MSc Programme in Urban Management and Development

Rotterdam, the Netherlands

September 2019

Thesis title: The measurement of the university activities' impact on the regional innovation development in Russian federation

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Country: Russia

UMD 15

IHS
Making cities work

Institute for Housing and
Urban Development Studies of
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Abbreviations

IHS	Institute for Housing and Urban Development Studies of Erasmus University Rotterdam
HSE	National Research University Higher School of Economics
HEI	Higher Education System
RANEPA	The Russian Presidential Academy of National Economy and Public Administration
NIS	National Innovation System
RIS	Regional Innovation System
R&D	Research and Development
Rosstat	Russian Federal State Statistics Service
SME	Small and medium-sized enterprises

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Chapter 1: Background and Problem statement

1.1. Background

The role of universities in regional development today is a popular issue among academia and policymakers. This interest stems from the fact that with the beginning of the new century, the functions of institutions of higher education have expanded the scope of the classical roles of teaching and research. Today, universities are also expected to actively participate in the economic, cultural and social life of the region (Arbo, P., Benneworth, P., 2007). In fact, universities have confidently taken their place among the main actors of regional development, along with the state and business.

The reason for the growing importance of universities in regional development was the growing awareness of the importance of knowledge as a new base for the economy. Accordingly, the importance of universities as the main producers of knowledge has also greatly increased. Some regional development concepts, such as Triple Helix, clearly put the university at the head of the trilateral university-business-state interaction within the framework of regional innovation system in developed knowledge-based economies (Etzkowitz, 2000).

However, the degree of the university influence on the regional economic development depends on numerous factors of its environment, opportunities and limitations, formed by both, internal and external factors. According to the collaborative approach adopted today in regional theory and practice, the role of the university is largely limited by the potential of its “partners” who are able or not able to take an active part in the synergistic process of producing innovations (Scott, A., 2002).

Despite the fact that regional development programs take into account the importance of the university as an established fact in their agendas, today there is still no clear understanding of exactly how and through which mechanisms this impact is implemented. Understanding these mechanisms is important for the effective work of the policies being developed and, as a result, the successful development of regions.

However, the literature on the regional innovation system and the role of the university in it, for the most part, is based on a studies of the regions of the developed countries, such USA and Western European countries (Goldstain et al., 2007). Does the statement about the university importance in the regional innovation development work for other countries? To answer the question, the example of Russia has been chosen.

Russia as a post-socialist country is very different from the countries of Western Europe and the United States in the principles and structure of the economy. Moreover, innovation and the knowledge economy are relatively new phenomena for Russia, which for the long time has had a source-based economy (Tereshchenko D.S., Shcherbakov V.S., 2016). However, in the conditions of accelerating globalization, Russia is forced to switch to a new type of production in order to acquire competitive advantages and sustainable socio-economic development as a whole.

Thus, this Master’s thesis aims to test whether the universities, through their activities, contribute to the innovative development of Russian regions.

1.2. Problem Statement

At present, the issue of shifting the country's economy to an innovative development path is extremely important for Russia. In 2011, within the framework of the long-term socio-economic development concept, the Russian Government adopted the "Strategy for the Innovative Development of the Russian Federation for the Period up to 2020". The goal of the strategy is to achieve the long-term development of the country through the "transition of the economy to an innovative socially oriented development model".

To achieve this goal, it is necessary to develop a mechanism to restructure all spheres of social relations in order to promote the development of an innovative economy. The transition to a knowledge economy requires the formation in the country and, accordingly, in the regions, of a holistic innovation system that effectively transforms new knowledge into new technologies, products and services that find their real consumers in national or global markets.

According to the document, it is regions that should give impetus to the innovative development of the country's economy. Universities are viewed as an important subject of a developing regional innovation system, but business still plays the main role. It is interesting that, from 2015 the state project "Support Universities" has been operating in the country, which aim is recognized to identify the most effective universities in terms of creating human capital. The Support University is, first of all, a university, which, together with the region, provides training for local business. One of the main tasks of the region is to retain young people, show perspective and prepare the necessary specialists for the region.

Thus, today the theme of the university contribution to the regional innovation is extremely relevant for Russia. However, the focus on the exclusive function of producing human capital seems to be narrow and efficient not for all regions. A detailed assessment of the various roles of universities in the regions of Russia will help to understand which functions work for a particular territory and which ones do not. Therefore, such an analysis can be useful for further research of specific territories and optimization of financial costs.

To date, the topic has been widely studied, especially in US and Western European countries, although there is still a gap in the separation of university activities according to roles in the regional innovation system. The problem of measuring these roles separately also remains unsolved. The most comprehensive information on all aspects of the topic can be found in the OECD working papers. However, designed mainly for developed countries, they need to be tested and adjusted when used in developing or countries with economies in transition.

1.3. Research objectives and Research question

Research objectives includes the main stages of the study:

1. To explore the main theories and concepts describing the influence of the university on the region innovation development
2. To identify the main activities of universities capable to influence the regional innovation development
3. To understand main characteristics of the regions using descriptive statistics
4. To build a statistical model for measuring the actual impact of university activities on the regional innovation development in Russian regions
5. To measure the impact of university activities on the regional innovation development in Russian regions

6. To give policy recommendations based on the obtained results

The main question of the research sounds as follows: To what extent do the Russian universities have an effect on the innovation of the Russian regions?

Sub-questions:

1. Which measurable activities do Russian universities have in terms of regional innovation development?
2. What level of regional innovation development do Russian regions have?
3. To what extent do the universities' activities have an effect on the innovation of the Russian regions?

1.4. Scope and limitations

The study relates exclusively to the specifics of the regional innovation system of the Russian Federation. It can be used as an initial stage of analysis with a deeper study of specific regions with specific university roles.

The one of the main limitation is the data available. In the chosen scale it is possible use only governmental data sets, as there is no other options to get ordered unified data for all regions of the country. In case the author does not manage to get relevant data, the chosen country should be change. This can imply the following difficulty - an even more limited amount of time and a possible language barrier.

Finally, another limitation relates to the fact that many university activities are poorly measurable, especially those which based on the network approach. Therefore, it is likely that the analysis will use the variables of the linear innovation approach.

Chapter 2: Theory Review

Introduction

This chapter reviews the theories and concepts used to answer the research question stated in the present Master's thesis. The main concepts include: innovation, innovative firm, university role in RIS; the main theories: National Innovation System, Regional Innovation System, Triple Helix. The conceptual framework to analyze the impact of University to the regional development is presented in the end of the chapter.

2.1. Innovation

There is a rapidly growing opinion among researchers and local authorities that innovation is significantly important for competitiveness and economic growth of a territory (Cooke and Memedovic, 2003). Of course, innovation is not the only factor needed for economic success. However, current literature considers it as a necessary element of regional long-term sustainable development. It is believed that a high level of innovation leads to the economic growth of companies, and through their profit to the development of the region.

For the first time innovation as an economic phenomenon has been considered by the Austrian economist Joseph Schumpeter (1926) in his theory of economic development (Karl H. Müller, 2013). According to which, innovation plays role of the main factor causing dynamic changes in the economy and leading to the formation of a new producing function. However, since the time of Schumpeter, the concept of innovation has changed in every way depending on the change of the scientific paradigm and the expansion of knowledge. Classically, the relation of science to the economic development has been considered through the simplified framework of the linear model of innovation. But today, innovation is more often viewed as part of a system or nonlinear model.

Thus, there are two main views on the innovation and innovation process: (1) linear and (2) nonlinear models. The linear model appeared after World War II, in the 1950-s. The model explains the innovation process quite simply as the direct way through the three main stages: scientific discovery - production of technology - satisfaction of market demand. More R&D means more innovations and, as a result, more profit. This model does not take into account the need of feedback loops within an innovation process and other complex relations between the actors (Edquist end Hommen, 1999).

The system approach appeared much later, in the 1970-s. As a result of the long-term development of the linear model, it was finally recognized that the innovation process is a complex system that includes various interdependent elements that constantly interact and mutually affect each other. So the most important feature of the nonlinear model is that it admits existence of feedback loops within the innovation process, which means that knowledge can take different directions between stages and actors. Therefore, the causal relations between inputs and outputs can be simultaneously directed. This idea has become a base of the modern theories of Innovation Systems and especially the Triple helix model of innovation.

In general, Innovation System approach reveals the importance of the systemic and interdependent interaction of various elements of innovation process. However, according to the theory, the main actor of the innovation system is the state, which coordinates the elements ensuring interaction between them, mainly through the development of innovation policy. TWO PARTS NIS AND RIS

(Garcia and Calantone, 2002)

2.2. Systems of Innovation

In this section the author reviews the main literature on Innovation System (IS) at bough, national and regional levels. First, the concept of National Innovation System, as the core of the IS theory, is investigated. Secondly, since the subject of the Master's thesis is a region, in a broader way, the Regional Innovation System (RIS) theory is studied. Within the latter part, the concept and the structure of RIS is explained.

2.2.1. National Innovation System

The concept of National Innovation System (NIS) emerged in the middle of the 1980-s on the basis of a dialogue on the new European industrial policy. Today it is widely spread among researchers and especially policymakers all over the world (Lundvall, 2005). For instance, it is commonly used by the global organizations such as OECD, UNCTAD, European Commission in their analytical perspective.

There are disputes in the scientific literature who first introduced the NIS concept, Freeman (1987) or Lundvall (1985). Thus, it can be said that the concept has been developed in parallel in the USA and Western Europe by many authors and by 1987 its precise understanding was already in the air. This can be proved by the fact that in 1990-s, the concept already has been widely used among numeric empirical researches of Ludvall (1992), Nelson (1993), Edquist (1997). Common to these scientists has become an explanation of the national innovation system as a process and result of the integration of structures that are diverse in goals and objectives and engaged in the production and commercialization of scientific knowledge and technology within national borders. The functioning of these structures is provided by a complex of institutions of legal, financial and social interaction and has distinctive national features.

The central part of the NIS concept is the institutions which shape structure of the system and the way of the actors (organizations) interact. According to Nelson and Winter (1982), institutions are the routines which define how the processes within the system are implemented, how the actors interact with each other, how innovation is produced. In short, Institutions are "regularities of behavior", which determined by the national culture and history (Jonson,1992). They reduce uncertainties and in this way provide stability to the system.

To the NIS actors include different kinds of organizations (not institutions), such as government, firms, universities and R&D organizations, NGOs, industry associations (Edquist and Jonson, 2000). The structure of the NIS actors set is largely dependent on the specific circumstances and therefore may vary.

The NIS theory also has allowed to go beyond the classical understanding of innovation sources. Freeman (1982) as many other authors of that time mainly focused on the R&D (especially corporate) as the main source of innovation, while Lundvall (2005) argued that the main sources are informal (non-R&D), such as learning. Learning, in according to Lundvall, is the routine process that can be interactive and leads to the emerge of the new knowledge and therefore – innovation. Indeed, researchers proved that innovative firms more frequently use non-R&D sources than classical R&D (Lundvall, 2005).

The theory of the National Innovation System assesses the effectiveness of the institutional structure of a certain country, implying that this structure is homogeneous. However, within countries, especially large ones, the situation can vary considerably from region to region. And if formal institutions can be the same, then informal ones, even in a small country, can differ dramatically and thus influence the innovation outcome (Arbo, P., Benneworth, P., 2007). On the basis of this problem, within the NIS theory, the question arose of examining the regional level. This is how the logical extension of the theory has appeared - the concept of the Regional Innovation System.

2.2.2. Regional Innovation System

The Regional Innovation System (RIS) theory is in fact a scaled down version of the NIS theory, but considered on the smaller, optimal level of a region. The theory completely borrows the structure and basic principles of the NIS theory related to social interaction. The main elements of the regional innovation system are also divided into institutions and organizations, a firm is emphasized as the economic core.

The first attempt to consider the innovation system at the regional level was undertaken by Malerba (1993) on the example of the Italian NIS (Cooke et al., 1997). Four years after, the concept was conceptualized by Cooke et al. (1997) as a "collective order based on micro-constitutional regulation". In his another paper (Cooke et al., 1998) Cooke defined NIS as "a system in which firms and other organizations are systemically engaged in interactive learning through an institutional milieu characterized by embeddedness".

However, today still there is no single universal approach to define RIS. It is quite difficult to give a complete definition of it, firstly, because of the constant changing of the innovation system (Etzcowitz, 2000), and secondly, because this system may differ radically from region to region (Asheim B., Gertler M., 2004).

Since the early 1990-s the concept of RIS has received widespread coverage by both, theorists and practitioners of economics (Doloreux, 2005). The approach was assessed as a potential analytical structure for profound understanding of innovation processes in regions. The rapid spread of the concept is connected, among other things, with the appearance of active clusters and industrial groups, with a sharply increased innovation activity in the regions, as well as with the emergence of a multitude of regulations, strategies and programs dedicated to regional innovation policy (Asheim B., Gertler M., 2004).

Thus, the RIS theory is in constant development, based on both theoretical and empirical studies. According to its empirical goals mentioned above, the theory covers many overlapping concepts related to the innovation development of regions. As a result, the system approach provides a consolidated framework for a large set of concepts such as cluster (Porter, 1990), creative class (Florida, 1995), innovative milieux (Crevoisier, 2004), learning regions (Asheim, 1996), the Triple Helix (Etzkowitz and Leydesdorff, 1997).

Most of these theories, as well as RIS, consider a firm as the main economic agent (Maskell and Malmberg, 1999). Since it is a firm which introduces innovations made within the system to the market and bring economic profit to the whole region. However, in the RIS theory, the main factor of a firm effectiveness is associated with social interaction within the system and the importance of human capital. Whereas in the similar cluster theory, interaction between companies can only be based on impersonal market relations, but not personal social ties.

So according to the RIS concept, innovation process is an interactive process. Therefore, firms cannot to innovate without cooperation with other actors of RIS (Cooke et al., 1997). The same NIS principle of the mutual interdependence of the main elements remains fair for the regional level. Thus, the performance of firms producing innovations highly depends not only on their own capabilities, but also on the other organizations and institutions as parts of the system (Neely and Hii, 2012).

By this collaboration all the elements create an innovation network, which is emphasised as the core of the RIS approach (Doloreux and Parto, 2005). The wide regional networks with the tight social ties enable actors to perform collective learning process and, thus, innovate. These networks at the same time are linked to the national and global networks (Bjorn and Asheim, 2011). Henry and Pitch (1999) suggest in this perspective, that for fruitful economic results the firm need to be incorporate into both, local and global relations.

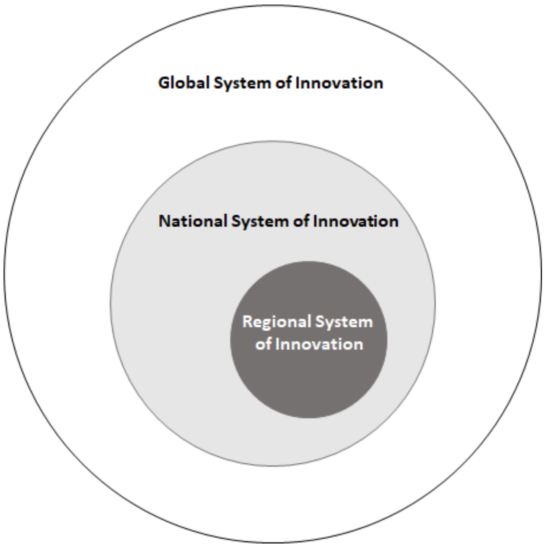


Figure 1. Integration of the Innovation Systems

Source: Bjorn and Asheim (2011)

Since the regional innovation system is deeply integrated into other higher-level innovation systems, development of the region depends not only on internal, but also external factors of national and global levels (Neely and Hii, 2012; Teece and Pisano, 1994). Such an openness of the system and its dependence on all kinds of interconnected elements raises the question of methods for RIS assessing. In this regard, the problem of methodology is related to the features of the nonlinear approach to innovation discussed in this chapter earlier. Namely, the mutual influence of the elements both, inside the system and beyond it, makes it difficult to measure individual impacts to the overall outcome.

Another major issue in the literature is that most of the literature is based on successful examples of the highly developed RIS. As a result, the scientific community poorly understands the patterns of development of less dynamic regions, and therefore limits the possibilities for constructing adequate policies for their development.

2.3. Triple Helix model

The "Triple Helix" model is a relatively new concept of innovation theory. It is can be considered as a closely related to the systems of innovation approach model, which focus on the leading role of university, rather than company, in innovation. The model emphasizes the importance of the nonlinearity and dynamism of the innovation system, and thereby continues developmening the idea of collaboration and synergy in the innovation systems.

The main thesis of the “Triple Helix” concept is that the institutions responsible for creating new knowledge begin to take a dominant position in the system of innovation. The reason for such an important transformation was the logic of the development of science, giving rise to more and more synthetic areas, which include both, fundamental and applied research of an interdisciplinary nature and development.

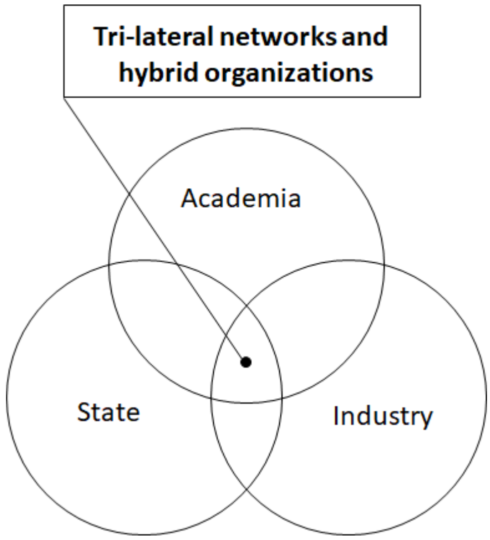


Figure 2. The Triple Helix Model of University-Industry-Government Relations.

Source: Etzkowitz and Leydesdorff, 2000

The "Triple Helix" model complicates ideas about the nature of the links between actors within the innovation process. In the "Double Helix", for instance, part of the links between the components is ignored. In the "Triple Helix" the presence of a network between the actors leads to changes not only of themselves, but also of the connections between them. University, industry and government enter into mutual relations with each other, in which each seeks to increase the efficiency of the other. This is what, in addition to performing its traditional tasks, each assumes the role of the other (Etzkowitz, 2008). Companies are engaged in the production of goods and services, but also conduct research and provide high-level specialist training (for example, through a corporate university). The government is responsible for market failures by adjusting government policies, but also provides venture capital to start up new businesses, especially for high-risk industries. Universities, while maintaining their traditional roles of teaching and research, are engaged in the commercialization of knowledge, patents, and the creation of start-up companies (Y.Cai and C.Liu, 2012).

In this way, during the evolution of the theory of innovative systems, an important question arises related to a wide range of new university functions within the socio-economic development of the territory.

2.4. Role of University in regional innovation

The contribution of the university to the economy and innovative potential of the region is the subject of intensive research in recent years. Researchers distinguish various functions of university in the regional development, but we will focus only on the most relevant to the topic of the study.

There are quite a lot tools by which universities can influence regional economic development. Modern universities are active economic entities, as an employer and taxpayer. However, in addition to the obvious economic functions, the examined literature highlights following university roles which can influence regional economic development (Trippl et al. 2015; Goldstain et al., 2007): (1) Creation of knowledge, (2) Human-capital creation, (3) Transfer of existing know-how, (4) Technological innovation, (5) Capital investment, (6) Regional leadership, (7) Knowledge infrastructure production, (8) Influence on regional milieu.

Drucker & Goldstain (2007) state that university, as a complex system, can contribute to the economy of a region or country through various activities, directly (job creation, selling licenses, patents) and indirectly (human capital development, knowledge creation). Its importance is especially great in the development of innovation systems (Mowery & Sampat, 2005; Arbo & Denneworth, 2007; Uyarra, 2010; Etzkowitz and Leydesdorff, 2000).

In this regard, Uyarra (2010) identifies five related university functions, focused specifically on the role of the university in the development of a regional innovation system. These functions include the following: (1) Knowledge factory, (2) Relative University, (3) Entrepreneurial University, (4) RIS University, (4) Engaged University.

2.4.1. Knowledge factory

The knowledge factory approach considers the university as the main source and depository of knowledge, contributing to raise of R&D concentration in the region and, ultimately, increasing the share of innovation in the production of regional firms (Geiger end Sa, 2008). Such a concept became popular in the postwar era of the 1950-s and reflected a linear model of the innovation process.

In addition to the importance of R&D, many authors also considered the geographical proximity of the university and business as a factor contributing to the intensification of the knowledge use, i.e. stimulating the knowledge spillover effect (Jaffe, 1989; Acs et al., 1994; Anselin et al., 1997). Basically, a significant spillover effect of university research was seen in high-tech, pharmacological and medical fields. For example, Varga (2002) found a causal relationship between the presence of a university and the choice of location by high-tech firms. According to his analysis, firms are trying to locate in the regions where there are universities, producing researches and human capital in related high-tech areas.

Despite important findings, the “knowledge factory” approach based on the linear model of the innovation process is not able to separate the various functions of the university in assessing its contribution to the development of the regional economy, as well as to identify the various mechanisms of knowledge distribution. A broader view of the role of the university will appear in the next function of the “Relational” university.

2.4.2. Relational university

In the 1980-s, due to the economic downturn in developed countries, the academy and politics began to actively look for new ways to boost the economy. The linear innovation model was considered too simplistic. The transition to the new model, which is based on the collaborative approach, recognized the expanded role of the university. The Industry-university relations were considered far more complex than previously thought within the framework of the linear model

(Scott et al., 2002). Companies have recognized the benefits of communicating with the university to achieve a wider range of innovative results (Uyarra, 2010).

Research on the topic of relational university revealed the presence of a wider range of communication channels between the university and other actors in the process of knowledge distribution, rather than just a classic set of R&D, licensing and patenting. For example, many authors (Cosh et al., 2005; Cohen et al., 2002) found that US and UK firms mainly used open channels of interaction with universities to gain knowledge, such as conferences, informal meetings or published articles, rather formal channels, which had a far less significant role (D'Este and Patel, 2007). Informal face-to-face meetings turned out to be the most frequent type of industry interaction with institutions. And according to Azagra-Caro et al. (2006), such meetings often lead to formal collaborations. However, it should be noted that the frequency of use of the new channels is not related to their quality, in contrast to the formal type of cooperation.

2.4.3. Entrepreneurial university

In fact, the concept of entrepreneurial university emerged largely due to the Bayh-Dole Act in the United States in 1980. Prior to this law, the federal government held the rights to any "patentable" scientific discovery resulting from research that was made with federal money (Duecker K., 1997). Bayh-Dole Act transferred federal rights to patents and discoveries to universities, allowing the latter to decide whether to leave the rights to the university corporation, or to transfer it to someone else. Thus, initially the concept of entrepreneurial university is based on the function of the commercialization produced knowledge.

At the same time, more modern authors, such as Etzkowitz, Webster, Gebhardt and Terra (2000) define the entrepreneurial university more broadly - as a university which activity, in any form, is aimed at developing the economy of a region or a country as a whole, as well as gain of own profit. Thus, any university that promotes the development of entrepreneurial thinking, the emergence of business and any other activity in the field of entrepreneurship can be considered as an entrepreneurial (Audretsch & Keilbach, 2008).

The approach is limited by strategic and organizational aspects related to the functioning of university-industry communications. It also does not take into account the importance of the environment in which this relationship functions, i.e. the specificity of the region is not considered important. To a certain extent, this bias may be related to the overwhelming basis of this literature on US cases (Uyarra, 2010).

2.4.4. Systemic university

Today, Innovation System literature considers the university-industry communications within the context of a territory network encompasses different actors. In addition to the main links of universities with large corporations, the focus of their interaction also extends to serving regional clusters consisting mainly of small and medium-sized enterprises (Chatterton & Goddard, 2000). Literature studying the RIS university takes into account the specifics of the regions, encompassing both successful (Lowe and Feldman, 2008) and lagging territories (Benneworth and Charles, 2005; Gunasekara, 2006), where the nature of the university contribution may vary considerably. Thus, RIS studies mainly say that the role of the university is always specific and depends on the conditions of the region, the demand for knowledge produced by regional users and the structure of the regional innovation system (Cooke, 2005).

However, Uyarra (2010) notes that the importance of human capital mobility remains underestimated, in other words, the university's contribution to the innovative development of other (host) regions. In addition, intangible contributions such as, for example, regional branding are rarely analyzed. In general, the author states that RIS literature focuses more on the ability of a university to commercialize knowledge in a given region, but not on the entire spectrum of university capabilities.

2.4.5. Engaged university

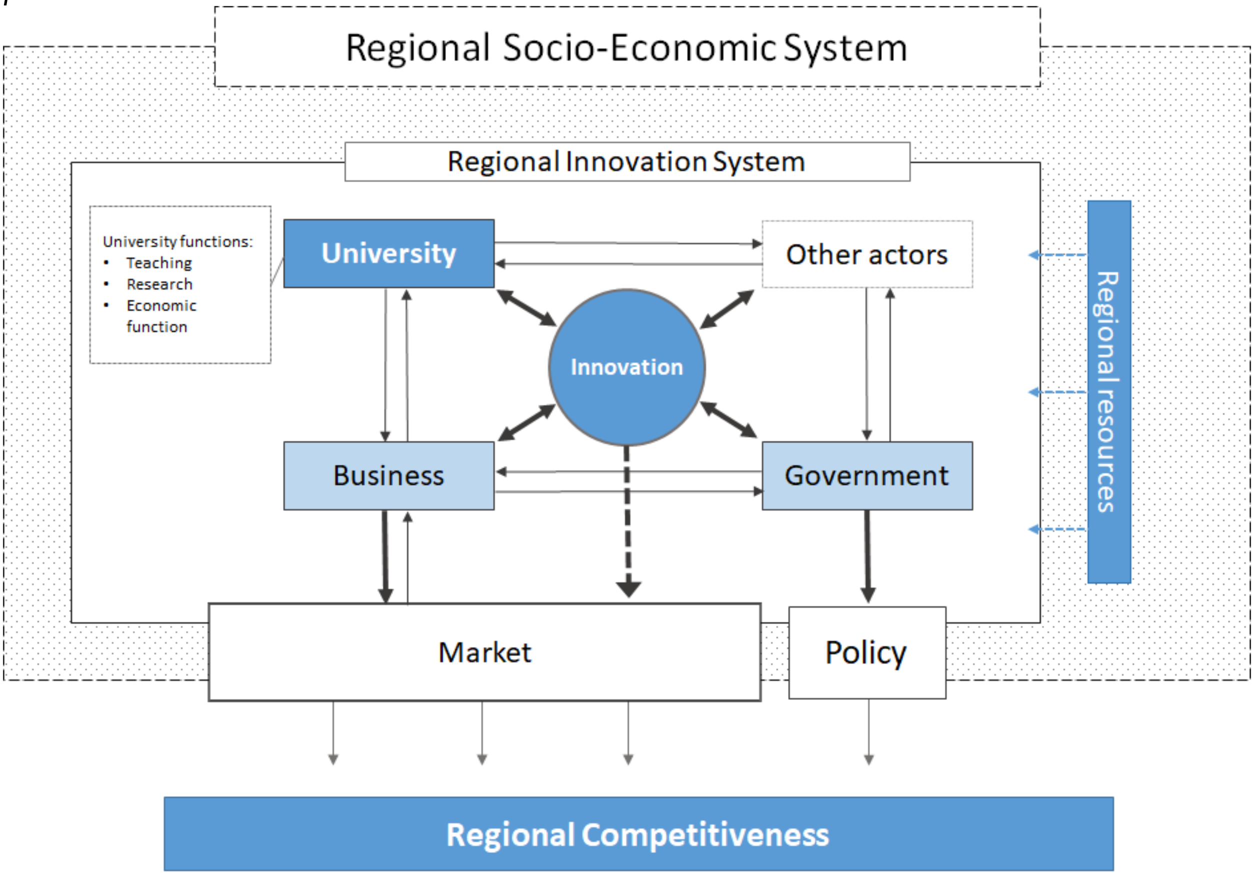
In this approach, instead of one specific function of the "third mission" (Drucker & Goldstein, 2007), the role of the university is comprehensive and based on the regional needs and capabilities of the university itself. Therefore, the university contribution to a regional innovation system may be explicit and implicit, formal and informal, through the cultural, social or environmental sphere (Boucher et al., 2003).

The university is viewed in the literature as a node integrated into the global innovation system network, but at the same time contributing to the regional innovation system (Benneworth and Hospers, 2007). In this way, university aggregates external resources and use them for the regional needs (Bathelt et al., 2004). However, In order to perform this, university should be comprehensively embedded to the regional policies at different levels and in different fields, which is rather rare. In reality, for many countries university is limited in its activities by the local and national government by funding and legislative regulation.

In general, there are many doubts over the capacity of university to combine so many functions within the region at the same time. In addition to the limitations described above, other constraints relate to the age and density of HEI in the region. Charley and Conway (2001) claim that modern universities are more flexible and focus on the economic functions more than older university. The location also depends on age, as the old universities mostly have emerged in the large cities, while new ones tend to be more spread. Finally, the degree of university engagement is likely to vary according to the nature of interaction with other universities within the region, as well as their number.

2.5. Conceptualization

Figure 1. Conceptual framework of the university impact to regional innovation within RIS framework



The theoretical background for the following empirical findings is provided by the theory of Regional Innovation System and the "Triple Helix" model, as well as related studies mentioned in the Chapter 2.

According to literature examined, regional innovations are produced in the process of constant interaction of interdependent actors. The main actors includes: University, Business and State. They constitute an innovation network where each of them directly or indirectly affects the production of regional innovations and receives multiple feedbacks from other elements of the system.

The operation of the innovation system is also affected by the resources that the region possesses. Resources play the role of input factors that determine the innovative potential of the region and affect the final result. Resources include human resources, natural resources, financial resources, scientific and information potential, infrastructure.

The connection of the innovation system with the market occurs through the activities of firms that bring innovative products to sale and earn economic profit for the region. When introducing new products to the market, the business also receives feedback, expressed in the reaction of consumers and rivals. After, the feedback returns to the innovation system, where it is again processed by interacting actors in order to improve innovative product.

The university affects the entire system as a whole through three main functions. Firstly, it produces human capital, and secondly, it participates in R&D. The third function is performed through the commercial activity of the university.

Blue color indicates the main concepts involved in the empirical analysis of the study. Some of them are expressed indirectly or partially due to inaccessibility of data or the difficulty of finding an indicator. Bold arrows indicate the resulting effects. For example, such an arrow indicates the role of a business that launches an innovative product - the result of an innovation process. The state, in turn, uses the results of the interaction of the entire network for the development of relevant policies, which is also indicated in the diagram by a bold arrow.

Chapter 3. Methodology

3.1. Assessment Approach

Despite the fact that today innovation is the one of the key topics in the regional economy, there is still no single approach to operationalization and evaluation of it. Development of suitable indicators for the measurement of regional innovation impact of university is also still in its infancy because of methodological difficulties. However, the most common approach used among modern literature is the quantitative assessment with a single indicator based on patent statistics as an "output" measure. Therefore considering prevalence and consequential reliability of the assessment approach, its main principles were chosen as the base of existent study.

In terms of operationalization problem, relationships between the regional innovation and university activities were expressed through the classical variables, widely used in literature. For the dependent variable the overall number of patents granted in a region was taken. For the variables of interest (university activities) three indicators were chosen. Two indicators reflect the classical university roles, such as research and teaching, and one - a commercial role. The ratio of the roles and indicators is as follows:

1. Research function - the share of universities in the regional R&D expenditure;
2. Teaching function - the share of economically active population in the region with the higher education;
3. Commercial function - the number of spin-offs companies established by the regional universities.

However, the "university-innovation" relationships is a part of a more complex concept of the regional innovation system, the effectiveness of which, in its turn, depends on the internal and external factors. Therefore, an assessment of the university contribution to regional innovation in isolation would be unreasonable. Thus, the model is expanded by the control variables reflecting activities of the main elements of the regional innovative system.

Based on the existing methodologies for assessing the regional innovative potential and RIS as a whole, and also taking into account the data available, the list of indicators for the analysis has been compiled into 4 logical blocks reflecting the main actors activities and main regional resources:

1. Business innovation related activity
2. Government innovation related activity
3. University innovation related activity
4. Regional innovation potential (regional resources)

As a result, based on the logical model and data available, the complete set consists of 13 variables: 12 independent and 1 dependent (Table 1).

Table 1. Operationalization table

Concept	**Definition**	**Variable**	**Indicator**
Dependent variable			
Regional Innovation	The output of innovation process performing in the region by all the actors.	PATENTS	The overall number of officially received patents in the region during the reporting year.
Independent variables			
University innovation related activity	Classical and new university functions which influence the regional development, in particular - innovation.	UNI_RD	The share of university in the total amount of regional expenditure on R&D in the reporting year, %.
		EDUC	The share of the regional population with the high education, %.
		SPINS	Number of the universities' spin-off companies established during the reporting year in the region.
Government innovation related activity	The Government activity within the regional innovation system, aimed at maintaining and stimulating the production of innovations through legal, financial and non-financial channels.	GOV_RD	The share of the Government in the total amount of regional expenditure on R&D in the reporting year, %.
		CLUSTER	The number of new clusters established by the Government in the reporting year in the region.
Business innovation related activity	Activities of the regional companies aimed at the development, financing and production of innovative goods and services.	(ln)SPNDS_F	Firms technological innovation costs, in million rubles.

Regional innovation potential (resources)	Combination of factors and resources of the region that ensure the implementation of innovative activities by the regional economic system, and as a result, increase regional competitiveness.	
Human capital	UNEMPL	The share of unemployed population in the total number of economically active population of the region.
	RSCH_STAFF	Total amount of research staff the region have in the reporting year.
Economic and financial capital	HT_GRP	The share of the high-tech and knowledge-intensive sectors of economy in the GRP registered in the reporting year.
	(ln)GRP_PC	Gross regional product (total economic output of the region) divided into the total regional population in the reporting year.
Infrastructure	URB	Share of urban population in the region, %.
	INT	The number of firms in the region which use the high-speed Internet connection in the reporting year

3.2. Research Strategy

Taking into account time and source limitation of the study, it would be impossible to conduct it using research strategy based on primary data collection. Therefore, the most suitable strategy is the Desk research.

Desk research is a set of methods for collecting and evaluating information contained in secondary sources (statistics or reports) prepared for any other purposes. Secondary sources can contains both secondary (external and internal) and primary documents: answers to questionnaires, materials from focus groups and free interviews, raw statistics.

3.3. Data Collection

The secondary data collection method has been used. The selected method requires existing statistical data derived from all the possible sources, such as science articles, government reports, books etc. Considering time and source limitations, this method appears to be most adequate choice. Taking into account the scale of the research covered all the Russian regions, most appropriate sources are the open public sources provided by the government bodies.

Thus, the most necessary data has been collected from the open sources of Russian Federal State Statistics Service (Rosstat), which provides consolidated statistics for all the Russian regions. Unfortunately, there is no other possible sources provided detailed information on the regional level to validate the derived data.

Some data has been collected and processed manually. For example, the data for variable "CLUSTER" was collected from the website of the consulting center of the Higher School of Economics "Russian cluster observatory". Statistics for the variable "SPINS" was requested from the Republican Research Scientific Advisory Center of Expertise in raw format and were processed manually.

Descriptive analysis was partially performed on data of the statistical compilation of HSE "Science Indicators: 2017" (HSE, 2017).

3.4. Sample

The unit of analysis is a constituent entity of the Russian Federation or simply an administrative region. Overall, Russia has 86 regions, however not all of them participates in this research. Some regions were removed from the sample because of the missing data, some as outliers. As a result, the final sample does not have 7 regions: Moscow, Saint Petersburg, Sevastopol, Republic of Crimea, Republic of Tatarstan, Moscow region, Kaliningrad region, Yamal-Nenets Autonomous Province, Baikonur City. Thus, the final sample consists of 77 regions. All the regions are indicated by the Russian tax codes for the convenience of analysis (Annex 1).

In order to increase the chances of unbiased results, the sample was expanded through the use of longitudinal data for a period of 6 years, from 2012 to 2016. Thus, the sample consist of 468 observations overall, what enables the research to achieve more reliable results. Unfortunately, it is not possible to extend the time period due to lack of available data.

3.5. Data Analysis Techniques

The character of the research question determined the chosen instruments. In order to estimate the university impact on the regional innovation, the research requires regression analysis. Considering the type of data, the regression model should be suitable for analysis of panel data. Though there exist many different ways to analyze panel data, I used simple panel data model with OLS estimator - 'fixed-effects" model.

First, the "fixed effects" model allows to take into account the influence of important effects fixed in time that may be omitted in the model, such as geographical location or specific local cultura etc. It is usually used for the analysis of unique samples of heterogeneous firms, regions or countries, which is highly relevant for the considering case. Second, the feasibility of the model choice is also approved by the conducted statistical tests (Waldt test, Breusch-Pagan test, Hausman test).

Regression analysis was performed in the statistical software package "Stata".

3.6. Validity and Reliability

The use of a reliable dependent variable in the research increases the likelihood of obtaining reliable results. In addition, factual indicators, such as the number of spin-offs firms and clusters, which can easily be quantified, is also reliable. In general, the indicators used in the study are provided by the state authorities of the regions and are used in official government reporting, which gives us reason to believe that they are reliable.

3.7. Limitations

The quantitative analysis approach has two main limitations. First, it is an issue of the data available for the any specific topic chosen by a researcher. Second, it is an operationalization issue. Ideally, in order to have reliable results it is highly desirable to have at least one highly-quality indicator for each concept of the model. However, in case of the combination of the quantitative approach and the secondary data collection method, it is problematic to express the concepts by means of secondary data collected for other purposes.

The analysis techniques, in our case regression analysis, also has some drawbacks. For instance, despite the advantages, such as possibility to take into account the heterogeneity of units, the "fixed-effects" model imposes certain limitations on research opportunities. Firstly, it cannot estimate time-invariant regressors. Therefore, important binary parametres, such as number of universities or geographical position of a region, cannot be estimated. Secondly, OLS model estimator is not able to take estimate lagged variables. For example, it is impossible to measure the time-delayed effect of the built clusters or the effect of the number of patents of the previous year on their number in the current year.

But at the same time, using a panel-data regression enables us to obtain more accurate results than from a simple pooled regression, which has much more limitations for the analysis. Therefore, despite the limitations listed above, the existing conditions adequately allow us to answer the research question of this study.

Chapter 4. Research Findings and Analysis

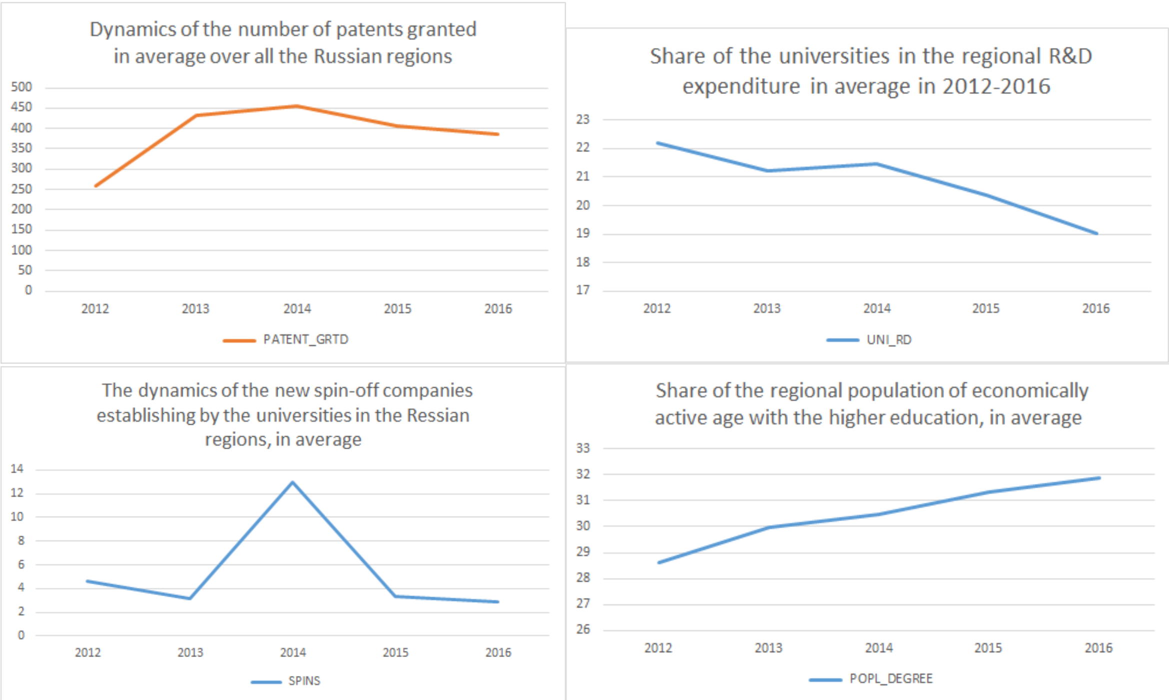
Introduction

In this chapter the data used for the analysis is presented. The analysis is conducted in two steps: first, the general dynamics and trends among the regions and years was analysed - this is the part of descriptive analysis; second, the regression analysis was conducted. The chapter also presents all the preparation stages for the regression analysis, such as data transformation, correlation analysis, fitting specification model, choosing appropriate regression model and its testing.

4.1. Descriptive analysis

For the descriptive analysis in order to see a general trends, the panel structure of data was transformed to the mean values by years.

Graph 1. Main dynamics of the innovation indicators of the Russian regions in 2012-2016

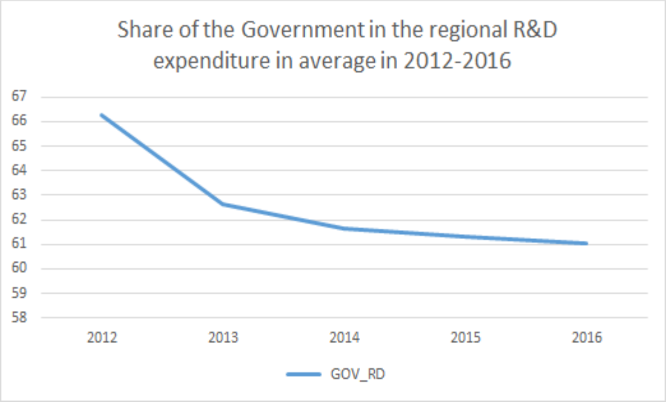


The graph above shows the trends of the main variables - the dependent variable “PATENTS” and the three variables of universal activities.

We can see that on average for the 5 years the number of patents granted by Russian regions increased by almost 150 units or about 60%, which shows the positive dynamic of invention activities overall in the country. The highest level was marked in 2014 with more than 450 patents and the lowest one took place in 2012 with about 250 patents. While in the next year the sharpest increase in the number of patents was observed - the value increased by about 80%.

The variable "SPINS" indicates interesting dynamics. We can observe a dramatic increase of the new university spin-off companies in 2014. Whereas in the other years the level remains stable with about 3-4 new companies a year.

Graph 2. Share of the Government expenditure on R&D in 2012-2016, on average

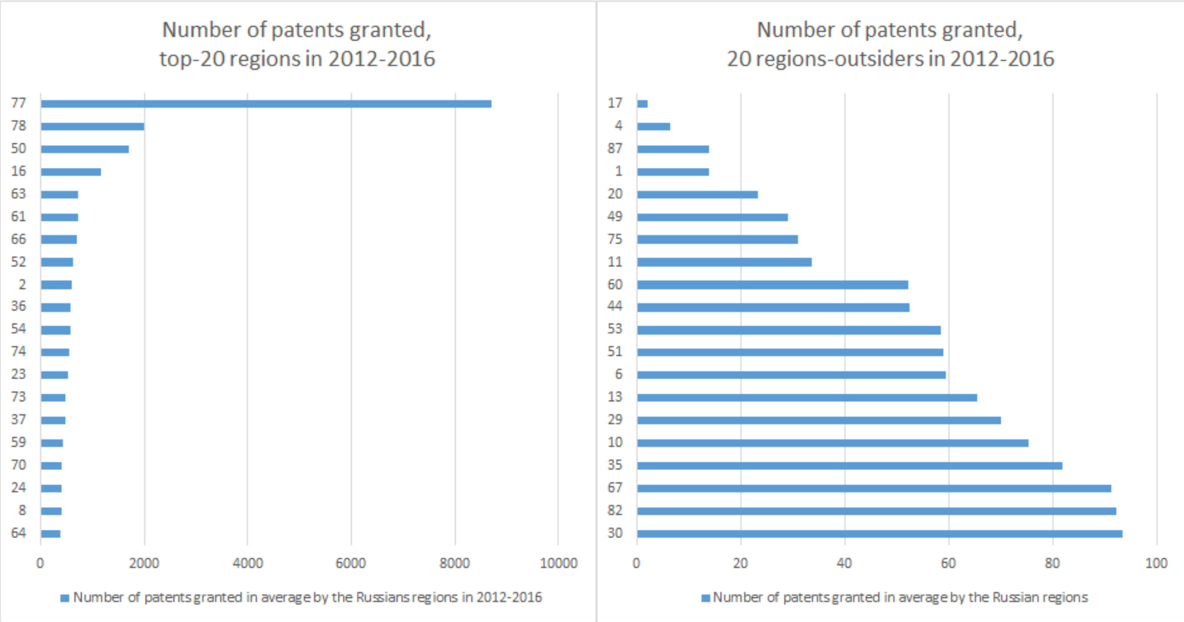


Two other university variables indicate extremely opposed trends to each other. While the teaching role of university expressed by "*EDUC*" was constantly growing, the university role in R&D activity was gradually declining with a little period of stability in 2013-2014 years. So during the 5 years the level of higher education in regions increased on average by 4%,from 28% to 32%, whereas the share of universities in R&D expenditure decreased by 3%, from 22% to 19%.

However, the share of Government as a main actor (more than 60%) in R&D expenditure decreased too. Therefore we can make an assumption that the decreased may be explained by the growth of the role of other stakeholders. Unfortunately, the data on the share of other actors in R&D expenditure is not available in the public sources, therefore we cannot check the real reason.

Next, in order to observe the regional individual dynamics in general for 5 years, the data was averaged by units (Annex 2). If for the previous step, the data did not include the outliers in order to show representative average results, in this step all the regions participated to demonstrate high heterogeneity among them.

Graph 3. Lists of the regions with the highest and lowest number of patents granted in 2012-2016



On the graph above (Graph 5) we can observe top-20 regions with the highest and lowest number of patents granted on average for 2012-2016. It is very obvious from the graph that the distribution of the regions by the indicator is dramatically skewed.

Let's consider the main innovation characteristics of the top-10 regions with the highest number of patents (Table). From the table below we can conclude that there are 4 main outliers with an enormous deviation from the mean: Moscow, Saint-Petersburg, Moscow region and Republic of Tatarstan. Most of them are also marked by the high level of the indicators, expressing the active role of the regional universities, as well as the number of researchers. Though the level of R&D expenditure is below the mean for all the Top-10 regions, and Moscow region even has one of the lowest value from the whole sample.

In overall, from the list of the regions (Table), only 2 of them has the highest proportions of high-tech and knowledge-intensive sectors in their GRP. However, the difference of the values with the maximum is not so big. Most of regions have more then 20% of GRP from tigh-tech industries, which does not mean their high-tech specialization, but it is still a relatively large proportion for Russia. So the defined outliers also have quite high values of "HT_GRP".

Table 2. Top-10 regions by the number of patents

Code	Name of region	PATENTS	SPINS	UNI_RD	EDUC	R_STAFF	HT_GRP
77	Moscow	8705,400	48,800	10,740	49,138	236501,203	21,660
78	Saint-Petersburg	1986,400	27,400	9,280	43,848	78837,203	30,680
50	Moscow region	1712,000	8,800	1,800	42,065	86711,000	23,300
16	Republic of Tatarstan	1155,200	18,200	19,340	33,407	12737,600	20,040
63	Samara region	731,400	9,400	10,100	37,404	13847,200	25,920
61	Rostov region	718,000	13,000	17,000	30,917	12364,200	20,660
66	Sverdlovsk region	689,400	8,200	6,700	28,803	21300,801	23,840
52	Nizhny Novgorod Region	639,000	5,600	2,740	30,205	40697,199	30,160
2	Republic of Bashkortostan	601,800	8,400	11,240	26,589	8198,200	20,920
36	Voronezh region	574,600	13,000	16,760	30,455	10672,200	18,540
Mean value		385,861	5,395	20,788	30,483	9067,373	20,441

(pink)	*Top-5 regions with the highest values*
(green)	*Regions with the values above the mean*
(grey)	*Regions with the value above the mean*
(blue)	*Top-5 regions with the lowest values*

Next, we will consider the Top-10 richest Russian regions. The table shows that the list of regions has changed dramatically, leaving only two capitals, Moscow and St. Petersburg. The rest of the regions belong to the lagged regions in term of innovation production - innovation indicators are below mean value. Three regions, Sakhalin Oblast , Chukotka and Komi Republic are even marked with the minimum values. However, overall, they account for 30% of the GRP of all regions of the country. Thus, the results suggest that the regions do not focus on innovation production and obviously have commodity economies. And in fact, all of them relate to the leaders of the oil producing territories.

Table 3. Top-10 regions by the GRP per capita

Code	Name of region	GRP_PC	% of GRP to overall	HT_GRP	PATENTS
65	Sakhalin Oblast	1509665,600	5,6	8,320	106,600
87	Chukotka Autonomous Okrug	1099491,740	4,1	14,800	13,800
77	Moscow	1036482,280	3,9	21,660	8705,400
49	Magadan Region	723910,500	2,7	16,420	29,200
14	The Republic Sakha (Yakutia)	705912,940	2,6	13,440	222,400
72	Tyumen region	626375,050	2,3	17,280	248,600
11	Komi Republic	580936,560	2,2	12,040	33,600
78	Saint-Petersburg	562217,320	2,1	30,680	1986,400
24	Krasnoyarsk region	508354,480	1,9	15,380	411,600
41	Kamchatka Krai	490082,020	1,8	19,740	147,200
Overall		26851072,89	29,2		

Top-5 regions with the highest values

Regions with the values above the mean

Regions with the value above the mean

Top-5 regions with the lowest values

In general, we can conclude that the Russian regions are enormously heterogeneous in terms of common socio-economic indicators, as well as their innovation activities. There are 4 most innovative centers of the country: Moscow, St. Petersburg, Moscow Region and the Republic of Tatarstan. The remaining regions are far behind the leaders and probably cannot be considered sufficiently developed in the field of innovation.

Despite the fact that the vast majority of regions are not innovative-developed, activity in the field of innovation production is growing on average in the country.

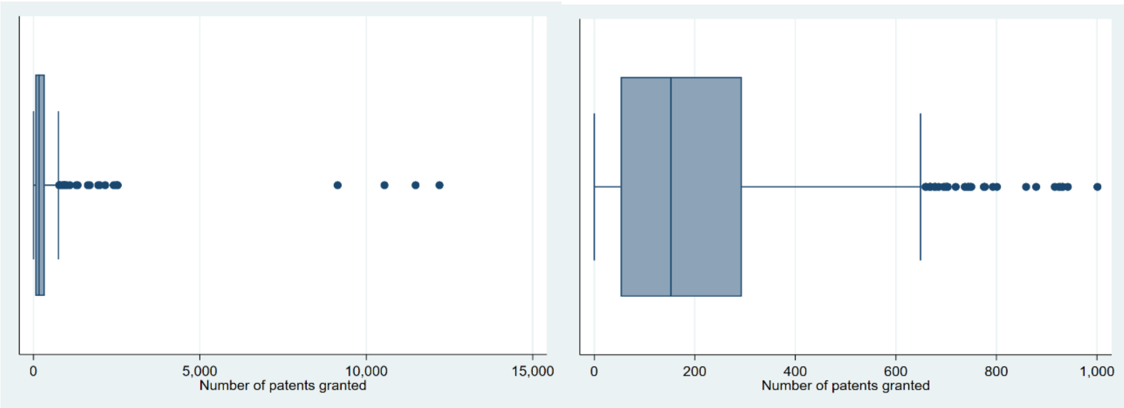
4.2. Regression analysis

Sample and Data transformation

Obviously, the regions are highly heterogeneous, which may prevent obtaining unbiased results. Box-plot of the dependent variable "PATENTS" clearly shows the presence of outliers (Table), which include four regions: Moscow (77), Saint Petersbourg (78), Moscow region (50), republic of Tatarstan (16). Analysis of all the independent variables also confirms the exceptions of these regions. Therefore, they will be removed from the further analysis in order to obtain a more consistent sample and, as a result, more reliable results of the regression analysis. In addition to the mentioned regions, 5 next regions with a lack of data were also removed from the sample: Republic of Crimea (91), Sevastopol (92), Kaliningrad region (39), Yamal-Nenets Autonomous Province (89), Baikonur City (99). Thus, the final sample includes 77 regions.

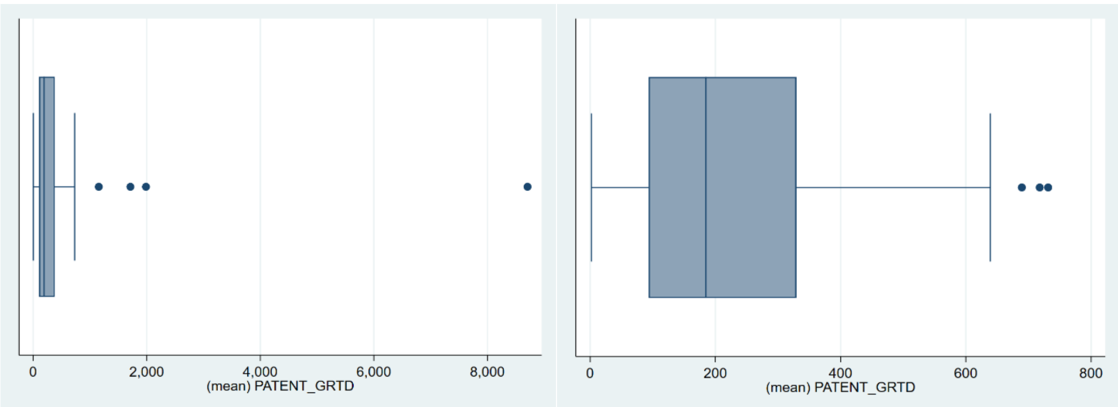
- *Despite the fact that Moscow, St. Petersburg, Sevastopol and Baikonur are cities, according to the legislation of the Russian Federation, at the same time they are also separate federal entities (regions) along with the other regions.*

Graph 4. Distribution of dependent variable "PATENTS" before and after removing the outliers



In order to compare a difference between the distribution of the dependent variable *"PATENTS"* before and after deleting the outliers clearer, the variable was transformed into mean values. In the analysis it is used in the actual panel values (Table).

Graph 5. Distribution of dependent variable "PATENTS" before and after removing the outliers (mean values)



Two monetary indicators, the GRP per capita and the firm's expenditure on the technological innovations, were log-transformed in order to normalize them relative to other variables. Transforming resulted in two log-variables: "lnGRP" and "ln_SPNDS_F" . The variable "Patents" also has high standard deviation, but cannot be log-transformed because of the null values. (Table).

Table 4. Summary statistics of the variables used after removing outliers

Variable	Obs	Mean	Std. Dev.	Min	Max
PATENTS	380	223.4842	232.5173	0	1001
UNEMPL	382	7.036387	4.657583	2.9	47.7
URB	380	68.23263	12.3568	28.7	95.8
INT	373	47.50536	11.37465	3.9	90.9
GOV_RD	383	62.77363	20.52614	8.9	100
UNI_RD	383	21.39634	19.11666	0	77.5
SPINS	385	4.335065	7.59519	0	69
EDUC	372	29.83822	3.924232	20.92755	42.48276
CLUSTER	385	.1896104	.5932749	0	7
ln_SPNDS_F	366	7.768555	2.041884	-.2626643	11.34709
R_STAFF	373	4151.769	6277.993	19	41513
lnGRP	377	12.52635	.4853533	11.26289	14.35593
HT_GRP	385	20.26	5.87038	0	41

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Thus, the sample obtained is strongly balanced and includes 77 (385 counting for 5 years) observations with 4,539 values overall. The time period covers 6 years from 2012 to 2016. The analysis includes 11 variables, where the number of patents granted "*PATENT GRTD*" is the dependent variable. The detailed list of summary statistics can be found in the Annex 3.

Before starting the regression analysis and selecting the model modification, it was necessary to conduct a correlation analysis of the independent variables in order to avoid the problem of multicollinearity. The analysis showed that the regressors are not correlated with each other, which means that they can be included in the same model at the same time (Appendix). Next, we proceed to regression analysis.

4.2.2. Model selection and evaluation

Fitting model specification

For the fitting regression model I used backward wisestep approach (backward elimination) with the 1% ɑ-level of significance. In the first step, all the selected variables were entered into the equation, then the insignificant variables and ones with the p-value greater than 0,01 were step by step eliminated. As a result, there is a final specification of the simple pooled regression with only highly significant variables - specification number 4. This regression is a cross-cutting over all the years and regions, so it does not take into account the structure of panel data. The model is estimated by the Least Squares Method.

The model is stable ($F < 0.001$) and explains 77% of the variance of the dependent variable ($R\text{-}sq = 0.77$), which indicates the high quality of the model.

It can be seen from the regression results that, firstly, the universities R&D expenditure does not matter in obtaining new patents in the regions, while the level of education of the population, as well as the number of spin-off companies have a great importance. Each new spin-off company created by a university in the region results in 6 new patents per year. And with an increase in the share of the employed population with higher education by 1%, the number of patents in the region will increase by 49 units.

Table 5. Comparison of the pooled regression specifications

Variable	(1)	(2)	(3)	(4)
PATENTS	Coefficients			
SPINS	5.126555***	5.150383***	5.266572***	6.015084***
UNI_RD	.1936941.			
EDUC	9.754851***	9.690704***	9.071166***	8.400372***
URB	1.853924*	1.809939**	1.533578.	
UNEMPL	4.411605.	4.105436.		
RSCH_STAFF	.0198647***	.0198553***	.01986***	.0193079***
CLUSTER	32.41426**	32.73049**	32.27732**	
GOV_RD	-1.304835**	-1.340962***	-1.026687*	
lnGRP	-140.5345***	-142.7236***	-145.468***	-100.6471***
HT_GRP	-5.161475***	-5.353227***	-5.278484***	
ln_SPPNDS_F	51.40377***	50.73946 ***	47.25304***	49.65018***
INT	-.4951736.	-.4816075.		
Cons	1348.584***	1295.055***	1377.175***	757.7623***
R-squared	0.7843	0.7850	0.7835	0.7718
Adj R-squared	0.7774	0.7781	0.7779	0.7686
Prob > F	0.0000	0.0000	0.0000	0.0000

Estimation of the specification by the panel data models

Since ordinary regression does not take into account the structure of panel data, I evaluated the specification using the three simplest models for panel data: the model with the between estimator (be), the fixed-effects model (fe) and the random-effects model (re) (Table).

Table 6. Comparison of three panel-data regression models

Variable	BE	FE	RE
PATENTS	Coefficients		
SPINS	12.38789***	2.618706***	2.906986***
EDUC	9.46106**	-.2073901.	-.5722988.
RSCH_STAFF	.0186958***	.0355995***	.0226744***
ln_SPPNDS_F	45.70828***	2.358311.	16.59571***
lnGRP	-102.082**	-83.50875*	-61.25551**
Cons	748.0723.	1269.926***	788.3166**
R-sq between	0.8170	0.6100	0.0969
R-sq within	0.0838	0.1202	0.7604
Prob > F	0.0000	0.0000	0.0000
rho		.9483394	.82896961
Wald chi2(5)			294.01
Breusch and Pagan Lagrangian multiplier test for random effects, Prob.chi2			0.0000
Hausman-test		0.0000	

****p < 0.01, **p < 0.05, *p < 0.1.*

The first model is the "between" regression, which estimates the time-averaged values of variables using an ordinary OLS. The quality of the regression fit can be evaluated by the R-sq "between", which is very high (0.8170). It is slightly higher than the simple regression R-sq (0.77), which suggests that the change on the average time-averaged indicators is more significant for the variables than their temporal fluctuations relative to the average. The dependence between the variables remained the same, as in a simple regression. However, the impact of spin-off companies has doubled.

The second testing regression type is the model with the "within"-estimator or the fixed-effects model. This type of regression has the advantage of taking into account the unobserved individual effects of the units which are fixed in the time and missing in the model as the explanatory variables. For example, regional effects of cultural or climatic features. Thus, the model allows constructing individual constants for each region, considering their unobservable heterogeneity.

The results of the "fixed-effects" model extremely differ from the previous results. Only two variables remained significant. However, even though "SPINS" is still at 1% level of significance, its value reduced in 6 times in comparison with the coefficient of the "between" model. The variable “*lnGRP*” remained almost the same and has little statistical effect - the 1% increase in GRP will result in receiving less then one patent (0,83) by the region. What is interesting, the coefficient has remained negative throughout all the regression models, which seems illogical.

Finally, the third type of the panel data regression to be tested is the random-effects model. This type of regression is evaluated using GLS-estimator, therefore, it can not be checked by R-squared coefficient. The quality of this model can be judged by the relatively high Wald chi2 (5)=294.01.

After estimating the specification with different panel data models, one needs to select the most adequate one, which is most adequate to the data used. For this, I made a pairwise comparison of the models.

4.2.3. Selection of the most appropriate model

In order to choose the most appropriate model, it is needed to compare three evaluated models: pooled regression, fixed-effects model, and random-effects model. The “between” model is auxiliary and therefore will not participate in the selection. Pairwise comparison of the models will be realized by using next tests:

1. FE vs Pooled regression - Wald test;
2. RE vs Pooled regression - Breusch-Pagan test;
3. RE vs FE - Hausman test.

The comparison of the pooled and the fixed-effects models by Wald test (Prob> F) indicated that the fixed-effects model is better than the simple regression model. According to Breusch-Pagan test indicator (Prob> chibar2 = 0.0000), it is suggested that the model with random effects is also better than the pooled model.

Thus, it is only needed to choose between the “fixed effects” and “random effects” models. The verification is carried out using the Hausman test (Prob> chibar2 = 0.0000), which in our case suggests that the model with fixed effects is more suitable than the model with random effects. The result is expected, since the sample did not change and had the same regions throughout the entire period of time.

Interpretation of the "fixed effects" model results

Table 7. Results of the "fixed-effects" model

Variable	Coefficients
PATENTS	
SPINS	2.618706***
EDUC	-.2073901.
RSCH_STAFF	.0355995***
ln_SPPNDS_F	2.358311.
lnGRP	-83.50875*
Cons	1269.926***

****p < 0.01, **p < 0.05, *p < 0.1.*

The number of researchers in the region also has an important effect. Despite the fact that the statistical effect is really small - less than 0.4 patents per year. It is important to consider that hiring only one employee gives such an effect. Taking into account this fact, according to our data, the rank of the "RESCH_STAFF" variable covers values from 19 to more than 41 thousand scientists, which means that the effect on the number of patents can be enormous.

Moreover, the sign at the GRP coefficient remained negative for all models and specifications, which may seem counterintuitive. In the "fixed-effects" model, we observe that with an increase in GRP by 1%, the number of patents in the region will slightly decrease by an average of 0.84 or almost 1 patent per year. Considering the fact that Russia has commodity economy, it can be assumed that GRP growth is often associated with the presence of oil and gas raw materials in the region, which leads to focusing the economy not on high-tech industries, but mining. However, this is only an assumption requiring detailed consideration and evidence, which is not included in the scope of this work.

Chapter 5. Conclusions and recommendations

5.1. Conclusions

According to the initially state research question, the main aim of this Master thesis was to estimate the contribution of the university activities to the regional innovations in the Russian regions. The analysis conducted by the author examined the effect of three functions of university: research, education and commercial role. As suggested by theory (Etzkowitz, 2000), the "third mission" of the university or its commercial role has the greatest influence among the listed functions. While there was no connection found between the two classical roles of the university and the number of patents granted by the regions.

Thus, the analysis confirmed the statement of "Triple helix" model for the Russian regions. This theory distinguishes the university as a core of the innovation process in the region, where it contributes to the development of the regional economy through its "third role". However, according to Etzkowitz (2000), the university can fulfill this role mainly in highly-developed knowledge-based economies. Therefore the further research on this topic is needed.

The found effect of university spin-off companies is also supported by the theory of a regional innovation system, which considers a non-linear approach to the innovation process and also recognizes the university as the one of its main actors (Cooke, 2001). University spin-off companies connect university, business, and investors, thereby increasing connectivity and providing a transfer of knowledge within the regional innovation system.

5.2. General findings and further vectors of research

The results of the study show that the distribution of Russian regions for all the considered parameters of innovation is highly heterogeneous. Among the 86 existing regions, the most developed in all respects are cities of federal significance - Moscow and St. Petersburg. These cities can not only compete with entire regions, but they are the best among them. In addition to the two capitals, the Republic of Tatarstan also has a high level of development of innovative potential and innovation activity in general. Evidence of these findings can be found in the official ratings of the innovative development of the regions of the Russian Federation of the two leading economic universities of the country (HSE, RANEPA), where, according to the results of a more complex and deep analysis, the same regions are identified as top-developed subjects of the Russian Federation. Therefore, provided data available, those regions can be suggested as the relevant sample for the future researches on innovations in Russia.

As a consequence of the high heterogeneity of the regions, the regression analysis indicated that there is no clear causal relationship between innovations and general socio-economic conditions for all the Russian regions. Such a result can be an argument for the idea of developing a unique path of innovative development for each region, taking into account its specific features, advantages and disadvantages. In this regard, subsequent researches on this topic may have a vector towards the theory of smart specialization.

Among other things, an indicator of the number of researchers was found to be an important factor in the development of innovations in the Russian regions. This fact is an obvious and logical conclusion, since the results of the activities of scientific personnel are often evaluated by the scientific citation index, the number of publications and patents. We can also associate this find with the theory of the creative class (Florida, 2002), to which researchers can undoubtedly be attributed. Understanding this fact gives us reason to believe that in further researches an important part of the analysis may be the search and estimation of the factors that attract the creative class to the regions, and as a result, contribute to the level of development of regional innovations and its competitiveness as a whole.

Another important and interesting observation is that the welfare of the region expressed in GRP per capita plays a negative role in the development of innovation. This fact contradicts with logic, but it may turn out to be fair for Russian realities. The author suggests that the negative impact of the growth of wealth in the region could be related to the raw material structure of the Russian economy. From a descriptive analysis of Chapter 4, it can be seen that in addition to the developed financial centers of Moscow and St. Petersburg, oil-producing regions are included in the top richest regions of the country. Thus, the following phenomenon is likely to exist - regional economies specializing in mining do not pay attention to the development of innovations, since they simply do not need them because of the profitability of traditional sectors of the economy.

5.3. Recommendations

Based on the research result the following policy recommendations can be given:

1. It is needed to recognize the importance of the university as one of the main actors in the development of an innovative economies of the Russian regions. Particular attention should be paid to the commercial activities of the university.
2. It is necessary to develop a methodology for collecting data on the activities of regional universities, which does not exist in Russia.
3. Take into account the heterogeneity of regions and develop policies suitable for their own way of innovation development.
4. Policies also should focus on finding and developing conditions for attracting creative class (researchers).

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Annexes:

Annex 1: Tax codes of the Russian regions

Tax code	Name of Region
01	Adygey Republic
02	Bashkortostan Republic
03	Buryat Republic
04	Altay Republic
05	Dagestan Republic
06	Ingush Republic
07	Kabardin-Balkar Republic
08	Kalmyk Republic
09	Karachay-Cherkess Republic
10	Karelia Republic
11	Komi Republic
12	Mariy-El Republic
13	Mordovia Republic
14	Sakha Republic
15	North Ossetia Republic
16	Tatarstan Republic
17	Tuva Republic
18	Udmurt Republic
19	Khakass Republic
20	Chechnya Republic
21	Chuvash Republic
22	Altay Territory
23	Krasnodar Territory
24	Krasnoyarsk Territory
25	Primor'ye Territory
26	Stavropol' Territory
27	Khabarovsk Territory

28	Amur Region
29	Arkhangel'sk Region
30	Astrakhan' Region
31	Belgorod Region
32	Bryansk Region
33	Vladimir Region
34	Volgograd Region
35	Vologda Region
36	Voronezh Region
37	Ivanovo Region
38	Irkutsk Region
39	Kaliningrad Region
40	Kaluga Region
41	Kamchatka Territory
42	Kemerovo Region
43	Kirov Region
44	Kostroma Region
45	Kurgan Region
46	Kursk Region
47	Leningrad Region
48	Lipetsk Region
49	Maga Buryatdan Region
50	Moskva Region
51	Murmansk Region
52	Nizhegorod Region
53	Novgorod Region
54	Novosibirsk Region
55	Omsk Region
56	Orenburg Region
57	Orel Region
58	Penza Region
59	Perm' Territory
60	Pskov Region
61	Rostov Region

62	Ryazan' Region
63	Samara Region
64	Saratov Region
65	Sakhalin Region
66	Sverdlovsk Region
67	Smolensk Region
68	Tambov Region
69	Tver' Region
70	Tomsk Region
71	Tula Region
72	Tyumen' Region
73	Ul'yanovsk Region
74	Chelyabinsk Region
75	Zabaykal'ye Territory
76	Yaroslavl' Region
77	Moscow City
78	City of St. Petersburg
79	Yevrey Autonomous Region
83	Nenets Autonomous Province
86	Khanty-Mansiy Autonomous Province
87	Chukot Autonomous Province
89	Yamal-Nenets Autonomous Province
91	Crimea Republic
92	Sevastopol City
99	Baikonur City

Annex 2: The mean values of the considered variables for all the Russian regions

MEAN	48,840	6,812	20,441	62,717	20,788	69,276	5,395	385,861	331494,727	30,483	9067,373	0,227
MEDIAN	49,220	5,760	20,020	62,880	16,000	70,490	3,000	191,800	292090,340	29,526	1708,400	0,000
MODE	48,3	4,38	14,8		11,24	66,06	0					0
RGN	INT	UNEMPL	HTIND_GRP	GOV_RD	UNI_RD	URB	SPINS	PATENT_GRTD	GRP_pc	POPL_DEGREE	RSCH_STAFF	CLUSTER
1	51,080	8,480	15,860	47,300	35,020	47,060	0,000	14,000	172445,660	33,827	301,600	0,000
2	50,540	5,820	20,920	32,320	11,240	61,360	8,400	601,800	306151,820	26,589	8198,200	0,200
3	40,000	8,620	27,900	81,640	17,180	58,900	4,400	133,400	190184,140	31,419	1210,400	0,200
4	43,440	11,040	20,020	68,060	54,960	29,000	0,200	6,400	177811,580	29,833	155,200	0,000
5	46,000	11,040	12,580	78,620	32,120	45,080	0,800	381,200	168042,840	31,516	1680,200	0,000
6	43,540	36,380	19,560	91,980	13,740	40,300	0,000	59,400	103536,680	29,518	206,000	0,000
7	53,920	9,860	20,380	81,900	37,800	53,020	5,000	108,600	137241,140	30,646	857,800	0,000
8	38,460	11,560	14,800	88,600	5,260	44,860	3,200	406,800	168721,260	36,529	187,200	0,000
9	42,360	12,240	19,200	85,560	7,960	42,820	0,000	200,000	140098,420	38,419	548,200	0,000
10	67,740	8,260	17,380	77,920	25,480	79,180	4,600	75,400	307803,160	27,300	1108,000	0,000
11	54,780	7,040	12,040	39,760	4,340	77,520	2,000	33,600	580936,560	27,059	1851,800	0,000
12	45,560	5,560	23,400	64,740	72,480	64,720	4,000	146,200	208446,900	28,264	215,200	0,200
13	48,300	4,380	21,560	32,380	45,940	61,220	3,600	65,400	206621,740	32,847	930,000	0,200

14	26,860	7,460	13,440	84,360	15,040	65,080	5,000	222,400	705912,940	31,193	2307,200	0,000
15	48,780	8,760	17,720	75,880	34,800	64,000	2,000	108,000	168327,080	40,224	646,600	0,000
16	56,920	3,960	20,040	38,120	19,340	76,080	18,200	1155,200	439201,360	33,407	12737,600	1,200
17	27,980	18,400	28,200	94,020	5,580	53,920	0,400	2,200	143383,340	35,582	392,000	0,000
18	56,260	5,400	23,620	45,660	24,060	66,060	5,000	194,000	300304,740	26,243	1643,000	0,200
19	56,920	6,440	15,620	61,340	46,620	68,120	0,600	117,200	298082,540	26,903	245,800	0,000
20	21,840	22,220	22,180	74,000	60,260	34,800	0,000	23,400	102294,900	24,902	574,400	0,000
21	53,120	5,380	29,180	20,080	7,460	60,280	1,400	184,800	192029,720	28,621	1338,000	0,000
22	41,840	7,660	19,860	47,700	17,720	55,740	9,600	279,000	186142,000	25,791	2969,200	0,400
23	45,700	5,840	14,120	59,700	5,740	53,820	2,200	529,800	328176,700	28,288	7551,600	0,000
24	44,380	5,700	15,380	78,600	8,740	76,640	14,000	411,600	508354,480	28,597	7243,600	0,000
25	46,680	6,760	18,020	83,700	15,560	76,700	9,000	342,400	334106,720	32,197	5620,000	0,000
26	51,260	5,520	23,140	45,520	39,540	57,860	3,000	233,200	194307,880	34,533	2551,200	0,000
27	55,840	5,660	17,960	61,380	21,000	81,700	3,000	173,400	403327,600	35,799	1753,600	0,200
28	36,180	5,740	14,360	73,700	21,100	67,160	1,400	143,000	301162,260	30,406	802,200	0,000
29		6,820	25,680	73,460	18,400	76,940	0,200	70,200	365415,800	26,948	1065,200	0,400
30	53,300	7,600	13,520	48,540	28,560	66,620	8,200	93,400	284743,240	31,084	925,200	0,200
31	51,580	3,960	10,360	36,160	73,680	66,760	21,400	200,600	408361,500	30,457	1462,000	0,200
32	44,240	4,900	21,160	62,820	25,240	69,540	2,200	118,000	197522,580	27,409	797,800	0,000
33	59,300	4,740	28,100	53,140	5,120	77,720	3,600	245,800	239016,780	26,034	5336,000	0,000
34	41,160	6,640	17,240	64,400	11,640	76,400	3,200	375,400	263960,860	30,385	3784,600	0,400

35	42,780	6,180	19,900	52,700	30,160	71,580	2,000	82,000	343281,280	25,319	487,000	0,800
36	51,280	4,740	18,540	59,160	16,760	66,580	13,000	574,600	301638,960	30,455	10672,200	0,400
37	49,960	5,400	21,220	57,160	55,220	81,140	1,400	470,400	155141,780	27,966	751,200	0,000
38	47,260	8,380	17,820	62,880	20,620	79,280	10,600	295,000	374749,260	28,996	4874,000	0,400
39	57,620	6,020	24,460	72,200	20,100	77,600	3,800	265,000	328877,660	32,095		0,000
40	51,660	4,300	35,800	62,780	0,880	76,000	1,800	128,200	320582,240	29,036	10318,600	0,400
41	24,700	5,240	19,740	94,700	4,160	77,460	0,200	147,200	490082,020	38,577	1155,400	0,000
42	61,900	6,980	16,900	40,880	21,760	85,600	7,600	267,000	281961,000	27,710	1369,200	0,400
43	37,240	5,700	28,220	48,140	9,140	75,180	2,600	120,400	193124,140	25,366	1736,600	0,000
44	41,500	4,960	16,860	37,960	73,340	70,860	0,400	52,400	224539,480	26,768	123,000	0,000
45	39,860	7,820	24,860	73,040	17,200	61,100	1,800	103,500	195365,500	27,869	661,200	0,200
46	38,140	4,420	18,420	76,320	11,240	66,620	2,200	254,000	271068,200	31,607	2951,000	0,000
47	62,260	4,340	13,640	89,100	0,000	64,860	0,400	114,000	432131,280	27,841	6899,200	0,200
48	54,160	3,820	12,180	35,560	37,700	64,080	1,000	136,800	334820,020	28,578	500,600	1,000
49	26,400	3,620	16,420	70,400	1,620	95,540	0,000	29,200	723910,500	32,467	626,400	0,000
50	62,460	3,000	23,300	63,380	1,800	81,260	8,800	1712,000	402337,700	42,065	86711,000	0,600
51	56,980	7,420	17,820	83,080	3,620	92,640	1,400	59,000	455744,820	32,018	2334,000	0,200
52	58,040	4,500	30,160	73,980	2,740	79,240	5,600	639,000	308097,220	30,205	40697,199	0,200
53	55,400	4,380	29,280	66,140	21,060	70,660	2,200	58,600	334224,760	25,238	1342,800	0,800
54	49,220	6,180	23,160	76,760	7,920	78,180	10,600	573,200	330356,840	32,892	21627,199	0,200
55	41,520	6,880	17,720	40,380	11,940	71,980	28,600	329,400	292090,340	27,646	4535,200	0,600

56	52,640	4,880	11,620	52,000	37,860	59,780	0,600	198,800	360861,660	26,218	963,000	0,000
57	46,560	5,760	18,740	57,880	47,100	66,060	0,400	170,400	238266,560	31,765	791,200	0,600
58	48,300	4,720	22,820	87,020	4,760	67,940	4,000	185,000	220733,660	28,844	5534,800	0,600
59	55,520	6,140	29,220	59,380	10,760	75,280	5,600	425,800	370020,840	25,414	10450,000	0,400
60	54,120	6,740	21,280	46,160	54,240	70,320	0,800	52,250	191938,560	26,918	618,000	0,000
61	44,480	5,960	20,660	63,880	17,000	67,740	13,000	718,000	247052,620	30,917	12364,200	1,600
62	51,140	4,560	22,440	68,520	24,720	71,140	3,200	164,800	261414,620	29,526	2634,800	0,200
63	43,820	3,420	25,920	69,020	10,100	80,280	9,400	731,400	353282,660	37,404	13847,200	0,600
64	48,840	5,000	23,640	60,720	16,120	75,020	9,800	382,000	227695,400	31,400	4981,200	0,000
65	46,640	6,800	8,320	67,440	7,140	81,060	0,800	106,600	1509665,600	28,012	848,400	0,000
66	63,640	6,100	23,840	54,800	6,700	84,220	8,200	689,400	394480,840	28,803	21300,801	0,400
67	49,860	5,660	21,060	26,660	9,320	72,240	0,200	91,400	244830,300	30,460	758,200	0,400
68	47,520	4,580	17,020	69,980	16,000	59,440	4,400	114,400	252397,380	25,810	1547,600	0,000
69	46,120	5,400	21,380	46,920	5,660	75,060	5,200	193,400	238868,120	25,487	4410,000	0,000
70	53,420	7,700	20,880	60,460	36,120	71,560	0,000	411,800	402479,400	34,279	9154,000	0,600
71	50,440	4,220	35,140	49,820	5,560	76,760	2,000	229,600	272501,740	28,500	3868,600	0,400
72		5,180	17,280	29,460	8,440	63,540	10,000	248,600	626375,050	33,728	5941,400	0,200
73	51,700	5,080	31,020	20,860	4,720	74,240	4,600	491,200	223614,060	27,458	6299,200	0,000
74	55,560	6,540	20,820	84,880	4,740	82,360	12,600	548,400	297570,780	31,425	15401,400	0,000
75	41,640	10,460	19,820	59,880	33,060	67,080	0,800	31,000	222822,800	23,830	430,400	0,000
76	56,740	4,740	25,460	55,340	9,520	81,800	8,800	214,600	314099,640	26,607	6270,600	0,000

77	86,360	1,520	21,660	74,280	10,740	99,080	48,800	8705,400	1036482,280	49,138	236501,203	1,000
78	76,040	1,540	30,680	60,020	9,280	100,000	27,400	1986,400	562217,320	43,848	78837,203	1,000
79	37,640	8,320	15,740	85,440	46,300	68,140	0,000	191,800	252601,460		270,500	0,000
82	81,633	7,000	13,520	89,567	9,267		0,600	92,400	103005,875	32,864	1774,000	0,000
87	11,760	3,660	14,800	89,940	0,900	67,540	0,000	13,800	1099491,740		22,333	0,000
		Top-5 regions with minimum values										
		Top-5 regions with maximum values										

Annex 3: The detailed summary statistics of the variables used

```
. xtsum PATENT_GRTD POPL_DEGREE RSCH_STAFF LN_STAFF CLUSTER ln_SPPNDS_THIN SPDS_THIN_F UNEMPL INT HTIND_GRP GOV_RD UNI_RD URB SPINS
> GRP_pc lnGRP
```

Variable		Mean	Std. Dev.	Min	Max	Observations
PATENT-D	overall	223.4842	232.5173	0	1001	N = 380
	between		229.7231	0	898.2	n = 76
	within		42.99452	32.48421	500.2842	T = 5
POPL_D-E	overall	29.83822	3.924232	20.92755	42.48276	N = 372
	between		3.544055	23.83036	40.22358	n = 75
	within		1.716561	24.78693	34.0695	T-bar = 4.96
RSCH_S-F	overall	4151.769	6277.993	19	41513	N = 373
	between		6257.165	22.33333	40697.2	n = 76
	within		429.646	-80.43056	7610.569	T-bar = 4.90789
LN_STAFF	overall	7.482773	1.373453	2.944439	10.63376	N = 373
	between		1.40903	3.100182	10.61375	n = 76
	within		.1250708	6.74604	8.134558	T-bar = 4.90789
CLUSTER	overall	.1896104	.5932749	0	7	N = 385
	between		.2863493	0	1.6	n = 77
	within		.5204165	-1.41039	5.58961	T = 5
ln_SPP-N	overall	7.768555	2.041884	-.2626643	11.34709	N = 366
	between		2.073204	1.661195	10.95708	n = 76
	within		.570776	5.328829	10.07389	T-bar = 4.81579
SPDS_T-F	overall	9053.011	14652.05	.769	84718.55	N = 366
	between		13377.75	11.16515	58963	n = 76
	within		5782.566	-21145.11	67764.31	T-bar = 4.81579
UNEMPL	overall	7.036387	4.657583	2.9	47.7	N = 382
	between		4.497678	3.42	36.38	n = 77
	within		1.231699	.4563874	18.35639	T-bar = 4.96104
INT	overall	47.50536	11.37465	3.9	90.9	N = 373
	between		10.59263	11.76	81.63333	n = 75
	within		4.900061	28.92536	83.62536	T-bar = 4.97333
HTIND_-P	overall	20.26	5.87038	0	41	N = 385
	between		5.622149	8.32	35.8	n = 77
	within		1.783834	6.74	30.24	T = 5
GOV_RD	overall	62.77363	20.52614	8.9	100	N = 383
	between		18.5502	20.08	94.7	n = 77
	within		9.096872	17.29363	133.2136	T-bar = 4.97403
UNI_RD	overall	21.39634	19.11666	0	77.5	N = 383
	between		18.37847	0	73.68	n = 77
	within		5.496648	-12.54366	44.99634	T-bar = 4.97403
URB	overall	68.23263	12.3568	28.7	95.8	N = 380
	between		12.4133	29	95.54	n = 76
	within		.4762984	65.99263	71.07263	T = 5
SPINS	overall	4.335065	7.59519	0	69	N = 385
	between		5.095038	0	28.6	n = 77
	within		5.65667	-18.26494	46.33506	T = 5
GRP_pc	overall	315585.7	212199.4	77877.2	1716734	N = 377
	between		206859.5	102294.9	1509666	n = 77
	within		52329.07	93706.72	608318	T-bar = 4.8961
lnGRP	overall	12.52635	.4853533	11.26289	14.35593	N = 377
	between		.4740486	11.52349	14.22188	n = 77
	within		.1311603	12.21019	12.89784	T-bar = 4.8961

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Annex 4: Correlation matrix

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. corr POPL_DEGREE RSCH_STAFF LN_STAFF CLUSTER ln_SPPNDS_THIN SPDS_THIN_F UNEMPL INT HTIND_GRP GOV_RD UNI_RD URB SPINS GRP_pc lnGRP
(obs=345)
```

	POPL_D~E	RSCH_S~F	LN_STAFF	CLUSTER	ln_SPP~N	SPDS_T~F	UNEMPL	INT	HTIND_~P	GOV_RD	UNI_RD	URB	SPINS
POPL_DEGREE	1.0000												
RSCH_STAFF	0.0567	1.0000											
LN_STAFF	0.0111	0.7822	1.0000										
CLUSTER	-0.0281	0.0978	0.1212	1.0000									
ln_SPPNDS_~N	-0.1942	0.5272	0.7127	0.1805	1.0000								
SPDS_THIN_F	0.0091	0.6362	0.5823	0.1192	0.6769	1.0000							
UNEMPL	0.1163	-0.2067	-0.3469	-0.0931	-0.6137	-0.2246	1.0000						
INT	-0.0831	0.2445	0.2578	0.0616	0.2473	0.1747	-0.2407	1.0000					
HTIND_GRP	-0.0860	0.3266	0.3083	0.0471	0.1322	0.1056	-0.0794	0.0672	1.0000				
GOV_RD	0.2983	0.1139	0.0570	-0.0219	-0.2081	0.0426	0.2719	-0.2437	-0.0881	1.0000			
UNI_RD	-0.0840	-0.3683	-0.5703	-0.0144	-0.3591	-0.3165	0.0849	-0.0334	-0.2370	-0.1990	1.0000		
URB	-0.0675	0.3069	0.4245	0.0639	0.4757	0.3047	-0.5230	0.2339	0.1220	-0.0452	-0.3370	1.0000	
SPINS	-0.0436	0.2235	0.3255	0.0670	0.3078	0.2965	-0.1396	0.0396	-0.0371	-0.1023	-0.0325	0.1458	1.0000
GRP_pc	0.0528	0.0500	0.1171	-0.0052	0.3176	0.3090	-0.1960	0.0184	-0.3743	0.1031	-0.2591	0.4153	0.0005
lnGRP	0.0554	0.1760	0.2911	0.0545	0.4705	0.3612	-0.3823	0.1399	-0.3344	0.0516	-0.3216	0.5644	0.0737

	GRP_pc	lnGRP
GRP_pc	1.0000	
lnGRP	0.9037	1.0000

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