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Ukraine's Economic Transformation Toward Innovation-Driven Economic Development: Institutional Challenges

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Introduction

Innovations are crucial for a high level of productivity and economic growth for any country. Even though Ukraine has a large economic potential, it was ranked 73rd out of 144 countries in the economy competitiveness index (Schwab, K., & Sala-i-Martín, X., 2012) and 71st out of 142 countries in the ranking of innovativeness (Dutta, S., & Lanvin, B., 2013). Despite the importance of innovation-driven economic development, Ukraine's economy is characterized by cheap labour force and low level of added value in goods. Its main internationally traded goods are raw materials and heavy industry output.

It is believed that countries have technological trajectories (Dosi, G. (1982)). However, the technological change in Ukraine tends to be path-dependent and locked-in within trajectory since the USSR times. Ukraine is facing systemic failure, which is hampering the innovation development. Under transformation conditions, Ukraine can overcome economic recession, reach a higher level of competitiveness and guarantee sustainable development only by implementing an innovation-driven economic development model, in which institutions play the decisive role. This opens a broad discussion on institutional challenges faced by Ukraine in developing its research, technology and industrial capacity. This fieldwork is relatively new in Ukraine and not well explored, which makes our research up to date and important.

As institutions may either constrain or facilitate innovativeness (Hollingsworth 2002), our research aims to study the components of the institutional arrangements in Ukraine, to understand (1) why particular institutional arrangements emerged and developed in Ukraine and (2) how they influence the innovative development.

The aims of this dissertation is to investigate whether, and if yes, to what extent, institutional arrangements in Ukraine influence its innovation-driven economic development and how this impact can be measured for the whole economy and for particular sectors.

This study aims to answer the following question:

How the pillars of the National Innovation System (NIS)[1] and their interactions in the dynamic perspective influence the innovative development of Ukraine in general, and IT sector in particular (their correlation, causality, positive/negative/null impact)?

Their interaction in Ukraine will be studied in a broader socio-cultural context, taking into account external factors, contributing to the institutional impact i.e. European integration, international cooperation, technology diffusion, transfer of best practices.

The the following hypothesis is tested in this dissertation: current institutional arrangements in Ukraine do not stimulate innovative activity due to (1) the strong influence of a poorly developed political system, and (2) an industrial system lacking motivation and payoffs that would drive it to become more innovative.

It is expected that in Ukraine, country with big educational and research potential, but weak government effectiveness, regulatory quality and rule of law, the crucial role in the transformation conditions may be played by the business sector. However, this is sustainable only in the short-time perspective and has to be accomplished by the decentralization of power, transition to free market economy together with abolishment of oligarchic system. In the long-term perspective innovation-driven economic development is possible only due to the structural transformations in all three pillars, which would enable their effective cooperation.

The study is organized as follows. Firstly, the theoretical framework addresses the issue of positive link between innovative development and long-run economic performance (Schumpeter (1962), Solow (1956), Romer (1990), Krugman (1991), Grossman & Helpman (1993)), while also recognizing the role of institutional arrangements in economic growth (North and Thomas (1973), Sala-i-Martin (2002), Tebaldi and Elmslie (2008)). A positive correlation between institutional arrangements and innovation-driven economic development is presented with findings by Hage and Hollingsworth (2000), Edquist (1997), Langlois and Robertson (1995)). The study is focusing on the concept of National innovation system (NIS), which enables to integrate institutions, innovations and economic growth; and to analyse the complex set of

[1] NIS concept presumes that "innovative development is the result of a complex set of relationships among actors (pillars) in the system" (OECD, 1997). By the pillars of NIS we understand political, educational and research, industrial systems.

relationships in the process of innovative development inside the country by incorporating political, research and education, and business pillars.

Secondly, the research presents the overview of institutional constraints and institutional incentives for the innovation-based economic development in Ukraine. Emergence and development of the NIS of Ukraine and the aspects of its path dependence are going to be analysed. The quantitative analysis is provided, studying the (1) quality of the NIS pillars, (2) impact of institutional factors on the quality the NIS pillars, and (3) relationship between the quality of the analysed NIS pillars and the level of Ukraine's economic development.

Thirdly, the research focuses on the sectoral approach, in particular IT sector as one the fastest growing in Ukraine. Interviews of IT representatives take the place to support or to contradict the results of empirical research. The dissertation will conclude with the most essential findings with a focus on motivation of actors in NIS, entrepreneurial culture and trust in the process of coordination.

Value of the research

The interdisciplinary approach is applied in the dissertation to connect economic and sociological concepts. While there are studies showing the importance of NIS consolidation (Zhilinska, 2010) and NIS modernization (Heyets and Semynozhenko, 2006), innovation studies in Ukraine are rather limited to issues of the impact of legislation and state financial support on stimulating innovation-driven economic growth (Yaremko, 2007; Palyvoda, 2008). At the same time, studies of the role of institutional formal and informal arrangements, institutional incentives and constraints are still unexplored in Ukraine. Moreover, there are almost no studies of the impact of institutional arrangements on particular sectors of the economy. To fill this gap, our research focuses on the role of institutional arrangements in innovative development in general, and IT sector in particular.

Due to political and economic turmoil in Ukraine, the country’s modernization prospects are a very timely. Therefore, the dissertation has clearly a practical dimension and touches upon up-to-date issues. At the same time, we believe that the research topic is important not only for Ukraine, but also for other post-Soviet countries and may be of

interest for the scholars working on the innovation-driven development in emerging countries.

It is expected that this dissertation will help to fill the gaps in existing work on implementation of new institutional approaches in Ukraine; to extend the understanding of factors, tools and mechanisms which can facilitate transformations of Ukraine's economy (using the example of IT sector).

CHAPTER 1. THEORETICAL AND METHODOLOGICAL FRAMEWORK: INNOVATION, INSTITUTIONS AND ECONOMIC GROWTH

1.1. Complexity and systemic nature of innovation

The information society reflects tremendous shift from industrial society in defining knowledge and technology as new drivers of development. Relying on human capital, rather than physical or natural resources, enabling transformation of new ideas into tangible and intangible values, information society helps to understand complexity of knowledge-based and innovation-driven economy.

Today it is generally acknowledged that innovation underpins productivity and lay at the heart of economic growth. However, the nature of innovation is complex and ubiquitous. As Lundvall noted, innovation is “practically all parts of the economy, and at all times, we expect to find on-going processes of learning, searching and exploring, which result in new products, new techniques, new forms of organisation and new markets” (Lundvall, 2000, p. 8). Moreover, innovation has gradual and cumulative nature, and can be best understood as a process. This process involves different social and economic actors, as well as different flows between them (financial, human, knowledge, regulations flows), which makes it non-linear and dynamic. Therefore, the definition of the innovation captures both the invention itself and the way it is being diffused and exploited (Roberts, 1988). Moreover, innovation process strongly relies on institutional context, which is "constituted by laws, social rules, cultural norms, routines, habits, technical standards, etc.” (Lundvall, 2000, p. 24).

The growing need for analytical framework and methodological approach to the study innovations evolved in the OECD manuals, such as Oslo Manual - guidelines for collecting and interpreting innovation data, Frascati Manual – R&D guideline, Canberra Manual – guide on information society and human recourses in S&T.

OECD prepared the first edition of Oslo Manual in the cooperation with Eurostat (European Commission) in 1992, focusing on innovation as technological product and process. Based on numerous surveys, the third Oslo edition (2005) addresses non-technological innovations and pays more attention to the measurement framework,

including such factors as institutions and linkages between firms. The definition of innovation was expanded and since then represent four types of innovations, namely product innovations, process innovations, marketing innovations and organisational innovations (see Fig. 1). This helps to broaden the measurement of innovations in different industries and to go beyond high-technology industries to less R&D intensive industries, for example, to study innovation in services and low-technology manufacturing.

Even though innovation intensity varies depending on the sector and industry of economy, innovation can occur in any of them. This formulation gives us a broader understanding of processes that are happening in economies these days. For example, the most innovative are industries of computing and communication equipment, electronics, chemicals and pharmaceuticals (EBRD 2014). However, service sector is becoming more and more innovation-intense, in particular, Information Technologies (IT) sector.

Product innovations	**Process innovations**
introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses	implementation of a new or significantly improved production or delivery method
Marketing Innovations	**Organisational innovations**
implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing	implementation of a new organisational method in the firm's business practices, workplace organisation or external relations

Fig.1. Types of innovation
Source: composed by the author, based on OECD/Eurostat Oslo Manual, 1997

Research on innovations spans different disciplines. However, we aim not to analyse innovation *per se*. As innovation is not an end in itself, we pursue to study its impact on economic growth. And, as this impact strongly relies on the institutional arrangements, we analyse those interrelations in a broader concept. In this research author combines economic approach together with sociological to provide a complementary insight for a better understanding of the innovation-driven economic growth.

In the following paragraphs the author will review (1) the economic approach: economic growth theories and growth models, leading to the heterodox economic approach and evolutionary economics; (2) the sociological approach on the role of institutions in the economic development; and (3) the concept that helps to organize the knowledge about innovation, economic growth and institutions on the national level, namely National Innovation System.

1.1.1. Economic growth and innovation

Productivity and economic growth are the key concepts in Economics. While schools of economic thought vary in topics, assumptions and methods, there is a broad distinction between mainstream economics (orthodox) and heterodox economics. Mainstream economics are based on neoclassical assumptions, such as rational choice theory, rational expectations and deal with “rationality-individualism-equilibrium” nexus, while heterodox economics (i.e. innovation economics and institutional economics) use “institutions-history-social structure” nexus (Harvey, J. T., & Garnett, R. F. (2008)) to understand workings of economic life. However, economic growth theories and models converge on giving a central role to innovation. From Schumpeterian and neoclassical economics to evolutionary approach, economists agree that innovation plays the central role in economic growth theory, as a "channel through which improved knowledge is applied in the economic process" (BIS, 2011). Let us briefly overview the main examples of the growth theory and their understanding of innovation.

Joseph Schumpeter's research on "creative destruction" was probably the most distinctive contribution to innovation economics. In his Capital, Socialism and Democracy (1942) dynamic process leading to the replacement of old technologies by new ones, was explaining the role of radical and incremental innovations. While putting innovation in the centre of the economic growth, Schumpeter gave insights for the further research. The shift has been done in the models of growth: from emphasising physical capital, such as labour, capital and land to intangible capital.

Among the models of economic development, which explain the development of technology and innovations, knowledge production and technological changes, special

attention should be given to endogenous growth models. The empirical evidence of the positive influence of innovation on economic growth was shown with models of R. Lucas (1988), Mankiw-Romer-Weil (1992), P. Romer (1990), G. Grossman and E. Helpman (1991). Despite the fact that both exogenous and endogenous growth models consider physical capital, human capital and technology as determinants of the economic growth, they differ significantly in approach of understanding technological progress.

Exogenous models explain technological progress as an exogenous variable. For example, Robert Solow (1957) argues that technological progress increases both labour and capital productivity over time, however technological progress (total factor productivity) stays residual. Considering neoclassical production function, with respect to time t, the so-called "Solow residual growth" can be expressed as follows:

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + \alpha(\frac{\dot{K}}{K}) + (1-\alpha)(\frac{\dot{L}}{L}) \tag{1.1}$$

where Y - aggregate output, A - total factor productivity, K - physical capital, L - labour force (growth rates of K and L are weighted by α and $(1-\alpha)$.)

While Solow's model helps to understand the move along the production function (due to the increase of tangible capital) it cannot explain the shift in the production function (due to the technology change) (Santangelo, 2003). Thus, the model does not attempt to determine the origin of the technology, but only shows that technological progress occurs and will grow in the future with a certain constant speed. Innovation stays the indisputable factor ensuring economic growth, but policy implementation cannot directly affect the technological progress.

New endogenous models, by contrast, explain technological development as an endogenous variable that affects long-term economic growth and depends primarily on the investment in R&D and human capital. While making innovation internal to the economic process, endogenous growth models stress the importance of the government policy (e.g. intellectual property rights policy, tax incentives). For example, let us consider Romer's model (1990). The model is described by the equations (1.2) – (1.5) as follows:

$$Y = K^{\alpha}\ (AL_Y)^{1-\alpha}, 0 < \alpha < 1 \tag{1.2}$$

where Y - production of goods and services; K - fixed capital; L - total labour supply; L_Y - labour supply used to production of the goods and services; L_A - labour employed in the new knowledge sector; A - technology, knowledge and ideas; $\dot{A}$ - a growth rate of technologies, knowledge and ideas (new technologies, knowledge and ideas); α - factor of production function of the goods and services; $\overline{\delta}$ - average labour productivity in the knowledge sector (quantity of new knowledge per one researcher); δ, ϕ, λ are constants.

- labour market equilibrium

$$L_Y + L_A = L \tag{1.3}$$

- production of new knowledge

$$\dot{A} = \overline{\delta} L_A \tag{1.4}$$

- average productivity of the knowledge sector

$$\overline{\delta} = \beta A^{\phi} L_A^{\lambda-1}, \delta > 0, 0 < \lambda < 1 \tag{1.5}$$

From equations (1.4) and (1.5), a function of the new knowledge production is obtained as:

$$\dot{A} = \delta L_A^{\lambda} A^{\varphi} \tag{1.6}$$

This equation shows that producing of new knowledge at the present time depends on quantity of researchers and the volume of knowledge. From the equation (1.6) it follows that for $\varphi > 0$, there is a positive knowledge's spillover in the future; if $\varphi < 0$, then the basic knowledge have been produced in the past, and in the future it could be more difficult to improve new knowledge.

In Romer's seminal work (1990) a specific factor of knowledge production at constant "effect of scale" is defined, if $\varphi = 1$, $\lambda = 1$:

$$\dot{A} = \delta L_A A \tag{1.7}$$

That is how the equation of knowledge' growth rate is received:

$$\frac{\dot{A}}{A} = \delta L_A \tag{1.8}$$

Hence, in a stationary condition we obtain:

$$g_Y = g_A = \delta L_A \tag{1.9}$$

The equation (1.8) demonstrates, that in the long-run production of knowledge, measured as the number of scientists, is going to increase the rate of economic growth per capita. Thus, the government policies aimed at increasing the number of employees in R&D (for example, by subsidising them), has a direct positive influence on the long-term economic growth rate.

But how realistic are the assumptions of this model? Can one expect the innovation economic growth can be driven by simply increasing the investments in human capital, as input, and wait for the increase of innovation, as an output? In author's opinion, even though endogenous growth theories made a great step forward, they were still relying on the neoclassical economics and continuing equilibrium, while failing to encompass the role of institutions and evolutionary perspective on technological change. For many years, technological change was seen as a process of transformation of scientific research to the commercialized products or processes. The "linear model of innovation" was explaining relation between science and technology to economy as the sequence of basic research to applied research, which then was leading to development and further production and diffusion (Godin, 2006). His model had a profound place especially, in the countries with policies aiming to adopt science to the industry needs. However, it soon became clear that such approach was neglecting wider set of factors, lying beyond the classical research.

Tebaldi and Elmsli criticised Romer's model as it presents "restrictive and unrealistic assumptions regarding the role of institutions in the economy". Thus, oversimplifying the phenomena of innovation development. As the idea of this research is based on the premise that innovation is not an end in itself, but a process, author aims to incorporate institutional analysis in the economic analysis and explain the role of institutional arrangements as determinant of the innovation development in the following section.

1.1.2. Institutions and economic growth

Institutions are interpreted broadly and encompass formal and informal set of norms and rules (North, 1990; Burns and Flam, 1987), cultural-cognitive, normative, and regulative elements (Scott, 1995). While North interpreted institutions as rules and enforcement of procedures ("rules of the game"), Engerman and Sokoloff (1997) argue about the importance to interpret institutions broadly "to encompass not only formal political and legal structures but culture as well" (p.216). Following Lin and Nugent (1995), institutions can be interpreted even more broadly as "a set of humanly devised behavioural rules that govern and shape the interactions of human beings, in part by helping them to form expectations of what other people will do" (Lin and Nugent (1995, 2306-2307)). Scholars operate at multiple levels of institutional analysis distinguishing institutional arrangements, institutional sectors, organisations, outputs and performance as the components of institutional analysis (Hollingsworth, 2000). Thus, making it difficult to conceptualise institutions and incorporate them into the framework of economic growth (see Table 1).

Table 1. Components of institutional analysis

Institutions	norms, rules, conventions, habits and values (North, 1990; Burns and Flam, 1987).
Institutional arrangements	markets, states, corporate hierarchies, networks, associations, communities (Hollingsworth and Lindberg, 1985; Campbell et al., 1991; Hollingsworth et al., 1994; Hollingsworth and Boyer, 1997)
Institutional sectors	financial system, system of education, business system, system of research (Hollingsworth, 1997; Streeck, 1992)
Organizations	(Powell and DiMaggio, 1991)
Outputs and performance	statutes; administrative decisions, the nature, quantity and the quality of industrial products (Hollingsworth, 1991, 1997); sectoral and societal performance (Hollingsworth and Streeck, 1994; Hollingsworth et al., 1990; Hollingsworth and Hanneman, 1982)

Source: J. Rogers Hollingsworth, p.601

While a variety of definitions of institutions have been suggested, in our research we will use the definition suggested by North who saw institutions as "the rules of the game of society" (1990, p.3). These humanly devised rules are both incentives and

constrains, which shape human interactions, whether social, political or economic. Institutions, as guiding rules help to reduce uncertainty, creating a stable structure for the interaction within a given society.

Along with North's definition, we will make a distinction between formal rules (politics and government), and informal rules (culture, values, norms of behaviour, codes of conduct). This differentiation can be also seen as explicit versus tacit, and regulative versus cognitive rules (Scott, 1995). At the same time, there is no clear dividing line between formal and informal institutions. In order to operate, formal rules have to be supported by inexplicit norms. Without being incorporated in custom, formal rules can be simply ignored, perceived as proclamation/declarations. Thus, enforcement mechanisms are essential part of the institutional framework: institutions must be effectively enforced, being rules-in-use (North 1990).

Both formal and informal institutions are constantly evolving and changing, but there is a varying speed of change. As the formal institutions can be changed fast, informal institutions can not be easily adjusted, as they are "embodied in customs, traditions, and codes of conduct" and therefore are more "impervious to deliberate policies" (North 1990, p.3). Transformation of informal institutes may take decades, as cultural traits are being passed from one generation to another (Yeager, 1998, p. 53).

In the process of the institutional transformation, North draws special attention to the role of organizations. They are the "actors" or "players", which are bound together to achieve common objects. The way organizations evolve is defined by the existing institutional framework. Separating "rules from the strategy of the players" (North 1990, p. 5), author explains that organizations can be political bodies, economic bodies and education bodies. Accordingly, while institutions form the rules of the game, organizations can be the agents of change. According to North, the fundamental source of change is learning by entrepreneurs. The learning can be the outcome of curiosity, growing competition or monopoly power. It can be also the function of expected pay-offs and mental models of the players. Thus, the rate of learning will determine the speed of economic change, the kind of learning will define the direction of economic change (North 1995, p. 6). North has made a significant impact placing the institutions at the centre of understanding economy. In research we will rely on his studies, arguing that

institutions together with technology employment affect the economic performance, in particular by the effect of the exchange and production (transaction and transformation) costs.

In recent years, there has been an increasing amount of economic literature on the role of the institutions. While less than 20 years ago the vast majority of research was dedicated primarily to the macroeconomic stabilization, trade liberalization and privatization, as the policies leading to economic growth (i.e. Washington Consensus) (Carlin et al. 2010). However, there is still no consensus in the mainstream economics on whether or not one can consider institutions as proxy measures, to explain economic growth and how to measure the scale of institutions' impact on economic growth.

A large and growing body of literature has investigated a strong association between institutions and economic growth. For instance, Knack and Keefer (1995) argue that institutions that ensure the enforcement of property and contractual rights are crucial for increase of investment, efficiency of inputs allocation and country's specialization. Engerman and Sokoloff (1997) show that institutions that advantage elites, while limiting the access of other members of population to the economic opportunities, increase the degree of inequality in wealth, human capital and political power, thus hampering the economic development. The empirical findings of Barro (1997), conducted for 100 countries, support the notion that political and economic institutions explain the growth differences across economies.

Yeager (1998) illustrates the effect of institutions on economic performance and technological progress with a dynamic model (see Fig. 2). He argues that the process of Schumpeterian creative destruction may only occur when the proper institutional framework is present (Yeager 1998, p. 50). Thus, technological progress and economic wealth will take place in the country, which influence the behaviour of organizations with the relative institutions. One of the important preconditions is the competitive environment that stimulates firms to constantly improve their technological level of advancement. Among other factors are well-functioning capital market, as well as openness and willingness of society to new technologies, its readiness to deal with the disruption in the status quo.

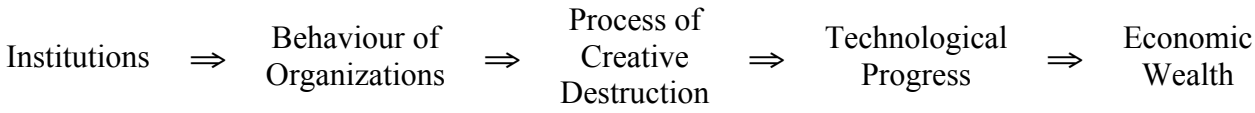

Fig. 2. Institutions and economic growth: the dynamic case
Source: Yeager, 1998

In the same vein, Hall and Jones (1999) consider that output per worker and overall country's long-run economic performance are determined by institutions that create a favourable social infrastructure to stimulate individuals and firms to accumulate skills and capital and "create and transfer ideas, produce goods and services" (p.38). And, according to Rodrik, regulatory institutions, institutions for macroeconomic stabilization, social insurance, conflict management and property rights play the most significant role for the market development and economic growth (Rodrik, D. 2000, p. 5).

Positive link between economic institutions and economies' innovativeness was shown by Hage and Hollingsworth (2000), Edquist (1997), Langlois and Robertson (1995), Huang and Xu (1999), Gradstein (2002). The role of institutional set-up in innovation-based economic growth was further investigated by Sala-i-Martin (2002), Tebaldi and Elmslie (2008). The study of Sala-i-Martin (2002) suggest hypothetical variable to measure and model institutional arrangements. It encompasses law enforcement; political and government institutions; financial institutions and market functioning; sociocultural context. Similarly, Tebaldi and Elmslie (2008) argue that there is a direct link between innovative development, economic growth and institutional support. Authors present aggregate index, measuring enforcement of contracts and property rights; perceptions that the judiciary system is predictable and effective; transparency of the public administration, control of corruption; and pro-market regulations.

Commenting on Romer's model, Tebaldi and Elmslie (2008) argue that his approach is not able to capture „linkages in the dynamics of economic growth". Based on Romer model, they developed a Baseline growth model, which proves empirically the influence of quality of institutions on human capital, R&D and income growth. The implications are summarised in Box 1, as the following propositions:

Proposition 1: There is an optimal mix of technology and institutional quality, so that technological change will only take place in an economy that has an institutional structure suitable to its level of technological development.

Proposition 2: Poor institutions or institutional barriers that prevent or restrict the adoption of newly invented technologies decrease the share of human capital employed in the R&D sector, which hinders innovation.

Proposition 3: Institutional barriers to adopt newly invented technologies decrease the short-run growth rate of output.

Proposition 4: Controlling for diffusion of technology and human capital, a country with a lower level of income and relative poor institutional arrangements will not converge to the levels of income existing in countries with better institutions.

Box 1. Propositions of Baseline model
Source: Tebaldi and Elmslie, 2008, p.39 - 42

Therefore, it is possible to conclude that institutions fundamentally determinate the economic growth by the direct impact on income generation through effects on factor productivity and innovation, which are considered the direct and proximal-casual determinants of income. However, the models discussed above have numerous limitations:

1) empirical analysis of the impact of institutions has certain limits, as it is focusing only on particular kinds of institutions, giving an understanding of limited issues. Empirical estimates may also be biased as they usually ignore other factors that simultaneously affect innovative outcomes.

2) the formal growth models are not able to take into account flexibility of institutions and their ability to adjust to new circumstances, informal institutional set-up, especially in developing countries with poor institutions.

1.1.3. The concept of National innovation system

While moving from linear to more complex models of innovation development, many researchers understand institutions not only alongside political institutions (Nelson, R. and Winter, S.). The new evolutionary approach in economic growth contributes to the growth theory by presenting a model of innovation system, stressing on the point that "it

is necessary to think about innovation within integrated system of growth components" (BIS p.22).

National innovation system (NIS) is one of approaches, which enable to integrate institutions and innovations. NIS concept helps to understand innovation development as the "result of a complex set of relationships among actors in the system", which includes enterprises, universities and government (OECD, 1995). NIS argues that it is no longer possible to measure input and output indicators (for example expenditures on R&D, number of research personnel as inputs and patents as outputs) to explain the level of innovativeness of economy. First and foremost, because they represent a "static snapshot of technology performance", while neglecting the fact that innovation development and technological change does not occur in a perfectly linear sequence. Therefore, NIS focuses not only on the pillars/actors, but also on the linkages and interaction between them to explain the translation of inputs into outputs.

- " .. *the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies*." (Freeman, 1987)
- " .. *the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state*." (Lundvall, 1992)
- "*... a set of institutions whose interactions determine the innovative performance ... of national firms*." (Nelson, 1993)
- " .. *the national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country.*" (Patel and Pavitt, 1994)
- "*.. 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 artefacts which define new technologies*." (Metcalfe, 1995)

Box 2: National innovation systems: definitions
Source: OECD, 1997, p. 10

There is no single definition of NIS. According to Freeman NIS is a "network of institutions in the public and private sectors whose activities and interactions initiate,

import, modify and diffuse new technologies" (Freeman, 1987; p.1), and according to Lundvall NIS can be studied as "elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge" (Lundvall, 1992; p.12). The important aspect for understanding NIS is the interaction within the system (see Box 2).

1.1.3.1. Broad/narrow understanding of NIS

While analysing the NIS, one has to pay attention to the broad and narrow definition. The definition of functional boundaries of NIS can be illustrated with "narrow" and "broad" definition. The narrow definition refers to agents, which are directly involved in the "generation and use of innovation in a national economy" (Adeoti, 2002, p. 95). Conceptually, narrow definition of NIS is embedded in the broader one, which encompasses "all important economic, social, political, organizational, and other factors that influence the development, diffusion, and use of innovations" (Edquist, 1997).

In our opinion, NIS concept has a strong sight, which comprise not only the actors, but the links between them. Links, both formal and informal, serve as the channels of communication, contributing to the diffusion of innovations (Rogers, 2010). Therefore, in our research, we use the broader definition, which enables the better understanding of the actors, linkages and flows of the innovation system.

Studies on the models, which help to illustrate the interaction between political system, research & education system and business system were developed on national and international level since the beginning of 90th. There are different approaches to the NIS formation. Among them are successful NIS models in US, Japan, EU countries (particularly Scandinavian, Continental, Anglo-Saxon, Mediterranean models) (see UK innovation system in Annex A). However, countries that do not have developed NIS models and want to adapt already existing NIS models face with sufficient difficulties. Institutional setting cannot be implemented without taking into account national peculiarities.

1.1.3.2. NIS in developing countries

As the majority of studies focus on NIS concept in developed countries, it is important to distinguish the specific nature of NIS in developing countries, which demonstrate less success in technological catching-up (Intarakumnerd et al, 2002). For example, Gu (1999) point out that while analysing the NIS in developing countries it is necessary to take into account the level of overall economic and institutional development, with a particular attention to country's strategic management for catching-up, market mechanisms and capital accumulation.

While NIS policies in developed countries have a relatively simple task of maintaining or supporting the existent level of innovativeness and technological capacity, developing countries have to undergo the "catching-up" process to close the "technology gap". While strongly relying on resources, developing countries face numerous challenges: limited indigenous capacity is usually related with rare opportunities and high risks to innovate. Therefore, NIS policies in developing countries require to go beyond "technology push" or "demand pull" strategies. This demands new approaches towards developing "nation's capacity to acquire, absorb and disseminate modern technologies" (Feinson, 2003, p.).

For example, Edquist considers that developing countries should focus on the absorption of already existing innovations, and production of incremental innovations rather than radical ones. His concept of System of Innovation for Development also presumes that product innovations are more important than the process innovation, and innovations in low- and medium- technology sectors are better than in the high-technology ones for developing countries. This can be explained with the further argument of Dahlman and Nelson (1995), who consider that developing countries have to advance their abilities "to learn and implement the technologies and associated practices of already developed countries".

This goes in line with the argument of the stages of innovation development, referring to Freeman's understanding of NIS, thus countries "initiate, import, modify and diffuse new technologies". Therefore, developing countries must focus on initiating and

importing innovations first to be able to modify and diffuse them later. Developing countries may face both, advantages as well as disadvantages of such approach.

“Advantages of backwardness” (known as Gerschenkron effect) refer to the fact that less technologically advanced countries may indeed benefit from their stage of development as they can relatively easy borrow already existing innovative products and services that have already proven their effectiveness. The use of this advantage can be a strong push for modernization and catching up. But do countries borrow effectively?

While some countries choose the active learning model and demonstrate the ability to master “technology and its improvements through a deliberate effort” (Juma et al., 2001), other countries prefer "black-box" approach, while using technology without understanding innovations. Therefore, developing countries often rely on foreign investment in the short-term, which enable them to license foreign technology. However, in the long-term it may lead to the dependence on foreign technology, while paying costly licensing fees (Juma et al., 2001).

Thus, absorptive capacity has a profound impact on technological catch-up in developing countries. As Juma et al. have pointed out, "domestic innovation will not be possible without access to international markets; access to international markets will not be possible without domestic technological innovation" (Juma et al., 2001, p. 638).

1.1.3.3. Absorptive capacity

The complex set of skills, enabling to organize the flow of the knowledge, and to deal with the tacit components of in order to modify and exploit it, is known as absorptive capacity (ACAP). It is an important factor on both macro and micro levels. The term was first coined by Cohen and Levinthal (1990), describing the ability of the firms to value, assimilate and apply the knowledge. While the unit of analysis is often firms or organizations, studies of Mowery and Oxley (1995), Keller (1996) Liu and White (1997) explain the role of absorptive capacity on the national level.

ACAP was later reconceptualised by Zahra and George (2002), who made a distinction between potential absorptive capacity (PACAP) and realised absorptive capacity (RACAP). Thus, PACAP encompass ability to acquire and assimilate

knowledge, while RACAP stands for transformation and assimilation of the knowledge (see Table 2).

The first two capacities are closely linked with country's or firm's openness to new, external knowledge, creativity and strategic flexibility, certain degree of freedom to adapt and evolve. For example, in case of firms, PACAP is critical for firms wishing to achieve innovative outputs. At the same time PACAP does not necessary lead to RACAP: new knowledge does not automatically enable firms to create their own innovative products or services. RACAP demands a different set of firms' characteristics, such as stability, order and control. PACAP theory is important not only in the scope of county's or firms' capacities, but also to understand the logic and sequence of changes. Firm or economy can not generate innovation without going trough the learning cycle, the comprehension will not take place without the country's openness to new ideas and technologies.

Table 2.
Dimensions of ACAP

Dimension/Capabilities	**Components**	**Role and importance**
Acquisition	Prior investment and knowledge; Intensity; Speed; Direction	Scope of search; perceptual schema; new connections; speed and quality of learning.
Assimilation	Understanding	Interpretation; Comprehension; Learning
Transformation	Internalization; Conversion	Synergy; Recodification; Bisociation
Exploitation	Use, Implementation	Core competencies; Harvesting resources.

Source: Zahra and George, 2002, p. 189

As the innovation development relies on the past experience and is cumulative, the process of gradual learning in bringing economies closer to the global technological frontier. But in cases of less developed countries, there is usually a technological gap,

which is difficult to close rapidly, as the institutional change is a long term process. Besides, countries may fall in the trap of path dependency.

1.1.3.4. Path dependency

A certain trajectory of development, usually as a result of historical series of actions, may significantly contribute to the innovation-driven growth, as well as keep countries locked-in within a certain trajectory. Although the notion of path-dependence can be used in a positive context, to generate positive feedback processes while reinforcing successfully established path, usually it has a negative connotation. Countries may face technological, as well as institutional path dependence. First type of path-dependence referrers to technological lock-in. The country may continue developing within the same trajectory, regardless available alternative, usually, more advanced technologies or solutions. Secondly, countries may fall under self-reproducing nature of both formal and informal institutions, referring to institutional hysteresis exerts. Resistance to change may also be seen as a cognitive lock-in among the NIS actors. Sector-specific, or territory specific narratives dominating over the time may keep country reluctant to changes, regardless new trends or development (Martin & Sunley, 2006).

In developing countries, the lack of acquisition and assimilation capabilities (PACAP) together with excessive monopoly and lack of the competition on domestic markets deprives firms to innovate. And without sufficient incentives, firms are not motivated to innovate, as borrowing already existing technologies or solutions is not only easier, but essentially cheaper (Polterovich, 2010).

In the following passages author will present the Concept of NIS of Ukraine to study institutional arrangements and provide international comparison with existing models.

1.2. National Innovation System: Ukrainian realm

A considerable amount of literature has been published on Ukrainian NIS by Y. Bagal, V. Geyets, L. Fedulova, Y. Zalilo and others. What we know about Ukrainian NIS is largely based on studies that investigate the impact of the formal institutions. At the same time, studies on the role of informal institutional arrangements are still underdeveloped in Ukraine.

Whereas there are studies showing the importance of NIS consolidation (Zhilinska, 2010) and NIS modernization (Geyets and Semynozhenko, 2006), innovation studies in Ukraine are rather limited to issues of innovation legislation and government's financial support (Yaremko, 2007; Palyvoda, 2008) for improving the innovative environment and stimulate the economic growth. Moreover, there are almost no studies on institutional arrangements for particular sectors. While recognizing the shift from linear to non-linear NIS model (Fisun, 2004), only a few authors pay attention to the importance of the linkages between the NIS actors. At the same time, the facilitation of this process is fully regarded from the perspective of the government pillar.

The studies on diffusion of innovation, and absorptive capacity of the firms and economy, as a whole, are very rare. These aspects are mainly analyzed from the perspective of hi-tech import and/or the impact of transatlantic corporations (Khomych, Cherkas). While omitting the differences between the potential and realized absorptive capacity, authors are looking for direct correlation between the hi-tech import/export and the innovation growth of the country. At the same time little or no attention is given to such factors as entrepreneurship culture, tacit knowledge. Thus, to fill this gap, our research focuses on the role of institutional arrangements in innovative development in general, and IT sector in particular, with a particular focus on informal institutional arrangements.

For a better understanding of the Ukrainian NIS development, author relies to the studies of the Organization for Economic Cooperation and Development (OECD). OECD NIS model demonstrates the complexity of structural connections and serve as an example for many countries. Let us compare the NIS model, designed by OECD with the actual NIS of Ukraine.

According to the Concept of NIS development in Ukraine, NIS consists of the following pillars: government regulation, education, knowledge generation, and innovation infrastructure and production, with the main purpose of creating "the necessary conditions for increasing the productivity and competitiveness of domestic producers" (see Table 3). This goal must be achieved by: (1) technological modernisation of the national economy, (2) increasing the level of innovation activity; (3) the manufacture of innovative products, (4) and the use of advanced technologies and methods of economic management (Concept of NIS development in Ukraine, 2009).

Table 3.
NIS pillars and their functions in Ukraine

Pillars	Components	Functions
Governance	legislative, structural and functional institutions	establishing and enforcing rules, regulations, requirements in the field of innovation; interoperability of all NIS pillars
Education	schools, universities, scientific and research institutions, scientific and industrial enterprises, state and local education authorities	training, advanced training and professional skills development for staff
Knowledge generation	scientific institutions and organizations regardless of ownership, government research centres, academic institutions, research departments of higher education institutions, research and design divisions of enterprises	research and development, generating new scientific knowledge and technologies
Innovative infrastructure	industrial, technological, financial, informational and analytical, expert consulting components; technological and scientific parks, innovation centres and technology transfer centres, business incubators and innovation structures of other types; information networks of scientific and technical information, expert consulting and engineering firms, public and private investors	providing efficient infrastructure for innovation development
Industry	organizations and enterprises	development of innovative products and services and (or) consumption of innovations

Source: composed by the author, based on Concept of NIS development in Ukraine.

While the components of Ukrainian NIS are almost identical to some international models, the Concept fails to demonstrate the integrity itself, as well as structural links between pillars. Ukrainian NIS is rather foreseen as a static model, where there is no interaction between its pillars. According to OECD, linkages between the pillars are crucial, as they enable the knowledge flows. This knowledge is "codified" in publications, patents, joint projects etc. Such flows can take place in the business sector (among enterprises, as they are the main pillar of R&D and innovation performance in OECD countries; or inter-industry via technology diffusion by dissemination and adoption of new technology i.e. equipment and machinery); between public and private research sectors (for example, flows between public research institutes and universities with private enterprises; or via personnel mobility).

As shown in Figure 3, firms and their linkages with science systems, research bodies and supporting institutions are central to the OECD model. Ukrainian NIS model does not consider firms' capabilities and networks potential in knowledge generation, diffusion and use, as a priority. Ukrainian NIS is centred around the government pillar, as it is responsible for the interoperability of all NIS pillars by establishing and enforcing rules, regulations and requirements in the field of innovation development. In author's opinion this is a leftover from the centrally planned system and is quite artificial in the process of innovation development, limiting both product and factor market conditions.

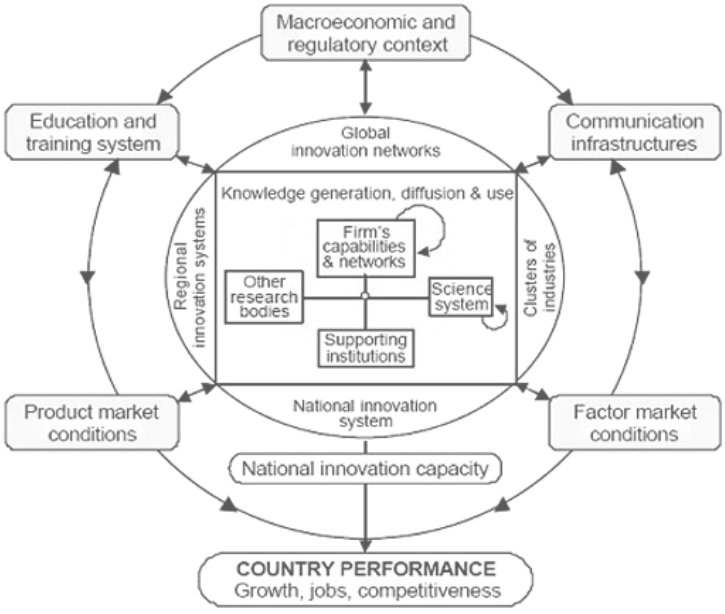

Figure 3. OECD NIS model
Source: OECD 1999, p. 23

One may also note that Ukrainian concept is not paying enough attention to the development of regional innovation systems and industrial clusters. Due to highly centralized budget system, regions in Ukraine have limited possibilities to develop local strategies of innovation development. At the same time, a little if no attention is paid to the aspects of international cooperation. This, in turn, eliminates Ukrainian NIS from global innovation network.

As we already mentioned, for the developing countries the macroeconomic situation plays the crucial role. At the same time NIS formation is a dynamic process that must be considered as integral part of overall economic policy and cannot function as a standalone program. In OECD model, macroeconomic and regulatory context are included in NIS, however in Ukrainian model this issue is rather a matter of question.

1.2.1. Measuring NIS performance

Due to the complexity of NIS concept, there is a lack of unified measurement indicators that can help to evaluate innovation system quantitatively, in particular, NIS quality and performance. Previously analysed indicators, developed by international organisations such as Global Competitiveness Index (World Bank), Global Innovation Index (Cornell University, INSEAD, and the World Intellectual Property Organization) offer some important insights into the overall level of innovation development. At the same time the aggregated unified data can not fully explain national peculiarities.

As it was already discussed, it is difficult to incorporate institutions into the economic models, thus making it very difficult to provide empirical analysis of NIS. One of the methods, applied in the field of economics to study NIS is Data enveloped analysis (DEA) method. It is a nonparametric frontier method for efficiency analysis, which is applied for NIS evaluation and international comparison. Even though, DEA method has a number of disadvantages, in particular the efficiency scores can be seriously biased by statistical noise, large set of input and output variables, as well as the sample of decision making units (Kotsemir, 2013), the case of Ukrainian NIS analysis with this method is rare. So far it was investigated only once within the paper of Abbasi F., Hajihoseini H.,

Haukka S. (2010). Their study analyses a sample of input and output variables[2] for 42 countries. The results of the cross-country comparison are limited and unsatisfactory to elaborate further on the institutional arrangements.

Among the serious constraints, limiting the understanding of NIS effectiveness in Ukraine is a lack of instruments to monitor and evaluate the development of the NIS pillars. Even though, there are indicators that help measuring innovation activity of particular pillars (such as education and industry) linkages between the pillars, as well as innovation infrastructure are left without the proper attention. No national targets are designed to evaluate short-, mid- and long-term development.

Therefore, the methodological approach of this thesis study provides an important opportunity to advance the understanding of formal and informal institutes of Ukrainian NIS, applying mixed method research.

Sectoral approach: peculiarities of Information technologies sector in Ukraine

This research is focusing on IT sector, as the most innovative sector (globally) and the most dynamic in Ukraine (locally). This sector is drawing particular attention, as despite the economic downturn it demonstrates continuous growth. In 2015 IT's export volume reached $ 2.5 billion, showing the 3rd best results as an export sector. In 2016, 10 companies from Ukraine were included in top-outsourcing companies in the world. Among them are local companies (SoftServe, Eleks, Sigma, and Miratech), as well as international companies with R&D centres in Ukraine (EPAM, Ciklum, Luxoft, Intetics, Softjourn and TEAM International Services). According to the research made by AVentures and Ukraine digital news, there are over 500 firms with over 50 000 engineers in outsourcing; 100 R&D centers, 100 e-commerce companies and over 2000 software tech startups (Sysoyev et al).

Thus, research is designed to understand the peculiarities of institutional arrangements of innovation-based economic development on example of the most progressive sector. By choosing only one sector, we understand the limitations of such

[2] Analysis includes the following variables: (1) input variables: number of scientists in R&D, expenditure on education and R&D expenditures; (2) output variable: patent counts, royalty incomes and license fees, high-technology export and manufacturing exports

approach. However, we assume that in-depth knowledge of IT sector can help to project the findings on the other sectors. Therefore, it is necessary to explore how did the IT sector developed in Ukraine? What were the institutional incentives and constraints? What are the linkages between the key-pillars in NIS of Ukraine, allowing such development? Or maybe IT sector developed not with the help of institutional arrangements, but rather despite of it?

1.3. Methodological framework

The logic behind our research can be presented as a simple chain of interactions between institutions, innovations and economic development (see Fig. 4). While it is possible to use quantitative (QT) methods to study the impact of innovations on economic development, it is nearly impossible to use the available databases to measure the impact of institutions and their dynamic interaction on innovations. Therefore, qualitative (QL) methods must be used.

In order to achieve a deeper understanding of institutional challenges, mixed methods research[3] is applied, in particular explanatory sequential design. This design helps organizing qualitative study to explain quantitative findings.

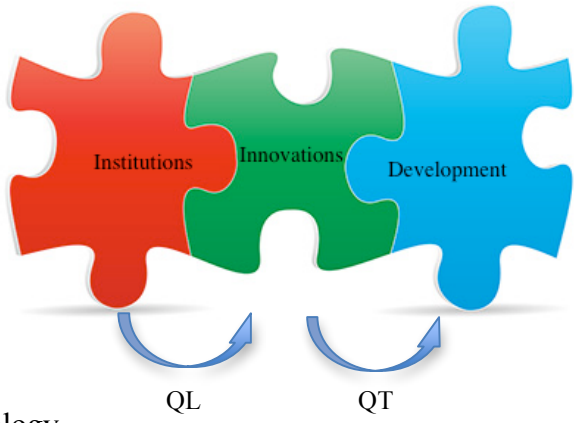

Figure 4. Research Methodology
Source: composed by the author

[3] Mixed methods research refers to combination of qualitative and quantitative research approaches (for example, use of qualitative and quantitative view points, data collection, analysis, inference techniques) for the purpose of breadth and depth of understanding and corroboration (Johnson, Onwuegbuzie and Turner, 2007, Journal of Mixed methods research)

First, the quantitative data is analysed, providing the general understanding of the research problem. Second, the qualitative data is collected and analysed, explaining statistical results, while exploring in-depth views of firms operating in one of the most innovative-intense sector - Information technologies (IT).

1. Conceptualisations of institutional arrangements, identification of the pillars of Ukraine's NIS and presentation of their interaction. SWOT analysis, defining weak and strong sides of Ukrainian NIS.

2. Data collection on innovation statistics and empirical estimations using STATISTICA 6.0 package. Data is collected for the years 2000 to 2013 in order to present the dynamics of key pillars development. Estimations include:

a) modelling synthetic indicators of the quality of NIS:

- data collection from State Statistics Service of Ukraine, World Bank World government indicators, UN to present the development of NIS pillars.
- reduction of the data, explaining the key-pillars with multiple regression test
- normalization and measurement scale unification
- principal component analysis

b) Measuring impact of government pillar on the business pillar and pillar of research and education

c) Impact of pillars' quality on the GDP growth.

3. Interviews with representatives of the most successful innovation sector (IT), the results of which support or contradict the hypothesis based on quantitative estimations.

1.3.1. Quantitative analysis: data and methodology

We now turn to further elaborating on the methodology of quantitative research. There is a number of methods of constructing and measuring various indicators based on the principles of objectivist and subjectivist approaches. All these methods are aimed at constructing indicators in the form of a certain function (convolutions) from a set of available indicators (partial criteria). In the objectivist approach, statistical indicators are

used, in subjectivist - the corresponding characteristics, calculated on the basis of the results of expert surveys or individual questionnaires.

Ukrainian NIS is a synthetic category (i.e. combining various aspects of innovation activity) and latent (that is not amenable to direct measurement). To investigate NIS and its pillars we use the technique of system analysis. Firstly, we decompose NIS; secondly we study the quality of each sub-pillar. Then we measure the impact of the political institutions (government pillar) on the business pillar and pillar of research and education. And finally we analyse the impact of pillars quality on the economic development of Ukraine.

Each NIS pillar can be measured with a synthetic indicator as well. Sequential hierarchical decomposition of each of NIS pillars, takes us to the lowest level. This level presents the set of characteristics, which are based on international indices and national statistics. In our research we use the NIS structure, which is defined in the Concept of the NIS of Ukraine (see Fig. 5). While the concept defines five pillars, for the purpose of this research author is modifying it, using the experience of international models. Therefore, in our quantitative analysis we will focus on 3 key pillars of Ukrainian NIS:

I – government pillar;

II – research and education pillar;

III – business pillar.

For the government pillar we use the World Governance Indicators. The pillar of research is combined with the pillar of education to create a cumulative pillar, allowing us to unite both firms R&D, scientific organization, scientists as employees, tertiary and secondary education. For this pillar, as well as for the business pillar, we use data, collected with State Statistics Service of Ukraine. Some data, allowing us to enrich domestic statistics, is collected from UNESCO Institute for Statistics. At the same time, we find it impossible to find data to measure innovation infrastructure pillar. Moreover, as highlighted earlier, one of the most essential parts of the NIS is linkage between pillars, and those cannot be measured quantitatively.

In the building and interpretation of the set of synthetic indicators of quality of NIS we follow the methodological approach of Ayvazian S. (2016), applied in his studies

of the measuring quality of life. Accordingly, the following three conclusions are most relevant to this thesis.

First, we find it scientifically important and practically feasible to use two-step formation of input statistical indicators to explain complex characteristics of the category "NIS quality". This means that we reduce the number of pre-selected in-put indicators with the statistical algorithms without losing substantial information in the smaller set. And then, based on results, we build synthetic indicators of the NIS quality.

Second, we use the method of modified first principal components to build integral indicators of NIS quality. This method is based on the idea that among all scalar variables, which characterize the quality of each NIS pillar, we look for specific variable. With the help of the value of this particular variable and using linear regression we are able to restore the value of other input indicators. This is the essential characteristic of the 1st principal component, based on unified input data. So-called modified first principal component has almost the same characteristics. However, it is determined on the basis of squared components of its vector in the covariance matrix of standardized input variables corresponding to the largest eigenvalues of matrix.

And thirdly, in practice there are cases that show incapacity of the first modified principal component approach. In such case, unfortunately, it is difficult to find a satisfactory solution to the problem of scalar synthetic indicator modelling. One of possible solution then is to determine the minimum number of main components that collectively satisfy the requirement of minimal loss of information. In this case, the weights of the factors can be determined by experts, thus subjectively.

Modelling synthetic indicators of the quality of Ukrainian NIS pillars

The hierarchical system helps modelling synthetic indicators and allows conducting comprehensive quality assessment of the NIS pillars, as well as the entire NIS of Ukraine. The essence of the problem is that the input statistical indicators have to be weighted, i.e. we have to estimate the proportion of their impact on the synthetic indicators. Only after this we will be able to present aggregate indicators to measure NIS quality. This indicator is latent (hidden) and cannot be measured directly, as it does not exist yet or we cannot assign it to an objective scale.

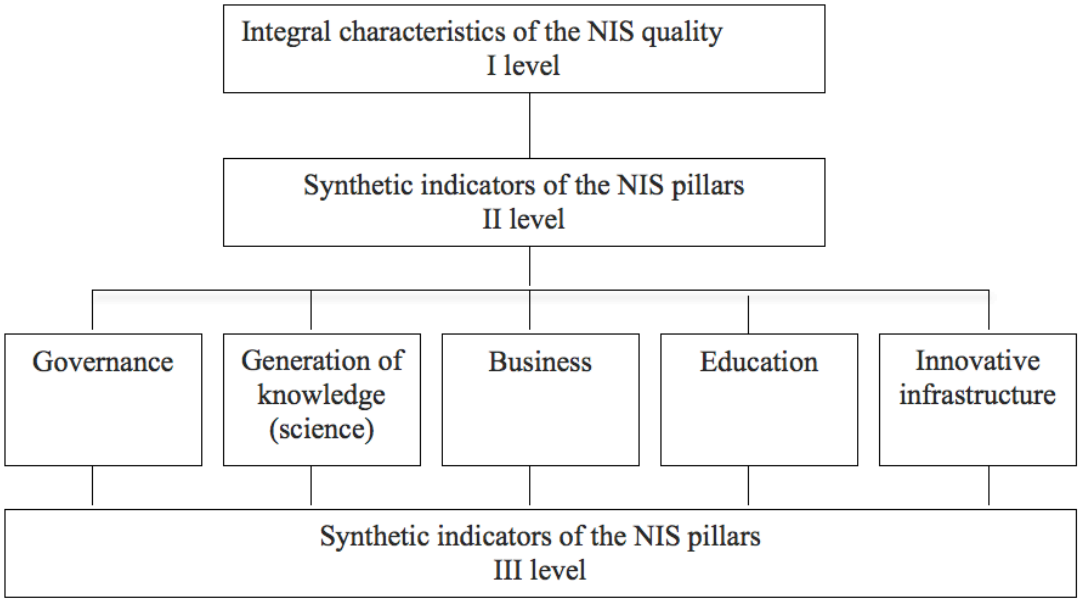

Figure 5. Modelling synthetic indicators of the quality of Ukrainian NIS pillars
Source: composed by the author

Synthetic Indicators of the quality of NIS (SIQNIS) in our research are understood as a special type of statistical indicators convolution. We limit ourselves to the linear convolution (aggregation), while using standardized measurement scale. Therefore, we can explain SIQNIS in the form of the following relationships:

$$y^{(q)}(t) = \sum_{j=1}^{p} w_j x^{q(j)}(t), \tag{1.10}$$

$$Y(t) = \sum_{q=1}^{5} v_q y^{(q)}(t), \tag{1.11}$$

where $x^{q(j)}(t)$ is a unified value of statistical indicator *j,* which characterizes the quality of NIS pillar q in time t $(j = 1,2,\ldots,p;\quad q = 1,2,\ldots,5;\quad t = 1,2,\ldots,T)$; $y^{(q)}(t)$ – synthetic indicators of the quality of the q pillar of NIS in time t; $Y(t)$ – integral characteristic on the NIS quality in t time; w_j, v_q – additional weight coefficients (or just weights), which equal 1 in total, so $w_j > 0, v_q > 0$ and $\sum_j w_j = 1, \sum_q v_q = 1$. Thus, to model SIQNIS, we have to determinate the unknown vectors of weights: $W = (w_1,\ldots,w_p)$ and $V = (v_1,\ldots,v_5)$.

To model SIQNIS we apply the scheme, which is based on the basis of pre-defined statistic indicators and criteria of the basic quality features of the NIS of Ukraine. Namely:

1. To design a method of selecting convoluted sets of statistical indicators that play a crucial role in shaping the values of certain indicators, referring to the quality of NIS pillars;

2. To use unified scales $[0; N]$ to measure statistical indicators, where 0 denotes the lowest quality and N is the highest quality of a particular variable.

3. To propose an approach for building SIQNIS based on principal component analysis of convoluted statistical indicators and basic features as NIS pillars.

When implementing the proposed logical scheme, it is advisable to use the criteria of informativeness, which is based on the following quality of representation: the percentage of the total variation, which is explained by the first main component, should be greater than 55-60%. Otherwise, it is necessary to determine the minimum number of main components for which the accumulated percentage of the explanation variation will be more than 55-60%.

Reducing statistical indicators

To form the reduced set of statistical indicators, author is using econometric approach, described by Aivazian (2016, pp. 45-95). This includes:

1) Analysis of multicollinearity of partial criteria of a priori set of indicators. This encompasses analysis of the matrix of values of the pair coefficients of correlation, which helps to explain the degree of tightness of pair-wise statistical relationships between partial quality criteria of analysed NIS pillars. Further on, analysis includes the determination coefficients R2 of each of the partial criteria of the analyzed a priori set for all other indicators of this set.

2) The selection of the most informative particular criteria among the indicators of a priory set for the NIS pillars. With a pre-defined list of in-put statistical indicators $x^{(q.1)}(t),\ldots,x^{(q.p_q)}(t)$, that determine the quality characteristics of NIS pillar q in time t, we have to select relatively few indicators for the further analysis $p < p_q$. New indicators have to characterize the quality of NIS pillar directly. Moreover, on their basis, we have

to be able to restore parameters excluded from the list, using suitable regression models. Therefore the formula for our statistical indicators: $x^{(q.j_1^0)},\ldots,x^{(q.j_p^0)}$ can be defined as follows:

$$\sum_{j=1}^{p_q} R^2\left(x^{(q.j)};\left(x^{(q.j_1^0)},\ldots,x^{(q.j_p^0)}\right)\right)=\max_{j_1,\ldots,j_p}\sum_{j=1}^{p_q} R^2\left(x^{(q.j)};\left(x^{(q.j_1)},\ldots,x^{(q.j_p)}\right)\right), \quad (1.12)$$

where $R^2\left(y;\left(x^{(1)},\ldots,x^{(p)}\right)\right)$ – coefficient of determination of variable y for explanatory variables $x^{(1)},\ldots,x^{(p)}$ в in the context of certain q NIS pillar. With such a reduction of statistical indicators predictive power of regression models increases. The formula is modified version of the formula proposed by Aivazian (2016, p.63). The set of particular criteria p is based on requirements for the minimum acceptable value $R^2_{\min}$ of the coefficient of determination $R^2\left(x^{(q.j)};\left(x^{(q.j_1^0)},\ldots,x^{(q.j_p^0)}\right)\right)$ (Aivazian, 2016, p.95)

Measurement scale unification.

As analysed input parameters can have different dimensions, the procedure of their convolution requires unification of the measurement scale. Analysed indicators of the reduced sets $x^{(q.j_1^0)},\ldots,x^{(q.j_p^0)}$ must be measured on the scale $[0;N]$. Where 0 is the lowest quality and N is the highest quality of particular characteristic.

Unification conversion depends primarily on the type of indicator. One can distinguish the following types of indicators:

a) indicator-stimulator (stimulus) $x^{(q.j)}$ $(j=1,2,\ldots,p_1)$. Such indicator has a stimulating influence: the bigger the value of x, the higher is the evaluation of quality of NIS pillar. The value of unified variable $x^{q(j)}$ can be calculated with the following formula:

$$x^{q(j)}=\frac{x^{(q.j)}-x^{(j)}_{\min}}{x^{(j)}_{\max}-x^{(j)}_{\min}}\cdot N, \quad (1.13)$$

where $x^{(j)}_{\min}$ and $x^{(j)}_{\max}$ are the lowest (the worst) and the biggest (the best) value of the variable, respectively.

b) indicator-destimulator (regressor) $x^{(q.j)}$ $(j=1,2,\ldots,p_2)$: the bigger the value of x, the lower is the quality of studying phenomena. So, the indicator has a hampering effect

on the analysed characteristic of NIS pillar. In such case the value of unified variable $x^{q(j)}$ can be calculated with the following formula:

$$x^{q(j)} = \frac{x_{\max}^{(j)} - x^{(q.j)}}{x_{\max}^{(j)} - x_{\min}^{(j)}} \cdot N. \qquad (1.14)$$

c) indicator-nominant $x^{(q.j)}$ $(j = 1,2,\ldots, p_3)$, has a non-monotonic relationship with NIS pillars, and such indicator has an optimal (the most desirable) value $x_{opt}^{(j)}$ in the intermediate range between $x_{\min}^{(j)}$ and $x_{\max}^{(j)}$ values. In such case the value of unified variable $x^{q(j)}$ can be calculated with the following formula:

$$x^{q(j)} = \left(1 - \frac{\left|x^{(q.j)} - x_{opt}^{(j)}\right|}{\max\{(x_{\max}^{(j)} - x_{opt}^{(j)}), (x_{opt}^{(j)} - x_{\min}^{(j)})\}}\right) \cdot N. \qquad (1.15)$$

Identification of the $x_{opt}^{(j)}$ value depends on the specific situation. For example, if we have data on the governance efficiency, as one of the NIS pillars, we can define $x_{opt}^{(j)}$ as an average of three or five countries, which have the leading positions in the countries rank. Normalized in-put statistical indicators can now be convolved with formulas (1.10) - (1.11).

Modelling SIQNIS on the basis of principal component analysis.

To determinate the vectors of weights in formulas (1.10) - (1.11) we use the method, which relies on relative contribution of the analysed variables to the dispersion of the principal components. This approach allows us to form the set of scalar indicators of NIS quality. It includes the following steps:

1. On the basis of centred values ($x^{q(j)}(t) - \bar{x}^{q(j)}$) and unified input parameters ($q = 1,\ldots,5;\ j = 1,\ldots, p;\ t = 1,\ldots, T;\ \bar{x}^{q(j)}$- the average value of the index j) we define the elements of covariance matrix $\mathbf{\Sigma} = (\sigma_{jl})$ with the formula:

$$\sigma_{jl} = \frac{1}{T-p} \sum_{t=1}^{T} \left(x_t^{q(j)} - \bar{x}^{q(j)}\right)\left(x_t^{q(l)} - \bar{x}^{q(l)}\right); \qquad (1.16)$$

2. To identify k-value of λ_k in matrix $\mathbf{\Sigma}$, as well as relative contribution of d_k of λ_k in total dispersion, which equals 100%.

$$\left|\mathbf{\Sigma} - \lambda_k \mathbf{I}\right| = 0, \tag{1.17}$$

3. To solve a system of equations $(\mathbf{\Sigma} - \lambda_k \mathbf{I})\, u_k = 0$ and determine the squares of the component j $(u_{kj})^2$ of the vector $u_k = (u_{k1}, \ldots, u_{kp})$ in matrix $\mathbf{\Sigma}$ (i.e. the relative contributions of *j* variables to dispersion of *k* principal component $\left(\sum_{j=1}^{p} (u_{kj})^2 = 1\right)$;

4. To identify the unknown vector of weights $W = (w_1, \ldots, w_p)$

$$w_j = \sum_{k=1}^{p} d_k (u_{kj})^2, \tag{1.18}$$

for which $\sum_{j=1}^{p} w_j = 1$ is fulfilled;

5. To calculate the values of the synthetic indicators q, which characterize the quality of its q-pillar of NIS:

$$y^q(t) = w_1 x^{q(1)}(t) + w_2 x^{q(2)}(t) + \ldots + w_p x^{q(p)}(t), \tag{1.19}$$

Consequently, on the basis of the centred values of the synthetic quality indicators of the NIS pillars we can perform the further steps, finding the unknown vector of weights $V = (v_1, \ldots, v_5)$

$$v_q = \sum_{\alpha=1}^{5} d_\alpha (u_{\alpha q})^2, \tag{1.20}$$

for which $\sum_{q=1}^{5} v_q = 1$ is fulfilled. So it is also possible to calculate the integral characteristic of the quality of the whole NIS of Ukraine. However, this lays beyond scope of this study and requires further research.

$$Y(t) = v_1 y^{(1)}(t) + v_2 y^{(2)}(t) + \ldots + v_5 y^{(5)}(t), \tag{1.21}$$

The computation of presented methodology is implemented in STATISTICA package.

1.3.2. Qualitative analysis: data and methodology

Despite the fact that data for empirical analysis relates to the years 2000 to 2013, the research on economic transformations is very sensitive to the specifics of the current economic situation in Ukraine. Ukraine's economic fundamentals have worsened

significantly over past two years. This economic turmoil is accompanied by political instability, poor governance and widespread corruption, and the economic situation is exacerbated by Russia's aggression in the south-east of Ukraine. Therefore, the second part of the research takes these aspects into consideration in order to provide comprehensive results.

With the qualitative analysis author is aiming to understand the impact of institutional arrangements on innovation-based economic development on example of the most progressive sector. By choosing only one sector, we understand the limitations of such approach. However, we assume that in-depth knowledge of IT sector will help to project the further studies on other sectors. Therefore, it necessary to explore how did the IT sector develop? What were the institutional incentives and constraints? What are the linkages between the key-pillars in NIS of Ukraine, allowing such development? Or maybe IT sector developed not with the help of institutional arrangements, but rather in spite of it?

We focus on firm-level survey, as firms' capabilities and their linkages with science (scientific) systems, research bodies and supporting institutions are considered to be central for NIS development (OECD, 1995). Recent studies suggest that firm-level innovation survey approach is also one of the most relevant for measuring impact of various institutions on firms' development and performance (Carlin *et al*. 2010).

The form of in-depth interviews with the representatives of IT firms is chosen to collect detailed information, that cannot be found in other databases (see the questionnaire in Annex B). There are no statistical databases on IT development, except the reports, collected in 20015-2016 by the private company AVentures. Moreover, there are no surveys on the role of institutional arrangements for this sector. The form of in-depth interviews helps to explore the perspective of business on the institutional arrangements, allowing latitude to explore IT development within the framework of National innovation system.

Our analysis is based on 12 in-depth interviews with IT business representatives, which includes managerial staff of big companies, owners of small business, workers with experience at least 5 (desirable 10 years), and with experience working abroad. The

work experience of respondents was essential to understand the process of formation of IT sector in Ukraine, as well as the recent development trends.

Data collection is limited to firms' representatives from Lviv city and region. This can be explained by the fact that Lviv is best known as "IT-friendly city". In 2009 Lviv city council adopted Lviv economic competitiveness Strategy, declaring IT as one of the strategic industries, which lies in the center of the region's development. Lviv city council is also taking active part in Lviv IT cluster, which unites 34 companies, 5 Universities.

The in-depth interviews were recorded with Audacity software during on-line Skype conversations in May 2015 - January 2016. The interviewers gave their permission for recording under the condition of full anonymity. To preserve the anonymity of respondents, the interviews use only numbers (#1, #2 etc.). First, the interviews were transcribed. As respondents were speaking in both Ukrainian and Russian languages, we decided to transcribe and code in original language. The results of analysis, as well as selected fragments of interviews are translated into English. Then interviews were imported to the MAXQDA software. The principle of pre-defined coding was chosen. The unit of research is a phrase, sometimes the whole sentence, which helps to capture the main idea and code it accordingly.

Following the structure of the questionnaire, the code-tree contains the four basic parent-categories: business pillar, government pillar, research and education pillar and linkages between pillars (see the Code tree in Annex B).

First, we want to understand firms' activities, study the peculiarities of their involvement in the process of absorption, creation, and distribution of innovations. For us it is important to understand which business model IT companies prefer (product or outsourcing/outstaffing), as well as the geography of trade. As IT companies work globally and may outsource software development and testing, mobile applications development, graphical and web-design etc., our knowledge about Ukrainian IT products and services may be not accurate. While outsourcing companies do not possess the right to them, while also signing the agreement of non-disclosure of the country where outsourced products/services were created. For example, Ukrainian company Softserve (founded in Lviv in 1993) is working in the field of cloud technologies, security,

BigData, internet of things, with such counterparts as General Electric, Panasonic, BMC Software, Unilever, AB InBev, Nestle, Cisco, IBM, Logitech. ELEKS (founded in 1991 in Lviv) works in Finance and analysis, mobile and digital technology together with Microsoft, IBM, and NVIDIA.

However, if outsourcing usually stays not recognized as Ukrainian product, Ukrainian start-ups are showing increasing activity, appearing on the international markets, like Readdle (application for document reading, scanning, formatting, and printing on iPhones and iPads); Grammarly (writing app, which is checking on-line grammatical, spelling, and punctuation mistakes); Deposit Photos (service which provides royalty-free stock photos, vector images, as well as videos); PetCube (interactive camera, which allows you to watch, talk and play with your pets on a distance, using a smartphone), Branto (security device, equipped with 360 degree camera, sensors and microphone); and many other startups like Augmented Pixels, MacPaw, Viewdle, Ecoisme, iBlazr. Originally from Ukraine, these startups with headquarters in the EU or US successfully raise rounds of investment and scale up. In 2015 one of the biggest start-up discovery of the year was Looksery mobile application. Looksery is using face-mapping technology to turn photos into 3D animated avatar. It has been valued and acquired by Snapchat for $150 million.

Unlike other sectors, IT business is very flexible: it can be based in Ukraine and operate on Ukrainian market; it can be legally registered abroad, but operate from Ukraine, using the Ukrainian manpower; but it can also be based in Ukraine and see in other markets. The most beneficial for the innovation-driven economic development of Ukraine is the scenario, in which IT firms are based in Ukraine (they pay taxes here), use Ukrainian manpower (they contribute to the human development), they invest in firm's R&D, create innovative products/services for both Ukrainian and international markets. From the perspective of this thesis, it is crucially important to understand whether innovative products or services from IT sector are forwarded towards Ukrainian market and if not, what reasons stand behind it. To understand these peculiarities, we interview the respondents studying the structure of their firms, as well as motivation and reason that are standing behind the selection of the market.

Second, as institutional setup influence firms' level of innovative activity we try to understand the influence of Government pillar and Research and Education pillar, as well as interlinks between the key-pillars:

- For the Government pillar, we try to understand the influence of WGI indicators on IT development and functioning, namely voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, control of corruption. However, for the respondents it was difficult to grasp the difference between indicators and interpret their influence. To simplify the questionnaire, interviewers were asked to elaborate on bad governance and good governance, as well as necessary steps the government has to provide the IT development.
- Research and Education pillar refers to the role of both formal and informal education in providing students with necessary skills and knowledge; firms investment in R&D; motivation of the graduates to develop their career in IT sector, and human capital development.

However, the crucial for our analysis of the innovation-driven development within the framework of the National Innovation System, it is crucial to understand the linkages between the pillars: business to business, business to research & education and business to government. This is the most essential part of the interview, as it provides us with unique information, which cannot be found elsewhere.

Thus, mixed methods research, in particular explanatory sequential design, is applied in this research to organize in-depth, comprehensive analysis of Ukrainian NIS and answer the following question: how the pillars of the Ukrainian NIS and their interactions in the dynamic perspective influence the innovative development of Ukraine in general, and IT sector in particular. In the following Chapter we will decompose the NIS of Ukraine to study its pillars and apply mixed method research to answer the research question.

Conclusions Chapter 1

The first Chapter opens with the definition of innovation, its complex nature: gradual and cumulative. The term captures both the invention itself and the process of its diffusion and exploitation. Thus, studies on innovation span different disciplines. For the purpose of the thesis, author combines economic together with sociological approach, aiming to incorporate institutional analysis in the economic analysis and explain the role of institutional arrangements as determinant of the innovation-driven economic development.

Author analyses economic growth theories and models, with a particular attention to exogenous and endogenous growth models, showing that they continue relying on the neoclassical economics, while failing to encompass the role of institutions and evolutionary perspective of technological change. They also neglect wider set of factors, lying beyond the classical research. As a result, known economic growth models largely oversimplify the phenomena of innovation development.

With numerous examples, author re-states that institutions determinate the economic growth and shows direct link between innovative development, economic growth and institutional arrangements. At the same time, author draws attention to the limitations on the empirical analysis of institutions' impact. Empirical estimates are focusing only on formal institutions, primarily political, which is narrowing range of analysed issues. Moreover, these estimates may also be biased as they usually ignore other factors that simultaneously affect innovative outcomes.

Moving from linear to more complex models, author presents concept of the National Innovation System, which helps to incorporate institutions and innovation. Unlike the previous models representing a static snapshot of technology performance, neglecting the fact that innovation development and technological change does not occur in a perfectly linear sequence, NIS focuses not only of the pillars/actors, but also on the linkages and interaction between them to explain the translation of inputs into innovative outputs. Linkages within NIS, both formal and informal, play important role, serving as the channels of communication, contributing to the diffusion of innovations. NIS concept gives a great versatility in measuring country's innovation development. Through the

thesis concept is analysed in the broad understanding, however, author pays a particular attention to the peculiarities of NIS in developing countries, which demonstrate less success in technological catching-up. Thus, stressing on the countries absorptive capacity and path dependency as important factors.

Further on, author demonstrates that research on Ukrainian NIS has been mostly restricted to analysis of the government pillar and its role in introducing legislation and/or providing financial support for the innovation development. Although some research has been carried out on the linkages between other NIS pillars and actors there is very little scientific understanding of their importance in Ukrainian system. Moreover, there is a general lack of research in diffusion of innovation, and absorptive capacity of the firms and national economy, as a whole. At the same time little if no attention is given to such factors as entrepreneurship culture, tacit knowledge. This indicates a need for a comprehensive analysis on the role of institutional arrangements, with a particular focus on informal institutional arrangements. Author also highlights the gaps pitfalls, hampering the NIS analysis, while providing the comparison of the Concept of Ukrainian NIS with the international OED model.

For the purpose of breadth and depth understanding of institutional challenges in Ukraine, author applies mixed methods research, in particular explanatory sequential design. To answer the research question, author organizes the study in the following way:

1. Conceptualisation of institutional arrangements, identification of the pillars of Ukraine's NIS and analysis of their interaction.

2. Data collection and quantitative estimations using STATISTICA 6.0 package: a) modelling synthetic indicators of the quality of Ukrainian NIS pillars; b) measuring impact of governance pillar on the business pillar and pillar of research and education c) Impact of pillars quality of the GDP growth.

3. In-depth interviews with representatives of the most successful innovation sector, the results of which support or contradict the hypothesis based on quantitative estimations.

CHAPTER 2. NATIONAL INNOVATION SYSTEM OF UKRAINE: INSTITUTIONAL INCENTIVES AND CONSTRAINTS

1. Economic transformation and path-dependence: national patterns

During the Soviet era, Ukraine demonstrated high industrial capacity, accommodating nearly 20% of all experimental equipment and 15% of R&D potential of the USSR. Numerous research institutes, design bureaus, engineering departments of enterprises were playing important role in developing a solid R&D sector. Ukraine had leading position in transport aviation, electric welding, software development etc. At the same time, the bulk of S&T potential was concentrated in military-oriented industries (Yegorov, 2005).

In comparison with other countries, the innovation system of the USSR demonstrated sufficient differences. Let us consider Japan NIS to compare country's approaches to innovate (see Table 4). While in the USSR the gross domestic expenditure on R&D was very high, less that 10% was financed by firms. The main explanation is that in a centrally-planned system, there was a lack of incentives for the management and the workforce to innovate. The crucial difference can be seen at the level of institutional linkages: strong integration of R&D, production and import technology at the enterprise level in Japan versus separation of those processes in the USSR. In the same vein, strong network linkages in Japan juxtaposing weak or non-existent linkages between marketing, production and procurement in the USSR.

Central-planning system in the USSR imposed the control of all R&D results and was not considering intellectual property rights protection and further commercialization. Soviet innovation system was a subject of critique due to inefficiency in producing innovations (Weiss, 1993). This confirmed by numerous research of Yegorov, 1995, 2009, Yegorov and Carayannis, 1999 on registered patents, number of scientific publications and structure of exported products in the USSR.

After the collapse of the USSR, Ukraine faced sharp economic decline. During the first years of independence the GDP has shrunk over 60 %, which was followed by reduction of R&D financing and outflow of research personnel. While undergoing the

process of market transformation, Ukraine failed to secure hi-tech industries (some industries, like electronics, disappeared). As domestic demand for innovation fell, national economy became dominated by mining, energy and ferrous metallurgy sectors (INNO-Policy TrendChart, 2007). Thus, Ukraine became oriented at the production of simple and low value added goods, while developing strategy to import and adapt innovation from abroad, rather than introducing domestic ones.

Table 4.
Contrasting national systems of innovation: Japan and the USSR in the 1970s

Japan	**USSR**
High gross domestic expenditure on R&D (GERD)/GNP ratio (2.5%)	Very high GERD/GNP ration (c 4%)
Very low proportion of military or space R&D (<2% of R&D)	Extremely high proportion of military or space R&D (>70% of R&D)
High proportion of total R&D at enterprise level and company financed (approx. 67%)	Low proportion of total R&D at enterprise level and company financed (<10%)
Strong integration of R&D, production and import technology at enterprise level	Separation of R&D, production and import of technology and weak institutional linkages
Strong user-producer and subcontractor network linkages	Weak or non-existent linkages between marketing, production and procurement
Strong incentives to innovate at enterprise level involving management and workforce	Some incentives to innovate made increasingly strong in 1960s and 1970s but offset by other negative disincentives affecting management and workforce
Intensive experience of competition in international markets	Relatively weak exposure to international competition except in arms race

Source: Freeman 1995, p.12
Note: Gross domestic expenditures on research and development (GERD) are all moneys expended on R&D performed within the country in a given year.

Even though Ukraine managed to stabilize the macroeconomic situation in 2000s by introducing the new currency, privatization program, as well as important liberalization measures, it failed to integrate reforms of R&D sector, innovation and economic growth policy in the general economic transformation. Country's S&T potential was declining, keeping Ukraine technologically dependent.

Ukraine's economic growth in 2000s, averaging at 7,5% (Aslund, 2015), was caused by extensive resource-based export and aided by high commodity prices on the

international markets. However, commodity boom has finished and the global financial crisis in 2008 has exposed the results of Ukraine's reluctance to engage in reforms. These days Ukraine is experiencing deep economic downturn, struggling with the consequences of the global economic crisis (Toporowski, 2014). Its GDP per capita in 2013 was estimated at $ 3900. In 2008 it was estimated as $ 3891, which means that economic output barely moved over the past 5 years (World Bank). This is poor track record compared with other CIS countries. For example, Belarus improved the GDP per capita from $ 6377 in 2008 to $ 7575 in 2013 (see Fig. 6). As the economic situation was further deteriorated with the Annexation of Crimea and war with Russian Federation in the East of Ukraine, the GDP continued decreasing. In 2014 was estimated at $ 3082 per capita.

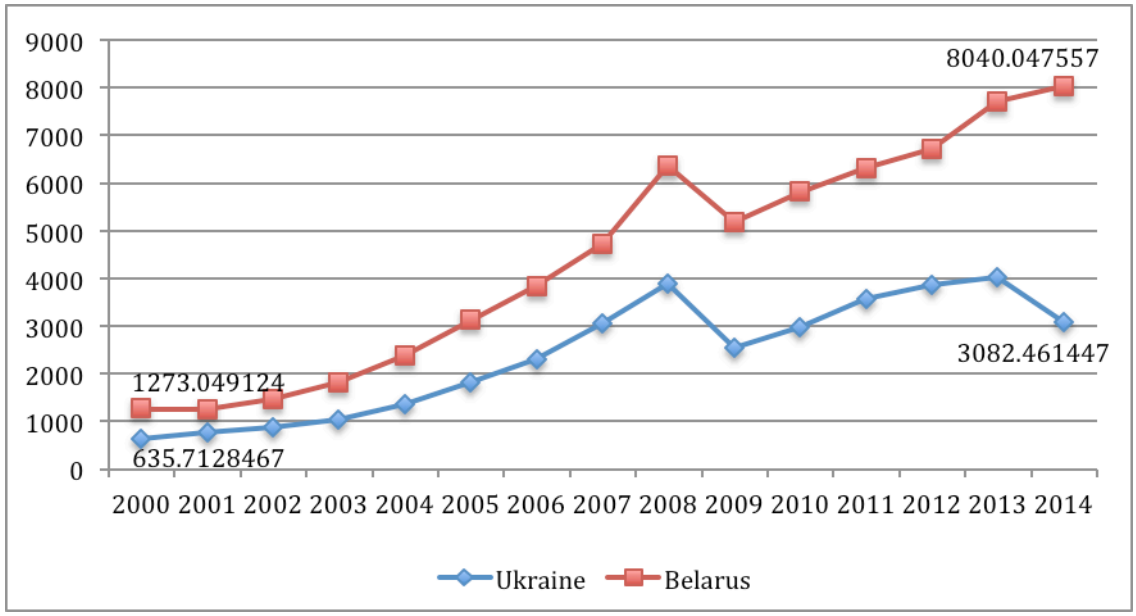

Figure 6. GDP per capita growth in Ukraine and Belarus, 2000-2013
Source: composed by the author, based on the World Bank data

Over the last years the stock of foreign direct investments (FDI, net inflows) in Ukraine has shrunk drastically: from $ 8.2 billion in 2012 to $ 4.5 billion in 2013. The overall negative trend continued in 2014, estimating FDI net inflows as $ 847 million (for example, in neighbouring Poland the FDI net inflows are estimated as $ 17.3 billion in 2014) (World Bank). Moreover, the potential effect of FDI on improving of Ukraine's total factor productivity growth and industrial modernization is limited as the origins of these investments are rather questionable. Almost 32% are coming from Cyprus, 4,3%

from British Virgin Islands, which are well known as tax heavens. Meanwhile real foreign investments are rather modest.

Besides, Ukraine Foreign Exchange Reserves have decreased to a dangerous level: from $ 20.4 billion in January 2014 to $ 14225,8 million in May 2014 (Trading Economics). Ukraine is also unable to maintain the stability of its national currency. The National Bank of Ukraine continues devaluating the official rate of hryvnia from 7, 99 to 22 UAH per dollar. Ukraine's credit ratings were downgraded, indicating that economy of Ukraine is very vulnerable. As of 2014 State was close to default and the creditors had very little prospects of recovery. Ukraine's government debt was rated Caa3 by Moody's, CCC by Standard&Poor's and Fitch.

The economic turmoil reflects poor governance, political instability and widespread fraud and corruption in Ukraine. Economic situation is exacerbated by the war in the East of Ukraine and annexation of Crimea in 2014. In such circumstances, country's capacity to innovate is limited. Let us take a closer look at the international indexes, in particular Global Competitiveness Index and Global Innovation index, which will help to compare Ukrainian innovativeness on the international level.

Global Competitiveness Index

According to World Economic Forum, Ukraine ranked 73rd out of 144 countries in the Global Competitiveness Index in 2013-2014. In the following edition (2014-2015) it finished 76th and later on it dropped to the 85th place out of 138 countries[4] in 2015-2016 (Global Competitiveness Index, 2013-2014, 2014-2015, 2015-2016).

Despite its the large domestic market and solid education system, Ukraine's competitiveness on the international arena is low. The pillar of Innovation and Business sophistication demonstrate the poorest performance.

For the innovation pillar, the crucial factors are low company spending on R&D, weak university-industry collaboration in R&D and very small government procurement of advanced technological products. The technological readiness of Ukrainian economy

[4] GCI provides comparison of 138 countries (144 countries before 2014-2015 edition) and relies on the following pillars: institutions; infrastructure; macroeconomic environment; health and primarily education; higher education and training; goods market efficiency; labour market efficiency; financial market development; technological readiness; market size; business sophistication; innovation

is hampered by low firm-level technology absorption as well as moderate technology transfer.

The indicator "nature of competitive advantage" for Ukrainian economy has one of the lowest scores, which means that domestic goods and services are not competitive on the international markets. Without innovation-driven economic development and structural shift, we can hardly expect overall improvement, as currently Ukraine's economy is characterized by cheap labour force and low level of added value in goods and services. Its main internationally traded goods are raw materials and heavy industry output.

At the same time, the most problematic factors for doing business in Ukraine remain corruption and policy instability, clearly suggesting that Ukraine's institutional framework needs an overhaul.

Global Innovation Index

The preliminary analysis of the key-factors of Ukraine's performance may be also organized using Global Innovation Index (GII)[5]. According to GII, Ukrainian economy was ranked 71st out of 142 countries in 2013 and it subsequently moved to 63th, 64th place and then 56th place in 2016 (Global Innovation Index, 2013, 2015, 2015, 2016). These recent improvement is explained largely with a high number of utility model and patent applications by origin and total computer software spending and ICT services export.

GII also helps to identify weak and strong sides of Ukrainian economy. A closer examination of in-put sub-indices demonstrates Ukraine success within the pillar of human capital and research (44th place), in particular, due to education (expenditures on education as % GNI) and tertiary education (tertiary enrolment and graduates in science and engineering). Another output sub-index indicates that Ukraine has strong position in knowledge and technology outputs due to knowledge creation (domestic residents utility

[5] GII relies on Input and Output sub-indices that help to estimate the activity among 143 countries. The following pillars, enabling the innovation activity are, represent Input sub-index: institutions; human capital and research; infrastructure; market sophistication; and business sophistication. The output sub-pillar captures knowledge and technology outputs and creative outputs pillars.

model ap/bn PPP$ GDP) and knowledge impact (growth rate of PPP$ GDP/worker, %) as well as creative outputs (domestic residents trademark reg/bn PPP$ GDP).

At the same time, institutional sub-index shows one of the worst results: negative tendencies can be observed for political, regulatory and business environment. In particular, innovation development is hampered by extremely low level of government effectiveness, regulatory quality, rule of law and difficulties with paying taxes and resolving insolvency in Ukraine. Moreover, market development pillar indicates low level of investors' protection and local competition. Meanwhile, poor ecological sustainability and low gross capital formation are holding the infrastructure development.

To study the National innovation system of Ukraine we proceed with technique of system analysis, described in the methodology section. Firstly, we decompose NIS, and secondly we study key pillars, namely government, research & education and business pillars.

2.2. Pillars of Ukrainian NIS: current state and development trends

2.2.1. Government pillar

Government regulation plays a leading role in Ukrainian NIS. At the same time, this pillar is characterized by very unfavourable framework conditions, in particular political and regulatory environment i.e. political stability; government effectiveness; regulatory quality; rule of law (Global Innovation Index, 2014). Ukraine does not meet the transparent standard of government policymaking as well as the efficiency of its legal framework in settling disputes and challenging regulations, which help to strengthen the framework for innovative development (see Table 5). Moreover, the business climate is seriously jeopardised by the complexity of insolvency laws and tax paying system.

Different ministries, state agencies and advisory bodies are involved in NIS governance, however their roles, responsibilities are unclear and often overlap with each other. Thus, innovation policy on Ukraine remains fragmented and far from coherent. The pillar itself is the subject of permanent change, especially at the highest executive level.

Table 5.
Institutions sub-index, Global innovation index

Global Innovation Index, Institutions sub-index for Ukraine		
Indicator		Rank (out of 143)
Political environment	Political stability	77
	Government effectiveness	109
	Press freedom	103
Regulatory environment	Regulatory quality	115
	Rule of law	112
	Cost of redundancy dismissal, salary weeks	56
Business environment	Ease of starting business	62
	Ease of resolving insolvency	136

Source: composed by the author, based on Global Innovation Index, Ukraine profile 2014

For example, in 2005 the National Council for Investments and Innovations as an advisory body under the President of Ukraine was created. In 2006 it was changed to the National Council for Innovations. In February 2010, the Council amended it to the National Council for Science, Innovation and Sustainable Development of Ukraine. And in April 2015 this Council was completely liquidated. The State Agency of Ukraine for Investments and Innovations, as a subsidiary body to the President of Ukraine, was first changed to the State Agency of Ukraine for Investment and Development, and later on reorganized into State Agency for Investment and National Projects. This agency was liquidated in 2015. The government also reorganized the State Agency on Science, Innovation and Informatisation to the State Service for Electronic governance.

In comparison with other CIS countries, Ukraine managed to form relatively fast the regulatory framework for the innovation-based economic development. Already in 1991 the Law of Ukraine "On the basis of state policy in the sphere of science and scientific-technical policy" it was proclaimed that scientific and technological progress are the key factors in the development of society and declared that "the state provides priority support for science as the defining source of economic growth ". In later editions this declaration was reaffirmed by the Law of Ukraine "On scientific and technical

activity" (1998). Further implementation of the objectives and development of innovation-based economic development model were specified by resolution of the Verkhovna Rada of Ukraine from 13.07.1999 p. No 916-XIV, by approving the Concept of scientific, technological and innovation development of Ukraine.

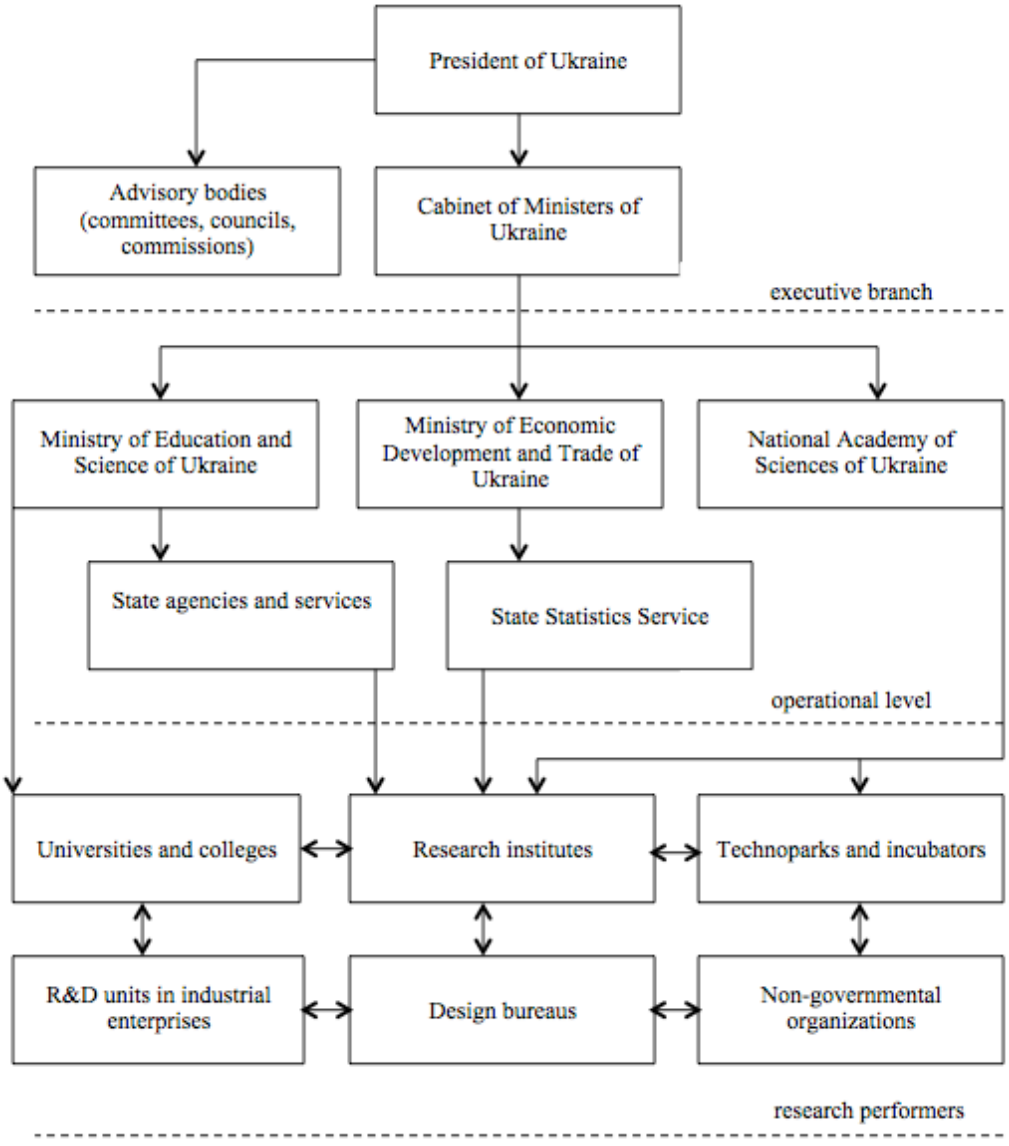

Figure 7. Structure of Ukrainian research system
Source: ERAWATCH Country Report Ukraine, 2011

In our research a number of laws and regulations, as well as policy documents are analysed to study the role of government in providing political and regulatory framework for the innovative development. Among them: Concept of National Innovation System Development in Ukraine, 2009; State Law on Priorities in Science and Technology

Development, 2010; State Programme on Forecasting of S&T Development in Ukraine for 2008-2012; National Strategy for Social and Economic Development of Ukraine for 2004- 2015 (see Table 6 for the list of existing laws and regulations). However, we can argue that they were not implemented according to the initial plans.

Table 6
Laws and regulations on S&T and innovations in Ukraine

Law/regulation	Adopted	Last amendment
Law on science and scientific and technological activities	1991	2011
Law on the public forecasting and development of the economic and social development programmes of Ukraine	2000	
Law on priorities of science and technology development	2001	2010
Law on science and scientific and technological examination	1995	2006
Law on science and technological information	1993	2011
Law on the legal specifics of the functioning on the national academy of sciences of Ukraine, field academies of sciences and their property complex	2002	2010
Law on innovation	2002	2011
Law on scientific parks	2009	2010
Law on national programme of information	1998	2010
Law on state regulation of actions in the technology transfer field	2006	2013
Law on priorities in innovation activities in Ukraine (defines innovation priorities)	2011	
Internal documents regulating S&T activities introduced by central executive authorities that are responsible for S&T		2013
Resolution on the approval of the list of priority thematic directions of scientific research and science and technology designs for the period up to 2015	2011	
Ukraine president's plan for realising the economic and social development programme "wealthy society, competitive economy and effective state"	2010	
Concept on S&T reforms	2012	

Source: Yegorov, I., & Ranga, M. (2014), p.24

Despite the numerical base of legal documents, the actual state of innovation development remains below Ukraine's potential. Instead, researchers are concerned whether in fact the scientific and technological development of the country was and is a real priority for many governments of Ukraine (Yegorov, 2009). The vague wording of policy priorities, lack of mechanisms for their implementation and the lack of clearly defined responsibilities for the execution are combined with the state of the constant change. For example, only during the 1992-2009 Parliament has adopted about 85 laws related to innovation activities.

Moreover, there is a lack of strategy how to organize the innovative development, as government has not approved the National Strategy for the innovative development of Ukraine for 2010-2020. Therefore, it is difficult to understand how the prioritization and coordination of policy at various levels can take part, as well as further process of consultation with research organizations, universities, and other stakeholders.

Thus, national innovation policy making is far from coherent. Without a proper system of monitoring and control, it is extremely difficult to target national priorities of innovative development, as well as expenditures on them. Consistency of strategy of innovative development of the state, with short- and long-term priorities must be accompanied by appropriate funding. Otherwise, ways and means of achieving the objectives, including financing remain uncertain. Meanwhile the level of financial support of the R&D sector is extremely low. Despite the fact that R&D expenditure has been growing in absolute numbers, its share in the GDP has been constantly decreasing: gross domestic expenditure on R&D in 2013 represented only 0,77% of GDP, with the share of the public sector estimated at 0,33 %.

Financial support

Let us consider the role and place of the government in the provision of financial support for innovation. There are direct and indirect mechanisms of supporting innovation policy:

1. Direct government funding – direct transfer of public support in the form of public grants can have (a) horizontal strategy, which has no thematic priorities and covers broader issues (for example, the scientific quality of academic research) and (b) vertical strategy, focusing on certain thematic priorities (biotechnology, communications, etc).

2. Indirect government support is aimed at creating incentives for the private sector participation in investment research and innovation projects, such as R&D tax credits. According to the principles of liberal market economy, most developed economies prefer indirect state intervention, which means that the main goal of the government is to establishing legal and tax environment that would facilitate the involvement of the private sector and the effective functioning of markets.

There are also catalytic financial policy measures, structural R&D policy measures, R&D and innovation linkage policies, which can be used as mechanisms of innovation policy. Catalytic financial policy is aimed at providing better access to private sector financial sources. This may include risk capital measures; loan and equity guarantee measures. Structural R&D policy measures seek to provide a research infrastructure and knowledge pools, while R&D and innovation linkage policies focus on knowledge transfer in public and private domains (Hofer, R., Dinges, M. (2008). Moreover, public procurement, as a demand-based innovation policy instruments, can be used to support innovation development.

Direct government funding dominates in Ukraine. It is driven by the annual budget cycles, however financing of both generic and thematic policies is insufficient. In general, there is a negative dynamic in support of science, technology and innovation. According to the State Statistics Service, the financing of innovation activity in Ukraine has been gradually growing from 2000 to 2007 and reached 11.9942 billion UAH in 2008. Funding for the next 2 years was declining, while in 2011 it has grown again and reached 14.3339 billion UAH. Such fluctuations may be partly explained by the global financial crisis of 2008-2009 and the political instability within the country. Even though financing of the innovation activity is continue growing in absolute terms, its share in GDP is less than 1%.

In 2013 Gross domestic expenditures on R&D as a share of GDP (GERD) was 0,76%, and in 2015 it accounted 0,62% (see Fig. 8). Even though R&D investment in relative terms does not exceed 1% in some EU member states that have recently joined, it is important to take into account real R&D investments. For example, in 2012 R&D investment in Poland was 0.9% of GDP, while in Ukraine - 0,75%. However, taking into account the difference in GDP, expenditure in Poland amounted to nearly US $ 4.5 billion, and in Ukraine 3.4 times less - US $ 1.3 billion.

The evaluation of these parameters indicates the tendency of technological lag of Ukraine, compared with economically developed countries in general and the EU in particular. For example, in 2012, according to Eurostat, the average GERD in EU-28 was 2.01%. It should be noted that this indicator has positive dynamics, given the fact that

one of the main objectives of the EU Strategy "Europe 2020" is to achieve GERD at the level of 3% in 2020.

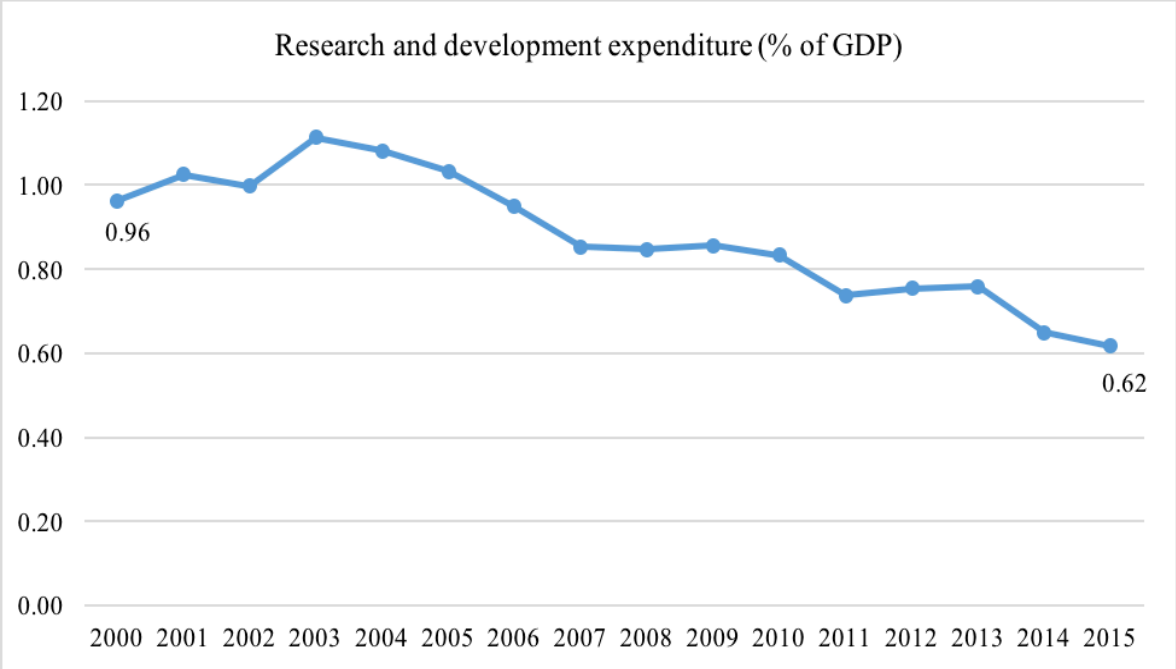

Figure 8. R&D expenditure as % of GDP, 2000 - 2015
Source: composed by the author, based on statistics from the UNESCO Institute for Statistics

Taking into account limited financial resources of the state budget, a priority should be given to the mechanisms of indirect government support. However, indirect government support measures and alternative catalytic mechanisms are underdeveloped in Ukraine. Policies targeting the development of technology platforms, cluster and science parks are one of the weakest aspects of innovation development.

Analysis of NIS business pillar reaffirms the critical lack of economic incentives for innovation development. In particular, this applies not only to the costs of research, but the costs associated with the introduction of industry R&D results and innovative projects.

Thus, in author's opinion financial support for R&D, high-risk innovative projects should be carried out not only with the support of the public sector but also with active participation of private sector and international programs of technology transfer. It is important to create necessary conditions for venture capital and private business angels for the innovation funding. Moreover, there is a growing need of international cooperation, which include but is not limited to programs promoting internationalization

of enterprises, their participation in international business networks. Establishing business contacts, exchange of experience may largely contribute to the development of innovation culture in Ukraine.

2.2.2. Research and education pillar

High level of human capital and research development largely explain Ukraine's capacity for innovation. In particular Ukraine has a relatively high level of expenditure on education (as a share of GDP) and government expenditure per pupil (as a share of GDP per capita). Tertiary education is also well developed, especially in terms of tertiary enrolment and share of graduates in science and engineering.

However, the number of R&D organizations, as well as number of researchers in Ukraine, follow a negative trend. According to the State Statistics Service of Ukraine, the number of R&D organizations fell from 1490 in 2000 to 1143 in 2013. Meanwhile, the amount of researchers decreased by 65%: from 120773 to 77853 (see Fig. 9).

According to international scientometric databases, Ukrainian scientists and research teams demonstrate low performance. With SJR indicator (SCImago Journal & Country Rank) which is developed on the basis of the information available in the Scopus® database (Elsevier BV) we can analyse the current state of scientific system of Ukraine in international comparison. Despite the positive trend in the number of scientific publications, Ukraine remains far behind the EU and Eastern European countries, especially in terms of citable documents and H-index. In the world ranking Ukraine has moved from 26th place in 1996 to 45th in 2013. Academic ranking of world universities (ARWU) does not include any Ukrainian university among the Top 500 universities. Besides, Ukrainian universities are rather isolated from the international cooperation. There are very little foreign publications, joint international projects, joint MA or PhD programmes.

Universities in Ukraine mainly play the educational role, while only a half of them (176 out of over 350) conduct research (Yegorov and Ranga, 2014). The curriculum of universities is detached from the market needs. At the same time big companies do not practice to have their campuses in the Ukrainian universities. The lack of cooperation

between business and universities is one of the reasons why universities are not successful in preparing students for the labour market. Thus, despite the high level of human capital in Ukraine there is a large gap between education and business. According to recent research of the World Economic Forum, business perception of mathematical and science technical education scored 4.76 out of 7. In the same survey the ability of business to attract talent - 2.28 points, and the ability of businesses to retain talent is only 2.29 points.

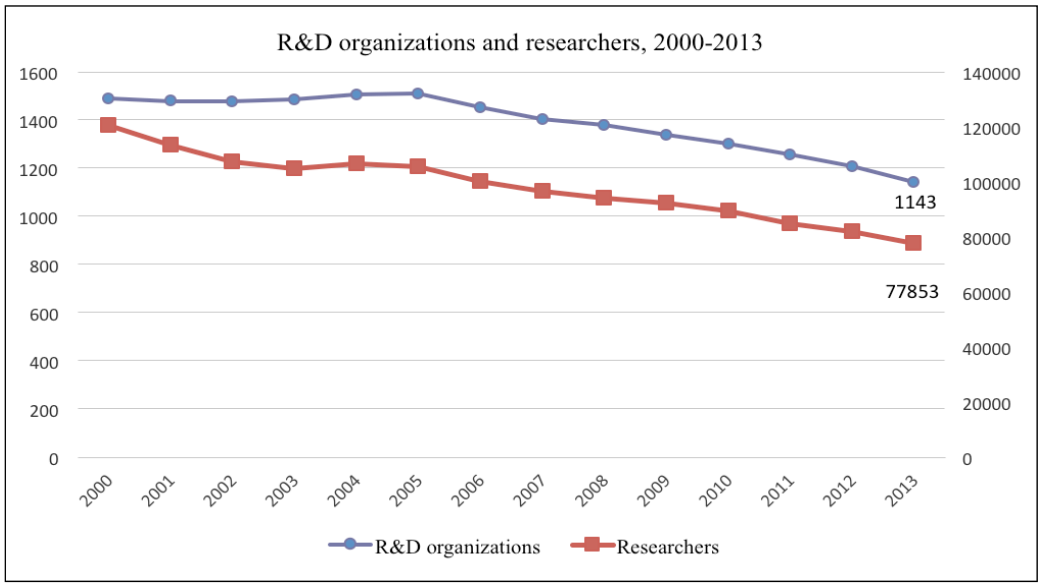

Figure 9. R&D organizations and researchers, 2000 - 2013
Source: composed by the author, based on statistics from the of State Statistics Service of Ukraine, Science and innovations, Research and development activity.

Ukraine faces a problem of failure to use human capital, as there is no long-term strategy for the development of scientific and creative potential. This applies particularly to young professionals. One of the negative consequences of the reduction of scientific institutions and public spending cuts, is that young professionals experience fierce competition in the market of higher education and research. There is an increasing evidence of "brain drain", which is mainly due to the outflow of young professionals abroad.

University-industry collaboration in R&D is low, ranked 75th out of 142 in the GII (2014) as many universities miss the possibility to cooperate with industries largely because of their non-profit organizational status. At the same time industries lack motivation of developing clusters, science parks and business incubators, which are

bringing together academia, research and business. The state of the cluster development in Ukraine ranked 126th out of 142 according to GII (2014).

2.2.3. Business pillar

Ukraine does not create favourable conditions for innovative large companies and SMEs. The direct financial support is insufficient, while conditions enabling access to loans and venture capital for business are very poor.

Relatively small amount of companies in Ukraine has R&D capability. Large resource-oriented companies, operating in such industries as coal mining, metallurgy or agriculture, stay in the hands of oligarchs, a result of the drawbacks of early privatisation in the beginning of 1990s. These companies were subsidised by the government and had resources to spend on R&D. However, for years, they were not investing in the development of technology capability. Instead, their goal was to increase the production of raw materials and/or products with little-added value. In the short run, it paid off, as these companies were generating profit due to extensive resource-based export and high commodity prices on the international markets. However, in the long-term perspective, implementing short-term strategy for the profit growth caused their technological backwardness. The necessity of development of indigenous technology capability was overlooked.

At the same time, the lack of coherent industrial policy also caused the misuse of FDI, which were not contributing to the growth of economic efficiency in the country (Demchuk, Zelenyuk, 2009). SMEs in Ukraine mainly have a trading background, which explains their expectations of a quick return of investment, rather than long-term investments in R&D.

The innovation activity of enterprises remains very low. In 2013 only 16.8% of enterprises were involved in complex scientific, technological, organizational, financial and marketing activities aimed at creation of innovations. The share of enterprises implementing innovation was even lower: 13,6%. This has a direct impact on the volume of innovative products. Thus, in 2013 the share of sales of innovative products in industrial output was only 3.3% (State Statistics Service of Ukraine, 2013).

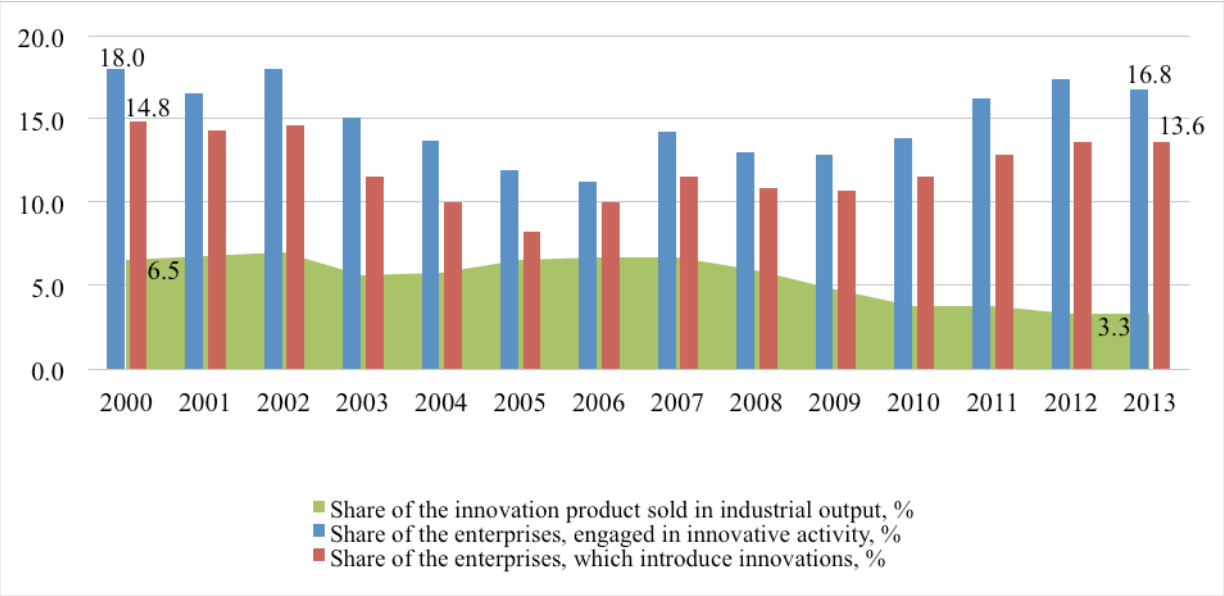

Figure 10. Innovative activity of enterprises in Ukraine, 2000-2013
Source: composed by the author, based on statistics from the State Statistics Service of Ukraine, Science and innovations, Research and development activity.

Moreover, the majority of innovative production represents the third and fourth generation of innovations, such as light, wood, pulp and paper industry and production of building materials, steel and metal. At the same time, the output of the innovations of the fifth generation is only 3.9%, and production of the sixth generation is almost absent - 0.1%.

The biggest traction of innovative enterprises operates in manufacturing (20,3%), electricity, gas, steam and conditioned air supply (18.6%), as well as information and telecommunications (16.3%). The study of non-innovative enterprises, held by State Statistics Service of Ukraine, unveil the reasons of non-innovative enterprises. A very significant percentage of non-innovative enterprises (82,2 %) consider that there are no compelling reasons to implement innovations, while only 17,8% recognise certain factors that are hampering the process of innovation implementation (see Table 7). Thus, motives of the businesses in Ukraine are not driven by the growing competition and technological improvement.

In 2015 Ukrainian high-technology exports [6] accounted only for 7,3% of manufactured exports. Despite a positive trend of growth since 2008, this is a moderate

[6] High-technology exports – exports of products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery (World Bank).

improvement, as in 2003 the same indicator was at 6,9 %. Analysis of international cooperation of Ukrainian enterprises with technological innovation shows low level. During 2008-2010 the percent of cooperation with companies from the EU amounted to 6.8%; US companies - 0.9%, from China and India – about 1%. Positive dynamics were observed in 2010-2012: Ukrainian enterprises cooperated with 7.1% companies from the EU, 2.4% from the USA; 2,1% - from China and India. The main economic activities performed in international cooperation with enterprises in Europe were: manufacturing; transportation, storage, postal and courier activities; architecture and engineering, technical testing and research.

Table 7.
Non-innovative enterprises: reasons for not implementing innovation in 2012-2014, %

There are no compelling reasons to implement innovations	**82,2**
including	
Low demand for innovations on the market	6,0
Recent innovations on the market	3,9
Weak competition on the market	3,0
The lack of good ideas or opportunities for innovations	7,4
There are important factors, hampering the process of innovation implementation	**17,8**
including	
Lack of funds within the enterprise	11,4
Lack of loans or direct investments	6,1
Lack of skilled/qualified workers within the enterprise	1,7
Difficulties with obtaining public assistance or subsidies for innovations	5,8
Lack of partners for cooperation	1,9
Unspecified demand for innovations	2,1
Too much competition on the market	4,3

Source: State Statistics Service of Ukraine, Science and innovations https://ukrstat.org/uk/druk/publicat/kat_u/publnauka_u.htm

In summary, Ukrainian economy is dominated by energy intensive industries, producing low value added products, using relatively cheap labour force. As recent studies confirm, Ukraine does not use properly the existing scientific and technological potential.

2.3. Linkages between NIS pillars: assessing innovation development

NIS concept presumes that innovation-based economic development can be achieved only if a close cooperation exists between all the NIS pillars, generating channels of flows (financial, human, knowledge, regulations flows). We are now going to elaborate more on the linkages between the pillars in Ukrainian NIS with a focus on the forms and mechanisms of financial support, strategies for innovation adoption and diffusion.

Research and education pillar is highly dependent on the government pillar, both operationally and financially. The higher education institutions are subordinated to the Ministry of Education and Science of Ukraine, which centrally "sets standards, develops qualifications, organises and conducts licensing and accreditation processes; monitors educational processes and governance of higher education institutes (HEIs)" (European Commission, Tempus, 2012, p.5). The Ministry has an authority to define qualification requirements, workload and award academic statuses to the staff of HEIs. Moreover, it is also responsible for appointing or dismissing heads of HEIs. The Ministry of Education and Science also defines budgets of public HEIs, while setting key objectives e.g. the number of specialists in HEIs, covered from the state budget; quotas of scholarships for every specialization. This is reckoning with practises of defining the students' quotas in the USSR. The basis for such calculations were 5-years plans of economic development. There are no practical tools which can be used to calculate the necessary amount of such stipends these days. This is leading to a large supply of graduates in certain fields (like lawyers or economist in the recent decades) which cannot be absorbed by the labour market.

Explicit usage of mechanisms of direct financial support creates vertical links and limits the independence of the pillar actors. The highest research body in Ukraine, the National Academy of Sciences, is the largest beneficiary of the state financial support, obtaining 75% of the state funding. Over 350 research institutes are subordinated to the National Academy of Sciences of Ukraine (including Academy of Agrarian Sciences, Academy of Pedagogical Sciences, Academy of Medical Sciences, Academy of Arts, Academy of Legal Sciences) (Yerogov and Ranga, 2012). That is why the research

institutes, their research and budgetary plans are subordinated and dependent on the National Academy of Sciences. Universities' financial autonomy was severely restricted as well. The Ministry of Finance was retaining all the free cash universities had in the central Government's Treasure, turning them into State reserves. Only since 2015 universities were allowed to deposit money in the State Banks, not with the Treasury. However, these restrictions were seriously affecting cooperation with foreign partners, for example the reception of grants from the EU.

Linking Education and Business is a challenge. Small amount of scientists in business is the result of diminishing demand for highly qualitied personnel and very low innovation activity of the Business pillar. Academia is disconnected from the labour market. The status of State diploma, inherited from the Soviet past, serves both as an educational certificate and a professional license. If the Ministry of Science and education is responsible for the curriculum, can it also be responsible for shaping the needs of the labour market, defining "educational-proficiency" level? One can hardly imagine that government can keep up with such responsibilities. While many HEIs create careers centres in order to provide placement programmes of the graduates, Business pillar is not contributing much on such mechanism of cooperation.

Limiting the decision-making, fundraising opportunities and establishment of ties with business, HEIs' transition to the Bologna process is very sluggish. Vertical linkages between the Government and Research and education pillars, suppress HEIs status as autonomous or self-governing bodies. Private education institutions are an exception. For example, Kyiv School of Economics (KSE), which is offering MA program in Business and Financial Economics and MA programme in Economic Analysis jointly with the University of Houston (USA). KSE graduates receive diplomas from the University of Houston. This institution offers numerous MBA courses and function as a centre for economic policy research and analysis. KSE is solely responsible for the curriculum, inviting top professors from Western Universities, receiving grants and donations, establishing cooperation with business representatives (business consulting, banks, international business and multinational corporations).

As the vast majority of scientifically educated personnel is concentrated in the education sector, and mostly engaged in teaching, there are relatively small amount of scientists in business.

Innovation Diffusion

One of the known methods of innovation development evaluation is assessment of the country patent activity. However, it should be noted that this method has several disadvantages, among which are the following:

- not all innovations are being patented, this applies in particular to service innovations;

- the tendency of firms to patent depends on the regulatory framework and financial burdens inside the country;

- patents can be of different quality. This difference is mainly between of ground-breaking innovations and innovations that only improve to a certain extent products or processes. One method is to evaluate the quality of a patent with a citation index. As EBRD research shows, citing of Ukrainian patents in the international market is very low.

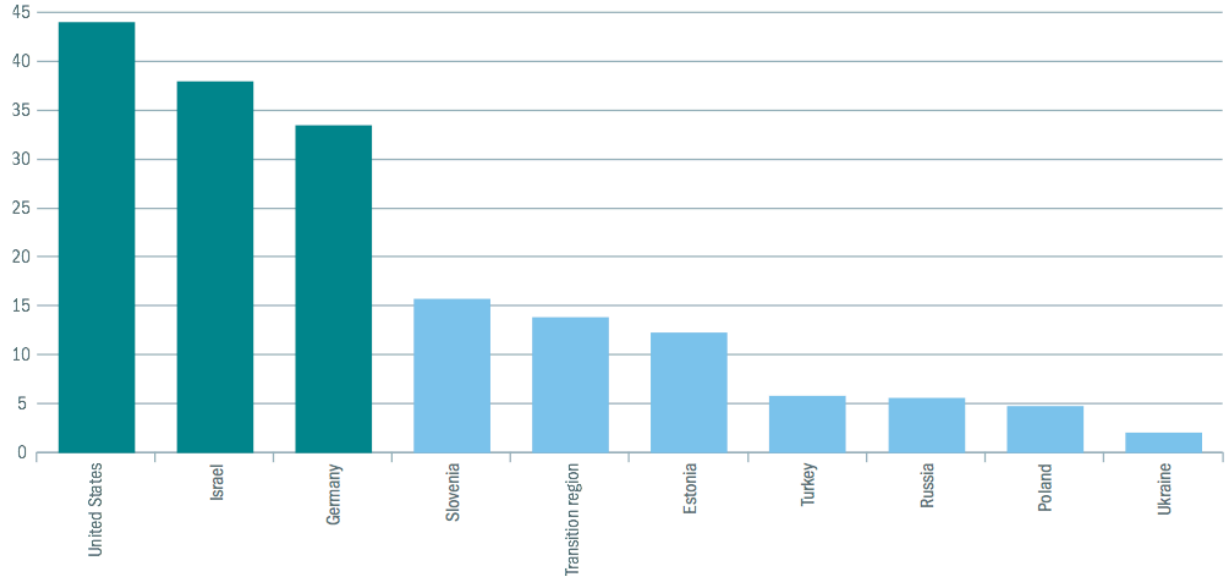

Figure 11. Percentage of patents with at least one citation, 1991-2011
Source: EBRD Transition Report 2014, p. 19

However, a major challenge is that patents may not always be commercialized and put into production. In Ukraine the majority of patents are owned by universities, while patenting in the business sector remains very low. For example, in 2013 State Intellectual Property Service has issued 8,432 enforcement documents with which 6,342 were given to higher education sector, 1,821 to public sector and only 269 to the business sector.

Therefore, given the fact that universities have no incentive to commercialize patented research (due mainly state-owned structure), and given the dissociation of structural links between science and business, we can consider that increasing patent activity in science and education sector does not have a significant impact on increasing productivity in Ukraine.

Innovation adoption

While analysing innovative development, many researchers consider innovations as products and processes that advance the global technological frontier (ground-breaking technology). However, according to the research of European Bank of Reconstruction and Development, most of innovations in the Eastern Europe and Caucasus[7] countries are innovations that improve already existing technologies and products, while adopting them to the local market or firm (see Fig. 12). Although such innovations are not new to the international market, they can significantly improve to the aggregate productivity inside the country.

Therefore, technological backwardness of Ukraine should be considered as not only a lack of ground-breaking innovations, but rather as the failure to adapt the innovations that already exist on the international market. According to the State Statistics Service, only 2.9% of enterprises involved in innovation activities, spend money on research and development, while only 0.8% purchase external knowledge. In a situation where the business is investing a very small amount of money in internal R&D and expenditures on purchasing new knowledge and machinery is extremely low, it is difficult to expect the implementation of innovative model of development.

[7] Eastern Europe and Caucasus group include Armenia, Azerbaijan, Belarus, Georgia, Moldova and Ukraine.

Figure 12. Product innovation at the global technological frontier and the adoption of existing technologies
Source: EBRD Transition Report 2014, p. 13

2.4. SWOT-analysis of Ukrainian NIS

The analysis of NIS pillars can be summarized with the help of SWOT analysis. It gives the opportunity to create matrix of qualitative strategic analysis and serves as a convenient tool for describing the structural characteristics of the object of strategic analysis by grouping all factors in 4 categories, namely: Strengths, Weaknesses, Opportunities and Threats. This methodology does not imply any particular set of indicators that has to be applied and can take into account factors that may not have a formal description and unambiguous assessment (as opposed to quantitative indicators). This versatility and can be regarded as a drawback, which does not guarantee that all very real and important factors will be taken into account.

SWOT-analysis compared with other methods has both advantages and disadvantages. The main advantage is simplicity, as well as the flexibility and availability of many options. Also, this systematization of knowledge gives an opportunity to determine competitive advantage NIS and form strategic priorities. SWOT-analysis disadvantages to be considered are: inability to take into account all the strength and

weaknesses, opportunities and threats; subjectivity in selection and ranking of the factors; poor adaptation to the environment that is constantly changing.

With the SWOT analysis we can conclude that government pillar does not foster a sound environment for innovation development. While the institutional environment is not favourable, NIS of Ukraine faces numerous barriers, which hamper innovation development and diffusion.

Strengths	**Weaknesses**
- large and partially preserved S&T potential; - high human and intellectual capital, in particular due to the number of graduates in science and technology; - prospective studies in the country, particularly in the IT, aerospace and chemical industries.	- institutional environment (government effectiveness, regulatory policy quality, business environment and investment climate); - low demand for innovation within industry; - lack of financial resources (state and private) for R&D development and innovation implementation; - low commercialization of research; - the lack of effective mechanisms (experience, practice and standards) for establishing linkages between science and business (i.e. cluster development); - undeveloped innovation infrastructure (i.e. technoparks, business incubators).
Opportunities	**Threats**
- Ukraine's participation in European Research Area (ERA), joint research project with the EU; - fast technology diffusion, especially in IT sector.	- brain drain, particularly among young scientists and innovators; - low protection of intellectual property rights; - continuous domination of resource intensive sectors in the national economy; - lack of political consensus on implementation of innovation strategy, creating conditions for the innovation development; - ongoing political and economic crisis, war in the east of Ukraine.

Figure 13. SWOT analysis of Ukrainian NIS
Source: composed by the author

One of the most striking is a gap between high human capital and S&T potential in Ukraine and the lack of demand for the innovations within industry. The national economy is still dominated by resource intensive sectors. This might work well if those sectors could continue stimulating the economic growth. However, we see a sharp decline of prices on the raw materials on the international markets, as well as sharp decline of Ukraine's GDP.

Besides, there are weak linkages between NIS pillars, lack of system integrity, namely:

- Misuse of potential R&D results from academic sectors;

- The imbalance in the development of individual elements of innovation infrastructure, lack of effective economic cooperation between them, resulting in a poorly functioning mechanisms of transfer of knowledge and new technologies to domestic and global markets.

Among the biggest challenges of the linkages between NIS pillars are (1) the lack of effective mechanisms (experience, practice and standards) for establishing linkages between research & education and business pillars (i.e. cluster development); and (2) undeveloped innovation infrastructure (i.e. technoparks, business incubators).

Numerous threats, which are foreseen not only for the innovative development, but generally for the economic development, make us study more closely the weak sides. For the purpose of this research we will proceed with the analysis of formal and informal institutional arrangements and their impact on the innovative development. What is their impact and how can it be measured? To answer these questions, we will continue with quantitative and then qualitative research.

Conclusions Chapter 2

The second chapter starts with the analysis of Ukraine's economic transformation and path-dependence since USSR time. The author presents Ukraine's general reluctance to engage in reforms and inability to secure hi-tech industries after gaining the independence. Together with the decline in domestic demand for innovation, Ukraine's economy became dominated by mining, energy, and ferrous metallurgy sectors. Country's capacity to innovate on the international scale is later presented with the help of Global Competitiveness Index and Global Innovation Index. Low position in both rankings indicate that Ukrainian economy is characterized by cheap labour force and low level of added value in goods. Subsequently, the author is decomposing Ukrainian NIS to study its key-pillars, namely government, research & education and business pillars.

Analysis of the government pillar indicates that NIS governance remains fragmented and ineffective, as the roles, responsibilities and financial obligations of the different state bodies are blurred. There is a clear lack of strategy on how to organize the innovative development, as government has not approved the National Strategy for the innovative development of Ukraine. The national innovation policy making is far from coherent. While the government expenditure on R&D is extremely limited, without a proper system of monitoring and control, it is extremely difficult to target national priorities of innovative development, as well as allocate scare financial resources efficiently.

Research and education pillar fail to employ human capital effectively, as there is no long-term strategy for the development of scientific and creative potential. Meanwhile, the number of R&D organizations, as well as number of researchers in Ukraine demonstrate continuous decline. The pillar is largely dependant on the Government pillar, both bureaucratically and financially. Higher education institutions face limitation in the decision-making, fundraising opportunities and establishment of ties with business. There is relatively small amount of scientists in business as the vast majority of scientifically educated personnel is concentrated in the education sector, and mostly engaged in teaching. However, this is also the effect of the lack of demand from the business pillar on highly qualified personnel. The gap between high human capital

and S&T potential in Ukraine and the lack of demand for the innovations within the industry is striking.

The innovation activity of enterprises remains very low. Less than 14% of enterprises implement innovation. Moreover, 82,2 % of non-innovative enterprises consider that there are no compelling reasons to implement innovations, while only 17,8% recognise certain factors that are hampering the process of innovation implementation.

Thus, development of NIS pillars and linkages between them are weak. Despite the patent activity, the marginal number is owned by the business sector, while the bulk amount of patents can not be commercialised. However, country's technological backwardness is caused not only by the lack of ground-breaking innovations but rather due to the failure to adopt the innovations that already exist on the international market. Ukraine's absorptive capacity is well below average.

The chapter conclude with a SWOT analysis, presenting weakness of Ukrainian NIS and threats to the further development, in particular the absence of effective mechanisms for establishing linkages between NIS pillars.

CHAPTER 3. NIS OF UKRAINE: EMPIRICAL STUDY

A few attempts have been made to measure the NIS of Ukraine. In this Chapter we will apply quantitative and qualitative approach to measure the impact of the institutions and institutional arrangements on the NIS development. Our quantitative approach relies on the available statistics, aggregated from national database, statistics from the World Governance Indicators and UNESCO Institute for Statistics database. However, the quantitative analysis has a number of limitations. First of all, the State Statistics Service of Ukraine only collects data on a very limited number of indicators in the innovation sphere. Second, the time series start from 1996. Moreover, statistics change from 2013 because of the annexation of the Crimea peninsula and exclusion of temporarily occupied Donetsk and Luhansk regions from the national statistics of Ukraine. This seriously restricts the quantitative analysis of this study and for this reason it has to be considered as descriptive one. Consequently, the first section of this Chapter helps to capture the trends and provides a comprehensive overview. The second section relies on the quantitative data and enriches the understanding of the institutional arrangements in Ukraine.

3.1. Analysing the impact of institutions: quantitative approach

The sample includes values for 19 indicators observed over a 14-year period from 2000 to 2013 (see Annex B, Table 1), i.e. input matrix has the following dimensions: $p = 19$ i $n = 14$. While analysed indicators vary, but they all can be easily normalized, as they easier represent the %, or the rank from 0 to 100. Thus, the size of the unified scale N is equal to 100, and therefore the value of SIQNIS, will be determined from 0 to 100, where 0 is the worst and 100 is the best quality of the analysed characteristics. Normalized input data for the pillars in presented in Annex B, Tables 4-5.

According to the methodology, presented in the Chapter 1 we can now proceed to the reduction of input indicators. Two-steps regression of inclusion and exclusion of variables, enables us to identify the set of the most informative indicators. As it was described in the formula 1.12, we aim to maximize coefficient of determination of

variable y for explanatory variables in the context of certain NIS pillar. The results for the pillars are as follows:

- For Government pillar: x1.1 - voice and accountability, $x^{(1.3)}$ - government effectiveness. Results can be presented with the following equation:

$$y1\_QSM = -34{,}109 + 0{,}597 * x1.1\_WVA + 0{,}984 * x1.3\_WGE$$

N=14	Regression Summary for Dependent Variable: x1.6_WCC (+Input-innov 2000-2013) R= ,87890621 R?= ,77247612 Adjusted R?= ,73110814 F(2,11)=18,673 p<,00029 Std.Error of estimate: 3,2701					
	Beta	Std.Err. of Beta	B	Std.Err. of B	t(11)	p-level
Intercept			-34,1094	8,752718	-3,89700	0,002489
x1.1_WVA	0,774447	0,149374	0,5965	0,115056	5,18461	0,000302
x1.3_WGE	0,674518	0,149374	0,9838	0,217866	4,51562	0,000878

- For Research and academia pillar: x2.6 - R&D performance, as a share of GDP; x2.8 - pupil-teacher ratio, tertiary education. Results can be presented with the following equation:

$$y2\_QKG = 0{,}000 + 0{,}282 * x2.6\_OVN + 0{,}009 * x2.8\_VIN;$$

N=14	Regression Summary for Dependent Variable: x21_NAZ (+Input-innov 2000-2013) R= ,96938194 R?= ,93970134 Adjusted R?= ,92873795 F(2,11)=85,713 p<,00000 Std.Error of estimate: ,01708					
	Beta	Std.Err. of Beta	B	Std.Err. of B	t(11)	p-level
Intercept			0,000260	0,037940	0,006855	0,994654
x2.6_OVN	0,667907	0,087731	0,281598	0,036989	7,613080	0,000010
x2.8_VIN	0,430353	0,087731	0,009044	0,001844	4,905340	0,000468

- For Business pillar: x3.2 - share of the enterprises, which introduce innovations.

$$y3\_QPR = 2{,}09 + 1{,}068 * x3.2\_PVI.$$

N=14	Regression Summary for Dependent Variable: x3.1_PZI (+Input-innov_y1-y3 2000-2013) R= ,93917949 R?= ,88205811 Adjusted R?= ,87222962 F(1,12)=89,745 p<,00000 Std.Error of estimate: ,81282					
	Beta	Std.Err. of Beta	B	Std.Err. of B	t(12)	p-level
Intercept			2,090059	1,369542	1,526101	0,152901
x3.2_PVI	0,939179	0,099139	1,068131	0,112751	9,473385	0,000001

Selecting the most informative particular criteria among the indicators of a priory set helps to maximize the predictive power of the regression models. This reduction helps us to overcome the possible multicolinearity, so we can proceed with building synthetic indicators of the quality of NIS pillars (SIQNIS).

To model SIQNISS first we have to identify the unknown vector of weights $W = (w_1, \ldots, w_p)$ with (see formula 1.18 in Chapter 1). The results for the weights of the indicators, namely eigenvalues and vectors of covariance matrix, variable contribution, contribution of and weights of variables, based on covariation for NIS pillars are presented in Annex D.

The SIQNIS $y^{(q)}(t)$ are build on criteria of informativeness, which is based on the following quality of representation: the percentage of the total variation, which is explained by the first main component, should be greater than 55-60%. In case of the business pillar, scalar quality indicator consists of a single statistical indicator, thus the synthetic indicators will be determined by the value of this indicator, i.e. $y^q(t) = x^{q(p)}(t)$, $t = 1, \ldots, T$. Table 8 presents the results of comprehensive quality assessment of the NIS pillars.

Table 8

Comprehensive quality assessment of the NIS pillars of Ukraine**:** $y^q(t), q = 1,2,3$

Year	Synthetic indicators of NIS pillars quality		
	y1	y2	y3
1	2	3	4
2000	27,98	26,24	14,30
2001	29,48	24,14	14,60
2002	31,19	21,85	11,50
2003	30,92	21,45	10,00
2004	30,27	21,05	8,20
2005	39,78	20,45	10,00
2006	44,40	20,25	11,50
2007	43,84	20,15	10,80
2008	45,13	21,15	10,70
2009	43,34	21,15	11,50
2010	41,85	21,25	12,80
2011	39,63	20,25	13,60
2012	38,02	20,25	13,60
2013	35,59	26,24	14,30

Source: composed by the author

With the analysis of NIS pillars quality, we can trace the dynamics (positive or negative) of the synthetic indicators between 2000 and 2013. As shown on Figure 14, the trend of y2 and y3 during 2003-2011 is stationary. Since the middle of 2012 there is a slight increase in research and academia pillar. By contrast, y1 reflects a very different pattern, the dynamics of this pillar demonstrates slow growth until 2006, but since mid-2008 the quality of governance has been constantly decreasing. Taking into account the scale of the measurement (from 0 to 100), all the pillars demonstrate poor quality. The lowest quality demonstrates y3 – business pillar. The value of this indicator barely reaches 15 points.

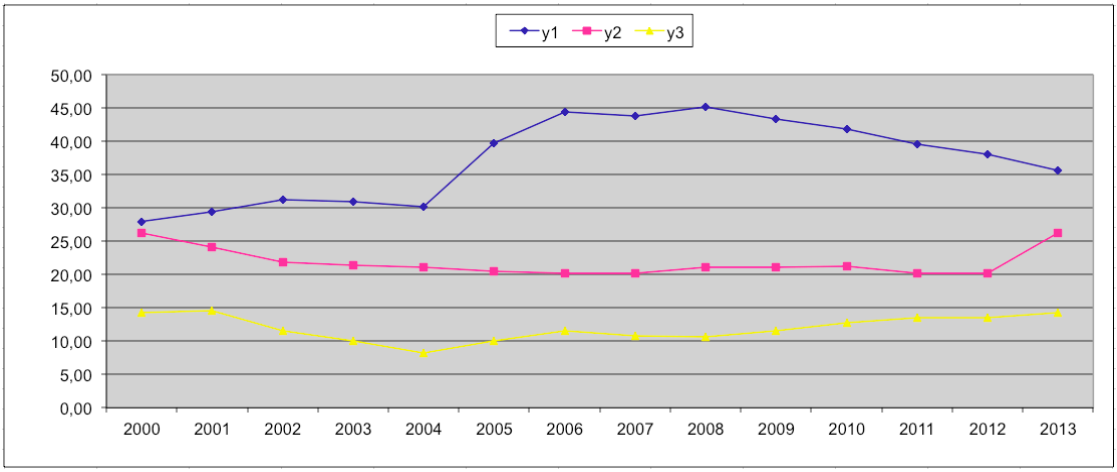

Figure 14. Quality of synthetic indicators of NIS pillars, where y1 – government pillar; y2 – research and education pillar; y3 – business pillar.
Source: composed by the author

Complex assessments analysis of NIS pillars quality (Figure 15) also demonstrates the tendency of pillars volatility.

Figure 15. Quality level of NIS pillars of Ukraine
Source: composed by the author

3.1.1. The impact of institutional factors on the NIS pillars quality

Table 8 presents the set of synthetic indicators and quality indicators of NIS pillars. Among them are the indicators of quality (effectiveness) of governance, which can be considered as institutional factors that affect the quality of major subsystems of NIS of Ukraine. Our task is to test the hypothesis that institutional factors impact the quality of the analysed NIS pillars, using regression analysis, where $Y = \left(y^{(1)}, y^{(2)}, ... y^{(m)}\right)$ is the dependent variable and $X = \left(x^{(1)}, x^{(2)}, ..., x^{(p)}\right)$ are the independent variables (predictors). So we can formulate this regression analysis in the following way:

$$y = f\left(x^{(1)}, x^{(2)}, ..., x^{(p)}; \theta\right) + \varepsilon,$$

where ε is a residual component that allows for a possible error in determining the specific indicator y with values of the factors $x^{(1)}, x^{(2)}, ..., x^{(p)}$. $f(X;\theta)$ is a function of parametric family $F = \left\{f\left(X;\theta\right)\right\}$, for which numerical values (including constants) are unknown.

To analyse the impact of institutional factors on the quality of the NIS subsystems we consider a set of input (explanatory) and output (resulting) variables. The dependent variables in our equitation are the synthetic indicators of the pillar of research and education – y2 and the synthetic indicator of the business pillar – y3, which were obtained with the help of the method of the principal component. Our predictors are the indicators of WGI, previously used to obtain the quality of the government pillar – y1, namely:

- $x^{(1.1)}$ - voice and accountability,
- $x^{(1.2)}$ - political stability and absence of violence,
- $x^{(1.3)}$ - government effectiveness,
- $x^{(1.4)}$ - regulatory quality,
- $x^{(1.5)}$ - rule of law,
- $x^{(1.6)}$ - control of corruption,
- $y^{(2)}$ - synthetic indicator of the science pillar,
- $y^{(3)}$ - synthetic indicator of the business pillar.

Although we have the aggregate synthetic indicator of y1, we test the impact of all the possible institutional factors in our models.

Determination of the overall regression function type, which helps to investigate relationship between variables, the calculation of unknown parameters in the regression equation, the analysis of the adequacy of the constructed equations as well as the testing of statistical relationship between the variables, is performed with STATISTICA package.

Results for research and education pillar

The study shows the following results for measuring the impact of institutional factors on the quality of research and education pillar: there is no statistically significant influence of the institutions on the pillar's development, with the exemption of the x1.5 – rule of law[8].

Table 9

Stepwise regression, backward elimination, $R^2 = 0,78$

	Regression Summary for Dependent Variable: y2 (+NInput-innov 2000-2013) R= ,89409435 R?= ,79940470 Adjusted R?= ,78268843 F(1,12)=47,822 p<,00002 Std.Error of estimate: 1,4161					
N=14	Beta	Std.Err. of Beta	B	Std.Err. of B	t(12)	p-level
Intercept			38,41668	2,377792	16,15645	0,000000
x1.5_WRL	-0,894094	0,129291	-0,67919	0,098215	-6,91534	0,000016

Source: composed by the author

R-square value indicates that model fits the data. P-level shows that in 100% cases, we can explain the impact on the research and education pillar with the help of regulatory quality indicator.

Results for Business pillar

Measuring the impact of institutional factors on the quality of business pillar shows there is no statistically significant influence of the institutions on the pillar's

[8] Rule of law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence

development, with the exception of x1.6 – control of corruption[9], which demonstrate significant impact.

Table 10

Stepwise regression, backward elimination, $R^2 = 0,72$

N=14	Regression Summary for Dependent Variable: y3 (+NInput-innov 2000-2013) R= ,86572573 R?= ,74948104 Adjusted R?= ,72860446 F(1,12)=35,901 p<,00006 Std.Error of estimate: 1,0416					
	Beta	Std.Err. of Beta	B	Std.Err. of B	t(12)	p-level
Intercept			16,91232	0,866955	19,50772	0,000000
x1.6_WCC	-0,865726	0,144487	-0,27448	0,045810	-5,99171	0,000063

Source: composed by the author

The coefficients of determination (R^2) and significant level of p-value show that our linear regression models adequately describe the correlation between the analysed variables. Estimation of unknown parameters of regression equations indicate the most significant explanatory variables that affect the quality of synthetic indicators:

$$y2\_QKG = 38,42 - 0,68 * x1.5\_WRL;$$
$$y3\_QPR = 16,91 - 0,27 * x1.6\_WCC.$$

Consequently, we can draw the following conclusions regarding the impact of institutional factors on the quality of the analysed NIS pillars of Ukraine:

- the quality of research and academia pillar is primarily influenced by rule of law;
- the quality of business pillar is primarily influenced by control of corruption;
- the impact of those variables on y2 and y3 is significant and marked red in our results.

The quality of the research and academia pillar is negatively correlated with the rule of law, while business pillar is negatively correlated with the control of corruption. This relation is represented with the regression coefficient, which in the equation of multiple regression shows a change of the average value of dependent variable with increase (or decrease) of predictor variable, while holding all other independent variables constant.

[9] Control of corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.

Normally, it is expected to see the positive correlation between the quality of the institutional factors and the development, i.e. we would expect that the higher is the control of corruption, the better the business pillar quality will be. However, the results of our regression analysis show different results. To explain the rationale behind it, let us elaborate more on the relative value of these indicators.

In 2013 the average percentile rank for rule of law in Europe and Central Asia was 66, while in Ukraine it was only 24. The average percentile rank for control of corruption in countries of Europe and Central Asia was 63, while in Ukraine the score in 2013 was only 11,96 (lower than average among low-income, where the average rank is 19.). According to our model, every 1-unit increase of rule of law will decrease the quality of research and education by 0.68 units and every 1-unit increase of control of corruption variable will decrease the dependent variable by 0,27 units. However, taking into account the current decrease of the quality of the business pillar we can also assume that the level of control of corruption is that low that even increase of the indicator by 1 unit will not change the quality of the business indicator.

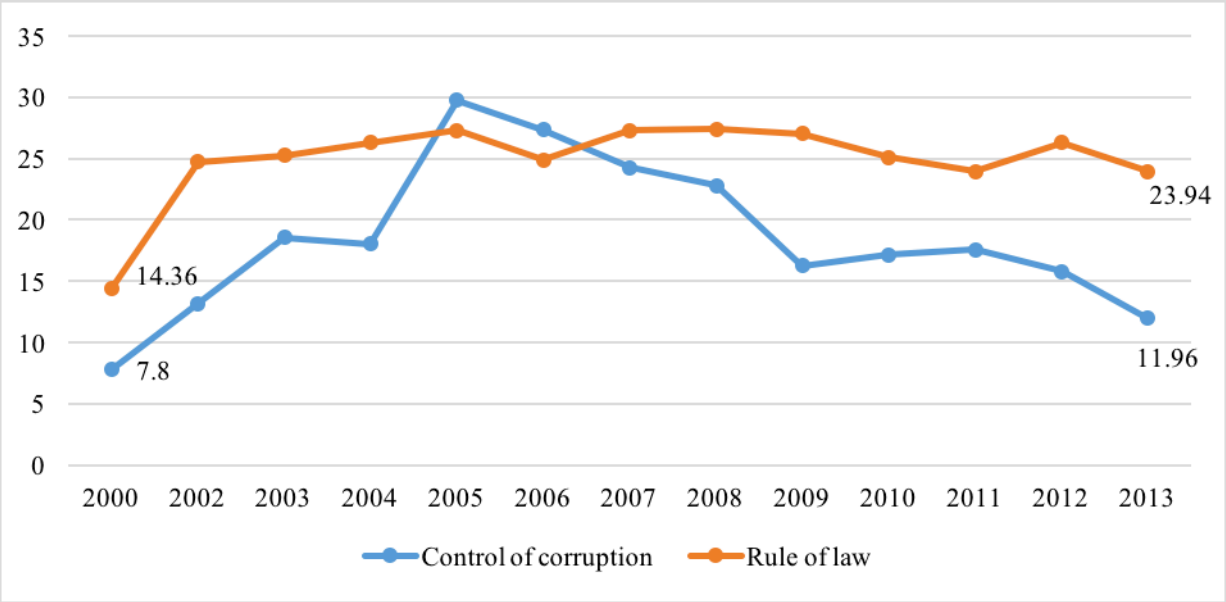

Figure. 16 dynamics of Control of corruption and Rule of law in Ukraine, percentile rank in 2000-2013
Source: composed by the author, based on Worldwide governance indicators

At the same time, one can understand corruption as an essential element at some level of country's development, especially when the rule of law is not respected. While the formal regulations are usually disregarded, corruption in case of Ukraine can be

understood as a functional necessity: to optimize relationships, to leverage risks etc. Thus, this kind of pathologies is required to maintain within the system: what would be considered as pathological in another institutional setting, becomes a quasi-necessity to maintain or even improve the efficiency of the State's administration. Another possible argument is that control of corruption creates even larger bureaucracy and reinforces corruption itself. These assumptions will be also studied further with the qualitative research.

3.1.2. The impact of NIS pillars quality on the economic growth

Our next task is to explore the relationship between the quality of the analysed NIS pillars and the level of economic development. In the international comparisons, the level of economic development is measured by GDP per capita based on purchasing power parity (DGP PPP)[10].

Analysis of the impact of NIS pillars quality on GDP PPP for 2000 - 2013, demonstrates very strong correlation between the analysed variables.

$$y0\_GDP = 6408{,}93 + 136{,}54 * y1 - 381{,}23 * y2 + 309{,}27 * y3.$$

Table 11

Regression summary for GDP PPP and NIS pillars y1, y2, y3

N=14	Regression Summary for Dependent Variable: y0_GDP (+Input-innov_y1-y3 2000-2013) R= ,92504847 R?= ,85571468 Adjusted R?= ,81242908 F(3,10)=19,769 p<,00016 Std.Error of estimate: 725,74					
	Beta	Std.Err. of Beta	B	Std.Err. of B	t(10)	p-level
Intercept			6408,926	3682,963	1,74016	0,112456
y1	0,506313	0,173890	136,541	46,894	2,91169	0,015520
y2	-0,691121	0,179948	-381,228	99,261	-3,84067	0,003262
y3	0,369011	0,153137	309,268	128,344	2,40968	0,036703

Source: composed by the author

Regression analysis shows positive correlation between the quality of y1 and GDP PPP: an increase of the government pillar by 1 unit increases GDP PPP by 136,54 USD, while holding other predictors in the model constant. The correlation between y3 and

[10] PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States (World Bank, http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.KD).

GDP PPP is also positive: an increase of business pillar by 1 unit increases GDP PPP by 309,26 USD, while holding other predictors in the model constant.

At the same time results for y2 show an opposite pattern – there is a negative correlation. Results show that Research and education pillar hampers the economic development: the increase of y2 will decrease the GDP PPP by 381,228 USD. Although one might find it contradictory, let us elaborate more on the possible factors that are influencing such results. First of all, as it was shown on the Figure 15 the level of development of this pillar quality is very poor. Second, such regression results may be caused by the significant negative impact of government effectiveness on this pillar.

Finally, it is important to note that time series span in our research is rather short. Methodological section of WGI does not recommended to evaluate the impact of World governance indicators for less than a decade. Therefore, our sample of 14 years might be also too short to capture accurately all the institutional changes, or to measure the impact of institutional changes on the economic performance. The further analysis shows possible munlticolinearity between the factors. Due to these limitations, the reader should bear in mind reduced predictive power and reliability of the presented models.

The quantitative approach in this study is rather descriptive due to the data limitations and must be considered as a brief overview of the available data. The results of analysis will be further used as the guidelines for the qualitative analysis. Moreover, it will help to enrich the qualitative analysis by incorporating not only political (formal) institutions but also informal ones that can not be quantified. As a result, it will enable to elaborate more on the linkages between the pillars, as well as linkages between the key actors.

3.2. Analysing the impact of institutions (on example of IT sector): qualitative approach

Measuring the impact of institutional arrangements is a challenging task. In our quantitative estimations we were discovering the influence of the institutions on the economic development via their impact on the NIS pillars. Decomposition of the NIS gave us possibility to design the quality indicators artificially and measure quantitatively

their impact. But in our qualitative research we have a different point of departure: we analyse concrete cases of individual firms, operating in the context of Ukrainian NIS. In this section we study the impact of NIS arrangements on IT development.

Table 9
Statistics of codes

Codes		280
Business pillar		0
	Innovation intensity	8
	Trends in the sector development	13
	Business model	0
	Product	8
	Outsourcing/outstaffing	16
	Geography of trade	0
	International market	7
	Ukrainian market	16
Government pillar		0
	Necessary steps/initiatives	3
	Bad governance	41
	Good governance	5
Research and academia		0
	Firms investment in R&D	6
	Motivation of graduates	13
	Formal education	20
	Informal education	20
	Human capital	15
Linkages between pillars		0
	Business and government	26
	Business and academia	18
	Business and business	13
Other		0
	Costs optimization, minimization of risks	14
	Risks for the further development, problems	18

Source: composed by the author

With MAXQDA analysis, collected interviews were coded with 280 codes (see Table 9). These are the main trends, observed from the interviews:

- IT sector development has positive dynamics. Outsourcing/outstaffing model prevails. It means that firms provide the range of engineering capabilities for other customers (i.e. business process outsourcing, dedicated team outsourcing), very often abroad. This business model is successfully employed because of the big human capital

in Ukraine, in particular engineers, mathematicians, designers which is combined with the lack of entrepreneurship skills and entrepreneurship culture. Outsourcing allows generating profits relatively fast with minimum risks. The easiest way to scale up for the company is by increasing the number of workers. Human capital plays the crucial role in this sector (see Fig. 17).

- There is an extremely negative perception of the government and the political system itself. The political system of Ukraine is understood, as the factor which is hampering IT development. Initially, the questionnaire was constructed to separate the views of respondents on all WGI indicators; however, the respondents were not able to distinguish policy tools and mechanisms of governance. The answers show that they were not familiar with all the spectrum of normative regulations, declared strategic plans. Therefore, the perception of WGI indicators was divided by "bad" and "good" governance.
- The great interaction and cooperation between business and academia, win-win strategy. Despite a relatively weak quality and outdated model of formal education, the informal education is flourishing. A prominent role is played by IT companies, which establish the cooperation with Universities.
- Supportive business to business ties.

Figure 17. Word cloud visualization of the most frequently used words in interviews
Source: composed by the author

Let us elaborate more on the trends, with a particular focus on the formal and informal institutional arrangements, as well as linkages between NIS pillars. First, we will analyse the business pillar itself. Then we will proceed with the analysis of linkages between business and government, business and research & education, business and business.

3.2.1. Business pillar characteristics

As it was already mentioned, IT sector experiences a dynamic growth. However, this growth is rather extensive than intensive. IT companies are facing the dilemma: either to continue using outsourcing model, or to increase investments and develop its own products.

"Outsourcing is the simplest business model. It is, blatantly saying, like renting engineering resource". Respondent #2.

Respondents note that companies slowly start developing their own products, however, there is a number of limiting factors, such as the absence of innovation eco-system, problems with intellectual property rights (IPR) protection, lack of investment funds. The most important is the lack of entrepreneurship skills and entrepreneurship culture. So far IT innovation intensity of the firms highly depends on the customer and his/her demands. Therefore, outsourcing services may vary from highly innovative to offering little or no particular innovation.

100 % of respondents said that their firms rely on international markets (mainly USA and EU countries), while the share of products or services for Ukrainian market is not exceeding 10% of the total output. In this context, relatively low cost of skilled labour coupled with low taxes and the recent depreciation of hryvna enhance the competitive advantage of the Ukrainian outsourcing companies.

Respondents note that Ukrainian market is not ready for innovations. There is a lack of demand from both private and public sector for IT solutions. While the number of code for Ukrainian market is bigger than for International market, the respondents mainly explain the problems in the domestic market. First, Ukrainian market cannot afford the costs of IT professionals. It is easier for them to buy the products that are already

available in the market, as they could solve the problems faster and easier. Second, Ukrainian customers usually are "bad clients", as they can breach the contracts and delay payments. Ukrainian market code was also re-accruing with the code of Bad governance, referring to the bad experience of working for the Ukrainian government, in particular during public procurement.

3.2.2. Business – Government ties

While tracing the development of IT sector, respondents were noting that at the beginning IT sector was very small and successive governments were acting as if they were ignoring its existence. Without really understanding the specifics of IT sector, the government was focused on supporting traditional low-tech industries and low-value-added export. Unlike such sectors as coal mining, metallurgy, which were subsidized by the government, and now stays in the hands of wealthy oligarchs, IT developed independently. Its absolute advantage was the ability to increase profits rapidly without extra investments in the costly infrastructure.

Despite government declarations on the crucial need for the innovative development, there were no real incentives introduced for the IT sector.

"Laws? Which laws? Who heard about them?!" respondent #6

After the question about the government support, 30% of respondents were amused. Explaining that "government support for IT sector" was laughable, respondent #3 called the government support "oxymoron". The respondents were demonstrating negative attitude towards government, perceiving it as an enemy. 70 % or respondents mentioned that their biggest expectation, related with the government is that it does not disturb the IT sector.

"In our company, we do not expect anything good from the government... In our annual plans, we rather laid risks and predict that government will only make our lives worse", Respondent #2.

"Government comes with all the possible inspections: tax, sanitary, fire inspections. Creates bureaucracy and corruption; hampers the development of the company", Respondent #6.

At the same time, some respondents were openly declaring even though the current official institutional arrangements cause many difficulties for running IT business, the government couldn't scare them.

"You have to understand that IT sector managed to survive all these 20 years … IT-guys are clever. It is not easy to scare them. Today he/she works from Ukraine, tomorrow from Thailand … The most important is the brain. All you need is a computer, electricity, and Wi-fi". Respondent #5.

- The only positive aspect of the business environment in Ukraine is relatively low taxes for IT business, which have been improved since January 2013. According to the Tax Code of Ukraine, IT companies are exempt from paying value added tax. The income tax from 2015 is to be paid at the rate of 18%. At the same time, many companies, in particular small ones, hire their employees as independent contractors. This helps employer not to pay taxes on salaries, while the employee pays only 4% tax on earnings. Companies and employees find this system beneficial as VAT does not have to be paid as well. However, the tax system cannot compensate the great risks, companies are facing.

Analysis of Government pillar code relations with other codes demonstrates that bad governance co-occurs with the code of Risks as well as attempts of IT business to optimize costs or minimize risk.

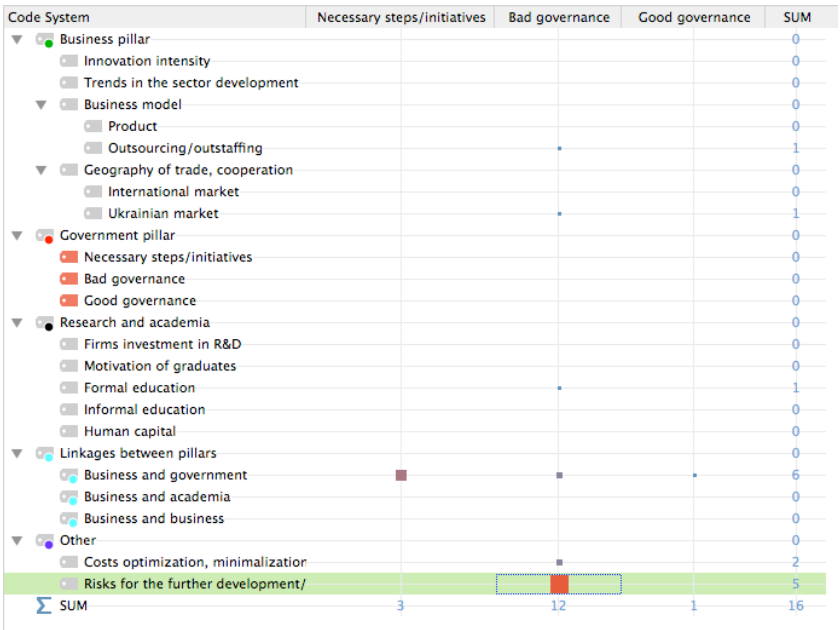

Figure 18. Co-occurrence of Government pillar codes and other codes
Source: composed by the author

The relations of these codes are even stronger when analysing the near codes

Figure 19. Code relations: codes followed by Government pillar codes
Source: composed by the author

One of the biggest concerns of the companies is tax police inspections. 80% of respondents noted that they do not feel safe doing business in Lviv.

"People do no sleep well", Respondent #5

Risks are related to the fact that tax police inspections are arbitrarily led. The reason for such inspection might be the anonymous information on the unlawful activity or suspicion on company's involvement in the porno production. Moreover, these inspections are executed in an excessive manner. Breaking into offices with special police forces, they seize documents, firm's equipment, and most importantly, servers, where all the information is stored. The investigation might last for weeks or months, while keeping firms paralyzed. Losing access to documents and property, firms are unable to continue their work. These operations are labelled as "masks show", as special police forces wear black masks during such raids. As it was reported by business representatives, the physical seizure of servers, in particular, is used as an attempt to threat company and extort bribes.

The Respondent #3, the owner of IT company, confess:

- *I face corruption every day. But I don't wait till "masks show" come to my office. Yes, I pay bribes to prevent their appearance in my office. Because when they come it is far more expensive.*
- *Did you try not to pay bribes?*
- *I would have to close. I would not be able to do business.*

Concerns about illegal acts of Security service and Tax police were discussed at the highest level. In 2014 the Ministry of Economy of Ukraine promised to take this situation under control but with no effect. In 2015 there were more than 20 attacks on IT companies, which cost companies around $10 mln losses (IT news).

"This is the most stupid thing the government could do!", Respondent #2

"The government has no idea what is happening in IT, they just see that there is money, so they do everything possible to get that money", Respondent #3

Lviv has a good reputation of the IT-friendly city. In September 2015, the mayor of the city, Andriy Sadovyi, has officially declared that he will not allow "masks show" in Lviv and guarantee the support from Lviv City Council and Lviv IT cluster to all the IT companies that would like to move to Lviv and start doing their business there. Nevertheless, in March 2016, Lviv-based company IT-sfera reported about the withdrawal of their documents and equipment by the Security Service of Ukraine.

The information about such raids is not only available in Ukraine. When the clients abroad hear such information about the sector turbulences they sometimes may cancel their joint project with Ukrainian firms. Since 2013, the situation has only worsened because of the war in the East of Ukraine. Business forecast for Ukraine stays grim. Political instability, as well as widespread corruption, is seriously hampering international cooperation and investment profitability assessment for the future.

As a response to such acts, many companies decided to relocate their main offices abroad. The most popular way to protect data is to keep all the information in clouds or by keeping servers abroad. Even though operating in Ukraine, many companies prefer to establish legal entities in foreign jurisdictions. The probability of companies leaving Ukraine is rising with the risks of increasing taxes.

3.2.3. Business – Research & Education ties

The business states that formal education is insufficient: the curriculum is theory-heavy and very outdated. Universities and colleges are very inert, while IT sector is changing very fast. Moreover, lecturers themselves do not really know how to work with novel technology, how to code.

"I can tell you how it was at my own department, where I used to work. Among 45 lecturers only 5 could code. The others were teaching theory, they never had an experience of programming", Respondent #5

Taking into account the demand for IT specialists, active steps were taken by the industry to provide high-quality IT education and overcome the shortage of practical skills. Many companies from the early stages try to pick the future workers from the pool of talented students. They invest in their professional development by organizing trainings, additional courses. SoftServe, Lviv-based company, was the pioneer in developing cooperation with the universities. Now they have they own SoftServe university.

It is important to note that this cooperation was initiated by the IT companies themselves, without any government support programme. IT companies started opening laboratories with modern equipment. Then they also recruited the most talented lecturers. As the salaries of lecturers in Universities are very low, compared to the compensation in the IT sector, firms are interested in paying lecturers high salary themselves and give him/her opportunity to continue teaching students at the university.

Besides, informal education in Lviv includes numerous courses, led by private companies, which in a short period of time can help graduate students or professionals from other sectors to re-train to become IT specialists. Analysis of code relations shows co-occurrence of Informal education code and Human capital code. Respondents are convinced that investing in human capital via informal education is beneficial for business and academic ties, as well as beneficial for the business and business ties in the long-term perspective.

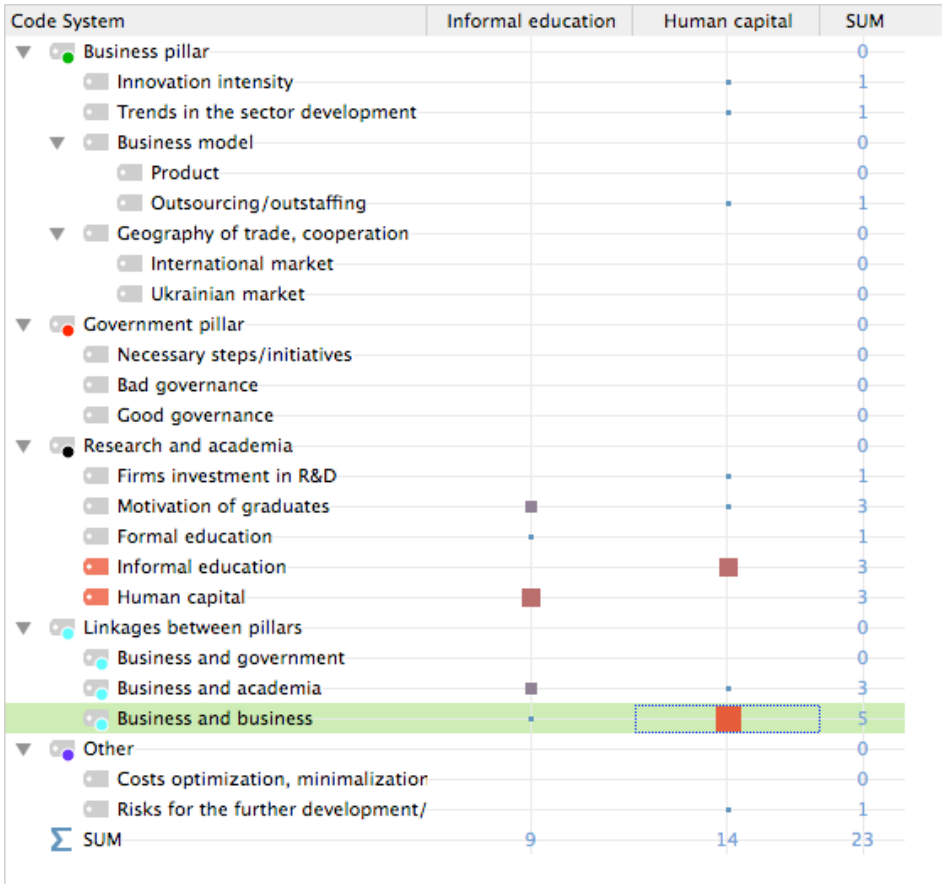

Figure 20. Co-occurrence of Informal education and Human capital codes and other codes
Source: composed by the author

3.2.4. Business and business ties

Although the number of IT companies is growing, there is no competition for customers between them. Respondents note that there are enough jobs for all the companies. However, there is a competition for the employees. This recalls again the co-occurrence of Human capital and business to business linkages.

Firms think that it is better to employ students before they graduate and provide them with in-house training. The employee will not only acquire the necessary skills and knowledge but will also learn the culture and become more attached to the company.

"The better your workers, the better your product/service", Respondent #6

"Business understands that there are not enough qualified workers on the market. They have to teach them, they have to grow them. That is why companies are fighting for good specialists", Respondent #7

Business ties are supportive. Despite the competition for programmers, respondents mention that there are informal agreements not to recruit each other's employees. Many companies are in Lviv IT cluster. This helps them to communicate their fears, needs; to establish cooperation with universities and colleges.

"I think that the people who have launched the IT business 20-25 years ago in Ukraine, now are quite successful businessmen. They have good ties between each other, and they are aware of possible waves of "unpleasant things", so they have ideas how to work on the problems. I see how many conferences are taking place, I can see how people gather in associations, work with each other", Respondent #7

At the same time, again we can see very negative attitude towards the government. *"Yes, business unites when we have to fight the common enemy – the government", Respondent #2* .

Conclusion of the Chapter 3

This chapter presents the analysis of impact of institutional arrangements on the innovational-driven economic development in Ukraine. As the mixed method research is applied in this study, the first part is dedicated to the quantitative analysis, while the second one - to the qualitative.

For the quantitative approach, the author is using available statistics to model synthetic indicators of the quality of NIS pillars and study the trends of their development. With the WGI data, the Author is measuring the impact of the formal (explicit) institutions on the business pillar and pillar of research and education. While the quality of research and education pillar is influenced by the regulatory quality, business pillar development is strongly relying on control of corruption. While the results for the first two indicators were predictable, the correlation between business pillar development and the control of corruption has shown negative relationship, requiring closer analysis. Besides the critically low level, below the average for the low-income countries, corruption in Ukraine could be also interpreted as a regulatory mechanism modulating the business development, which filled the institutional void. Further analysis of the relationship between the quality of the NIS pillars and the economic development explicitly shows a positive correlation between the quality of the government pillar and the GDP PPP growth. Even stronger correlation is observed for the quality of the business pillar and the economic growth. At the same time the quality of research and education does not explain the economic growth. This can be both, due to the downwards dynamic in the y2 performance, as well as the strong negative impact of the government effectiveness, which was shown before.

The qualitative research helps to understand better above-mentioned trends and learn more about the impact of informal institutional arrangements, in particular linkages between business and government, business and research & education, business and business. The results of the in-depth interviews support our quantitative findings on the impact of the formal institutions. In line with the obtained results, respondents consider political instability, government ineffectiveness and corruptions as the factors that are hampering the development.

Business representatives consider government as an "enemy", thus express very negative attitude towards formal institutional arrangements. The biggest hope of the business representatives is that the government do not interrupt their activities. A number of factors, such as inefficiency of the legal framework, irregular payments and bribes, weak intellectual property rights protection, were considered as threats, jeopardising the sector's further development and creating incentives for the possible re-location of business abroad. At the same time linkages between the business and research and academia pillar, in particular informal, are mutually beneficial. Business is actively involved in updating curriculum, organizing courses for both students and lecturers, as well as investing in modern laboratories at the universities. Besides, numerous private schools operate in the market to prepare students for the market needs. The linkages between IT firms also play important role. In particular, firms' capacity to design intermediate organisational forms and interact within associations and clusters. While considering government as an obstacle for the innovation, business actors are not choosing the exit strategy. Gradually, firms become important institutional entrepreneurs capable of re-shaping the institutional framework.

These and other mechanism of establishing the linkage organizational forms the institutional framework will be closely analysed in the following passages. Chapter 4 will also conclude the most essential findings with a focus on motivation of NIS actors, entrepreneurial culture and trust in the process of coordination.

CHAPTER 4. INNOVATION-DRIVEN ECONOMIC DEVELOPMENT OF UKRAINE: ENABLING THE TRANSFORMATION

There are compelling pieces of evidence demonstrating that Ukrainian NIS mainly revolve around the government pillar, which continues to be considered as the sole pillar establishing the institutional set-up. A widespread belief that the government can step in and present the best choice for the market to correct NIS development takes prominent place in Ukrainian literature on innovation-led growth. Even though NIS concept is putting firms in the centre, Ukrainian scholars continue assuming the greater foresight of the government in comparison with the market players, which is similar to the central planning and has been widely practised in the USSR. This approach has to be weighed against low quality political institutions, as well as other drawbacks, which make the process of leadership and coordination of NIS development very difficult if not impossible. Moreover, in author's opinion, all the recommendations, even though highly valuable, which exclude the role of the other pillars and their actors in shaping institutional set-up, fail to capture properly the factors driving the real transformations in the economy.

The key findings in Chapter 3 demonstrate low quality of political institutions in Ukraine. In particular, poor regulatory quality, and control of corruption, which are the crucial factors influencing the pillar of Research and Academia and Business pillar. Returning to the hypothesis formulated at the beginning of this study, it is now possible to state that weak political institutions in Ukraine are unable to stimulate NIS pillars development. Further qualitative analysis confirms these findings and contributes additional evidence that suggests the great importance of informal linkages. Therefore, this Chapter elaborates on the weaknesses of NIS analysis in the Ukrainian literature and contributes to existing knowledge in this field while reconsidering the role of the Government pillar in designing institutional set-up in Ukraine.

The second hypothesis of this dissertation holds true only partially. The vast majority of firms do lack the capacities to acquire, assimilate, transform and exploit the external knowledge. The low level of firms' potential absorptive capacity causes virtual absence of the innovative products. However, the most innovative sector globally, and

the fastest growing sector in Ukraine – IT sector – demonstrates sufficient differences. The experience of IT sector brings important insights regarding the importance of linkages in NIS between the pillars and the actors. It also shows the role of intermediate organisational forms.

In this Chapter the author focuses on informal institutional arrangement of the NIS development and elaborate more on the mechanisms, which were successfully implemented by the IT firms. The Chapter concludes with the policy recommendations.

4.1. Trust and linkages in NIS: redefining the role of the Government pillar

The important thing for Government is not to do things which individuals are doing already, and to do them a little better or a little worse; but to do those things which at present are not done at all.

John Maynard Keynes (1926)

According to the OECD, the role of the government is to foster a sound environment for innovation, remove barriers for innovation development, enhance technology diffusion, promote networking, groups and instruments of influence in research and development. Recent research of the World Bank "Innovation Policy: A Guide for Developing Countries" suggest that innovation is a plant, so government has to play a role of "gardener", who has to create an "overall climate that helps innovative initiatives flourish and grow". New approaches to innovations' coordination and management provide a qualitative change from the usual function of "state as investor" to "state as coordinator" for interaction between all participants in the innovation process.

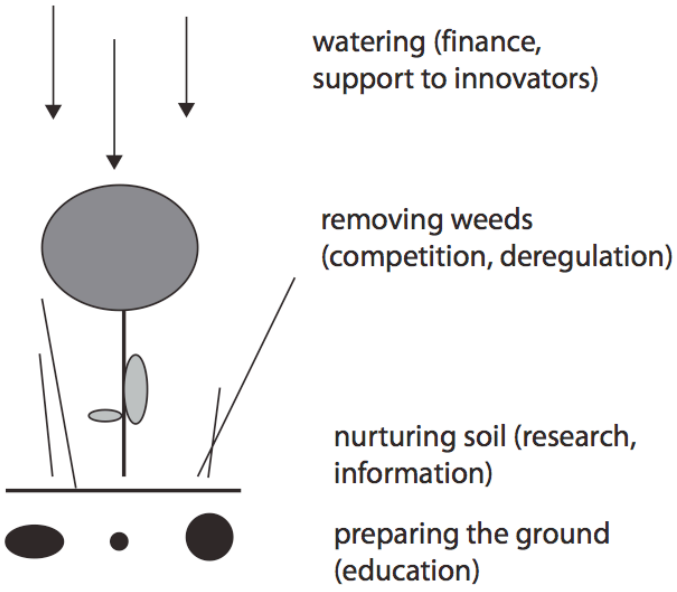

Figure 21. Gardening innovation
Source: World Bank "Innovation Policy: A Guide for Developing Countries"

However, there are also arguments that support the proactive and decisive role of the government. For example, arguments provided by Mazzucato (2012) explain that state can and has played the key role. In developed countries (such as the USA) the government was a "leading agent in achieving the type of innovative breakthroughs that allow companies, and economies, to grow, not just by creating the 'conditions' that enable innovation" (p. 18). The government was investing in the very early stages in pharmaceuticals and biotechnologies, computer industry and internet, nanotechnologies and other innovative sectors. In the USA public sector grants were the first investments for Google's algorithm (National Science Foundation), Compaq, Intel and Hewlett-Packard (Small Business Innovation Research programme). The government was investing at the early stage and continue supporting basic research, which venture capitals or business angels were not entering. Moreover, the state was playing the role of "picking the winners" and giving directions to the innovations, while venture capitals were rather "surfing the wave". In her opinion, as innovations are characterised by "Knightian uncertainty" it is impossible to calculate the risk and forecast the probability of economic success. Therefore, it is unlikely to expect that profit motive of the market will lead to the innovation growth. However, we can hardly agree with such approach in

the case developing countries, with weak institutional environment. And after a closer discussion with Mazzucato, professor has agreed on the role of the government which it used to play and continue playing in Ukrainian realm.[11] Therefore, author would like to draw a particular attention to the importance of recognizing what should be the role of the Government pillar in Ukrainian NIS and what roles can be given to the other pillars.

This is particularly relevant for the topic of Ukraine's economic transformation, as state-governance continuous to be very inert to changes. Studies such as that conducted by Solonenko (2016) show that Ukraine's government dysfunction and poor record of reforms are deeply rooted legacies. After the fall of the Soviet Union, the neopatrimonial regime was established. Rent-seeking political businessmen and neopatrimonial bureaucrats were using administrative resources to defeat political opposition and eliminate economic competitors (Fisun, 2016). Not surprisingly, they were interested in maintaining the status quo to keep their spheres of influence and control capacity. Therefore, the reforms, which require systemic change, met fierce resistance.

Weak government institutions and imitation of reforms led to the phenomena of "captured state"[12]. A situation, where access to public resources is granted to a limited group of individuals (usually oligarchs from post-Soviet nomenclature elite), who have strong influence on decision making of public institutions. This explains monopolization of entire sectors, abuse of rule of law, and corruption. The results of the Crony-capitalism index (The Economist), analysing the source of the wealth of the world's billionaires, explicitly demonstrates a strong relation between political instability and cronyism in Ukraine. It ranked number 5 in the world, as the wealth of crony capitalists[13] accounts 85% of country's annual GDP. Among the industries which are the most vulnerable to crony capitalism (the most rent-seeking sectors) are coal, palm oil and timber; oil, gas, chemicals and other energy; ports, airports; steel other metals, mining and commodities. Even though this index is not recognized internationally due to the number of limitations, it gives the general understanding of the scope of the crony wealth in Ukraine.

[11] The discussion with prof. Mazucatto took place during the YSI INET Conference in Budapest, October 2016.

[12] "... situation in which decisions are made to appease specific interests, maybe even through illicit and nontransparent private payments to public officials, rather than to suit the national interest aggregated and mediated through a democratic process. State capture takes place when the basic rules of the game are shaped by particularistic interests rather than by the aggregated national interest". Encyclopaedia Britannica, retrieved from: http://www. britannica.com/topic/state-capture

[13] individuals who earn their riches thanks to their chumminess with government

Poor democratic practices, combined with excessive bureaucracy, make governance system of Ukraine extremely inefficient. Regulations continue being unconducive to innovation, while elites extract resources to reduce the ability of the other members to question the power they maintain. The systemic failure in Ukrainian governance pillar refers to Ukraine's path-dependency and both political and technological lock-ins.

Lack of trust and credibility to the Government pillar questions its leadership and coordination potential in NIS development. In the following sections we will focus more on trust and credibility of the Government pillar. And, secondly, on coordination roles of the Government pillar and actor's motivations in NIS.

4.1.1. Trust and credibility of the Government pillar

As innovation process is highly uncertain, the trust plays crucial role in NIS. Trust is considered to be the major driver of the cooperation, due to its tacit nature, which relies on shared norms and values (Ganzaroli, 2002). We assume that due to the lack of credibility of Ukrainian government, one can question its leadership in shaping the institutional set-up. Constant change and ambiguity cause short-term horizon of economic actors, which in its turn, hamper the innovation-driven growth. This assumption is supported by OECD findings, which demonstrate the positive correlation between the confidence in national government and perception of government leadership: the greater is the confidence in the national government, the greater is the approval of the government leadership (OECD, 2015).

In Ukraine, public opinion polls show that citizens do not trust the State. Moreover, this perception has a negative trend. In 2015 over 90% of citizens responded that state/government is not fulfilling its obligations to citizens, 93 % of respondents thought that they could not trust the state/government to do what is right (Berenson M., 2016). This is particularly vivid in our qualitative findings: the respondents have very negative opinions on the government as a whole and its separate governing bodies. There is no trust to the new government, as interviews took place after the Maidan revolution. Moreover, Respondent #3 clearly articulates that:

"We had a hope the new government will change something, but the things are the same if not worse".

This negative attitude turns into the perception of the Government pillar as the enemy to business. Thus, the biggest expectation of 70% of respondents, related with the government is that it does not disturb the IT sector. In author's opinion, this is a troubling trend, as it may further lead to the "exit strategy" of the Business, which in its turn may have very negative consequences for the whole NIS.

Another big issue is the accountability of the Government pillar. Both quantitative and qualitative findings demonstrate that corruption jeopardize NIS functioning and further development. OECD findings suggest that correlation between confidence in national government and perception of government corruption is inversely proportional: the bigger is government corruption, the lower is the confidence of the citizens to the national government (OECD, Government at a Glance 2015). Business perceive cases of public resources misuse extremely negatively.

The lack of trust dramatically increases uncertainty and instability thus hampering mutually beneficial cooperation between actors. The negative expectations of business from government reinforce shadow economy sector, tax evasion.

"What will they do with my money? I know better ways my company can invest in the education of future workers!" Respondent#3

Partially that is how the proverb "Only fools pay taxes" (Тільки дурні платять податки (in Ukrainian)) has gained such a popularity. The business does not see the incentives to pay taxes, as they know that the corruption on the highest level is widespread. The logic of this sequence is if government officials keep their money offshore, evading taxes, why should I pay them?[14].

This is the trap of cultural inertia. The behavioral norm of the economic actors continues to be stable, however not in the favor of paying taxes. Entrepreneurs feel that it is disadvantageous to deviate from the norm. The punishment for a norm deviation in the country, where no-one is paying taxes, is obvious - less profit. The coordination effect, described as a norm fixing mechanism (Polterovich, 2000), reinforces this relation: the

[14] The recent declaration of incomes in Ukrainian officials with a platform proZZoro confirmed many expectations among the citizens on undeclared financial assets on the government officials, who can not explain the origin of their money.

more entrepreneurs avoid paying taxes, the more tax evasion becomes socially acceptable This phenomenon is closely related with a linkage effect: as norms are closely related with the multitude of other rules and may trigger changes on different levels. Consequently, such institutional traps increase transformation costs in the whole system.

As we find in our quantitative results the control of corruption has negative impact on pillars development. In practise, our observations show that corruption recreates itself in various forms. The more the Business pillar is facing it, the more often it comes up with "creative" solutions. In the classic institutional literature, it is argued that the largest advantage of having transparent, rule-based institutions is to eliminate uncertainties which in turn decreases the transaction costs, thus lowering the production and operation costs (North, 1990). And as the institutional set-up is of such a low quality, the actors in Ukraine use elements of corruption to ease the way of doing business. Again, results reaffirm our qualitative analysis, showing that control of corruption in Ukraine has no positive impact on the quality of NIS pillars and overall development. As it appears from our interviews, Business representatives find it easier to pay the bribes in advance to avoid the possible black-mailing by the Government.

4.1.2. Motivation of actors and NIS coordination

Overall, the social capital and trust are linked to the motivation of the actors. Credibility of the government policy, in particular its sequence, impact actor's expectations, optimistic or pessimistic, willingness for the co-operative action. Lack of financial stimulus for innovative products and services can be one of examples. As the motivation of actors in NIS pillars varies, depending on their strategic short-, or long-term views, if business is not expecting any incentives from the government to purchase or implement innovation, they would rather pick a short-term horizon, aiming to increase the profitability utilising already existing products/services. This is one of the reasons the large companies were not interested in innovation and continued to play minor role in R&D investment themselves. High level of uncertainty together with weak judicial system and unsecured intellectual property rights restrain foreign investments. Lack of substantial financial stimulus can also demotivate actors in the Research and education

pillar. Tiresome bureaucratic procedures, lack of modern scientific equipment and chronical lack of adequate compensation for researchers, discourage R&D activities. The enthusiasm of young researchers, aiming to stay in science is diminishing each year. At the same time, the lack of demand from the Business pillar for highly qualified personnel furthermore deteriorates development of Research and education pillar.

Different set of policies can be used to engage actors into mutually beneficial cooperation. The successful coordination of their actions can be achieved by understanding in-depth of actors motives. Moreover, these motives have to be accepted by other actors. The important feature is coherence of motives, not the enforcement of certain behaviour models or patterns by the dominant pillar.

Informal norms, such as trust and reciprocity, social capital in a broad sense, are crucial elements, which can facilitate effectively cooperate between NIS actors on both, national and regional levels. So far, the coordination of NIS is highly centralized on the national level, leaving very little room for the regional initiatives. The current state of the coordination re-produce ineffective links and lead to overall network failure. Therefore, in author's opinion, the coherent coordination of the government's responsibilities need to be realised via regional innovation systems and/or regional research councils, acting on the local level.

4.2. Shifting the focus: the role of institutional entrepreneurs and linkage organizations

'How can actors change institutions if their actions, intentions, and rationality are all conditioned by the very institution they wish to change' (Holm, 1995)

The institutional logic is inherited from the past, and, as long as it constrains actions, it can also be the source of change. According to Friedland and Alford (1991) actors can develop new institutional arrangements by recognizing failures and low performance of the current institutional arrangements. Existing institutions enable actors to construct new institutional set-up (Campbell,1997).

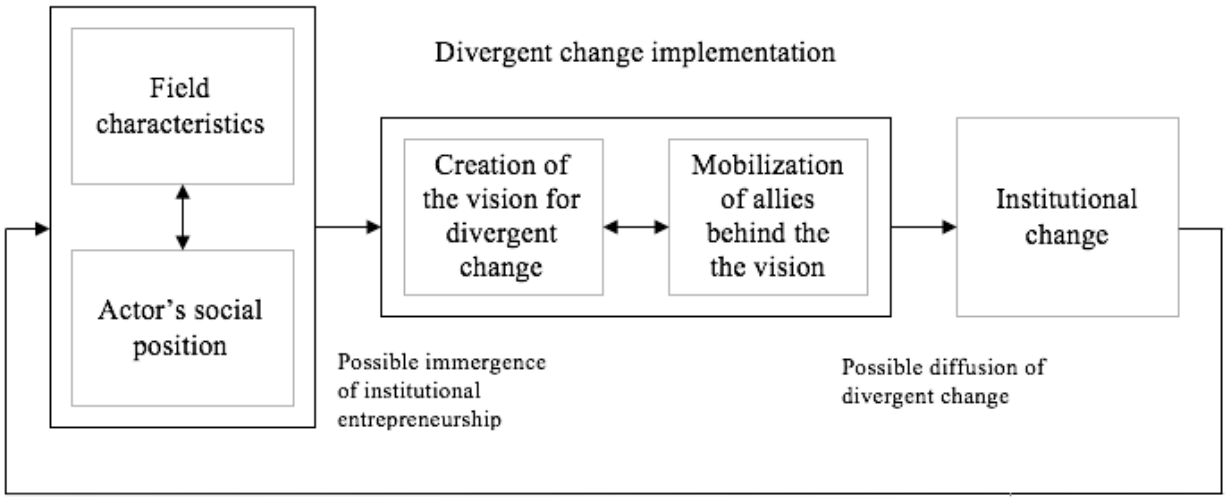

Fig. 22. Model of the process of institutional entrepreneurship.
Source: Battilana et al., 2009, p. 87

Following DiMaggio (1988) arguments we consider that actors in NIS pillars can modify old institutions and/or create new ones. In particular, we can consider IT firms in Ukraine as institutional entrepreneurs, because of their potential to tie "the functioning of disparate sets of institutions together" (DiMaggio, 1988, p.14) and to create the vision of divergent change and mobilize allies behind the vision (Battilana et al., 2009).

Despite the certain degree of inertia, from witch it is difficult to depart, IT firms managed to mobilize recourses and other actors to construct informal institutions. In particular IT firms fostered collaboration with the Research and academia via formal and informal cooperation in education, encouraging workers' mobility, sharing facilities[15].

IT firms managed to integrate the necessary courses into Universities curriculum and/or establish separate laboratories for the advanced schooling for the students. Besides they supported creation of dozens of private IT schools. The firms were contributing not only to training and retraining of the students, but also to co-financing the University personnel. The cooperation between lecturers and business segment went to totally

[15] This evidence form the IT sectors is important and can serve as guiding mechanism for other sectors. We are fully aware that IT sector has its own peculiarities, such as low entry costs, easy access to international market, ability to attract foreign capital etc, and practises can not be easily translated to other innovative sectors, in particular when it comes to the fundamental research where government traditionally plays the key role.

different level, driven by the idea to prepare the best students for the market needs. These steps were taken by Business pillar without the government support.

Moreover, IT firms managed to develop networks, which gradually enhanced the knowledge flow in NIS. IT firms managed to establish associations to support their activities, like Internet Association of Ukraine (e-commerce, e-government); The Association of Information Technology Enterprises of Ukraine (R&D, e-commerce); Information Technologies Ukraine (outsource, R&D); IT Committee of European Business Association (outsource, R&D); Ukrainian Venture Capital and Private Equity Association (startups). Moreover, dozens of firms united in regional clusters all over Ukraine in Lviv, Kharkiv, Odessa, Dnipro, Cherkasy, Lutsk. The quality of the linkages between pillars in NIS are as important, as the quality of pillars themselves. Networks and linkage organizations boost firms' absorption capacity, both potential and realised. Firms' cooperation in the complex network of NIS pillars and actors build up the capacity to value, assimilate, and apply new knowledge (Cohen, Levinthal, 1990). We consider the success of IT firms particularly important because of it demonstrates the effects of such cooperation.

Absorptive capacity of firms can develop through different channels. International cooperation and the demand on the foreign markets across the globe has reinforced innovation-led development in Ukraine. IT sector rapidly developed due to outsourcing potential on demand of foreign companies and markets. As this development was not stimulated by the demand on internal market, there is a number of negative assessments of the outsourcing model it relation to Ukraine's economic development. However, author's assessment is different. Besides the direct money flows, generated via international projects, IT sector went through the stage of active learning, understanding of the mechanism and principles on the international arena and now has a potential to produce its own products and services. The stage of active learning is incredibly important as if we consider the transformation in the economy, we have to understand that it is merely possible for country to "jump" from the non-innovative stage to innovative leaders. Ideas on innovation do not come up from nowhere. Outsourcing made possible the market development, but most importantly it contributed to better understanding of business models, needs and expectations of the customers in the

national and international markets. The stage of studying is important not only for the engineering or business skills improvements but for the entrepreneur culture. The results of gradual learning are new ideas. However, it is expected to see the gradually demand on the internal market. That is why we can observe a development of Ukrainian IT start-ups, which are also becoming successful abroad. In other sectors such as agriculture, automotive sector and e-governance we can also see a progress but it is much slower. This supports the arguments of Arthur (2009) on the pace of technological change, which has accelerated speed in the sector of Information and communication technologies, IT in particular.

4.2.1. Re-shaping institutional set-up: horizontally integrated NIS

Based on our findings and following the example of the OECD model, we suggest to shift the focus in Ukrainian NIS to Business pillar and networking schemes, that adverse interactions between the actors and the interplay of pillars. The proposal is illustrated at the Fig. 23. In author's view the role of the Government pillar can no longer be defined as "to establish and reinforce interoperability of all NIS", as defined by the Concept of NIS development in Ukraine. To avoid the top-down governance and decision-making model, we put the Business pillar and its actors in the centre, allowing to design the possible horizontal linkages between the sub-pillars, and introducing intermediate organizational institutions for the enhanced cooperation. The second reason of putting Business pillar in the centre, is the example of firms, that can act as entrepreneur actors, willing and being able to re-shape the institutional set-up.

We consider that linkage institutions, such as accelerators, incubators, techno parks, spin-offs and clusters can play important role in linking all the pillars, enhancing the cooperation between the actors. Besides, public procurement of innovative products and/or services can shorten the gap between Business and Government pillar. In our opinion, the lack of effective linkage mechanisms adversely affects the NIS functioning. As there are only certain elements of networking mechanisms in Ukraine, independent consultants, brokers as well centres of science, engineering and economic information must be promoted and encouraged. As well as national and regional thematic platforms,

centres for information exchange that can potentially play important role in the international cooperation. We believe this illustration will allow to expose more accurately the Ukrainian NIS and identify pitfalls, that are hampering the coordination[16].

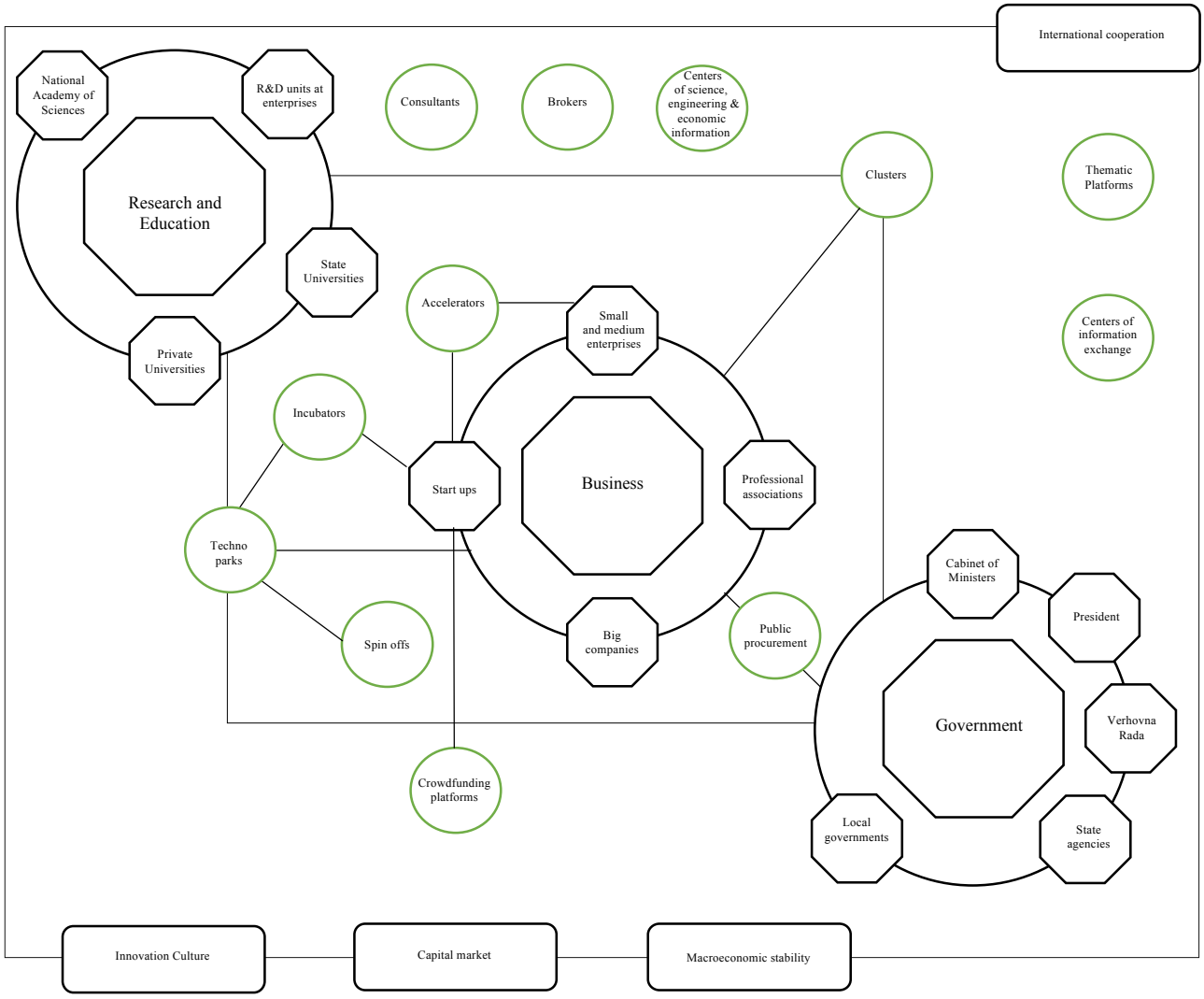

Fig. 23. NIS of Ukraine: pillars, linkage organizations and framework
Source: composed by the author

[16] The illustration is an author's interpretation of major pillars and actors in Ukrainian NIS. Due to the high NIS complexity and dissertation focus, some elements might be omitted.

4.2.2. Closing the gap: bringing together the actors from NIS pillars

As science continues to be isolated from the market needs, research cooperation between business and research and education pillar is virtually absent. Despite the availability of databases of patent offices, enterprises often do not have access to information on research that is taking place in universities and research institutions. There is a lack of cooperation in the framework of joint research programmes or business training. One can argue about the lack of effective communication between research institutions and business on needs and possible scientific developments to solve problems.

Thus, in the alternative model, author suggests to pay special attention to business incubators, accelerators, spin-offs and science parks that can facilitate the development of early-stage, growth-driven innovative firms, bridging the "missing middle" between fundamental research and technology commercialization. Intermediate elements can help to eliminate the bottlenecks of technological, financial or cultural development, while operating on the boundaries of different NIS pillars.

Business incubators and **accelerators** play very important role in the early stages of new companies' development, which include, but not limited to, strategic planning, financial planning, market research, marketing assistance, mentoring and other prerequisites to running the business. Both incubators and accelerators are aimed at helping firms to become revenue-generating companies. However, they have different structures which correspond to the stage of development. Business incubators are mainly focused on the start-ups that are at the initial stage of development (so they "incubate"), while accelerators work with companies which went from idea to minimum viable product (so they "accelerate"). Accelerators offer very intense and immersive programmes within a fixed timeframe (usually few months), which result in demo-presentations of the companies in front of investors. In the business incubators mentorship is minimal or tactical, participants can stay in incubators as long as they need to develop their ideas in learning-by-doing way. Business incubators can be co-sponsored by government entities, academic institutions. They can be also run as for-profit programmes by private sector.

Overall, there are around 15 incubators/accelerators in Ukraine, however not all of them are active. Mainly they are focused on startups working in IT sector, while the other sectors are being left without a proper attention. Random events take place to promote entrepreneurship and creativity in Ukraine. Largely due to embeddedness of IT in other sectors, events like hackathons[17] give the impetus for creative solutions in various sectors, like governance or finance. Meanwhile, these initiatives are rather spontaneous, lack long-term strategy and have very limited effects.

One of the success stories is Sikorsky Challenge programme, initiated by Kyiv Polytechnic Institute. Sikorsky Challenge is a trinity of startup school, incubator and venture funds. The school is dedicated to entrepreneurship and business education. It is a two-month programme, free of charge. Incubator programme helps entrepreneurs to validate their ideas and the funds are secured to provide the seed funding support for selected teams.

Spin-offs and **science parks** (also called techno-parks) are specialized at gaining profit from knowledge and technology transfer. Spin-offs are generated within universities or public research organizations. Usually, the founders of spin-offs are public sector employees, public sector students or alumni. Spin-offs commercialize inventions by translating research results to workable market solutions. They can also license technology from a public institution. However, such form of intermediate institution is absent in Ukraine. Instead, there are number of science parks, which provide value-added business services and facilities for the growing companies. They use incubating and spin-off processes to enable knowledge commercialization. Science parks serve as catalysts for the regional clusters development and have great potential to contribute to the innovation-led growth by disseminating and commercializing research results.

According to the official data, there are around 30 science/technoparks in Ukraine, however, the experts underline that such number is overrated. The preferences, which were first introduces by the Government of Ukraine to facilitate their development, were soon cancelled. The lack of a sustainable business strategy on their further development has undermined the idea of their involvement in the innovation eco-system.

[17] Hackathon is a linguistic blend of words "hack" and "marathon". The first is used in the sense of exploratory programming.

There is a growing need in the **offices of interaction** that could actually provide brokerage services, present newly developed technologies or solutions from the pillar of Research and Education; search of interested customers; provide consultations on intellectual property rights. The successful experience of cooperation between universities and liaison offices be seen by the example of Max Planck Innovation in Germany.

Clusters play important role leveraging trust among the members of the same community. This may result into reduction of transaction costs (Ottati, 2005), as well as motivate participants to share ideas and combine knowledge between each other (Inkpen & Tsang, 2005). Thus, advantaging social cooperation and cooperation mechanisms (Tsai, 2009), contributing to the collective innovative capacity.

Clusters unite actors of all NIS pillars, contributing to the co-operative behaviour. Business actors find clusters important place for cooperation, where they can discuss common problems, plan joint actions, come up with proposals and strategies. Inter-firm cooperation and face-to-face interaction between the actors increase the flow of un-codified, tacit knowledge and create productive linkages within a cluster (Giuliani, 2003). Trustworthy relations in clusters support collective mechanisms of co-ordinations. In particular, this is important for inclusion of the representatives of the local government. As actors of the cluster operate in the geographically bounded area, they contribute to the de-centralized governance and regional growth.

Cluster development in Ukraine is still at the early stage. The programmes of the regional development recognize the importance of cluster approach in the innovation growth. However, there are no cities, except Lviv, which have implemented cluster approach in the Strategy of City growth.

The examples of linking institutions mentioned above have not been selected randomly, as they all have proven to work for the IT sector: from incubators to clusters. The author considers that these linkage organizations have a great potential to enhance cooperation between the pillars and the actors in Ukrainian NIS.

There is a certain extent to which entrepreneur actors can re-shape the institutional framework. While initiating changes, if not supported by the transformation in other sectors, they may never come into life, take longer time or be neglected at all. That is

why, despite the negative perception of the Government pillar, author considers that there are concrete steps that the government can do to facilitate the NIS development, in particular via indirect support.

4.3. Nurturing an innovation culture: invoking innovation-led growth

The discussion on innovation culture usually takes minor place within NIS analysis, in particular in developing countries. While focusing of formal institutions and framework conditions, such as macroeconomic stability or capital availability, cultural factors are often overlooked. Analysed studies on Ukrainian NIS have not treated cultural factors in detail, and failed to describe its role in county's growth. In this research author focuses not only on formal, but also informal institutes and institutional arrangement, as she finds it important to demonstrate the impact of innovation culture in NIS development and innovation-led growth.

As shown in OECD publications, innovation culture, which represent the society's attitude to creativity, risk taking and entrepreneurship, willingness to change, openness to new information, is an important factor of innovation-led growth. Culture creates preconditions for innovation development and diffusion. Thus, cultural factors may both facilitate or discourage: (1) new ideas and creation of innovative products or service; (2) the adaptation, use and dissemination of new products and services in a society (Gee and Miles, 2007). For instance, the fear of failure, negative attitude towards risk may affect the rejection of innovation in a society and hinder the innovation performance on the national level.

According to Gee and Miles (2007), cultural factors can be studied in spatial and organizational dimensions. Spatial dimension refers to geographical context and applies to innovation culture on national, regional or city level. That is how cultural factors can explain differences in innovation performance not only among countries, but also among regions or cities within the same country. Organizational dimension refers to organizational level from both public and business sectors and entails managerial and organizational practices, mechanisms of motivation to innovate. Numerous studies underline that the culture of organization shapes innovation development to a great extent

(Ahmed, 1998, Tushman and O'Reilly, 1997, Smith, 2006). Van der Meer in his studies show how regulations inside organization can impact attitudes and values (summarized in Table 10). This dependence also holds true the other way round: organization's culture shapes its rules and regulations, i.e. the decision making process, planning and communication, company's strategy and orientation.

Table 10
Factors important to an innovative climate

Negative		Factor		Positive
short	←	horizon	→	long
kept out	←	maverick	→	accepted
punished	←	failures	→	tolerated
formal	←	communication	→	informal
kept out	←	uncertainty	→	accepted
analyses	←	planning	→	action
means	←	planning	→	opportunities
closed	←	external co-operation	→	open
autocratic	←	decision-making	→	participative
internal	←	orientation	→	customer
vague	←	strategy	→	clear

Source: Van der Meer, H. (2007), p. 192

In Ukraine, the country where innovation process was detached from the market for decades, entrepreneurship and innovation culture are seriously constrained. As inventions were produced within a framework of the planning economy at the big state enterprises, the tradition of personal initiative was very low, as well as assumption of personal responsibility. Until 1991 introducing innovation for the military and industrial complex, was not regarded as a solution leading to the commercial success (Dehenkari and Solovyov, 2011). At the same time, the principle of punishing for "less than ideal" outcomes, caused a virtual absence of the innovative culture.

In this section author would like to focus on the impact of innovation culture for both creation and absorption of innovation, presenting our finding on individual and organizational level. Despite the fact that impact of individual entrepreneurs on innovation-led growth is limited and can not be adequately compared with the impact of large companies, conducting R&D activities, we consider this dimension to be important in the transformation process of Ukraine's economy. Innovation and technology

absorption on the individual level can be decisive in all organizational structures, and society on a large scale.

4.3.1. Risk acceptance and fear of failure

Soviet legacy is resilient when it comes to the risk taking and showing initiative in risk-taking ventures among Ukrainians. Ukrainians demonstrate very low risk acceptance and very high fear of failure. They are not showing readiness to become self-employed, particularly in risky, innovative sectors. While the proportion of the population willing to start a business is low, the likelihood of their success is also very low. According to the EBRD research (2012) only 5% of entrepreneurs from Ukraine report successful set up (while the same percentage in Western Europe this is markedly higher - 16%). Among the cultural factors, inherited from the Soviet times, one may underline the following:

4.3.2. The image of entrepreneur in the society

The image of entrepreneur had a negative connotation in the society. Usually it was associated with a dealer, who wants to buy cheaper and sell more expensively various items, providing no additional value to them. It is important to note that this image was predominantly indoctrinated by the political regime, as the entrepreneurship was forbidden in the USSR. A few categories of people were falling under this type of activity: (1) people, who had foreign currency, called "valyutchik"; (2) people, who were buying and re-selling deficit products from abroad, called "farcovshik"; and (3) people, who were producing goods on their own, called "cehovshik". This kind of activity was prosecuted and if caught, "entrepreneurs" in today's understanding, were sent to jail. Entrepreneurs had to cheat and dodge. There was no doubt that for their successful economic activity they will be punished [18].

[18] The most known case of Rokotov and Faibishenko demonstrate how USSR was fighting with foreign currency operations. In 1961 these young men were sentences to jail for 15 years with a confiscation of the property and later on faced death penalty. Among the chargers were foreign currency operations and jeans trafficking. As it was established by the Court "Rokotov and Faibishenko led parasitic type of life and enriched themselves through the benefits created by the working people", as cited in Feofanov, Y., & Barry, D. D. (1996). *Politics and justice in Russia: major trials of the post-Stalin era*. ME Sharpe, p.30

In author's view this fear is still present among Ukrainian entrepreneurs. Entrepreneurs are afraid of showing financial success, explaining that

"...government does not like when someone is richer than they are … They are only looking where to get the money from", Respondent #2

"They know we have money", Respondent #7

This fear is reinforced by the lack of trust to the government and lack of respect to all the existing structures. This is only recently when young people started openly declaring the desire for the economic autonomy and self-employment in Ukraine, largely due to start-ups business model.

4.3.3. The carrier choice

As individuals have to chose between traditional profession and entrepreneurship, they prefer to avoid high personal responsibility. Traditional professions are also associated with stability, even if this stability is not rewarded financially.

Do not look for a perfect job – create it yourself! This popular motto in European countries, which is being more and more often addressed to young people is difficult to adopt in Ukraine. The narrative (left from the Soviet times) says that government has to take responsibility for that. The public sector was securing first education and then working places, usually through the mechanism of redistribution of alumni across the USSR. After the graduation, students were directed to different state-owned firms, factories or institutions. Therefore, showing the initiative and creating own business, in particular among the young generation, was very rare, even in the beginning of 90th. This trend was consequently reinforced by the lack of available funding schemes and financial mechanism directed to potential entrepreneurs. That is why individuals, who were starting entrepreneurs in the modern Ukraine were considered as necessity entrepreneurs rather than entrepreneurs

4.3.4. Entrepreneurial Skills

Even though Ukrainians are well-educated, the university degree is not seen as a proxy for successful venture. As entrepreneurial skills, in particular management, strategic and leadership skills, which are key for successful long-term development of companies, can not be acquired in-class, the role of formal education in teaching business acumen is limited

Very often the fear of the risk taking is caused by the absence of appropriate knowledge and understanding of the business principles. In practice, entrepreneurs do risk assessment and risk management, what is making them rather "calculated" risk takers. Ukrainians lack knowledge on growth strategies, investing mechanisms of the companies, strategies to establish and maintain a competitive advantage, scaling and internationalization of their business. As these courses are not expected to be included in the University curriculum, in is rational to substitute the by informal education, private business schools, MBAs etc.

One of the main conclusions of the qualitative study was an evident lack of entrepreneur culture and skills among the respondents e.g. their inability or (sometimes) unwillingness to create their own products. This explains their choice of business model relying on massive outsourcing and outstaffing of IT specialists Lack of entrepreneurial skills together with limited investments pool, increase the fear of failure. Therefore, innovation culture must be further studied Author's proposals on improving the entrepreneur culture in Ukraine are presented in the section 4.5.

4.4. International cooperation

International cooperation is an important proxy of the openness of the country. These days, globalisation is accompanied with intensification of knowledge flows via foreign direct investment, patents and licenses, international mobility of researchers, co-patenting and co-publication. International cooperation can bring a number or direct and indirect benefits for the NIS, in particular, transfer of best practices, know-how and technology. This applies both to (1) Business pillar due to increase of exporting potential

of the business and penetration of foreign markets, as well as to the (2) pillar of Research and education through internationalisation of research institutions and universities of Ukraine, which is crucial for mobility of Ukrainian scientists, their education and training, opportunities to share the knowledge and experience. That is why author integrates international cooperation in the NIS scheme, as the important framework condition. In the following passages we will consider Ukraine's experience in the international cooperation and the recent results.

Ukraine has signed bilateral and multilateral agreements of cooperation in the research, science and technology with different countries, international organisations and foundations such as CERN, NATO, UNESCO, US Civilian Research and Development, Joint Institute for Nuclear Research (JINR), the International Committee on Space Research (COSPAR) etc. (European Commission, 2016). One of the most important strategically partner for Ukraine is the European Union (EU). Ukraine is pursuing a policy of European integration and aspires to become a member of the EU, thus particularly welcoming the idea of strengthening co-operation with the EU in scientific exchanges, distribution of information and participation in joint research programmes. Cooperation between Ukraine and the EU in research and innovation is also vital because of significant experience of the EU in shaping innovative and competitive economy.

The Agreement between Ukraine and the EU on Science and Technology Cooperation (signed on 4 July 2002) together with the Roadmap of cooperation "EU – Ukraine: Cooperation in Science, technology and Innovation" establish the legal basis for cooperation and serve as a framework for dialogue. The cooperation in research, technology and innovation (RTI) between the EU and Ukraine is supported by a number of programmes, namely Erasmus Mundus; Tempus; Jean Monnet Programme; INSC and INOGATE, Cross-Border-Cooperation Programmes etc. Since 1990, Ukraine has participated in the Framework programmes (FP) for research and innovation. Ukraine's involvement in FPs has grown significantly: from 58 projects in FP5 to 148 projects in FP7 (Melnyk and Koval, 2015). Let us have a closer look at the peculiarities of Ukraine's participation in the most recent FP.

Ukraine was undertaking cooperation with the EU in the 7FP cooperation programme during 2007-2013 as an International Cooperation Partner Country. This

means that Ukraine was allowed to apply for EU funding, using the same right as EU-member countries. Ukraine could also fully participate in consortia, while involving EU-member countries or FP7 associated countries in project proposals.

Table 11

7FP, Specific Programmes and Thematic Areas in 2007-2013

Specific programmes	Thematic areas	Budget bn EUR
COOPERATION	Health; Food, Agriculture, and Biotechnology; Information and Communication Technologies; Nanosciences, Nanotechnologies, Materials and new Production Technologies Energy Environment (including Climate Change) Transport (including Aeronautics) Socio-economic Sciences and Humanities Space Security General Activities	32,4
IDEAS	Starting Independent Researcher Grants Advanced Investigator Grants Consolidator Grants Synergy Grants Proof of Concept Grants	7,5
PEOPLE	Initial Training of Researchers; Lifelong Training and Career Development; Industry - Academia Partnerships and Pathways; The International Dimension; Specific Actions	4,7
CAPACITIES	Research Infrastructures; Research for the Benefit of SMEs; Regions of Knowledge; Research Potential; Science in Society; Coherent Development of Research Policies; Activities of International Cooperation	4,1
EUROATOM	Indirect action: Fusion energy; Nuclear Fission and Radiation Protection. Direct action: Nuclear field (undertaken by JRC)	2,7
Joint research centres, Direct actions	Prosperity in a Knowledge Intensive Society; Solidarity and the Responsible Management of Resources; Security and Freedom; Europe as a World Partner	1,7

Source: author's compilation, based on http://ec.europa.eu/research/evaluations/pdf/archive/fp7_monitoring_reports/7th_fp7_monitoring_report.pdf, p.5

The key programmes in FP7 were Cooperation, Ideas, People, Capacities, EUROATOM and Joint research centres (see more in Table 11). The total budget of the programme was 52 billion euros. FP7 was open to research groups, individuals, research organizations, SMEs, public government (local, regional or national level); civil society and international organizations.

According to surveys conducted by experts BILAT-UKR*AINA, FP7 participants positively assessed the scientific and strategic impact of this program. Specifically, 85.15% of respondents believe that FP7 has opened new opportunities for ambitious projects and 55.56% believe it helped science and education. 96.3% of respondents believe that FP7 significantly increased mobility of researchers, as well as it increased scientific reputation of the participants both nationally (77.78%) and internationally (92.59%).

The number of Ukrainian participant varies depending on the thematic area. The largest number of applications was submitted to the “People” programme, Marie Curie Actions (208 applications). The second most popular was “Cooperation” programme and the following thematic areas: Environment, including Climate Change (114), Food, Agriculture and Biotechnology (81), Socio-economic Sciences and Humanities (74) and Transport, including Aeronautics (69).

Figure 24 illustrates an assessment of the intensity of submitted proposals (quantity) and the success ratio (quality) of Ukrainian teams in comparison with participants from the other countries. In other words, it illustrates Ukraine’s participation index (proportion of Ukrainian project proposals within a specific research theme) and success index (success rate of submitted project proposals within a specific research theme). The higher is the index, the better is the quantity and quality of Ukrainian participation. The value of 1 is the average rate, the value over 1 means over average. The size of the circle is proportional to the funding amount provided by the European Commission.

As shown in Fig. 24, Ukraine's participation in programmes People and Nuclear research has the highest index of participation and success, rated above average among the countries participating in FP7 (horizontal line is close to the value of 1). Successful projects at very low participation level are among Regions of knowledge; Science and

society; The research infrastructure. The results of Ukraine's participation in such thematic areas as International cooperation; Space; Energy; Transport; Socio-economic Sciences and Humanities; Environment; Food, Agriculture and Biotechnology are placed in the lower right quadrant. This means that the high level of participation is usually accompanied by low levels of success. However, these potential trends may develop in the future. The least successful areas of cooperation, characterized by low-participation index and low success index, are the research and development of SMEs and Information and communication technologies (ICT).

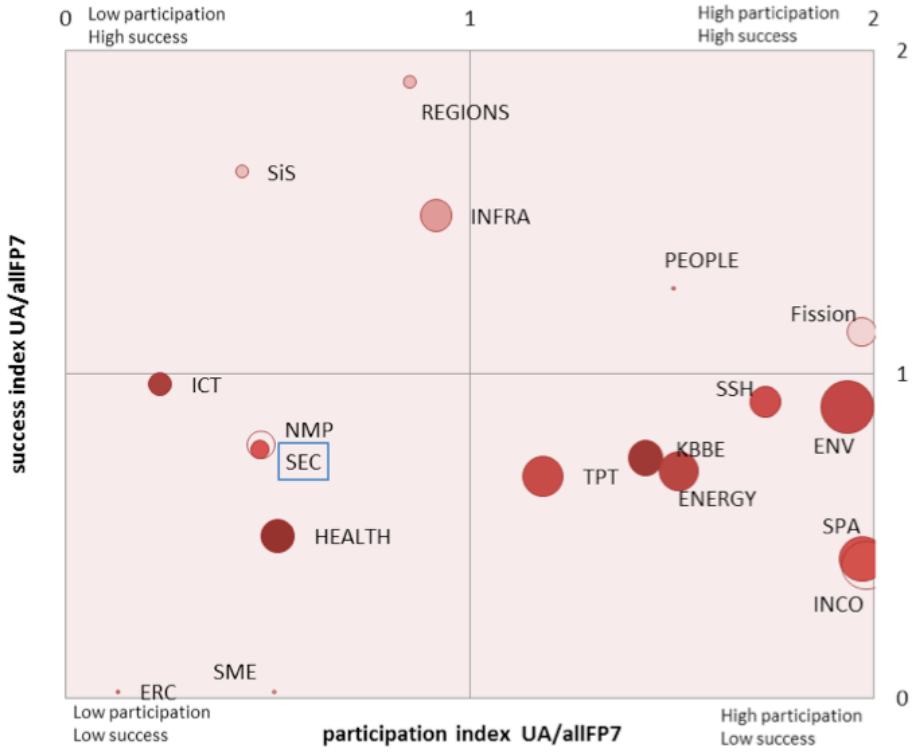

Fig. 24. Intensity of FP7 participation and success ratio by specific programme
Source: BILAT-Ukraina (2014), p. 14.
Acronyms: HEALTH – health; ENERGY – energy; ENV - Environment Including Climate Change, KBBE - Food, Agriculture; ICT – information and communication technologies, SSH - Socio-economic Sciences and Humanities; TPT - Transport (including Aeronautics); INFRA – research infrastructure; REGIONS - Regions of Knowledge; SiS - Science in Society; Fission - Nuclear Fission and Radiation Protection; INCO - Activities of International Cooperation; SPA – Space; SEC – security, SME – small and medium enterprises; PEOPLE – people, ERC – European research council; NMP - Nanotechnology and nanosciences, knowledge-based multifunctional materials and new production processes and devices.

To conclude, the cooperation between Ukraine and the EU in RTI is the most successful in the areas of education, training and career development for researchers. This cooperation is taking place via joint programs of mobility, integration and support

grant programs of Marie Curie Actions. The advanced program of nuclear research, including research on fusion energy, nuclear fission and radiation protection is the second best. Promising areas of cooperation are the program of cooperation that provides the creation of international consortia of industrial and academic communities, particularly in thematic areas of Environment, Socio-economic Sciences and Humanities, Transportation, Energy, Food, agriculture and biotechnology. However, Ukraine needs to strengthen cooperation in such promising areas such as Research for SME development; and ICT.

Prospects for further cooperation

Since 2014, the EU launched a new program - Horizon2020. It is designed for consistent implementation of the Europe 2020 Strategy and the Innovation Union initiative from 2014 to 2020. The total budget is 87.74 billion euros. The program will bring together existing programs EU for research and innovation (the Research Framework Programme, Competitiveness and Innovation Framework Programme, and EU contribution to the European Institute of Innovation and Technology).

In the new program, the EU will continue to apply the principle of universal openness, to facilitate Ukraine's access to programs. Moreover, in March 2015 Ukraine has signed an agreement on Associated membership in Horizon 2020, which opens the possibility of using all the benefits of the program on the same basis as for the EU. In addition to the financial capacity of the program, Ukrainian scientists can develop now their own project proposals, to be project coordinator and to form research consortia.

Thus, Ukraine will be able to join the following priority areas: (1) Excellent Science - 27818 mln. euros; (2) Industrial leadership - 20280 mln. euros; (3) Societal challenges - 35888 mln. euros (European Commission, 2011). Participation in Horizon 2020, like in previous programs, implies financial contribution of Ukraine (the amount is calculated in accordance with the country's GDP). However, given the difficult macroeconomic situation inside the country, the EU will give Ukraine a 95% discount. Besides the EU provides the return of the remaining 50% of the amount by instruments of international technical assistance.

The analysis of opportunities that can contribute to Ukrainian NIS development under the EU framework programmes for research and innovation, provides enough reasons to believe that the active participation of Ukraine is an important factor that will help prevent technological backwardness and promote faster Ukraine's integration into the international scientific space, in particular European research area (ERA).

4.5. Policy Recommendations

Based on the analysis, the author would like to follow up with the several policy recommendations, which can be implemented to provide the economic transformation.

4.5.1. NIS linkages: closing the gaps

The government policies on NIS development can target 1) market failure, and 2) systemic failure. The first set of policies is directed at stimulating the Business pillar to invest in R&D, while the second one is aimed at tackling malfunctioning of linkages between the pillars, coordination mismatches, which impede innovation development. While policy measures for the market failure are important, we consider policies directed to actors' interaction between the NIS pillars and policies to improve absorptive capacities to be prominent.

Government financial support can take different forms and mechanism to stimulate the innovation development and enable the linkages between NIS pillars. As discussed earlier, current direct financial support is insufficient. Analysing the possible mechanism of indirect government support we can draw the following proposals:

1. Tax preferences for innovative enterprises

To provide tax incentives that promote innovation development one can choose tax credits and/or changes in the tax base; incremental and/or cumulative tax benefits for enterprises engaged in innovation activities. This may include:

- Expansion of the list of items, which can be deducted from the taxable income. For example, R&D investments (patents, utility models, industrial designs, etc.).

- Expansion of the list of operations that may be exempted from taxation. For example, import of new equipment, facilities, and materials that are not produced inside Ukraine.

- Credit support for the innovative enterprises. This can be realized through low interest loans (total or partial) credit compensation (total or partial) for innovative projects.

The state may also provide state guarantees for banks that provide loans for innovative projects.

2. Support and encouragement of the development of new innovative enterprises

New innovative enterprises, such as start-ups (developing as an independent fast-growing innovative business) and spinoffs (developing within academic institution, research institute or another firm) play important catalyst role for the economic development. Often these companies require seed capital. In support of the new innovative businesses, these companies can be granted public loans on a competitive basis, or even creating the development bank.

Considering the fact that the vast majority of universities and research institutes face difficulties with commercialization of their research activities, the government should encourage the creation of spinoff companies. A major impetus for the development of such companies would be the removal of taxation on income from licensing. The funds in the future could be used for upgrading equipment of laboratories of universities and research institutes. Positive dynamics can be achieved by providing preferential taxation for such companies during first years.

3. Public-private partnerships and public procurement

Public procurement can be also used as a demand-based innovation policy mechanism for the implementation of the R&D results in business. Thus, depending on the volume of public procurement, business will have lower risks and clear incentives to present innovative products. To ensure effective cooperation between the state and business, the practice of concluding agreements on public-private partnership should be considered. In particular public funding for business should take place in prioritized industries.

4. As it was analysed, the government of Ukraine provide limited financial resources of the state budget, a priority should be given to the mechanisms of indirect government support and alternative catalytic mechanisms. Analysis of NIS pillars reaffirms the critical lack of economic incentives for innovation development. In

particular, this applies not only to the costs of research, but the costs associated with the introduction of industry R&D results and innovative projects. Thus, financial support for R&D, high-risk innovative projects should be carried out not only with the support of the public sector but also with active participation of private sector and international programs of technology transfer. It is important to create necessary conditions for venture capital and private business angels for the innovation funding. Besides, it is important to encourage crowdfunding platforms, that can serve to fundraise seed investment at the early stages of start-ups. This is particularly important for the social start-ups. It is important that companies providing access to external sources of innovation, including venture capital, accompanied by programs promoting internationalization of enterprises, their participation in international business networks.

Reorganization of innovation infrastructure of Ukraine, consolidation of participants in the innovation process can contribute to the unification of NIS, intensification of flows between the actors and thus enabling effective cooperation.

4.5.2. Entrepreneur culture

Despite the urgent need for policy measures to encourage and motivate creative and innovative potential, development of innovative culture gained no particular attention. The notion of innovation culture was first defined by the Law of Ukraine "On innovation activity priorities in Ukraine". It was described as innovative potential components that characterize the educational level, the common cultural, social and psychological readiness of the individual and society as a whole to adopt and implement creative ideas of economic development based on innovation. However, in 2003 this Law has changed and the new version does not indicate innovative culture as a factor of innovation development in Ukraine any more.

On the one hand, the government can not "create" top-down the innovative culture. On the other hand, we consider political push to play important role for the innovation culture. Therefore, we consider the following steps would need to be implemented by the Government to nurture the innovation culture in Ukraine:

1. There is a need to develop innovation culture in both business organizations and public institutions. That might take place in the form of joint programs and training courses for personnel of companies and public servants. Due to the involvement of representatives of the government in joint training programs with innovative businesses, participants will be able to better analyse case studies and reach a common understanding of problems, which occur during the development, administration, or management of innovation projects.

2. Support of innovators, in particular young inventors and university graduates with technical skills. Unfavourable innovation eco-system (low level of development of innovation incubators, spin-offs and start-ups) often lead to failure to develop ideas and commercialize them in the end. Low level of interest in the young inventors' potential, results in a threat of so-called "brain drain". Development of innovative culture in the society must be accompanied by support for the younger generation and the development of their entrepreneurial talent: from the skills of starting their own business, finding investors and business partners and access to the international markets.

3. Providing trainings to develop professional knowledge and skills, including the development of innovative courses on project management, human resources management and so forth. Particularly important is the knowledge of the management of intellectual property rights and commercialization of public research.

4. Formation of innovative culture by involving civil society organizations, in particular associations of entrepreneurs, to discuss innovative component that ensures the development of the state.

5. Ukraine can use international experience in developing the innovation culture, however rather than simple benchmarking of the best practices, it can use the method of "learning by comparing" (Lundvall, 2001). In our opinion, the EU may serve as an important example of the implementation of policies to support innovation culture and tools to attract private sector to research projects, increasing cooperation between the private and the public sector.

The need to foster genuine innovation culture in the EU was enshrined in 1996 in the "First Action Plan for Innovation in Europe". The document underlines that innovation requires a "state of mind combining creativity, entrepreneurship, willingness

to take calculated risks and an acceptance of social, geographical or professional mobility" (p.3). It also describes the ways the EU can promotes innovation mentality, namely by

- stimulating creativity and a spirit of enterprise via education and training programmes
- encouraging mobility for researchers and engineers to business, in particular SMEs
- engaging business representatives together with citizens in the debates on technological change and innovation development
- promoting the best managerial and organizational methods among businesses
- stimulating innovation in the public sector and in the government.

In 2009, the EU celebrated the European Year of Creativity and Innovation, which aimed to raise awareness among the public about open innovation, cultural creativity and research capacity. Among the measures aimed at the transfer of international experience, the Commission has selected the best projects, proposed instruments to provide training for SMEs in the field of intellectual property rights protection; innovative curriculum in the education sector; training programs for teaching the subject of innovation, regional cooperation in the development of innovations; new ways of business development, based on knowledge. These and many other policy proposals can be also applied in Ukraine.

4.5.3. International cooperation and technological catch-up

There is a great need to place Ukraine's international cooperation among domains of strategic importance. While the NIS development requires the endogenous actions, globalization and the EU political integration and economic cooperation can play important exogenous role. European RTI programmes and initiatives have a great potential to contribute to Ukrainian NIS. Even though they can not directly unravel the challenges already mentioned, they can nevertheless smooth the transition to the innovation-driven economic development of Ukraine in a number of ways.

First, European programmes have a great potential to consolidate the actors in

joint cooperation programmes. Due to the specifics of the framework programmes, the EU strongly supports the involvement of research organizations, business, in particular SMEs, together with the government. Thus, Ukraine's participation in the international programmes can encourage innovation activity in the Business pillar and stimulate the bigger government involvement in projects, in particular on the regional level, and as a result, to facilitate the cooperation and coordination among the actors inside Ukraine,

Second, the EU programmes bring to Ukraine tacit and codified knowledge. Learning interactions, creation of formal and informal international networks of cooperation among NIS actors is highly beneficial for Ukraine. In the framework programmes, Ukraine can strengthen cooperation with the EU, as well as bilateral cooperation with individual EU member countries, in specific scientific disciplines, which correlate with the thematic priorities, for example energy, environment, health etc. The international personal or experience-based knowledge of participants, gained qualifications and skills may have tremendous impact on the innovation-driven economic development of Ukraine.

Third, one should not underestimate the amount of financial support, which is available under the cooperation programmes. The funding schemes cover

- collaborative projects, which result in new knowledge or technology;
- networks of excellence, which are functioning as virtual research centres;
- coordination and support actions, which disseminate knowledge and stimulate participation of different actors

It also covers individual projects of research teams; training and career development of researchers; research for the benefit of special groups (SMEs, in particular). Financial assistance is provided is forms of grants, which can reimburse up to 100% of all expenses of the projects, depending on the legal status of the participants. These funds are particularly of the great importance due to the continuous economic downturn in Ukraine. Thus, they can help increasing national and international financial support for NIS development.

Conclusions for Chapter 4

In this Chapter author elaborates on the pitfall of NIS analysis in the Ukrainian literature and contributes to existing knowledge in this field while reconsidering the role of the Government pillar in designing institutional set-up in Ukraine. Author shows that lack of trust and credibility to the Government pillar, is questioning its leadership and coordination potential in NIS development, re-producing ineffective links and leading to overall network failure.

The author is shifting the focus, emphasizing the role of the Business pillar in NIS development. Author presents the concept, suggesting a great importance of informal institutions and peculiar role of institutional entrepreneurs. The study suggests that IT firms can be considered as actors which recognize the failures and low performance of the current institutional arrangements and modify old institutions by creating new ones. While tackling the problems of firms' low level of absorptive capacity, the lack of capacities of acquiring, assimilating, transforming and exploiting the external knowledge, author presents the importance of linkages in NIS between the pillars and the actors, as well as the role of intermediate organisational forms. In particular, business incubators, accelerators, spin-offs and science parks. Further on, the author is focusing on the importance of trust, social capital and entrepreneur culture for the innovation development.

Finally, Chapter shows the role of the international cooperation, in particular with the EU, as an important factor of innovation-driven growth in Ukraine, as well a possible impetus for the economy's transformation.

This Chapter concludes with the policy recommendations, targeting both market failure and systemic failure. While the first set of policies is directed to stimulate Business pillar to invest in R&D, the second set is aimed at tackling malfunctioning of linkages between the pillars, coordination mismatches, which impede innovation development. Recommendations also include steps to enhance international cooperation and technological catch-up.

CONCLUSIONS

This dissertation aims to investigate whether, and if yes, to what extent, institutional arrangements in Ukraine influence its innovation-driven economic development and how this impact can be measured for the whole economy and for particular sectors. Author endeavours to answer the following questions: how the pillars of the NIS and their interactions in the dynamic perspective influence the innovative development of Ukraine in general, and IT sector in particular.

Two hypothesis are tested in this dissertation

1. The current institutional arrangements in Ukraine do not stimulate innovative activity due to the strong influence of a poorly developed political system, and

2. Business in Ukraine is lacking motivation and payoffs that would drive it to become more innovative.

The research has four chapters.

Chapter 1 presents theoretical and methodological framework for studying innovation, institutions and economic growth. Firstly, author explains the complexity and systemic nature of innovation and shows its impact on the economic growth. Combining economic and sociological approach, author studies (1) economic growth theories and growth models, leading to the heterodox economic approach and evolutionary economics; (2) the role of institutions in the economic development. Secondly, author presents the concept of National Innovation System, which helps organizing the knowledge about innovation, economic growth and institutions at the national level. Author is focusing on NIS analysis in developing countries, as well as factors of absorptive capacity and path dependence. Thirdly, author analyses the concept of Ukrainian NIS, defining the key pillars and their roles. Authors demonstrates the differences between Ukrainian NIS model and OECD model, as well as gaps in the Ukrainian literature on the methods and approaches to NIS analysis. For the purpose of this dissertation, author applies mixed method research, in particular explanatory sequential design to answer the research question and advance the understanding of informal institutional arrangement of Ukrainian NIS in general, and IT sector in particular.

Chapter 2 presents the analysis of Ukrainian NIS. First, author presents the overview of Ukraine's macroeconomic situation, tracing its development since USSR times. Then, author decomposes NIS to study the current state and development trends of the key pillars, namely government, research and education and business. A particular attention is given to linkages between pillars. Author explains that they are crucial for enabling effective NIS functioning, further innovation development and economic growth. At the level of linkages between pillars of government and research and education, author is focusing on problems of vertical linkages, explicit usage of mechanisms of direct financial support and high dependence of the actors of research and education pillar on the government. At the level of linkages between pillars of business and research and education, author shows that low demand for innovation exists within the business pillar. This is reinforced by a relative shortage, compared to the education sector, of business personnel with advanced degrees in science. In both cases there is a strong evidence of practices inherited from the Soviet past. Chapter summarises the findings with the SWOT analysis. Among the urgent challenges are weak linkages between NIS pillars, lack of system integrity, in particular absence of effective mechanisms for establishing linkages between research & education and business pillars.

Chapter 3 presents the quantitative and qualitative analysis of impact of institutional arrangements on the innovational-driven economic development in Ukraine. Quantitative findings show the impact of formal institutional, namely poor rule of law and corruption, which are hampering the development. The qualitative findings support the preliminary results, as respondents consider the burden of government regulation, inefficiency of the legal framework, irregular payments and bribes, weak intellectual property rights protection to be to be the key obstacles for development. These obstacles are followed by the numerous risks for the sector further development such as loss of credible and reliable partners' image on the international arena, which may affect international cooperation and investment profitability assessment in the future; inability to continue doing business inside Ukraine and relocation of main offices and employees abroad. Thus, supporting our hypothesis that low-quality political system does not stimulate innovative activity. At the same time, peculiarities of IT sector made its development possible not because of the formal institutional arrangement incentives, but

rather in spite of them. Unlike other sectors, IT managed to develop and scale up without costly investments in manufacturing, using high human capital and outsourcing/outstaffing business model, which is mainly oriented on delivering services abroad. Numerous informal linkages between business and research & education pillar, as well as supportive linkages between IT companies play important role in the sector's development. Among them are business investments in opening laboratories in universities, developing informal courses for students and lecturers; establishment of IT cluster and other supporting organizations.

Chapter 4 summarises the findings and the institutional traps, which Ukraine is facing on the path to the innovation-driven economic development. Author re-defines the role of the government pillar, presenting firms as institutional entrepreneurs, which are capable of changing the institutional set-up with the help of intermediate organizations, facilitating the exchange of knowledge, resources and technology. The special attention is given to the informal institutions, in particular culture. Finally, Chapter shows the role of the international cooperation, in particular with the EU, as an important factor of innovation-driven growth in Ukraine, as well a possible impetus for the economy's transformation. This Chapter concludes with the policy recommendations, aiming to fill the gaps in linkages in the NIS, nurture innovation culture and enable effective international cooperation of Ukraine.

5.1. Research hypothesises

Returning to the hypothesis formulated at the beginning of this study, it is possible to state that current institutional arrangements in Ukraine do not stimulate innovative activity due to the strong influence of a poorly developed political system. The quantitative findings indicate that formal institutions impact the quality NIS pillars: regulatory quality has the statistically significant impact on the pillar of research and academia; and control of corruption has an impact on the quality of the business pillar. The qualitative research, support the quantitative findings on the formal institutional arrangements. Respondents consider corruption, political instability, and government ineffectiveness to be the key obstacles for development. In particular, the burden of

government regulation, inefficiency of the legal framework, irregular payments and bribes, weak intellectual property rights protection, as well as other risks of doing business in Ukraine.

The second hypothesis holds true partially as business in Ukraine do lack motivation and payoffs that would drive them to become more innovative. At the same time, peculiarities of IT sector made its development possible not because of the formal institutional arrangement incentives, but rather in spite of them. Numerous informal linkages between business and research & education pillar, as well as supportive linkages between IT companies play important role in the sector's development. Among them are business investments in opening laboratories in universities, developing informal courses for students and lecturers; establishment of IT cluster and other supporting organizations. For the majority of the businesses sectors, and for the economy as a whole, the lack of motivation and payoffs hampers the innovative development. As the extractive institutions persist, bottlenecks impede the institutional change, consequently block the innovative development. However, for the development of the IT sector it did not play the decisive role. Quite opposite, the IT sector developed not due to the existing institutional set-up, but despite of it.

It is believed that countries have technological trajectories. However, the technological change in Ukraine tends to be path-dependent and locked-in within trajectory since the USSR times. Ukraine is facing systemic failure, which is hampering the innovation development. It is clear that Ukraine has to re-design long-term development strategy, leading to the modernization of economy and catalysation of investments to the strategic sectors. New institutional settings could allow reaching higher level of competitiveness and guaranteeing sustainable development Ukraine through the implementation of innovation-driven economic development model.

5.2. Contributions

First, this dissertation provides an important opportunity to advance the understanding of institutional lock-ins, which Ukraine is facing on the the path of innovation-driven development. Weak institutional environment, such as low

enforcement of rules and little respect to their application, constant change, accompanied with the change of power, produces inefficient, yet stable norms. As these norms continue keeping country's development within the same trajectories, which are difficult to change, we can understand them as institutional lock-ins. The changes, which may take place under such circumstances are limited. The findings of this study indicate that the following lock-ins:

Political lock-in

As it was explicitly showed, Ukrainian's government dysfunction and poor record of reforms are deeply rooted legacies. The established neopatrimonial regime continues using administrative resources to defeat political opposition and eliminate economic competitors. As a result, there is no interest in reforms, which require systemic change. Oligarchs, usually from post-Soviet nomenclature elite, interested in maintaining the status quo to keep their spheres of influence and control capacity. Thus, government's leadership in shaping the institutional set-up is limited. In case of IT sector, it is persuaded by the other actors as a constrain.

Technological and functional lock-in

The "captured state" which helps the limited group of people to control the budget resources, lead often to the subsidizing of the less innovative companies and does no stimulate the competitions, which is based on the innovative characteristics. Ukrainian economy is dominated by energy intensive industries, producing low value added products, using relatively cheap labour force.

Political lock-in restrains innovation development and business restructuring in Ukraine. Over 80% of the businesses in Ukraine see no need to innovate. Government continues supporting the economic activity of the firms, which were regarded as country's economic ground, however no longer correspond to the market needs and trends. Large state-owned firms, as well as firms, which stay in the hands of oligarchs, do not see need to innovate, as they remain "under protection" of the government, receiving subsidies and exploiting natural resources

At the same time smaller firms, see no incentives to invest in risky projects. Confronted with the emergence of a new technology, they apply a black-box approach (copying without understanding). Thus, failing to transform potential absorptive capacity

to realized absorptive capacity, and reinforcing the technological backwardness, reducing the chances of further opening towards new markets.

Cultural inheritance and cognitive lock-in

The interplay between political and technological lock-ins in Ukraine is largely influenced by the cultural inheritance. During the Soviet Union period entrepreneurship was prohibited and punished in Ukraine. The narrative of the entrepreneurship had strongly negative connotation in the minds of Ukrainians. Lack of tradition of private entrepreneurship, together with society's adverse attitude towards creativity, risk taking and willingness to change, limits innovation activity these days. Besides, one of the biggest obstacles for the current entrepreneurs is the lack of management, strategic and leadership skills. Combined together, these weaknesses contribute to creating a cultural environment in which the knowledge and understanding of business principles (specific to the modern free market economies) are largely absent.

Secondly, this thesis underlines gap in the research literature, as Ukrainian scholars repeatedly assume institutions strength for granted. Thus, while explaining the role of formal institutions, the role of informal institutions is largely omitted. this study provides an opportunity to advance our knowledge on informal institutional arrangements in Ukraine.

Weak formal institutions, large gap between formal rules enforcement and actual compliance together with large instability influence informal adjustments. This gives room to actors, institutional entrepreneurs, to develop intermediate institutions. These prototypes-institutions can help to overcome the institutional lock-in by layering already existing institutions with the new institutional forms. Consequently, if managed successfully, they may transform in new institutions.

Institutional Entrepreneurs

The evidence from this study suggests that business in IT sector is playing proactive role in re-shaping the institutional setup, developing new informal rules and practices. In particular, in establishing informal linkages with pillar of research and academia and tight cooperation with the other IT firms. IT firms managed to establish new forms of cooperation, such as clusters, and enhance further development with incubators, accelerators, technoparks. In ~~the~~ Chapter 4 Author presents the scheme of

linkage institutions, which were established with by the institutional entrepreneurs in Ukraine. Such intermediate institutions largely contributed to the exchange of the knowledge, technology and facilitate the innovation development.

It is still remains unclear to what extend IT firms managed to develop alternative set of institutions. And whether these intermediate institutions will be efficiently managed to guarantee their maturation and further formalization. However, this goes beyond the scope of this dissertation and would require a further investigation.

5.3. Limitations of research

The scope of thesis does not cover all sectors of the Ukrainian economy. And thus, the reader should bear in mind that the outcomes of the study, in particular qualitative study, reflect best the results for the IT sector. However, the same approach of the mixed method analysis can be implemented to study the other sectors, identifying not only the quantitative growth of the separate pillars, but the quality of the linkages between the pillars, motivation of the actors, institutional incentives and contrarians.

The policy recommendations are formulated more broadly, targeting both market failure and systemic failure. While the first set of policies is directed to stimulate the Business pillar to invest in R&D, the second set is aimed at tackling malfunctioning linkages between the pillars, coordination mismatches, which impede innovation development. Recommendations also include steps to enhance international cooperation and technological catch-up. However, these recommendations have to be followed by broader reforms, such as decentralization of power, transition to free market economy together with abolishment of oligarchic system. In the long-term perspective innovation-driven economic development is possible only due to the structural transformations in all three pillars, which would enable their effective cooperation. The author believes, that innovation-driven economic development can be brought only by inclusive institutions, that will encourage new ideas, new technologies, as well as large participation of the other actors.

5.4. Direction for Future Work

Because of complexity of this topic, further investigations are needed. Author hopes that her findings will serve as a basis for the further in-depth analyses of innovation-driven economic development of Ukraine. The suggested approach of mixed method analysis can be applied to study the other sectors. At the same time, this research has raised many questions on IT sector itself. In continuation of this work, the author suggests to increase the number of in-depth interviews by including the respondents from other centers of IT activity, namely Kyiv, Dnipropetrovsk, Odessa to conduct for future studies. Moreover, it might be of a great interest to conduct interviews with the founders of successful Ukrainian startups, which have gained worldwide recognition. The scope of research may focus on both (1) factors/mechanisms which have startups to overcome the weak institutional environment, (2) impact of startups for Ukraine's economic development.

While the importance of the first question is obvious, the second one requires further explanation. There is a growing skepticism about the startups, which grow in Ukraine and then leave the country to expand further their activities abroad (either in the EU or USA). The examples of successful startups from IT sector can be a source of inspiration for other companies developing their potential products. Yet it becomes as well a source of criticism, pointing out to "brain drain" phenomenon affecting the developing countries trying to transform their economies. These discussions seem to omit the fact that the majority of startups prefer to be located in the countries, which at the same time are markets broad enough for the business to grow. Ukrainian market is very small, therefore it is unlikely to see that new services will be designed for it. The second argument showing the positive side of the startups, although they do register abroad they keep their departments in Ukraine, largely contributing to the development of the absorptive capacity. The insights from the successful entrepreneurs can shed a light on this discussion as well as help to understand the cultural peculiarities, which they have developed.

Innovation system of Ukraine can also be analysed from the perspective of technological system. Thus author suggests to study IT development not only as a sectorial example. Because IT embededness is growing, it is almost impossible to find a

sector, which would not apply IT solutions. It is worth continuing the study in this field, referring to the concept of ICT for development, which explains why information and communication technologies as the key driver for the development in governance, education, business and societal changes. It is necessary to continue the studies on Ukrainian NIS.

It is beyond the scope of this study to examine all the actors in Ukrainian NIS, however author suggests that the logic of intermediate institutions and the role of institutional entrepreneurs can be translated to the other sectors of economy.

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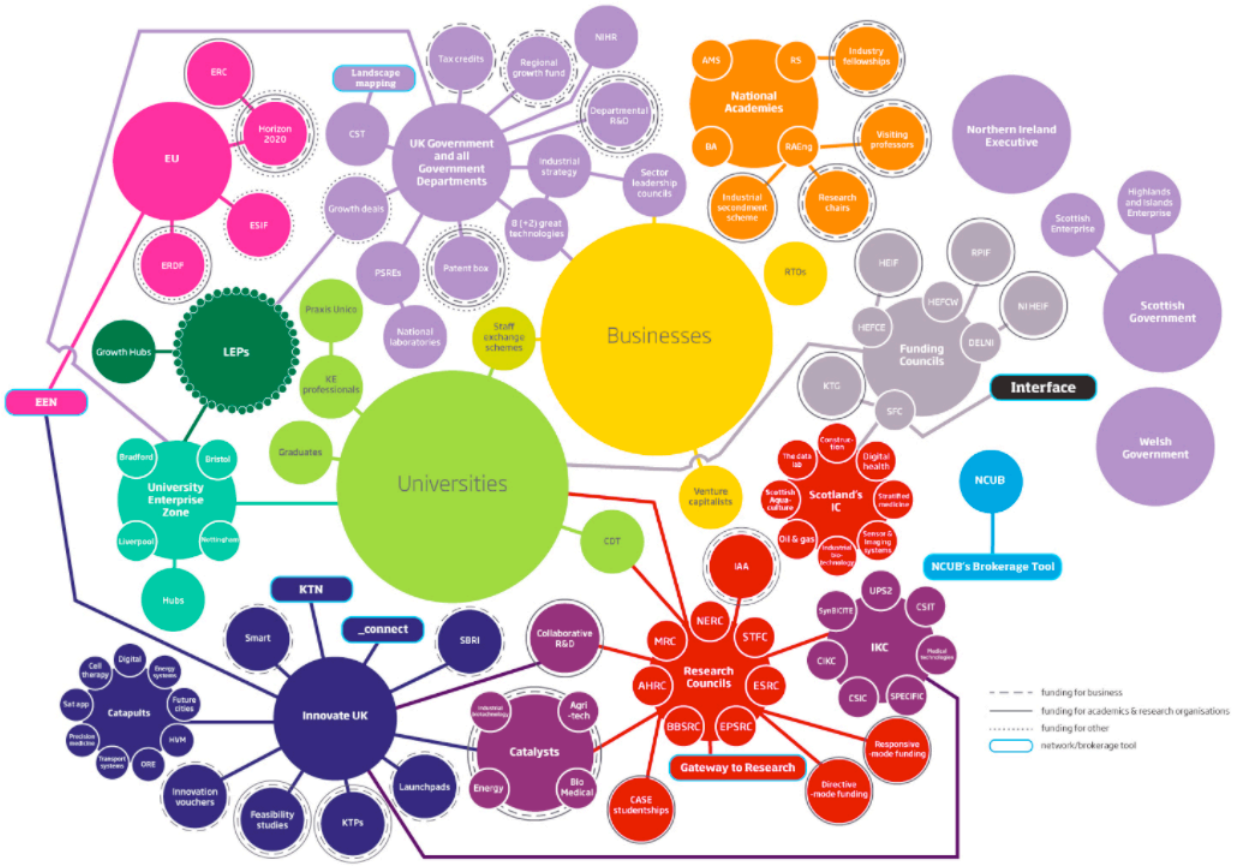
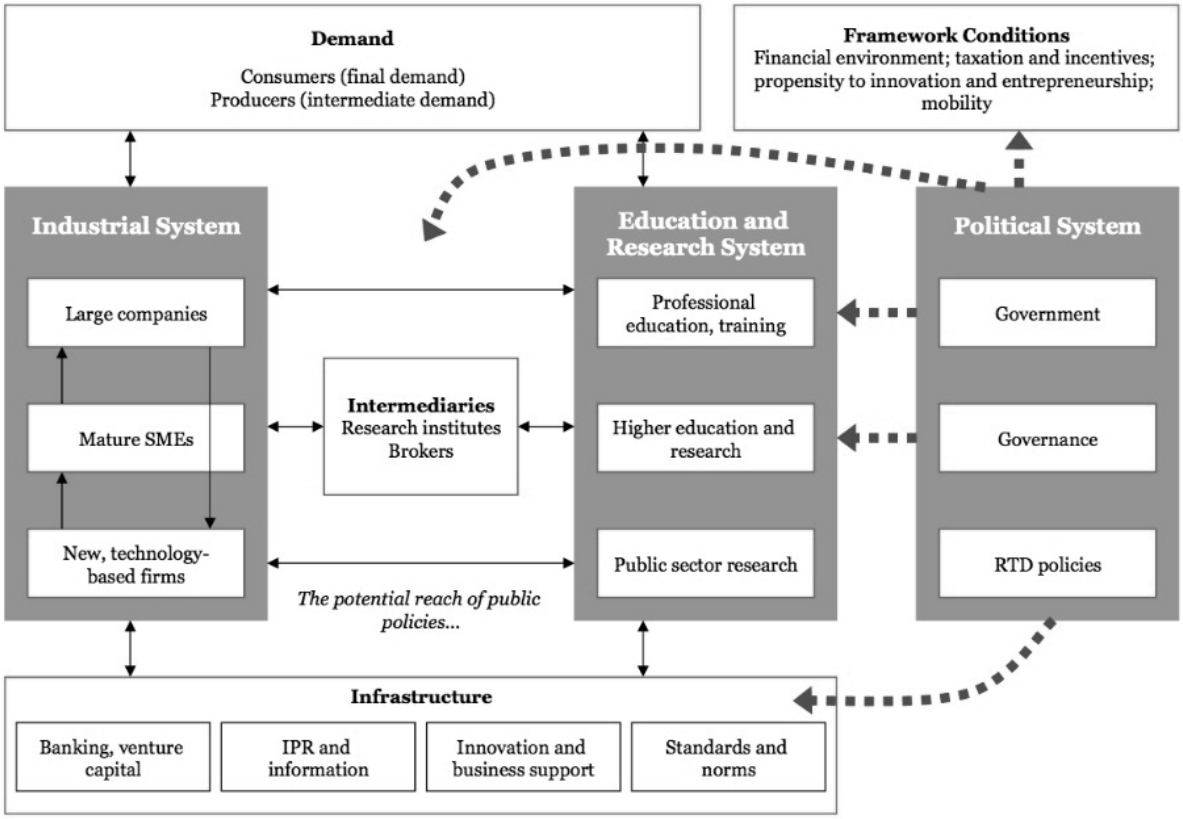
Annexes

Annex A. UK innovation system



Source: Dowling, A. (2015), p. 25.



Source: Arnold and Kuhlman, 2001, p. 6

Annex B. Input data

Table B.1.

Input indicators for modelling synthetic indicators of the NIS pillar quality

Indicators of NIS of Ukraine	
*y*1_*QSM*	Synthetic indicator of the quality of the governance
*y*2_*QKG*	Synthetic indicator of the quality of research and education
*y*3_*QPR*	Synthetic indicator of the quality of business
(1). Indicators of government pillar	
*x*1.1_*WVA* (rank)	Voice and accountability
*x*1.2_*WPV* (rank)	Political stability and absence of violence
*x*1.3_*WGE* (rank)	Government effectiveness
*x*1.4_*WRQ* (rank)	Regulatory quality
*x*1.5_*WRL* (rank)	Rule of law
*x*1.6_*WCC* (rank)	Control of corruption
(2). Indicators of research and education pillar	
*x*2.1_*NAZ* (%)	R&D researchers per 1000 employees
*x*2.2_*FDR* (%)	R&D expenditures, as a share of GDP
*x*2.3_*VDR* (%)	Share of R&D investments in the total expenses on innovation activity
*x*2.4_*VPZ* (%)	Expenditures on acquisition of machinery, equipment and software as a share of the total expenditures on the innovation activity
*x*2.5_*VZZ* (%)	Expenditures on external knowledge acquisition, as a share of the total expenditures on the innovation activity
*x*2.6_*OVN* (%)	R&D performance, as a share of GDP
*x*2.7_*VOS* (%)	Expenditures on education, as a share of GDP
*x*2.8_*VIN* (%)	Pupil-teacher ratio, tertiary education
*x*2.9_*VVO* (%)	Graduates in science and engineering, tertiary graduates in engineering, manufacturing, and construction (% of total tertiary graduates)
(3). Indicators of the business pillar	
*x*3.1_*PZI* (%)	Share of the enterprises, engaged in innovative activity
*x*3.2_*PVI* (%)	Share of the enterprises, which introduce innovations
*x*3.3_*FVK* (%)	Financing innovation activity by own funds, as a share of the total expenses on the innovation activity
*x*3.4_*FDB* (%)	Financing innovation activity from the state budget, as a share of the total expenses on the innovation activity
*x*3.5_*FII* (%)	Financing innovation activity by foreign investors, as a share of the total expenses on the innovation activity
*x*3.6_*VTE* (%)	High-technology exports, as a share of manufactured exports
*x*3.7_*RIP* (%)	Share of the innovation product sold in industrial output

Table B.2.
Normalized input indicators for the quality assessment of the Government pillar

Year	*x*1.1_*WVA*	*x*1.2_*WPV*	*x*1.3_*WGE*	*x*1.4_*WRQ*	*x*1.5_*WRL*	*x*1.6_*WCC*
2000	28,85	29,33	24,88	29,41	12,92	7,80
2001	30,15	30,29	27,08	29,41	18,66	10,49
2002	31,73	31,25	29,27	29,41	24,40	13,17
2003	30,29	32,69	33,17	28,92	23,44	18,54
2004	29,33	28,85	33,66	39,71	26,79	18,05
2005	41,35	37,02	34,15	34,31	27,27	29,76
2006	47,12	44,23	34,63	32,35	24,40	27,32
2007	48,08	48,56	28,64	36,89	26,32	24,27
2008	50,00	45,45	27,67	32,52	29,33	22,82
2009	49,29	34,12	22,01	32,06	24,17	16,27
2010	46,45	45,75	25,36	33,97	24,64	17,14
2011	44,60	43,40	21,80	29,86	23,47	17,54
2012	39,81	42,18	31,58	28,71	25,59	15,79
2013	36,97	21,80	30,62	28,71	23,22	11,96

Source:

- Worldwide Governance Indicators (WGI), 1996-2014. Retrieved from: http://info.worldbank.org/governance/wgi/index.aspx#home.
- UNESCO Institute for Statistics, UIS online database. Retrieved from: http://data.uis.unesco.org/.

Table B.3.
Input indicators for the quality assessment of the Research and education pillar

Year	*x2.1_ NAZ*	*x2.2_ FDR*	*x2.3_ VDR*	*x2.4_ VPZ*	*x2.5_ VZZ*	*x2.6_ OVN*	*x2.7_ VOS*	*x2.8_ VIN*	*x2.9_ VVO*
2000	0,60	0,96	15,12	61,15	4,14	1,16	4,17	31,0	48,70
2001	0,57	1,02	8,66	63,38	6,34	1,11	4,68	26,3	51,87
2002	0,53	1,00	8,95	61,90	7,59	1,11	5,43	24,2	56,43
2003	0,52	1,11	10,23	61,24	3,13	1,24	5,60	21,9	60,85
2004	0,53	1,08	9,82	59,93	3,16	1,19	5,31	21,5	66,00
2005	0,51	1,17	10,65	54,76	4,23	1,09	6,06	21,1	71,11
2006	0,48	0,95	16,12	56,64	2,59	0,98	6,21	20,5	76,86
2007	0,46	0,85	9,12	68,85	3,03	0,93	6,15	20,3	80,90
2008	0,45	0,85	10,37	63,90	3,52	0,90	6,43	20,2	83,54
2009	0,46	0,86	10,65	62,57	1,46	0,95	7,31	21,2	84,20
2010	0,44	0,83	12,38	62,79	1,76	0,90	6,74	21,2	81,93
2011	0,42	0,74	7,53	73,18	2,27	0,79	6,16	21,3	83,32
2012	0,40	0,75	10,42	70,13	0,41	0,80	6,69	20,3	82,13
2013	0,38	0,77	17,13	58,00	0,91	0,81	6,67	20,3	80,07

Sources:
- Scientific and innovation activity in Ukraine: Statistics (2014). State Statistics Service of Ukraine.
- Scientific and innovative activities in Ukraine (1990-2014). Retrieved from: http://ukrstat.gov.ua.

Table B.4.
Input indicators for the quality assessment of the Business pillar

Year	*x*3.1_*PZI*	*x*3.2_*PVI*	*x*3.3_*FVK*	*x*3.4_*FDB*	*x*3.5_*FII*	*x*3.6_*VTE*	*x*3.7_*RIP*
2000	18,0	14,8	79,6	0,4	7,6	5,23	9,4
2001	16,5	14,3	83,9	2,8	3,0	4,66	6,8
2002	18,0	14,6	71,1	1,5	8,8	4,86	7,0
2003	15,1	11,5	70,2	3,0	4,2	6,92	5,6
2004	13,7	10,0	77,2	1,4	2,5	6,30	5,8
2005	11,9	8,2	87,7	0,5	2,7	3,72	6,5
2006	11,2	10,0	84,6	1,9	2,9	3,40	6,7
2007	14,2	11,5	73,7	1,3	3,0	3,65	6,7
2008	13,0	10,8	60,6	2,8	1,0	3,29	5,9
2009	12,8	10,7	65,0	1,6	19,0	5,55	4,8
2010	13,8	11,5	59,4	1,1	30,0	4,34	3,8
2011	16,2	12,8	52,9	1,0	0,4	4,39	3,8
2012	17,4	13,6	63,9	1,9	8,7	6,30	3,3
2013	16,8	13,6	72,9	0,3	13,1	5,89	3,3

Sources:
- Scientific and innovation activity in Ukraine: Statistics (2014). State Statistics Service of Ukraine.
- Scientific and innovative activities in Ukraine (1990-2014). Retrieved from: http://ukrstat.gov.ua.

Table B. 5.

Input data in *.sta formate

Data: +NInput-innov 2000-2013* (24v by 14c)

+NInput-innovation 2000-2013

	1 Rik	2 x1.1_WVA	3 x1.2_WPV	4 x1.3_WGE	5 x1.4_WRQ	6 x1.5_WRL	7 x1.6_WCC	8 x2.1_NAZ	9 x2.2_FDR	10 x2.3_VDR	11 x2.4_VPZ	12 x2.5_VZZ	13 x2.6_OVN	14 x2.7_VOS	15 x2.8_VIN	16 x2.9_VVO	17 x3.1_PZI	18 x3.2_P
1	2000	28,85	29,33	24,88	29,41	12,92	7,80	0,60	0,96	15,12	61,15	4,14	1,16	4,17	31,0	48,70	18,0	1
2	2001	30,15	30,29	27,08	29,41	18,66	10,49	0,57	1,02	8,66	63,38	6,34	1,11	4,68	26,3	51,87	16,5	1
3	2002	31,73	31,25	29,27	29,41	24,40	13,17	0,53	1,00	8,95	61,90	7,59	1,11	5,43	24,2	56,43	18,0	1
4	2003	30,29	32,69	33,17	28,92	23,44	18,54	0,52	1,11	10,23	61,24	3,13	1,24	5,60	21,9	60,85	15,1	1
5	2004	29,33	28,85	33,66	39,71	26,79	18,05	0,53	1,08	9,82	59,93	3,16	1,19	5,31	21,5	66,00	13,7	1
6	2005	41,35	37,02	34,15	34,31	27,27	29,76	0,51	1,17	10,65	54,76	4,23	1,09	6,06	21,1	71,11	11,9	[illegible]
7	2006	47,12	44,23	34,63	32,35	24,40	27,32	0,48	0,95	16,12	56,64	2,59	0,98	6,21	20,5	76,86	11,2	1
8	2007	48,08	48,56	28,64	36,89	26,32	24,27	0,46	0,85	9,12	68,85	3,03	0,93	6,15	20,3	80,90	14,2	1
9	2008	50,00	45,45	27,67	32,52	29,33	22,82	0,45	0,85	10,37	63,90	3,52	0,90	6,43	20,2	83,54	13,0	1
10	2009	49,29	34,12	22,01	32,06	24,17	16,27	0,46	0,86	10,65	62,57	1,46	0,95	7,31	21,2	84,20	12,8	1
11	2010	46,45	45,75	25,36	33,97	24,64	17,14	0,44	0,83	12,38	62,79	1,76	0,90	6,74	21,2	81,93	13,8	1
12	2011	44,60	43,40	21,80	29,86	23,47	17,54	0,42	0,74	7,53	73,18	2,27	0,79	6,16	21,3	83,32	16,2	1
13	2012	39,81	42,18	31,58	28,71	25,59	15,79	0,40	0,75	10,42	70,13	0,41	0,80	6,69	20,3	82,13	17,4	1
14	2013	36,97	21,80	30,62	28,71	23,22	11,96	0,38	0,77	17,13	58,00	0,91	0,81	6,67	20,3	80,07	16,8	1

Indicators for y1 – government pillar

N=14	Regression Summary for Dependent Variable: x1.6_WCC (+Input-innov 2000-2013) R= ,87890621 R?= ,77247612 Adjusted R?= ,73110814 F(2,11)=18,673 p<,00029 Std.Error of estimate: 3,2701					
	Beta	Std.Err. of Beta	B	Std.Err. of B	t(11)	p-level
Intercept			-34,1094	8,752718	-3,89700	0,002489
x1.1_WVA	0,774447	0,149374	0,5965	0,115056	5,18461	0,000302
x1.3_WGE	0,674518	0,149374	0,9838	0,217866	4,51562	0,000878

Indicators for y2 – research and education pillar

N=14	Regression Summary for Dependent Variable: x2.1_NAZ (+Input-innov 2000-2013) R= ,96938194 R?= ,93970134 Adjusted R?= ,92873795 F(2,11)=85,713 p<,00000 Std.Error of estimate: ,01708					
	Beta	Std.Err. of Beta	B	Std.Err. of B	t(11)	p-level
Intercept			0,000260	0,037940	0,006855	0,994654
x2.6_OVN	0,667907	0,087731	0,281598	0,036989	7,613080	0,000010
x2.8_VIN	0,430353	0,087731	0,009044	0,001844	4,905340	0,000468

Indicators for y3 – business pillar

N=14	Regression Summary for Dependent Variable: x3.1_PZI (+Input-innov_y1-y3 2000-2013) R= ,93917949 R?= ,88205811 Adjusted R?= ,87222962 F(1,12)=89,745 p<,00000 Std.Error of estimate: ,81282					
	Beta	Std.Err. of Beta	B	Std.Err. of B	t(12)	p-level
Intercept			2,090059	1,369542	1,526101	0,152901
x3.2_PVI	0,939179	0,099139	1,068131	0,112751	9,473385	0,000001

Annex D. Building synthetic indicators, principal component analysis

y1 – government pillar

Value number	Eigenvalues of covariance matrix, and related statistics (+Qy1-y3 2000-2013) Active variables only			
	Eigenvalue	% Total variance	Cumulative Eigenvalue	Cumulative %
1	63,93643	80,31973	63,93643	80,3197
2	15,66597	19,68027	79,60240	100,0000

Variable	Eigenvectors of covariance matrix (+Qy1-y3 2000-2013) Active variables only	
	Factor 1	Factor 2
x1.1_WVA	0,982303	0,187297
x1.3_WGE	-0,187297	0,982303

Variable	Variable contribution, based on covariances (+Qy1-y3 2000-2013)	
	Factor 1	Factor 2
x1.1_WVA	0,964920	0,035080
x1.3_WGE	0,035080	0,964920

Variable	Contribution and weight variables, based on covariances (+Qy1-y3 2000-2013)				
	F1 : u1(j)	d1*u1(j) =0;803197*v1	F2 : u2(j)	d2*u2(j) =0;196803*v3	w(j) =v2+v4
x1.1_WVA	0,964920	0,775021	0,035080	0,006904	0,781925
x1.3_WGE	0,035080	0,028176	0,964920	0,189899	0,218075

y2 – research and education pillar

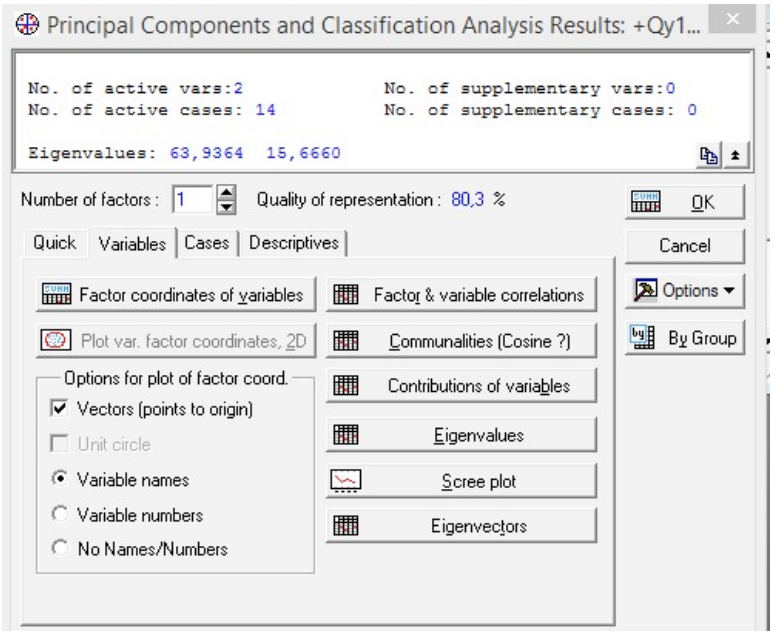
Value number	Eigenvalues of covariance matrix, and related statistics (+Qy1-y3 2000-2013) Active variables only			
	Eigenvalue	% Total variance	Cumulative Eigenvalue	Cumulative %
1	8,617035	99,82363	8,617035	99,8236
2	0,015224	0,17637	8,632259	100,0000

Variable	Eigenvectors of covariance matrix (+Qy1-y3 2000-2013) Active variables only	
	Factor 1	Factor 2
x2.6_OVN	0,026777	0,999641
x2.8_VIN	0,999641	-0,026777

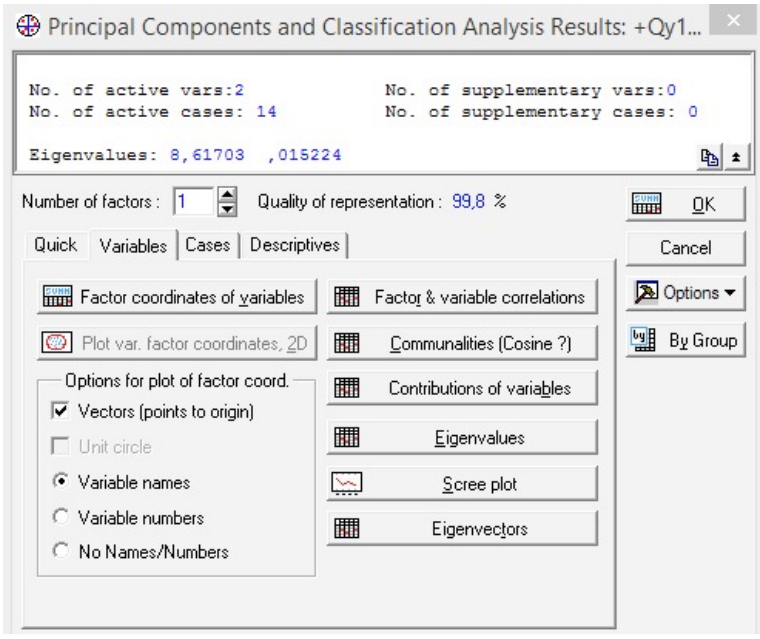
Variable	Variable contribution, based on covariances (+Qy1-y3 2000-2013)	
	Factor 1	Factor 2
x2.6_OVN	0,000717	0,999283
x2.8_VIN	0,999283	0,000717

Variable	Contribution and weight variables, based on covariances (+Qy1-y3 2000-2013)				
	F1 : u1(j)	d1*u1(j) =0;998236*v1	F2 : u2(j)	d2*u2(j) =0;001764*v3	w(j) =v2+v4
x2.6_OVN	0,000717	0,000716	0,999283	0,001763	0,002478
x2.8_VIN	0,999283	0,997520	0,000717	0,000001	0,997522

For y3 – business pillar: x3.2_PVI – share of enterprises, which introduce innovations



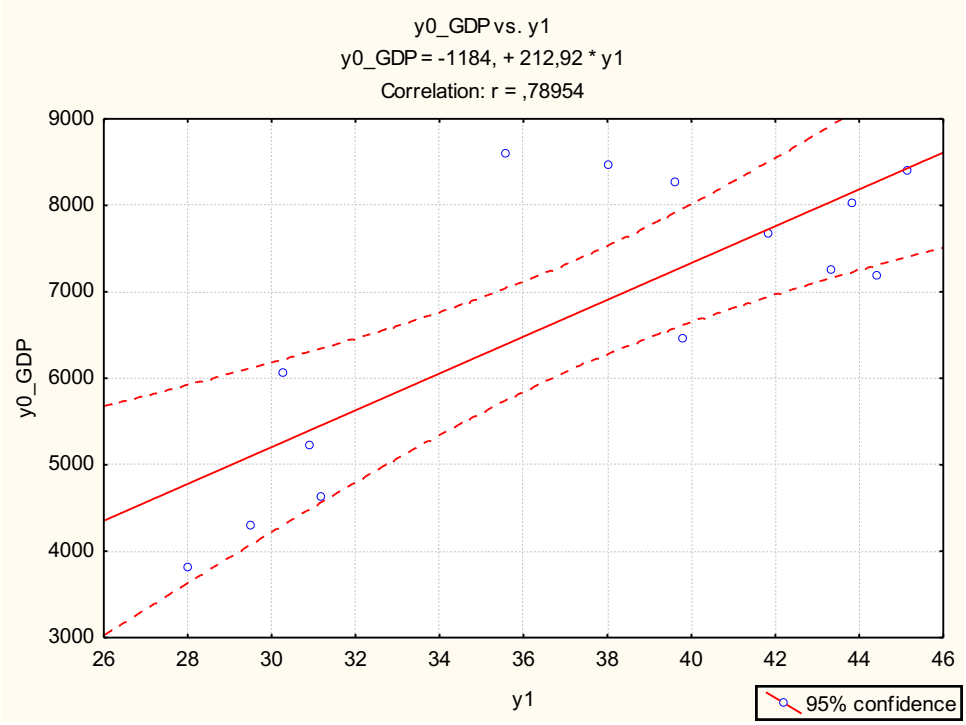
Quality of representation for y1



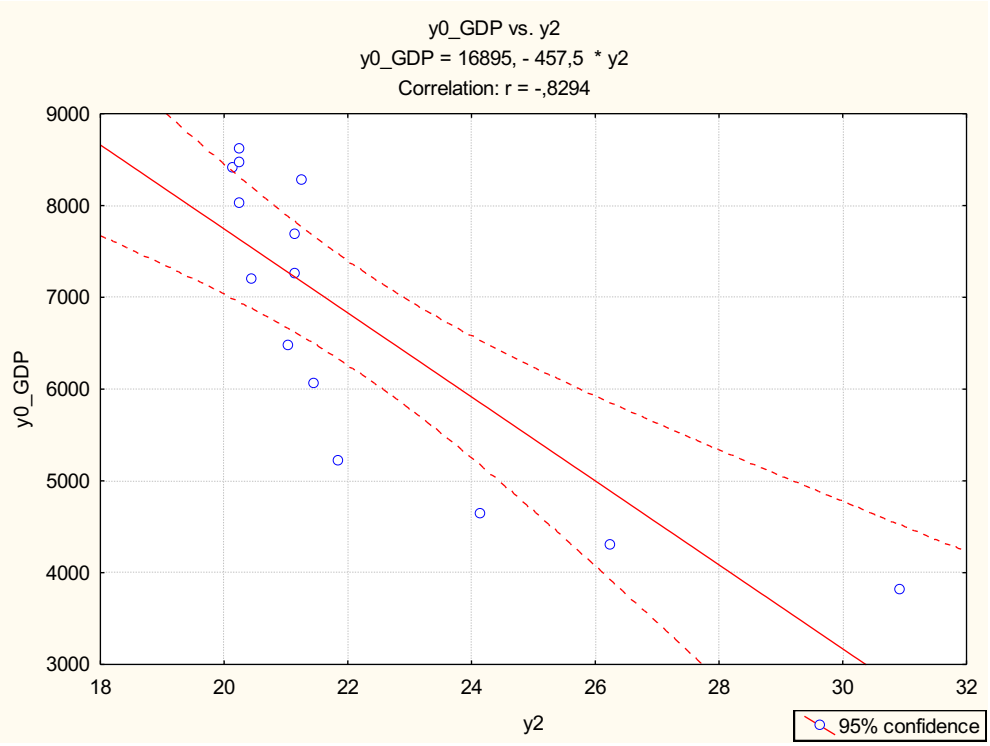
Quality of representation for y2

Annex E

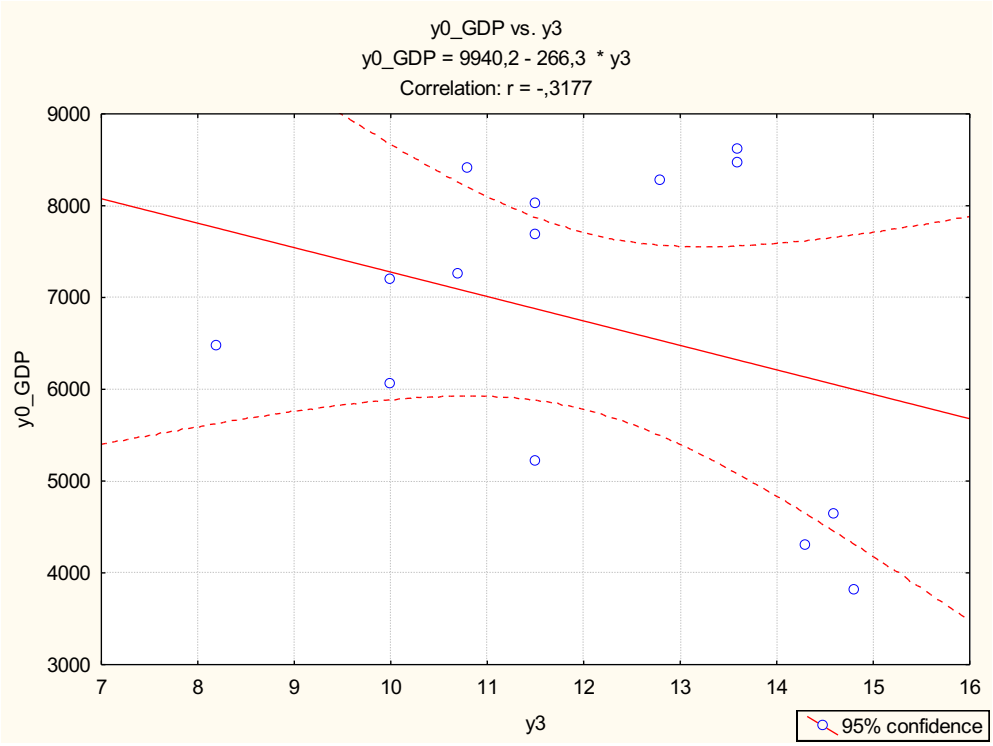
Measuring impact of NIS pillars quality of the GDP growth



The relationship between the quality of the NIS pillar y1 (governance pillar) and level of economic development of Ukraine



The relationship between the quality of the NIS pillar y2 (research and development) and level of economic development of Ukraine



The relationship between the quality of the NIS pillar y3 (business) and level of economic development of Ukraine

Introduction

Thank you very much for agreeing on this interview!

My research is dedicated to the analysis of the institutional factors, that are influencing Ukraine's innovation-driven economic development. Within the framework of the National Innovation System, I study the key pillars and linkages between them, namely:

- business pillar,
- government pillar and
- pillar of research and education

As for today, NIS of Ukraine remain inefficient, and the level of innovative development, as well the level of competitiveness of Ukraine are very low.

However, the IT sector demonstrates intense growth. As it is very difficult to estimate changes in the IT sector with the traditional empirical estimations, in particular to track the dynamics of its development and the impact of institutional arrangements, I conduct in-depth interviews with the representatives of this sector. I guarantee a total anonymity. This means that neither you name, nor additional information about your company or position in the company, will be mentioned in my research.

Our interview will be recorded, transcribed and analysed with the software programme. Further, it will be the source of reference though my dissertation, which is conducted at the Graduate School for Social Research, Polish Academy of Sciences

Questions

Introduction

- How many years do you work in IT sector?
- What is your general impression on the IT development in recent years?

1. Business pillar

- How innovative is your company? The products/services that you make/provide in your company?
- It is generally acknowledged that Ukraine is outsourcing country. Last year 10 companies in Ukraine joined the list of top-100 outsourcing companies worldwide.
- In your opinion, why the majority of Ukrainian firms focus on outsourcing and not on creation of their own products?
- Does your company invest in R&D?
- Does your company acquire knowledge from abroad, for example in forms of patents.
- What is the focus market of your company? What percentage of your products/services is oriented to Ukraine?

2. Government pillar

- How would you evaluate the influence of the government on business activity in IT sector?

For example, how does the following political institutions influence your business?

Voice and Accountability

Reflects perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.

Political Stability and Absence of Violence/Terrorism

Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism.

Government Effectiveness

Reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.

Regulatory Quality

Reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.

Rule of Law

Reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.

Control of Corruption

Reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.

- Yes/No? Why?
- Positive/Negative? Why?

Additional questions to clarify:

If no, then why? Why it all did not have big impact on the IT sector?

If yes than how bid was the influence? Did it hamper/helped the development a lot?

- How big is this impact? Can you give examples of this impact your business?
- Have you noticed any progress/regress in recent years? How this influence changed over time?

Was the government supportive in creating conditions for developing innovation infrastructure, such as scientific parks? Clusters?

3. Research and Education

- Could you please elaborate on the educational level, competences of graduates, who are coming to your business?
- Are you satisfied with the knowledge they have, experience.
- Have you noticed the changes in the level of their?
- Can you tell me more about the motivation of people, who are entering IT sector.
- What is the role of informal education in this process?

4. Linkages

- How do you evaluate your cooperation with the pillar of Research and education? In particular, with Universities.
- Do you know any successful examples of business-university cooperation? For example, in clusters, techno-parks in Lviv?
- Do you have experience of successful cooperation at the level business-government? Maybe in form public-private partnership? Public procurement on innovation?
- It is said that IT-sector is the priority sector for Lviv. Have you experienced any particular support from the government? Financial support? indirect government support? (financial benefits, tax reduction)
- How do you evaluate the relation with other companies in IT sector? Do you compete? Yes/No? How? Do you cooperate? Yes/No? How?

Code System

1 Business pillar	0
1.1 Innovation intensity	8
1.2 Trends in the sector development	13
1.3 Business model	0
1.3.1 Product	8
1.3.2 Outsourcing/outstaffing	16
1.4 Geography of trade, cooperation	0
1.4.1 International market	7
1.4.2 Ukrainian market	16
2 Government pillar	0
2.1 Necessary steps/initiatives	3
2.2 Bad governance	41
2.3 Good governance	5
3 Research and academia	0
3.1 Firms investment in R&D	6
3.2 Motivation of graduates	13
3.3 Formal education	20
3.4 Informal education	20
3.5 Human capital	15
4 Linkages between pillars	0
4.1 Business and government	26
4.2 Business and academia	18
4.3 Business and business	13
5 Other	0
5.1 Costs optimization, minimization of risks	14
5.2 Risks for the further development/problems	18

1 Business pillar

Business pillar helps to evaluate IT firms activities, study the peculiarities of their involvement in the process of absorption, creation, and distribution of innovations.

1.1 Innovation intensity

Helps to evaluate firm's innovation activity in product innovations, process innovations, marketing innovations and organizational innovations.

1.2 Trends in the sector development

Refers to the overall development of the sector helps to track changes up to 10 years.

1.3 Business model

The business model of the firm predetermines the strategy of doing business, firms priorities.

1.3.1 Product

The product business model suggests that the firm is concentrated on developing and selling their own software products.

1.3.2 Outsourcing/outstaffing

Outsourcing/outstaffing model suggests that the firm provides the range of engineering capabilities for other companies (i.e. business process outsourcing, dedicated team outsourcing), often using pay-per-hour model.
According to http://www.usupport.in.ua IT outsourcing in Ukraine may include:
Business process outsourcing – outsource of operations and responsibilities of specific business functions (or processes) to a third-party service provider.
Software development and testing – testing investigation conducted to provide stakeholders with information about the quality of the product or service under test.
Mobile applications development – software development for low-power handled devices
Graphical and web-design – the production and maintenance of websites and banners; web graphic design; interface design; authoring; user experience design and search engine optimization
Data entry services – input of data of expected quality from one medium to another or into the database via voice recognition, document scanning, manual typing
Contact center outsourcing – provides solutions to clients, including customer care services, e-mail answering and sending of SMS

1.4 Geography of trade, cooperation

Geography of trade helps to understand the preferences as well as the motivation of the firms to develop the business either within Ukrainian market, or abroad.

1.4.1 International market

Refers to firm's preferences of doing business outside Ukraine.

1.4.2 Ukrainian market

Refers to firm's preferences of doing business on Ukrainian market.

2 Government pillar

Helps to evaluate the quality of governance with firms' perception of WGI indicators influence on IT sector (voice and accountability, political stability and absence of violence government effectiveness, regulatory quality, rule of law, control of corruption).

2.1 Necessary steps/initiatives

Necessary steps or initiatives firms believe the government should or could do to contribute to IT's development.

2.2 Bad governance

Refers to negative perception of WGI indicators influence on IT sector.

2.3 Good governance

Refers to positive perception of WGI indicators influence on IT sector.

3 Research and academia

Refers to the universities, research centers, firms' R&D centers, involved in the process of innovation creation.

3.1 Firms investment in R&D

Refers to firms' investment in R&D.

3.2 Motivation of graduates

Refers to the motivation of graduates, standing behind the decision of working in the IT sector.

3.3 Formal education

Refers to firms' evaluation of curriculum in colleges and universities and practical skills acquired within formal education.

3.4 Informal education

Refers to firms' evaluation of the role of private education centers, private initiatives, online-education etc in providing necessary skills and knowledge.

3.5 Human capital

Refers to knowledge and skills, abilities and experience possessed by individuals in IT sector.

4 Linkages between pillars

Helps to analyze the complex set of relationship between the key-pillars by tracking the linkages and interactions.

4.1 Business and government

Refers to links between business and government pillars.

4.2 Business and academia

Refers to links between pillars of business and research & academia.

4.3 Business and business

Refers to cooperation between firms in IT sector.

5 Other

5.1 Costs optimization, minimization of risks

Refers to the firm's approaches to react to risks and market challenges.

5.2 Risks for the further development/problems

The risks that firms see for their further development, problems that are hampering their development.