadband penetration	18.0	19.0	66.7
1.3.2 Opportunity-driven entrepreneurship	3.6	2.4	-82.7
INVESTMENTS			
Finance and support			
2.1.1 R&D expenditure in the public sector (% of GDP)	0.68	0.47	-31.7
2.1.2 Venture capital (% of GDP)	0.149	0.006	-6.8
Firm investments			
2.2.1 R&D expenditure in the business sector (% of GDP)	1.36	1.39	-34.3
2.2.2 Non-R&D innovation expenditures (% of turnover)	0.86	0.69	-11.1
2.2.3 Enterprises providing ICT training (% of all)	23.0	29.0	13.3
INNOVATION ACTIVITIES			
Innovators			
3.1.1 SMEs introducing product or process innovations as % of SMEs	34.3	25.9	-18.7
3.1.2 SMEs introducing marketing or organisational innovations as % of SMEs	35.6	27.0	-42.1
3.1.3 SMEs innovating in-house as % of SMEs	28.1	22.4	-15.5
Linkages			
3.2.1 Innovative SMEs collaborating with others (% of SMEs)	11.8	12.2	-20.7
3.2.2 Public-private co-publications per million population	81.7	95.3	-61.2
3.2.3 Private co-funding of public R&D expenditures (percentage of GDP)	0.05	0.04	-21.4
Intellectual assets			
3.3.1 PCT patent applications per billion GDP (in PPS)	3.53	1.86	-31.0

Table 1. Summary Innovation Index and its components in Slovenia relative to EU28 in 2018 (index EU28 in 2011=100)

	EU28	SI	Change in index relative to EU 28 in 2011
3.3.2 Trademark applications per billion GDP (in PPS)	7.85	10.79	12.6
3.3.3 Design applications per billion GDP (in PPS)	4.17	2.69	-19.9
IMPACTS			
Employment impacts			
4.1.1 Employment in knowledge-intensive activities (% of total employment)	14.2	13.7	3.8
4.1.2 Employment in fast-growing enterprises (% of total employment)	5.2	3.9	25.1
Sales impacts			
4.2.1 Exports of medium. high technology products % of total product exports	56.3	57.3	8.4
4.2.2 Knowledge-intensive services exports as % of total services exports	68.4	36.5	6.5
4.2.3 Sales of new-to-market and new-to-firm innovations as % of turnover	12.96	8.68	-75.4

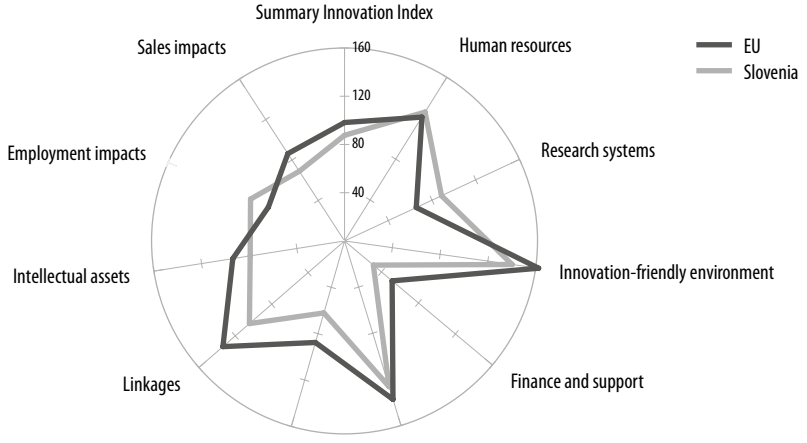
Source: European Commission. 2019.

While the country is exceeding expectations in basic research (when measured by comparative success in international scientific publications), it is marked by an unattractive research system. Slovenia trails behind in publications in cited journals (7.8 percent of publications) and in its number of foreign doctorate students (8.9 percent, while the EU28 on average has 20.8 percent). Regarding its innovation environment, Slovenia is average in broadband penetration, despite significant progress compared to 2011 (column 3, Table 1). Since 2011, however, Slovenia has lagged significantly behind the EU average in entrepreneurial opportunities.

In *investments*, R&D expenditure in the business sector is slightly above the EU average with 1.4 percent of GDP, but Slovenia is lagging behind the EU in non-R&D innovation expenditure, which includes investment in equipment, machinery, patents, and licenses. Public expenditure on R&D is significantly below the EU average, while the share of venture capital is only 0.006 percent of GDP (0.15 in the EU). Slovenia is lagging behind the EU averages in all innovators' indicators and their status has also deteriorated in all of them since 2011; but Slovenia is performing better than the EU average in innovative SMEs collaborating with others and private-public co-publishing. Unfortunately, Slovenia has again deteriorated in its position since 2011.

On the other hand, in *innovation activities*, Slovenia has improved since 2011 and is above the EU average in trademark applications, which is important for raising value added. This is undercut by a declining performance in patent and design applications. These three components are constituent parts of intangible capital, which is contributing to up to a third of productivity growth (Corrado et al., 2013; Roth and Thum, 2013). In terms of impacts, Slovenia is significantly behind the EU in all components except in medium and high-tech product exports, where it is actually slightly above the EU average. Worryingly, the country's standing significantly worsened in the indicator of sales of new-to-market or new-to-firm innovations as a percentage of turnover (European Commission, 2019).

Figure 3. European Innovation Index components in Slovenia in 2011 and 2018



Source: European Commission, 2019.

Since 2011, Slovenia has significantly deteriorated in its position, especially in terms of linkages, innovators, finance and supports, innovation-friendly environments, and consequently in overall value. A substantial improvement was made only in research systems (Figure 3). This is comparatively slow progress and creates a lag behind Germany as well as the Czech Republic[1].

Table 2 provides data on the innovation index sub-component values for Slovenia, Czechia, and Germany for 2011 and 2018. Slovenia has fallen behind its main trading partner in several important aspects.

1 The choice of Germany and Czech Republic was made due to the fact that the former represents main trading partner for Slovenia, while the latter represent former transition economy, that achieved significantly higher growth during last decade if compared to Slovenia.

Table 2. Innovation index by component in Czechia (CZ), Germany (DE), and Slovenia (SI) in 2011 and 2018

	SI		DE		CZ	
	2011	2018	2011	2018	2011	2018
New doctorate graduates per 1000 inhabitants aged 25-34	1.5	1.9	2.7	2.7	1.3	1.7
% of population aged 25-34 having completed tertiary education	38.0	41.2	28.4	32.1	29.9	33.6
% of population aged 25-64 involved in lifelong learning	16.4	12.0	7.8	8.4	10.0	9.8
International scientific co-publications per million population	1032.6	1492.1	792.2	995.1	576.8	980.1
Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	6.1	7.8	11.1	11.8	4.9	5.9
Foreign doctorate students as a % of all doctorate students	8.5	8.9	11.2	9.7	10.8	15.9
Broadband penetration	13	19	9	17	8	13
Opportunity-driven entrepreneurship	5.4	2.4	2.4	3.8	2.1	2.6
R&D expenditure in the public sector	0.6	0.5	0.9	0.9	0.6	0.7
Venture capital (% of GDP)	0.01	0.01	0.1	0.1	0.1	0.01
R&D expenditure in the business sector (% of GDP)	1.8	1.4	1.8	2.1	0.8	1.1
Non-R&D innovation expenditures (% of revenues)	0.8	0.7	0.9	1.3	1.0	0.7
Enterprises providing ICT training (% of all)	27	29	23	30	21	25
% of SMEs introducing product or process innovations	31.0	25.9	53.6	41	34.9	33
% of SMEs introducing marketing or organisational innovations	39.4	27	68.2	45.6	45.9	31.3
% of SMEs innovating in-house	25.8	22.4	46.0	36.8	29.6	30.5
Innovative SMEs collaborating with others (% of SMEs)	14.2	12.2	11.8	8.5	11.3	12.6
Public-private co-publications per million population	136.6	95.3	112.4	137.3	50.7	60.3
Private co-funding of public R&D expenditures (% of GDP)	0.06	0.04	0.1	0.1	0.02	0.03
PCT patent applications per billion GDP (in PPS)	3.1	1.9	7.5	6.3	0.8	0.8
Trademark applications per billion GDP (in PPS)	9.5	10.8	10.1	9.4	4.7	5.1
Design applications per billion GDP (in PPS)	3.6	2.7	7.1	6.3	2.9	4.2
Employment in knowledge-intensive activities (% of total employment)	13.4	13.7	15.4	14.8	12.3	12.9
Employment in fast-growing enterprises (% of total employment)	2.8	3.9	5.9	4.8	6.7	7.1
Exports of medium and high technology products as a share of total product exports	54.3	57.3	65.5	68.3	63.2	67.1
Knowledge-intensive services exports as % of total services exports	33.3	36.5	76.2	75.5	37.9	42.7
Sales of new-to-market and new-to-firm innovations as % of revenue	16.3	8.7	17.4	14.0	18.7	13.0

Source: European Commission, 2019.

Compared to Germany, Slovenia declined in its share of sales of new-to-market or new-to-firm products/services in terms of revenue. In 2011, Slovenia was at 92 percent of Germany's level, but in 2018 it was only at 51 percent. It has also deteriorated in the number design and patent applications. In all these aspects, the Czech Republic has improved its relative position in the same period. A similar comparative performance to Germany with Slovenia weakening and the Czech Republic improving can also be observed in R&D expenditure in the business sector, share of SMEs with product or process innovations, share of SMEs with marketing or organisational innovations, SMEs innovating in-house, and in public-private co-publications.

2 Innovation characteristics in Slovenia at firm level

Eurostat has been studying the characteristics of innovation activities at the firm level every two years since 2002 using the Community Innovation Survey (CIS). The survey studies the prevalence and detailed characteristics of main innovation types (product, process, marketing, and organization) in firms, how companies innovate (cooperation, expenditure, organization, the role of supports, etc.), and other characteristics of companies (Eurostat, 2019a). Selected results for Slovenia are presented to further explain the already aggregated results.

The 2016 CIS analysis included 4,440 Slovenian companies and focused on the period between 2012 and 2014. In Slovenia, 40 percent of companies reported performing an innovation activity or introducing innovation in the studied period, which is significantly less than in the EU28 on average (Table 3).

Only one fifth of product-innovative enterprises introduced a new product compared to one fourth in the EU28; however, the data also show that in Slovenia, large companies have carried out significantly more innovation than average Slovenian firms as well as conducted more innovation than comparable firms in the EU28 (Table 3).

Eurostat (Eurostat, 2019b) also shows that among the companies that introduced no innovation and have no innovation activity, 42 percent claim that the local, regional, or national market is their most important market. For larger firms, which are typically more innovative, the situation is reversed. 34 percent of innovators (product, process, organization, or marketing) claim foreign export markets to be their most important markets. This difference between companies

based on their target market is in line with previous findings, which stressed the importance of the link between access to knowledge, cooperation within global value chains, competition, and consequently strong strategic orientation toward innovation (Prašnikar, Redek, and Drenkovska, 2017).

Table 3. Innovation in Slovenia and the EU28: percent of firms with specific innovation type by firm size (number of employees)

	EU28				Slovenia			
	Total	10 to 49	50 to 249	250 or more	Total	10 to 49	50 to 249	250 or more
Total	100	100	100	100	100	100	100	100
Enterprises that have either introduced an innovation or have any kind of innovation activity*	50.6	46.4	63.2	77.4	39.8	34	55.6	82.7
Product and/or process innovative enterprises only*	14	13.1	16.9	17.3	11.3	9.9	16.1	17.2
Product and/or process and organisation and/or marketing innovative enterprises only*	25.5	22.2	34.5	50.5	19.9	15.3	31.3	60.2
Product innovative enterprises (regardless of any other type of innovation)	25.9	22.6	34.7	51.3	20.4	15.3	33.7	59.8
Organisation and/or marketing innovative enterprises only	11.1	11	11.7	9.6	8.5	8.8	8.2	5.4
Enterprises that have not introduced any innovation and have no innovation activity	49.4	53.6	36.8	22.6	60.2	66	44.4	17.3

Note: * regardless of any other type of innovation.

Source: Eurostat, 2019b.

The product and process innovators carried out a number of innovation activities to support their efforts. Table 4 demonstrates the different types of innovation activities carried out by firms which conducted at least one activity.

The companies that do innovate generally combine a large number of different research activities as well as other support activities. Large companies again dominate in the field of research and innovation as well as support activities. The difference is most obvious in the presence of continuous in-house R&D, contracted-out research, and in the presence of other innovation activities. Given that in the literature, product and process innovation is deemed as more resource-demanding, the data are aligned with the literature (Forbes and Wield, 2000).

Table 4. Types of innovation activities in innovative* firms by firm size (number of employees)

	No. of firms	Total (in %)	10 to 49 (in %)	50 to 249 (in %)	250 or more (in %)
All innovation activities except contracted-out R&D (external R&D activities)	1379	99.4	99.5	99.1	99.2
In-house R&D	1069	77.0	73.5	82.5	84.4
In-house R&D – continuous	509	36.6	28.4	45.7	64.9
In-house R&D – occasional	561	40.4	45.1	36.8	19.5
Contracted-out rR&D	609	43.8	36.5	52.2	68.4
Acquisition of machinery, equipment, buildings and software	1040	74.9	73.1	76.3	83.2
Acquisition of existing knowledge from other enterprises or organizations	499	35.9	32.5	40.8	44.3
Enterprises engaged in training, market introduction, design or other innovation activities	967	69.6	67.9	69.0	83.2
Training for innovative activities	611	44.0	41.2	44.5	61.0
Market introduction of innovations	590	42.5	41.2	41.6	53.8
Design activities to alter the shape, appearance/usability of goods	582	41.9	42.0	41.3	43.2
Other innovation activities	506	36.4	31.6	39.2	60.6

Note: *innovative companies reported at least one innovation activity (n=1388).

Source: Eurostat, 2019b.

The product/process-innovative companies developed their new products or processes primarily by themselves (63 percent of innovative companies) or in cooperation with other enterprises or companies (47 percent of innovators reported this). On the other hand, only around five percent of innovators relied on modifying other organizations' products or processes or relied entirely on other organizations for innovation (Eurostat, 2019b).

Throughout the innovation process, companies normally rely on a number of different sources, absorb externally available information and knowledge, and then combine it with their own (Chesbrough, 2003; European Union, 2014). This is also consistent with the aforementioned theory. Slovenian corporate innovation relies mostly on enterprises within the group, which was reported by almost 70 percent of companies and even more so among large firms (Table 5).

Table 5. Product and/or process innovative enterprises which used information as highly important source for their innovation activities, by source of information and size (number of employees)

	All (in %)	10 to 49 (in %)	50 to 249 (in %)	250 or more (in %)
Enterprises within the enterprise group	68.1	64.1	74.3	76.4
Suppliers of equipment, materials, components or software	34.8	34.5	33.7	40.2
Clients or customers from the private sector	42.3	39.6	46.0	49.1
Clients or customers from the public sector	15.5	14.3	18.2	15.2
Competitors or other enterprises of the same sector	30.6	25.9	35.7	47.2
Consultants or commercial labs	10.6	9.5	11.0	16.3
Universities or other higher education institutions	11.3	9.3	12.5	21.0
Government or public research institutes	6.1	5.2	6.7	10.5
Private research institutes	6.0	5.4	5.3	11.4
Conferences, trade fairs or exhibitions	24.7	22.2	27.0	34.7
Scientific/technical journals or trade publications	17.1	21.1	12.0	5.7
Professional or industry associations	21.4	25.3	17.5	6.6

Source: Eurostat, 2019b.

Invaluable sources of information were also clients and customers from the private sector, as this is where almost half of all large companies and 40 percent of total companies received relevant information. Competition was also acknowledged as an important source of information by almost half of large companies and one third of total firms. Companies also mention conferences, trade fairs, and exhibitions as important sources.

Just as competitors and clients are important sources of information, enterprises within the same business group are key partners in the innovation process for companies of all size classes (Table 6).

Moreover, around 50 percent of large companies list competitors as co-operators, around 57 percent rely on clients from the private sector, and almost 70 percent list suppliers as important partners. Interestingly, over 70 percent of large enterprises cooperate also with research institutes. This structure confirms the previous findings about the importance of cooperation within the value chain for Slovenian B2B companies, as there are a number of development partners who assist leading multinational companies. Expectedly, due to the structure of our trade, most innovation partners are from the EU, EFTA, or candidate

countries. It is also interesting to note that Slovenian companies are much more engaged in cooperation during innovation than the average company in the EU (last column, Table 6).

Table 6. Product and/or process innovative enterprises engaged in co-operation with specific type of co-operation partner, by type of co-operation and size (number of employees)

	All (in %)	10 to 49 (in %)	50 to 249 (in %)	250 or more (in %)	EU (in %)
Any type of co-operation	44.7	35.2	55.2	76.9	32.5
Enterprises within the enterprise group	18.1	7.7	27.9	58	15.8
Private research institutes	41.5	32.8	50.5	72.8	:
Consultants or commercial labs	19.7	15.9	21.4	40.8	12.6
Suppliers of equipment, materials, components or software	37.1	27.8	47.3	69	21.5
Clients or customers from the private sector	29.9	23.6	35.1	56.8	16.6
Competitors or other enterprises of the same sector	26.5	22.8	27.7	47.7	11.3
Universities or other higher education institutions	22.5	13.8	31.2	54.8	13.8
Government or public research institutes	15.6	10.2	19.7	39.7	8.4
Clients or customers from the public sector	16.1	14.8	14.7	29.1	9.1
National partner	35.3	25.6	45.5	69.9	:
Partner in EU, EFTA or EU candidate countries (except a national partner)	44.7	35.2	55.2	76.9	11.3
Partner only in the EU	13.6	9.5	17.2	29.4	9.0

Source: Eurostat, 2019b.

Generally, as is reported in the following survey among Slovenian companies, companies increasingly rely on their own resources in the process of innovation; however, different public sources are still used in a significant share of companies. For example, over 40 percent of large companies rely on public funding which comes from different sources (national, EU) (Table 7). Smaller companies rely significantly less on such resources. Given the desire of the EU to stimulate the growth of SMEs, it is important to further investigate the causes. It should be decided whether the mechanisms are deemed inappropriate for their specific needs, or perhaps the procedures are too complex for the companies, where often the lack of human resources is one of the main challenges in implementing changes (Prašnikar et al., 2017; Redek et al., 2018; Redek and Oblak, 2016).

Table 7. Product and/or process innovative enterprises that received public funding for innovation activities by source of funding and size, in percent

	Public funding	National central government	Local or regional authorities	European Union	EU 7th Framework and Horizon EU2020 Programmes
All firms	26.0	20.4	2.8	12.6	5.5
10 to 49 employees	21.5	17.4	3.2	10.0	3.6
50 to 249 employees	31.0	23.9	:	15.0	7.8
250 employees or more	41.0	29.8	:	22.5	11.9

Source: Eurostat, 2019b.

Overall, the data reveals that Slovenia on the one hand in many aspects of innovation, according to the European Innovation Scoreboard lags behind the EU averages and comparatively it has also deteriorated since 2010. However, more detailed firm level data nonetheless show that Slovenian companies, especially the larger and export-oriented ones, are significantly more successful that the average European company, while primarily smaller companies lag behind in several examined aspects, which results also in a smaller proportion of innovative enterprises among them.

3 Discussion and conclusion

Slovenia has a number of strong, primarily large companies, which are systematically investing into R&D and being a research-oriented company also presents their strategic orientation. A survey of around 100 large Slovenian companies revealed that these companies are primarily highly export-oriented B2B companies, which are strong partners in some of the biggest global value chains. (Prašnikar et al., 2017) The companies on the one hand are faced with strong competition from outsiders and on the other hand expectations of partners within the value chain to deliver products that contribute to overall competitiveness of the final product. Being research-oriented is thus a strategic imperative. The vast majority of these companies invests at least three percent of their revenue to R&D. The latest survey of large Slovene companies, reported in this book, showed that in year 2018 they have invested even more, on average 4.5 percent of their revenue to R&D. (Domadenik et al., 2019) Large companies also invest systematically into building human capital, involve large majority of employees into training and thereby build their competences. In addition, often they build a core group of employees, which is expected to build future success.

Gathering information, cooperation between departments and other companies (partners) are extremely important for innovation. Companies also acknowledge the importance of human capital, their motivation and consequently systematically report above average payment. The role of the management and their strategy for the company is evident.

This research also revealed that there is a number of other companies, which are less strategically oriented towards R&D, invest less and also devote less attention to organization of processes and human capital that would support this innovation. While their reported performance in the market varied, from some which are very successful, to others, which were less, the long-term prospect if these two groups (strategic innovators and the rest) are compared, is clear. In the knowledge-driven highly competitive global economy the first will be more successful and are likely to generate higher value added thereby stimulating a virtuous cycle of growth, where innovation increases value added and this allows companies to be even more innovative, as they can invest more.

The data presented here presents a similar picture. But here, primarily the differences between the large and smaller companies are highlighted. Smaller lag behind, probably for a number of related reasons, which goes beyond the scope of this paper. However, to successfully develop, all companies will have to become more innovative and policy-makers should thus carefully evaluate the reasons behind these results and (where possible) develop mechanisms for the laggard companies to become more innovative and scale-up in international context.

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Polona Domadenik, Daša Farčnik, Denis Marinšek

THE EFFECT OF SUBSIDIES ON FIRM SURVIVAL IN SLOVENIA

Introduction

The public discussion on industrial policy often revolves around the short and long-run efficiency of various instruments of state support; however, the government subsidy program is not designed only to correct for market failures, but to stimulate economic agents to behave in a socially desirable way to generate welfare effects. Moreover, in order to support inventions and innovations facing challenges related to mega trends such as growing inequality, climate change, and aging population, the existence of the 21st century State crucially co-creates and co-shapes the markets (Mazzucato, 2013).

Debates about the effectiveness of industrial policy, broadly defined as a policy agenda that shapes a country's industrial structure by promoting specific sectors, have been present in academic literature since the 60's (see Baldwin, 1969, for example). Today, industrial policy is at the forefront of economic policy and as Rodrik (2010) puts it, "the real question is not whether industrial policy should be practiced but how". State subsidies have been at the core of industrial policy since the 60's and affect the entry and exit decisions of the business sector. In academic debates, turnover (firms' entry and exit) is often associated with the process of creative destruction, in which more innovative and productive companies replace those that could not adjust to new market conditions and/or use outdated business models (Baldwin, 1995; Geroski, 1995; Jovanovic, 1982; Ericson and Pakes, 1998; Asturias et al., 2019). The survival of companies depends also on institutional and regulatory frameworks. Developed economies provide large-scale services to help start-ups and small firms to survive, develop (Gu et al., 2006), and experience a high rate of firm entry and exit.

In this chapter we assess the effect of public subsidies on firm survival in Slovenia. Moreover, we test for heterogeneity relating to different types of subsidies. In the first section, we review the literature on predictive factors for corporate failures and the effect of subsidies on firm survival, followed by a description of sample, model, and estimations using a virtually complete set of companies in Slovenia with more than 25 employees in the period of 2006-2018.

1 Literature review on the effect of subsidies on corporate survival

The literature on firm survival mostly focuses on identifying financial indicators that might be used to predict corporate failure. Most empirical research confirms that financial ratios are important when discriminating between surviving firms and those that exit the market. Most empirical studies follow the Altman model (often referred to as Z Score model) that builds on five financial ratios to predict failure: (1) working capital compared to total assets; (2) retained earnings to total assets; (3) earnings before interest and taxes to total assets; (4) market value equity to value of debt; and (5) sales to total assets (Altman, 1968; Lincoln, 1984; Gadenne and Iselin, 2000; Tan and Dihardjo, 2001).

Several studies show that including market-driven variables (market returns, for example) and other company characteristics (age and size) improve the accuracy of the model (Shumway, 2001). The younger or smaller firms are more likely to fail than established or larger firms as they have less business experience, limited network connections, and a lack of sufficient information capital. Audretsch and Mahmood (1995) and Honjo (2000) found that larger firms are less likely to experience financial distress; but Rommer (2004) points out that the effect of size on firm exit is not so trivial and is likely to be bell-shaped. Large firms also suffer from inefficiency in their business models or ineffective organization, agency conflicts, and communication problems within the company.

The most important instruments in the industrial policy toolbox are subsidies for specific purposes. While most evidence supports horizontal measures aimed at regional development or innovations, some recent studies show that production and investment subsidies can be justified by revenue generation as they favour large and efficient firms that benefit from economies of scale, whereas entry subsidies are not efficient and attract small and high-cost producers (Barwick et al., 2019). R&D subsidies, one of the most common horizontal measures, aim to stimulate private investment in innovation and related technological improve-

ments, a major source of productivity growth (see Griliches, 1998, for example) at the national level (Hall, 2011; Crepon et al, 1998). The main argument for R&D subsidies are market imperfections, as firms invest less in R&D than is optimal from a social point of view (Arrow, 1962).

Although the theory provides plausible arguments to use R&D subsidies to fix market imperfections, empirical evidence remains inconclusive. Several studies show that the estimated productivity effect of R&D subsidies is insignificant. Irwin and Klenow (1996) find an insignificant correlation in the case of high-tech firms in the US, while Criscuolo et al. (2012) finds an insignificant correlation in the case of regional subsidies in Britain, and Bernini and Pellegrini (2011) also find inconclusive results in Italy. The heterogeneity of subsidy effects is visible also within a single country. Einio (2014), for example, reports a significant impact of R&D subsidies from the European Regional Development Fund on productivity in Finland three years after the subsidy was granted, while Koski and Pajarinen (2013, 2015) report that any kind of subsidies in Finland had a slightly negative or insignificant effect on productivity growth. Based on prior studies that discuss the heterogeneity of subsidy effects on productivity we might suspect that innovation policy design should take into account also the size, industry, and other characteristics of the firm. Several studies stress that the effect of public subsidies on productivity is positive in small companies (Lach, 2002), especially in those that operate in low-technology sectors (Gonzales and Pazo, 2008) and those that rely on external financial sources (Hyytinen and Toivanen, 2005).

The studies that estimate the effect of public subsidies on firm survival mostly relate to the efficiency of active labour market policy. While some studies report a negative effect in the case of subsidies given to unemployed people[1], Almus (2001) found a statistically significant higher rate of survival and higher employment growth in the case of subsidy recipients five years later when compared to those who received no support. Similarly, the positive effect on firm survival of subsidies for unemployed people to create new businesses has been estimated in the case of French companies (Crepon and Duguet, 2003). Empirical evidence for South Korea shows a significantly positive impact of credit guarantees on firm survival and employment (but not productivity or investment) in small and medium-sized companies in the period following the 1999 financial crisis (Oh et al., 2009). On the other hand, recent evidence on Korea shows that government R&D subsidy programs have a negative effect on firm survival in the long-run (Kim, 2018). Subsidies did not have any sig-

1 Firms created by unemployed people that received public support in eastern Germany had a lower probability of survival one year later than those firms that receive no support (Pfeiffer and Reize, 2000).

nificant effect on firm survival in the short-run, while the survival probability of subsidized firms was significantly lower after six years of subsidy receipt.

2 Description of sample and data

In order to test the impact of various subsidy schemes on firm survival we use accounting data of Slovenian firms, available from the Agency of the Republic of Slovenia for Legal Records (AJPES), and a complete set of corporate subsidies from 2006 to 2018. We include all Slovenian firms which were in operation in 2006 and employed at least 25 employees.[2] We then exclude firms operating in the regulated industries. These are *Electricity and Gas* (NACE Rev. 2: two-digit code 35), *Water supply and Waste management* (NACE Rev. 2: two-digit codes 36-39), and *Financial and Insurance Activities* (NACE Rev. 2: two-digit codes 64-66).[3] For the remaining firms we calculate the number of years a firm operates up to 2018, which is the last financial year in our study. We also excluded a few firms for which the last available accounting data was from 2006. The final sample therefore comprises 2,354 firms.

In Table 1 we present descriptive statistics for the sampled firms. An average firm generated 34,410 euros of value added per employee, had 117 employees, and reported 8.5 million euros of tangible assets (representing 43.65 percent of total assets). EBITDA on average amounted to 7.96 percent of total assets, while average financial leverage was 26.43 percent. The average ratio between current assets and current liabilities was 1.78, ranging from as low as 0.24 up to 8.89. The average share of exports of total sales was 26.41 percent. An average subsidy per mean number of employees amounted to 269 euros, average development subsidies were 124 euros, and average crisis relief subsidies were 145 euros. Regarding industry structure, 42 percent of firms operated in the manufacturing industry, 12 percent of firms in construction, and 46 percent in the service industry.

A more detailed analysis of the period 2006-2018 reveals that the average value added per employee increased by 51 percent in 12 years, starting at 29,491 euros in 2006 and finishing at 44,703 euros in 2018. Average EBITDA in total assets was 10.5 percent before the crisis, fell to 7.2 percent in 2009, and rose up again to 10.3 percent in 2018. Slovenian firms had the highest average financial leverage in 2010,

2 By setting this limitation, our analysis emphasizes on firms that can be expected to behave accordingly to the financial theory (e.g. Byoun (2008)).

3 This is a common practice in such types of studies (see e.g. Lemmon, Roberts and Zender (2008)). Firms operating in excluded industries might have very different capital structures. For example, high leverage can be normal for financial and regulated firms, while the same leverage may indicate possible financial distress for other firms, as discussed by Byoun (2008).

amounting to 29 percent of total assets. After that year, fast deleveraging can be noticed, reaching as low as 19 percent in 2018. The ratio of current assets to current liabilities has been improving over the analysed period (from 1.51 to 2.40), while the share of tangible assets was rising between 2007 to 2013 (from 42.5 percent to 46 percent) and then fell to 44 percent in 2018. The average subsidy amount per employee was constant at around 86 euros in the period 2006-2012. In the years 2013, 2014, and 2015 there was a huge increase of 874 euros, 1,304 euros and 1,145 euros, respectively. After 2015, average subsidies per employee fell to around 160 euros. The same pattern can be observed for development and crisis relief types of subsidies. The average share of exports was growing linearly from 2010 to 2018 (from 25 percent to 32 percent), while the average number of employees saw a significant decrease during the crisis (the lowest was 112 in the year 2012) followed by a strong increase of 20 percent from 2012-2018, with an average of 135 employees in 2018.

Table 1. Descriptive statistics for sampled firms

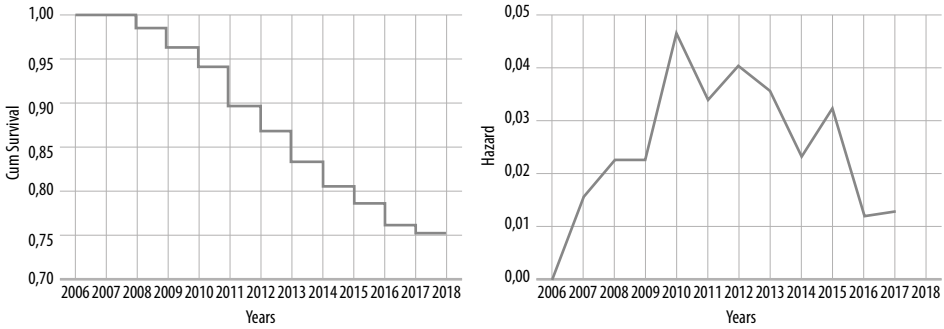
	Mean	Standard Deviation	Median
Financial indicators			
Value added per employee (in euros)	34,410	23,352	28,639
EBITDA to total assets (in percent)	7.96	8.30	7.74
Financial leverage to total assets (in percent)	26.43	19.74	24.15
Current assets to current liabilities	1.78	1.56	1.28
Tangible assets (in euros)	8,509,038	22,908,833	2,086,092
Tangible assets to total assets (in percent)	43.65	22.75	43.81
Subsidies			
All subsidies per mean employee	268.89	707.42	21.30
Development subsidies per mean employee	123.50	437.91	0.00
Crisis relief subsidies per mean employee	145.39	548.01	1.43
Other firm level characteristics			
Share of export (in percent)	26.41	32.66	8.18
Number of employees	117.28	190.72	54.58

Note: Data relates to the sample of 2,354 firms. Variables are measured as the average firm value, calculated from all available firm-year observations. All continuous variables are winsorized so that values below the 1st percentile (above 99th percentile) are replaced with the value of the1st percentile (99th percentile). Subsidy ratios are calculated per mean number of employees.

Source: AJPES, 2019; Ministry of Finance, 2019; own calculations.

For each firm we check if during the period 2006-2018 goes into the process of bankruptcy/liquidation or stops operating due to other reasons. In Figure 1 we report *survival function* and *hazard rates* for our set of firms.

Figure 1. Survival function (left) and Hazard function (right) for a sample of Slovenian firms



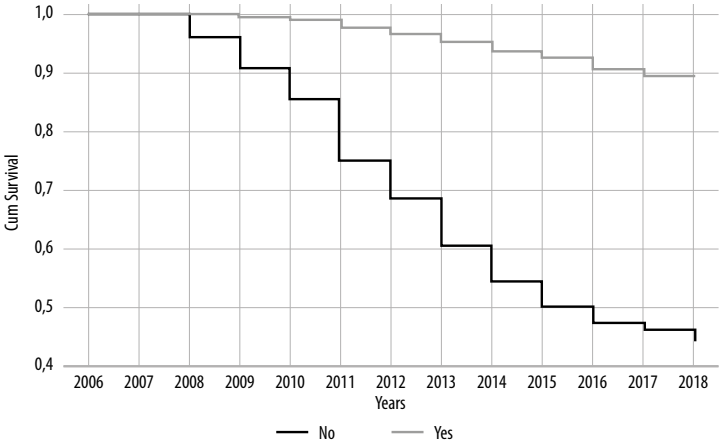
Source: AJPES, 2019; Ministry of Finance, 2019; own calculations.

On left side of Figure 1 we graphically show the cumulative proportion of firms surviving to the end of each interval (i.e. financial year). By the end of 2018 (the beginning of 2019), the cumulative proportion of surviving firms is 0.74. The highest number of bankruptcies/liquidations happened over the period 2010-2011 with 4.5 percent of operating firms failing to survive to the next year, followed by the period 2012-2013 (3.9 percent), with the lowest number of defaults occurring during the period 2016-2017 (1.2 percent). Figure 2 shows the hazard rates (the probability of not surviving to the middle of each year, given survival at the start of the interval) over the years. Slovenian firms experienced the highest hazard during the 2010-2013 period, which corresponds to the peak of the financial crisis. In the last available financial year, the hazard rate slightly increased but is still lower than when it was in 2007-2008.

Figure 2 compares survival rates of the groups subsidy recipients and non-recipients. The first group consists of 1,499 firms that received one or more subsidies over the period 2006-2018, while the second group consists of 855 firms that did not receive any subsidies over the analysed period.

Results show that there are highly significant statistical differences in survival rates among the compared groups (Willcoxon-Gehan $\chi^2(1) = 502{,}3$, $p < 0.001$). The median survival time for a group that received no subsidy is only nine years, indicating that 50 percent of companies did not survive to 2015, while the survival of subsidy recipients was above 90 percent. Although results suggest that subsidies improve survival rates, there might be a selection bias, especially when we speak about subsidies for development, that are usually granted to more successful firms.

Figure 2. Survival rates as a function of subsidies



Source: AJPES, 2019; Ministry of Finance, 2019; own calculations.

3 Empirical model and results

To further investigate whether the survival of firms in the studied period was affected by the subsidies they received from 2006-2018, and controlling for variables which were found to affect the likelihood of bankruptcy (productivity, financial indicators, and other firm-specific variables like size, age, and industry)[4] *Cox Proportional Hazard Regression Model* as shown in Equation 1.

$$h(t) = h_0(t)\, e^{(b_1\chi_1 + b_2\chi_2 + \ldots + b_p\chi_p)} \tag{1}$$

In Equation 1, t represents the survival time, and $h(t)$ is the hazard function determined by a set of covariates ($\chi_1, \chi_2, \ldots, \chi_p$), which can be either time-variate or constant. The coefficients ($b_1, b_2, \ldots, b_p$) measure the impact of covariates, h_0 is the baseline hazard and e^{b_i} is hazard ratio (HR). Besides subsidies per mean number of employees, we included value added per employee and EBITDA to total assets as measures of productivity as well as several financial indicators (financial leverage compared to total assets, current assets to current liabilities, and tangible assets to total assets). We also controlled for size (total assets), export orientation (share of exports in sales), type of companies (private vs public firms), and industry.

The Cox Proportional Hazard Regression is a statistical method for analysing the survival time of a subject as a function of selected covariates. It is

4 See for example Shumway (2001) and Graham and Leary (2011).

commonly used in medical studies but can be applied to economic problems. Its main advantage is the ability to treat subjects that fail during the analysed period for unknown reasons (i.e. reasons other than bankruptcy/liquidation) as censored observations. Similarly, firms that remain in operation after the end of the selected time period of analysis are also treated as censored observations. The Cox Proportional Hazard Regression, unlike classical regression methods, makes it possible to use the information of these censored observations and provides consistent parameter estimates (Cox, 1972).

Table 2. Cox Regression Analysis of effect of selecting variables on hazard rate of Slovenian firms

Variables	Hazard Ratio	Prob.	Hazard Ratio	Prob.
Value added per employee	0.999	< 0.001	0.999	< 0.001
EBITDA to total assets	0.994	< 0.001	0.995	< 0.001
Financial leverage to total assets	1.002	< 0.001	1.002	< 0.001
Current assets to current liabilities	0.970	< 0.001	0.973	< 0.001
Logarithm of total assets	0.977	0.036	0.977	0.040
Tangible assets to total assets	0.999	0.070	1.000	0.238
Public vs private	1.645	< 0.001	1.754	< 0.001
Share of export	0.999	0.001	0.999	0.005
Manufacturing	1.644	< 0.001	1.753	< 0.001
Construction	2.447	< 0.001	2.317	< 0.001
Subsidy			0.999	< 0.001
χ^2	980.52	< 0.001	1044.19	< 0.001
Pseudo R^2	0.34		0.36	

Note: Data relates to the sample of 2,354 firms. Firms with at least 25 employees in the year 2006 and have at least 2 years of financial data (2006 and 2007) are used in the analysis. Firms operating in NACE Rev. 2: 35, 36-39, and 64-66, are excluded. HR stands for Hazard Ratio.

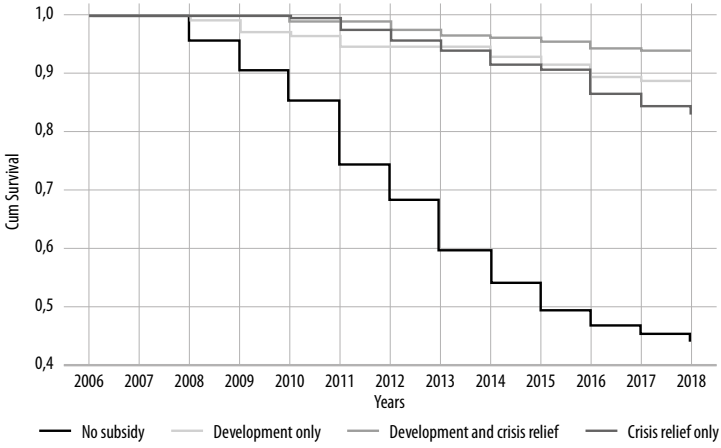
Source: AJPES, 2019 and Ministry of Finance, 2019.

The results of the Cox Regression are shown in Table 2 and are consistent with other empirical studies. Two models were estimated in order to compare the effect of subsidies on a company's survival probability: one without the subsidy as one of the explanatory variables (first two columns) and one with the subsidy per mean employees (last two columns). When the subsidy is included in the model, the explanatory power of the model increases (a pseudo R^2 of 0.36, which is relatively high for such types of studies). The productivity, profitability, liquidity, and size of the company decrease the hazard rate of bankruptcy which means that they improve survival rates (all $p < 0.001$). On the contrary, higher financial leverage is associated with a higher probability

of failure ($p < 0.001$). The highest survival rates have been reported for service firms, while manufacturing firms were 1.7 times more likely to fail and construction firms were 2.3 times more likely (both $p < 0.001$) in the observed period. Higher export rates improved survival rates ($p = 0.005$), though we do not find statistically significant evidence that firms with more tangible assets had a higher probability to fail. The inclusion of subsidies statistically significantly improves the fit of the model ($\chi^2(1) = 63.67$, $p < 0.001$) and reveals that firms receiving higher amounts of subsidies per employee were less likely to fail, all else being equal ($p < 0.001$).

Next, we test the effect of different types of subsidies on firm survival. Subsidies are divided into two groups: (1) development subsidies and (2) crisis relief subsidies. In this chapter we are especially interested in subsidies classified as development subsides, as they are used for SME development, R&D and innovation, venture capital, training, and environmental protection. In the observed period, a firm could either receive subsidies for development, subsidies for crisis relief, both, or none. Figure 3 shows that the highest survival rates were held by companies that received both types of subsidies (compared to all other groups, the differences are statistically significant at $p < 0.01$), followed by firms that received only development subsidies and finally firms that received only crisis relief subsidies (survival rates for these two groups of firms are not statistically significantly different). Firms that received no subsidy had significantly lower survival rates compared to every other group ($p < 0.001$).

Figure 3. Survival rates as a function of different groups of subsidies



Source: AJPES, 2019; Ministry of Finance, 2019; own calculations.

By re-estimating the Cox Proportional Hazard model with different types of subsidies, we found out that companies receiving higher amounts of development as well as crisis relief subsidies per employee were less likely to fail; however, development subsidies affect the survival rate with a lag (Table 3).

Table 3. Cox Regression Analysis of subsidies effect on survival of Slovenian firms

Variables	Hazard Ratio	Prob.	Hazard Ratio	Prob.
Development subsidy			0.999	0.150
Crisis relief subsidy			0.999	0.459
Development subsidy(t-1)	0.999	0.021	0.999	0.053
Crisis relief subsidy(t-1)	0.999	0.452	0.999	0.246
Development subsidy(t-2)			1.000	0.186
Crisis relief subsidy(t-2)			1.000	0.003
Development subsidy(t-3)			0.999	0.567
Crisis relief subsidy(t-3)			0.999	0.789
Development subsidy(t-4)			0.999	0.957
Crisis relief subsidy(t-4)			0.999	0.842
χ^2	988.73	< 0.001	999.85	< 0.001

Notes: Subsidies are calculated per mean employee in the observed years. Only hazard ratios for subsidies are presented, but the model was estimated using the covariates listed in Table 2.

Source: AJPES, 2019; Ministry of Finance, 2019; own calculations.

Our results show that companies that received more development subsidies per employee one year prior to the analysis of survival in each financial year were more likely to survive (first two columns in Table 3). However, we should be aware that development subsidies are usually granted to more successful firms with sound innovation projects and it's very likely that subsidized firms had higher likelihood to survive also without governmental financial support.

When controlling for different groups of subsidies received with longer lags, we find that crisis relief subsidies received two years before the analysis of survival in each financial year statistically significantly lower the hazard rate of bankruptcy. This means that those firms that received higher amounts of crisis relief subsidies per employee two years ago were more likely to survive.

Conclusions

Subsidies represent an important element within the industrial policy toolbox and are usually justified by argument that the 21st-century State should co-create and shape markets, rather than simply fixing them in the case of positive (public goods such as basic research) or negative externalities (pollution and carbon taxes). As shown by Mazzucato (2013), the classic market failure perspective of public investment in innovation does not justify the breadth and depth of public investment that has been used across the entire innovation chain, from basic research to applied research, early-stage financing of companies, and demand-side procurement policies.

In 2018, the subsidies in Slovenia amounted to €481.64 million or 1.05 percent of GDP. In this chapter we investigated whether those subsidies affected company survival rates from 2006 to 2018. By controlling for the factors that usually affect the survival of the firms, such as productivity, profitability, liquidity, export rate, and firm size, we find that firms that received subsidies in this period were less likely to go bankrupt. In particular, including subsidies per mean number of employees in the survival model of the firms, we find that subsidies received were an important predictor of the firm's failure. By categorizing subsidies into two broad groups (development and crisis relief subsidies), we found out that companies receiving both types of subsides have the highest survival rates, followed by firms that received development subsidies only and finally firms that only received crisis relief subsidies. Firms that received no subsidies had by far the lowest survival rate. We also confirmed that development subsidies affect the survival rate of a firm with a time lag of one year.

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Denis Marinšek, Irena Ograjenšek, Vid Janša, Ula Kočevar, Fati Sadikaj

THE IMPACT OF R&D SUBSIDIES ON PRODUCTIVITY IN SLOVENIA

Introduction

To stay competitive in this turbulent global environment, countries must continuously strive to improve their innovation performance, promote broad dissemination of experience gained from innovation implementation, and monitor corporate performance and productivity. Innovation activities at the corporate level (regardless of the firm size) seem to depend heavily on the operational efficiency of the national innovation promotion system. This system is based on different innovation policy instruments. The choice of instruments depends on the country's development level, economic policy goals, and general factors affecting the policy implementation. Innovation policy is thus a complex mix of instruments, which guides the innovation processes via different support activities such as public procurement, subsidies, and tax breaks with the goal of facilitating development, diffusion, and implementation of innovations to improve corporate performance (Reiljan and Paltser, 2015).

Slovenia recently published their "Slovenia development strategy 2030". In the report, factors such as lagging labour productivity, demographic changes, and specific environmental issues such as their above-average level of raw material consumption and high proportion of energy-intensive activities are emphasized (Government Office for Development and European Cohesion Policy, 2017). These are factors that are influenced by innovation policy, and specifically by R&D subsidies. It is therefore crucial to explore how effective these policies and subsidies have been up until now, and what might be the most efficient way to pursue policy regarding subsidies, considering their effect on productivity, in the future. In this chapter we analyse the impact of corporate R&D subsidies on Slovenian corporate productivity over the period 2006-2018

using the data provided by the Agency of the Republic of Slovenia for Public Legal Records and Related Services (AJPES) and by the Ministry of Finance.

The first section of the chapter identifies the policy framework through which subsidies are given to companies in the EU and Slovenia, and summarizes recent empirical evidence on the link between subsidies and productivity. In the second section we provide an overview of types and characteristics of subsidies offered in Slovenia. In the third section, empirical analysis quantifies the impact of R&D subsidies on firm productivity. The final section of the chapter provides policy recommendations that can be derived from our empirical findings.

1 The impact of subsidies on productivity in the literature

In the most advanced countries, innovation policy is conducted through a complex mix of instruments, mainly through direct funding (subsidies and capital transfers), tax reliefs (reduced payment of taxes and contributions), and support activities (favourable loans and debt guarantees), known also as state aid in general. Overall, the goal of policymakers is to strengthen the system for tax incentives, support the employment of R&D developers, provide incentives for increasing private investment into R&D, and promote knowledge-sharing between the public and private sector (European Commission, 2011).

In the European Union, the majority of member countries try to achieve the so-called Barcelona goal. Its goal is to raise overall research and development to three percent of the GDP by 2020 (European Commission, 2019). Despite the significant progress made since the objective was set, many of the EU countries, including Slovenia, have not yet achieved this goal (SORS, 2017).

Despite the overwhelming theoretical support for the role of subsidies as incentives for innovation, most empirical studies so far have been inconclusive in establishing a causal link between subsidies and the financial performance of firms and/or increased innovation in general along with improved productivity. David et al. (2000) examined 19 micro-econometric studies and found that only half of those were able to posit an effect of public support on innovation performance. Specifically, only half of the studies found a statistically relevant, positive relationship between public support (in the form of either subsidies or tax reliefs) and the innovation performance[1] of firms, though they do mention

1 Measured differently among different studies, but could include innovation spending, patent applications, journal and media mentions, productivity, etc.

possible methodological issues as a cause. Bronzini and Iachini (2014) found that of the 12 studies between 1999 and 2013, only half confirmed that subsidy programs have had a positive effect on R&D investments. Furthermore, there is conflicting evidence on whether or not public subsidies crowd out private investments (see for example Wallsten (2000) and Gonzalez et al. (2005)).

There is also rich empirical evidence suggesting that the positive link between subsidies and productivity exists. Harris and Robinson (2004) examined the impact of two UK government industrial support schemes (RSA - Regional Selective Assistance and SMART/SPUR - the Small Firm Merit Awards for Research and Technology) on a UK manufacturing plant. They were able to prove that RSA did improve total factor productivity for most regions it assisted; however, the support did not appear to have a large effect on corporate performance.

2 The characteristics of subsidies in Slovenia

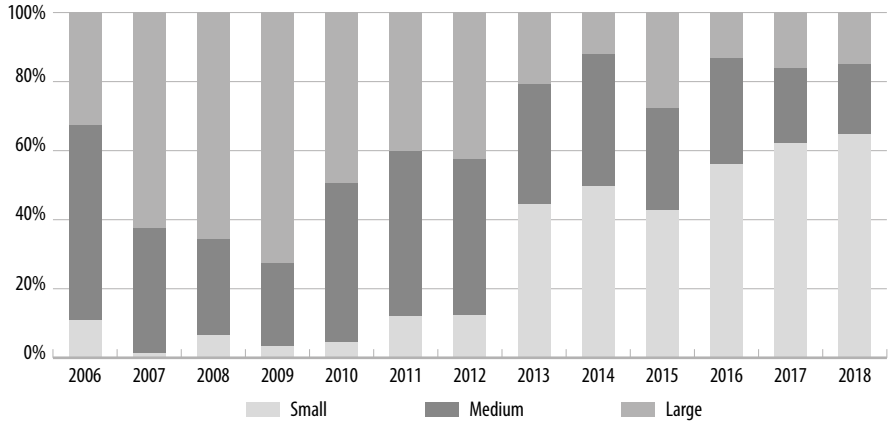
In the first two decades of the 21st century, the amount of total state aid[2] given to the Slovenian corporate sector has been as low as 0.62 percent of GDP in 2007 (Ministry of Finance, 2009), and as high as 1.61 percent of GDP in 2014 (Ministry of Finance, 2018). Currently it stands at 427.2 million euros or 0.99 percent of GDP (Ministry of Finance, 2018). Of that amount, about 70 percent, or 302.4 million euros, is distributed in the form of direct subsidies.

The most common state aid in Slovenia during 2006–2018 were subsidies for employment, while the least common were subsidies aimed to suppress serious imbalances in the economy (an enormous outlier that occurred only in 2013 and 2014). From 2006 to 2012, the structure of subsidies was quite consistent, while from 2013 on, new categories have been emerging (subsidies for agriculture, SMEs, transport (land), etc.). There were also two interesting outliers: a subsidy for restructuring in 2013, and a subsidy to help firms in financial distress in 2015. Results show that the most important types of subsidies were supportive of small and medium enterprises (316 million euros), subsidies for the protection of the environment (265 million euros), and subsidies for R&D and innovations (119 million euros).

2 State aid represents the measures of a government that intervenes in its current and investment expenditure (subsidies and capital transfers), revenues (reduced payments of taxes and contributions), financing (favorable loans) and debt (guarantees) and have an impact on the single market of the EU. The impact on the single market is defined by rules adopted by the European Commission, the European Council, and the European Court of Justice, whereby a significant part of state aid to agriculture, i.e. measures under the Common Agricultural Policy (CAP), is no longer recorded as state aid (IMAD, 2019).

In Figure 1, the distribution of R&D subsidies is shown by firm size. Firm size is defined by the average number of employees (small firms have between 10 to 50 employees, medium-sized 50 to 250, and large firms above 250). Within a group of R&D subsidies, the following types are included: R&D and Innovations, SME, General Economy, Venture Capital, Training and Environment Protection. Although the structure of small (numbering 4,500), medium-sized (1,000) and large (200) firms has been fairly constant throughout the observed period, it is evident that the allocation of R&D subsidies fluctuated throughout the years. From 2006 to 2012, medium-sized and large firms received the majority of subsidies. In 2013 there was a huge increase in subsidies granted to small firms. That share has been increasing, amounting to more than 60 percent of total R&D subsidies given to small firms in 2018.

Figure 1. The allocation of R&D subsidies to firms, by firm size, in percent of total subsidies paid



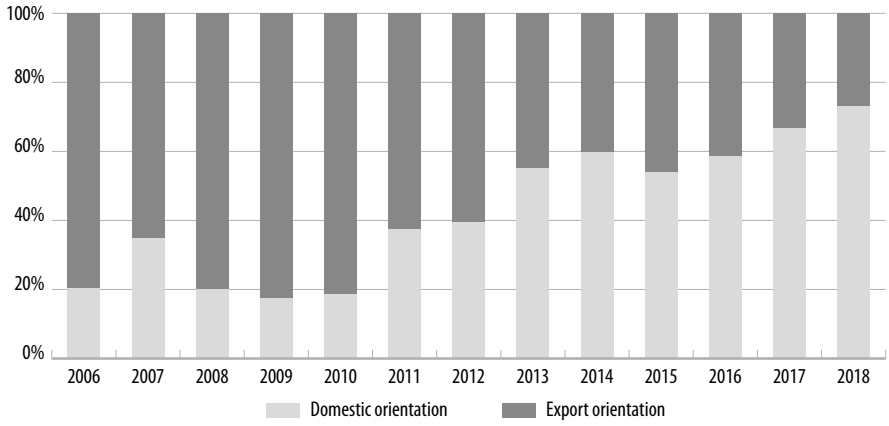
Source: AJPES, 2019 and Ministry of Finance, 2019.

The geographical location of subsidy receivers was extremely diverse. The dataset reveals that in 2018, the region of Central Slovenia received the highest percentage of subsidies (30 percent), followed by the Savinjska region (14 percent), the Coastal region (10 percent), and the Podravska region (9 percent). A similar distribution characterizes the whole observed period.

Figure 2 compares the distribution of R&D subsidies given to firms that are either domestically or export-oriented (the latter are the firms with at least 50 percent of revenues made on foreign markets). The numbers show that export-oriented firms have been receiving the highest share of subsidies up to the year 2012. Afterwards, more subsidies have been granted to domestically-oriented

firms, probably to counter the effects of the global financial and economic crisis on the Slovenian economy and society.

Figure 2. The allocation of R&D subsidies to firms in percent of total subsidies paid, by market orientation of firms



Source: AJPES, 2019 and Ministry of Finance, 2019.

Finally, comparing median values of selected performance indicators by groups of firms that did not receive any subsidies during 2006-2018, firms that received subsidies, and firms that received an R&D type of subsidy (see Table 1), some interesting differences can be observed. In general, companies that received any type of subsidy (R&D subsidy included), were larger than non-receivers. They had a much higher EBITDA, were slightly more indebted, more profitable, and had significantly higher value added per employee. Of those companies that received subsidies, R&D subsidy receivers were the most successful.

Table 1. Firm performance indicators by type of subsidy recipient

	Employees	EBITDA (in euros)	Financial leverage (in percent)	ROA (in percent)	VA per employee (in euros)
Non-receivers	18.2	75,807	19.4	1.8	23,289
Any subsidy	23.9	214,369	21.3	3.9	31,223
R&D subsidy	28.4	321,662	23.3	4.1	34,528

Note: Median values are shown. Time period is 2006-2018.

Source: AJPES, 2019 and Ministry of Finance, 2019.

3 Impact of R&D subsidies on corporate productivity

In this section we estimate the Cobb-Douglas production function to quantify the effect of a subsidy on firm productivity. First, in Table 2, median values of two performance indicators are shown. Share of export serves as indicator of international competitiveness of a firm, while value added per employee is an indicator of productivity. Comparisons are further subdivided based on firm size and industry type.

Table 2. Comparison of median performance indicators, split by firm size and industry

	Share of exports (in percent)			VA per employee (in euros)		
Subsidy type	**Non**	**Any**	**R&D**	**Non**	**Any**	**R&D**
All firms	2.81	6.30	12.26	23,290	31,223	34,528
Small firms	2.33	4.75	8.55	23,397	31,303	35,355
Medium firms	7.03	14.66	27.77	22,539	30,082	32,920
Large firms	18.61	30.97	48.39	20,062	32,785	35,154
Services	1.67	1.64	3.73	28,568	32,916	36,943
Manufacturing	22.40	34.93	46.59	21,410	30,378	32,957
Construction	0.01	0.79	1.35	16,861	26,616	31,203

Note: Subsidy type groups: *Non* is a group of firms without subsidies over 2006-2018; *Any* is a group of firms that received any type of subsidy over 2006-2018; *R&D* is a group of firms that received R&D types of subsidies. Median values are shown. Time period is 2006-2018. Small firms are firms with an average number of employees between 10 and 50, medium firms between 50 and 250, and large firms above 250.

Source: AJPES, 2019 and Ministry of Finance, 2019.

Table 2 reveals that firms that received subsidies are more export-oriented, and have higher value added per employee. Receivers of R&D subsidies are, compared to any subsidy receivers, even more export-oriented and have significantly higher value added per employee. More detailed analysis reveals that larger firms operating in the manufacturing industry were also more export-oriented. The median value added per employee was the highest among small and large subsidy receivers, with a significant increase among service firms. Based on Table 2, the conclusion can be made that subsidy receivers are more productive; yet the question remains whether subsidies are a result or a cause of being more productive. To investigate this problem further, production function is estimated using lagging subsidies as an explanatory variable.

The empirical model is based on a study by Hall and Jones (1999), assuming that the production function of an individual firm can be approximated by a Cobb-Douglas form. The Cobb-Douglas function involves Y_{it}, K_{it} and L_{it}, which

are observable measures of output, capital, and labour, respectively, while A_{it} is an unobservable residual which captures the effect of all other determinants of firm productivity. *Equation 1* shows the estimated function in logarithms, where lnA_0 measures the average efficiency level across all firm-year observations, μ_{it} captures firm-specific deviations from the average, and $Subsidy_{it-1}$ represents the crucial covariate in the analysis.

$$lnY_{it} = lnA_{it} + \alpha lnK_{it} + \beta lnL_{it} + Control_{it} + Subsidy_{it-1} + \mu_{it} \quad (1)$$

In *Equation 1,* value added is used as a proxy for output Y_{it}, estimated as gross operating income, reduced by costs of material and services and other business-related expenses. K_{it} is defined as the value of tangible assets and L_{it} as a cost of labour[3]. As control variables, NACE industry classification (INDUSTRY – First digit code), year dummies (YEAR), and firm size (SIZE) are used. The key variable, *subsidy*, is defined as the amount of subsidies received per employee in thousands of euros. All variables are winsorised at the upper and lower first percentile, as is usually done in such types of studies (see for example Lemmon et al. (2008)). *Equation 1* is estimated with the Maximum Likelihood Multilevel Regression approach (Marinšek, 2017).

The results of five estimated regression model specifications, built hierarchically, are presented in Table 3. Results confirm that throughout all five specifications, estimates are robust. Models *(3)* to *(5)* include subsidies in the current year, with one-year and two-year lags, respectively. Results show that elasticity of capital for Slovenian firms is around 0.15, while elasticity of labour is much higher at around 0.8. Subsidies in the current year statistically significantly increase value added per employee and highly improve the fit of the model. It is interesting to note that 1-year lagging subsidies have a similar and statisticaly significant positive effect on productivity as the current year subsidy; however, two-year lagging effects become statistically insignificant (see specification 5).

Since there are 25 different categories of subsidies, of which not all can be linked to R&D activities, Table 4 shows an estimate of *Equation 1* using only the following subsidy categories: R&D and Innovations, General Economy, Venture Capital, Training and Environment Protection. Results show that using only subsidies linked to R&D give consistent results – the same effect as found in specifications *(3)* and *(4)* in Table 3. Specification *(8)* further compares the effect of R&D subsidies between different firm sizes, but differences in effects are insignificant.

3 By using costs of labour instead of number of employees, the differences in employee expertise are modeled.

Table 3. Results of regression models (any type of subsidy)

Covariate	Different specifications of the estimated equation, given by Equation 1				
	(1)	(2)	(3)	(4)	(5)
lnK_t	0.159*** (0.000)	0.157*** (0.000)	0.157*** (0.000)	0.154*** (0.000)	0.155*** (0.000)
lnL_t	0.816*** (0.000)	0.815*** (0.000)	0.816*** (0.000)	0.799*** (0.000)	0.804*** (0.000)
Year dummy	Yes	Yes	Yes	Yes	Yes
Industry dummy	No	Yes	Yes	Yes	Yes
Small firms	–	-0.013 (0.102)	-0.012 (0.140)	-0.046*** (0.001)	-0.041*** (0.000)
Large firms	–	0.017 (0.285)	0.017 (0.290)	0.049*** (0.003)	0.040** (0.023)
$Subsidy_t$	–	–	0.002** (0.013)	–	–
$Subsidy_{t-1}$	–	–	–	0.002** (0.017)	–
$Subsidy_{t-2}$	–	–	–	–	0.000 (0.847)
Intercept	0.690*** (0.000)	0.737*** (0.000)	0.728*** (0.000)	1.021*** (0.000)	0.916*** (0.000)
Firms	7,486	7,486	7,486	7,331	7,026
AR(1)	0.73	0.72	0.72	0.73	0.74
AIC	13,547	13,245	13,070	9,469	8,068
-2LL	13,538	13,229	13,052	9,451	8,050
χ^2=Δ-2LL	–	309*** (0.000)	177*** (0.000)	–	–

Note: Time period is 2006-2018. Dependent variable is defined as $lnValueAdded_t$. Models are estimated with the SPSS ML Linear Mixed Model procedure and based on multilevel approach. P-values are reported in parentheses. ** and *** denote a statistically significant coefficient at a five and one percent level of significance, respectively.

Source: AJPES, 2019 and Ministry of Finance, 2019.

Table 4. Results of regression models (R&D subsidies only)

Covariate	Different specifications of the estimated equation, given by Equation 1		
	(6)	(7)	(8)
lnK_t	0.157*** (0.000)	0.155*** (0.000)	0.155*** (0.000)
lnL_t	0.815*** (0.000)	0.798*** (0.000)	0.799*** (0.000)
Year dummy	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes
Small firms	-0.013 (0.099)	-0.044*** (0.000)	-0.044*** (0.000)
Large firms	0.017 (0.278)	0.047** (0.005)	0.047** (0.005)
R&D $Subsidy_t$	0.002** (0.024)	–	–
R&D $Subsidy_{t-1}$	–	0.002** (0.016)	0.002 (0.475)
Small X R&D $Subsidy_{t-1}$	–	–	0.000 (0.733)
Large X R&D $Subsidy_{t-1}$	–	–	0.000 (0.915)
Intercept	0.737*** (0.000)	1.015*** (0.000)	1.015*** (0.000)
Firms	7,486	7,353	7,353
AR(1)	0.72	0.73	0.73
AIC	13,242	11,038	11,041
-2LL	13,223	11,020	11,020

Note: Time period is 2006-2018. Dependent variable is defined as lnValueAdded$_t$. Subsidy categories: R&D and Innovations, SME, General Economy, Venture Capital, and Training and Environment Protection. Models are estimated with the SPSS ML Linear Mixed Model procedure and based on a multilevel approach. P-values are reported in parentheses. ** and *** denote statistically significant coefficients at five and one percent levels of significance, respectively.

Source: AJPES, 2019 and Ministry of Finance, 2019.

Finally, the results in Table 5 reveal that subsidies have had positive effects on productivity over each of the analysed sub-periods, but only the effects during the period 2013-2015 can be statistically confirmed.

Table 5. Results of regression models (R&D subsidies only), split by time period

	Different specifications of the estimated equation, given by Equation 1			
Covariate	**2006-2008**	**2009-2012**	**2013-2015**	**2016-2018**
lnK_t	0.168*** (0.000)	0.152*** (0.000)	0.160*** (0.000)	0.165*** (0.000)
lnL_t	0.772*** (0.000)	0.789*** (0.000)	0.820*** (0.000)	0.820*** (0.000)
Year dummy	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes
Small firms	-0.054*** (0.000)	-0.067*** (0.000)	-0.009 (0.497)	-0.007 (0.579)
Large firms	0.014 (0.515)	0.086** (0.005)	0.021 (0.415)	0.002 (0.939)
R&D Subsidy$_{t-1}$	0.039 (0.515)	0.012 (0.231)	0.016*** (0.000)	0.003 (0.584)
Intercept	1.240*** (0.000)	1.175*** (0.000)	0.603*** (0.000)	0.544*** (0.000)
Firms	5,661	6,078	5,600	5,579
***AR*(1)**	0.62	0.72	0.75	0.76
AIC	4,940	9,396	4,055	627
-2LL	4,922	9,378	4,037	609

Note: Dependent variable is defined as $lnValueAdded_t$. Subsidy categories: R&D and Innovations, SME, General Economy, Venture Capital, and Training and Environment Protection. Models are estimated with the SPSS ML Linear Mixed Model procedure and based on a multilevel approach. P-values are reported in parentheses. ** and *** denote statistically significant coefficients at five and one percent levels of significance, respectively.

Source: AJPES, 2019 and Ministry of Finance, 2019.

Conclusions

Research and development is a recognized driver of economic growth, and is therefore also an important strategic target of policy makers. Slovenia still has a lot of room for improvement and progress to enhance its strategic research and development position, to achieve the Barcelona goal, and to nurture its aspiration to join, in this context, the top EU countries.

The results of our empirical analysis indicate that firms that received subsidies are larger, have higher EBITDA and return on assets, are more indebted, more export-oriented, and have significantly higher value added per employee, an important measure of productivity. The question remained whether higher productivity is a prerequisite for more efficient use of subsidies, or if subsidies contributed to better results. We dug deeper with an estimation of the Cobb-Douglas production function and managed to confirm that current and one-year lagging subsidies are important factors of firm productivity, significantly increasing value added per employee; however, for the two-year lagging subsidies, the effect becomes insignificant. We further investigated the effect of R&D subsidies alone, and found their effect comparable to any other type of subsidy. Finally, the division of the analysed time period into four sub-periods reveals that all subsidy effects are positive, yet statistical significance was found only over the 2013-2015 period. Results indicate that even though more successful firms (including more productive firms) are probably more likely to get a subsidy, the money received is on average invested well and ultimately results in an increased productivity.

Our findings show that Slovenian policy makers should include more R&D and innovation topics in their strategic goals and agendas. A more detailed specification of subsidy-related goals and measures of achievement should be made, since subsidies have an ultimately positive effect on the Slovenian economy.

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Polona Domadenik, Matjaž Koman, Tjaša Redek

BUILDING A SUPPORTIVE ENVIRONMENT FOR INNOVATION-LED GROWTH IN EUROPE

Introduction

European productivity growth has been sluggish in the past two decades. In the Euro area, the average productivity growth was in this period below 1.5 percent per year. In 2018, growth was only 0.5 percent. On average, European productivity growth was lagging behind the US and the OECD with the exception of a few recent years (OECD, 2019b). In developed economies, technological progress has long been acknowledged as the main driver of overall productivity growth; however, as the OECD acknowledges in its recent "Going for Growth" publication, growth has slowed, become fragile, and the gap between strong and weak performers is widening. The key factors contributing to this lethargic productivity growth have been a decrease in technological adoption, weaker business dynamism, skill mismatches, and reduced quality (OECD, 2019a). Global Innovation Index data reveal that European countries like Sweden, the Netherlands, Finland, the UK, Denmark, and Germany are among the top ten economies on the global innovativeness scale, while Ireland, France, Austria, and Estonia are among the top 25 (Global Innovation Index, 2019). Despite this, recent R&D data show that R&D expenditure in the European Union was on average 2.07 percent, which is much lower than in South Korea (4.2 percent), Japan (3.3 percent) and the US (2.8 percent) and well behind the Europe 2020 goal of three percent. Only Sweden, Austria, Denmark, and Germany have already reached their R&D targets. Europe on average should therefore strengthen its innovation activity to maintain its competitiveness and stimulate productivity growth. The purpose of this chapter is to examine in detail the characteristics of the innovation environment in Europe in order to point to the possible de-

ficiencies that could be successfully addressed with different policies at the European or national level.

The purpose of this chapter is to examine in detail the characteristics of the innovation environment in Europe and point to the possible deficiencies that could be successfully addressed with different policies at the EU or national level. To begin, we discuss the characteristics of the innovation environment and the theoretical traits that stimulate success in innovation. Next, we present the characteristics of the most innovative economies. Finally, we review existing policies and the innovation support system and make further suggestions.

1 An innovation supporting environment

The Global Competitiveness reports by the World Economic Forum distinguish between factor-driven, efficiency-driven, and innovation-driven economies. Factor-driven economies rely on an abundance of cheap resources. Efficiency-driven economies depend on higher-value production, and therefore place greater importance on education, efficiency of all markets, technology adoption, and market size. Innovation-driven economies sustain their growth and competitive advantage if they are able to use most sophisticated methods of production and innovate new products and processes (World Economic Forum, 2018a). The majority of European economies are in the innovation-driven group, with exception of some that are either in the efficiency-driven group (e.g. Bulgaria) or in transition from an efficiency to an innovation-driven economy (e.g. Croatia, Hungary, Latvia, Poland, Romania, Slovakia) (World Economic Forum, 2018a). To remain competitive and innovation-driven, these countries and the European Union should continue to support an environment that stimulates investment into adoption and development of new technologies, products, and services.

1.1 Innovation ecosystem

The World Economic Forum (World Economic Forum, 2018a) in their analysis of global competitiveness studies also the "innovation ecosystem", which refers to how innovative a business is as well as how supportive of innovation the environment is. Due to the lack of a comprehensive and established definition of what kind of business environment best supports innovation, we rely on the definition provided by the innovation ecosystem in order to investigate the characteristics

of the optimal environment. Some elements of the innovation ecosystem are similar to the European Innovation Scoreboard methodology (European Innovation Scoreboard, 2019).

Innovation ecosystem methodology, according to the World Economic Forum (World Economic Forum, 2018a), comprises the following components (Pillars 11 and 12 of the Global Competitiveness Index):

Pillar 11: Business dynamism

- Administrative requirements
  - Cost of starting a business
  - Time to start a business
  - Insolvency recovery rate
  - Insolvency regulatory framework
- Entrepreneurial culture
  - Attitudes towards entrepreneurial risk
  - Willingness to delegate authority
  - Growth of innovative companies
  - Companies embracing disruptive ideas

Pillar 12: Innovation capability

- Diversity and collaboration
  - Diversity of workforce
  - State of cluster development
  - International co-inventions
  - Multi-stakeholder collaboration
- Research and development
  - Scientific publications
  - Patent applications
  - R&D expenditures
  - Research institutions prominence index
- Commercialization
  - Buyer sophistication
  - Trademark applications

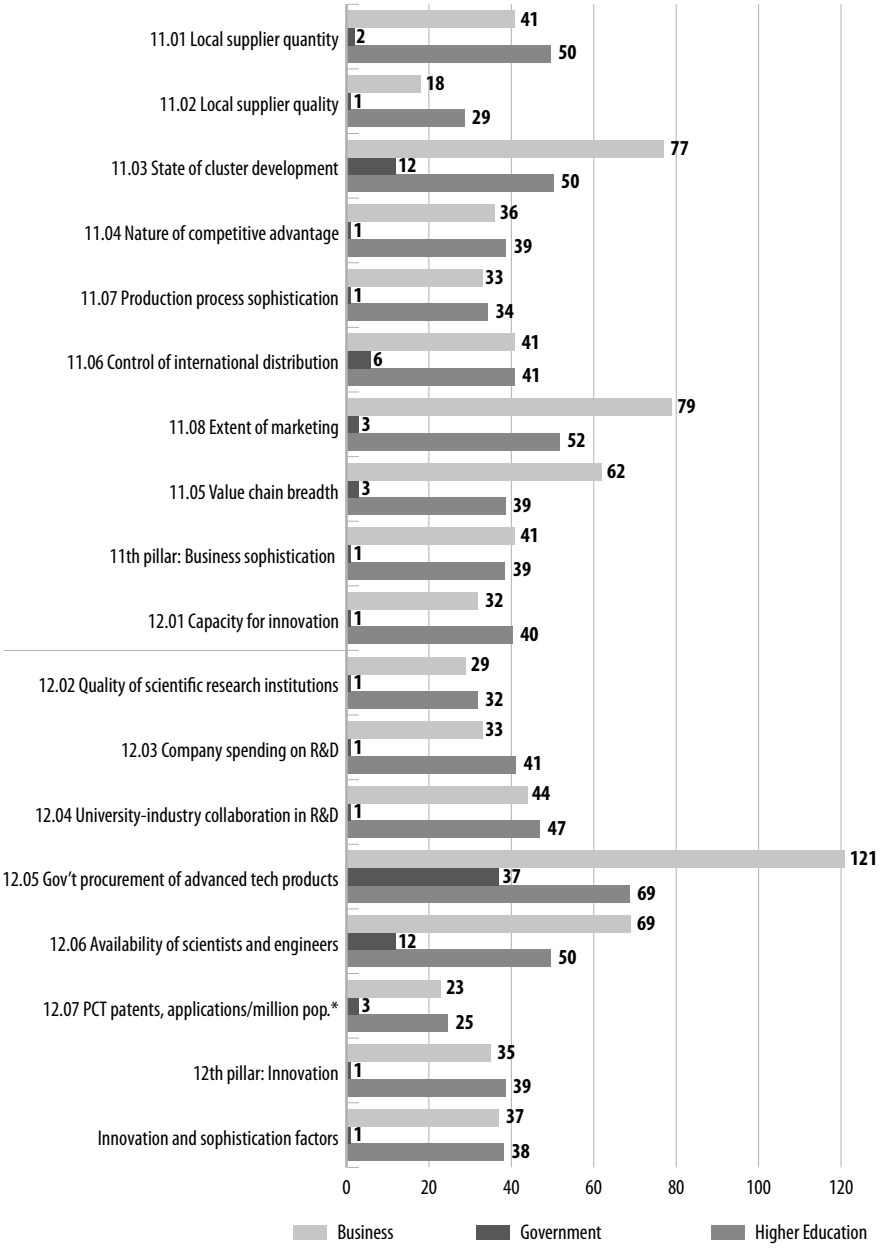
Innovation ecosystem methodology first captures business sophistication, which is important from the perspective of stimulating further innovation since innovation-driven economies are primarily those that have already stopped relying on extensive growth based on resources and are growing primarily due to technology and knowledge. As the WEF (World Economic Forum, 2018a) argues, it is very important that the country has extensive business networks, strong supporting industries (both in terms of quality and quantity), and strong and innovative clusters, which together form an ecosystem of highly efficient firms that are competitive in the global environment and are driven to innovate by strong internal motives and external push factors. The approach follows the idea already presented in the Porter diamonds of country competitiveness and Porter firm and cluster competitiveness models (Porter, 1979, 1990, 1998). The

next aspects of the innovation ecosystem are the characteristics of innovation themselves. Innovation and the ability to innovate (more than just adopt and adjust technology) becomes increasingly important as the country approaches the technological frontier. To remain competitive, which also ensures long-term growth and productivity improvements, firms must be able to develop novel technologies, introduce and develop process, marketing, and organizational innovation to stay on top. This requires that both the state and the private sectors are intensely active. While the state has to support innovation by supporting basic research and higher risk projects (in line with the idea of mission-oriented innovation policy (Mazzucato, 2019)), it must also ensure a high-quality labour force and research institutes which must be closely connected to the companies and collaborate with them.

1.2 Characteristics of the innovation eco-system in selected EU economies

Figure 1 presents data on rankings of countries according to the dimensions of Pillars 11 and 12 in the 2017-18 Global Competitiveness report (World Economic Forum, 2018b). The EU average represents a simple, unweighted ranking of the 28 EU economies. The EU28 and Slovenia are compared to Switzerland, which is the most innovative country in 2019 based on the Global Innovation index (Global Innovation Index, 2019). While Switzerland is the best-ranked in many dimensions, Figure 1 primarily highlights the dimensions where the EU and Slovenia are lagging behind. The most problematic area is the state of public procurement of advanced technologies, where EU economy rankings average to 69, while Slovenia itself ranked only 121st among 158 economies. The EU28 is also weak in local supplier quantity, state of cluster development, extent of marketing, and availability of science and engineers. Slovenia is also doing poorly in these areas, although it is performing better in the state of cluster development. Generally, both the EU and Slovenia are not strong performers in university-company collaboration, company spending on R&D, capacity for innovation, and control of international distribution. While some of these dimensions are linked to firm strategic behaviour, the state directly affects certain dimensions and indirectly supports the development of others. Thus, these findings can be used to investigate the role of the EU and national policy.

Figure 1. Innovation eco-system dimension ranking in Slovenia, Switzerland and the average EU28 rank among 158 economies



Source: World Economic Forum, 2018b.

2 The innovation policies in the EU and in Slovenia

2.1 Background

The European Union already placed "innovativeness" high on its list of priorities with the Lisbon goals set in 2000. The Lisbon document had three broad goals: (1) economic development focusing on creating a competitive, dynamic, and knowledge-based economy, including a quick transition to an information society and a focus on R&D; (2) modernizing the EU social model by developing human resources and reducing social exclusion, including increased attention to education, training, life-long learning, and active labour market policies that would allow an easier transition to a knowledge economy; (3) environmental goals to lessen the link between the environment and economic growth (European Commission, 2013b). The document also expects the European Union to invest three percent of GDP into R&D.

The Innovation Union was the next big policy step. It was introduced in 2010 as part of the Europe 2020 strategy to reduce the identified gap between the EU, US, and Japan. The Innovation Union was designed to "*improve conditions and access to finance for research and innovation in Europe, to ensure that innovative ideas can be turned into products and services that create growth and jobs"*. The policies within the Innovation Union focused on the (1) weak cooperation between the public and private sectors in the field of innovation, and (2) lowering or removing bottlenecks (slow and expensive patenting, small and fragmented markets, slow adoption or change of standards, shortages of skills) which prevent firms from presenting their novel ideas quickly to the market. Namely, poor innovation environment conditions were considered one of the main obstacles to innovation. Also problematic were low private R&D investment, inefficient transition of ideas from invention to the market, problems in the availability of finance, and problems within the regulatory environment, which include setting standards and the inability to use public procurement efficiently to stimulate investment (ss was suggested by the Aho report (Aho & Independent Expert Group on R&D and Innovation, 2006)).

The EU identified two groups of problems as main obstacles to innovation within the EU (European Commission, 2010):

1. Unfavourable framework conditions, where primarily the insufficient private investment in research and innovation is lower than desired because of poor finance availability, costly patent registration, market fragmentation, and regulatory problems.

2. Fragmentation of efforts due to numerous national and regional R&D systems which cause inefficiencies. On the other hand, the creation of a European Research Area would increase efficiency and strengthen value chains.

The European Commission has in 2015 set three goals for the European Research and Innovation policy: "open innovation, open science, and open to the world" (European Commission, 2019). Open innovation aims to open up the innovation process, to gather more ideas externally, to involve people and cooperants from other fields, to share knowledge, and then build on this more easily accessible knowledge. Open science aims to spread knowledge as soon as it is available, rather than at the end of the projects or research processes. Knowledge dissemination is done using primarily digital technologies. This is expected to stimulate even faster creation of knowledge and contribute to improvements in European innovativeness. The last goal refers to being "open to the world", which promotes international cooperation in order to grow further. International cooperation should be based on an international exchange of ideas, new business opportunities, and the exchange of talents and stronger cooperation in the international research community.

2.2 European policy framework

Innovation is key to sustaining future growth and to support the development of social and environmental policies. This will allow Europe to develop a sustainable growth model. To achieve stable growth and increase competitiveness, the EU has set out to achieve three goals, already mentioned (European Parliament, 2019):

1. Make Europe a world-class performer in science;
2. Remove obstacles to innovation (expensive patenting, fragmented markets, slow changes in standards and skills imbalances and shortages), which prevent faster commercialization of ideas;
3. "Revolutionize the way the private and public sector work together" through innovation partnerships between national and EU institutions as well as national and regional authorities and companies.

So far, the European union has already been successful in the implementation of the policies and has made some significant steps toward achieving its goals. The achievements of the EU could be grouped into several categories (see Table 1 for overview).

Table 1. Overview of policies' main results

	Goal	Main instruments/ results so far
Innovation Union	• Improve conditions for innovation; • Improve access to finance; • Final goal to improve commercialization of ideas.	• European Innovation Scoreboard (25 indicators) to measure progress (dividing countries into several groups by innovation characteristics); • Regional innovation Scoreboard grouping EU regions into four groups; • Innobarometer – annual poll among businesses and public on attitudes and activities related to innovation; • Patent protection, standardization, public procurement and smear regulation (EUR-Lex, 2011); • European Innovation Partnerships.
Horizon 2020	• Financial instrument to provide financing for European Innovation union in the amount of 77 billion (EUR-Lex, 2018) to simplify access to finance, involve SMEs, support public procurement, strengthen collaboration, public R&D and social innovation.	• First interim evaluation in 2018, which led to the new Horizon Europe plan that further improves the policy tools.
Cohesion policy	• Supporting research in innovation via European Regional Development Fund.	• Innovation that stimulate low-carbon economy, more competitive SMEs.
Financial instruments	• Stimulate private investment, increase venture capital, improve access to loans for R&D.	• InnovFin – EU finance for innovators in cooperation with European Investment bank Group (EIB, EIF); • Investment plan for Europe to support public and private investment in strategic areas (infrastructure, research, innovation, education, renewable energy, energy efficiency, risk financing); • COSME for SME.
Innovation council	• Support the development of future programme that will follow H2020.	• European Innovation Council.

Source: European Parliament, 2019.

The programs developed by the European Union target the main deficiencies in European innovation competitiveness, which were identified in the data. These were mainly public procurement, the extent of marketing new solutions, collaboration between the public and private sectors, international distribution, and others. While some cannot be successfully directly addressed through public policy (e.g. quality of suppliers, although it can be supported indirectly), the EU has developed mechanisms that will support collaboration, increase R&D, improve access to finance, and stimulate faster marketing of new products. These mechanisms are primarily available within the Innovation Union program and the H2020 as well as financial mechanisms that support access to finance for innovation. This includes venture capital, where the EU has a significant lag behind the US (Table 1). It is

also important that the EU has, through the Innovation Union, developed extensive mechanisms to monitor the innovation environment, which will support further development of policy tools that will be aligned with the identified problems as well as the needs of stakeholders.

Table 2. Overview of policies that support innovation

Innovation policy target	Brief summary of purpose and instruments
Social innovations	• Improve social networks, meet social needs, stimulate new collaborations.
Design	• Design is part of value creation (e.g intangible capital), improves competitiveness; • Stimulate the role of design in innovation activities (design-driven innovation), important in building attractive and user-friendly products; • Design for Europe, Design for enterprises to provide training on various applications of design methodologies in their day-to-day business, The European Design Initiative* with projects IDeALL – Intergrating Design for All in Living Labs, EuroDesign – Measuring Design Value, DeEP – Design in European Policies, SEE Platform: Sharing Experience Europe – Policy Innovation Design, EHDM – European House of Design Management, REDI: When Regions support Entrepreneurs and Designers to Innovate.
Demand-side innovation policies	• Support and increase the uptake of innovations in society in different sectors (BUILD-THE-FUTURE Plus-Energy-Buildings, ENERGY-4-HEALTH, innovative energy solutions in the healthcare sector, EV-CONNECT- shift from the current random and isolated charging infrastructure for electric vehicles to interconnected charging networks based on market demand, MAPDRIVER - uptake of ICT innovations in European transport, • RESIDE- propose an implementation plan for regionally effective demand-side policy measures, SUNROAD - roadmap for uptake of European photovoltaic innovations).
Public sector innovation	• Public sector acts as regulator, service provider, and employer innovation; • Goal to "do new things and do existing faster and better", new or improved processes or services, new forms of organization and management in public sector; • Organizations, introduction of new operational and management tools to improve quality and public sector service delivery, reduce cost, improve transparency, increase stakeholder involvement; • European public sector innovation scoreboard to monitor progress.
Workplace innovation	• Incorporates change in business structure, HR management, relationships with clients and suppliers, or in the work environment; • Goal to stimulate uptake of workplace innovation in companies, primarily SMEs; • Increasing policy-makers' awareness of importance of workplace innovations • European Workplace Innovation Network.

Note: * The initiative comprises 6 projects: IDeALL – Intergrating Design for All in Living Labs, EuroDesign – Measuring Design Value, DeEP – Design in European Policies, SEE Platform: Sharing Experience Europe – Policy Innovation Design, EHDM – European House of Design Management, REDI: When Regions support Entrepreneurs and Designers to Innovate (European Commission, 2016c)

Source: European Commission, 2013a, 2016c, 2016b, 2016f, 2016g, n.d.

The European Union framed its innovation policy based on four broad areas: design, demand-side innovation policies, public sector innovations, and workplace innovations (Table 2). The first area is "design", where the EU primarily stimulates the role of design in general as well as in enterprises. To stimulate

design, the EU has developed a series of programs and two key networks, the Enterprise Europe network and the European Innovation Management Academy. The platforms provide education and training, including training for SMEs. In addition, the projects (Table 3) allow companies to benefit from the EU and support design uptake in innovation also in terms of education and training, collaboration, and financial support (also in cooperation with other mechanisms).

Demand-side policies have long been acknowledged as crucial for innovation, as the creation of demand lowers the risk for innovators and eases the transition of products to the market (as suggested by the Aho report (Aho & Independent Expert Group on R&D and Innovation, 2006)). A number of different sets of measures have been created to stimulate the uptake and therefore also create a market for specific sets of innovations, such as clean energy, new transport solutions, etc. (Table 3). Public sector innovation is another dimension, which is extremely important in the creation of an innovative and competitive society. Public sector innovation comprises: doing new things; doing existing things better or faster; creating new or improved processes or services; creating new forms of organization and management in the public sector; creating new operational and management tools to improve quality and public sector service delivery; reducing cost; improving transparency; and increasing stakeholder involvement (Table 3). A number of successful projects and workshops have been undertaken in order to stimulate innovation (European Commission, 2016f). Additionally, workplace innovation is a segment which will increase overall productivity and has been addressed through financing as well as training programs and raising awareness among policy-makers of their importance. Especially important in this context is the European Workplace Innovation Network (European Commission, 2016g).

The funding for innovation-supportive investment is ensured by four key mechanisms (European Commission, 2016d):

1. Horizon 2020 with a budget of almost 80 billion euro over the period of 2014-2020;
2. European structural and investment funds with around 110 billion euros for innovation activities, ICT investment, SMEs development, competitiveness policies, and supporting the transition to a low-carbon economy;
3. European fund for strategic investments, which will attempt to increase investment into strategic projects (infrastructure, R&D, education, renewable energy, energy efficiency) to support the general recovery of the economy;
4. Special SME financing schemes with several important plans (COSME, Action plan to improve access to finance for SMEs, Competitiveness and Innovation programme financial instruments, SME instruments (European Commission, 2016a).

The European Commission is also developing tools to monitor progress in the field of innovation. It systematically evaluates its approach toward innovation via interim reports. The most important tools to monitor innovation progress and progress in the support of a healthy innovation environment include the European Innovation Scoreboard, the Regional innovation scoreboard, the European Public sector innovation scoreboard, the Innobarometer, the Regional Innovation Monitor Plus, Business Innovation Observatory and Digital Entrepreneurship Monitor, the European Cluster Observatory, KETs Observatory, and KETs Technology Infrastructure Mapping (European Commission, 2016e).

Conclusion and discussion

Innovation is the most important element of growth in developed countries, which are usually innovation and knowledge-driven economies. The European Union is definitely successful in innovation, especially Sweden, which is among the top three most innovative economies in the world according to the Global Innovation Index (Global Innovation Index, 2019). Several other European economies such as Finland, Denmark, and the Netherlands are highly innovative and are together with Sweden are among Europe's innovation leaders, according to European Innovation Index (2019). The most innovative economy in the world is Switzerland. While the EU is on average a strong performer in innovation, it is lagging behind Switzerland in several aspects, primarily in public procurement of advanced technologies, local supplier quantity, state of cluster development, extent of marketing, availability of science and engineers, university-company collaboration, company spending on R&D, and capacity for innovation as well as control of international distribution. These gaps are quite significant when the EU's achievements are compared to Switzerland's. If these gaps are not narrowed, future EU competitiveness, productivity, and growth will be affected. This is evident given the high focus of emerging markets on innovation. For example, South Korea and China are rapidly and successfully becoming leaders in the high-tech marketplace (Pisano, 2009; Pisano and Shih, 2012). Their innovation ability is improving, which is supported by their performance in global innovation rankings (Global Innovation Index, 2019).

The success story behind Swiss innovation is based on seven principles: strengthening of competitiveness, promotion of mathematics and science, promotion of the dual education system, provision of funding for research, maintaining open markets, promotion of international networking, and pursuit of a policy that creates freedom of action (Bauer, 2014). The European Union tried

to follow some of these principles already with Lisbon strategy, since they set a target R&D investment goal of three percent of GDP. The Lisbon strategy also tackled the EU's innovation environment. These were primarily unfavourable framework conditions (insufficient private investment in research and innovation, costly patent registration, market fragmentation, and regulatory problems) and fragmentation of European economies. From the perspective of the presented data, the adopted innovation strategies have correctly identified some of the key problem areas and prepared a consistent set of measures that will address these efficiencies. The set of measures were prepared within the context of the Innovation Union and are supported by two funding schemes with a total value of 190 billion euros: Horizon 2020 and the European Regional Development Fund. In addition, there is a special focus on the different sectors (private and public), company sizes (especially SMEs, including their scale-up), collaboration between private and public sectors, and different research efforts. Moreover, the programs focus on training and raising awareness. Also extremely important, the schemes support strategic investment, which indirectly supports innovation (infrastructure, education, etc.). Several evaluation and monitoring approaches have been set up which will allow the efficient steering of policy instruments.

The state, national and supranational, has again been recognized as an important agent and partner in the economic system in regard to innovation. While the previous focus was on the free market and the role of competition as a promotion for innovation and development, the focus is now turning to more active industrial policy, which can efficiently support the development in areas with higher uncertainty. The comprehensive set of European innovation policies addresses the identified problems and has the potential to improve the innovation environment and performance. It stimulates private activities with suitable mechanisms to support a strong innovation environment. This is in line with the idea of "mission-oriented innovation policy" within the new model of the state for the 21st century (Mazzucato, 2019). Of course, the results will not be visible overnight and will also require significant effort and innovative drive on the side of the private sector. As Einstein said, "innovation is not the product of logical thought, although the result is tied to logical structure" (Bauer, 2014); and the EU is at last building a logical framework.

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Authors
(Alphabetical order)

Matea Bezić
Aljuška Bonča
Teja Breskvar
Tine Burja
Guillaume Cavallari
Andreja Cirman
Barbara Čater
Tomaž Čater
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Vesna Žabkar

Published by
Časnik Finance d. o. o.

Editors:
Polona Domadenik, Matjaž Koman, Tjaša Redek

Reviewers:
Janez Prašnikar, Maja Vehovec

Proofreader:
Thyme F. Nord

Technical Editor:
Ciril Hrovatin

Graphic Designer:
Ciril Hrovatin

Cover Designer:
Laura Pompe Sterle

Printed by
Plusbiro d.o.o.

CEO of Časnik Finance:
Peter Frankl

Editor-in-Chief of Časnik Finance:
Simona Toplak

First printing

Ljubljana, November 2019

Circulation: 450 copies

Under the Value Added Tax Act (Official Gazette of RD, No. 89/1998),
the book belongs to products for which 9.5 % VAT is charged.