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How to break the soviet NIS model?

Lessons from Estonia and Moldova.

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Abstract: Estonia has taken an upward trend in terms of innovation and economic growth since 1991 and is currently the most prosperous ex-USSR country. Moldova on the other hand, another ex-USSR country, is one of the poorest countries in Europe and it has more or less stagnated for the past 2 decades in terms of innovation and R&D. Estonia's NIS (National Innovation System) has evolved remarkably and we would like to see what specific changes has Estonia implemented in order to modify and disestablish the soviet NIS model. This study seeks to make a contribution towards the understanding of soviet-specific failures determining the stagnation of Moldova's NIS while also looking at the actions taken by Estonia which helped it make the transition from a soviet NIS to a modern and efficient one. At the same time, a causality relationship is identified between certain system failures which contribute to the organisational and institutional thinness of a post-soviet NIS. By mapping the specific actions undertaken by Estonia, advisory guidelines could be created for overcoming post-soviet system failures, in countries like Moldova which are struggling in transforming and transitioning their NIS.

Key words: NIS, innovation, innovation system

Contents

List of Tables

List of Figures

Acknowledgements

1. Introduction

Innovation is not an ultimate goal in itself, its true value is reflected in how it affects competiveness, dynamism of an economy, and economic outcomes that lead to increase in life standards. The concept of innovation systems, has recently started being seen as an evolutionary process, being path dependent, with the involved actors not being able to foresee the final output of the innovation (Varblane, 2012). At a national level such systems can be called National Innovation Systems and are considered extremely complex structures which makes it almost impossible to create an optimal and generally-valid model for the production of innovation. The concept of *optimal strategy for all countries should* be left aside from the very beginning. Understanding that a generally valid innovation recipe does not exist is part of the innovation systems approach. This is due to the very specific characteristics of each country: political, social, cultural or technological. When developing a national innovation system, these specifics must be taken in account together with the current technological frontier and the different national knowledge bases (Varblane, 2012).

Karl Marx believed that socialism is a perfect system for innovation and economic development and Schroeder (1989) explains why. A centrally planned socialism was believed that would leave no reason for enterprises to withhold innovation, as it is in the case of capitalism. Additionally, a centralized National Innovation System (NIS) would avoid inefficient duplication of R&D work and will remove all barriers for diffusion of knowledge. However, the reality showed different results: the institutions of centrally planned socialism have significantly limited innovation and progress (Schroeder, 1989). In Soviet Union all key institutions which supported innovation activities were public owned, with centrally dictated inputs and outputs. In addition, a hierarchical system was in place for organization of production and distribution, artificially imposing prices, and creating incentives which were tied to meeting production targets (Schroeder, 1989). All these were contributing factors to a significant gap between productivity and innovation in East and West. The "centre knows best" approach has proven to be seriously malfunctioning (Schroeder, 1989). Even though the R&D in USSR had a very large resource base (both funds and human resource), innovation tended to be imitative of discoveries abroad, evolutionary rather than revolutionary, and incremental rather than radical. Probably the most serious drawback of the soviet centralized NIS was the behaviour of enterprises, which in the lack of economic competition, had no trigger for improvement as through the allocation process even low quality products would be sold (Schroeder, 1989). The opposite to such NIS is the capitalist NIS which is comprised of R&D performed by private sector, governments with supportive rather than controlling roles, competitive markets which foster improvement, productivity and innovation on both national and international markets. Another fundamental disadvantage in the soviet NIS model, was the somewhat artificial separation between science/technology and economic/industrial development (Schroeder, 1989). Therefore a conflict between technology and economy would appear when introducing new technologies. This was due to the non-market-orientated characteristic of the innovations, and lack of commercial traits of the new developments.

As these were the general characteristics of a soviet NIS model, Moldova and Estonia had both such NIS systems in 1991, at the fall of USSR. However today, these two countries are showing very different levels of economic and innovative performance. Our study will focus on the NISs of Moldova and Estonia, and here we explain the choice of countries. Beside the fact that both are ex-soviet countries and are comparable in size, Estonia is today the most prosperous ex-soviet country, while Moldova – one of the poorest countries in Europe. As both countries had to torn apart a soviet economy structure and build a new one from scratch, Estonia, as opposed to Moldova, has registered outstanding results in terms of innovation and economic development in the past 2 decades while Moldova has more or less stagnated since 1991.

The goal of this paper is to find out how did Estonia achieve these results so we can map the crucial actions to be taken in the process of transformation and reorientation from a soviet NIS model to a modern and more efficient one. At the same time, we aim to define the actions Moldova failed to take/or could take in the future, in order to improve the performance of its NIS system.

Our findings aim to contribute to a better understanding of the main actions ex-soviet countries could take in order to break the soviet NIS model and create the foundation for a healthy and efficient NIS system.

The second purpose of our paper is of conceptual nature as we will try to determine if there is any causality between system failures which contribute to organisational and institutional thinness in a NIS (based on the analysis of the post-soviet NIS model). As literature on the causality between system failures in NIS is limited, our findings could enlarge the general understanding of such relations.

After describing the used methods of our research, we will continue with our theoretical framework where we define the main concepts to be used in this paper: institutional and organisational thinness/thickness and types of system failures. In the 4th chapter we will shortly describe the NIS systems of Moldova and Estonia, and determine their institutional and organisational thinness/thickness. In the fourth chapter we will analyse each system failure in Moldova's NIS, specifically those inherited from the Soviet Union, while looking at Estonia's actions for overcoming those same failures. We will then summarize our main empirical findings in chapter 5 and then finalize our study with some final conclusions and reflections in the last section.

1.1. Methods

Our study can be defined as a qualitative research as the main goal is to define the main actions which can help to overcome systemic failures in post-soviet NIS systems. In our research we have used secondary data sources, mainly reports, databases, statistics and relevant literature. The data was selected by availability and relevance. Data was gathered and combined in order to form a complete image of specific treated aspects. We acknowledge however that there is a risk of data interpretation in reports and literature.

2. Theoretical Framework

In literature we come across the term Systems of Innovation (SI) which is defined as "all important economic, social, political, organizational, and other factors that influence the development, diffusion, and use of innovations." Generally, SIs are constituted of components and the relationships between them (Edquist, 2006).

When it comes to National Innovation Systems (NIS), there is no single, generally-accepted definition, however Freeman has defined them in 1987 as the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies (OECD, 1997). It is considered a challenge to define which are those constitutes as for example not all authors see R&D institutions equally important part of NIS. Nelson, R. R., for example has narrowly focused only on R&D institutions in his studies, while Lundvall, B.-Å., considered interactive learning, user–producer interaction and innovation as centre of NIS (Edquist, 2006).

In our paper, we will consider as main components of NIS all private and public companies, institutions and organisations supporting, promoting, encouraging, financing, creating and diffusing knowledge and innovation and the relationships between them. More specifically we will refer to governing and funding institutions for innovation and R&D, supporting organisations (such as tech parks and incubators, etc.), R&D centres both private and public, business sector as a whole, high education institutions and the relationships in-between them all.

Increasing interest emerged for Regional Innovation Systems (RIS) concept, as the regional dimension is considered to be of key importance when analysing SIs (Todtling and Trippl, 2005). Very useful concepts have been developed for RIS, therefore we took the liberty of applying some theoretical concepts originally designed for RIS, to describe and understand different typologies of NIS. We find this concepts suitable and valid even when scaled up to national level. Additionally, we believe that theoretical concepts in general should not be limiting by their initial purpose, but rather flexible in use and evolutionary tools used for understanding empirical evidence.

Our theoretical framework shall help us define the types of NIS Estonia and Moldova have and understand the types of system failures present in Moldova's NIS. We believe it is important to first look into organisational and institutional thickness/thinness as that will enhance our understanding of the systemic failures present in Moldova and the causational relation between them.

2.1. ORGANISATIONAL AND INSTITUTIONAL THICKNESS/THINNESS

As previously mentioned we will use in our study concepts originally designed for RIS (regional innovation systems by Isaksen and Trippl (2014). A RIS is considered to be a specific framework in which collective learning, innovation and entrepreneurial activity is generated through inter-firm interactions, knowledge and policy support structures and socio-cultural and institutional structures (Isaksen and Trippl, 2014). Formal and informal institutions and organizations stimulate and propel cooperation and innovation activities, while shrinking uncertainties in the innovation processes (Isaksen and Trippl, 2014).

A term which is crucial to be introduced in our theoretical framework is the concept of **thickness/thinness** which is defined by Trippl, Asheim and Miörner (2015) as the number of organizations in a regional system. Zukauskaite, Plechero, and Trippl (2014) have made a very useful distinction between the organisational and institutional dimension of thickness/thinness. **Organisational thickness/thinness** refers to the presence of a critical mass of firms, universities, research centres, support organizations, associations etc. While **Institutional thickness/thinness** is defined as the presence or absence of both formal institutions (laws, rules, regulations) and informal institutions (innovation and cooperation culture, norms and values) that promote collective learning and knowledge exchange (Trippl, Asheim and Miörner, 2015). Based on the distinction made by Zukauskaite, Plechero, and Trippl (2014), some RISs are less-developed due to organisational thinness, institutional thinness or a combination of the two, therefore we can classify such regions in 4 categories, while only three of them are in our scope of study (marked in grey):

Table 1. Classification of RIS by organizational and institutional thinness

	Organisational thickness	Organisational thinness
Institutional thickness	**Examples**: Metropolitan regions (city regions in Northern and Western Europe)	**Examples**: Industrial areas in the third Italy, Nordic peripheral regions are a good example for this category. **Particularities**: Italian culture is well known for tight collaboration between industrial districts however they are lacking vital elements for propelling innovation such as research centres and organisations, science-focused companies. In the case of Nordic peripheral regions, these have access to high quality government institutions (institutional thickness) with only few relevant innovative organizations (organisational thinness).
Institutional thinness	**Examples**: Larger cities in Southern and Eastern Europe; old industrial areas in Western Europe **Particularities**: These regions have an essential amount of research organizations, education and support organizations or innovative firms (organisational thickness), while the low quality of government institutions (institutional thinness) and the lack of cooperation culture hinders the innovative activities.	**Examples**: Southern and Eastern peripheral regions **Particularities**: These areas are unfortunately lacking both innovation-relevant organisations (organisational thinness) as well as healthy governmental institutions (institutional thinness).

Source: Trippl, Asheim and Miörner (2015) and own modification

It is considered that regions with limited and inefficient economic structures with weak knowledge organisations, fail to develop progressive innovation systems and have less potential to create new industrial areas. Furthermore, poor policies and governing capacities will hinder even more the development of innovation systems (Trippl, Asheim and Miörner, 2015).

2.2. TYPES OF SYSTEM FAILURES

System failures are used in the identification of regions with less developed regional innovation systems or detect weak areas of those. These system failures result from institutional and organisational thinness and we will describe the main typologies in this chapter.

2.2.1. INFRASTRUCTURAL FAILURES

Even though this specific group gets the least attention, we consider it worth mentioning. This group refers to knowledge infrastructure and a high-quality ICT infrastructure.

As Woolthuis, Lankhuizen and Gilsing (2005) grouped them, there are failures in the area of communication and energy which could range from poor ICT infrastructure, limited electricity supply or limited usage of mobile telephony and failures in the science–technology infrastructure such as limited availability of scientific and applied knowledge and skills, limited testing facilities, shortage of possibilities for knowledge transfer, few patents, poor training or education.

Here we can also add poor quality of roads, railroads, offices, R&D space, science parks, etc. all hindering a flourishing economy. We will however not refer to this aspects of infrastructural failures.

2.2.2. INSTITUTIONAL FAILURES

This category is probably the most central in relevant literature, as the institutional context is seen as a defining element in NIS. There are multiple authors trying to categorize these type of failures. Carlsson and Jacobsson (1997) have classified them as hard- and soft institutional failures. Edquist et al. (1998) describes them as consciously created vs. spontaneously evolved institutions, while Johnson and Gregersen (1994) classifies them as formal and informal institutions. However, all these classifications are referring to "hard" institutions which are the formal ones and are consciously created and the "soft" institutions which are the informal ones which often evolve spontaneously.

Both types of institutions are considered to be regulating the economic behaviour and the interactions between the actors and therefore directly influence innovation, one way or another. Therefore we can have 2 types of failures in this group. Hard institutional failures refer to poor laws, regulation on labour market and in the business environment in general which hinder innovation and economic development (Woolthuis, Lankhuizen and Gilsing, 2005). Here are also included poor intellectual property rights policies, focus on short-term planning horizons, risk averseness, strong emphasis on short pay back periods for investments, all these will most likely hinder innovativeness in an economy (Woolthuis, Lankhuizen and Gilsing, 2005).

On the other hand there are soft institutional failures referring to the informal institutional failures such as culture, social norms and values which don't promote collaboration and innovativeness (Woolthuis, Lankhuizen and Gilsing, 2005). The soft institutional failures refer to the lack of willingness to share resources with other actors and poor entrepreneurial environment (Woolthuis, Lankhuizen and Gilsing, 2005).

2.2.3. INTERACTION FAILURES

This group of failures refers to the links, interactions and cooperation between the actors. And not only between business actors, but also between business and government institutions, R&D centres or academia. There are 2 types of interaction failures. The strong interaction/network failures such as too intense interaction between certain actors creates the risk that the actors can be guided in wrong direction by each other and in this case there is a risk of lack of renewal from outside (lock-in), dependence on dominant actors and ultimately a loop which ends up in path exhaustion (Woolthuis, Lankhuizen and Gilsing, 2005).

The second type of interactional failures are the weak interaction/network failures, which is the type we will focus on, and these are poor interaction between certain actors in a NIS. As a result of weak network failures, there are very few possibilities for interactive learning and innovation and companies may fail to adjust to new technological developments (Woolthuis, Lankhuizen and Gilsing, 2005).

2.2.4. CAPABILITY FAILURES

This type of failures refers to the lack of competences and resources inside the companies or institutions supporting NIS. These resources (professionals and funding) can hinder businesses to adapt to new technological paradigms. In the case of SME's such adaptation is even more challenging. Smith (1999) has called this type of failure – "the transition failure",– which refers to the inability of companies to learn fast enough, in result being trapped in the existing technological trajectories, we will further see that this is the case of Moldova. Less developed innovation systems can be considered those which exhibit a weak capacity to generate transformative change.

We will further see in our study, that Estonia has successfully used the transition momentum in 1991 in order to catch up and embrace the technological wave from western countries.

3. NIS in Moldova and Estonia

In this section we will assess the NIS systems of the two countries based on the theoretical concepts introduced in subchapter 2.1. We will of course start with a general overview, continuing with a more in-depth analysis by presenting a few aspects, relevant for our study, in order to assess Moldova's and Estonia's **organisational and institutional thickness/thinness.** By managing to do this classifications we will be able to understand better Moldova's system failures and map the successful changes made in Estonia's NIS.

3.1. GENERAL OVERVIEW - NIS OF MOLDOVA

When talking about the innovation system in Moldova, we must begin by mentioning that the country is split into a main region which is controlled by the Government of Republic of Moldova and a much smaller region called Transnistria which has its own local administration. Therefore when presenting data on Moldova, we will not refer to Transnistria.

Moldova's R&D and innovation system is very centralized around one institution – The Academy of Sciences of Moldova (ASM) which already points towards institutional thinness. The Academy of Science has the role of the main policy-maker and main funding body for R&D and innovation activities and projects (IIMS ERAWATCH). ASM is also the main research institution in the country and it also has a higher education institution attached to it. The limited number of R&D centres indicates an acute organisational thinness (IIMS ERAWATCH).

Moldova's NIS has a very modest performance when compared to European countries. As an example, the number of researchers per million inhabitants is only a fifth of European level and this gap will most probably widen even more in the coming years due to political instability, economical unattractiveness which intensifies the brain drain process. Brain drain is an important challenge as the scientific and academic personnel is continuously emigrating to countries with better professional prospects (ERAWATCH, 2013). We will describe this phenomena in detail in chapter 4.

The R&D funding in Moldova is mainly coming from governmental sources. Governmental R&D funding is mainly orientated towards ASM and governmental institutions, ignoring the R&D in business sector. Recent trends show that R&D started playing an increasingly important role in higher education institutions (IIMS ERAWATCH). Modest improvements are registered in the infrastructure of the innovation system due to recently established techno-parks and incentives for supporting business R&D (IIMS ERAWATCH).

Only few collaborative projects are established between Moldova's research centres with those from other countries. But this is a start to facilitate the mobility of researchers and leads to knowledge circulation (IIMS ERAWATCH). The link between education and research was very weak in Moldova

even before the fall of USSR. Research was mostly focused in academy sector and in research institutes subordinated to ministries (IIMS ERAWATCH). Higher education institutions perform very limited research activities with almost no links to business sector which is a strong sign of institutional thinness. This pattern is still predominant today in Moldova however the research starts playing an increasing role in higher education institutions (IIMS ERAWATCH).

Overall we can say that the current system is supporting mainly basic research and not applied research (Popa, 2011). In result, the innovations have very limited applicability in practice. The limited involvement of the private sector in R&D activities, in addition to little funding available for R&D activities, small number of innovative companies and the mass migration of skilled work force, creates an unfavourable environment for a dynamic innovation system in Moldova (Popa, 2011).

3.2. GENERAL OVERVIEW - NIS OF ESTONIA

Just like Moldova, Estonia is an ex-USSR country, gaining its independence in 1991 which makes its NIS relatively young. Estonia has faced typical problems of ex-soviet countries which were trying to build a market-based economy (Varblane, 2012). Challenges such as liberalisation of markets, privatisation of the state-owned firms and stabilisation of financial markets were faced, therefore creating an innovation system was not a priority at the beginning of the way (Varblane, 2012).

However, during the past 2 decades, the country has developed an impressively strong innovation system which shows a healthy performance. Estonian science-driven innovation has as central focus increasing efficiency and capital intensity (Expert Group, 2012).

Estonia was ranked as a *Moderate Innovator* by the Innovation Union Scoreboard (2015), (which is a level lower than the level achieved last year - *Innovation Follower*). In the Moderate Innovator group, Estonia is the top performer. When looking at specific dimensions, Estonia scores best at Finance and Support and Firm investments, next to countries like Denmark, Sweden and Finland (EUIUS, 2015).

Figure 1. EU Member states' innovation performance
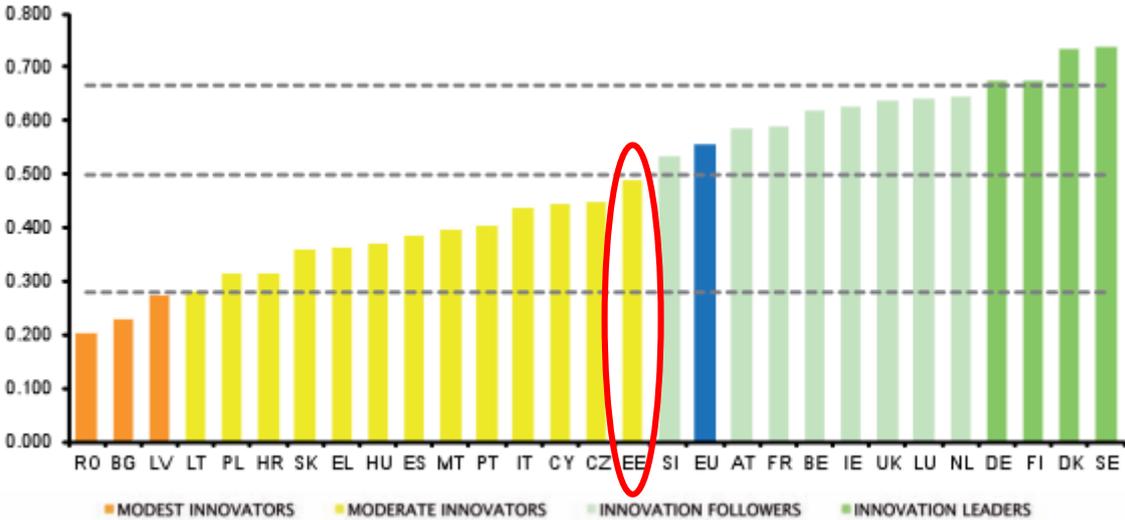
Note: Average performance is measured using a composite indicator building on data for 25 indicators going from a lowest possible performance of 0 to a maximum possible performance of 1. Average performance reflects performance in 2012 due to a lag in data availability.

Source: Innovation Union Scoreboard (2015)

In Figure 1, we can see that Estonia is performing better than half of the European countries, getting close to European average. Even more interesting is Figure 2, which shows the performance increase over last 8 years in terms of innovation, Estonia being the leading country. This figure is supporting our perception of the extraordinary leap Estonia has made in the past 2 decades.

Figure 2. Increase in innovation performance of EU countries over 8 years
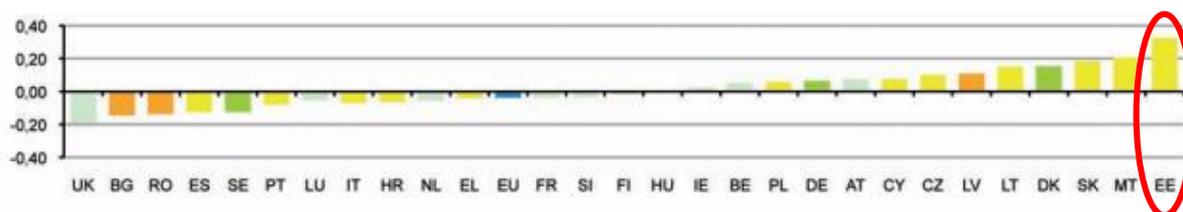
The Estonian NIS is characterized by government funding and central role of higher education institutions in performing research and innovation. Investments in R&D infrastructures in Estonia are mostly funded by EU structural funds (Expert Group, 2012). Estonia has a relatively good public and academic research system, a solid human capital base, strong bank of skills (especially in finance) and generally a well-structured NIS with active R&D-driven companies (Expert Group, 2012). These aspects point towards organisational and institutional thickness of the Estonia's NIS.

Some of Estonia's weaknesses are the modest economic returns generated by the innovation system, limited availability of doctoral students in the needed areas and lack of skilled professionals in some sectors like IT and marketing (Expert Group, 2012).

A new focus area in government policies are the environmental issues. Consequently, new programs are implemented to create cooperation between research, business and the state, to develop oil shale technologies and new renewable energies (OECD Estonia, 2012).

Further on, we will assess Moldova's and Estonia's institutional and organisational thickness/thinness based on the presented overviews and additional findings presented later in the study.

3.3. ASSESSMENT OF NIS TYPES

As introduced in the theoretical chapter, **organisational thickness/thinness** refers to the presence of a critical mass of firms, universities, research centres, support organizations, associations (Trippl, Asheim and Miörner, 2015). While the **Institutional thickness/thinness** is defined as the presence or absence of both formal institutions (laws, rules, regulations) and informal institutions (innovation and cooperation culture, norms and values) that promote collective learning and knowledge exchange (Trippl, Asheim and Miörner, 2015).

3.3.1. ORGANISATIONAL AND INSTITUTIONAL THICKNESS/THINNESS IN MOLDOVA

Based on our findings in this chapter and in the next chapter, we can say that Moldova can be defined as an institutionally and organisationally thin system. The existing R&D facilities, funding and supportive institutions are all centralized under one structure – the Academy of Science – which we will further see that – is a characteristic of soviet NIS model. The R&D centres are engaged in basic research mostly, which is not benefitting the market or the economy as a whole. As we will see in the next chapter, the newly established bodies such as The Agency for Innovation and Technology Transfer, which has initiated the establishment of techno parks and incubators, and is trying to establish connections between research community and business sector – is a first step towards organisational thickness. However the little funding received by these new institutions is a big limitation for real results. As we will further see in our study, there is almost non-existent support for start-ups and no linkages between business sector and academia and private/public R&D centres – again a characteristic of the soviet NIS. Additionally there are very limited efficient initiatives and regulations which promote innovation and research.

We will also present later in our study that the high-education system is quite developed but it does not show expected performance. Despite the high number of universities, there is a low level of gross enrolment and number of doctorate students, however this can be explained by the raising enrolment

fees which turned the academia in a lucrative funding for government's budget. We will present supporting data in the next chapter.

Overall, Moldova is challenged by the lack of efficient government institutions to support innovation. In addition, the lack of cooperation and learning culture in the society is also a big bottleneck. In conclusion, we consider that Moldova is an organisationally and institutionally thin NIS but with some modest, first steps taken towards organisationally thick system.

3.3.2. ORGANISATIONAL AND INSTITUTIONAL THICKNESS/THINNESS IN ESTONIA

In the case of Estonia, even though the quality of its NIS system is highly debated, we will further show in our study that it is considered to have quite strong institutions which were create by the model of its successful neighbours. Innovation in Estonia receives significant attention from policy-makers. There is a strong trend for cooperation between both private and public sectors, but also between entrepreneurs. The research activities are done actively by independent and public centres and business sector is willing to invest and get involved in innovative activities. Academia is also involved in R&D activities and has linkages with business sector. There is healthy enrolment in the high education institutions and the number of universities seems to be reasonable for the size of the country. All these findings will be developed in the next chapter.

The OECD Economic Review has defined Estonia as one of the most open and competitive economies in the world. It has a dynamic and transparent business environment, with an outstanding openness for creating networks over borders (OECD, 2009).

One of the most recognized achievement is the Estonia's e-government, which is considered one of the best examples in Europe for facilitating the interaction of individuals and businesses with the government (Expert Group, 2012). As we will further see in our study, Estonia has a high number of supporting organisations, such as techno-parks, incubators, entrepreneurial support bodies, diversified funding opportunities. All in all, we consider that Estonia has an institutionally and organisationally thick NIS. And further we will go through each post-soviet specific system failure in Moldova's NIS and explain how Estonia overcame it.

4. System Failures in Moldova. How did Estonia do it?

In the previous chapter, we have concluded that Moldova has an organisationally and institutionally thin system while Estonia has an organisationally and institutionally thick one. Now we can elaborate on the system failures in Moldova's NIS which determine its institutional and organisational thinness.

We will begin by explaining the particularities of the soviet NIS model, in order to better understand how these failures are specific for soviet NIS. We will continue by analysing the system failures inherited from Soviet Union by Moldova's NIS while presenting the key-actions undertaken by Estonia in overcoming those failures.

4.1. SOVIET NIS MODEL

The central paradigm in the soviet NIS system was centralisation of efforts, research and development in order to avoid duplications, waste of resources and possible mistakes. The other major supporting belief was that in a centralized system the dissemination of knowledge and experience will have no boundaries and the best technologies will be easily mapped and implemented into production. This utopia did not happen in reality, more than that, the lag between living standards in the East compared to those in the West was steadily increasing (Gertrude, 1989). As an example, the GNP per employed worker in USSR was about half of that in OECD countries in 1987, and in 1960 was about 56% of the OECD level. Similar situation could be seen in the consumption gaps between the 2 groups of countries (Gertrude, 1989).

An interesting aspect is that, this economic gap was not due to a failure in resource allocation for NIS. The share of expenditure on education, innovation and R&D, was larger than in countries with comparable levels of development (Gertrude, 1989). The explanation for the failure of soviet NIS

model lies in the soviet economic institutional environment. The general secrecy, lack of personal, civic and economic liberties were part of the problem. The key institutions leading innovation activities were 100% public owned, centrally controlled, and with imposed outputs and inputs. Production targets were the major driving force, not productivity (Gertrude, 1989). Ironically, as opposed to the expected effects, the restrictions on freedom and the collective bias have hindered the knowledge and information exchange. The created centralized system, simply removed the possibility of spontaneous generation of technical progress, and most innovations had to be administratively introduced into the economy (Gertrude, 1989).

However, we cannot deny the well-trained and dedicated researchers from the R&D institutes, next to the academic institutions with strong academic performance (Kotz, 2000). But this is a perfect case which shows how an abundance of resources in staff, funding and availability of research facilities was not a guarantee for an innovative economy (Kotz, 2000).

The central innovation-driving organisations were State Planning Committee, State Committee for Science and Technology, numerous ministries all collaborating with academic research institutes (Gertrude, 1989). All these had to forecast technological and scientific developments, execute plans for introduction of new technologies and products, estimate the future need of professionals, and assign R&D activities to appropriate R&D institutes (Gertrude, 1989). The R&D institutes were most of the time assigned to ministries, specifically to the Ministry/Academy of Science. The same institutions would then assign the enterprises for production and introduction on the market of the new products; they would also artificially fix the prices at which the innovation/new product will be sold. All this process is responsible for the technological backwardness of the soviet countries (Gertrude, 1989). The process of scanning the technological frontiers, selection, prioritization, choice of producer and artificial price imposing, has formed a conservative attitude towards innovation and promoted uniformity rather than diversity. Therefore innovations were imitative of western developments, being mostly incremental rather than radical. (Gertrude, 1989)

In soviet NIS there was a deep rupture between R&D institutes and the enterprises. The new developments in soviet countries were mostly supply-driven and not demand-driven as it was in the West (Gertrude, 1989). The lack of feedback from the market was deepening the rupture as the R&D facilities were developing products which were not in concordance with the market needs.

As the administrative process was so long and time consuming, the idea of concentrating on fewer areas was embraced - *greater concentration brings greater efficiency* - therefore the diversity of innovations was also limited. This led to monopoly of few production companies and the diffusion on the market was almost inexistent (Gertrude, 1989).

And probably the most serious drawback of the soviet model was the environment in the business sector. In soviet type economy, the company is state-owned, therefore has no private shareholders. The company did not have to fight for a market share or look for the most effective suppliers (Gertrude, 1989). The funding and the direction for expansion and modernization were controlled by the central planning system. The competition risks were eliminated and together with it the need for improvement and continuous development in order to keep a market share. As Leonid Brezhnev once stated "business firms have shied away from innovation as the devil shies away from incense" (Gertrude, 1989, p.40).

4.2. INFRASTRUCTURE FAILURES

This category of failures refers to poor physical infrastructure which affects innovation. We will look into a few indicators which will tell us how Moldova is situated compared to Estonia, namely we will analyse the ICT infrastructure and higher education institutions.

4.2.1. ICT INFRASTRUCTURE

We consider ICT infrastructure an important part of the infrastructure failures as ICT has proved to be a key propeller of socioeconomic progress and development in general. Good ICT infrastructure increases the use of modern technologies and therefore improves living standards and reduces

poverty. ICT in general is improving productivity, opens new markets, new information sources and creates new networks. Therefore we looked into two indicators in order to asses Moldova's and Estonia's ICT infrastructures: number of internet users and amount of secure internet servers.

In terms of internet users per 100 people, Moldova and Estonia started at somewhat same level at the fall of USSR, however Estonia has showed incredible performance rate, even before joining EU in 2004. Today, Estonia has almost double number of internet users than Moldova.

Figure 3. Internet users in Moldova and Estonia (per 100 people)
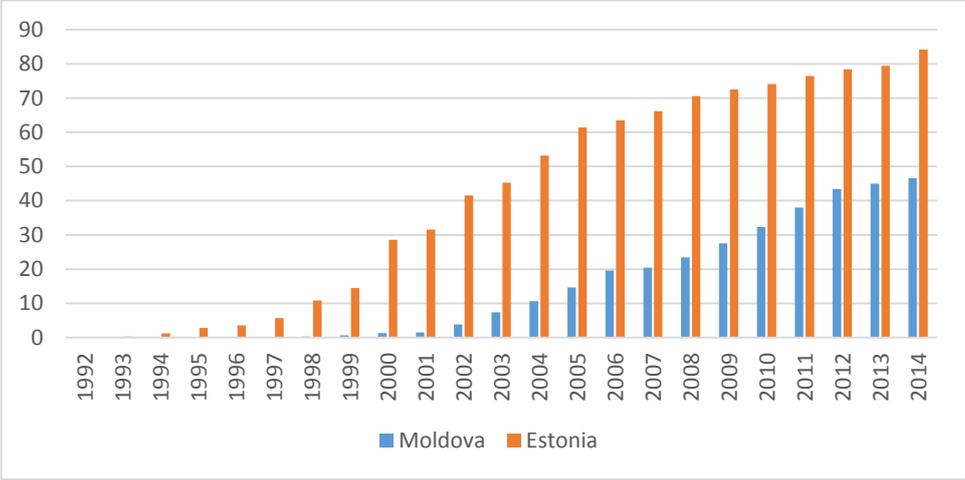
Source: Own calculations using data from World Bank[1]

Moldova's performance is even worse when looking at the access to secure internet servers. Again, both countries started at close to zero levels in the beginning of the century, but Estonia has registered spectacular development of its ICT infrastructure, while Moldova is still stagnated at very low levels.

Figure 4. Secure Internet servers in Moldova and Estonia (per 1 million people)
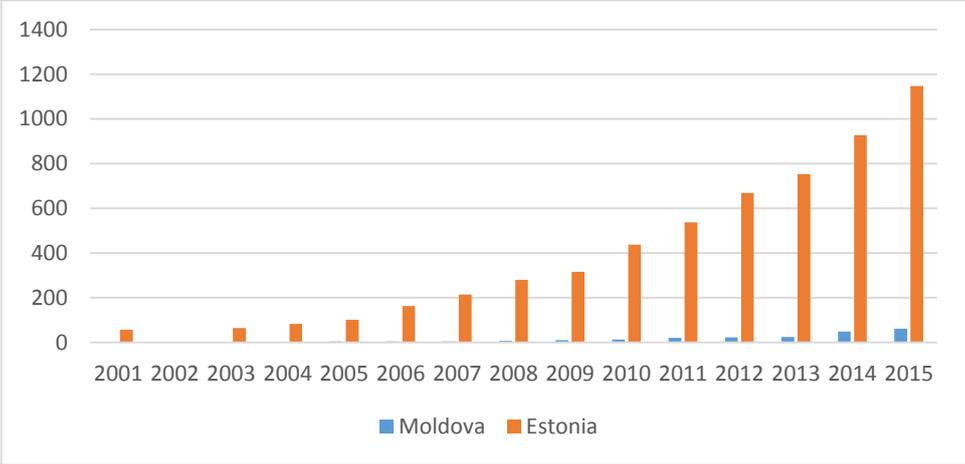
Source: Own calculations using data from World Bank[2]

Moldova has to follow Estonia's example and improve its ICT infrastructure. By creating good ICT infrastructure people would consume more information and communication technologies. Internet access should be a top priority as it is crucial in a globalized and technologically intensive economy. Moldova is still focusing on the old practices and old ways typical for soviet times, and there is a resistance towards improvement and modernization especially in rural areas. This however can be addressed through the right policies.

4.2.2. HIGHER EDUCATION INSTITUTIONS

The particularities of higher education system is a very important aspect of the infrastructural failures in Moldova, which is contributing to its organisational thinness. Moldova has officially 30 accredited universities out of which 13 are private and 17 are state universities (ERAWATCH, 2014). In 2010/2011 academic year there were 108,000 students enrolled with about 83% of them being enrolled in state institutions (ERAWATCH, 2014). These figures indicate 303 students per 10,000 inhabitants which is significantly less than in neighbouring countries like Romania and Ukraine. (ERAWATCH, 2014)

In 2010, Moldova had around 28,000 students who graduated and approximately 1,600 doctoral students (ERAWATCH, 2014). If until 2006/2007 the number of enrolled students was increasing with each year, in 2006 the government has introduced enrolment fees for all universities which affected the number of enrolled students the number declining ever since, we can see this phenomena in the graph below (ERAWATCH, 2014). The levels registered by Moldova have not changed significantly since the regain of its independency in 1991 as we can see in Figure 5.

In Moldova, unfortunately, universities are not interested in accessing private funds for research projects, which is an important drawback as universities can be an important propeller of scientific innovations in innovation systems (ERAWATCH, 2014).

The stagnating enrolment rates in Moldova (Figure 5) indicate that the quality and the accessibility of these universities can be improved. We consider this again a sign of organisational thinness as the number of universities does not reflect growing enrolment, and the low number of doctorate students is again a sign of organisational thinness.

Figure 5. Gross enrolment ratio, tertiary, in Moldova and Estonia both sexes (% of total population)
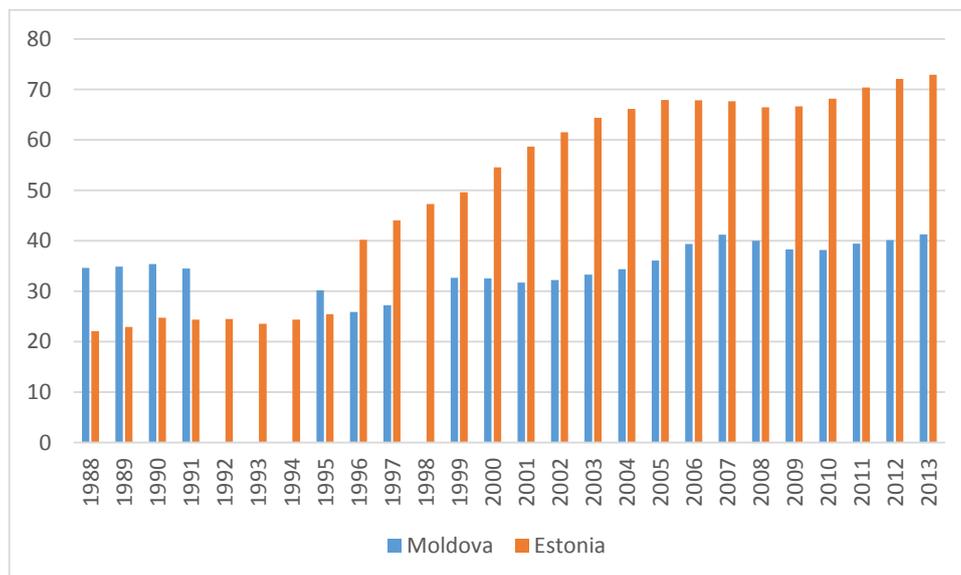
Source: Own calculations using data from World Bank[3]

On the other hand, Estonia has registered remarkable changes in its system of higher education. We can see in Figure 5 and 6 how the percentage of total population enrolled in tertiary education has constantly increased in the past 2 decades.

One of the most significant reforms adopted in Estonia during the 2012/2013 academic year, was the eradication of education fees for those studying full-time in Estonian language, while in Moldova the increase of study fees affected negatively the enrolment levels (Expert Group, 2012).

Figure 6. Students enrolled in Estonian high education (total nb. per academic year)

Number of students

Academic year	Doctoral study	Master's study**	Integrated study programmes of Bachelor's and Master's study	Bachelor's study*	Professional higher education study
2009/10	2,653	12,097	4,160	27,531	22,544
2010/11	2,928	12,632	4,122	27,461	21,970
2011/12	3,051	13,170	4,024	26,591	20,791
2012/13	3,044	13,055	3,949	24,525	20,233
2013/14	2,982	12,746	3,751	22,661	17,878
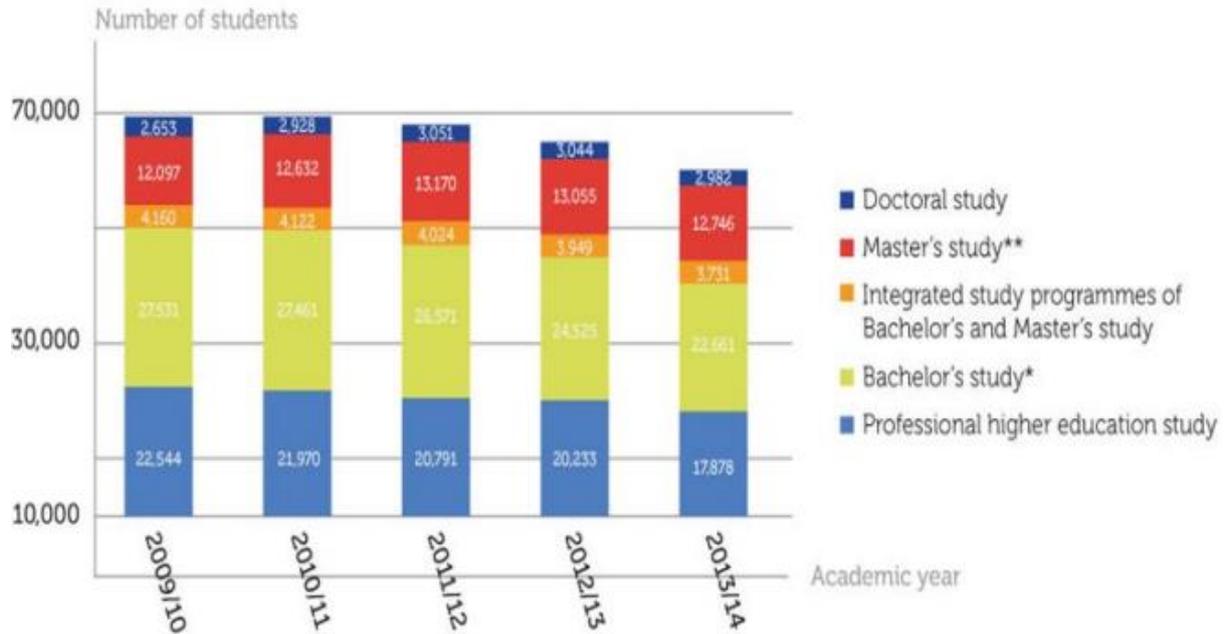
Source: Erasmus, 2015

There are 6 state universities in Estonia and the largest part of the academic R&D is performed at the 4 main state universities: University of Tallinn, University of Tartu, Tallinn University of Technology, Estonian University of Life Sciences and one private university specialized in business administration and management (Expert Group, 2012).

These institutions existed before 1991, however after the regain of country's independence, significant changes occurred in their operation. One significant change is that the research institutes, formerly part of the Academy of Science – typical for a soviet model – were allocated to universities instead (OECD, 2012). Additionally, the current Tallinn University has been created at the merge of the largest academic library in Estonia, 2 institutes and a university, which created a strong, new establishment with a solid staff structure (OECD, 2012).

There were around 1,500 exchange and summer school students in Estonia which shows a well-established cooperation between Estonian and international universities (OECD, 2012). In the Figure 8 we can also see that the number of doctoral students is higher than the level achieved in Moldova (1,600 in 2010).

The Estonian government has adopted several programmes to support research and knowledge production in universities, along with increasing universities' excellence, competitiveness and internationalisation. We can see that even though Moldova has 30 universities with no R&D centres, compared to 7 universities in Estonia out of which 4 are important R&D actors, the gross enrolment is almost double in Estonia. Due to the increasing fees for enrolment in Moldova, universities have become a lucrative business (therefore the high number of universities) becoming less accessible for young population.

We consider that the level of enrolment reached in Estonia is a sign of a strong education system and therefore reflect organisational thickness. We believe that Moldova needs to improve the infrastructure of its high education institutions in order to facilitate the access to high education for future students and doctorates.

4.3. INSTITUTIONAL FAILURES

The institutional failures usually receive the most attention in literature due to the defining role these are playing in a NIS. The hard institutional failures that we will refer to are: governing NIS institutions, smart specialization incentives and other political incentives in innovation. We will also look into the following soft institutional failures: R&D in business sector, R&D expenditure, start-ups' support, patents and publications, economic freedom and corruption. We consider that all these elements can stimulate or hinder innovation and are good indicators for organisational and institutional thickness/thinness.

### 4.3.1. INSTITUTIONAL CENTRALIZATION IN NIS

When looking at the organisational landscape in Moldova we can see that the Academy of Science of Moldova (ASM) is playing a central role in the innovation and R&D system. It is the main policy-maker in the sector and it has the role of Ministry of Science, with its president being a member of the government (Popa, 2011). The central role played by this institutions is an acute sign of institutional thinness.

The ASM is in charge of managing most of the public funds in R&D. It has 19 research institutes which makes it the main research organisation in the country (ERAWATCH, 2014). In 2004, The Agency for Innovation and Technology Transfer (AITT) was created, which is also subordinated to the Academy of Science and is in charge of coordinating, encouraging and supporting technology transfer and innovative activities (ERAWATCH, 2014). AITT is attempting to create the link between the research centres and business sector by encouraging companies to test and apply scientific solutions on the market. The organisation however can only access a very small amount of funding.

The AITT has also the responsibility to finance, administrate and control technological transfers' projects such as science parks and incubators, a responsibility which is unusual for such agencies. In mature innovation systems, universities, incubators and techno parks usually are autonomous and are only receiving assistance or support from such agencies (Popa, 2011). If between 2006 and 2008, only accredited institutions by the National Council of Accreditation and Attestation could create technology transfer projects, since 2009 private institutions and non-accredited organizations have the right to apply for such projects as well. Such projects can receive up to 50% financing while ASM-related institutions can receive 100% (Popa, 2011).

We can see in Figure 7 that the number of technological transfer projects is falling since 2007 and this can be due to focus on fewer projects or due to limited available financing.

**Figure 7. Number of technological transfer projects in Moldova, 2005 - 2015**
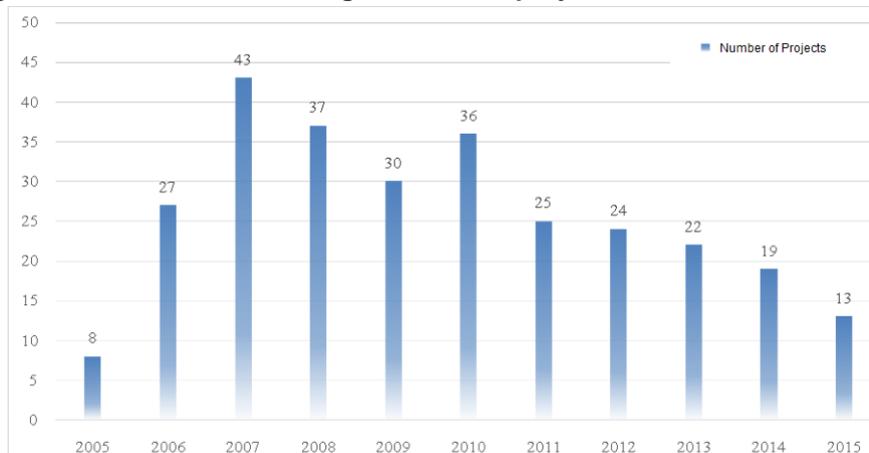
Source: AITT, 2015

The Moldova's R&D activities are highly concentrated in the public research organisations with most of them being subordinated to the ASM. In 2008, there were 47 public R&D centres registered. The researchers from public R&D organisations get the most of patents and have the most publications in the Web of Science, when compared to the higher education and business sector researchers (ERAWATCH, 2014).

When we look at Figure 8 we can see that all NIS governance in Moldova is deriving from the ASM which again shows the centralized character of its thin institutional infrastructure, which is inherited from the soviet-model.

Figure 8. Moldova's NIS governance structure
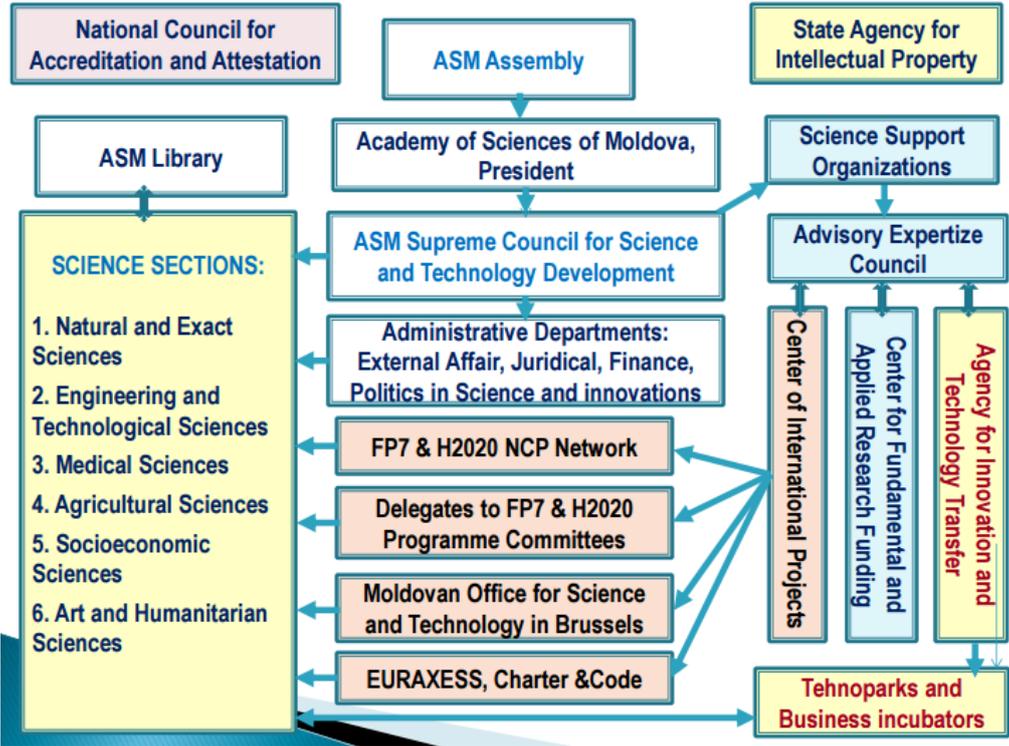
Source: Romanciuc, 2015

Even 2 decades after the fall of USSR, the centralization of R&D activities and institutions is still in place. We have seen in subchapter 4.1 that having the Academy of Science as the centre institution was a typical structure in soviet countries. Centralization and lack of diversity of actors is dangerous for a flourishing NIS because the directions of R&D are unilateral and are disconnected from the business environment and economy as a whole. Additionally, we will see further that the efficiency of public institutions in Moldova is low due to corruption and lack of transparency which is compromising the whole NIS system as it is based fully on public institutions, namely one – the Academy of Science.

Overall, we can say that the highly centralized position of the ASM, and the monopoly it keeps on both funding and R&D institutes is a clear indication of organisational and institutional thinness and it negatively affects the development of the NIS system.

Estonia is ranked much higher than Moldova in terms of quality of R&D institutions:

Figure 9. WEF Score on the quality of R&D institutions 2009 – 2010
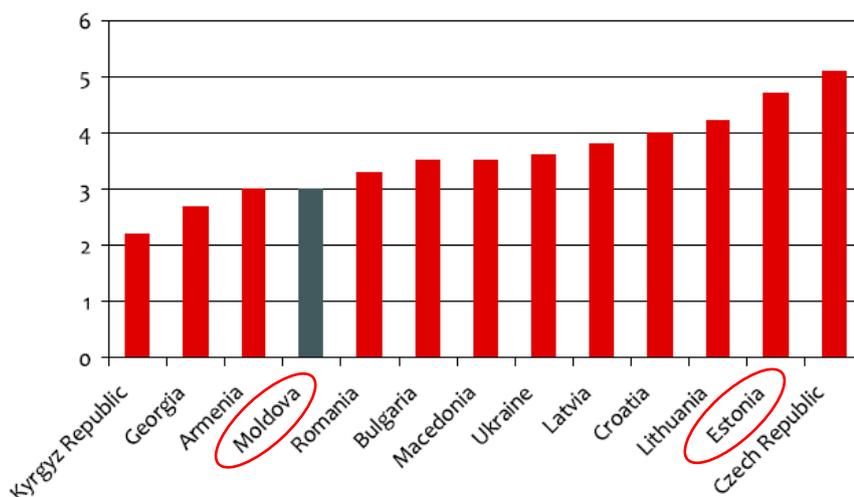
In 2011, in Estonia was created The Estonian Research Council which is the main funding agency (OECD Estonia, 2012). Its main objectives are to increase basic and applied research, support researchers, encourage international cooperation, and coordinate national and international training and research programmes.

In Estonia, the national innovation strategy including the associated programs are implemented by Ministry of Education and Research (MER) and the Ministry of Economic Affairs and Communications (MEAC) (Expert Group, 2012). These two ministries are primarily involved in financing NIS and formulating and implementing NIS policies and they have multiple implementing agencies and bodies at the operational level (Expert Group, 2012). This shows once again the institutional and organisation thickness of Estonia's NIS.

MEAC has the Enterprise Estonia Foundation – the main implementing body which is responsible for insuring business support, innovation and managing technology programmes (Expert Group, 2012). KredEx is offering risk capital for start-up ventures and business actors in general. MER has 2 agencies offering funding and support: the Archimedes Foundation which is responsible for supporting activities related to European Research Area, international research programmes, academic mobility, etc.; and the Estonian Science Foundation which offers grants to researchers (Expert Group, 2012).

Even though the government sector is the largest founder of R&D and innovation activities (44.3% in 2010) the public sector itself is not a major performer of research and innovation activities, therefore public research institutions play a limited role in innovation while the 4 state universities perform the most of the academic research (Expert Group, 2012).

When looking at the governance structure of Estonia's NIS system in Figure 10, we can see that the amount and type of implementing and operating bodies and agencies is much more diverse than in Moldova and there are more influencers in funding and supporting institutions. We can also see that the Estonian Academy of Science is cooperating with the universities but not controlling them, same with the Public Research Organisations/Institutes.

Figure 10. Estonia's NIS governance structure
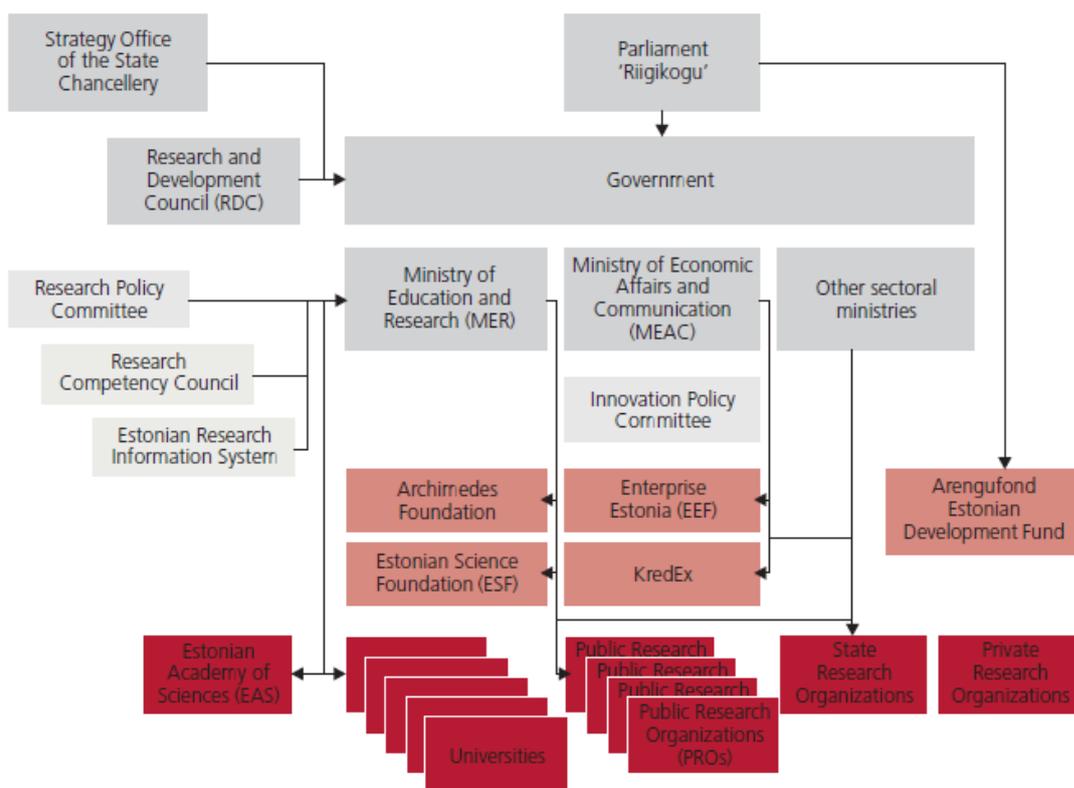
Source: Expert Group, 2012

Clearly, Estonia has changed the centralized NIS model characteristic for soviet countries. One important change Estonia implemented was that the research institutes, controlled by the Academy of Science – as it is still in Moldova – were made independent state-owned research institutes and incorporated into universities (Expert Group, 2012). We should emphasize on the institutional decentralization which Estonia achieved after the fall of USSR. We believe that when students are given the facilities and infrastructure to be part of research, entrepreneurship dynamism is propelled and therefore will create bridges between public and private sectors. The public research institutes have been taking out from the Academy of Science and allocated to universities, which are using them in more practical research and also for collaborative projects with business sector. This is an important element lacking in Moldova due to its still soviet NIS system.

Another major difference between Moldova and Estonia is that Moldova has almost no private research organisations (something typical for soviet model) which is negatively affecting the development of its NIS system and contributing to its institutional and organisational thinness. All in all, Estonia seems to have an institutionally thick system, due to the decentralized system of governing, funding and operational institutions, in addition to the existence of private research organisations.

4.3.2.   SMART SPECIALIZATION INITIATIVES

Smart specialization can be defines as: *"the identification of a small group of sectors/technologies at regional/national level, which can be potentially competitive in international markets and generate new activities with comparative advantage over other locations"* (Gulc, 2014, p.96). We consider smart specialization an important aspect of institutional failures, as it is part of the legislation which could encourage and support innovation in a NIS, therefore the lack of smart specialization is also a good indicator of institutional thinness.

In Moldova, in February 2016, has been organized the first workshop on smart specialisation strategy by the S3 Platform and the Academy of Sciences of Moldova (S3platform). The goal of the workshop

was to help Moldova benefit from S3 methodology by focusing on knowledge-based investments on a limited number of priority areas (S3platform). This event suggests that Moldova did not investigate smart specialisation yet and is only at an incipient phase in the process of acknowledging its benefits which contributes to Moldova's institutional thinness.

In Estonia, a group managed by Urmas Varblane has carried out a research to identify key areas with highest growth potential in Estonia. Eight potential growth areas were determined (EDF, 2013): ICT, health technology and health services, mechanical engineering, logistics, chemical products, innovative house-building (wooden houses), timber enhancements (doors, windows, furniture, design, cellulose, paper and cardboard), functional food.

The first 2 areas defined are the same as the ones defined by the Estonian Development Fund and the strategy defined was supported by the Ministry of Education and Research, the Ministry Economic Affairs and Communication, Enterprise Estonia and the Estonian Research Council (EDF, 2013). Estonia's Smart Specialization Strategy is focused on: ICT (use of ICT in industry, e.g. automation and robotics; cyber security and software development), health technology and services (biotechnology, e-medicine) and more efficient value-added from the use of resources (material science and industry, development of the 'smart house' concept, food that supports health, chemical manufacturing) (EDF, 2013).

Smart specialization is a focus area in the NIS policies in Estonia and will definitely gain even more attention in the coming policies. We consider that Moldova is stagnating at initiating smart specialization which contributes to its institutional thinness and it will have to focus more on eradicating this drawback.

4.3.3.   POLITICAL INITIATIVES IN INNOVATION

We consider that efficient political initiatives are very important in diminishing institutional thinness, however the lack of sufficient legislation and rules supporting innovation is an important institutional failure. During the past decades, innovation became a central focus in the creation of policies in most emerging economies even in the developing and least-developed countries. In 2013, in Moldova was approved the innovation strategy called *Innovation for Competitiveness for the period 2013 – 2020,* developed by ASM. This strategy foresees five general objectives (ERAWATCH, 2014):

1. Adoption of an open governance of the R&I system
2. Encourage innovation by supplying entrepreneurship trainings
3. Orientation of companies towards innovation
4. Apply knowledge to solve social and global problems
5. Stimulation of demand for innovative products and services

Another strategy approved by the Moldovan Government in December 2013 is the *Strategy of research-development of the Republic of Moldova until 2020* which is not yet effective but has the following elements in scope: capacities, research priorities, linkages, internationalisation, and governance of research (ERAWATCH, 2014).

These policies were complemented by an agreement between the Academy of Science of Moldova and the Moldovan Government – The 2013 Partnership Agreement, which included more specific objectives such as *strengthening the infrastructure of science and innovation, improving the system of R&D funding, stimulating the creation of innovative small and medium sized enterprises (SMEs), attracting direct investments in science and expanding technology transfer* (ERAWATCH, 2014, p.2).

Another important strategy adopted is the Educational Development Strategy – Education 2020, which has as objective the implementation of lifelong learning, promote a system of social, scientific, professional values, create skills for integration on the labour market and build entrepreneurship skills (ERAWATCH, 2014).

Since July 2014, Moldova has gained full access to the EU's 7-year research and innovation programme Horizon 2020: 2014 – 2020 (Romanciuc, 2015). In the same year, EU and Moldova has signed the agreement of participation of Moldova in COSME 2014 – 2020. Based on the agreement

Moldova is eligible to 3 out of 4 COSME actions and namely access to markets, supporting entrepreneurs and more favourable conditions for business creation and growth. The 2020 Innovation Strategy is the main document for the development of innovation activities in Moldova (Romanciuc, 2015).

At the end of 1990's, two crucial documents were prepared in Estonia (based on Finish example): *The Estonian State Innovation Programme* and the *National Development Plan for the years 2000–2002*. Later on, Estonia has defined its innovation strategy in *Knowledge-based Estonia: Estonian Research and Development Strategy 2002-2006* (Varblane, 2012)*.* Very ambitious target was set: to increase the R&D expenditure of GDP from 0.08% to 1.5% by 2006. Later, Estonia has defined 3 focus areas: user-friendly information technologies and development of the information society, biomedicine, and material technologies (Varblane, 2012). Narrowing the focus was considered a wise decision at that time. Unfortunately, the proposed strategy was more suited for Finland than to Estonia, and very little attention was given to the diffusion and absorption of knowledge. Another strategy was prepared, the so-called *Knowledge-based Estonia II,* which put emphasize on the fact that R&D spending and GDP per capita should go hand in hand with the growing share of private sector R&D (Varblane, 2012). The main objective of this document is to increase the quality of both public and private research and innovation, and this shall be achieved by developing human capital (increasing the career opportunities for researchers), increasing companies' capacity to innovate, develop new long term policies and modernising R&D infrastructure (OECD Estonia, 2012).

The third Estonian Research and Development and Innovation (NIS) strategy called 2014-2020 "Knowledge-based Estonia" was developed based on the lesson learned from the previous two strategies and has as central goal to create favourable conditions for increase in productivity and in the standards of living of the population, in addition to insure good-quality education and the longevity and development of Estonia. Other governmental policies like *Entrepreneurship Awareness and competence Raising Programme 2009-1*3, *Innovation and Entrepreneurship Awareness and Competence Raising Programme 2009-13, Start-up Estonia*, Estonian Entrepreneurship Growth Strategy 2014 – 2020, and multiple programs and initiatives which for example aim to prepare sufficient NIS staff, promote attractive working conditions and address gender and dual career aspect (OECD Estonia, 2012).

Even though there are some important ad promising policies and strategies in place, in Moldova the R&D policies are still weakly linked with other relevant policies for innovation. In addition the weak institutional structure affects the implementation of these policies (ERAWATCH, 2014). The mix of institutional failures in Moldova is making it difficult to put those policies in motion. We consider that Estonia has much more clearly-defined goals in a larger spectre of policies and strategies which adds to its institutional thickness. Additionally, Estonia's strategies also put emphasis on encouraging and supporting R&D in private sector, a focus Moldova still lacks.

4.3.4.   R&D in Business Sector

R&D in business sector is dependent on policies and legislation, therefore the lack of it is considered an important institutional failure therefore we consider important to look into this aspect.

Moldova has over 52,000 SME's, which represents about 96% of the total number of enterprises in the country (Romanciuc, 2015). The very limited statistics show that in 2008 there were registered 6 private R&D organisations focusing on applied research and experimental development; 4 mixed (private and public) R&D organisations and one joint venture organisation (ERAWATCH, 2014). However the National Bureau of Statistics in Moldova does not systematically collect data in this field, therefore these figures might be a very narrow glimpse into the real situation.

Today, the business sector in Moldova is engaged in very minor R&D activities, with predominantly own funding and with main focus on implementation of developments (ERAWATCH, 2014). Most of these companies are located in the country's capital – Chisinau. Overall, we can say that the private sector has very limited R&D activity. When looking at the types of organisations conducting R&D activities in Moldova, we can analyse the situation in Table 2:

Table 2. Number of institutions conducting R&D activities in Moldova in 2008

	Total	Public	Private	Mixed*	Joint ventures
Total	70	58	7	4	1
Scientific-research institutions	42	40		2	
Design-investigation organizations and design offices for construction works	16	7	6	2	1
Higher education institutions	12	11	1	–	

Source: Popa, 2011

We can see that the biggest share is taken by the public institutions. Private sector usually generates innovations applicable on the market which could generate growth and development, therefore lack of R&D in private sector affects heavily the innovation system in Moldova and contributes to its institutional thinness.

A big difference between Moldova and Estonia is that the business sector in Estonia exceeds the education sector in terms of performance in R&D and innovation with higher Gross Enterprise Expenditure on R&D (GERD - 0.82% to 0.62%) while the government sector is a more marginal performer - 0.17% (Expert Group, 2012).

In Estonia, there are about 400 companies conducting R&D activities (Eurostat, 2012). Out of all companies operating in the country 47.6% of them are considered innovative enterprises in 2010 – 2012, with a slight fall from 56.8% in 2008/2010 – to right below the EU27 average (Eurostat, 2012). The share of the business sector in R&D funding was 43.6% in 2010 while abroad funding summed up to 11.4%. (Expert Group, 2012). Nonetheless, business innovation in Estonia remains below OECD average in terms of key indicators and is concentrated in a limited number of high-technology sectors (ICT, biotechnology, financial and telecom services) (OECD Estonia, 2012).

The Estonian government has adopted the Innovation and Entrepreneurship Awareness and competence, Raising Programme 2009-13, in order to stimulate business R&D and innovation. Instruments like direct funding (innovation vouchers) and non-financial measures (policies and programs) are used for fostering business R&D. This kind of actions are missing in Moldova, and as long as business sector will be kept with no support in getting engaged in R&D, Moldova's NIS will not be able to overcome this institutional failure.

4.3.5.   START-UP SUPPORT

The start-up's support is an important aspect of a functional and modern NIS as start-up's are in many cases the generators of innovation and developers of new technologies. In our case we consider it an important indicator of the institutional and organisational thinness/thickness and therefore we will try to determine if Moldova's NIS is providing any kind of support for start-ups.

Unfortunately, the support new entrepreneurs get in Moldova is very limited or lacking at all. There are 6 innovation incubators in Moldova, and their activities range from consultancy and services around intellectual property, legal consultancies, and marketing/accounting/financial services to seminars and conferences (AIIT). These services are offered at a reduced price or for free. But given the limited amount of supporting institutions, the start-up environment in Moldova is still under-developed and non-attractive for new entrepreneurs which is a sign of organisational thinness.

On the other hand, there are around 450 start-ups in Estonia with the goal of reaching 1000 by 2020. It is considered that the *start-ups' fever* started in Estonia in 2003, when the three schoolmates Ahti Heinla, Priit Kasesalu, and Jaan Tallinn, have written the software for Skype (even though the entrepreneurs behind it were 2 Scandinavian friends) (Work in Estonia, 2015). This was the first truly global multinational created in Estonia and it created a trend. The start-up entrepreneurs in Estonia have a strong support system comprised of more than 180 supporting structures/organisations (Work in Estonia, 2015). An important science park is The Tartu Science Park which is considered an

innovation engine in Southern part of the country which has as objective to grow start-ups into global businesses (Work in Estonia, 2015). A multitude of incubators, techno hubs, techno parks, etc, are offering support of all ranges to the young entrepreneurs.

The business start-up process is simplified and easy in Estonia, with the costs of licencing requirements significantly decreasing (IEF, 2015). The government is attempting to create a *Baltic Silicon Valley* (for information technology start-up business) with the help of European funds (IEF, 2015). Start-up Estonia is a significant governmental project which is putting together the start-ups with incubators, accelerators, public research centres in order to develop and support start-ups. Multiple programs and initiatives such as *Innovation and Entrepreneurship Awareness and Competence Raising Programme 2009-13, Start-up Estonia, Fostering entrepreneurship in higher education institutions -part of the Government Action Plan 2011-15,* etc. are creating and developing a favourable environment for entrepreneurs in Estonia, which is also called the "the start-ups heaven" (Start-up Estonia).

Estonia is clearly giving real support to its new entrepreneurs and there is already a strong community created among young entrepreneurs. This dynamism is a sign of healthy environment for start-ups and its definitely contributing to Estonia's organisational thickness.

4.3.6. PATENTS AND SCIENTIFIC PUBLICATIONS

Lack of patents and publications are an important indicator of institutional failure. When looking at the number of patent applications in Figures 11 and 12, we can see that Moldova is registering very high levels of applications made by the residents. Moldova is registering more patents than Estonia and more than many other "better innovation-performing" countries. These figures could be explained but the low costs for registering a patent in Moldova, however the true applicability of these patents is reflected in the renewal rate over 5 years which is very low (Popa, 2011). The high number of patents can be explained by the 5-year remission from taxes for individuals certified in R&D sector (Popa, 2011). In Moldova there is also a low share of patents registered as companies' assets which can suggest a low applicability of the inventions. In figure 11 and 12, we can see a significant decrease in patent applications in Estonia for non-residents in 2004, which is explained by the fact that Estonia entered EU and the application process became more costly and less accessible as it had to be in compliance with the European Patent Office. Estonia is far below EU27 when it comes to number of patents due to high costs for patenting and complicated bureaucracy. Another reason for the limited amount of patents can the academia's strong focus on "high science" publications which are considered a larger merit than patents (IR, 2012).

**Figure 11. Patent applications in Moldova and Estonia 1993 - 2014, non-residents**
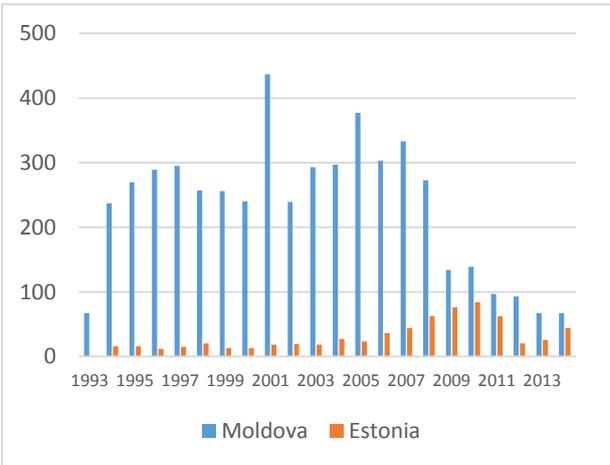
**Figure 12. Patent applications in Moldova and Estonia 1993 - 2014, residents**
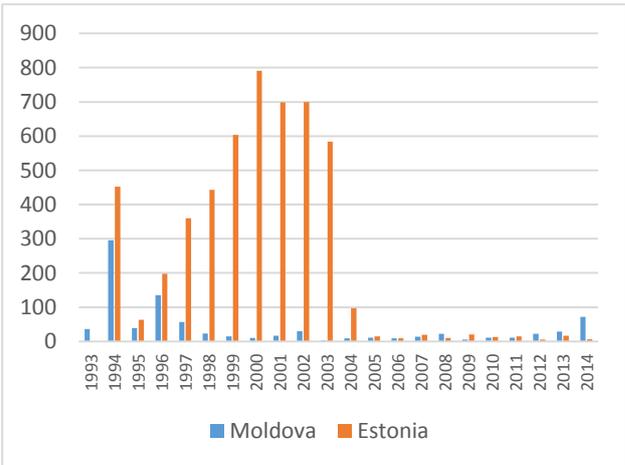
Source: Own calculations using data from World Bank[4,5]

The number of patents is often used as a comparison indicator for innovation intensity, however the Moldova-Estonia example makes us question the validity of this indicator as an indicator of innovativeness. It might reflect in a larger extent the quality or accessibility of the patent's legislation rather than the performance of the NIS.

In terms of number of scientific publications, we can see on figure 13 that the two countries started at similar level in 1993, however Estonia took a very strong upward trend with a continuous growth until 2013, while Moldova kept more or less the same levels since 1993. This indicator could tell us about the intensity of R&D activity in the higher education institutions and it is alarming that Moldova is not showing any sign of revival or dynamics in this field.

Figure 13. Scientific and technical journal articles in Moldova and Estonia, 1992 - 2013
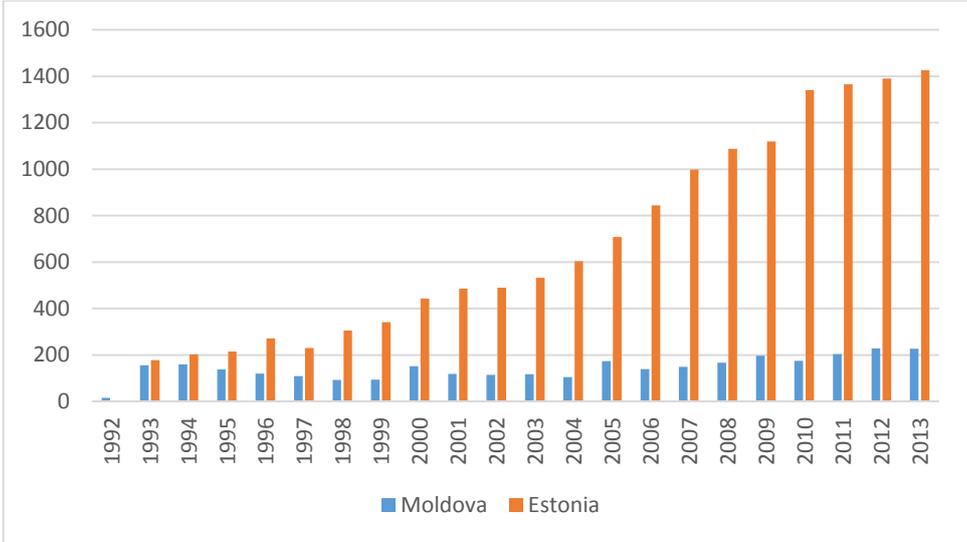
Source: Own calculations using data from World Bank[6]

The little number of scientific publication in Moldova is due to the fact that universities in Moldova do not have R&D facilities, lack professionals and sufficient funding. Due to the fact that Estonia's R&D institutes have been distributed to universities (from the Academy of Science), there is a high number of publications, as in academic circles scientific papers and publications are much more prestigious than patents. The centralization of R&D centres under the Academy of Science in Moldova is clearly a drawback for the number of publications and scientific papers published.

4.3.7. CORRUPTION, ECONOMIC FREEDOM AND PROPERTY RIGHTS

We consider economic freedom and corruption to be related to the soft institutional failures. These indicators are important for our study as they affect directly the functionality of all governing institutions, business sector and start-up environment reflecting also the values and norms in the society.

For analysing the level of economic freedom and corruption in Moldova and Estonia, we chose to look into the Index of Economic Freedom which ranks countries with score 100 to 80 as economically free countries, 79.9 to 70 - mostly free countries, 69.9 to 60 – moderate free, 59.5 to 50 – mostly unfree, 49.4 to 40 – repressed. As we can see in Figure 14, Moldova had an overall score of 57.4 in 2015 (which is lower with 0.1 point as compared to last year). This makes the economic freedom status of the country Mostly Unfree, with a global average at 60.7 (IEF, 2015). Estonia is positioned significantly better at 77.2 overall score with the Economic Freedom Status being assessed as Mostly Free (IEF, 2015).

In Moldova, limited actions have been undertaken by the government for improving the entrepreneurial climate and promoting economic freedom. Bureaucracy and lack of transparency, makes the creation

and operation of private companies expensive and difficult in addition to the high non-salary costs of hiring workers. (IEF, 2015)

Figure 14. Index of Economic Freedom in Moldova, Estonia and World Average 1995 - 2016
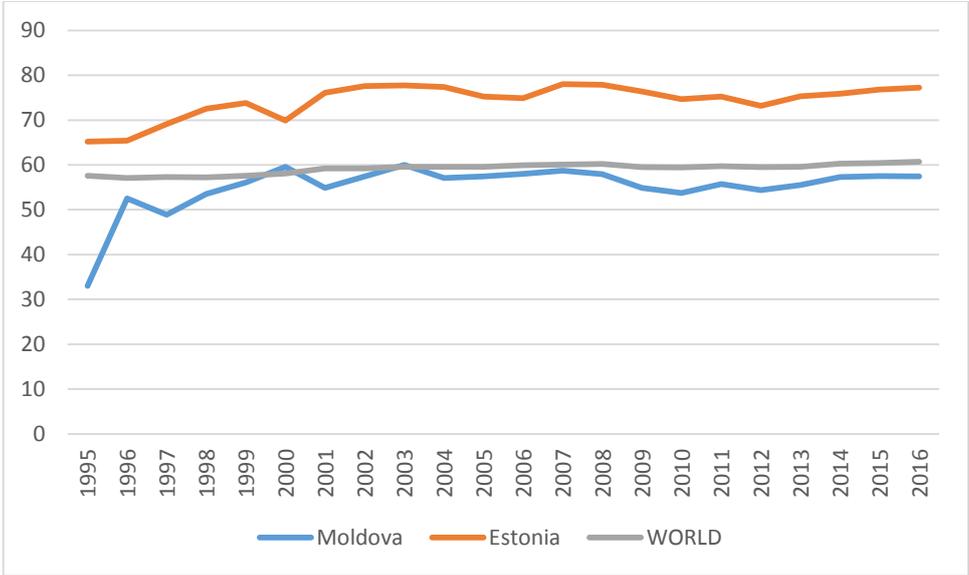
Source: Own calculations using data from IEF 2015

Most of the Moldova's population considers corruption to be one of country's main challenges. It is scored at as low as 35 (on same scale as for the index of economic freedom) which is below the world average as we can see in Figure 15. Corruption in Moldova is a systemic problem present in public institutions, in the judicial system, in public service, political parties, educational system, healthcare and legislature (IEF 2015). The rule of law in Moldova is not completely institutionalized and the judiciary system is heavily affected by political interference and corruption (IEF 2015). Coetzee (2012) has defined corruption as a social pathology contributing to poverty and systemic under-development. He also sustained the idea that corruption must be understood through a systemic framework with all its relationships to other variables of an economic system. We have also applied a systemic approach when analysing corruption, in addition we believe that corruption plays a central role in the causality relation between the system failures and we will elaborate on this idea in the last section of the study.

Figure 15. Freedom from corruption in Moldova, Estonia and World Average 1995 - 2016
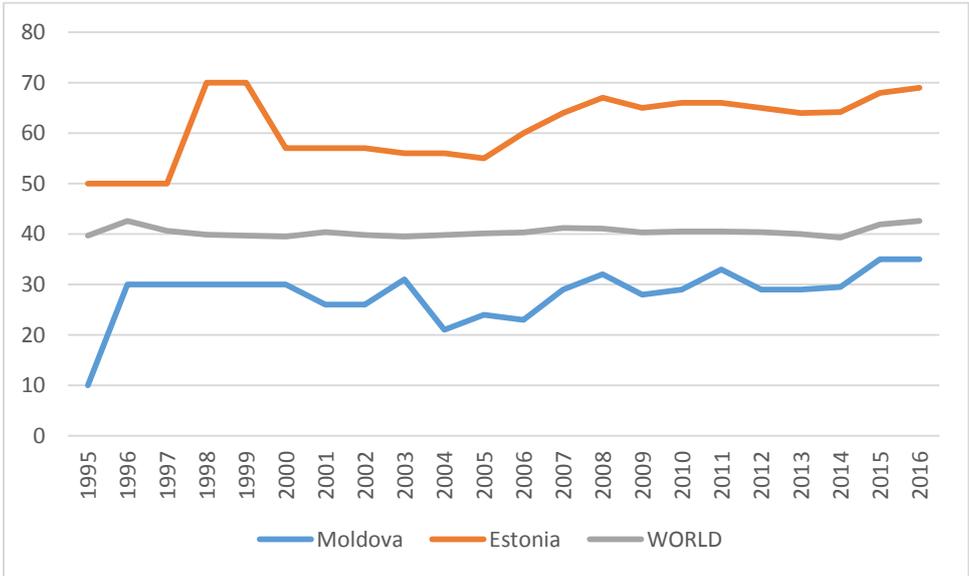
Source: Own calculations using data from IEF 2015

Estonia scores 69 in Freedom of corruption, far above the world average, and even if there are still occasional problems of government corruption, and these are heavily mediatized and publicized (IEF 2015). The judiciary system in Estonia is effectively separated by the influence of the government. Estonia is promoting well enforced property rights and contracts while Moldova is performing poorly in property at this indicator as we can see in Figure 16.

Figure 16. Property Rights in Moldova, Estonia and World Average 1995 - 2016
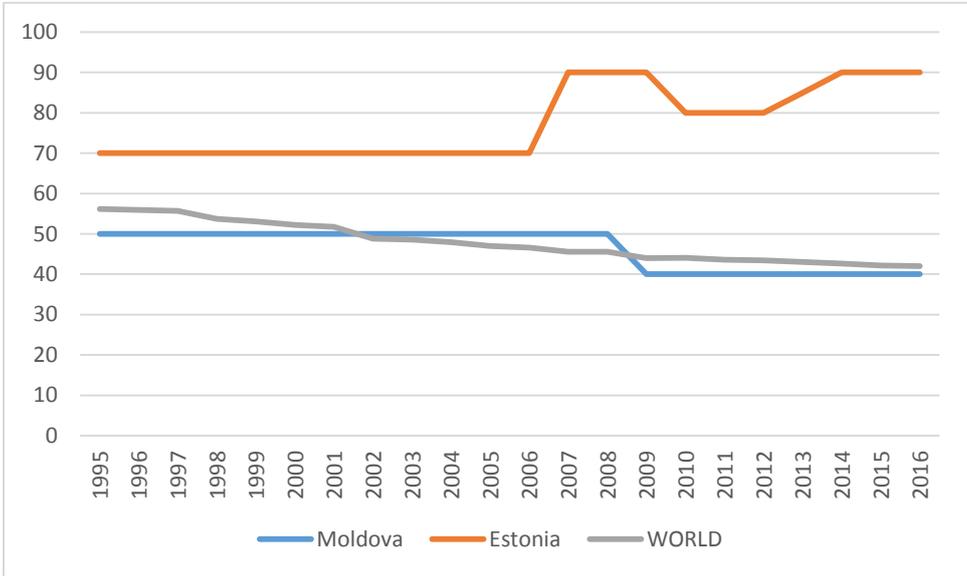
Source: Own calculations using data from IEF 2015

Estonia managed to put the foundations of a fair and transparent judiciary and economic system. And from the very beginning, Estonia was more alike its western neighbours. Geographical proximity has clearly played an important role in many factors for Estonia, including in the establishment of rule of law. Corruption and lack of transparency and economic freedom is a typical ex-soviet trait and it is handicapping not only the NIS system of Moldova, by the whole economy and society in general. There is no reason in building new organisations and institutions as long as they will be doomed to corruptive and non-transparent operation. This is an aspect which needs the most attention of the ruling class, as it seems to be the most difficult failure to eradicate.

4.4. INTERACTION FAILURES

Lack of cooperation between research institutions and business sector is an important aspect of the interaction failures. In Moldova, before the fall of USRR the link between research centres and private companies was quite well developed (even in between different republics inside USRR), however this changed drastically after the fall of USSR and it happened because of the division of labour between companies and R&D institutions (ERAWATCH, 2014). Most of the private companies have broken their links with old R&D partners and the public R&D funding decreased significantly.

In Moldova, the cooperation between universities and private companies is a very rare phenomenon. And this unfortunate reality can be reflected in the WEF score for University – Industry collaboration in R&D in figure 17:

Figure 17. WEF Score for University Industry collaboration in R&D, 2009 – 2010
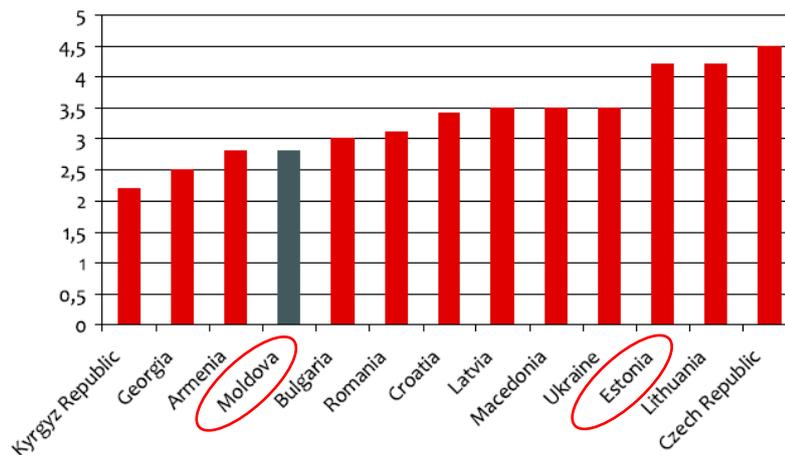
Source: Popa, 2011

Again we can see that Estonia is performing much better at this indicator as well, showing a more intensive cooperation between academia and private sector.

There is an important state institution we have mentioned in a previous subchapter, responsible for knowledge transfer between research centres and business sector and that is the Moldovan Agency for Innovation and Technology Transfer which is running the Innovation and Technology Transfer Projects. Through the 3 techno parks and the one incubator, some basic infrastructure is provided for knowledge transfer (ERAWATCH, 2014). Another important tool for knowledge transfer is the cluster created by the Academy of Science of Moldova, the UnivEr Science cluster project. But in general, there is very weak infrastructure for knowledge transfer between R&D institutes, higher education institutions and business sector (ERAWATCH, 2014). Availability of venture capital or business angels programs are almost non-existent. This reflects again the organisational thinness of Moldova's NIS.

The poor (almost inexistent) link between private sector and public R&D, and the still weak technology and knowledge transfer is probably due to the lack of cooperation culture and also due to lack of an efficient infrastructure in place. There is a resistance of getting involved in collaborative activities and we believe that changing the mentality takes much longer than improving the infrastructure for knowledge transfer and R&D cooperation. All this indicates again that Moldova's NIS system is institutionally and organisationally thin in terms of informal institutions such as values, innovation and cooperation culture.

In Estonia, since 2000s there were a number of policies implemented aiming to increase cooperation and knowledge transfer between public and private sectors. The Competence Centre Programme, The R&D Grant Support, The Innovation Voucher Programs, are only a few of the programs which encouraged universities cooperate with business sector and become more business-thinking, in order to create applicable innovations which can be used on the market (Expert Group, 2012). Other programs aimed to link successful innovative companies with research academic teams which would support doctoral students in return for assistance in research activities (Expert Group, 2012).

There are a few success stories of public-private partnership in innovation such as the collaboration between IT and knowledge societies which were driven by public policies and public procurement. In some sectors, innovative thinking and public-private partnerships are a common practice, but this is not characteristic for all policy sectors (Expert Group, 2012). We can say that the public sector innovation is still in emerging phase in Estonia. Estonia has actively integrated in the European Research System, the country has strong ties in terms of scientific and technological cooperation with Finland, Sweden, Germany and UK (Expert Group, 2012).

Estonia's situation is clearly better in terms of cooperation between business and universities. There are a number of tools and policies which help and support this type of cooperation and there is larger

number of companies which performs R&D activities (while in Moldova they are rather exceptions) therefore this indicator is again indicating an institutional and organisational thickness in the case of Estonia's NIS system and Moldova needs to put more emphasis on this crucial element of NIS.

4.5. CAPABILITY FAILURES

As explained in our theoretical framework, this type of failures refer to the lack of competences and resources inside the companies or institutions supporting NIS and it also has been referred to as the transition failure, in other words the inability of companies to learn fast enough, in result being trapped in the existing technological trajectories. Capability failures can however derive from both institutional and organisational thinness. We will hereafter look into the availability of staff in R&D and academia and into the ability for transformative change and adaptation.

4.5.1. R&D AND ACADEMIC STAFF

The lack of staff in the field of research and higher education can seriously affect the performance of a NIS. We consider this indicator an important aspect to be looked into when analysing Moldova's capability failures.

The R&D personnel has drastically declined in Moldova during the past 25 years. If in 1990 the number of R&D personnel was around 25,200 it dropped to one fifth by 2010 (ERAWATCH, 2014). The cause for this was a sharp decrease of R&D spending which led to fall in salary levels in this sector. This particular challenge has been addressed in the 2004 – 2008 period through specific incentives and policies which increased the wages of R&D personnel by 4 times (ERAWATCH, 2014). Even with the increase of wages and increase of scholarships for doctoral candidates, these are still very low and are discouraging the R&D activities. This in combination with low employment opportunities in the R&D sector is reflected in the acute brain drain process in R&D sector with a large number of researchers emigrating permanently to Western Europe or North America (ERAWATCH, 2014). As a response to this, ASM has created a program of collaboration between the local researchers and the ones who emigrated, trying to create a brain circulation effect.

In 2008, there were 1.83 researchers per 1,000 labour force and 1.92 per 1,000 total employed – numbers which are significantly lower than in neighbouring countries (Romania – 3.27 and respectively 3.5, Ukraine – 3.49 and respectively 3.72). In the same year, 1,601 have enrolled in doctoral studies (ERAWATCH, 2014). The share of researchers aged 65 and above increased from 4.8% in 1999 to 14.2% in 2010 while the share of researchers aged 35 to 45 decreased from 26.5% in 1999 to 15% in 2010, an alarming trend which reflects the non-attractiveness of the R&D sector for young professionals (Government of RM, 2014).

Figure 18. Availability of scientists, engineers, researchers and technicians 2009 – 2010
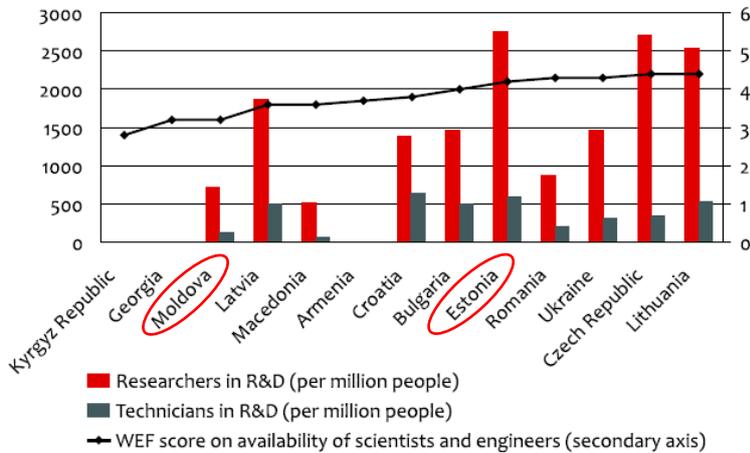
Source: Popa, 2011

In figure 18, we can see that Moldova is facing big challenges with the availability of R&D staff such as scientists, engineers, researchers and technicians in 2009 – 2010, while Estonia is experiencing a much better situation in this regards.

In 2011, in Estonia were registered 10.99 researchers per thousand labour force, which is way above Moldova's level (1.83 in 2008). Estonia's availability of researchers is even above the European average – 10.55 (Deloitte, 2014). Estonia has also a very good level of number of women as Grade A academic staff – 17.2% of total (while European average is at 19.8) (Deloitte, 2014). All in all, Moldova has lost its base of skilled professionals in R&D which was grown during the Soviet Union, while Estonia has grown it with specific incentives and new technological trajectories which absorbed these resources.

We want to emphasize on the brain drain process which plays an important role in Moldova's lack of staff in R&D and academia. The social and economic crisis which came in the first decade after the fall of USSR, has triggered a strong flow of emigration and the most affected sectors where education and healthcare (IOM, 2012). In the 1996 to 2000 period only - 12,000 of healthcare professionals have permanently left the country, due to very low salaries and poor working conditions (IOM, 2012).

In the education system, the mass emigration of professionals had a strong and negative impact on the quality of education in Moldova. The staff in education system in Moldova have among the lowest salaries in the national economy which explains the massive brain drain in this sector. During 2005 and 2010 over 9,400 teachers have permanently or semi-permanently left the country (IOM, 2012).

The brain drain process is one of the main factor in the lack of staff in research and academia sectors. It is a capability failure which resulted due to the institutional failures such as lack of efficient and transparent institutions and lack of legislation and support which would favour professionals in these fields. Therefore, we can say that there is a clear causality relation between the capability and institutional failures. We will emphasize on the causality relations between different failures in the last section of this paper.

4.5.2. ABILITY FOR TRANSFORMATIVE CHANGE AND ADAPTATION

The ability to transform is crucial when it comes to post-soviet countries which had to transit and adapt to completely new types of economic systems. Estonia has experienced an ICT revolution through the emergence of Internet and mobile telecommunications. This emergence has coincided with, and was made possible by, the political and economic transition period from socialism to capitalism. Estonia has experienced both institutional and technological discontinuities and took advantage of the new ICT revolution taking place in the west (Högselius, 2005). Per Högselius (2005) has a very interesting theory which said that technological landscape in economically stronger countries, is characterized by well-established companies which tend to protect older technological paradigms and organisational and institutional order from the *invasion of alien technologies*. While in countries going through economic and political changes – like Estonia was during the collapse of the soviet regime – will be less likely to resist the new technologies and trends and will faster adapt new technological paradigms and trajectories. Estonia's competences were also fitting with the emerging ICT technologies. (Högselius, 2005) This is where Moldova has failed to act in the right moment. It failed to adapt and create new institutions and organisations in response to the new technological wave.

Both Moldova and Estonia has the availability of well-prepared staff in R&D and science inherited from the Soviet Union, but only Estonia used those competences in building new trajectories and infrastructures. Estonia has showed great results in the development and implementation of, for example, the digital signature and e-government, all built on its already existing skill and competence base. Unfortunately, as we have seen in previous subchapter, the competence and skill base of Moldova has been destroyed by the mass emigration of the academic and research professionals due to the unfavourable economic and social circumstances.

5. Discussion

Our analysis shows that there are indeed some specific actions undertaken by Estonia which helped it overcome the limitations of the soviet NIS model, managing to build an efficient and modern innovation system.

One very important action was to allocate its public R&D institutes to universities. Merging the scientific research and university education was one the main goals in the very first science reforms made in Estonia in 1994. This decision has been taken after an internal evaluation of research institutions and an evaluation carried out by the Royal Swedish Academy of Sciences and Swedish Research Councils at the request of Estonian Science Foundation in 1991 (Tartes, 1999). The results obtained by the two evaluation correlated completely, and lead to the implementation of this important reform. There can be a few positive consequences for this action judging by Estonia's example. By giving R&D facilities to universities, students obtain the chance of getting involved in research projects which increase enrolment attractiveness and improves the quality of studies. Doctorate programs are much more attractive at universities with R&D centres. In Moldova, universities perform no R&D activities, and that is by far due to the lack of R&D centres in universities. Second advantage is that the research made in centres which are part of universities is much more market-oriented, due to the multiple collaborative projects aiming to connect students and business sector. Therefore, there are much more opportunities for applied research, rather than focus on basic research as it is in the case of Moldova. One of the biggest weaknesses of soviet NIS was the disconnection between R&D and the economy, a trait still present in Moldova's NIS, but which can be overcome by incorporating R&D into the academia. The third and very important consequence is that by giving R&D facilities to universities, this will become the bridge between the business sector and academia. Often, it is difficult to create a natural link between business sector and public sector, especially with universities. However, entrepreneurs are more likely to turn towards the assistance of a university R&D centre, due to dynamism and availability of creative, freshly educated students, often cost-free, as being part of academic projects.

A second and significant action which helped the transition from a soviet NIS to a modern model was the de-centralization of the funding institutions. We have seen in our research that the heavy institutional centralization in Moldova's NIS, especially of funding power, has a very detrimental effect on the whole NIS. As a very first step after fall of Soviet Union, Estonia has created 3 distinct foundations, subordinated to different ministries (Tartes, 1999): Estonian Science Foundation for financing scientific research, Informatics Foundation for working out national informatics policy and the Innovation Foundation - supporting technological advancement. Today there are 5 different funding institutions each of the foundations focusing on different type of projects, like the Enterprise Estonia Foundation is responsible for insuring business support, innovation and managing technology programmes; KredEx is offering risk capital for start-up ventures and business actors in general; Archimedes Foundation which is responsible for supporting activities related to European Research Area and the Estonian Science Foundation which offers grants to researchers. This diversity of funding institutions is critical. In Moldova, the funding is monopolized and the projects which are not in-line with the vision of the Academy of Science do not receive funds. Therefore, the research performed is locked in closed circle with no opportunities of being developed in new sectors and new directions. The soviet model of artificially directing innovation is still present in Moldova, and it can be overcome by offering the opportunity of getting research funds to a far larger type of actors. Business sector is not getting any funding in Moldova which is a very grave drawback as the enterprises are the ones who usually create commercial innovations.

One interesting aspect we consider important when transitioning from the soviet NIS model, is the way Estonia learned from the best. Estonia's evolution especially in the ICT sector, was in a great extent due to its links with Sweden and Finland. With neighbours which were, and still are, the best in this sector on global level, Estonia has created multiple linkages with the Nordic countries in the ICT sector. Everything from trade links, foreign ownership and investment, subcontracting, financial support from abroad, consulting in business, academic and governmental field, students and research exchange, cross-border joint innovation, and even using foreign systems of innovation as model (Högselius, 2005). Estonia was looking up to its more economically advanced neighbours even during

the Soviet Union by analysing principles of market economy, new technological trends, etc. In the second half of 1990's, Estonia started being aware of the need for a systemic approach towards innovation, an awareness which came from the neighbouring example – Finland. Strong business cooperation was started by foreign direct investments coming from Finland, which was facilitated by the already existing links between the universities of the two countries (Varblane, 2012). Critics consider that the Estonian policy makers where naive and did not take in account the differences between Estonia and Finland, however Estonia had no experience in developing NIS strategies, and by looking up to and trying to copy from the best, maybe shouldn't be considered a mistake. Only by trial and error, processes are improved, efficient systems are developed. We consider that Moldova should also find a model system to look up to, and tailor its own, while taking in account its particularities and specifics.

We have also seen in our research that a strong ICT infrastructure was a focus area for Estonia's NIS transformation. We have seen in our study that Moldova has not developed its ICT infrastructure which is possibly affecting its transition to a modern NIS as well. Estonia understood the importance of a good ICT infrastructure and developed it right after the fall of USSR. ICT consumption and specific sectors can originate from an efficient and reliable ICT infrastructure.

Another lesson which should be learned from Estonia is to put more focus and resources into Smart Specialization. Smart Specialization is the perfect tool for a country with limited resources for NIS. This way, those resources will be concentrated in the most promising sectors where Moldova has the best abilities or perspectives. Even though, soviet model was also about narrow specialization, it was not smart specialization and the focus on productivity and efficiency was lacking. This is a soviet trait which must be changed, and the upgrade from specialization in traditional sectors to smart specialization must be a priority in future policies.

An important change Estonia did in its transformation process was to create a support system for start-ups and young entrepreneurs. As during the Soviet Union, the enterprises were public-owned, there was no need for the support of newly started companies, as they were secured from the very beginning. As Moldova transited to capitalism, and the private sector emerged, no effect has followed in regard with support for new entrepreneurs. Estonia is showing great results in encouraging and funding its young entrepreneurs it is even called "the start-up paradise" in international media. Start-up Estonia is the main governmental project which is uniting start-ups, incubators, accelerators, public sector and research facilities. Even though Moldova has young entrepreneurs which are enthusiastically trying to bring innovation and development, they get no support from the government, and therefore those entrepreneurs without personal funding possibilities, renounce the endeavour. Moldova must offers its entrepreneurs the support and help they need in order to propel innovation and progress.

Estonia also shows great results in supporting its business sector to engage in R&D activities. Almost half of Estonia's enterprises are considered to be innovative and are involved in some kind of research activities. However, Moldova still keeps the soviet format by keeping R&D separate from enterprises, which is obviously detrimental for the NIS system. We have already described in the funding de-centralization argument, that first step is to create institutions with different direction of focus, which would support business sector get involved in research activities. Estonia is a good example on how this can be achieved by creating the multiple funding bodies, some of which being specifically focusing on supporting R&D in business sector.

In addition, encouraging linkages between public and private sectors is another important action which can be taken by an ex-soviet country transitioning its NIS. Linkages in general are crucial for a healthy NIS system. Estonia managed to create multiple networks and connection both internally and externally. It was not characteristic for the soviet model to have universities or research institutes cooperate with enterprises. Actually there was a deep rupture between enterprises and the R&D centres, as the directions for R&D were decided in the governing institutions, and the enterprises were just the producers of the developed products and technologies. This is a phenomena which is still present in Moldova. As we have already described, by integrating the R&D institutes into universities, could be a first and important step in creating a link between private and public sectors. Of course an interest in this collaboration should also be created through the help of diverse projects. The

opportunities of the link between public and private sectors should be fructified in Moldova, and looking at the Estonia's example could be a start.

Adhere to an economically developed union could be a positive step as well. Adhering to the European Union in 2004 is something which absolutely helped Estonia a lot in its process of transmission from communism to capitalism. Estonia had the opportunity of receiving structural funds, support, counselling, and guidance from the EU. By being part of a union with some co-members in the posture of the most developed economies in the world, it is of course an important factor in the development of not only Estonia's NIS but of its economy and society in general.

Lack of economic freedom and the systemic corruption is probably the core of the systemic failures in Moldova. It is characteristic for most ex-soviet countries, due to a deeply installed mentality during the Soviet Union. As USSR was a closed union and yet not capable of supplying all needed for its population's better standard of living, there was an omnipresent "black" trade between friends, family members, neighbours, etc., people would trade products they manufacture at their workplaces, which evidently were stolen. The same goods would be eventually exchanged for services or illegally imported goods from the west. The reason for this was that there was no other way of getting all a family would need or want to have, due to the central ideology of absolute equality between all members of society. Communism has taught its society that corruption is the only way. At the fall of USSR, there were still no functional institutions and organisations which would operate in a democratic way. Therefore, the society continued to function in the same old way, except this time it was no more need to hide, as the regime has fallen.

Estonia has managed to build a society and economy based on transparency, economic freedom and rule of human rights. The geographical proximity to its Nordic successful neighbours is of course very important. Additionally, being part of European Union is also something which helped Estonia create its healthy foundation. We should understand that geographical position of Moldova is not helping and the longer the corruption and lack of freedom and rights will dominate the country, the harder it will be to change this reality. It is important to start building healthy and independent judiciary system and sanction corruption in public institutions, healthcare system, education system and most of all in the government system.

We will try to summarize all our findings and also answer to our conceptual question in the last section of our research.

6. Conclusions and reflections

Estonia has registered a remarkable progress in the transformation of its NIS system. Today Estonia is the most prosperous country among the ex-USSR countries while Moldova is still one the poorest countries in Europe and it experiences continuous internal political and economic turmoil during the past 2 decades. This paper has examined what soviet-specific system failures are present in Moldova's NIS and what actions have been taken in Estonia's NIS to overcome those same failures.

We have found out that the soviet NIS had very clear particularities which have been inherited by the ex-USSR countries. Some of the main particularities of the soviet model we have identified are: the heavily centralized NIS institutional system in both planning, funding and executing R&D activities; public R&D centres being incorporated in the Academy of Science instead of universities; a deep rupture between R&D and economy itself; lack of linkages between public (R&D centres, universities) and business sector; lack of support for entrepreneurs and start-ups (during Soviet Union the enterprises being pubic were automatically receiving artificial government support); no R&D activities in enterprises and lack of smart specialization. Moldova has inherited these system failures which are the contributors of its institutional and organisational thinness.

One of the question we have asked in the beginning of our research was whether there are any soviet-specific failures inherited by ex-soviet countries which Estonia managed to defeat, and what can be learned from Estonia's success story in this regard. We have seen that there are indeed some specific actions Estonia has taken in order to overcome some soviet-inherited failures of its NIS. Moldova's NIS system is still dominated by the soviet model traits while Estonia has managed to change them

and impressively transform its NIS system. So how did Estonia break the soviet NIS model? We will go shortly through our main findings.

One of the first actions taken by Estonia was to de-centralize the R&D centres which were under the control of the Academy of Science and allocate them to universities. This way, the quality of higher education has increased, the interest in doctoral programs has grown and a natural link between business and public sectors has been created through multiple research joint projects between students, professors and businesses. We have seen that Moldova's NIS system is heavily centralized around the Academy of Science, which contributes to its institutional thinness. By decentralizing the R&D centres and allocating them to universities as Estonia did, the quality of academic studies improves, the research performed becomes more practical and linkages are created between academia and the private sector.

Another important step taken at the very beginning of Estonia's transformation process, was to create new funding institutions which would focus on specific areas such as: business research, risk capital, international research projects etc. Moldova still owns a heavily centralized funding system in NIS, under the Academy of Science, which is a big limitation for the transition to a modern innovation system.

Estonia understood the importance of a strong ICT infrastructure as it is a crucial aspect for the development of new ICT sectors. In this regard, Moldova lags and it contributes to its infrastructural failures due to its poorly developed ICT infrastructure. In addition, Estonia has initiated the process of smart specialization by mapping the key sectors which have the most potential. Moldova however is still at a very early stage in this regard, and we believe that increased focus should be given to smart specialization in future policies.

It is important to mention that Estonia has created strong ties between business sector and academia, and public R&D centres. There are multiple projects and tools in place which are enhancing the cooperation between public and private sectors in the field of R&D and innovation. Moldova still keeps the soviet characteristic of having a deep rupture between the two sectors which is a serious drawback in its transformational process.

The support received by the Estonian enterprises for engaging in research activities is another very important aspect of the actions taken by Estonia for its NIS. As we have seen almost half of Estonia's enterprises are considered to be innovative and are involved in some kind of research activities while in Moldova's case we still witness a lack of interest in supporting business sector R&D. The similar situation is witnessed in the start-up's environment in Moldova where very limited actions have been taken in supporting new entrepreneurs. Estonia has some very efficient programs and numerous incubators which are focusing on encouraging entrepreneurship and develop new start-ups.

We have of course emphasized on the importance of geographical proximity with the Scandinavian countries in the case of Estonia, and also being part of EU. Estonia has followed the model of Finland and tried to implement same type of strategies in the transformation process, something which was criticized but also admired, as by trying to copy the best, Estonia has managed to get out of the soviet NIS model and put its economy on a modern path of development. The geographical proximity, and adhering to EU also played a great role in terms of eradicating corruption and promoting economic freedom and healthy entrepreneurship environment in Estonia.

As the second question of this paper was to determine if there is any causality between system failures which determine institutional and organisational thinness, we must say that we believe such relationships exist but are extremely complex in nature and often indirect. When it comes to post-soviet countries, we would like to emphasize that we consider corruption – an institutional failure which could be considered the determinant in the formation of other types of failures. We have discussed in subchapter 4.3.7 that corruption in post-soviet countries was inherited from the inefficiency of the soviet system. It was a moral value which was transmitted during the transition to the capitalistic system and it became the omnipresent element of the economy (in Moldova's case at least). If we would consider the moment of transition to capitalism as the moment zero, before new capitalist institutions and systems have been created, we can say that corruption could be the first institutional

failure which could create a chain of other system failures in a post-soviet NIS model. For a better understanding of our reasoning, we have constructed the following diagram:

Figure 19. Causality between system failures in soviet-model NIS
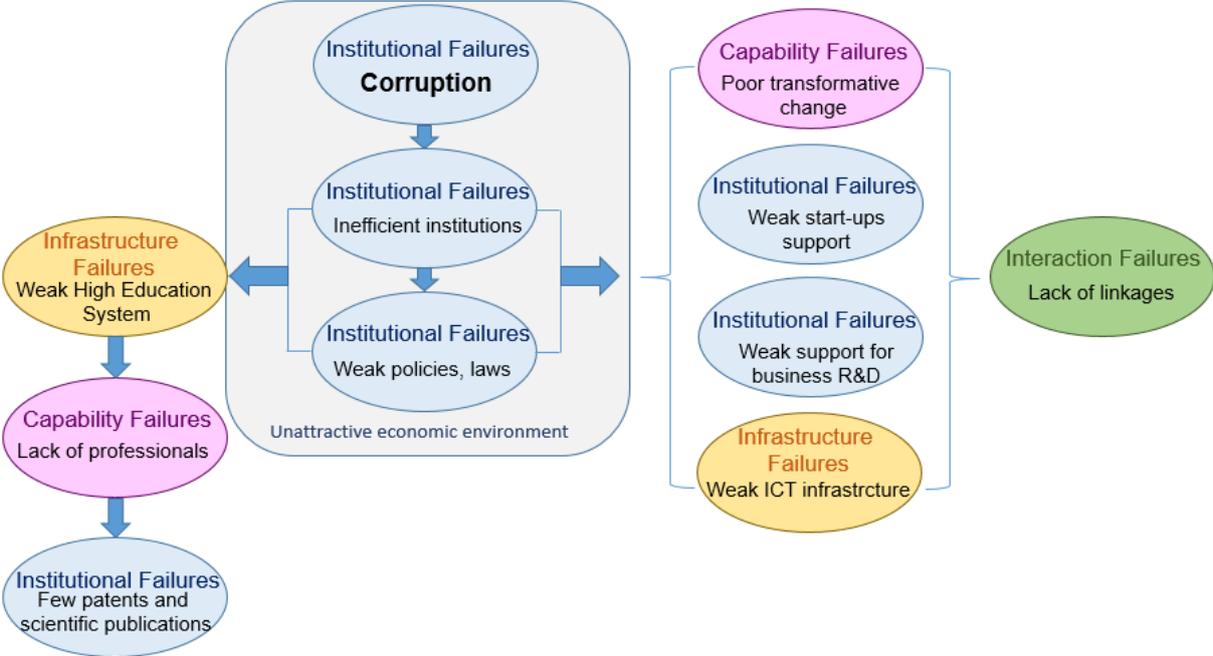
Source: Own interpretation.

The inefficiency of the institutional system, which is an institutional failure, is probably a consequence of the corruption deeply infiltrated in the mentality of the country's population. Therefore any kind of attempts in improving the NIS institutions and organisations would probably fail due to the corruptive behaviours at all levels of the system. Further on, if institutions fail to improve, the new formulated policies would probably be poor or might fail to be implemented adding to the institutional failures. We believe that corruption, inefficient institutions and weak legislation/policies will most probably affect the economic performance of the country, leading to unattractive economic environment which only amplifies all the chain effects. A combination between these first 4 elements could lead to: capability failures (poor transformative change), institutional failures (weak start-ups support and weak support of business R&D) and infrastructure failures (weak ICT infrastructure). All the mentioned failures combined could affect the linkages between all actors in NIS which leads to interaction failures. On the other hand, the 3 main institutional failures on the centre might negatively affect the quality of the high education system leading to another infrastructure failure. This failure in combination with the unattractive economic environment might cause unfavourable conditions on the labour market for professionals in R&D and academic sector, which ultimately leads to brain drain and lack of sufficient resource for the development of NIS which is a capability failure. This capability failure further affects the quality of research made, leading to low quality patents and limited number of scientific publications, which is again an institutional failure.

In our understanding, the causality cannot be made between categories of failures, but rather between sub-categories of failures. Therefore, we consider that the causality of system failures exists but has a much more complex character, and we believe that at the top of the sub-categories of failures pyramid we could place corruption. We believe that this is valid not only for Moldova's case but also for most of other post-soviet countries. Most of the attempted changes made in a post-soviet NIS, would most probably fail if corruption would not be eradicated first.

It is important to understand the typology of such specific innovation systems and we hope that our study has provided some useful insights and contributed to a better understanding of the importance

of creating specific set of guidelines for the transformation of a soviet-model NIS into a modern and efficient one along with understanding the causality of its system failures.

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