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COMPARATIVE ANALYSIS IN CASE OF INNOVATION AND INTELLECTUAL PROPERTY: HOW TO OVERCOME THE GAP IN INNOVATION ACTIVITY

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ABBREVIATION

IP	Intellectual Property
IPRs	Intellectual Property Rights
EIS	European Innovation Scoreboard
NIS	National Innovation System
EU	European Union
WIPO	World Intellectual Property Organization
OECD	Organization for Economic Co-operation and Development
R&D	Research and Development
GII	Global Innovation Index
WTO	World Trade Organization
NIC	National Innovation Capacity
TIS	Technological Innovation System
GDP	Gross domestic product
UK	United Kingdom
USA	United States of America
SMEs	Small and Medium Enterprises
S&T	Science and Technology
FDI	Foreign Direct Investment
TRIPS	Agreement on Trade-Related Aspects of Intellectual Property Rights
CIS	Commonwealth of Independent States
KZT	Kazakhstan national currency
JSC	Joint-stock company
EAPC	Eurasian Patent Convention
PCT	Patent Cooperation Agreement
IPC	Intellectual Property Classification
PCA	Principal Component Analysis
SII	Summary Innovation Index

1. INTRODUCTION

Globalization and technological change have made innovation important to national economic growth (Schumpeter 1939, 1942; Solow 1956, 1957; Rosenberg 1982; Rosenberg and Birdzell 1986; Dodgson & Vandermark 2000; Archibugi & Iammarino 2002; Baumol 2002; Pavitt 2005; Borrás et al. 2009). Innovation has become a major source of increasing competitiveness. At the same time, countries with innovation activity have very different levels of development, culture, institutions, etc. (Chandra & Neelankavil 2008; Zanello et al. 2016). It follows that innovation policy schemes should be shaped by country specifics. This will allow developing countries to work more on the national features of the economy and development policies.

R&D statistics, patents, and innovation research are standard metrics used in the study of innovation and technological development. In our dissertation, we use exclusive data from patents and innovation research. The research focuses on the topic of the global innovation gap, which exists because countries with advanced innovation systems play the role of technology leaders and countries with emerging innovation systems play the role of innovation followers (Kowalski 2021). The European innovation system has a wide range of different economic levels of countries within the union, according to the European Innovation Scoreboard. This fact makes it interesting to aggregate countries to recognize the innovation effect within groups within the EU countries. The EIS methodology is also of interest in this study to understand and compare it with the innovation activities of EU countries in Kazakhstan.

Innovation stimulates economic growth. But how do we move to a new level of innovativeness for transition economies? In the following sections, I will examine innovation, particularly at the macroeconomic level and intellectual property. In order to explore the relationship between innovation, growth, and patents, it is first necessary to give the theoretical background and scientific principles related to this problem.

The field of IPR studies has historically been related to the study of law and, quite rarely, economics (Arrow 1962; Romer 2002; Domeij 2003). However, as a result of the growth of patents worldwide since the late 1990s (e.g., Granstrand 1999; Reitzig 2004; Pisano 2006; Pisano & Teece 2007; Somaya 2012), IP research has intensified (Granstrand 1999; Hall & Ziedonis 2001; Hu & Jefferson 2009; Hu 2013). Through its primary goal of exploring and clarifying Kazakhstan's inventive process, which has implications for the upcoming commercialization of patents on inventions, this dissertation also contributes to the growing body of research on intellectual property.

1.1. Research Problem

With globalization and the rapid speed of technological change, innovation has become a major source of competitiveness and catch-up development for developed and developing countries. In both cases, there are both challenges and opportunities. Competition used to be limited to the local market, but with the opening of borders, competition in developing countries has expanded to a global level (Dahlman 2007). For example, catching up on innovation requires more knowledge and entrepreneurship to compete not only in the local market, but also in global competition. There are different options for upgrading or creating innovation, for example, by adapting technology to local market needs (Eryiğit et al. 2012).

Despite considerable experience in innovation policy in developed countries, the use of similar models in developing countries has shown their failure (Vivarelli 2014). This is due to geography (Crescenzi & Rodríguez-Pose 2012; Corsi & Di Minin 2014), cultural differences, firm levels (Hobday 2005) and other characteristics that these countries have. The time has come to recognize that the concept of "developing country" covers a wide range of situations in terms of level of development, culture, institutions, and so on. As a result, it is a recognized fact that innovation policy models must be adapted to the specifics of individual countries. One successful model cannot be applied to all countries. It is much more effective to base innovation policies on national characteristics of the economy and development policies (Intarakumnerd et. al 2002; Bortagaray & Ordóñez-Matamoros 2012).

However, the development of a strategic plan, program, etc. is not enough to create a national innovation system. This is a long and time-consuming process that does not produce immediate results. Each country independently chooses a model of innovation development in the country, relying on the experience of more successful countries and their resources. But how do we know which innovative model is best for the country? There are no specific solutions, which is even more misleading and controversial among politicians, economists, scientists and others.

Innovation is closely tied to various metrics, including inventions and patents. A limited number of people associate the results of innovation with systematic, consistent, and collaborative efforts. Society still believes that innovation is about uncertainty, risk, and chance (Scherer & Harhoff 2000; Scherer et al. 2001) and that only gifted people or "geniuses" can invent. This way of thinking gives rise to numerous myths about innovation and invention, and it also influences the development of R&D indicators, technological production, the creation of new industries, human resources, and so on.

The other side of invention concerns the level of intellectual property protection (Papageorgiadis & Sharma 2016). The tools to protect the rights of patentees in industrialized countries are stronger at the legislative and executive levels (Branstetter 2004) than in countries with lower economic levels (Lall 2003; Cabaleiro & Salce 2020). Thus, inventors in transition economies face a contradiction in terms of the actual design of an innovation patent and the protection of the rights of the patentee.

In addition, despite a steady increase in the number of patents granted for inventions, the degree of commercialization remains low (Ghafele & Gibert 2014). Many of the patents obtained remain permanently on store shelves (Bhattacharjee 2008; Sampat 2009). While in countries with high levels of innovation the commercialization process has been practiced for a long time, it remains unclear and undeveloped in countries with economies in transition.

This dissertation explores the problems associated with innovation and commercialization of intellectual property, which remain unexplored issues for Kazakhstan.

1.2. Research Question

The above-mentioned gaps and shortcomings in research emphasize the need for a comprehensive framework for enhancing innovation activities with the redefinition of intellectual property in Kazakhstan.

The purpose of this dissertation is to study the functioning of national innovation systems in terms of protection and promotion of intellectual property and understanding of the inventive process. Thus, the main research questions of this dissertation are:

How do the innovation activity indicators in the European Innovation Scoreboard interact with intellectual property indicators, and what's their contribution distribution within the innovation ecosystem?

Do countries with strong national innovation systems, reflected in high innovation outcomes, prioritize intellectual property protection more than those with lower innovation outcomes?

What variables are important for the potential growth of intellectual property through inventiveness and patenting in Kazakhstan?

1.3. Justification for Research

The literature review in chapter 2 emphasizes the interdisciplinary nature of the topic of innovation. In general, the innovation process includes various tools such as human resources, entrepreneurship, intellectual property, science, technology, and so on. Despite the seemingly broad meaning of the term, this study focuses on a more specific understanding of innovation in interaction with intellectual property.

International experience shows different empirical results depending on the level of the state economy. However, most of the empirical research concerns developed countries. Innovation research in developing countries is also reflected in the world literature, but to a small extent. In the practice of Kazakhstan, for example, the study of innovation activity is associated with theoretical materials and little with real research. This demonstrates the need for an empirical study of the country's current situation.

Based on the available literature, this dissertation defines innovation as the most important mechanism and practice of stimulating economic growth, as well as a phenomenon inherent in modern society and a response to global trends. To understand the level of innovation activity in Kazakhstan, it is important to compare it with other economic entities. Kazakhstan is represented in several rankings, including the Global Innovation Index.

However, a larger study of innovation rankings provides a complete picture of Kazakhstan's innovation performance in comparison with other groups of countries. Studies by Kazakhstani scientists often use statistical data from the Statistics Committee of Kazakhstan or the Global Innovation Index. This limited data makes it difficult to study innovation activity from different perspectives and identify shortcomings.

During research on innovation, it was revealed that the output of innovation in Kazakhstan is not fully disclosed. Certainly, there are works on intellectual property, which tend to show it through the prism of judicial practice and legislative changes. However, in Kazakhstan, patents have never been considered as a significant source of new solutions from an economic perspective. Most economic studies on patents focus on the analysis of secondary data obtained from statistical reports. No one studies the problems, requirements and obstacles associated with the process of invention. Therefore, the process of patenting and commercialization in Kazakhstan has not yet been fully studied. There is no understanding of who the modern inventor is, how he commercializes an issued patent, what difficulties he faces. In Kazakhstan, there is no reflection of the number of patents with the results of commercialization.

Materials of countries with a high level of innovation activity, where the process of invention is an integral part of empirical research, were studied. The high level of economic research in the field of patents implies a deeper understanding of the process of invention, its strengths and weaknesses, its impact on innovation. However, the experience of developed countries in studying invention cannot be transferred to countries with a lower level of innovation activity. Each country has its own instruments to support patenting of inventions, encouragement of innovators and so on. Therefore, it is extremely important to study the experience of countries in transition, including their shortcomings and advantages in the field of patenting and the commercialization process.

1.4. Practical Justification

The practical explanation of this study draws attention to the failures and successes of young national innovation systems through EIS innovation methodology (Zygmunt 2019; Bielińska-Dusza & Hamerska 2021).

Kazakhstan, which has a rapidly growing economy and ranks first in the Central Asian region in adapting innovation, is a logical choice to study this problem. The importance of this point can be illustrated by comparing the global drivers of change with the situation in the country and thus their implications for innovation strategies in Kazakhstan.

In addition, the geographical location of Kazakhstan is on the border of Europe and Central Asia. The gaps in the literature highlight the need to rethink innovation from an intellectual property perspective. An integrated innovation methodology with an indexing system will illustrate important variables for the future growth of innovation in Kazakhstan. This methodology will also provide insight into the role of intellectual property in innovation within the countries studied.

Moreover, the gap in empirical research on the inventive process bares the importance of understanding the patent system in Kazakhstan from the inventor's side. Understanding the main factors of inventiveness in Kazakhstan allows for spreading the seeds of the invention characteristics in the regional level. These steps give will encourage innovation spread from intellectual property side in Kazakhstan. The study of innovations has made it possible to draw attention to the problems of intellectual property in innovations. It will provide a fresh boost innovation and intellectual property research in Kazakhstan.

1.5. Methodological Justification

This study consists of two parts methodology and collection of secondary and primary data (discussed in Chapter 4). The first part of the study uses secondary data, which are turned into primary data through a process of data normalization. In the data normalization process, we consulted the co-founder of the EIS methodology, Hugo Hollander, with one main goal in mind: to get the indicators right. The next steps allow us to consider innovative activity in principal component analysis and clustering to visualize the results. During the analysis we revealed the importance of intellectual property in innovation activity. The second part of this thesis consists of a questionnaire and the results of a survey of Kazakhstani inventors. The questionnaire attempted to examine the patent process from the inventor's perspective in Kazakhstan. We discuss the invention process, patent procedures and commercialization of patents from 2008 to 2018. The result of the survey is based on a non-parametric test, the Kruskal-Wallis test with a post hoc test. This test revealed important elements of invention in Kazakhstan.

1.6. Boundary Line of Research

This study is limited to a specific geographic area and is limited to a specific selection of countries, as the EIS includes countries within the EU or neighboring countries. In addition, the conditional selection of 19 indicators was limited by the lack of data for normalization. Data normalization involved analyzing a 10-year period to calculate one year of the study, which made data retrieval difficult. Other limitations of this study relate to the survey of inventors as limited to 109 responses and the lack of grading by the nature of the invention.

1.7. Thesis Outline

This dissertation consists of six chapters.

Chapter 1 describes an overview of the research, discussing the relevance of the study through the theoretical and practical rationale in addition to the motivation and limitations of the research.

Chapter 2 is a step toward understanding the concept of innovation and a review of past and current research on innovation in the literature through the macroeconomic level. Innovation related to intellectual property has also been examined. A historical approach to the study of the development of the national innovation system reveals the profound developments related to technology, invention, and patenting. The study of the origins of innovation led to the emergence of patents, which proved to be an important element in the development of the first industrial revolution. The literature review chapter discusses innovation, intellectual property, and patents in detail.

Chapter 3 discusses the research hypotheses based on the research questions posed. One important hypothesis suggests the possibility of data normalization for further research on Kazakhstan inventions. The next hypothesis concerns the function of intellectual property in Kazakhstan innovation. And the last hypothesis is related to adopting the experience of leading European countries and important indicators that Kazakhstan should improve in the near future.

Chapter 4 describes the research methodology and provides an overview of secondary and primary data. The method of principal component analysis helps to study Kazakh innovations in the European context. The study also included personal data collected through interviews with more than 100 authors of Kazakhstani patents for inventions. The disclosures should lead to a better understanding of how commercialization occurs in Kazakhstan, as well as the determinants of inventive activity in a particular country, as a result of this method.

The findings of Chapter 5 offer a consistent explanation of the data for Kazakhstan in the European Innovation Scoreboard, as well as the impact of intellectual property on innovation. The impact of the intellectual property indicator demonstrates the importance of patents in innovation. The results of the patent study revealed the most important aspects affecting the process of commercialization, the benefits for the authors of patents, and what is vital for the development of invention.

Chapter 6 concludes thesis by providing several policy implications and recommending directions for future research.

1.8. Definition of basic concepts

Innovation: The OECD's Oslo Manual (1997) provides guidelines to measure scientific and technological activity. It defines innovation as the ideation and implementation of significant changes to the product, the processes, the marketing, or a business organization, ultimately seeking to improve its results (https://www.oecd.org/berlin/44120491.pdf)..

National innovation system: According to Richard Christopher Freeman "… the network of institutions in the public and private sectors, whose activities and interactions initiate, import, modify and diffuse new technologies." (Freeman 1987) or "… that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies, and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artifacts which define new technologies." (Metcalfe 1995)

Intellectual property: According to the World Intellectual Property Organization, intellectual property refers to creations of the mind, such as inventions; literary and artistic works; designs; and symbols, names and images used in commerce. Intellectual property is protected in law by, for example, patents, copyright and trademarks, which enable people to earn recognition or financial benefit from what they invent or create (https://www.wipo.int/about-ip/en/).

Intellectual property rights: According to World Trade Organization, intellectual property rights are the rights given to persons over the creations of their minds. They usually give the creator an exclusive right over the use of his/her creation for a certain period (https://www.wto.org/english/tratop_e/trips_e/intel1_e.htm).

Patent: According to the World Intellectual Property Organization (WIPO), patent is an exclusive right granted for an invention, which is a product or a process that provides, in general, a new way of doing something, or offers a new technical solution to a problem. To get a patent, technical information about the invention must be disclosed to the public in a patent application (https://www.wipo.int/patents/en/).

I successfully presented the introduction, framework and foundation of the current research. This chapter described the overall objective, aim, justification, research design, methodology, basic definition, brief introduction of chapters of the research, key concept, scope, practical and theoretical justification and the boundary line of the research.

2. LITERATURE

2.1. Innovation

2.1.1. Theory of Innovation

The term "innovation" comes from the Latin word "innovare," which means "into the new”. Innovation is a term that is often used in the business sector, and it usually refers to something dangerous, costly, and time-consuming (Costello & Prohaska 2013; Stenberg 2017). Innovation is critical to business, and when used correctly, it can be a process, strategy, and management style (Kuczmarksi 2003). It is often linked to technological advances and plays an important role in the global economy (Baskaran & Mehta 2016).

Schumpeter developed and introduced the concept of innovation into economics in the first half of the twentieth century. He believed that the economy was in perpetual motion due to technological progress, and that enterprises compete through inventive activity, similar to pricing. According to Schumpeter, innovation is the effective introduction of a new combination of forces into the marketplace (Schumpeter 1980). He distinguished five types of innovation: the production of previously unknown consumption items or a new quality of certain goods; the introduction of a previously unknown production technique in a given industry, which need not be based on new scientific discoveries and may also be a new commercial procedure tied to a particular product; a new distribution opportunity, which may involve creating a market in which the provided industry of that country was not yet represented, regardless of whether that market previously existed.

In today's world, innovation is one of the main drivers of competitiveness and economic development (Pitti 2008; Pece et al. 2015; Pan et al. 2022). Technological innovation plays an important role in increasing productivity and can take business to the next level (Ahlstrom 2010). At the macro level, the development of technology and its transition to innovation means a country's economic growth and increased social welfare (Barro & Sala-i-Martin 2004; Prahalad 2008). Innovation has a direct impact on economic growth, which is reflected in practice and theory.

Thus, many countries and companies seek to encourage innovation by enhancing R&D capabilities (Sagar & Van der Zwaan 2006), levels of education (Lee et al. 2010), infrastructure and availability of financial resources, intellectual property protection (Smith & Mann 2004), and incubation opportunities (Balogh 2012). Moreover, innovation is a multi-step process with several sub-processes (Fritsch & Meschede 2001) that can have an effect in the long run. Thus, to understand the concept of innovation it is necessary to study the theory of innovation in depth.

The theory of innovation serves as a foundational framework for understanding the complex processes through which new ideas, technologies, and practices drive economic progress and societal development. This chapter delves into seminal works and contemporary perspectives, exploring the multifaceted dynamics of innovation across various domains. From the pioneering insights of Joseph Schumpeter and Robert Solow to the contemporary theories of Eric von Hippel and Carlota Perez, this chapter examines the evolution of innovation theory and its implications for research and practice.

Joseph Schumpeter's seminal work, notably "Capitalism, Socialism and Democracy," introduced the concept of "creative destruction" as a central theme in economic evolution. His pioneering insights into entrepreneurship, innovation, and market dynamics laid the groundwork for modern innovation theory. Schumpeter's emphasis on the role of entrepreneurs as agents of change and his delineation of the stages of innovation— invention, innovation, and diffusion—remain influential to this day (Schumpeter 1942).

Solow's work underscores the significance of technological progress in economic growth, highlighting its pivotal role alongside capital accumulation. While his model treats technology as exogenous, it has been critiqued for overlooking internal factors shaping technological advancement within nations (RA 1956; Carlson & Spencer 1975).

From the 1970s to the 1990s, scholars explored diverse perspectives to elucidate technological change. Induced innovation theories stress market forces and demand-pull mechanisms in shaping technical advancements, while evolutionary approaches delve into the behavioral dynamics of firms and routine-based innovations (Ruttan 1997).

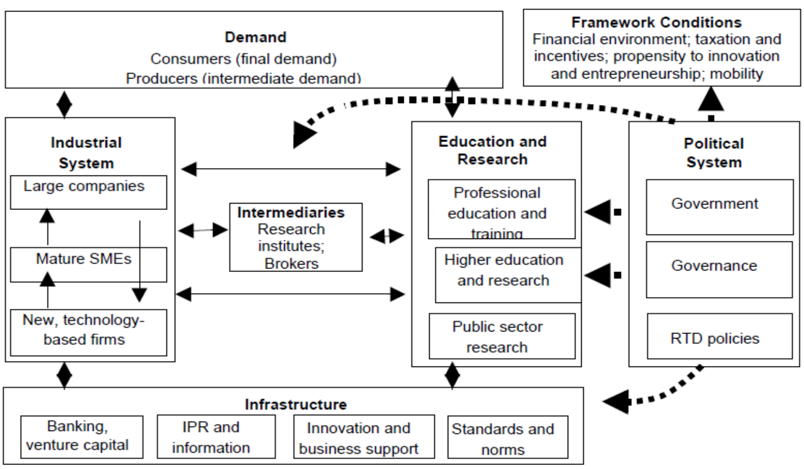
Path dependency models, pioneered by W. Brian Arthur, propose that past decisions constrain current innovation pathways, leading to a limited set of options for firms. Paul David's empirical work corroborates these models, demonstrating their applicability in various contexts (David 1985, 1986, 1993).

The 1980s witnessed a paradigm shift towards innovation systems thinking, emphasizing the pivotal role of enterprises in driving innovation. This era also saw the emergence of integrated models, encapsulating innovation policy, national innovation systems, and the functions of innovation within broader socio-economic contexts (Freeman & Perez 1988; Kuhlman & Arnold 2001).

Innovation discourse has evolved towards conceptual models grounded in integrated systems thinking, encompassing innovation policy terrains, national innovation capacities, and the functional dynamics of innovation systems (Jacobsson & Bergek 2004).

The concept of the National Innovation System (NIS), introduced by Christopher Freeman, Bengt Oke Lundvall, and Richard Nelson, underscores the importance of interactions between firms within innovation systems. Depicted in Figure 1 (Kuhlman & Arnold, 2001), innovation is viewed as a networked, collective endeavor characterized by competition, knowledge exchange, and collaborative networks.

Figure 1. A National Innovation System



Source: according to Kuhlman & Arnold 2001.

According to Michael Porter, significant innovation activity is concentrated in select countries, despite R&D spending being widespread. Disparities in patent jurisdictions further illustrate these differences, with certain countries exhibiting higher patent rates per capita. The National Innovation Capability (NIC) theory emphasizes common innovation infrastructure, cluster-specific conditions, and quality linkages as key elements driving innovation at both national and corporate levels (Schwab & Porter 2002).

Technological Innovation Systems (TIS) focus on understanding innovation dynamics around specific technologies. TIS highlight the importance of mature technologies and the emergence of radical innovations. Actors, institutions, and networks constitute the structural elements of TIS, influencing the trajectory of innovation within industries (Bergek et al. 2015).

The emergence of eco-innovation reflects a growing emphasis on sustainability in global markets. Categorized into incremental, integrated, and eco-efficient innovations, eco-innovations aim to minimize environmental impact while enhancing economic viability. However, the costly process of commissioning and commercializing eco-innovations poses challenges (Gee & McMeekin 2011).

Understanding the theoretical underpinnings of innovation is crucial for researchers and practitioners alike. By examining the origins and evolution of innovation systems, relationships, and developments, scholars can inform future empirical research and enrich our understanding of innovation dynamics (Greenacre et al. 2012).

2.1.2. The Impact of Innovation on Economic Growth

Economic growth, a fundamental indicator of prosperity and societal advancement, is intricately linked with technological progress. While traditional metrics of economic growth provide valuable insights, they often fail to capture the full extent of change, overlooking aspects such as illegal market activities and environmental degradation (Piętak 2014). The empirical evidence supporting the contribution of technological innovation to national economic growth is well-documented (Solow 1956; Mansfield 1972; Romer 1986; Nadiri 1993).

Schumpeter's pioneering work laid the groundwork for understanding the nexus between economic growth and innovation. His theory highlighted the transformative role of entrepreneurship and innovation in driving economic evolution (Schumpeter 1942). Solow's growth model further underscored the significance of technological progress as a catalyst for economic growth, albeit initially treating it as exogenous (Solow 1956). Subsequent research expanded upon Solow's model, emphasizing the multifaceted nature of growth drivers, including physical and human capital accumulation, institutional diversity, and global knowledge exchange (Smith 1937; Sala-i-Martin 2001).

Romer's endogenous growth theory emphasized the role of technological advancements in augmenting the supply of intermediate goods and enhancing human capital development (Romer 1990). Similarly, Aghion and Howitt's model highlighted the intrinsic link between innovation and economic growth, stressing the importance of product improvements and endogenous technological progress (Aghion & Howitt 1990). Despite theoretical advancements, empirical research on the impact of innovation on growth in developing countries remains limited (Darvas & Veugelers 2009).

The diffusion of technological innovations from developed to developing countries has significant implications for growth dynamics. Historically, Asian economies have experienced substantial growth driven by industrialization and domestic innovation efforts (Lall & Teubal 1998). Japan's remarkable economic ascent post-World War II epitomizes the transformative power of innovation in driving growth (Akamatsu 1962). Similarly, countries like China, Singapore, and India have leveraged innovation to propel their economic development trajectories.

While Southeast Asian countries have made strides in innovation, Central Asian nations, once lagging behind, are gradually embracing innovation as a catalyst for long-term growth. Despite lingering challenges such as resource dependence, the prospects for enhanced innovation in these regions signal a promising future (Lall & Teubal 1998).

The positive correlation between innovation and economic growth underscores the pivotal role of technological progress in fostering prosperity and development. As nations navigate the complexities of the innovation landscape, fostering a conducive environment for innovation becomes paramount to sustaining long-term growth and societal well-being.

2.1.3. National Innovation System

Early studies of innovation systems conducted at the national level by Freeman (1987), Lundvall (1992) and Nelson (1992). They have inspired work at the regional, industry, technology, and corporate levels (Granstrand

2000; Malerba 2004; Asheim & Gertler 2005). In this part of the thesis, we show how innovation works in different countries from the past to the present.

The concept of the "National System of Innovation" dates back to earlier works such as Friedrich List's concept of the "National System of Political Economy" (1841) and Bengt-Ake Lundvall's "National System of Innovation" (List 1841; Lundvall 1992; Freeman 1995). However, the conceptual basis for the definition of the NIS originated in the late 1980s as an institutional network of government, universities, industry and their environment (Freeman 1987, 1995) focused on innovation. The complex collaboration in the production, dissemination and application of knowledge that leads to technological progress depends on the quality of interaction between actors at the national level (Furman et al. 2002, Pan et al. 2010). Despite different approaches to NIS, scholars agree that the need for NIS is important for industry, economy and business in developed and developing countries (Alcorta 2000; Lim 2000; Brusoni & Geuna 2003; Hung 2006; Yeh & Chang 2003; Kaiser & Prang 2004; Godin 2009).

Central to the concept of the NIS is the way knowledge is disseminated and used. It is important to know how knowledge is transferred within firms, research institutes, universities, and how knowledge interacts among these institutions (Smith 2002). From an economic perspective, the prefix "national" to innovation systems adds practical meaning. In commercialization, profits accrue to the firm or other institutions; nevertheless, overall economic well-being as an innovation is accounted for at the national level (Lundvall 2007). The existence of different types of innovation systems makes economics multifaceted: the concept of "technological systems" (Carlsson & Stankiewicz 1995), "regional innovation systems" (Cooke 1996; Malmberg & Maskell 1997), "sectoral innovation systems" (Breschi & Malerba 1997), and so on.

2.1.4. Human Resources in Innovation

Human capital, conceptualized by past scholars such as Adam Smith and Alfred Marshall, remains a cornerstone of economic growth theories. Endogenous growth models, pioneered by Lucas and Romer, underscore the pivotal role of human resources in driving sustained economic progress (Lucas 1988; Romer 1990).

Contemporary research highlights the significance of human capital not only for economic growth but also for innovation. Studies by Agiomirgianakis, Dakhli, Kato, and others emphasize the positive impact of human capital on productivity and growth (Agiomirgianakis et al. 2002; Dakhli et al. 2004; Kato et al. 2015a).

Despite the rise of automation, human capital remains a crucial driver of economic advancement. Micro-level studies across various economies, including the United States, Italy, Belgium, the UK, China, Germany, and Japan, underscore the dependence of firm productivity and innovation on human resources (Tang et al. 2012; De Winne & Sels 2010; Ganotakis 2012; Rauch & Rijsdijk 2013; Kato et al. 2015b).

Tertiary education, in particular, has been found to have a more positive impact than secondary education, fostering the growth of science and technology in the long run (Agiomirgianakis et al. 2002; Duru-Bellat & Gajdos 2012).

In the digital age, lifelong learning emerges as a critical component of human capital development, enabling individuals to adapt to rapid technological changes. While some scholars debate the terminology and implementation of lifelong learning, its contribution to personal development and societal adaptation to uncertainty is undeniable (Fischer 2000; Sahlberg 2009; Dehmel 2006).

Overall, human capital remains a vital driver of economic growth and progress, with lifelong learning playing a crucial role in enhancing individuals' skills and knowledge within firms and society at large (Papalexandris & Nikandrou 2000).

2.1.5. Investment and Innovation

R&D expenditure serves as a critical indicator of innovation investment, influencing economic growth and technological development. Models by Romer (1990) and Lucas (1988) highlight R&D as an endogenous variable driving economic progress (Lucas 1988; Romer 1990).

Empirical studies consistently demonstrate the positive relationship between R&D expenditures and economic growth, underscoring its role in fostering technological change within companies (Solow 1956; Swan 1956; Goel et al. 2008; Ildırar et al., 2016).

However, the effectiveness of increased R&D investment varies across industries, with higher-tech sectors experiencing more significant benefits (Chan et al. 1990; Zantout & Tsetsekos 1994; Szewczyk et al. 1996).

The relationship between public and private R&D expenditures is complex, with studies examining the likelihood of substitution or supplementation between the two (Duguet 2003; Lööf & Heshmati 2005; Coccia 2011; Link & Scott 2012).

Government support for R&D, commonly observed in both developed and developing countries, typically focuses on basic research not pursued by private firms. Public R&D spending often subsidizes SMEs and supports less mature technologies, complementing private investment (Johnstone et al. 2010; Bointner 2014).

The distinction between public and private R&D investment reflects the level of innovative development within a country, with empirical evidence suggesting that public R&D can stimulate or partially displace private investment (Nelson 1959; Arrow 1962; Guellec & van Pottelsberghe 2003; Jaumotte & Pain 2005; Szücs 2020; Ziesemer 2020).

Furthermore, research highlights the positive impact of R&D investment on firm value and profitability, with R&D expenditures positively influencing subsequent stock returns (Griliches 1981; Hall 1993; Lev & Sougiannis 1996; Chan et al. 2001).

Thus, investing in R&D is paramount for fostering innovation and enhancing a company's capacity to innovate, regardless of its specific goals (Meliciani 2000).

2.1.6. Innovation Activity through Enterprises

Entrepreneurship encompasses innovative, high-growth, and SME enterprises, influenced by key policy parameters such as access to finance, knowledge, labor, and regulatory environment (Ahmad & Hoffmann 2008). Firm growth depends on factors like entrepreneurial characteristics, resource availability, and venture capital policies (Lee et al. 2001; Baum & Locke 2004).

Collaboration among firms, sharing research costs and resources, enhances innovation performance and R&D intensity (Belderbos et al. 2003; Abramovsky et al. 2008). However, collaborations can face challenges, with about 50% of alliances being incomplete or failing, often due to intellectual property issues (Hertzfeld et al. 2006).

In both developed and developing countries, entrepreneurship encounters distinct challenges, such as lack of awareness of laws and programs and limited access to financial resources (Zakirova & Alan 2018; Smagulova et al. 2018).

Academic entrepreneurship bridges research and business but faces hurdles like differing human resource understanding, lack of business networks, and conflicting interests (Corrolleur & Carrere 2004; Lockett & Wright 2005). Yet, it offers advantages like collaboration with industry, intellectual property tools, and government support (Klofsten & Jones-Evans 2000; Feldman & Desochers 2003).

Entrepreneurship thrives on collaboration, but challenges persist, necessitating effective strategies and frameworks to foster innovation and economic growth.

2.2. Intellectual Property

2.2.1. Theory of Intellectual Property

Intellectual property, encompassing copyrights, trademarks, and patents, traces its origins back to ancient civilizations, where recognition of intangible assets like manuscripts emerged (Hesse 2002).

The evolution of copyright and patents paralleled technological advancements, from guild monopolies to formal recognition like the Venetian patent granted to Johann Speyer in 1469.

England's Statute of Monopolies in 1624 marked a significant shift, promoting domestic manufacturing by importing foreign knowledge (Hulme 1897).

Over centuries, patent law evolved, transitioning from cathedral courts to common law courts in England, leading to the development of international intellectual property protection principles (Colston 1999).

Intellectual property history reveals various theoretical approaches, including utilitarian, labor, personal protection, and cultural promotion theories (Fisher 2001).

Utilitarian theory, advocated by Landes and Posner, grants exclusive rights to authors for a limited time to incentivize creativity (Landes & Posner 1987). Labor theory, inspired by Locke, asserts natural rights to the fruits of one's labor, with limitations to prevent infringement on others' rights (Locke 1967; Chander & Chander 2006). The personal protection theory, rooted in Kant and Hegel's works, emphasizes the societal or individual needs met through property rights (Hegel 1990; Kant 2002). Lastly, the cultural development theory posits that intellectual property rights should foster equitable cultural growth (Fisher 1987).

While these approaches contribute to intellectual property theory, conflicts between them often arise, posing challenges in their practical application without sufficient empirical data (Fisher 2001).

Despite these challenges, these theoretical frameworks shape legal instruments and agreements, such as the Berne Convention and the Paris Convention, influencing global intellectual property regimes.

2.2.2. Intellectual Property and Economic Growth

The impact of intellectual property rights (IPRs) on economic development is a subject of ongoing debate among scholars (Maskus & Reichman 2004; Gold et al. 2019). While economists are less concerned with the pure concept of intellectual property, they are interested in understanding how it influences economic performance and efficiency (Dixon & Greenhalgh 2002; Stiglitz 2007).

Strong IPR protection is linked to technological development and economic growth in advanced countries (Branstetter 2017). Countries with high per capita income tend to grow faster with stronger IPR protection (Thompson & Rushing 1996). Strengthening IPRs can provide confidence to inventors in developing countries (Maskus et al. 1998), but it also poses challenges, particularly for developing nations (Maskus 2000; Sherwood 2019).

While strong IPRs are crucial for technology development in developed countries, they can hinder innovation in developing nations by monopolizing strong technologies and reducing local market positions (Branstetter 2004; Yang et al. 2014). However, adapting technology to the local market can lead to disruptive innovations, as seen in Southeast Asia (Chen & Puttitanun 2005; Yu & Hang 2008; Wan et al. 2015; Williamson et al. 2020).

In low-income countries, strengthening IPR protection often stimulates imports and FDI, rather than promoting domestic R&D and innovation (Falvey et al. 2006). In middle-income countries, the relationship between economic growth and stronger IPRs is mixed, with trade and FDI inflows offset by slow knowledge diffusion and imitation barriers (Falvey et al. 2006).

Overall, enforcing intellectual property rights can have a positive effect on innovation and economic growth, offering opportunities for both developed and developing countries to enhance innovation expansion in local and global markets.

2.2.3. Intellectual Property and Innovation

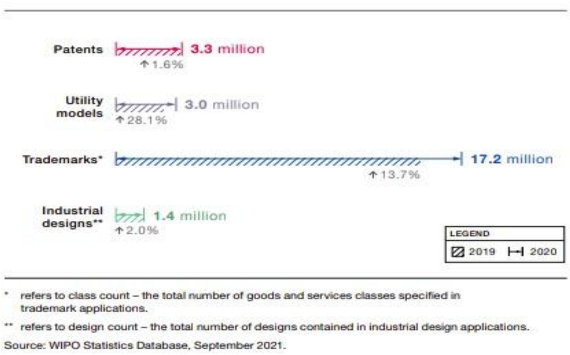
Intellectual property, particularly patents and trademarks, significantly influences the development and adoption of new technologies (Ziedonis 2008). While patents protect inventions, trademarks safeguard new products, playing a crucial role in reducing transaction costs (Milgrom & Roberts 1986). Trademarks, like patents, are indicators of innovation activity, often signaling new product launches (Flikkema et al. 2014; Flikkema et al. 2019). Approximately 60% of trademarks are registered for new products or processes, helping accelerate their launch within five years (Seip et al. 2018).

While patents are preferred for inventions, industrial designs are valued for innovative product design, particularly in medium-sized manufacturing firms (Brem et al. 2017). Industrial designs, often driven by customer preferences, are easier to launch than inventive patents and may represent artistic expression (Geng & Saggi 2015). Despite differences in procedures, both patents and industrial designs impact innovation, markets, and the economy.

2.2.4. Patent and Innovation

When we talk about a patent, we associate it with an "invention. However, the concept of a patent includes not only patents for invention, but also utility patents, design patents, and plant patents. There is a huge difference between these four objects of patenting. Design patents represent design, form, etc. Plant patents refer to new plant species and animal varieties. A utility model patent refers to an improved version of a previously granted patent or an improved part of an existing invention. However, a utility model is not recognized in some member countries of the Paris Convention. Thus, a patent for an invention is the most common intellectual property object after a trademark (Table 2).

Table 2. Total applications of intellectual property worldwide, September 2021



Source: according to the WIPO Statistics Database

What does an invention patent entail? A patent for an invention is the exclusive right of the inventor to commercially exploit the invention for a certain period under certain conditions in exchange for disclosure to the public. A patent document includes the following details: the invention's name, an abstract, and a complete description of it; the inventor's name, address, and country of origin; the owner of the invention's name, address, and country of origin; the technological classes to which the patent relates; and references to earlier patents, among other things (Archibugi 1992). Patenting has some negative aspects, such as the length of time it takes to register a patent. Sometimes it leads to a family of patents where one patent protects the next, which can be considered a positive. Unfortunately, the lengthy registration period can harm the process chain from registration to implementation of the invention. Furthermore, not every invention is patentable (Scherer 1983). Firms use another tool in this case, trade secrets (Wyatt et al. 1985; Levin et al. 1987).

A patent is not only a form of intellectual property, but it is also a valuable source of information in the scientific community. The patent citation contains information about the world's most recent level of invention as well as the technical characteristics of the most recent technologies (Akers 2003). Citing a patent, for example, can improve subsequent technologies or reduce time and economic loss in scientific fields (Karvonen and Kässi 2013), positively influencing the development of innovation.

When talking about inventions and patents, society understands that some technologies require more time to develop a product or process. Thus, patent information is a technology planning tool (Haupt et al. 2007). In particular, patent metrics help analyze competitors (Cohen et al. 2002), plan R&D directions (Ernst 1998), track technology trends (Kim & Kim 2012), and understand which technologies are improving and which are disappearing (Van Zeebroeck 2011). Patent metrics help in managing and strategizing the development of a company's technological capabilities over the long term. With this data, a manager can determine the age of the firm, the technology base, the strengths and weaknesses of a particular company, find out which firms have exited the technology game and who is about to enter the manager's company market (Lee et al. 2009).

Patent data also have an impact on economic performance. Significant work related to patent performance as a measure (Scherer 1965; Schmookler 2013, 1972; Pakes & Griliches 1980; Soete & Wyatt 1983; Basberg 1987; Pavitt 1988; Griliches 1990; Scherer 1992; Jaffe & Palmer 1997; Acs et al. 2002; Nagaoka et al. 2010; De Rassenfosse et al. 2013; Ponta et al. 2021) has laid the groundwork for the economic measurement of invention patents. Many scholars disagree about patent data. For example, Schmuckler (1962) believes that patent data is useless for measuring innovation. His empirical study showed a high correlation between patent data with the number of technology workers and R&D expenditures. More recent research has shown that increased patent activity leads to increased economic growth and productivity in a long-term relationship (Devinney 1994; Crosby 2000; Jalles 2010). The following patent indicators have been used to measure innovation: inventive efficiency and productivity of inventions, priority patent applications filed by a country's inventors (De Rassenfosse et al. 2013), and number of patents per capita (Svensson 2015), etc.

Several scholars have studied the impact of temporary monopoly rights on inventions and their impact on innovation (Hall et al. 2014; Williams 2017). A time limit (about 20 years) on an issued patent (Scherer 1972;

Ochoa 2001; Bracha 2004; Lester & Zhu 2018) allows the patent owner to gain an advantage by blocking other innovations under certain conditions (Sampat & Williams 2019; Farre-Mensa et al. 2020). There have also been studies regarding the use of patent data to calculate innovation (Galini 2002; McAleer & Slottje 2005; Van Zeebroeck 2011). One study refers to a new measure of innovation, the patent success rate, which has shown a strong relationship with real GDP (McAleer & Slottje 2005).

Another study relates measures of patent quality to variables of patent commercialization based on the Swedish patent database. The patent renewal process and patent equivalence showed a positive relationship with the probability of innovation. While the Japanese study showed a negative correlation between patent equivalents and innovation. However, these studies have some limitations due to the coverage of patents owned by small firms and individuals. In addition, the patent base consists of patents from large firms that create non-commercial patents to protect a group/family of patents. Moreover, many companies choose to protect their technologies through secrecy/trade secrecy (Svensson 2015; Papageorgiadis & Sofka 2020). Despite all these approaches, patent metrics are an underestimated source for calculating technological growth and play a secondary role in determining it (Rosenberg 1984). In recent decades, patent indicators have been actively involved in the calculation of innovation, appearing as indicators of major or non-major economies.

The international Scoreboard, which includes indicators of patent data and others (Schibany & Streicher 2008; Hollanders & Van Cruysen 2009; Kamariotou & Kitsios 2016), is one of the most extensive studies of innovation. The main tools for country innovation analysis are the Global

Innovation Index, the European Innovation Scoreboard, the Technology Innovation Index, the Consolidated Innovation Index, and so on (Archibugi et al. 2009). They use different approaches to calculate innovation. In particular, the Global Invention Index uses more than 80 indicators in counting innovation and has no territorial limitations, while the European Innovation Scoreboard considers territorial affiliation and uses a different methodology to count innovation (Bielińska-Dusza & Hamerska 2021). At the same time, the EIS included in the innovation dimension other types of intellectual property than patents: trademarks and design registrations after 2008.

2.2.5. Patent and Research and Development

The usefulness of patent and R&D indicators has always been compared to calculate economic data or innovation, contrasting one with the other (Schmookler 1966; Devinney 1994; Crosby 2000). In modern practice, researchers try to use these two indicators simultaneously to calculate innovation more accurately (Hollanders & van Cruysen, 2009). This chapter will examine the impact of patents on R&D and vice versa.

Patent protection is a tool to encourage innovation in the form of a temporary monopoly right for the inventor. Temporary monopoly rights allow patent holders to increase profits by encouraging further investment in private R&D. In this case, patent protection allows private investment in R&D to grow (Mazzoleni & Nelson 1998). This is especially true in biopharmaceuticals, where R&D costs represent not only money spent, but also time, effort, and knowledge. Only one in eight drug candidates survive clinical trials (DiMasi et al. 2016). Certainly, a company wants to feel confident in monopolizing the distribution of a new drug through patenting.

In the absence of exclusive protection of the technology, the company will not invest huge amounts of money in R&D (Grabowski et al. 2002; Scherer 2010). Thus, the further development of R&D in the biopharmaceutical field depends on patent power. Earlier empirical studies have found a close relationship between R&D expenditure and the number of patents (Pakes & Griliches 1980; Bound et al. 1982). This is especially true in pharmaceutical research, where the level of R&D expenditures contributes to the rapid growth of new drugs (Jensen 1987). Whereas pharmaceutical companies that spent less on R&D showed poor new drug results (Cardinal & Hatfield 2000). Moreover, recent studies show high levels of patenting among companies that pay attention to the development of basic and applied research (Peeters & van Pottelsberger de la Potterie 2007). Thus, the contribution of R&D to patent development is also significant.

Private investment in R&D is quite risky for companies, so this is a case of public R&D spending (Arrow 1962). Long-term strategic projects are often supported by government funds. The state stimulates innovation capacity through businesses, universities, and public research institutes (Svensson 2015). One-way companies increase patents is through access to university research (George et al. 2002; Markman et al. 2009). Moreover, a focus on technological recombination strengthens the relationship between university and firms, whereas conventional research activities lead to a weakening of the relationship (Soh & Subramanian 2014).

R&D is a criterion for investment in innovation, and patents are a criterion for the outcome of innovation (Svensson 2015). Thus, the interaction between patents and R&D shows a strong relationship with each other.

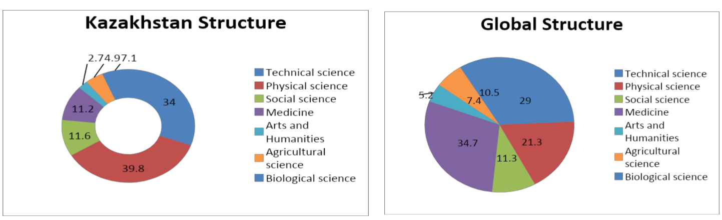
2.3. Kazakhstan Innovation System

2.3.1. The Current Situation in Kazakhstan

Kazakhstan's innovation landscape is evident that the nation, with its rich natural resources and strategic location, is undergoing a transformation towards innovation-driven growth (Kassenova 2020). The government's recognition of innovation as a vital component of economic development is reflected in initiatives like Decree No. 874 of 2014 and the State Program of Industrial and Innovative Development (Tulekbayev 2007). These policies prioritize knowledge-based innovation and emphasize collaboration between academia, industry, and government.

Kazakhstan's scientific and technological prowess is underscored by its research output, with significant contributions across physical, technical, and social sciences (Chankseliani et al. 2021). From 2015 to 2019, the nation produced 14,852 publications, representing 0.12% of the total share of world publications, with a notable focus on physical, technical, and social sciences (Table 3). However, there are challenges, including a shortage of skilled researchers and limited engagement of youth in STEM fields (Report of the Committee on Statistics of the Ministry of National Economy, 2019).

Table 3. The Structure of Kazakhstan and Global Publications in 2019



Source: created by author

Despite these challenges, Kazakhstan continues to invest in R&D, with funding sources from the state, corporate sector, and increasing foreign investment (Report of the Committee on Statistics of the Ministry of National Economy, 2019). In 2019, domestic R&D expenditures amounted to KZT 37.7 billion, with an additional 4% coming from foreign investment. However, the share of R&D in the gross product decreased to 0.12% in 2019, indicating a need for further investment (Report of the Committee on Statistics of the Ministry of National Economy, 2019).

Creating jobs for young people in creative fields is facilitated by an appropriate environment. Technology centers, company incubators, and acceleration centers are common examples of such venues. If they create and develop professional and startup communities, they become centers of innovation. More than 17 gas pedals, incubators and techno parks have been established in Kazakhstan, as well as nine innovation laboratories, co-working spaces and platforms for corporate innovation development. (Table 4)

Table 4. Open innovation ecosystem

Accelerators, hatchers and technoparks	Astana Hub, Tech Garden, Tech Hub, NURIS, MOST, Seedstars Kazakhstan, Terricon Valley, Kazakhstan Digital Accelerator (Quest Ventures, QazTech Ventures), KBTU Startup Incubator, ALMAU Business Incubator, KASE Startup, Digital Transformation Accelerator («Zerde» Holding, UNDP), technoparks KazNU, Alatau Hub, Jaiq Hub, ENU Youth Business Incubator, PSU Startup Academy)
Innovation laboratories	Accelerator Laboratory of UNDP, Innovation Laboratory ЮНИСЕФ, NURIS Fab Lab, NURIS Machine Shop, Smart Data Ukimet Laboratory (NITEC), Laboratory of Innovative Materials and Additive Technologies (Tech Garden), Laboratory BIM+ (Tech Garden), IntelliSense-Lab (Tech Garden), Blockchain & BigData Lab (Tech Garden)
Coworking	Astana Hub, SmArt.Point, Sail Coworking, FIFTY FOUR, Digital Space Coworking, Impact Hub, Level 8, Multispace, Digital Creativity Lab, iHub, IQ Coworking, Coworking Team, The HUB Coworking
Corporate innovation development platforms	Astana Hub, Tech Hub, Tech Garden, KPMG Digital Village, MOST, Seedstars Kazakhstan, NURIS, Plug and Play, Accenture, «Zerde» Holding
Venture funds	The AIFC, Zerde Holding (Astana Hub, QazInnovations), QazTech Ventures, QazIndustry, Damu Entrepreneurship Development Fund, Astana Innovations, and Akimats Digitalization Management provide state assistance for innovation. The following venture capital funds were established in 2019: Quest Ventures Asia Fund II (Quest Ventures, QazTech Ventures), Early Financing Venture Fund (Zerde Holding), Sturgeon Growth Equity Fund (Fund II), MOST Ventures Fund, V Global Fund (500 Global, QazTech Ventures), Da Vinci Capital Technology Fund III, Seed Money (Astana Hub), QazInnovations, Venture Rocket Eurasia, Tesla Capital, Falconry VC, TUZ.

Source: created by author

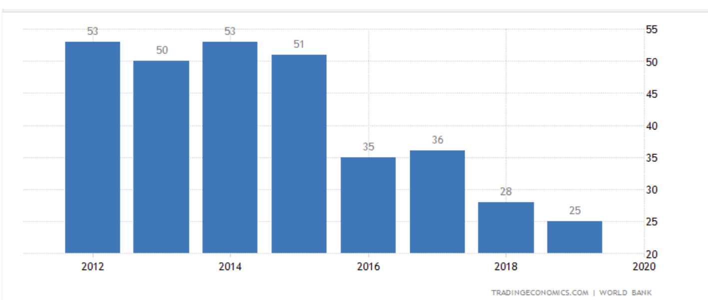
Initiatives like Astana Hub and Alatau IT City exemplify Kazakhstan's commitment to fostering collaboration and providing infrastructure for innovation (Sakhanova 2020). Moreover, international partnerships and collaborations enhance Kazakhstan's innovation ecosystem, enabling access to global expertise and resources.

In recent years, Kazakhstan has witnessed a surge in startups, incubators, and accelerators, supported by government initiatives like the "Digital Kazakhstan" program (Resolution of the Government of the Republic of Kazakhstan of December 12, 2017, No. 827 https://adilet.zan.kz/rus/docs/P1700000827). Despite progress, challenges such as limited access to financing, skilled workforce shortages, and weak intellectual property protection persist, according to the Global Competitiveness Report by World Economic Forum, 2020 (https://www.weforum.org/publications/the-global-competitiveness-report-2020/).

The nation's innovation landscape is evolving, driven by government-led initiatives, increased investment, and collaboration. Kazakhstan's ranking in the Global Innovation Index underscores its potential, yet weaknesses in commercialization and realizing inventive potential persist according to the Global Competitiveness Report by World Economic Forum, 2020 (https://www.weforum.org/publications/the-global-competitiveness-report-2020/). Strengthening the SME sector and addressing existing challenges will be crucial for Kazakhstan to unlock its full innovation potential and drive economic growth.

Kazakhstan is ranked 25th out of 190 nations in the worldwide ranking "Ease of Doing Business" (Figure 5). This ranking reflects Kazakhstan's openness to new ideological ventures and cooperative cooperation. Through reforms and digitalization, the state has streamlined property registration, customs processes, the "friendliness" of the tax system, and access to construction licenses in recent years.

Figure 5. Easy of Doing Business from 2015-2019 in Kazakhstan



Source: According to the World Bank annual ratings, 2019

In 2019, the rate of innovation climbed slightly to 11.3%, with around 3,206 creative firms. Unfortunately, around 159 businesses have halted their innovation implementation efforts. There are 856 businesses with product innovations, 1586 with process innovations, 614 with marketing innovations, and 1026 with organizational innovations. The number of businesses that have implemented all four types of innovations has also increased.

The total quantity of innovative items sold was KZT 996,890.6 million. The table comprises both new and considerably upgraded goods and services that are new to the market (KZT 725 952.7 million) as well as new to the organization (KZT 270 937.9 million). Simultaneously, the value of innovative items sold for export in 2019 was KZT 175,393.9 million. As a result, in 2019, the proportion of innovative items in GDP was 1.60% (Table 6).

Table 6. The share of innovative products (goods, services) in relation to GDP, %

Years	2015	2016	2017	2018	2019
The share of innovative products (goods, services) in relation to GDP, %	0.92	0.95	1.55	1.72	1.60

Source: Committee on Statistics of the Ministry of National Economy of the Republic of Kazakhstan

The entire cost of innovation was KZT 545,046.2 million, split into technological, marketing, and organizational innovations. The key expenditures in the fields of product and process innovations totaled KZT

263 949.6 million and KZT 271 968.6 million, respectively. The most money was spent on modern machines, equipment, software, and other capital goods (excluding R&D costs) – KZT 291,487.3 million – and other inventive expenses – KZT 190,369.0 million (Table 7).

Table 7. Indicators of innovation statistics of Kazakhstan from 2018 to 2020

Indicators	Years		
	2018	2019	2020
Gross domestic product, KZT billion	61819,5	69532,6	70714,1
Volume of innovative products (goods, services), KZT million	1064 067,4	1113566,5	1715500
Share of innovative products (goods, services) in relation to GDP, %	1,72	1,60	2,43
Innovation costs, KZT million	861915	545046,2	783271
Share of spending on innovation in relation to GDP, %	1,39	0,78	1,11
Number of enterprises, units	30501	28411	28087
Number of enterprises with innovations, units	3230	3206	3236
The level of activity in the field of innovation, in %	10,6	11,3	11,5

Source: Committee on Statistics of the Ministry of National Economy of the Republic of Kazakhstan

Despite the fact that most large corporations are dependent on natural resources, many of them enable themselves to purchase the most cutting-edge technology available on the global stage. Thus, they become consumers of technological innovations created earlier by others. Kazakhstan has a modest number of technologically innovative businesses. However, Kazakhstan's new strategy of growing innovation activity is beginning to increase the potential and chances for innovation production and collaboration. This influence will only be visible over time, but it will undoubtedly yield fruit.

Kazakhstan is one of the participants in the Global Innovative Index. It plummets to 79th position with a total of 31.03 points. Moreover, Kazakhstan is also one of Central and South Asia's top three creative economies by region (Figure 8).

Figure 8. Kazakhstan`s Rank, according to GII 2019

Source: created by author

The assessment also revealed innovation system's strengths and the weaknesses in Kazakhstan. The main strengths components of the business climate are the simplicity of opening or starting a business, the government's online services, the ease of safeguarding minority investors, the indication of FDI inflows, the quality of universities, the student-to-teacher ratio, and so on.

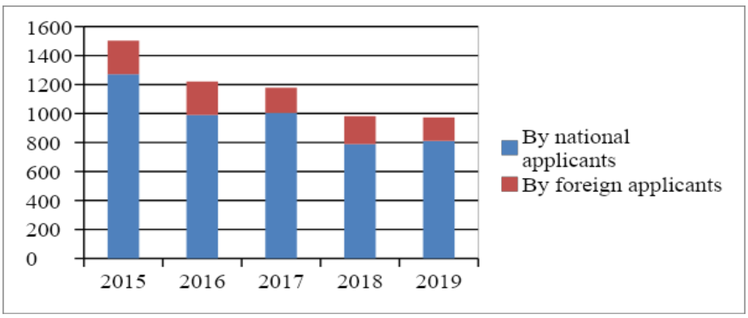
Weaknesses are connected to the production side of innovation. This example demonstrates Kazakhstan's difficulties in realizing its inventive potential, commercializing new items, and so on.

2.3.2. Patent System in Kazakhstan

During the independence of the Republic of Kazakhstan, more than 37,553 inventions, 4,558 utility models, 3,586 industrial designs, and 917 new varieties successes have been filed until 2019. These are elements of intellectual property that have a direct impact on patent law and patenting.

Currently, the Kazakhstan Patent Office has received 973 innovation applications, including 811 from domestic applicants and 162 from foreign applicants. These numbers are 0.9% lower than the same indication in 2018 (Figure 9). The proportion of domestic and international applicants was around 83% and 17%, respectively. In addition, 544 national applicants and 186 international applicants received patent protection paperwork for the invention in 2019. In 2019, the number of applications submitted under the Patent Cooperation Agreement (PCT) protocol increased by 38.9% over 2018, while the number of applications filed under the Eurasian Patent Convention (EAPC) procedure increased by 14.6%.

Figure 9. Dynamics of filing applications for inventions from 2015 to 2019.



Source: created by author

In terms of Kazakhstan's regions, the Almaty, Astana, and Karaganda regions submitted the most patent applications at the end of 2019. About

811 innovation applications were filed as part of national applications, with 466 receiving from legal companies and 345 from individuals.

Invention patents were issued in 730 cases in 2019, down 6.2% from the previous year. The dynamics of issuing patents for inventions over the entire period of the patent office are 37,553. They were separated into national and international applicants in the calculation of protection documents for innovations – 544 and 186 in 2019.

The state, represented by the Patent Office, encourages invention and stimulation of creative activity through the Government Contest of Inventors "Shapagat", the Government Contest among high school students of the Nazarbayev Fund Schools Challenge, the Government contest among schoolchildren for the best essay "The future is in your hands: invent and create", and the contest for the title "Honored Inventor of the Republic of Kazakhstan". The state also supports small enterprises by providing funding for innovative initiatives.

3. OBJECTIVES

3.1. Hypothesis

The main aim of this thesis is to determine the role of intellectual property indicators that contribute to innovation activity in Kazakhstan through the prism of the EIS methodology. In addition, to achieve the goals of the thesis, the author analyses the survey data to clarify the inventive process in Kazakhstan.

Regarding the aim of this study, the choice of author formulated the following hypotheses or objectives which, the author will justify in this thesis.

3.1.1. Innovation Activity: Contribution

In the recent decade, the international practice of calculating innovations has broadened: the Global Innovation Index (INSEAD), the European Innovation Scoreboard (European Commission), the Technology Readiness Index (World Economic Forum), and the Knowledge Index (World Bank) are widely recognized. Kazakhstan's data is presented just in the Global Innovation Index. In Kazakhstan practice the explanation of innovation indicators is reduced to the calculation of statistical indicators of growth or decline in human resources in the scientific field, R&D expenses, the volume of value of total innovative products, the number of patents granted, or the total volume of IP, and so on. This is due to insufficient experience in data processing methodology according to international standards (Egemberdieva et al. 2012; Nurlanova 2014). What are the benefits of the EIS for Kazakhstan innovation: diverse economic background of the represented countries; analysis of 29 indicators; the amount of data presented in the European Innovation Scoreboard is sufficient to collect and normalize Kazakhstan's statistics on time. Kazakhstan's secondary data allows the transformation of most of the indicators according to the European Innovation Scoreboard methodology.

In the calculation of indicators, direct and indirect data related to innovation. The direct indicators relate to the data that influence directly to innovation outcomes. While indirect indicators comprise indicators that in one way or another have an underlying phenomenon of interest for innovation of an intangible nature or are not directly observed (Hollanders 2008; Jozsef et al. 2018).

The distribution of innovative indicators will reveal what indicators have changed during the last decade. For understanding the involvement of IP in innovation to contribute one needs to concentrate on the contribution of each variable to the components and the contribution of intellectual property variables to the component.

H1: The principal components positively interact with intellectual property indicators distributing the level of contribution to each component.

3.1.2. Innovation Activity. Intellectual Property in Innovation

The IPR enforcement strength levels contain a highly considerable effect on national innovation. Studies of endogenous growth models focusing on R&D assume a steady positive relationship between the degree of strength of the IPR system and the rate of innovation (Helpman 1992). Simultaneously, the empirical evidence suggests a negative or inverted U-shaped relationship between the strengthening of IPR systems and innovation (O'Donoghue & Zweimuller 2004; Allred & Park 2007; Lerner 2009; Gangopadhyay & Mondal 2012), namely in developing countries.

Reinforcing a system of intellectual property rights fosters innovation development because it allows the holder of intellectual property to extend their innovation activities and direct their investments to a safer environment (Papageorgiadis & Sharma 2016).

IP protection on an industrial level is successful when a particular innovation threshold reaches a country with a developed scientific and technical infrastructure (Kim 1997; Lall & Albaladejo 2001; Kim & Kim 2012). Patent protection facilitates the development of innovation and economic growth in developed countries and less developing (Schneider 2005).

H2: Countries with a developed national innovation system through high innovation outcomes will have a more robust protection system and intellectual property promotion than countries with lower innovation outcomes.

3.1.3. Intellectual Property. Patent Survey

The global scientific community has studied how a patent affects an innovation outcome and what the value of a patent is (Sapsalis et al. 2006; Bessen 2008; Gambardella et al. 2008; Ernst et al. 2010). In Kazakhstan, the economic study of the patent devotes to a small number of articles. The major focus is on analyzing the dynamics of the number of patents granted analyzing the allocation of applications between national and foreign applicants, as well as the ratio of the number of registered license agreements and the number of patents in Kazakhstan (Mamrayeva & Tashenova 2012). « Regarding the invention and the profile of the inventor, studies were carried out in the West (Tijssen 2002; Toivanen & Väänänen

2012; Bell et al. 2016), but this is not enough for local use. What influences ingenuity in Kazakhstan is still an undisclosed topic at the empirical level?

The interaction of variables will show how the success of patents is determined, which variables are priorities in the patenting process and what the success of an invention means in the real conditions of the economic market and the process of patent origination.

H 3: Certain patent data influence ingenuity to a greater extent than other variables by stimulating innovation activity in Kazakhstan.

4. MATERIAL AND METHODS

4.1. Experiment Location Profile

Kazakhstan is the ninth-largest state in the world with a population of 19 million people in 2019-2020. Kazakhstan is a republic in Central Asia that borders south of Russia, which extends east from the Caspian Sea to the Altai Mountains and China in the west. The little portion of Kazakhstan west of the Ural River is physically located in Europe, although not so politically. China, Kyrgyzstan, Russia, Turkmenistan, and Uzbekistan are neighboring nations. Astana is the capital of Kazakhstan (Figure 10).

Figure 10. The map of territory of Kazakhstan.

The main sources of Kazakhstan's economic development are its gas and oil exports (around 35 percent of GDP and 75 percent of exports). Due to the COVID-19 epidemic, Kazakhstan's economy suffered a setback in 2020, with a negative growth balance of 2.6 percent, although it recovered in 2021 with a rate of +3.3 percent. In 2022 and 2023, growth is anticipated to rise, reaching 3.9 percent and 5.8 percent of GDP, respectively, according to the most recent IMF prediction.

Multiple natural resources are advantageous to Kazakhstan: uranium, bauxite, lead, zinc, nickel, cobalt, coal, natural gas, iron ore, manganese, chromium ore and so on. Kazakhstan is one of the world's leading wheat producers. An important portion of the agricultural industry is made up of the dairy and livestock industries. Kazakhstan's agro-food production is practically self-sufficient.

The Kazakhstan economy has expanded in recent years; it presently contributes 33.1% of GDP and employs 21% of the working population. The primary industrial products include textiles, chemicals, pharmaceuticals, fertilizers, and ferrous and non-ferrous metal metallurgy. The primary industry in Kazakhstan is the tertiary sector, which is expanding significantly. 64 percent of the working population is employed by it, and it contributes 56.1% to GDP. The primary services generated in the nation are in the financial, transportation, and technological sectors.

4.2. Tools and Material

This thesis uses the longitudinal design in datasets with two repeated measures to perform an empirical analysis. Notably, we use a dataset based on the European Innovation Scoreboard (EIS) database for the research proposed in Chapters 5.2. The dataset used in Chapter 5.3 based mainly on data from the Kazakhstan intellectual property, namely, the patent survey with inventors. The characteristics and the steps involved in their construction outlined in the following sections.

4.2.1. The Dataset Based on the European Innovation Scoreboard

This part of empirical research consists of quantitative data. The first stage is crucial for data selection and collection. The data used to investigate innovation comes from two primary sources: the European Innovation Scoreboard (Report of the European Innovation Scoreboard 2008, 2018) and the Statistics database's National Committee of Statistics.

The European Innovation Scoreboard (EIS) stands as a pivotal tool in evaluating and comparing the innovation landscapes across European countries and regions. The EIS is a ranking methodology for assessing innovation performance. This methodology encompasses a multidimensional approach, integrating input, output, framework conditions, and innovation-friendly environment indicators according to the European Commission in 2020 (https://research-and-innovation.ec.europa.eu/statistics/performance-indicators/european-innovation-scoreboard_en). Input indicators encompass factors such as research and development (R&D) expenditure, human capital in science and technology, and educational investment. Output indicators encompass tangible outcomes of innovation, including patents, trademarks, and scientific publications. Framework conditions and innovation-friendly environment indicators capture the broader ecosystem supporting innovation, including regulatory frameworks, intellectual property rights protection, and public-private collaboration.

The selection of indicators assumes the argumentation of choice. The fundamental problem comes down to choosing the weight with which the components contribute to the composite practice. The dilemma of choice consists of no single opinion between experts in choosing variables (Grupp & Schubert 2010). Some indicators change and remove because of the complexity of the calculation or lack of data. Further, several indicators displace because they build on a survey supported by the government. Due to the budget limit, the research concentrates on the available data. We changed the definition from “SMEs” to “enterprises” during normalization in our Kazakhstan data calculation. Because according to the official resource in Kazakhstan, the total number of innovative companies calls as "the total number of innovative enterprises". Therefore, we include indicators that can affect innovation and calculated from the official resources.

We examine the EIS in 2008 and 2018 with difference in one decade. The first level of the data gathering includes identifying the main variables and individuals for the following analysis. It needs to determine what indicators participate in EIS publications for ten years. For instance, from 2008 to 2018, the number of indicators decreased from 29 to 27. Every indicator has its capacity (load), proved by the EIS near two decades from 2001 to recent years. Past scientific studies have demonstrated what indicators are important for innovation interpretation (Schibany & Streicher 2008; Hollanders & van Cruysen 2009). We also look at the Global Innovation Index for checking the orientation of closed variables. The main indicator components in calculating are numerator and denominator. Finally, this data collection reflects only 19 independent variables (Table 11).

Table 11. Indicator Components.

Indicator	Numerator	Denominator	Data source
Q1	Number of doctorate graduates	Population between and including 25 and 34 years	World Bank data and Committee on Statistics of Kazakhstan
Q2	Number of persons in age group with some form of post-secondary education	Population between and including 25 and 34 years	World Bank data and Committee on Statistics of Kazakhstan
Q3	Population of lifelong learning statistics refers to all persons in private households aged between 25 and 64 years	Total population of the same age group	Analytical report on the implementation of the principles of the Bologna process in Kazakhstan (2018) and webpage: theglobaleconomy.com
Q4	All R&D expenditures in the government sector	Gross Domestic Product	Committee on Statistics of Kazakhstan
Q5	All R&D expenditures in the business sector	Gross Domestic Product	Committee on Statistics of Kazakhstan
Q6	Sum of total innovation expenditure for enterprises, excluding intramural and extramural R&D expenditures	Total turnover for all enterprises	Committee on Statistics of Kazakhstan
Q7	Number of Small and medium-sized enterprises (SMEs) with in-house innovation activities	Total number of Small and medium-sized enterprises (SMEs)	Committee on Statistics of Kazakhstan
Q8	Number of Small and medium-sized enterprises (SMEs) with innovation co-operation activities	Total number of Small and medium-sized enterprises (SMEs)	Committee on Statistics of Kazakhstan
Q9	Number of public-private co-authored research	Total population	Committee on Statistics of Kazakhstan
Q10	Number of patent applications	Gross Domestic Product in Purchasing Power Standard	National Patent Office in Kazakhstan and Committee on Statistics of Kazakhstan
Q11	Number of trademark applications applied	Gross Domestic Product in Purchasing Power Standard	National Patent Office in Kazakhstan and Committee on Statistics of Kazakhstan
Q12	Number of industrial design applied	Gross Domestic Product in Purchasing Power Standard	National Patent Office in Kazakhstan and Committee on Statistics of Kazakhstan

Q13	Number of Small and medium-sized enterprises (SMEs) who introduced at least one product innovation or process innovation either new to the enterprise or new to their market	Total number of Small and medium-sized enterprises (SMEs)	Committee on Statistics of Kazakhstan
Q14	Number of Small and medium-sized enterprises (SMEs) who introduced at least one new organizational innovation or marketing innovation	Total number of Small and medium-sized enterprises (SMEs)	Committee on Statistics of Kazakhstan
Q15	Number of employees in high-growth enterprises in 50% 'most innovative' industries	Total employment for enterprises with 10 or more employees	Committee on Statistics of Kazakhstan
Q16	Number of employed persons in knowledge-intensive activities in business industries	Total employment	Committee on Statistics of Kazakhstan
Q17	Value of medium and high tech exports	Value of total product exports	Committee on Statistics of Kazakhstan
Q18	Exports of knowledge-intensive services	Total value of services exports	Committee on Statistics of Kazakhstan
Q19	Sum of total turnover of new or significantly improved products, either new-to-the-firm or new-to-the-market, for all enterprises	Total turnover for all enterprises	Committee on Statistics of Kazakhstan

Source: created by the author

The list of countries rises at the EIS 2018 in comparison with 2008. In this investigation, the basis of the countries list is 2008. However, we add Kazakhstan as a new participant and remove Greece. The reason for the removal is the data absence of Greece in the EIS 2018. We add Kazakhstan because it lies at the point of our research interests during the whole research. The individual variables are present as developed countries, countries with transition economies, and developing countries of the European Union and Central Asia. Namely, we observe about 29 countries dividing these members into four groups: Innovation Leaders, Strong

Innovators, Moderate Innovators, and Modest Innovators. Probably, during the decade the position of some countries had changed. (Annex A). This study reflects the innovation activity of 29 European and Central Asia countries: Austria (1), Belgium (2), Bulgaria (3), Cyprus (4), Czech Republic (5), Germany (6), Denmark (7), Estonia (8), Spain (9), Finland (10), France (11), Croatia (12), Hungary (13), Ireland (14), Italy (15), Lithuania (16), Latvia (17), Malta (18), Netherlands (19), Norway (20), Poland (21), Portugal (22), Romania (23), Sweden (24), Slovenia (25), Slovakia (26), The United Kingdom (27), Turkey (28), and Kazakhstan (29). However, we don`t know what group Kazakhstan belongs to. Finally, this dataset includes 29 countries called individuals and 19 indicators called variables.

4.2.2. The Dataset Based on the Patent Survey in Kazakhstan

This study uses selective data to produce qualitative results focusing on innovation and how patents realize innovation performance in Kazakhstan practice. A patent survey is a supportive part of our study about the place of intellectual property in the national innovation system. This data set will help to consider the main features of contemporary invention in Kazakhstan. Empirical data collection choices include in-depth interviews, participant observations, and Patent Office reports in Kazakhstan.

The study period applies only to granted patents in 2008. Firstly, this is the start of an innovative activity study in Kazakhstan at this research. Secondly, commercialization usually takes more than six years in the case of medical and chemical patents. We choose this year by giving time for the realization of granted patents in the industries. Lastly, in 2008 comes the Global Financial Crisis, which becomes a zero point for developing innovation and new technologies (Archibugi et al. 2013).

In 2008 the total amount of granted patents was 171 at the Republic of Kazakhstan. The 22,8% of granted patents are the foreign granted patents. We skip them because we interest in how national patents develop in Kazakhstan. Organizations are filed the 96 granted patents, like research institutes, universities, and 36 inventions are filed independently by one inventor or a group of authors. Total numbers of authors and co-authors of 132 inventions were near 570. Although, near 104 domestic inventors participates in this survey.

The questionnaire's frame is the previous surveys in the field of the patent (Gambardella et al. 2008; Joho et al. 2010) and the author's experience in intellectual property (Annex F). The questionnaire builds in English, but the personal interview has conducted in Kazakh or Russian languages. The translation and pre-test of the survey help us avoiding the misunderstanding and takes near two weeks. The questionnaire's design starts at the end of 2018 and collecting the answers - at the beginning of 2019. The survey includes 43 questions about a patent, an inventive process, and a commercialization process. The questionnaire had Likert-type scales, semantic differential, yes/no questions, multiple-choice questions, rank order questions, dichotomous questions.

The main challenges that decrease the numbers of respondents during the survey: the author of invention died, some authors have severe problems with the health; some of them changed the work more than one time, or they moved out of Kazakhstan. During the paper-pencil interview, I discover that the priority of the primary author and other co-authors of invention captured chaotically at the column of the patent application "authors and co-authors". Most of the patents often have several authors. The authorship at the patent application often distributes by job position at the company, rather than the author's contribution to the invention. The practice has shown no specific regulation or rule on the importance of the priority of authorship in a registered patent. Thus, the co-authors participate in this survey with the authors. The limitation of this data is also the choice of patents. We choose granted patents from Kazakhstan residents without separation in fields of inventions because the small number of granted patents in 2008.

Some of the answers of inventors were greatly expanded and we categorized them by ranks: total number of patents by one inventor, time spent on invention, and the value of the patent. The research includes the dependent variables (Table 12) and the groups (Table 13).

Table 12. Dependent (Measurement Variable) Variables Used in the R

Dependent variables			
Name in R	Description of variables	Types of variables	Type of answer
authors	Number of authors in one granted patent	categorical variables	"1", "2", "3", "4", "5", "6", "7", "8", "9"
pat_rank	Total number of patents by one inventor	categorical variables	
srs_R&D	Source for R&D	categorical variables	"1" - Internal funds, "2" - Funds from any other organization, "3" - Funds from the financial intermediaries of any kind, "4" - Government research programs, "5" - Other
time_rank	Time spent for invention	categorical variables	"3 months – 1 year", "1-2 years", "2-4 years", "4-6 year"
val_pat_rank	The value of patent	categorical variables	"L $ 30 000", "$ 30 000 - $ 100 000", "$ 100 000 - $ 1 000 00", "$ 1 000 000 - $ 3 000 000"

Source: created by author

Table 13. Groups Used in the R Commander

Groups			
Name in R	Description of variables	Types of variables	Type of answer
city_inv	City of invention	categorical variables	“Almaty”, “Astana”, “others”
com_use	Commercial use of granted patent	categorical variables	“yes”, “no”, “I don`t know”
educ	Education of respondents	categorical variables	“PhD”, “Bachelors”, “others”
pat_fam	Existence of patent family	categorical variables	“yes”, “no”, “I don`t know”
work	Work place during invention process	categorical variables	“Hospital”, “University or research institution”, “Private and public research organization”, “Private
year	The age of author	categorical variables	>45, >59, <60

Source: created by author

4.2.3. Econometric Specifications

This thesis center on the concepts of comparative analysis of innovation among EU countries and Central Asia countries, namely around the intellectual property that has a vital part for approval of an outcome. Thus, our concern lies in studying intellectual property behavior in innovation activity across a specific time interval. This approach requires using longitudinal datasets and suitable econometric methods that allow paying respect to the particular issues related to the longitudinal nature of the data. Concerning to intellectual property, we must concentrate on how inventive process effect on innovation performance. The survey data allows us to use nonparametric analyses.

This section introduces the main characteristics of the estimation techniques applied in the thesis's empirical part, including the methods' weaknesses and strengths. The details specific to each econometric model discuss in the related chapter. This research used the R program to analyze the data.

4.3. The Methodology

4.3.1. The Methodology of Innovation Performance

Principal components analysis (PCA) is a nonparametric analysis method. Usually, this method extensively used in the social or behavioral sciences. The main idea is to reduce many variables to a smaller number of uncorrelated unobserved variables—called principal components—containing as much information from the observed variables as possible. The first components are often interesting since these typically account for a large proportion of the total variation. The last components usually discard, since these may reflect noise rather than a systematic pattern.

The main works about principal component analysis contribute by Cauchy (1829), Jordan (1874), Pearson (1901), and Boyer and Merzbach (2011) in the past (Abdi & Williams 2010). However, Hotelling made fresh perspectives for PCA by his work in 1933.

The PCA usually compares with Factor analysis. It is clear because there are many significant similarities between the two. These methods used to identify groups of observed variables that tend to hang together empirically. However, there are some considerable conceptual differences between principal component analysis and factor analysis (Hotelling 1933; Kramer 1991; Joliffe & Morgan 1992; Suhr 2006; Paul et al. 2013) (Table 14).

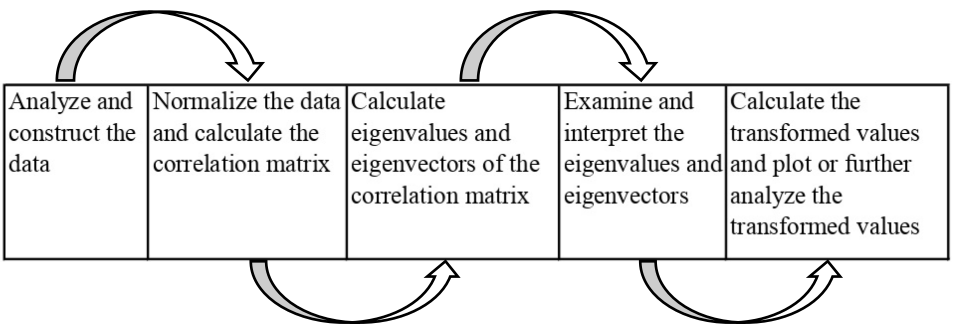
Table 14. The differences between the Principal Component and Factor Analyses

PCA	Factor Analyse
retained to account for a maximal amount of observed variables variance	account for common variance in the data
decomposes the correlation matrix, with ones on the diagonals of the correlation matrix	decomposes adjusted correlation matrix only with diagonals of correlation matrix adjusted by unique factors
minimizes the squared perpendicular distance to the component axis	estimates factors that influence observed variables' responses
linear combinations of the underlying and unique factors	linear combination of the observed variables weighted by eigenvectors
assumes no measurement error	captures both actual variance and measurement error

Source: according to Hotelling 1933; Kramer 1991; Joliffe & Morgan 1992; Suhr 2006; Paul et al. 2013

In this research, PCA's goals (Figure 15) extract essential information about intellectual property from the data table. It needs to preserve only vital information after compressing this data's size (Abdi & Williams 2010). It allows simplifying the description of the data set; and analyzing the structure of the observations and the intellectual property variables (Wold 1987; Jolliffe et al. 2016; De Silva 2019). For our particular research, the principal component analysis identifies if there are influences that are reflecting the universal dynamic of intellectual property variables in innovation in the sample countries.

Figure 15. The Basic Structure of a Principal Components Analysis.



Source: created by the author according to De Silva (2019)

The first stage is data selection by visual. We analyze the changes in the European Innovation Scoreboard (EIS) since 2008. The principal chosen data in years are in 2008, and also one decade after - in 2018. Comparing the 2008 and 2018 allows us to see how the strategy and indicators altered during one decade.

The methodology of transforming Kazakhstan statistical data for comparable analysis started with studying the differences in statistical information. Kazakhstan keeps records of direct innovation indicators, such as R&D costs, the number of innovative companies, data on intellectual property, etc. However, there is no specific algorithm for evaluating or indexing innovations in Kazakhstan. This difference complicates our task but also makes it more attractive in the research process. The data sources for PCA and cluster analysis are from the EIS 2008 and 2018, World Bank, Eurostat, and national statistical centers.

The second stage involves the calculation Kazakhstan indicators. The indicators have already submitted for European countries at the EIS in 2008 and 2018. The transformation from statistical numbers to indicators includes near eight steps according to the EIS methodology.

Normalization data defines by 1) identifying and replacing outliers, 2) setting reference years, 3) imputing for missing values, 4) determining Maximum and Minimum scores, 5) transforming data that have highly skewed distributions across countries, 6) calculating re-scaled scores, 7) calculating composite innovation indexes, 8) calculating relative-to-EU performance scores. The general formula for a min-max scaling is:

$$x` = \frac{x - \min(x)}{\max(x) - \min(x)},$$

where x is an original value, $x`$ is the normalized value.

During the normalization of data, we chose eight years: 2001-2009 and 2010-2018. Near 15% of some missing data, we replaced in previous or future years, depends on the data.

The final step of innovation research, we obtain normalized data to continue Principal Component Analysis (PCA). This stage includes PCA and Cluster allocation of received data.

4.3.2. The Methodology of Patent Survey

In the part of intellectual property, we used the nonparametric analysis for the processing of primary research. In this case, the Kruskal-Wallis test supports a null hypothesis that the measurement variables from which the group samples selected is equal in that none of the group dependent variables is dominant over any of the others. A group is dominant over the others when one element draws at random from each group's dependent variables; it is more likely that the most significant feature is in that group (Zaiontz 2015).

Thus, we test the Kruskal-Wallis algorithm for dependent and independent variables by R software. The Kruskal-Wallis (Kruskal & Wallis 1952) is a nonparametric statistical test that assesses the differences among three or more independently sampled groups on a single, non-normally distributed variable. Before starting the Kruskal-Wallis test, we have to estimate the probability of getting patent data from the normal distribution. Our sample sizes define our numerical means of assessing normality through the Shapiro-Wilk (Shapiro & Wilk 1965) test. Every normality test is necessarily a compliance test and compare the observed data with the regular or other specified distribution quantiles. In this study, we consider p-value < 0.1 as statistical significance. According to Fisher and Neyman, the level of value is based on the research context (Neyman & Pearson 1933; Fisher 2006). The received results showed that data non-normally distributed. The dependent variables are suitable for the Kruskal-Wallis test. After the Kruskal-Wallis test, we compute Dunn's test (Dunn 1964) for stochastic dominance and report the results among multiple pairwise comparisons.

5. RESULTS AND THEIR EVALUATIONS

5.1. Results

5.1.1. Normalization Process

Before starting the manipulation of data, we follow the EIS recommendation for normalization data. According to the EIS, the main result achieved through research proved the guess about the possibility of normalizing Kazakhstan data (Table 16). The findings touch only Kazakhstan data because other European countries' data were normalized and reported in the EIS 2008 and 2018. Kazakhstan variables are normalised to innovation indicators according to the methodology of the EIS (Archibugi et al. 2009; Bielińska-Dusza & Hamerska, 2021).

Table 16. Normalization of Kazakhstan data according to EIS 2008, 2018

Indicator	2008	2018
Q1*	0,07	0,3
Q2*	22,7	53,98
Q3*	1	1,1
Q4**	0,22	0,25
Q5**	0,11	0,5
Q6**	0,002	0,37
Q7***	3,1	36,6
Q8***	3,3	36,8
Q9***	1,6	5,9
Q10***	11,3	7,1
Q11***	22,6	29,2
Q12***	1,1	1,1
Q13***	2,4	6,6
Q14***	0,8	10,5
Q15****	0,2	2,3
Q16****	8,7	10,3
Q17****	20,2	17,3
Q18****	5,94	3,5
Q19****	17	32,7

Notes: *human capital indicators; **investment indicators; ***innovation activity indicators; ****innovation effect indicators.

Source: created by author

5.1.2. Principle Component Analysis

Table 17 showed variances and cumulative variances associated with the principal components with eigenvalues greater than 1 for the 2008 and 2018 samples. Five PCs extracted for both data sets explain approximately 80% of the variance for 2008 selections and 79% of the variance for 2018 samples. It was an acceptably large percentage.

Table 17. Variance explained by each principal component, 2008 and 2018

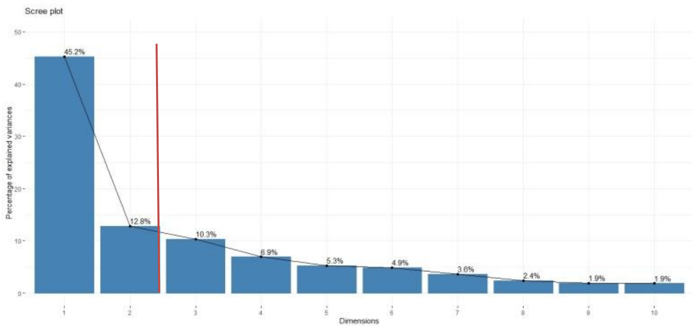
	Variance explained, 2008			Variance explained, 2018		
Component	Variance (Eigenvalue)	%	Cumulative %	Variance (Eigenvalue)	%	Cumulativ e %
1	8.59	45.25	45.25	7.46	39.28	39.28
2	2.43	12.79	58.04	2.58	13.58	52.86
3	1.96	10.34	68.38	2.07	10.9	63.76
4	1.32	6.93	75.31	1.67	8.83	72.59
5	1.01	5.29	80.6	1.39	7.36	79.95
6	0.93	4.89	85.49	1.21	6.39	86.34
7	0.69	3.64	89.13	0.59	3.09	89.43
8	0.46	2.41	91.54	0.51	2.66	92.09
9	0.37	1.93	93.47	0.39	2.07	94.16
10	0.35	1.86	95.33	0.27	1.41	95.57
11	0.25	1.34	96.67	0.21	1.11	96.68
12	0.17	0.88	97.55	0.19	1.02	97.7
13	0.13	0.69	98.24	0.11	0.58	98.28
14	0.1	0.55	98.79	0.1	0.52	98.8
15	0.09	0.46	99.25	0.09	0.48	99.28
16	0.05	0.28	99.53	0.06	0.33	99.61
17	0.04	0.21	99.74	0.04	0.23	99.84
18	0.03	0.14	99.88	0.02	0.12	99.96
19	0.02	0.12	100	0.01	0.04	100

Source: created by author

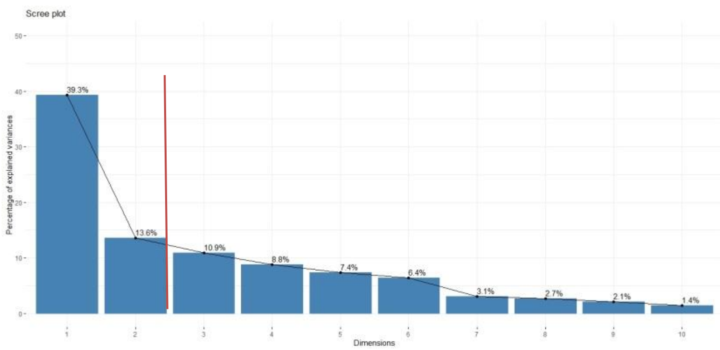
A prominent picture of how many principal components need this research was visualized by screen plots in 2008 and 2018: the first two components should provide an adequate representation of the indicators (the overall value for each researched year is less than 60%) (Figure 18 A, B).

Figure 18. Eigenvalues/variances of principal components (%), 2008 (A) and 2018 (B)

(A)



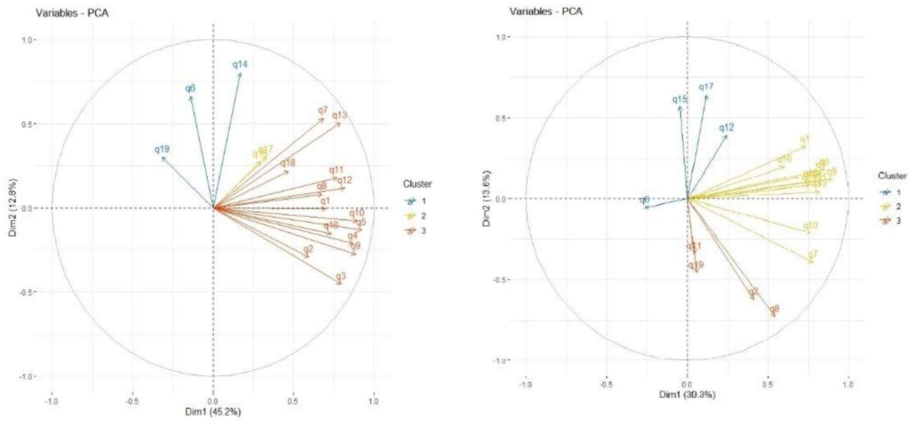
(B)



Notes: ——— The red dashed line on the graph indicates the expected average value

Source: created by author

Figure 19. Cluster plot of loadings for first two components, innovation indicators data, 2008, 2018.



Source: created by author

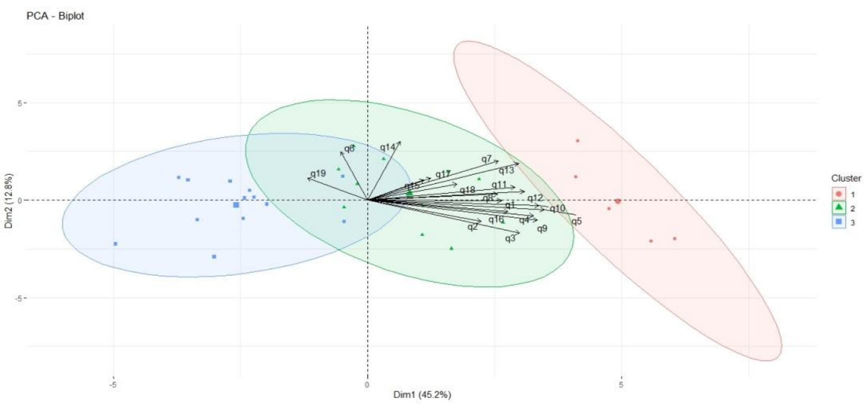
According to the cluster distribution in 2008, the first cluster included only three indicators - Q6, Q14, Q19 and the second cluster comprises Q15, Q17. The last group covered more indicators than the previous two in 2008. The indicators of intellectual property collected in the third cluster. They showed positive interrelation with the innovation indicators - Q1, Q2, Q3 (human capital), Q4, Q5 (investment), Q7, Q8, Q9, Q13 (innovation activity), Q16, Q18 (innovation effects).

In 2018 the first cluster of variables involved Q6, Q12, Q15, and Q17 indicators. Most of the indicators were included in the second cluster except Q2, Q8, Q11, and Q19 which were in the third cluster (Figure 19). In 2018 the situation changed in comparison with 2008. In particular, patent indicators were always correlated with most variables in 2008 and 2018. However, indicators Q11 and Q12 involved only certain variables in 2018. The indicators Q6, Q15, and Q17 communicated with industrial design. For the trademark variable, the interactions were important with Q2, Q8, and Q19.

5.1.3. Cluster

The received results display the first two principal components' score plot in 2008 and 2018 (Figure 19). In 2008 the biplot describes most innovative indicators toward the first and second clusters, where the most prolonged movements towards individuals are the indicators Q5, Q10, Q13 (Figure 20). Most indicators are specific not only for the first cluster but also for the second. The characteristic features of the third cluster identify the indicators Q6 and Q16 that proved to be stable, while Q14 is an indicator that needs to be improved in the future.

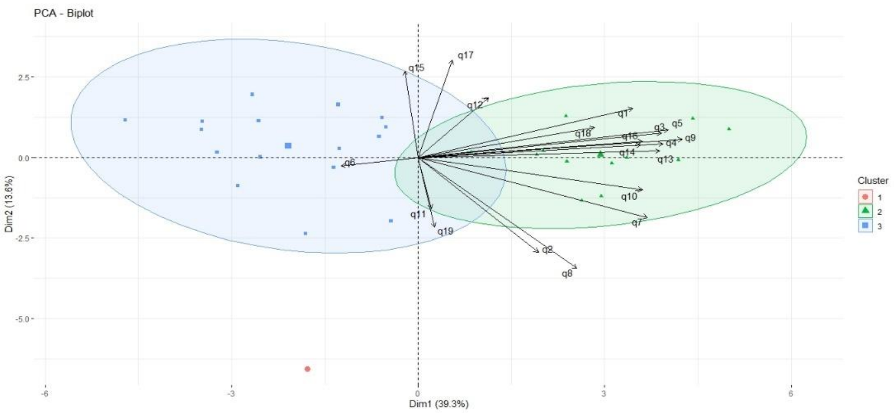
Figure 20. Score plot of PC2 versus PC1 for 2008 samples.



Source: created by author

The distribution of variables supposes the move of the majority of indicators to the second cluster in 2018 (Figure 21). The variables Q3, Q5, Q4, Q5, Q7, Q9, Q10, Q13, and Q14 show a considerable impact on innovation growth in the second cluster countries, whereas Q6, Q11, Q12, Q15, Q17, and Q19 characterizes the third cluster. The effect of indicator Q6 disseminates on the first cluster, but Q2, Q8, Q11, and Q19 are the indicators that should be improved shortly.

Figure 21. Score plot of PC2 versus PC1 for 2018 samples.



Source: created by author

5.1.4. Patent Survey

The following emergent themes identify from the non-parametric analysis: the differences in the inventive process by groups according to the number of authors, the total number of patents, the source for R&D, time, and the value of a patent.

The source of R&D the Kruskal-Wallis test for independent samples (see Table 22) indicated a significant difference between geolocation ($p<0.7$) where inventors live, the activities ($p<0.06$) and age ($p<0.02$) of the inventors and potential of commercial use of granted patent ($p<0.1$). Moreover, Kruskal Wallis tests further revealed a significant patent value difference in reported time spent in the process of inventiveness by location ($p<0.07$) and a considerable difference between the place of work ($p<0.04$). Significant differences were also evident in terms of the number of authors ($p<0.06$) with the existence of patent family and the number of patents invented by one author ($p<0.1$) with the work of inventor.

Table 22. The Result of Kruskal-Wallis Test

The differences	*Chi-squared (X2)*	*Df*	*P-value*
srs_R.D by city_inv	5,3474	2	0,069
srs_R.D by work	7,2558	3	0,06418
srs_R.D by com_use	4,5646	2	0,102
srs_R.D by year	7,5333	2	0,02313
val_pat_rank by city_inv	5,2935	2	0,07088
val_pat_rank by work	8,1159	3	0,04368
authors by pat_fam	5,7157	2	0,05739
pat_rank by work	5,8954	3	0,1168

Source: created by author

It needs to note that the level of significance for Dunn test equals alpha/2, where alpha=0.1. The result of the post-hoc test indicated that the most significant differences in source of R&D between geolocation were in Almaty and Astana (p = 0.03), between work of inventor - "private and public research institutions" and "private companies" (0.04). Moreover, the same results got the group about value patent, between geolocation were in Almaty and Astana (p = 0.03), between work of inventor - "private and public research institutions" and "private companies" (0.04).

Interestingly, there was found that the most significant differences in source of R&D was between age of authors where the age of "59" and "45" (p = 0.01) were more significant than "45" and "60" (p = 0.03).

5.2. Discussion

As a result of analysis, it is vital to define how the outcomes should be interpreted. Most of this research is focused on innovation and intellectual property. Patents and their interplay with macroeconomic innovation activity were the topics of discussion. The findings of the patent research demonstrated the relevance of developing patenting and comprehending inventiveness in Kazakhstan's national level.

H1: The principal components positively interact with intellectual property indicators by distributing the level of contribution to each component.

In the EIS table, the received indicators reflected an underestimated average value compared with highly developed innovative countries. However, as country with a transition economy, Kazakhstan indicators showed a stable rise in the potential development of innovative activity in the country. The four groups of innovation indicators showed remarkable growth empirically from 2008 to 2018 during data normalization.

Europe is one of the leaders in the production of high technologies and innovations in the world. The European countries have different economic levels; the union of these countries is of interest to scientists outside the European Union. During the study, it was revealed that the countries of the European Union had their own ranked methodology for calculating innovative activity - the EIS. It is necessary leading to a single calculation system only Kazakhstan data for a complete understanding of the national innovation systems difference in relation to the protection and promotion of intellectual property. From the previous results, it became clear that the EIS methodology was suitable for many countries, even outside the EU (Arbolino 2011). Every year non-EU countries were also included in the studies with the development of the EIS methodology: Bosnia and Herzegovina, Iceland, Israel, Montenegro, North Macedonia, Norway, Serbia, Switzerland, Turkey, Ukraine, United Kingdom, which was reflected in annual publications of the EIS.

The step of normalization process visualized the Kazakhstan data in comparison with EU countries in 2008 and 2018. The first group of indicators related to human capital (Q1-Q3). In comparison with 2008, Kazakhstan indicators Q1 and Q3 still showed a weak rate of growth among the other twenty-eight countries. The analysis of human capital indicators in Kazakhstan reveals a notable deficiency in the proportion of individuals attaining doctoral degrees, indicating a shortfall in advanced expertise and specialized knowledge within the workforce according to the Global Competitiveness Report by World Economic Forum, 2020 (https://www.weforum.org/publications/the-global-competitiveness-report-2020/). Furthermore, there exists a concerning lack of ongoing skill development among the existing workforce, as evidenced by the low participation rates in lifelong learning activities, according to the Reforming Kazakhstan. Progress, Challenges and Opportunities Report by OECD Oslo Manual, 2019 (https://www.oecd.org/eurasia/countries/OECD-Eurasia-Reforming-Kazakhstan-EN.pdf). This deficiency underscores the imperative for comprehensive strategies aimed at bolstering the nation's human capital potential, particularly through targeted investments in higher education and continuous professional development initiatives. Prior research emphasizes the pivotal role of human capital accumulation in driving innovation, economic growth, and competitiveness within national economies (Acemoglu & Zilibotti 2001). Addressing these deficiencies in human capital formation and lifelong learning is paramount for Kazakhstan to enhance its innovation ecosystem and sustain long-term socioeconomic development in an increasingly knowledge-intensive global landscape. At the same time the number of persons with post-secondary education illustrated a fairly high growth level in comparable countries. This part of human capital indicators is a resource for the formation of a potentially high-quality composition of young scientists and the growth of scientists with doctoral degrees in Kazakhstan (Grodzicki 2018; Duru-Bellat & Gajdos 2012; Bogoviz 2020).

The second group of indicators (Q4-Q6) in the European Innovation Scoreboard (EIS) is intricately linked with investments in Research and Development (R&D). In the case of Kazakhstan, the R&D expenditures in the public sector saw a modest increase from 22.2 in 2008 to 22.5 in 2018, while expenditures in the private sector tripled from 0.3 in 2008 to 0.10 in 2018 (Annex B). However, the apparent growth in these indicators is mitigated by the fluctuation of the national currency (KZT) against foreign currencies. Over the period from 2008 to 2018, the exchange rate of foreign currencies to KZT doubled, leading to significant fluctuations in the national currency and a decline in some Q-indicators reliant on foreign currency in 2018.

This currency exchange rate volatility underscores the challenges faced by countries with emerging economies like Kazakhstan in maintaining stable investment environments for innovation. Despite the challenges posed by currency fluctuations, countries with a high level of R&D investment from both government and Small and Medium Enterprises (SMEs) sectors have demonstrated enhanced innovativeness. High levels of R&D spending serve as indicators of the development of science and technology (Solow 1956; Swan 1956; Bozkurt 2015), bolstering innovation capacity (Porter 2001; Sagar & Van der Zwaan 2006), and driving economic growth (Ildirar et al. 2016).

The correlation between R&D investment and innovation outcomes is well-established in economic literature, with empirical studies consistently highlighting the positive impact of R&D spending on innovation performance and economic development. Furthermore, R&D investment not only fosters the development of new technologies and products but also enhances productivity, competitiveness, and the overall quality of human capital within an economy. Therefore, while currency fluctuations may present short-term challenges to the interpretation of innovation indicators, sustained investment in R&D remains a fundamental driver of long-term innovation-led growth and prosperity in countries like Kazakhstan.

The third category of indicators (Q7-Q14) in the European Innovation Scoreboard (EIS) represents the innovation activity group, reflecting the extent to which countries engage in innovative activities and generate new or significantly improved products, processes, or services. In the case of Kazakhstan, these indicators witnessed a significant increase from 2008 to 2018. However, it's noteworthy that despite this growth, Kazakhstan's performance remained largely average when compared to countries with more established innovation ecosystems, often failing to surpass moderate values.

The conditions facilitated by the government supported the growth of innovative companies in Kazakhstan, as evidenced by the increase in indicators such as the percentage of companies introducing new or significantly improved products or processes. Moreover, the indicator measuring cooperation among Kazakhstan's enterprises also saw substantial growth, indicating a strengthening network of collaboration within the domestic innovation landscape.

Nevertheless, challenges persist, particularly in building a robust human resource base and acquiring advanced equipment to support innovation activities. One notable area of concern is the level of collaboration between the public and private sectors in research publications, where Kazakhstan, along with several other countries, lags behind. This underscores the importance of fostering stronger partnerships between academia, industry, and government to drive collaborative innovation efforts.

Furthermore, the fluctuations in the number of patents granted in 2018 raise questions about the effectiveness of intellectual property (IP) policies and the mechanisms for incentivizing innovation. Despite Kazakhstan's efforts to improve its IP system over the past 27 years, there is still room for enhancement in public awareness and understanding of IP protection.

Overall, while Kazakhstan has made significant strides in fostering innovation and improving its IP landscape, sustained efforts are needed to address existing challenges and further advance the country's innovation capabilities. This entails continued investment in research and development, strengthening collaborative networks, and enhancing IP protection mechanisms to foster a conducive environment for innovation-driven growth and prosperity.

The analysis of the last group of indicators (Q15-Q19) in the European Innovation Scoreboard (EIS) provides valuable insights into the innovation effects and outcomes within Kazakhstan's context. These indicators gauge the extent to which countries engage in innovative activities and generate new or significantly improved products, processes, or services. In Kazakhstan, these indicators have shown significant growth from 2008 to

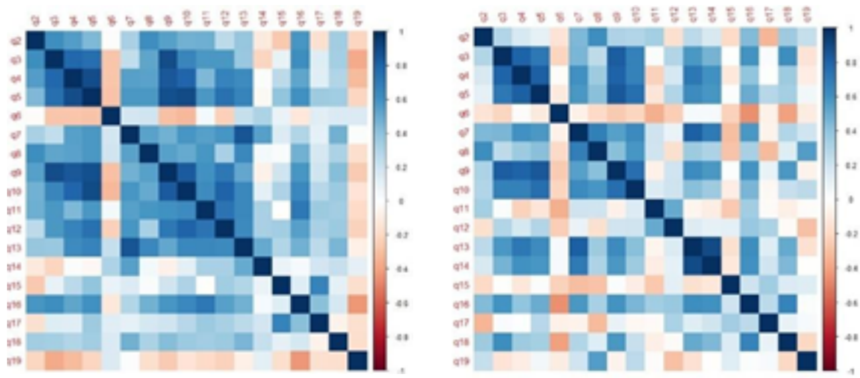
2018, aligning with strong innovator countries such as Austria, Finland, and Belgium in terms of the number of employees in the innovation sphere.

However, despite this progress, Kazakhstan's performance remains moderate when compared to countries with more established innovation ecosystems. While indicators such as the number of employees in the innovation sphere have seen notable increases, disparities persist, particularly concerning high-tech exports. This suggests that while Kazakhstan has made strides in fostering innovation activity, challenges remain in translating these activities into tangible economic outcomes.

The results of this study, as presented in Annex B, showcase the normalized variables for comparison with both EU and non-EU countries over the decade. The flexibility of the EIS methodology, as highlighted by Koreniako & Maltsev (2021) and Kowalski (2021), has allowed for the calculation of data from a wide range of databases, enabling countries to adapt their data to this methodology.

An examination of variables highly correlated with one another after normalization reveals interesting patterns. The principal component analysis (PCA) results, depicted in Figure 23, illustrate the correlation between different innovation indicators. For instance, the correlation between education, R&D support, innovative company development, and patenting underscores the interrelated nature of these variables in driving innovation outcomes.

Figure 23. Correlation matrix, 2008, 2018.



Source: created by author

Furthermore, the contribution of each variable to the principal components is crucial for understanding their quality and relevance in explaining the variability in the dataset. In both 2008 and 2018, indicators related to human resources, R&D investment, and innovation activity constituted the first principal component, highlighting their importance in shaping innovation dynamics.

The analysis also sheds light on the role of intellectual property (IP) indicators in influencing innovation outcomes. In 2008, IP variables, particularly patents, trademarks, and industrial designs, made significant contributions to the first principal component. However, in 2018, patents emerged as the dominant contributor, indicating their increasing importance in driving innovation in Kazakhstan.

Moreover, the comparison between 2008 and 2018 reveals shifts in the cluster analysis of variables, suggesting evolving patterns in innovation dynamics. While in 2008, intellectual property indicators exhibited strong correlations, indicating a cohesive approach to IP management, by 2018, these correlations had weakened, reflecting changing priorities and strategies.

This discussion underscores the complexities of innovation dynamics in Kazakhstan and the need for targeted policy interventions to address existing challenges and capitalize on emerging opportunities. By leveraging insights from the EIS and adopting a holistic approach to innovation policy, Kazakhstan can foster a more vibrant and competitive innovation ecosystem, driving sustainable economic growth and prosperity.

H2: Countries with a developed national innovation system through high innovation outcomes will have a more robust protection system and intellectual property promotion than countries with lower innovation outcomes.

The result of this study noted that the IP indicators were located on the planes of the first and second clusters. Patents were the most far-reaching points of the center than other IP indicators. The trend of the patent indicator showed that strong IP protection was more typical for countries with strong innovative skills (Tarantola & Gatelli 2007; Leogrande et al. 2020), namely for the first cluster. From the general IP group, it was patents that made a significant contribution to innovation. It was also important to note that the second group of countries had also developed IP protection, which was sufficient for this stage of innovation development. In this case, IP was presented as a tool for reinforcement innovation. Moreover, geographical distance had long been one of the characteristics of proximity that has been stressed and used in a multitude of studies across a variety of disciplines. Distance had been the most important component of geographical proximity (Boschma 2005; Ponds et al. 2007), and geographical proximity could impact innovation rates (Audretsch & Feldman 1996; Lundvall 2009).

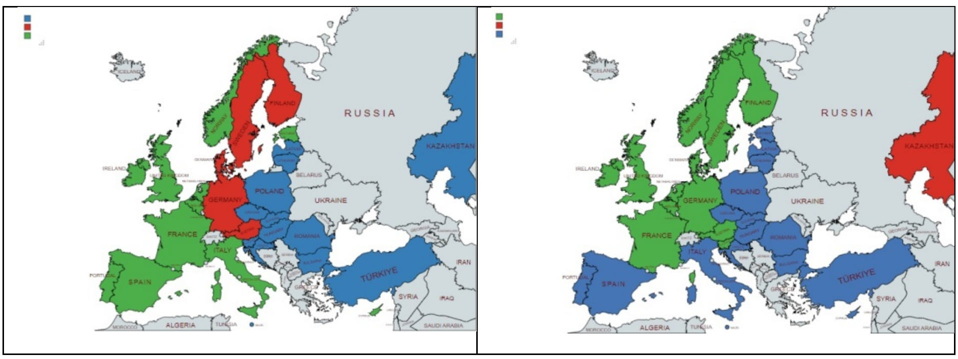
According to Figure 21, the biplot indicates the establishment of three clusters. In 2008 the individual cluster analysis branched three groups out of countries: the first cluster - Germany, Austria, Denmark, Finland, Sweden; the second cluster – Estonia, Cyprus, Portugal, Italy, Spain, France, Ireland, Norway, the United Kingdom, Netherlands, Belgium, and the third cluster – Romania, Slovakia, Czech Republic, Turkey, Croatia, Malta, Poland, Hungary, Slovenia, Bulgaria, Lithuania, Latvia, Kazakhstan (Figure 25).

The cluster distribution shows the importance of the geographical location of the country (Rhoden et al. 2022). Countries' spatial distribution considers their standard features in many ways, including the individual's location on the map. For instance, the Q14 indicator is typical only for the first and second clusters. The growth of cooperation between these clusters is higher than between the first and third. The second group acts as an intermediary between the first and third groups. It interacts only with the first or only the third group separately.

The biplot shows that Kazakhstan and other countries of the third cluster also have indicators of innovation activity but poor quality (Figure 20). They need to concentrate on improving these indicators in future years. Furthermore, considering the distance from the center of the biplot to the cluster centroid, the countries close to the cluster centroid advanced cluster are more likely to move to a higher level. For example, the second group countries - the Netherlands, Belgium, Ireland, Great Britain, France, and Norway-are close to the centroid of the first cluster, and the proximity to the centroid assumes that the following countries will be more comfortable with making the transition from the second group to the first.

In 2018 the biplot reveals three clusters with indicator distributions at the four planes (Figure 24). The second and third clusters include the majority a number of countries, while the first one emphasizes just a single country. The second cluster comprises Denmark, Sweden, Germany, Slovenia, Ireland, France, the United Kingdom, Norway, Belgium, Finland, Austria, and the Netherlands, and the third group unites the following countries: Turkey, Latvia, Croatia, Hungary, Slovakia, Romania, Poland, Portugal, Bulgaria, Lithuania, Cyprus, Estonia, Spain, Malta, the Czech Republic, and Italy. Only the first cluster has a single country – Kazakhstan (Figure 24).

Figure 24. Cluster distribution in 2008 and 2018.



2008 2018

Source: created by author

Our research leads us to understand how, in one decade, the European innovation support system has enabled many countries to become more innovative or move in this direction. During the last decade, the EU countries have moved to a new policy, supporting regional projects (De

Noni et al. 2018) and increasing the budget of EU funds for research and development and innovative entrepreneurship. Understanding the main components of country-specific innovation tools is likely to open up a new history of country-specific innovation development. In this research, we have touched a bit on the way of Kazakhstani innovations through the European prism, comparing with the EU countries. When comparing the budget of the EU and Kazakhstan between themselves, higher spending is observed for the EU budget with huge funds for the development of R&D and SMEs. At the same time, this also imposes certain obligations on the EU budget and is certainly not the main topic of this study. However, we consider it necessary to mention this point to clarify the cluster analysis in 2018.

Moreover, within the EU there is support for some countries in the form of increased funding for development and improvement of indicators important for the EU, which positively affects the budget of the country receiving aid (Becker et al. 2010).

During this research, we saw how the constant regularity of territorial arrangements impacts the innovation growth of the country in both study years (Figure 24). For instance, in 2018 according to the map's cluster distribution, the first and second clusters are close geographically. Most of these countries are included in the EU system. Correspondingly, these groups of countries transfer knowledge flow and technological experience fast and find common ground in cooperation with each other. One of the significant moments is reducing time for familiarization with the rules, laws, policies, and restrictions because of the unified rules in the territory of the EU (Aghion et al. 2010). Whereas Kazakhstan is part of Europe geographically, it is located far away, an independent unit and out of the EU system.

Both 2008 and 2018 show that enhanced IP protection is typical for countries with strong innovation skills (Figure 20, 21). Precisely these countries devote the importance of developing and improving IP where IP indicators enter the leading group of variables important for innovation. The most significant indicator among IP variables is a patent, followed by industrial designs, and only then trademarks. However, the remaining indicators on the same plane as a patent are significant for innovation activity because one indicator's growth extends the possibilities of other indicators standing nearby on the same plane.

In comparison of the distance between clusters, there is a probability of shifting from one level to a more advanced cluster. For example, in 2008, countries marked as close to the centroids of the advanced group of countries showed a transition to a more advanced level than other countries in innovation. In 2018, these countries reach the level of countries with strong skills in innovation: the Netherlands, Belgium, Ireland, the United Kingdom, France, and Norway. Thus, by reinforcing one of the groups of variables as human resources, R&D and the innovation activity indicators, these countries achieved a transition from one cluster to another.

H3: Certain patent data influence ingenuity to a greater extent than other variables by stimulating innovation activity in Kazakhstan.

The relevance of patent data is demonstrated in the analysis above by its contribution to innovative activity in Europe and Kazakhstan. The previous empirical studies had established the value of patents and who were the inventors for West society. While for Kazakhstan society remained an unclear subject to the value of patents and who these inventors are. The findings of this study show the characteristics of Kazakhstan's inventiveness and its potential in the market.

During investigation we found that groups had good potential for interaction with the city where the invention makes, the inventor`s place of work, and its capabilities in this organization, and it was also essential to emphasize the importance of inventor`s age.

The most significant results we saw with the groups of the city of invention, the possibility of commercial use of patent, patent family, work, year, and by the dependent variables that have the significant differences with the groups are authors, value of patent, and the source for R&D and total number of patents.

When studying between-group correlations, post-hoc tests help determine differences between sub-groups. The post-doc test (Annex G) helps to emphasize the received results and explore new findings. It is interesting that the impact on patents shown through the distribution of sources of R&D is mostly in the big cities of Kazakhstan – Astana and Almaty. The main instruments in the injection of R&D money are through private and public institutions and private companies. However, the flow of money from the side of private companies is miser infusions. The estimated value of the patent obtained in cities such as Almaty and other cities in Kazakhstan is higher than in Astana.

According to the empirical analysis, we can reject H0 because the Kruska-Wallis test shows significant differences between groups and variables.

Thus, future research should include questions developed to test not only for a decade of a patent but also from a great perspective. Besides, future research should increase the number of respondents included in the study. The analysis of patents should be conducted by diversification and specifying industries of inventions.

Research on the impact of a patent on innovation activity should be conducted at a national level, which is the recommendation for innovative policymakers in Kazakhstan.

Indeed, we can assume that the variables studied in this sample lead to the potential success of a patent. However, the process from the transition of the patented invention to the commercialization process needs to be considered in more detail to conclude the likely success of the patent in the presence of a certain number of variables in the long run. At present, the process of commercialization has not been adequately studied in Kazakhstan. It is a new process regarding the implementation of innovative patents, even though it has been operating in Kazakhstan since 1999. The interaction of the Patent Office and the innovative development institutions may give a significant boost in co-operation and improve the outcome of the innovation development of the country. However, in this research, the author has a limitation in disclosing the essence of the latter question but will continue to search for answers to this question in future studies.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusion

The thesis delves into the innovation process by leveraging intellectual property tools and employs Kazakhstan as a focal point for analysis. Through a comprehensive comparison spanning a decade, the study juxtaposes innovation performance and intellectual property practices across EU and non-EU countries with those of Kazakhstan. This approach facilitates a nuanced understanding of the innovation landscape, shedding light on disparities and commonalities among diverse economies.

By scrutinizing innovation dynamics through the lens of intellectual property, the thesis offers insights into the factors driving or inhibiting innovation across regions. Kazakhstan serves as a compelling case study, allowing for the examination of unique challenges and opportunities within its innovation ecosystem. The comparative analysis not only highlights areas where Kazakhstan may lag or excel but also elucidates potential strategies for bridging the innovation gap and fostering sustainable growth.

Through this exploration, the thesis contributes to the broader discourse on innovation and intellectual property, offering valuable perspectives on how different countries navigate the complexities of technological advancement and knowledge creation. By elucidating the interplay between innovation performance and intellectual property practices, the study provides a nuanced understanding of the innovation landscape and underscores the importance of targeted policy interventions to bolster innovation ecosystems worldwide.

Moreover, the research pioneers a novel approach by employing the European Innovation Scoreboard (EIS) methodology to analyze innovation indicators within the context of Kazakhstan's unique economic landscape. Unlike previous studies, which may have overlooked Kazakhstan or utilized conventional methodologies unsuitable for its specific circumstances, this research breaks new ground by customizing the analysis to suit Kazakhstan's needs.

Through the normalization process of Kazakhstan's data, the study achieves a significant milestone in innovation research. This process not only ensures the accuracy and reliability of the data but also enables a more meaningful comparative analysis with EIS member countries. By recalibrating the calculation of innovation indicators to align with Kazakhstan's economic realities, the study provides a more nuanced understanding of innovation dynamics within the country.

This pioneering approach sheds light on previously unexplored aspects of Kazakhstan's innovation ecosystem and offers valuable insights into the country's strengths, challenges, and opportunities. Moreover, by adopting a methodology tailored to Kazakhstan's context, the research sets a precedent for future studies seeking to analyze innovation in emerging economies.

The methodological approach adopted in this research represents a significant advancement in the field of innovation studies, demonstrating the importance of context-specific analyses and paving the way for more nuanced understandings of innovation dynamics in diverse economic settings.

The importance of intellectual property (IP) emerges as a central theme in the study, as evidenced by the findings of principal component analysis (PCA). Through PCA, the research elucidates the pivotal role played by IP indicators in driving innovation within the studied context. By identifying correlations between IP and a range of innovation variables, particularly patents, the study underscores the critical linkages between intellectual property protection and innovation outcomes.

The findings of the research underscore the multifaceted nature of IP and its impact on innovation dynamics. Specifically, the study demonstrates how patents, as a form of intellectual property protection, serve as catalysts for innovation by incentivizing knowledge creation, technological advancement, and commercialization efforts. Moreover, the correlations identified between IP indicators and various innovation variables shed light on the intricate interplay between intellectual property practices and innovation processes.

Furthermore, the study's emphasis on the significance of patents in innovation processes underscores the need for robust IP frameworks and effective enforcement mechanisms. By highlighting the positive correlation between patent activity and innovation outcomes, the research underscores the importance of fostering an environment conducive to IP creation, protection, and utilization.

The findings underscore the critical role of intellectual property in driving innovation and economic development. By elucidating the connections between IP indicators and innovation variables, the study provides valuable insights into the mechanisms underlying innovation ecosystems and underscores the importance of IP policies in fostering innovation-driven growth.

Cluster analysis and predictive analytics play crucial roles in identifying trends and forecasting future developments in innovation. Cluster analysis, in particular, offers insights into the differences in innovation variables over time, allowing for a deeper understanding of evolving innovation landscapes. By segmenting countries based on their innovation performance and characteristics, cluster analysis enables researchers and policymakers to discern patterns, trends, and emerging clusters within innovation ecosystems.

Furthermore, cluster analysis can be coupled with predictive analytics to forecast gaps in innovation based on the analysis of principal components. By leveraging predictive modeling techniques, researchers can anticipate future trajectories of innovation and identify potential areas of improvement or intervention. This proactive approach to innovation management enables stakeholders to address challenges and capitalize on opportunities before they fully manifest, thereby fostering more robust and sustainable innovation ecosystems.

The results obtained from cluster analysis and predictive analytics provide valuable insights into the interplay between national innovation systems and the contribution of intellectual property indicators to innovation at the country level. By elucidating the dynamics of innovation ecosystems and forecasting future trends, these analytical approaches empower policymakers, researchers, and industry stakeholders to make informed decisions and strategic investments in innovation.

The empirical findings from the Patent Survey offer valuable insights into the state of the patent system in Kazakhstan and its implications for innovation activity. By examining various patent-related metrics, such as the number of authors per patent, total number of patents per inventor, sources for research and development (R&D) funding, time spent on invention, and the value of patents, the study provides a comprehensive assessment of the patent landscape in the country.

One key observation is the statistically significant differences identified in these patent-related metrics, indicating variations in patent activity and innovation practices across different regions and sectors within Kazakhstan. For example, the distribution of R&D funding sources highlights the concentration of resources in major cities like Astana and Almaty, with commercial and governmental institutions, as well as private corporations, serving as primary contributors to R&D investment. However, the study also notes a relatively modest infusion of funding from private firms, suggesting potential areas for improvement in leveraging private sector resources for innovation.

Additionally, the estimated value of patents varies across different cities in Kazakhstan, with higher values observed in places like Almaty, indicating regional disparities in the commercialization potential of patents. This underscores the importance of addressing systemic challenges and blind spots within the patent system and patent commercialization framework to enhance innovation activity and economic growth.

Overall, the empirical findings provide valuable insights into the dynamics of the patent landscape in Kazakhstan and its implications for innovation. By shedding light on the strengths, weaknesses, and opportunities within the patent system, the study offers actionable recommendations for policymakers, industry stakeholders, and researchers to foster a more conducive environment for innovation-driven growth and development in Kazakhstan.

6.2. Theoretical and Managerial Implications

6.2.1. Theoretical Implications

The EIS was first released in 2001. During this time, it was improved by research groups and proved its usefulness. The presented analysis is an attempt to show the quality of Kazakhstan's data due to the prism of the EIS, which can be used with any country's data in the future. The results of the data give information on what kinds of indicators Kazakhstan needs to improve. The interesting findings in the process of cluster analysis demonstrate the importance of intellectual property in the innovation process, namely the enhancement of IPRs for innovation growth. In this case, IPRs need more research projects in this field in Kazakhstan. We recommend starting with the comparison method with countries that have strong IPRs and finding the differences for future modification of IPRs in Kazakhstan. Such small steps will make changes in the innovation system in Kazakhstan.

The macroeconomic comparison of countries gives a broad picture for building future innovation strategies. The understanding of the strong indicators that are inherent in highly developed innovative countries allows us to develop and reinforce innovative skills for countries at middle level and lower. During analysis, indicators are grouped by 3 clusters to show what is important and what is not in this story. In the course of this study, we find that the geographic location of a country is an important phenomenon for innovation and knowledge sharing. According to the study, in 2018, Kazakhstan formed its own cluster. Here comes the understanding that it is necessary to unite with countries that are close by geographic parameters for the exchange of knowledge, experience, and joint work. However, geographical location is one of the few factors that influence innovation activity in Kazakhstan.

6.2.2. Managerial and Policy Implications

According to practice, countries that have a high level of innovation achieve strong economic growth. Countries with economies in transition usually have a short gap with developed countries in some cases. This gap must be overcome by detecting missing or weak indicators that influence innovation. In comparison, it is important to enhance the indicators characteristic of a higher group and compare countries to begin the transition from one group to another. The possibility for the country to move from one group to another grows as the needed indicators gradually rise (Kowalski 2021). These actions help to reach a new level of innovation for countries with economies in transition (Kontic, 2018).

A huge budget is allocated for the development of innovative ideas and their implementation in Kazakhstan. Each patent can participate in the state grant program, but practice shows that preference is given to more profitable commercial projects with short-term implementation. The participation of patents in such projects should be allocated under a certain category of the grant system as an option.

From the results of the survey on inventive activity in Kazakhstan, it is clear that there is a lack of human resources in research and highly qualified specialists in creating quality inventions. This affects the output of innovation results and negatively affects the country's innovation activity. The growth of innovative activity lies in improving the quality of education, increasing the contribution to R&D and continuing education (lifelong learning). For continuing education, it is necessary to create prerequisites for the subsequent exchange of experience in their field, the qualitative transfer of practical and theoretical skills, and training from foreign companies in this field. Besides, it needs to consider the experience of countries that have created an institution of continuous education and their level of innovative activity (Fischer 2000; Tate et al. 2011; Biggs et al. 2012; Perri et al. 2018).

Lack of knowledge regarding the commercialization and intellectual property rights of inventors reduces the likelihood of increased technological innovation in the country. Often, the author of an invention is left alone with his invention after receiving a patent. So it creates an environment of passive patents that are on the shelves. Further work on inventors' awareness of commercialization leverage should be improved. Improving the awareness of ways to commercialize inventions should have practical tools with constant updating of information for inventors. The main information gap regarding the commercialization of a patent for an invention is at the post-patent stage and its potential commercialization. It is at these stages that it is necessary to fill in the gaps of additional awareness through practical cooperation between the Patent Office and QAZTECH VENTURES. Further, the information gap can be filled through accredited Kazakhstan patent attorneys who have access to patents and inventors from the other side of the invention patenting process. Moreover, for the growth of commercialization of patents, it is necessary to take into account the age data of inventors. According to the study, the average age of an inventor is approximately 55 years in Kazakhstan. It is necessary to build such a system of awareness about the possibility of implementing patents so that each author has the opportunity to understand and use the tools for commercializing the received patent for an invention.

Therefore, it is necessary to pay attention to how information about the commercialization of a granted patent reaches the author of the invention.

During the survey, we found that patents created to maintain the reputation of the research institute were often reflected. This means that initially the research resources were used inefficiently, creating patents that will forever remain on the shelves but will increase the rating of the scientific institute. For the effectiveness and growth of innovative activity, it is necessary to learn how to adapt such patents as efficiently as possible for society. It is proposed to create centers for the adaptation of patents for inventions at such institutions or online platforms where everyone can view a patent for an invention and offer their own options for its implementation, contact the author, or offer sponsorship.

Thus, according to the obtained results, we recommend changing the system for presenting information to inventors. It is necessary to work through patent attorneys, who must also have up-to-date information on the possibilities of public and private support for inventive projects. From the studied international experience, centers for the commercialization of patents at universities, research institutes with the possibility of mentoring are needed. We also propose to create an online platform to support received patents with a user-friendly interface. It is necessary to work through patent attorneys (Li et al. 2015; Frietsch & Neuhäusler 2019) who must also have up-to-date information on the possibilities of public and private support for inventive projects. From the studied international experience, centers for the commercialization of patents at universities and research institutes with the possibility of mentoring are needed. We also propose to create an online platform to support received patents with a user-friendly interface.

As part of this dissertation, IPB Group, together with one of the patent attorneys, decided to implement the obtained patents in the local market, creating a center to support its customers and inform them in a timely manner about the possibilities of realizing the potential of their patents. Based on the results of a survey of respondents who have held patents since 2008, we have gained an understanding of the process of invention in Kazakhstan. As part of a pilot project, IPB Group independently took on the implementation of two projects for the commercialization of a patent for an invention and a patent for a utility model.

Certainly, there are so many challenges in the process of commercialization granted patents that need to be discussed under this thesis. It was an attempt to clarify some questions growing in Kazakhstan in the fields of innovation and intellectual property.

6.3. Recommendations for Further Research

Multi-method studies and longitudinal research are unquestionably necessary due to the multifaceted, complex, dynamic, evolutionary, and revolutionary character of the concepts of intellectual property and innovation.

Qualitative and quantitative research, such as the one contained here, has several limitations. The methodological and research limitations were mentioned in Chapters 1 and 4. The following are recommendations to address some of the limitations and research gaps uncovered by this study:

1. The empirical conclusions of the study of innovation activity can be reproduced from the sample to the study's target population, i.e., different countries or regions. This thesis makes no claims on the universal applicability of its findings, for instance, in the case of data normalization which needs a huge data. The literal and theoretical replications of this study, particularly regarding the selection of innovation indicators, may be increased by additional research in different continents through available data.

2. The Kazakhstan scenario presented in this study gently suggests that, among other things, the future level increase of innovation indicators presented in this thesis have an impact on the trajectory of innovation activity in developing countries. It needs to investigate the issue of growing economies, which is characterized by a dearth of capital venture markets, skilled labor migration, a high percentage of unemployment, and a low level of education. Future research on the negotiation of the innovation gap and the rise of innovation in developed and emerging countries will be valuable to the literature on creating national innovation systems.

3. A high concentration of innovative activity is concentrated in large cities in Kazakhstan. An uneven distribution of innovations entails various consequences, including high migration to large cities, dying cities, a low level of education in the regions, etc. When studying literary sources, the development of innovations in the regions contributes to the growth of the economies of the regions, the development of society, the improvement of the quality of knowledge, the growth of highly qualified specialists, the even distribution of resources, the rise of the regions, etc. More research is needed on the development of innovations in the regions and comparison

with foreign research in this area. European countries have progressed in the study of regional innovation (Prange 2008; Buesa et al. 2010; Miguelez & Moreno 2018). It needs to be a trend to develop regional innovation in Kazakhstan.

4. According to this thesis, both authors and the government face the problem of during innovation and commercialization process. In the first ten years, roughly 10% of patents are commercialized on average. Due to the sophistication of the setup, the high level of manufacturing costs, and other factors, certain patents take longer to achieve realization. The notion of patent commercialization has not been completely explored here due to the scope of this thesis. Dedicated research on the problem of commercialization of patents would be an interesting contribution to the theory and practice of patents in economics and innovation strategy.

5. This study partly consists of industry research by comprehend the concerns of patent authors and holders. The multi-dimensional nature of the inventive process in an innovation system requires a study of patent holder actions and determinant factors with respect to a potential commercialization process. This research does not include this aspect of the study due to time and resource limitations. This thesis suggests more research to support this study from a commercial viewpoint on patents that investigates elements that may influence a patent's assimilation in a local market and those that may influence its likelihood of becoming an innovative technology.

6. Finally, an interesting trend was observed in this study - the dependence of innovation on the geographical location of the country. It was clear in 2008 and 2018 how important country location is for innovation activity.

How this tendency will develop in the field of cooperation in Kazakhstan and neighboring countries would be an interesting topic for future study.

7. NEW SCIENTIFIC RESULTS

1. The research conducted in this thesis underscores the critical importance of innovation and intellectual property in the Digital Era. By delving into the intricacies of innovation performance within the rapidly evolving technological landscape, the study sheds light on the drivers and barriers to innovation in Kazakhstan and beyond.
2. A primary objective of this study is to bridge the innovation gap between countries by examining the innovation process through the lens of intellectual property tools. Through a comparative analysis spanning a decade, the thesis elucidates differences in innovation performance and intellectual property practices among EU, non-EU, and Kazakhstan. This approach provides valuable insights into the factors influencing innovation outcomes and the strategies needed to enhance innovation capacity.
3. The research employs the European Innovation Scoreboard (EIS) methodology to analyze innovation indicators across different economic levels. By normalizing Kazakhstan's data and enabling comparative analysis with EIS member countries, the study offers a robust framework for understanding innovation dynamics. This methodological approach facilitates nuanced insights into the complex interplay between intellectual property, innovation, and economic development.
4. Principal component analysis reveals the significant role of intellectual property indicators in driving innovation. The study identifies correlations between intellectual property and various innovation variables, highlighting the pivotal role of patents in

innovation processes. These findings underscore the importance of fostering a conducive environment for intellectual property protection and innovation promotion.

5. Cluster analysis elucidates differences in innovation variables over time and predicts innovation gaps based on principal component analysis. By examining the interactions between national innovation systems and the contribution of intellectual property indicators, the study provides predictive insights into future innovation trends. This analytical approach offers valuable guidance for policymakers and stakeholders seeking to prioritize interventions and investments in innovation.
6. The empirical study of the Patent Survey uncovers statistically significant differences in various patent-related metrics in Kazakhstan, shedding light on the state of the patent system and its impact on innovation activity. These empirical findings underscore the need for targeted interventions to address challenges in patenting and commercialization processes, thereby enhancing innovation activity in Kazakhstan.
7. The conclusion highlights blind spots in the patent system and commercialization processes in Kazakhstan, suggesting areas for improvement to foster innovation ecosystems conducive to economic growth and development. By addressing these challenges and implementing targeted policy interventions, Kazakhstan can unlock its innovation potential and position itself as a global player in the Digital Era.

8. SUMMARY

The study examines the central issue of increasing innovation activity through understanding the innovation indicator gaps and intellectual property impact during this process. The expansion of this topic joined to consideration of inventive processes in Kazakhstan and understanding of intellectual property under the prism of patent holders. The study started with Chapter 1 with an introduction describing the research overview. This chapter explains the justification of research with the central idea of why this research is necessary to conduct. Further, the thesis describes the practical justification of this research and how the existing literature explains innovation and intellectual property in Kazakhstan. We found that there are limited research and topics that explore the patent system in Kazakhstan as well as the attempts to clarify the innovation level in Kazakhstan by empirical results. Due to the fact of razing innovation effort by Kazakhstan entrepreneurs this topic was raised for theoretical and practical specialists, managers, and politics and so on. Besides, this research starts with macroeconomic level to get attention of government to problems of measurement of innovation and comparison with different innovation level countries. During research we concentrate around intellectual property in innovation. It gives us understanding that there is no dialog between government and inventors for productive communication. After exploding reasons, this thesis describes the methodological justification, boundary line of the research, outline of thesis and definition related to this research which we further used in this thesis.

In the Chapter 2 we give the overview of the other research related to this thesis based on the topic describing the research problem and questions. In the literature review describes the past and present innovation situation in the world and it communication with other parts of economic system, and theoretical part of intellectual property with accent on patent. Moreover, thesis explains the relationship between innovation theory and intellectual property theory. At the end of literature review the participation Kazakhstan in this research also describes the innovation system in Kazakhstan with full picture of data by republic scale and regional perspective.

In the next chapter Objective of the dissertation proposed the hypotheses linked with Kazakhstan's innovation interests (three hypotheses related to innovation activity) and with understanding the inventiveness in Kazakhstan (one hypothesis about patent survey) Further thesis chapter moves to the Materials and Methods. This chapter explains the tools that are used during research. In the case of innovation, we used secondary data from statistical reports from 2 past decades in Kazakhstan. The other data were ready and taken from the EIS reports in 2008 and 2018 for EU and non-EU countries. By normalization process, Kazakhstan data become primary data and clean for the next step. The PCA helped us to see the contribution of each indicator in innovation, namely the contribution of intellectual property in innovation activity. Clusterization by countries and indicators helped us to visualize the empirical result. In case of Patent survey, it was explained the tools of questionnaire, process of gathering answers and data processing. The data analyzed by Kruskal-Wallis test with post-hoc test. In this chapter we also discussed about Kazakhstan location profile and length of survey.

The next chapter described received results. This part of thesis gives us explanation how intellectual property indicators contribute in innovation activity and what does mean inventive process in Kazakhstan. The describe of results starts he transformation from statistical numbers to indicators by normalization process in 8 steps. The obtained normalized data continues Principal Component Analysis (PCA). This stage includes PCA and Cluster allocation of received data. The PCA test gave us the contribution each variable to innovation. We found the impact of intellectual property in innovation scoreboard. In this conditions patent indicator was higher than other intellectual property indicators in 2008 and 2018. The clustering of countries and indicators together showed that in modern time needs cooperation by geo position of country for better innovation development. The Patent survey showed how it is important to develop regional invention and factors that improves invention in regions. The development of intellectual property gives the possibility to increase of technological innovation in Kazakhstan.

The chapter Discussion describes and evaluates 3 significant hypotheses step by step. Conclusion part describes the output of research and gives the recommendation to future research. At the end of thesis, it describes the uniqueness, importance and implication of research for policy makers, managerial and literature point of view.

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11. ARTICLE PUBLICATION

11.1. Publication on Thesis Topic:

1. Shakenova A. The role of small and medium enterprises in innovation activities in Kazakhstan= Kis és középvállalkozások szerepe az innovációs tevékenységekben Kazahsztánban //Köztes-Európa. – 2018. – T. 10. – №. 1. – p. 79-86. https://ojs.bibl.u-szeged.hu/index.php/vikekke/article/view/12781.

2. Shakenova A.: Comparative analysis of the innovation system of Kazakhstan: applying the European innovation scoreboard. In: Proceedings of the European Union's Contention in the Reshaping Global Economy. pp. 173-201. (2020) DOI:10.14232/eucrge.2020.proc.10

3. Shakenova A., Saparova B.: The importance of patents in economics: Proceedings of the International Scientific and Practical Conference "Modern trends in the development of the financial and banking sector under economic uncertainty"/Under the General editorship of Nasyrova G.A.- Nur-Sultan: L.N. Gumilyov Eurasian National University, 2022. – 337 p. (2022) (ISBN 978-601-337-682-0)

4. Shakenova A. A Survey About Patents, Invention and Commercialization Processes in Kazakhstan //Regional and Business Studies. – 2022. – T. 14. – №. 2. – C. 31-45.

12. CURRICULUM VITAE

Ainur Shakenova: 10 August 1988

Successfully graduated from the Faculties of Economics and Law of the Karaganda Economic University of Kazpotrebsoyuz in 2008, 2014, was also a scholarship holder of the Master's program of the Finance Academy of Ministry of Finance of the Republic of Kazakhstan and is currently conducting research as a PhD candidate at Szent Istvan University, Kaposvar Campus in Hungary.

Professionally she works from 2008. Her career started in Kazakhstan project at the international exhibition "EXPOZARAGOZA 2008" with the support of the Ministry of Industry and Trade of the Republic of Kazakhstan. In 2009, she worked at the Ministry of Foreign Affairs of the Republic of Kazakhstan in the State Protocol. In 2011, she continued her career at the Patent Office in Kazakhstan in the trademark department. Since 2020, Ainur holds a license as a Patent Attorney and deals with intellectual property in Kazakhstan. In 2021, she is a practical lecturer with the programs "Patent Law", "Copyrights" for Master and PhD students at Suleyman Demirel University.

13. ATTACHMENTS

Annex A

Countries rate in European Scoreboard (2008; 2018)

Individuals	In table	European Scoreboard 2008	European Scoreboard 2018
Austria	1	Strong Innovators	Strong Innovators
Belgium	2	Strong Innovators	Strong Innovators
Bulgaria	3	Modest Innovators	Modest Innovators
Cyprus	4	Moderate Innovators	Moderate Innovators
Czech Republic	5	Moderate Innovators	Moderate Innovators
Germany	6	Innovation Leaders	Strong Innovators
Denmark	7	Innovation Leaders	Innovation Leaders
Estonia	8	Moderate Innovators	Moderate Innovators
Spain	9	Moderate Innovators	Moderate Innovators
Finland	10	Innovation Leaders	Innovation Leaders
France	11	Strong Innovators	Strong Innovators
Croatia	12	Just moved	Moderate Innovators
Hungary	13	Modest Innovators	Moderate Innovators
Ireland	14	Strong Innovators	Strong Innovators
Italy	15	Moderate Innovators	Moderate Innovators
Lithuania	16	Modest Innovators	Moderate Innovators
Latvia	17	Modest Innovators	Moderate Innovators
Malta	18	Modest Innovators	Moderate Innovators
Netherlands	19	Strong Innovators	Innovation Leaders
Norway	20	Just moved	Strong Innovators
Poland	21	Modest Innovators	Moderate Innovators
Portugal	22	Moderate Innovators	Moderate Innovators
Romania	23	Modest Innovators	Modest Innovators
Sweden	24	Innovation Leaders	Innovation Leaders
Slovenia	25	Moderate Innovators	Strong Innovators
Slovakia	26	Modest Innovators	Moderate Innovators
Turkey	27	Just moved	Moderate Innovators
United Kingdom	28	Innovation Leaders	Innovation Leaders
Kazakhstan	29	Unknown	Unknown

Source: created by author according to the European Innovation Scoreboards 2008, 2018

Annex B

Harmonized data according to the EIS in 2008 and 2018

	q1	q2	q3	q4	q5	q6	q7	q8	q9	q10	q11	q12	q13	q14	q15	q16	q17	q18	q19
AT	1,72	17,6	12,8	0,75	1,81	n/a	41,1	18	58	183,1	237,1	284,6	47,8	54,9	6,66	14,15	53,2	31,3	7,08
BE	0,94	32,1	7,2	0,57	1,3	0,73	40,8	16,7	49,4	129,1	121,4	116,2	45,4	45,3	6,31	15,54	48,7	43,9	7,39
BG	0,36	22,4	1,3	0,33	0,15	0,79	15,1	3,8	0,5	1,4	32,8	19,2	17,8	15,7	5,13	8,35	21,2	18,2	3,59
CY	0,22	33,1	8,4	0,31	0,1	2,12	37,5	26,2	9,1	17	282,8	31,2	37,9	50,9	0,9	15,8	45,9	35,4	7,04
CZ	0,86	13,7	5,7	0,55	0,98	0,88	28	11,7	12,6	7,3	47,1	67,7	32	36,2	10,85	10,92	61,3	35,5	4,72
DE	1,56	24,3	7,8	0,76	1,77	1,07	46,3	9	45,9	275	187,7	222,6	52,8	68,1	10,72	15,37	65,5	53,8	10,11
DK	0,93	32,2	29,2	0,88	1,65	0,51	40,8	14,9	108,7	174,6	212,1	280,4	35,7	45,4	6,03	10,92	41,2	67,2	4,05
EE	0,57	33,3	7	0,58	0,54	3,36	37,1	18,1	14,5	5,6	81,4	17,9	45,8	48,4	3,9	11,01	36,2	38,5	9,27
ES	0,67	29	10,4	0,55	0,66	0,49	24,6	5	10,6	29,3	163,8	104,5	29,5	29,5	4,47	14,22	52,3	n/a	8,48
FI	2,17	36,4	23,4	0,94	2,51	n/a	40,9	27,5	83,1	267,6	137,3	116,8	44,7	n/a	7,03	16,49	51,5	26,7	4,83
FR	1,13	26,8	7,4	0,74	1,31	0,33	28,3	11,5	27,9	119,2	94,4	107,5	29,9	41,3	6,35	15,76	58,9	n/a	5,56
HR	0,47	16,2	2,9	0,55	0,38	0,92	24,4	9,6	11,9	5	4,5	2,9	28,3	38,1	4,7	9,71	39,5	14,8	8,45
HU	0,42	18	3,6	0,46	0,49	0,72	13,2	6,5	16,9	7,8	26	18,3	16,8	26,4	8,82	11,35	69,3	25,6	2,7
IE	1,11	32,2	7,6	0,44	0,88	0,96	38,8	11,7	14	64,1	172,5	132,7	43,8	40,9	5,26	16,05	51,8	70,5	5,43
IT	0,89	13,6	6,2	0,52	0,55	1,1	28,1	4,3	17,2	76,1	120	184,2	33	37,5	7,59	15,57	51,1	n/a	4,52
LT	0,61	28,9	5,3	0,58	0,23	0,64	17,7	10,3	0	1,3	20,4	2,6	19,7	28,5	2,44	8,19	33,1	13,8	6,39
LV	0,24	22,6	7,1	0,42	0,21	n/a	n/a	5,6	0,4	5,7	23,7	21	14,4	n/a	1,88	10,57	23,8	37,6	1,25
MT	0,03	12,5	6	0,21	0,39	1,1	n/a	5,7	0	21,6	127,1	46,7	14,4	31,8	6,16	15,22	74,5	23	3,85
NL	0,87	30,8	16,6	0,67	1,03	0,29	27,3	12,5	83,7	173,3	195,8	135,3	32,9	31,8	3,15	17,97	48,3	39,9	4,87
NO	0,94	34,4	18	0,77	0,81	0,17	25,9	9,8	38,5	95,5	51,2	67,1	29,8	34,7	4,21	16,05	11,4	54,8	3,17
PL	0,86	18,7	5,1	0,38	0,18	1,03	17,2	9,3	1,3	3	33,2	45,5	20,4	29,1	5,5	10,33	48,9	27,9	5,55
PT	2,75	13,7	4,4	0,46	0,61	0,95	34,1	6,7	4	7,4	118,5	55,8	38,7	53,4	3,45	9,65	38,7	27,5	6,12
RO	0,48	12	1,3	0,31	0,22	1,08	17,9	2,9	3,1	0,7	13,5	3	19,4	35,4	5,66	5,26	37,5	46,6	13,69
SE	2,25	31,3	32	0,99	2,64	0,66	41,8	16,6	116,1	184,8	201,9	161,9	40,7	n/a	6,2	18,45	54,8	49,7	5,1
SI	0,96	22,2	14,8	0,6	0,94	1,12	n/a	15,1	28,2	32,2	68,7	50,5	31,7	n/a	9,09	10,89	54,2	20,7	7,5
SK	0,89	14,4	3,9	0,27	0,18	1,51	17,9	7,2	4,5	5,8	20,6	18	21,4	21,5	9,89	9,86	57,2	20,8	8,95
TR	0,12	9,7	1,5	0,37	0,21	0,16	28,2	5,3	0,3	1	1,9	4,5	29,5	50,3	3,6	5,53	38	12,9	11,17
UK	1,61	31,9	26,6	0,64	1,08	n/a	n/a	10,7	54,7	91,4	153,1	87,1	25,1	30,3	5,4	18,64	58,2	8,9	4,81
KZ	0,07	22,7	1	0,22	0,11	0,002	3,1	3,3	1,6	11,3	22,6	1,1	2,4	0,8	0,19	8,7	20,2	5,94	17

	q1	q2	q3	q4	q5	q6	q7	q8	q9	q10	q11	q12	q13	q14	q15	q16	q17	q18	q19
AT	1,9	40,3	15,8	0,87	2,2	0,47	35	20,5	82,3	4,7	13,09	6,98	40,7	46,1	1,9	15	58	43,1	11,98
BE	1,9	45,7	8,5	0,74	1,73	0,56	39,8	28,6	80	3,16	8,11	2,72	48,3	45,1	2,7	15,6	48,2	68,9	7,6
BG	1,5	33,4	2,3	0,21	0,57	0,74	11,2	3,1	3	0,64	9,1	5,56	14	14,8	6,6	10,2	33,8	39	4,8
CY	0,6	57	6,9	0,27	0,17	0,21	30,5	11,7	21,1	0,82	43,15	3,67	32,8	31,1	0,1	17	54,4	70	4,49
CZ	1,7	33,8	9,8	0,64	1,03	0,94	28	10	21	0,93	5,09	4,07	30,8	25,7	6,5	12,9	65,7	43,8	14,57
DE	2,8	31,3	8,4	0,94	2	1,26	37,9	10,1	62,4	6,11	9,51	6,72	41,6	49,1	4,6	14,8	68,2	14,6	13,34
DK	3,2	46,2	26,8	0,97	1,89	0,29	28,2	13,2	162,8	6,05	12,79	7,94	34,7	40	4,5	15,1	48	71,7	6,96
EE	1,1	43,1	17,2	0,61	0,66	0,85	15,8	10,8	10,6	1,01	16,55	5,84	17,4	15	3,2	13,5	41,2	48,6	10,48
ES	2,6	42,6	9,9	0,55	0,64	0,36	14,5	6,7	21,1	1,45	8,99	2,97	18,6	25,5	4,8	12,5	47,2	33,1	15,94
FI	2,9	40,3	27,4	0,91	1,81	0,32	38,3	16,8	85,4	7,43	12,3	4,11	44,1	37,3	2,8	16,2	44,7	70,3	9,27
FR	1,7	44,3	18,7	0,78	1,43	0,5	31,5	13,2	42,8	3,98	6,04	2,96	35,5	41,6	4,1	14,5	58,5	67,6	15,02
HR	1,2	32,7	2,3	0,46	0,38	1,2	21,1	6,8	17,3	0,61	4	0,9	25,4	30,8	3,5	11,6	39,9	19,1	4,91
HU	1	30,2	6,2	0,29	0,89	0,75	11,7	6,2	29,6	1,34	4,15	1,15	15,1	15,2	8,7	11,6	68,5	49	12,47
IE	2,6	53,5	8,9	0,35	0,83	0,47	41,3	13,9	45,4	1,8	5,08	1,09	45,7	52,5	7,1	20,6	56	94,2	18,07
IT	1,5	26,9	7,9	0,5	0,75	0,57	30,5	6,7	22,2	2,16	8,46	6,23	32,7	34,6	3,1	13,7	52,4	50,9	10,06
LT	0,9	55,6	5,9	0,55	0,3	2,01	30,4	15,2	3,9	0,81	7,39	1,71	33,7	24	2,1	9,7	36,9	22	8,57
LV	0,7	41,6	7,5	0,33	0,11	0,58	10,2	2,8	1	0,82	7,77	1,2	11,9	19	5,2	12,1	34,7	52,4	5,31
MT	0,7	33,5	10,1	0,23	0,39	0,36	23,9	4,2	0	1,31	40,88	13,05	26,7	30,8	6,1	18,4	61,6	33,9	4,12
NL	2,4	46,6	19,1	0,87	1,16	0,16	35	17,5	99,3	5,82	9,78	4,34	42,9	32,5	4,8	17,1	49,7	77,7	10,81
NO	2	48,3	19,9	0,95	1,08	0,63	35,2	19	82,2	2,66	3,79	0,52	41,1	43,3	4	15,4	14,3	78,3	6,16
PL	0,6	43,6	4	0,32	0,63	1,24	8,3	3,5	5,4	0,69	5,33	5,71	13,3	11,4	5,8	10,3	49	40,2	6,45
PT	1,9	34	9,8	0,64	0,61	0,64	25,6	7,8	13,2	0,95	8,1	4,04	42,1	37,8	5	10,6	38,5	41,1	6,27
RO	0,8	25,6	1,1	0,21	0,27	0,23	4,5	1,8	3,7	0,22	2,64	1,31	4,9	8,8	2,6	7,7	55,8	46,2	6,51
SE	2,7	47,4	30,4	0,98	2,26	1,12	35,1	13,5	130,6	9,08	11,44	4,67	40,4	35,1	5,5	18,5	54,5	73,2	6,89
SI	3,5	44,5	12	0,49	1,51	0,81	26,1	13,2	56,1	1,65	11,09	2,97	32,6	33,2	3,2	13,7	57	36	12,44
SK	2,2	35,1	3,4	0,39	0,4	0,58	13,9	8,4	10,3	0,51	4,49	1,46	16,7	22,4	7,7	10,6	66,5	33,2	19,12
TR	0,4	30,5	5,8	0,44	0,44	2,7	22,5	6,3	2	0,73	1,34	0,11	31,5	40,5	n/a	6,7	43,4	31,9	10,51
UK	3,1	47,3	14,3	0,52	1,13	0,67	19	20,6	65,1	3,06	6,95	3,07	32,6	45,4	6,4	18,5	57,1	71,7	20,81
KZ	0,3	53,98	1,1	0,25	0,5	0,37	36,6	36,8	5,9	7,1	29,2	1,1	6,6	10,5	2,3	10,3	17,3	3,5	32,7

Source: created by author

Annex C

The quality on the factor map for the first and second principal components with variables in 2008 and 2018.

Indicator	2008			2018	
	PC1	PC2		PC1	PC2
q1	0.48968491	0.00005123091		0.540644099	0.0989775011
q2	0.35282387	0.08418067019		0.162691756	0.4094804378
q3	0.63308291	0.20384932647		0.692001917	0.0218318836
q4	0.75484439	0.04537177793		0.699367463	0.0083324396
q5	0.84679473	0.02014165069		0.721897295	0.0707097506
q6	0.02014700	0.44063303203		0.067983717	0.0006569313
q7	0.46727812	0.28250151290		0.601190233	0.1636625540
q8	0.46149673	0.00672043295		0.279904652	0.5418604182
q9	0.78720130	0.07607238443		0.811267344	0.0122076168
q10	0.80402922	0.00608485074		0.573883760	0.0487976938
q11	0.59526818	0.03225615572		0.001499521	0.1318298937
q12	0.67254784	0.01337977159		0.059348464	0.1409486780
q13	0.62250395	0.25394996268		0.686466898	0.0013823211
q14	0.02837582	0.64504910656		0.581964959	0.0056261303
q15	0.08611164	0.07401646233		0.001757060	0.3070437984
q16	0.53942491	0.02305535902		0.588966169	0.0057500033
q17	0.10905213	0.08901271486		0.015719230	0.4056142517
q18	0.21905763	0.04782170127		0.368461068	0.0304173836
q19	0.09875065	0.08833727445		0.001926149	0.2127481262

Source: created by author

Annex D

The correlation of contributed variables with PC1 and PC2 in 2008 and in 2018

PC1 - 2008

Variable	% of contribution	Correlation	p-value
Q5	9,943	0,9245831	7.909650e-13
Q10	9,339	0,8960648	5.053647e-11
Q9	9,144	0,8866619	1.536152e-10
Q4	8,779	0,8688189	9.907972e-10
Q12	7,818	0,8198946	5.268398e-08
Q3	7,357	0,7953183	2.534225e-07
Q13	7,256	0,7898438	3.494534e-07
Q11	6,921	0,7713867	9.668902e-07
Q16	6,272	0,7343439	5.767148e-06
Q1	5,697	0,6998605	2.383397e-05
Q7	5,441	0,6839479	4.302154e-05
Q8	5,368	0,679397	5.060256e-05

PC2 - 2008

Q14	26,489	0,8022863	1,65987E-07
Q6	18,066	0,6625644	9,0076E-05
Q7	11,59	0,5306829	0,003060043
Q13	10,398	0,5026636	0,005452145
Q3	8,447	-0,4530669	0,013581715

PC1 - 2018

Variable	*% of contribution*	*correlation*	*p.value*
Q9	10,85269507	0,8999789	3.082466e-11
Q5	9,73440036	0,8523504	4.416128e-09
Q4	9,32987523	0,8344522	1.850634e-08
Q3	9,21641159	0,8293627	2.697583e-08
Q13	9,10227893	0,8242114	3.901825e-08
Q7	8,16956365	0,7808417	5.810460e-07
Q10	7,85095802	0,7654642	1.314285e-06
Q16	7,84995289	0,7654152	1.317579e-06
Q14	7,71649648	0,7588809	1.829949e-06
Q1	7,17224978	0,7316296	6.498378e-06

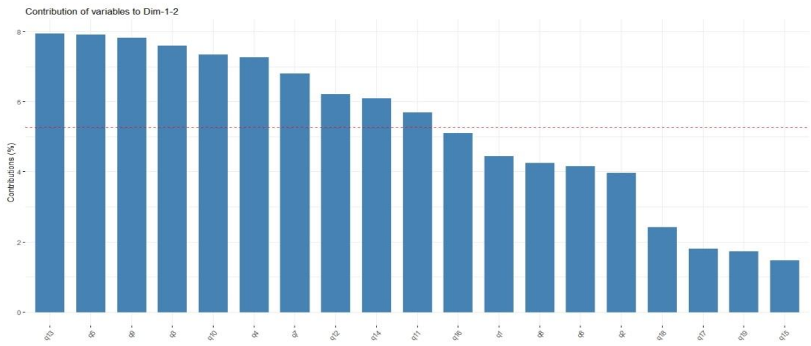
PC2 - 2018

Q8	20,63361901	-0,7296677	7,07776E-06
Q17	15,94036141	0,6413373	0,000177496
Q2	15,07888731	-0,6237665	0,000299819
Q15	12,4391114	0,566542	0,001355095
Q19	8,14829664	-0,4585333	0,01235952
Q7	6,04039143	-0,3947935	0,034051206
Q12	5,94224288	0,3915729	0,035672553

Source: created by author

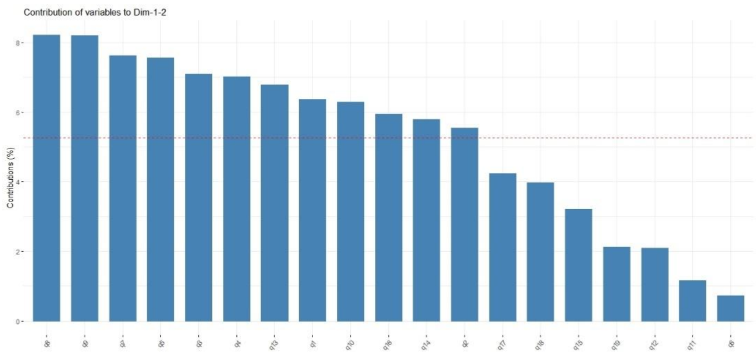
Annex E

The correlation of contributed variables with PC1-PC2 in 2008



Source: created by author

The correlation of contributed variables with PC1-PC2 in 2018



Source: created by author

Annex F

Questionnaire

GENERAL INFORMATION

Attention: This survey will help to identify the main problems of patenting in the Republic of Kazakhstan, the impact of a patent on innovation and the value of a patent. We also inform you that this survey is anonymous and your answers will be reflected as quantitative data. We guarantee that we will never use your personal data. Thank you very much for participating in the evaluation of the effectiveness and value of patents in the Republic of Kazakhstan!

Name of the inventor:

Patent name:

Annotation:

Year of publication in Kazakhstan:

Countries in which the patent was issued:

1.1. Personal data

1.2. Country of origin of the inventor ____________________________

1.3. Year of birth ___________________________

1.4. Country of Residence (when the research leading to the patent was done) __________

1.5. Gender Male ☐ Female ☐

1.6. During the process of invention and patenting, your highest degree of education was: (tick one box next to the appropriate answer)

- ☐ High school or below
- ☐ Diploma of Completion of Secondary Special Education
- ☐ Bachelor, Specialist or equivalent
- ☐ Master or equivalent

☐ Doctorate, PhD or equivalent

1.7. Please also indicate (at the time of patenting):

Year of completion of education (indicated in question 1.7.) ______________________

Country in which you were educated ___________________________

Bachelor and above, please indicate the specialty in which the degree was obtained (for example, mechanical engineering, biochemistry) ___________________________

(In case of more than one degree, please indicate only the most important for the patent)

2. Patenting process

At the time of obtaining a patent, before and after

3.1. What organization did you work for when the research leading to the above patent was being done?

☐ Large company (more than 250 employees)
☐ Foreign company
☐ Medium or small business
☐ Hospital
☐ Private research organization or foundation
☐ Government research organization
☐ University and Research Institute
☐ Other government agency
☐ Other (please specify)____

3.2. Please indicate your place and job title when your research leading to the patent was completed: ____

3.3. Does your organization have additional patents that exist separately and are not related to your patent?

☐ Yes
☐ No
☐ I don`t know

3.4. Have you officially participated in the study of other inventions related or not related (underline as appropriate) to this patent.

☐ Yes
☐ No

☐ Participated informally

3.5. In what year did you join this organization or start your own business if you are self-employed? ____

3.6. Have you changed your place of work after obtaining a patent:

☐ Yes
☐ No

This section is for respondents who chose answer 3.7. "No"

3.7. Have you had any co-authors listed on this patent where one or more employees were employed by organizations that were not your primary employer at the time of the invention?

☐ Yes
☐ No
☐ I don`t know

3.8. Were all co-authors of the invention related to the same organization or company at the time of obtaining the patent?

☐ Yes
☐ No
☐ I don`t know

3.9. How many co-authors participated in this patent (number)?

This section is complete (for respondents who selected in answer 3.7. "Did not change employer")

3.10. Has your position changed since you received the patent in question?

☐ Yes
☐ No

3.11. Have you changed jobs since you received your patent?

☐ Yes
☐ No

3.12. What organization did you work for after receiving the patent?

- ☐ Large company (more than 250 employees)
- ☐ Medium firm (100-250 employees)
- ☐ Small firm (less than 100 employees)
- ☐ Hospital
- ☐ Private research organization or foundation
- ☐ Government research organization
- ☐ University and Research Institute
- ☐ Other government agency
- ☐ Other (please specify) ________________________________

4. Investigation

4.1. Was there any formal or informal collaboration between your employer/organization and other partners during the research leading up to the patent (formal collaboration refers to contracts or agreements between the parties)?

- ☐ Yes
- ☐ No

4.2. ***If yes, please list the following information:***

Partner name

Purpose of cooperation

- ☐ Official collaboration
- ☐ Informal collaboration

4.3. Please select, in order of importance, the following sources of knowledge for the research that led to the patented invention?
(1 = not important, 5 = very important)

University laboratories and faculties
1 2 3 4 5 I did not use this source of knowledge
Other laboratories (not related to universities)
1 2 3 4 5 I did not use this source of knowledge
Technical conferences and seminars
1 2 3 4 5 I did not use this source of knowledge
Scientific literature
1 2 3 4 5 I did not use this source of knowledge
Patent Literature
1 2 3 4 5 I did not use this source of knowledge
Customers or users of products

1 2 3 4 5 I did not use this source of knowledge

Suppliers

1 2 3 4 5 I did not use this source of knowledge

Competitors

1 2 3 4 5 I did not use this source of knowledge

Other sources (please specify)

____
____
____
____

4.4. In what city or town was the invention made?

4.5. Which of the following scenarios best describes the creative process that led to your invention (Check only one box next to the appropriate answer)?

☐ The invention was the main purpose of a research or development project

☐ The invention was an expected by-product of a research or development project not directly related to the main purpose of the project

☐ The invention was an unexpected by-product of a research project not directly related to the main purpose of the project.

☐ The invention idea was directly related to your regular work (which is not invented) and then developed into a project (research or development)

☐ The idea for the invention came from pure inspiration/creativity or from your ordinary work (which was not invented) and was not developed into a project (research or development) (was patented at no additional cost to research or development) (if you selected this answer, please skip questions 4.6 and 4.7)

☐ Other (please specify) ______________________________________

4.6. How many months did it take for the research leading to the patent?

☐ Less than 1 month
☐ 1-3 months
☐ 3-6 months
☐ less than 1 year
☐ 1-2 years
☐ 2-4 years
☐ 4-6 years old

☐ over 6 years

4.7. What is your estimate of the material cost (in dollars) of the research that led to the patent up to the filing date? (Do not include legal fees or any other fees associated with a patent application) ____

4.8. Which of the following best describes the sources of research funding leading to this patent (more than one option may be selected)?

☐ Applicant's internal funds (including its subsidiaries)
☐ Funds from any other organization affiliated with the project
☐ Funds from financial intermediaries of any kind (banks, other financial institutions, etc.)
☐ Government research programs or other public funds
☐ Other (please specify)______________________________

4.9. Why was the decision made to patent the invention as it was, without further development, allocating additional resources (more than one option can be selected)?

The invention is good enough because it:

☐ The objectives originally intended for this invention have been fulfilled
☐ Further improvements could be achieved, but the estimated costs were higher than the available resources (budget)
☐ Further improvements proved to be above the existing technological possibilities
☐ Further improvements have led to another invention that can be patented separately
☐ The invention had to be patented quickly because your organization was aware of other inventors, research groups or firms that were working on inventions in the same field

4.10. Did the resulting patent have a significant impact on other inventions?

☐ Yes
☐ No
☐ I don`t know

If your answer was "Yes" to the previous question, please answer the following questions

4.11. Was the following invention made by the same organization as the patent?

☐ Yes
☐ No
☐ I don`t know

4.12. We define a "family of patents" as a group of patents that are critically dependent on each other in terms of their value or technical method. Was the patent in question part of a patent family?

- ☐ Yes
- ☐ No
- ☐ I don`t know

4.13. Indicate how many patents were part of the patent family

- ☐ 1-2
- ☐ 3-5
- ☐ 6-10
- ☐ 11-20
- ☐ More than 20
- ☐ I don`t know

4.14. How many months did it take for the research that led to the entire patent family?

- ☐ Less than 1 month
- ☐ 1-3 months
- ☐ 3-6 months
- ☐ 6-12 months
- ☐ 1-2 years
- ☐ 2-4 years
- ☐ 4-6 years
- ☐ 6-8 years
- ☐ 8-10 years
- ☐ over 10 years

4.17. What is your best estimate of the total cost (in dollars) of research leading the entire patent family up to the filing date? (Do not include legal fees or any other fees associated with a patent application)

Part 5

We understand that the questions in this section may sound "intrusive" as they relate to personal information and compensation. However, they are critical to understanding inventor rewards and developing innovative incentive schemes for the production of inventions. We invite you to respond openly. As a reminder, the information you provide on this form will never be disclosed in ways that would identify you or link your name to your responses. Thanks for supporting this research!

5.1. Have you received any personal monetary compensation related to the production of the received patent?

☐ Yes
☐ No

If your answer was "Yes" to the previous question, please answer the following questions

5.2. Was it a permanent or temporary increase in income?
(Permanent = e.g. salary increase, promotion with an implied increase, inflow of rent from a patent license or use of it in a new firm; Temporary = e.g. fees, bonuses, prizes, license fees or similar results received once)

☐ Constant
☐ Temporary
☐ Both

5.3. How important are the following patent awards to you?
(1 = not important; 5 = very important)

Cash rewards
1 2 3 4 5
Career achievements and new/better job opportunities
1 2 3 4 5
Prestige / reputation
1 2 3 4 5
Innovation improves the productivity of the organization I work for
1 2 3 4 5
Satisfaction to show that something is technically possible
1 2 3 4 5
Benefits in terms of working conditions as an employer's remuneration
1 2 3 4 5
Others (please specify) ____

5.4. How many patent applications where you are the author have you filed? (Including all inventions where you are the author or co-author) ____________________________

Part 6

Sometimes inventors don't have accurate information about the value of their patents, but they usually do. Then your "informed guesses" would be the perfect answers in this section. At the same time, we welcome you to consult with anyone in your company or institution that you feel would know better. The questions in this section are critical to understanding how to add value to patents in Kazakhstan. Once again, this information will never be disclosed in ways that would allow anyone to identify you or your patent.

6.1. Compared to other patents in your industry or technology, how would you rate the economic and strategic value of the resulting patent?

- ☐ To 10%
- ☐ From 25% to 10%
- ☐ From 50% to 25%
- ☐ Above 50%

6.2. Has the patent applicant/owner ever used the obtained patent for commercial or industrial purposes?

- ☐ Yes
- ☐ No
- ☐ Not yet, but still exploring options
- ☐ I don`t know

6.3. Has this patent been licensed by (one of) the patent holder(s) to an independent party?

- ☐ Yes
- ☐ No
- ☐ No, but I want to license

6.4. Was this patent used as a commercial project by you or co-authors as a new business, start-up or company?

- ☐ Yes
- ☐ No
- ☐ I don`t know

6.5. How important are the following reasons for patenting this invention?

- ☐ Commercial exploitation (obtaining exclusive rights to use the invention economically)
- ☐ Licensing (obtaining exclusive rights to license an invention in order to receive licensing income)
- ☐ Cross Licensing (Improve your trading position by trading your own patent rights in exchange for other firms' patent rights)
- ☐ Imitation prevention (protection of present or future inventions by patenting "findings")
- ☐ Patent blocking (avoid others patenting similar inventions)
- ☐ Reputation (patents as an element of inventor/research unit evaluation)
- ☐ Other (please specify) ________________________________

6.6. Has this patent ever been sued? (By court, we mean litigation other than an appeal at the Kazakhstan Patent Office)

- ☐ Yes
- ☐

No

6.7. This is a hypothetical question. “Let's assume that on the day this patent was granted, the applicant had all the information on the value of the patent that is available today. In the event that a potential competitor of the applicant was interested in purchasing the patent, what would be the minimum price (in dollars) that the applicant must claim?”

- ☐ Less than $ 30.000
- ☐ From $ 30.000 до $ 100.000
- ☐ From $ 100.000 до $ 300.000
- ☐ From $ 300 000 до $ 1 million
- ☐ From $ 1 to $ 3 million
- ☐ From $ 3 to $ 10 million
- ☐ From $ 10 to $ 30 million
- ☐ From $ 30 to $ 100 million
- ☐ From $ 100 to $ 300 million
- ☐ Over $ 300 million

If the patent is not part of a family, i.e. you answered "No" or "Don't know" question 4.12. above, skip the questions below and go to the “Your comments” section at the end of the questionnaire)

6.8. You have already stated the hypothetical value of the patent in 6.7. above. Please give below your best guess of the hypothetical value of the entire patent family.

- ☐ Less than $ 30.000
- ☐ From $ 30.000 to $ 100.000
- ☐ From $ 100.000 to $ 300.000
- ☐ From $ 300 000 to $ 1 million
- ☐ From $ 1 to $ 3 million
- ☐ From $ 3 to $ 10 million
- ☐ From $ 10 to $ 30 million
- ☐ From $ 30 to $ 100 million
- ☐ From $ 100 to $ 300 million
- ☐ Over $ 300 million

6.9. The main reasons for inapplicability in the event that the received patent was not used by you or other co-authors (more than one option can be selected):

- ☐ Still investigating commercial opportunity
- ☐ Blocking other firms
- ☐ Changed technology or market environment
- ☐ Line of business has shrunk

- ☐ Low level of research tools
- ☐ Lack of applied technology
- ☐ Complex technology development delayed
- ☐ Lack of interest from potential license
- ☐ Failed to create a new line of business
- ☐ Low tech level
- ☐ Lack of capital to start a new firm

6.10. What are the main factors that may not give you the opportunity to innovate in your invention? (You can choose more than one option)
Factors hindering innovation:

- ☐ Political instability
- ☐ Lack of incentive to invent
- ☐ The fast pace of life holds back creativity
- ☐ Weak economy
- ☐ No urgent need to invent anything
- ☐ Bad education system
- ☐ Lack of resources
- ☐ Lack of state protection of the rights of inventors
- ☐ Lack of information about innovative companies and funds
- ☐ Other (please specify)

Thank you for your participation!

Source: created by author

Annex G

Post-hoc test. Patent survey.

```
> pairwise.t.test(Normtest$authors, Normtest$gender,p.adj="bonferroni")

        Pairwise comparisons using t tests with pooled SD

data:  Normtest$authors and Normtest$gender

     Female
Male 0.0036

P value adjustment method: bonferroni
>
```

```
> pairwise.t.test(Normtest$time_rank, Normtest$com_use,p.adj="bonferroni")

        Pairwise comparisons using t tests with pooled SD

data:  Normtest$time_rank and Normtest$com_use

  IDN     N
N 0.0013  -
Y 3.9e-10 4.7e-10

P value adjustment method: bonferroni
>
```

```
>  pairwise.t.test(Normtest$pat_rank, Normtest$com_use,p.adj="bonferroni")

        Pairwise comparisons using t tests with pooled SD

data:  Normtest$pat_rank and Normtest$com_use

  IDN   N
N 1.000 -
Y 1.000 0.044

P value adjustment method: bonferroni
>
```

Source: created by author

13.1. Letter of Recommendation

13.2. Participant Information letter