Aalborg University

Innovation, Knowledge and Economic Dynamics

MASTER THESIS

THE EFFECTS OF THE CRISIS UPON THE NATIONAL INNOVATION SYSTEM

Supervisor:

Jacob Rubæk Holm

Student:

Cătălin Maior

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1. Introduction

Innovation has taken an important place in the specialty literature and research in the last years, even more after the 2007 financial crisis that affected companies and countries globally. It is possible that there will be a constant increase and focus regarding the concept of innovation.

Nowadays, the competition is even sharper, companies are trying to use their resources, knowledge, employees, technological capabilities and skills to get a top position on the market. This process has also increased the role of innovation, as combining new ideas into a specific product has often been the reason why customers choose a specific firm.

Having a vast literature concerning innovation from different aspects and point of views, there is a new challenge coming up.

What I consider motivating is conducting an analysis of how the innovation system behaved in an unfavorable economic situation, such as the 2007 financial crisis. An interesting opportunity is a research on the National System of Innovation from two different countries/ states that have several differences. According to the Organization for Economic Cooperation and Development's reports, even from older version such as 1997: "understanding of the national innovation system can help identify leverage points for enhancing innovative performance and overall competitiveness".

The analysis will focus on many aspects, starting from the microeconomic point of view investigating companies and their innovation activities as well as macroeconomic point of view for a more systemic approach.

All the economic agents contribute to the national economy of a region, state or country, therefore having the similar fate. Most of the time, if firms within the country suffer so does the national economy, or vice-versa: if the government suffocates itself with loans from other states, the economic agents will suffer later because of additional taxes issued by institutions upon them.

This becomes even more important to study in times of economic struggle, when companies, financial institutions and national governments are forced to find alternative solutions.

This aspect can be better investigated by looking at the National System of Innovation in that specific country. It shows the level of innovation, knowledge, technological capabilities, education level of human resources, and other aspects which, combined together, defines the overall strength of the innovation system in the country.

Also, a general idea based on the perceptions of 3 important authors who investigated the importance of the NSI, Lundvall, Nelson and Freeman is that the NSI "which has framed innovative activities and the way firms do things within the institutional national context"[1]. Other than that, there are several microeconomic factors that ultimately influence the decision of innovating: management and firm strategy, technology and profits.

As countries are different starting from general things like size, resources, culture, so is the innovation system between two countries, depending on their own characteristics. There is a necessity of understanding several aspects such as: how two National Systems of Innovation from different areas work, how much they influence the innovation in that country and how to improve these systems.

As a result, the countries chosen for the analysis are Denmark and Romania, sometimes compared to other European Union countries. The former is considered to have a relatively good level of innovation at the country level, while the latter has some problems. The paper will explain both perspectives, bringing up all the fundamental characteristics of each National Innovation System.

As this **introduction** part is going to present the general focus and structure of the paper, the second chapter consists of **research questions** that have a deeper meaning and a more explicit content on what aspects will be studied.

The research conducted in this paper has mainly a qualitative point of view, as it will explain the role of the National Innovation System in 2 countries and the effect of the crisis upon it. More information about data collection and limitations can be found in the next chapter, the third, which is the **methodology** one.

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[1] Lundvall, B.-Å.(Ed.),1992.*National Systems of Innovation* .Pinter Publisher, London.1992;
Nelson, R.R.(Ed.),1993. *National Innovation Systems: A Comparative Analysis*. Oxford University Press, Oxford.
Freeman, C.,1995 .*The 'National System of Innovation' in historical perspective*. Cambridge Journal of Economics 19(1)

It will act as an investigation starting from a theoretical point of view, explaining how traditional authors perceive innovation and an innovation system at the national level. In this consideration, there are several characteristics that will be explained, of without which, the system cannot exist. Each of the elements will be assigned its role in the system and how it affects the overall level of innovation.

The previous explained subjects form together the **theoretical framework** of the paper, which can be found in the 4th chapter.

The next chapter after the theoretical framework is the **analysis** chapter which contains 2 subchapters. The first part of the 5th chapter will bring in the 2008 global crisis explaining how it appeared and its repercussions upon the global financial system. A comparison of the two analyzed countries will be present as well as of other countries, in order to bring up the strong impact of the crisis.

The second part is going to bring up the National Systems of Innovation and their characteristics from the analyzed countries: Denmark and Romania. This will show in a real manner how the innovation system in both countries is working and how developed it is by taking in consideration its features. It will also present the impact of the economic downturn upon the innovation level in the two investigated countries. The National Systems of Innovation from both samples will then be studied to find out what were the effects of the crisis upon them.

Next, the **conclusions** will try give a more esthetic and comprehendible view of the paper by pointing out important aspects.

Last, but not least, are the references that provide additional information and possible readings.

2. Research questions

As countries differ according to their level of economic or financial development, the same way they do in aspects of innovation. It is true that some financial aspects affect the innovation level but that will be explained later on.

However, bringing up an unfavorable situation such as an economic downturn can seriously test the strength of a particular system, whether it is economic, financial or innovation.

Therefore, the main research question is the following: **what are the effects of the crisis on the National Innovation System**?

Of course, before going into the actual analysis there are several aspects that need to be treated. Some of them contain aspects like:

1. What are innovation and a National System of Innovation?

The starting point is the concept of innovation, looked at from a firm point of view, in the beginning. By explaining this concept, advancing to a system point of view will be easier and without ambiguity.

2. What are the components of the NSI and what its structure is in the country?
3. What is a crisis and how did the last global financial crisis appeared?
4. How are the financial system and the innovation system organized in each country (2 countries for analysis)?
5. How did the crisis affect the countries from a financial and innovation point of view?
6. What are institutions and what is their role concerning knowledge and innovation?
7. What needs to be changed in the NSI of each country? Or what can be improved?

The questions represent an overall view of the aspects treated in the paper. They have been introduced so that the reader has a clearer idea of how the paper will be structured and what characteristics will be analyzed.

3. Methodology

The following chapter will provide insight of how the whole project is structured. Before starting to work on any kind of data or scientific paper, it is important to have a consistent structure.

Therefore, the first thing explained in this chapter consists in explaining the main methodological approaches, and by this, the most relevant and thus, chosen, based upon the research method. This is based on the research problem that the current thesis is trying to explain. Other things mentioned in present chapter are the data collection that helped giving the paper a lot of relevant information and of course, some limitations, which usually take place in every scientific work.

When conducting a qualitative research after presenting the general research questions as we did earlier, the next part consists of selecting relevant sources and subjects and collecting relevant data. Interpreting the data gathered leads to theoretical framework and writing up the findings, the analysis. Last, but not least the conclusions refresh the structure of the paper. These are the steps used in writing the paper, as they are a widely used source of conducting qualitative research[2].

3.1. Research methods

Two research methods exist: the quantitative and the qualitative research.

The research method I decided to use in the project is a qualitative research method, the systems approach. "It is often essential to explain and understand the background of a real system's historical time in order to explain and understand what it is today – and thereby also its ability to face its future"[3].

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[2] Bryman Alan, Emma Bell- Business research methods, second edition, Oxford University Press, page 406.
[3] Arbnor Ingeman & Björn Bjerke- Methodology for Creating Business Knowledge, Methodical Procedures, SAGE Publications, 2011, page 25

According to Arbnor and Bjerke the system approach has the following characteristics:

- "Reality is assumed to consist of *units*, these units are called *systems*
- The units consist in turn of components that are fairly intimately related to each other.
- Each unit usually has connections to other units, and is then called an *open* system.
- Reality is seen as filled by objective and subjective facts treated the same"[4].

3.2. Data collection

Most of the data collected in this research can be categorized as secondary information or secondary data, as it contains various documents or other types of evidence (minutes, statistics, documents, etc.).

"Doing systems research means, above all, to make sure that all the steps in an operative paradigm fit each other and that conclusions can be drawn often only very late in the process of creating business knowledge using the systems approach"[5].

3.3. Structuring the theoretical framework and the case study

For a better understanding of the whole process and the economic evolution that took place, the project is separated in two big parts. The first part consists of pointing out crucial aspects of the economic theory, without which, the paper won't be understandable. This is carried out in the theoretical framework part.

The theory consists of several data collected from different authors of the scientific literature and used in the paper in different circumstances, mostly as qualitative work. Some examples that belong to a quantitative method may appear and have been used in order to confirm a certain aspect.

The second part of the paper contains the case study used from the real situation that occurred in the time the work is referred to, or the analysis. By having knowledge of the theoretical aspects presented before, the analysis comes in with specific examples that remodeled the theory view in a more abstract form. Most of the data used is official, such as: Eurostat data

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[4] Ingeman Arbnor & Björn Bjerke- Methodology for Creating Business Knowledge, The Systems Approach, SAGE Publications, 2011, page 2
[5] Same as previous, page 30

concerning the different situation and evolution of countries, OECD reports, national data from the central bank of Romania, etc.

It is important to mention that the format is not always in this standard; different features, such as certain events may be found in parts containing theoretical aspects. There are present there because they represent minor knowledge, it makes it easier to understand and/or may be relevant only in an empirical presentation of a particular situation.

3.4.Limitations

There is no scientific paper that is perfect or not in need/questionable of any modifications/perspectives. The paper treats the role of the National Innovation System and the 2007 crisis impact upon it. The analysis is restricted to the 2 countries and their NSI: Denmark and Romania. Therefore, the thesis has its own limitations as it is only analyzing the situation of these 2 countries presented earlier by doing a comparison between their NSI.

Also, the paper does not focus on public innovation policies of any of the countries studied, analyzing only the situation of each financial and National Innovation System during the crisis period.

Even though the data used is official from European authorities, it may differ from the national data collected by analyzed countries. However, the data is still eligible.

Using secondary data, different types of sources/authors were compared, their point of view analyzed while trying to understand the impact of the problem. Therefore, it cannot be sure that all the information used from different authors is reliable on the long run as the economic and innovation environment are in a continuous change.

4. The concept of innovation and NIS

4.1. Innovation and the role of knowledge

When we talk about **innovation**, we usually refer to something that has a significant importance compared to what was before it. "An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (OECD, 2005). In consider the OECD's definition a good point of start as it contains all the important aspects, innovating means creating something that is new and gives any kind of advantage, economically or in other areas.

"They may be brand new but are more often new combinations of existing elements" (Edquist, 1997: 2). It is important to know the difference between innovating and inventing. Of course, an invention can occur at a personal level: an individual coming up with a new product of huge impact as a result of personal need and tremendous intellectual activity (e.g.: the invention of the pen). The difference is that the innovation brings it to the market.

However, the first **definition** of innovation comes from Schumpeter himself: "recalling that production in an economic sense is nothing but combining productive services, we may express the same thing by saying that innovation combines factors in a new way or that it consists in carrying out New Combinations" (Schumpeter, 1939: 87).

From an individual point of view, which is kind of limited, innovation occurs in firms at a bigger level on a regular daily basis. Nowadays, more than at any point in history, we live in a society that is in a continuous change.

The aspect of commerce, the rule of demand and offer, marketing and many other things, make it in such a way that firms need to constantly adapt to the needs of their clients in order to keep them. As a direct result, firms always need to bring something new to attract potential customers.

Therefore, innovation, which was mentioned earlier as creating something new by combining existing elements, has a very important role in a company. The previous idea that firms bring out new products to fulfill a need for their clients it's a carefully designed innovation

process. This can be characterized as a user-driven innovation, if the customer gets involved in the creation of a new product by bringing feedback to the company. It is only an example of how careful firms are towards innovation.

Some firms are trying to satisfy certain customers' needs, others are creating a new need by innovating into a product that opens up a new market, in which the company will be the leader. As a result, we can say that innovation does not occur in isolation. It is a process that depends on several aspects and the final result is going to be created as a result of combining different existing things, which require quality and closer look, among others.

Additionally, firms collaborate not only with their customers in order to get a new product, but with many others. In order for the company to get the necessary goods, utilities, it contacts suppliers. They also interact with competitors, they have to see what their position is compared to them, sometimes they have a collaboration project. Last but not least, there are other several institutions that have an important impact on a firm's activity. Among these, we can find: banks, universities, governments, or other organizations with which the firm interacts.

There are a couple of things that need to be mentioned about innovation, that are crucial. Innovation means **uncertainty**. Companies can't know for sure if their new products or services are going to be successful. The only one that can decide that is the customer that buys it (product) or gets access to it (service).

As a result, the company gambles, by trying to get the best out of a specific product. Even though it took all the necessary preparation, collected all the information needed and adapt it into a product, they won't know how the market will react towards it.

Another aspect which makes innovation important to study is that the whole process **takes time** to complete. Sometimes, having an innovation project can be very hard for a company as its result can come only after months or even years of work. Linking it with the first aspect, we can say that even after a long time of broadcasting, it can still be unsuccessful. Also, even if it's a successful one, another aspect comes in: **continuous process**. It has to permanently adapt to new circumstances, in different sizes and shapes, according to the need of the customer, and even then, it may encounter resistance. The last aspect, probably the easiest to understand, which is also logical, is that innovation is a very **costly** process. It requires lots of financing, sometimes both from internal or external sources, as well as a permanent knowledge learn.

All the information the company gets access to, can be categorized as **knowledge**: which defines the overall capabilities of a firm to innovate.

As mentioned earlier, in order to understand what a customer want, a firm needs to focus its observation on the characteristics of the customer and his specific need. This may sound as a marketing process, but it's far more complex.

Usually, a company has a special department for innovations, called **Research and Development**, or R&D. The department usually focuses on big innovation projects chosen by the manager of the company. Innovation also occurs in a firm at smaller levels, not necessarily only on one big level such as the R&D.

We may think that innovation can only come from a technological point of view. An important amount is technological innovation, it's true, but there are other kinds of innovations, such as organizational. One thing is certain: in order to innovate, the company needs to have access to a lot of information.

This is where the role of knowledge comes in. What is knowledge though? And how can we quantify it? In an early 1997 report, the OECD clearly states the importance of knowledge as "the smooth operation of innovation systems depends on the fluidity of knowledge flows- among enterprises, universities and research institutions"

Lundvall argues that "the amount and type of information the agents have about the world in which they operate and the strength of their ability to process the information" are crucial problems (Lundvall 2004: 22).

Moving on to **knowledge**, it is viewed as "an asset" that can belong both to the private and public sector. The private sector has plenty amounts of knowledge as economic agents are forced to improve every day in order to survive. Firms produce and exchange knowledge with each other, which makes the market even more competitive but also advanced. Meanwhile, the government is trying to bring knowledge through several policies or institutions such as, education, universities and R&D facilities.

In order to understand **knowledge**, we need to have a look at its **taxonomy**, which contains four aspects (Lundvall and Johnson, 1994: 24):

- Know-what;
- Know-why;
- Know-how;
- Know-who.

According to Lundvall, k*now-what* means having general information about a specific thing, such as: what is a drone? What is a system? It contains knowing facts.

To *know-why* something is behaving in its own way means to understand its basic principles. We can say that the principles can be considered rules or norms. They give meaning in order to fully understand the process. By getting access to this aspect, the society has advanced technologically and has also reduced improbabilities.

Know-how implies certain characteristics, skills, that a person or society, need to have in their goal of changing the situation. For example: in order for a company to launch a new successful product, a strong market analysis is required initially to investigate the needs of the customers, as well as a possible impact of that product's launch. Let's say we are thinking about an automated security system for surveillance (for a property). The final product needs to a drone. There is a need for knowing how to build the drone in a way that flies at night without being seen, with very low noise, with a thermal-heat scan for robbers, and other technological properties.

This skill or ability to know how to do it the right way requires a lot of knowledge and analysis. That is why it may be secret in some aspects. For example, a company that produces national defense systems, such as aircrafts, radars or navy, is going to limit the spread of knowledge by keeping it inside its own company or group of companies.

Know-who, the last of the four, is probably the most important, as it gets increased attention as time goes by. Knowing what a product is, why is working a specific way, or how to build it it's not enough. The ability to make the product fast and easy is crucial for companies, thus the reason why the most qualified people are needed. These people have the level of knowledge needed to produce it. Ordinary people may get access to the necessary knowledge to

produce a certain product, but the person who is already qualified to do it will do it faster and without errors.

As mentioned previously, in the beginning of the subchapter, innovation means something new. Therefore, the concept almost specifies that it brings additional knowledge to the previous one. Another important aspect is that innovation satisfies a certain need, being demanded by the market. Innovation, viewed as a knowledge production, is an interactive process where companies are interacting with the other participants on the market, as well as other agents. Some examples which were also mentioned previously consist of customers, clients, suppliers, knowledge and financial institutions.

According to the Organization for Economic Co-operation and Development (OECD)[6] there are several **types** of innovations that need to be considered, such as:

- *Product innovation*: most of the innovation in this category may be technically affiliated, but it also may vary. It's not only about the final product, steps of innovation can happen in each department, e.g.: in the technological department an employee finds a method to reduce energy consumption for the product while in the marketing department an employee can bring a new idea to the existing product;

- *Process innovation or methods of production*: an easy example can be a technician which finds a way to reduce the production time and cost of a product by replacing a certain step in the production process. Another example can be giving the opportunity to all employees (not only hierarchical managers) to point out their opinions of improving the activity or several aspects in the company.

- *Supply innovations or new sources of supply*: finding a way to get cheaper products or to substitute the current products with others that are more favorable from several point of views. There are aspects that both the suppliers and the firms that are supplied with products may look for: financially, a faster way, energy (regenerating), with a better impact towards the environment, etc.

- *Market innovations*: firms may innovate in such a way that the new final product obtained will make the company a leader, as it opens a new market. This is characterized through a high degree of knowledge and an important amount of resources dedicated.

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[6] https://www.oecd.org/sti/inno/oslomanualguidelinesforcollectingandinterpretinginnovationdata3rdedition.htm

- *Organization innovations or ways to organize the business*: there are also innovation processes that can happen in an organization. This can be characterized as organizational innovation, by creating a new method or process in which the employees can improve their productivity.

On the other hand, innovations have a degree of significance, being classified by its effect. The effect of an innovation can be seen by looking at its impact towards features such as: economic growth, employment, development and the environment.

Usually, there are 2 categories of innovations, depending on their *final result upon the market* (Leifer, 2000):

- *Incremental Innovation*: relatively on a short term period, has a low risk level and the final product is only improving the previous version, with a few characteristics.
- *Radical Innovation*: it takes a long time, the innovation process is continuous, it has a high level of risk and the final product is something that the market has never seen previously, a new final product that puts the firm in a leader position.

4.2. A system of innovation?

When we usually think of a system, we see a series of elements, components that have a certain condition towards each other, and through their work or role, they define the global idea of what that system is and its role.

In one of the first writings about the **origins** of a system of innovation, from a theoretical perspective, Lundvall mentions that "in all parts of the economy, we expect to find ongoing processes of learning, searching and exploring, which result in new products, new techniques, new forms of organization and new markets" (Lundvall 1992: 8).

The perspective of a system on a same characteristic as innovation viewed from a particular point of view, interactive learning. This was also the background idea presented by Lundvall and his collaborators from Aalborg University in 1992. Firms cannot live through isolation, they need to communicate and share their knowledge with the other actors in order to improve their learning processes and get better outcomes.

As the role of knowledge appears again, it is important to mention that some authors established that "theories of interactive learning together with evolutionary theories of technical change constitute origins of the systems of innovation approach" (Edquist agreeing with Carlsson, Nelson, Rosenberg and Lundvall's previous works, 1997: 7).

Before Lundvall, Christopher **Freeman** defined a national system of innovation as: "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies"(Freeman, 1987: 1). He implies that elements like: the R&D in a company with its imported technology, education training and social innovations as well as industry's structure, are important aspects.

Moving on from the previous perspective, which is based on a Japanese study, Lundvall manages to define the **national system of innovation** in a more explicit way: "all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring- the production system, the marketing system and the system of finance present themselves as subsystems in which learning takes place" (Lundvall, 1992: 12).

In the same view, he considers that the system of innovation should not have a closed definition; it needs to remain open as new subsystems may emerge that can be included. I consider Lundvall's definition a good starting point as has the right approach to not limit or close the overall definition of a NIS, as new components may appear.

The national approach is not the only one present in the scientific literature. For example, the technological system is defined as: "a network of agents interacting in a specific economic/industrial area under a particular institutional infrastructure or set of infrastructures and involved in the generation, diffusion and utilization of technology" (Carlsson and Stankiewicz 1995: 49). As we clearly see from the definition, its purpose is more technological.

As the national term was a bit too broad, the change in attitude was needed which concluded in a different approach towards the size of the system. For example, many studies have been conducted on different national levels but the outcome still wasn't as expected. That is why, depending on the information you want to obtain, let's say from a smaller scale, a closer look on a specific area, different approaches have been adopted.

Therefore, a different version of the national system that can be more useful in an analysis towards a zone or geographical area, different and smaller than a country or a nation is

the *regional* system of innovation. This focuses on a region in the country or a comparison between two regions from the same or different countries.

Another aspect of study besides, national, regional, and technological systems is the *sectoral* system of innovation. The sectoral system of innovation focuses on a particular sector or industry, therefore on the lower level than a regional system. The *technological* system, for example, can be considered part of the sectoral system as it focuses on a particular industry (technology). These two are both parts of the regional system of innovation from that specific area, and also part of the national system of that country.

Even though all these systems are different in size they all have the same focus on increasing the innovation level, the processes of **learning and interacting** is present in all of them, and the role of other **organizations** and **institutions** affect them.

4.2.1. The National System of Innovation

After seeing all the different systems of innovation there is a question that comes up: Why should someone make an analysis of the national system of innovation instead of sectoral or regional? Why is the National Innovation System so important?

A very important thing is that from Nelson's (1993) various studies it has been shown that the national systems vary from one another in terms of Research& Development investment, institutions set-up and performance. An example is a study of Denmark and Sweden, which may seem similar, same geographical area, similar standard of living, culture, lifestyle, energy consumption, public sector (Edquist and Lundvall, 1993: 5-6).

Another important aspect is that policies, economical, innovation policies or others, are made in every country on its own views and implemented the same way, nationally.

Therefore, it depends on what the researcher wants to study and the level of the information he wants to focus on, national, regional or sectoral. As the previous example from the study regarding similar countries both geographically, lifestyle and economically concluded that the national innovation system differs, I consider it a motivation to study other countries from different regions, with different level of development and economic status, especially in hard economic periods.

Edquist mentions early researches of Kline and Rosenberg (1986) and Von Hippel (1988) as predecessors to the systems of innovation approach and states that "the systemic character of the systems of innovation approach means that it has the potential of transcending the linear view of technological change, which places R&D at the beginning of a casual chain that ends in productivity growth, mediated by innovation and diffusion"[7].

In the same paper the author mentions that the **system** needs to include: "all important economic, social, political, organizational, institutional and other factors and other factors that influence the development, diffusion and use of innovations."

Lundvall considers that "the structure of **production** and the **institutional set-up** are the two most important dimensions" (Lundvall 1992:10), Nelson having the same opinion bringing up the organization **R&D** support.

In order to understand better the national innovation system we need to have a look at the *common aspects of all its approaches*.

The first important aspect is that all of the approaches have **innovation** as a center point. As innovation is the crucial starting point, the process of **learning** is closely linked by, whether it's conducted in a research and development department in a company or through formal education.

As we have previously seen the importance of knowledge and its several aspects, we can confirm again that **not all the innovation can be quantified** in the R&D department. Of course, we have examples of OECD indicators measuring the amount of expenditure in R&D on different areas or point of views, but there are other learning benefits than the science and technology ones, such as the learning through doing, using and interacting.

On the analysis part of this paper we have mainly focused however on the research and development indicators and evolution as the period analyzed also contains data from an unfavorable economic climate, the last global crisis.

Therefore, we can say that the process of **innovation** is broader and much more **complex** with a larger area. As we previously saw from traditional authors, it includes different factors from economic to institutional and others.

Another common aspect, which goes back to an innovation feature, is that, similar to an innovation, the system of innovation is developed **over time**. This is why sometimes longer

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[7] Edquist Charles (2000) - *Systems of Innovation Approaches- Their Emergence and Characteristics*, page 15.

periods of time are often better for study than shorter ones. Together with the innovation, the system, the companies and other participants develop as well.

We have learned from Schumpeter that innovation does not happen in isolation but through collaboration. This leads to another characteristic of the system of innovation, the **interdependence**. Companies interact with other actors in order to improve their innovation activities. Some of them are customers, suppliers, while others can be competitors, other firms, institutions, research and centers, universities, etc.

Most of the innovation conducted by a firm ends up in **product innovation** (can technological innovation) or **organizational innovation**. This is another central aspect, from where we understand that the engines for productivity are the firms.

The last, and probably the most important aspect is the presence of **institutions**, which shape the innovation development of the market, region or country.

According to **Carlsson** et al. (1992; 14), the institutional **infrastructure** is divided into:

- Industrial research and development
- Academic infrastructure
- Other institutions
- State policy.

In another paper (1995: 51), the same author includes the **laws** and rules as well as the **organizational structure**.

4.2.2. What are the elements of the National Innovation System?

Having seen in the previous part the common elements of the different system of innovation approaches, in this part we are going to summarize the most important elements of the National System of Innovation.

Some of the elements have already been presented previously in different forms, but here we are going to list them for a clearer perspective, presenting their contribution or role to the system. As it was presented earlier, the National System of Innovation contains the Regional, Sectorial System of Innovation and the Technological System as well, all together forming a global system.

Introducing the definition of Freeman (1997), he sees the National System of Innovation as: "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies".

We find out that institutions have a central place in the system. From a general point of view, an **institution** is: "a set of common habits, routines, established practices, rules, or laws that regulate the relations between individuals, groups and organizations" (Edquist 1997: 49).

Institutions are not always seen only as the rules of the game, some may be attributed the role of an organization that collaborates and influences the innovation activity (theirs or those who collaborates with). This aspect comes out exactly from the definition.

From the same definition we can extract another important element, the organizations. "**Organizations** are formal structures with an explicit purpose and they are consciously created" (Edquist and Johnson 1997: 47). The most dominant type are companies or firms, from here we deduct the presence of competitors, suppliers, customers that function in relation to a firm. There are other actors besides companies, such as **universities**, **research centers**, and others.

National Systems of Innovation can be different regarding the money spent for research and development, the technology specialization, etc. but one thing is certain: the interaction between different organizations highly influences the development level of the area.

Besides the relation between organizations, we also have the presence of a relation between organizations and institutions, which benefits both sides.

Identifying the components is not enough; we also need to explain how knowledge is produced and how it ends in a product innovation, for example.

According to Liu and White, there are five activities which are fundamental and are related to "creation, diffusion and exploitation of technological innovation within a system" (Liu and White 2000: 6):

1. "Research (basic, development, engineering)
2. Implementation (manufacturing)
3. End-use (customers of the product or process outputs)
4. Linkage (bringing together complementary knowledge)
5. Education". (Liu and White 2000: 6-7).

If we look at the situation from a public- private point of view, both sectors have their own contribution of knowledge flow. The public sector mainly consists of **universities** and **research institutes**, which through their innovation infrastructure determines the support level for the companies.

Governments are often providing the private sector with basic knowledge in industries, contracts are being realized containing research aspects, researchers or financing opportunities. However these aspects vary a lot from country to country depending on national institutional set-up, which can be different.

Other authors, such as Rickne (2000), elaborated more on technology based firms and a long list of functions for their innovation growth. Among these, the **technological opportunities**, **financing** and **networking** have a central role.

4.2.3. The financial system- an important aspect?

As Lundvall mentioned in a previous definition, the system of finance is a subsystem of the National Innovation System. From the start-up moment, firms are oriented towards profit. Financial aspect takes a central place in any organization, as well as institutions, starting from the local level, but especially on the national level.

There is a lot of information on innovation activity in firms, on all levels, sectorial, regional and national. What this paper will focus on, however, consists of an analysis of how an unfavorable financial situation affected the innovation activity in two countries.

Innovation, as we mentioned, is costly, depending on the project size and the economic situation of a firm. Having presented the components of the National Innovation System and their innovation relation and role, I consider that looking at other aspects, less focused on, such as the financial system in a country, can bring up interesting information and conclusions regarding the NIS.

This aspect is even more important given the financial struggle through which the global market went through. The financial system in a country consists both of private and public actors or players. The banking system is considered to be a main cause of the recent crisis, as it will be presented later on and it's crucial for analysis.

The government's orientation and policies towards innovation is also important, often we find situations when firms are being offered fiscal benefits. There is an important amount of researchers in the public sector as well, even though the private sector has the biggest contribution to innovation and knowledge flow, as well as economic growth.

Schumpeter (1934) attributes the role of creating new products or combinations to entrepreneurs. Their innovation actions help the economic system grow. As the author mentions, the capital is not always from the start in the possession of the entrepreneurs but often supplied by bankers.

"Capitalism is that form of private property economy in which innovations are carried out by means of borrowed money, which in general, though not by logical necessity, implies credit creation… Therefore, we shall date capitalism as far back as the element of credit creation." (Schumpeter, 1939: 223-224)

From this point of view we can clearly see that the relation between innovation and credit is very important, especially nowadays, compared to Schumpeter's time, when many societies are highly credit consuming.

5. How the financial system influences the strength of the National Innovation System

In order to understand the importance of the financial system and its influence on the innovation activity in a country, we need to have a closer look at its characteristics and evolution in the crisis period. This chapter will provide insight of how and why the financial crisis appeared and how it influenced the financial system (with a focus on the banking sector), repercussions on the population, the struggling of firms and the evolution of innovation, with a particular focus on Denmark and Romania.

5.1.   The 2007/2008 global financial crisis

A financial crisis is "a situation in which the value of financial institutions or assets drops rapidly. A financial crisis is often associated with a panic or a run on the banks, in which investors sell off assets or withdraw money from savings accounts with the expectation that the value of those assets will drop if they remain at a financial institution"[8].

5.1.1.   The outbreak of the financial crisis

The financial crisis which started in 2007 has its origins in a specific sector of the American financial market: the market of subprime credits/loans. "The subprime credits are a type of loans that facilitates access to housing by those who do not have the necessary guarantee to be eligible for normal loans (prime loans)"[9]. The creditors have relied on the price increase on the housing/real estate market considering that this increase would limit the risks taken with their subprime loans to the population.

In case of not paying the rates for credits the bank could always resell the real estate pledged as security, at a bigger price. "In 2006, this kind of loan/credit represented about 10% of

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[8] http://www.investopedia.com/terms/f/financial-crisis.asp

[9] Daniel Badulescu, Roxana Leac- *Romanian banks in the context of economic-financial crisis 2007-2011: a comparative analysis*, Ed. Univ. of Oradea, 2012, page 15

the American mortgage loans market. The medium rate of these products increased from around 11% in the beginning of 2006 to over 20% in 2008"[10].

Starting with August 2007, the international financial system entered into a period of pressure and turbulences, launched by the failure to pay the subprime mortgages on the banking market in the USA. After the falling of USA's financial institution, Lehman Brothers, in September 2008, the financial turbulences from the American economy became global and lead to the outbreak of the economic crisis. The uncertainty appeared about big banks' financial health on global level lead to collapse of many financial market institutions. The crisis, as well, started to expand in the private sector also, causing a free collapse of the global commerce.

Many analysts, together the governor of the Romanian's National Bank, are saying that the real causes of the economic crisis are found both at the microeconomic and macroeconomic level. "The source of all this was the excess of liquidity generated by the main central banks of the world: Federal Reserve System (USA) and Bank of Japan, on one side, and by the attempt to limit the currency appreciation for countries exporting oil and natural gas. Liquidity in excess combined with the oversaturation of the economy and the greater appetite for assets with high gain (and high risk) created the background of the microeconomic causes that led to the crisis"[11].

5.1.2. The effects of the crisis felt worldwide

The uncertainty created an untrusted climate between financial institutions so that they stopped granting loans to each other. Therefore, the banks were forced to sell their assets, which weren't affected by the crisis, to avoid a liquidity crisis. Thus, the massive sell of quality assets led to a decrease of prices. The lack of money and the depreciation of the banking capital, led to bankruptcy, or close to it for many financial institutions. Europe was as affected as the United States, fact illustrated by the nationalizing of the Northern Rock bank, the biggest British mortgage bank, in February 2008.

With the fails in the banking sectors, the public authorities had a dilemma: choosing to save the banking institutions from bankruptcy or to let them go bankrupt and destabilize the

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[10] Paulo Sebastian- *Europe and the Global Financial Crisis- Taking stock of the EU's policy response*, 2011, Foundation Robert Schuman, page 3.
[11] Mugur Isarescu- The International Financial Crisis and challenges for Romania's monetary policy
http://www.bnr.ro/files/d/Noutati/Prezentari%20si%20interviuri/R20090226Guv.pdf

whole system; in many cases both in America and Europe the governments acted on the principle "too big to fail".

Even though the principle was used since 1984, the "too big to fail" term became a subject of wrangle/fight because of the global economic crisis, some specialists agreeing with it (Paul Krugman)[12], and others (Alan Greenspan, Mervyn King) consider that "if a bank is too big to fail, it means it's too big, so the institution should be reduced as volume"[13].

The perception that a bank is too big to fall leads to a healthier market discipline, in the way that, the big stakeholders, the depositors know that a bank is considered too big to fall, they won't follow the institution's financial stability and its exposures to risk because they would expect to be saved from failure. Another danger is the moral hazard, the banks knowing themselves safe, through this politic they will follow bigger profits through assuming bigger risks, based on their safely preferential policy received.

With all this, in November 2011 The Financial Stability Board made a list of banks around the whole world considered to be "financial institutions of systemic importance", in other words, institutions of whose role and volume, in case of failure, would lead to serious systemic problems. For those institutions it will be determined some specific requirements regarding bank resolution framework, additional capital for the absorption of loss, closer supervision, higher standards for the financial infrastructure and periodical evaluations of the national policies.

Out of the total of 29 banks, 17 are from Europe, 8 from the USA and 4 from Asia:

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[12] Paul Krugman- *Stop "Stop too big to fail"*, April 21, 2010
[13] "Greenspan says U.S. should consider breaking up large banks", Bloomberg, 2009-10-12

Table 1: List of banks considered of systemic importance[14]

Bank of America	Dexia	Nordea
Bank of China	Godman Sachs	Royal Bank of Scotland
Bank of New York Mellon	Group Credit Agricole	Santander
Banque Popularie CdE	HSBC	Societe Generale
Barclays	ING Bank	State Street
BNP Paribas	JPMorgan Chase	Sumitomo Mitsui FG
Citigroup	Lloyds Banking Group	UBS
Commerzbank	Mitsubishi UFJ FG	Unicredit Group
Credit Suisse	Mizuho FG	Wells Fargo
Deutsche Bank	Morgan Stanley	

5.1.3. General measures to overcome the crisis

Measures taken by the Central Banks:

- "The main Central Banks reduced the rates of interest between 0 and 1%;
- They substituted the interbank market which wasn't working, becoming "lender of last resort";
- Adopted unconventional measures to stabilize the financial system. For example: the promise to maintain the interest rates low for a longer period of time to reduce the degree of uncertainty and to directly intervene on the financial market through acquisition of financial products.

Measures taken by Governments:

- Injection of capital to consolidate the bank's capital in difficulty;
- The provision of guarantees to facilitate the access to financing;
- Buying or ensuring/guaranteeing "toxic" assets"[15].

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[14] Financial Stability Board, Policy Measures to Address Systemically Important Financial Institutions, 2011: http://www.fsb.org/wp-content/uploads/r_111104bb.pdf?page_moved=1
[15] Daniel Badulescu, Roxana Leac- *Romanian banks in the context of economic-financial crisis 2007-2011: a comparative analysis*, Ed. Univ. of Oradea, 2012, page 17

The degree of intervention varied significantly from country to country. In the end, governments around the whole world offered considerable incentive packages to support the real economy. The financial crisis in Europe appeared like a consequence of financial relations' globalization and financial markets' global size. This phenomenon destabilized the whole financial system and pushed the real economy into recession.

The financial crisis that erupted in the US, started to feel itself in Europe since august 2007, when an important bank BNP Paribas, suspended the capital withdrawals/outflows of investors. Another foreboding of the financial crisis in the European banking system was the announce of England's Central Bank that it will no longer offer emergency financial support to Northern Rock Bank institution, in September 2007. Soon after these announces, beginning October, it has announced the representative interest rate cut with 0.5%.

"By looking at the Central Banks' indicators at the beginning of the crisis it can be said that the financial turbulences in Europe started in October 2008 and developed rapidly the following months, European Central Bank (ECB) seeing itself forced to reduce the benchmark/reference interest rate with 1.75% in less than 2 months, a drastically measure unprecedented in its whole history"[16].

The measures taken by the European central were mostly on reducing the rate of interests and on ensuring an optimal level of liquidity/money in the economy, but also on some programs developed strictly so that the economies could overcome as fast as possible the financial crisis.

The impact of the financial crisis on the European banking system was very powerful. "The profits, the volume of credits granted and the economy's growth rate had reduced in a dramatic manner. Even though the problems from the European financial system appeared later than in the USA, their impact was similar. Because the European banking system was later influenced by the financial crisis, it offered an advantage to the European Central Bank (ECB) to adapt faster than the Federal Reserve and this way it had the occasion to deal with the financial crisis with a more efficient way"[17].

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[16] The financial crisis in Europe: www.istockanalyst.com/article/viewarticle/articleid/2702034
[17] Stefan Zidaru- The European Central Bank: Monetary Policy Instruments, Crisis Management and European Macroeconomic Performance, 2010, Aarhus School of Business, Denmark, page 23

5.1.4. The role of the state and regulation institutions

In the specialty literature there are some economists that consider governmental interventions and regulations a cause of the financial crisis (Jeffrey Hummel, professor at the Jose State University and David Henderson, researcher at Hoover Institution), and others which consider regulations to be absolutely necessary to prevent the failure of the free market and the spread of crises (Paul Krugman). Of course, there were always supporters of state intervention as well as liberals, but the lessons from the crisis need solid and convincing research.

Daniel Daianu, former finance minister says that: "Institutions such as Central Bank are obliged to have direct interventions, especially in the crisis"[18]. In the opinion of the Romanian economist the crisis is due to the fact that the central banks didn't watch closely the financial stability, considering that this can be assured in the natural way if the prices stability is assured, given that the market adjusts itself and the credit folds on economy's needs. The reality has shown that the financial intermediation risks require a revision; the commercial banks need to change their behavior and the central banks with regulations institutions will need to adopt more efficient means to maintain financial stability.

The lower power of financial regulations, unclear lines of regulation from authorities, uncontrolled inputs of capital had a significant importance to the crisis, but these are incomplete statements. "The failure of the whole system of financial regulations contributed to the crisis.

One of the deficiencies of the financial regulation which conducted to the crisis situation was inadaptability of the regulation system to a dynamic financial sector and in a continuously financial innovation. Security, obligations granted by credit, credit default swap would have had positive effects upon the life of the majority of citizens, but because of many regulation factors it permitted these financial innovations to contaminate the financial system"[19].

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[18] Daniel Daianu- *National Bank of Romania's regulations will not kill the credit/lending*, September 2011, http://www.business24.ro/daniel-daianu/stiri-daniel-daianu/daniel-daianu-reglementarile-bnr-nu-vor-omori-creditarea-1495400

[19] Ross Levine- *The governance of financial regulation: reform lessons from the recent crisis*, BIS Working Paper nr 329, 2010, page 1

5.1.5. The role of the multinational banks during the crisis

The presence of more and more foreign banks in many countries, in the context of the global crisis, has raised some questions of how much and in what conditions do the foreign banks influence national banks systems in which they open subsidiaries.

There is an ample series of studies on the role of the foreign banks in the financial stability but the conclusions are ambiguous. Studied conducted before crisis concluded that the foreign banks have the role to stabilize and help countries that experience internal crisis. De Haas and Van Lelyveld (2010) found out after empiric studies those foreign subsidiaries, with powerful main banks, helps diminishing the local financial shocks, exactly by stabilizing credit due to the funding received from inside the group. These results are the same with the theoretical results of Morgan et al. (2004) where it is shown that financial integration ameliorates local financial shocks.

"Alongside with financial crisis from 2008-2009, the big multinational banks were affected being necessary a reevaluation of their role in the stability of the financial system. If before, the mother company were more powerful directing capital into subsidiaries from other countries, in this period, of absence of inter-banking liquidity, the flow reverses, from the subsidiaries to the centrals. According to some publications, subsidiaries from Russia and Czech Republic of some foreign banks have supported the mother bank from Italy and France around late 2008 and middle of 2011"[20].

After the outbreak of the global financial crisis, more researchers analyzed the impact of the multinational banks subsidiaries upon credit stability in different countries and regions. Conclusions were that foreign banks reduced the loans more compared to traditional/domestic banks, according to Ongena et al (2011), De Haas et al, Popov and Udell (2011) or De Haas and van Lelyveld's study (2011) referring to subsidiaries' behavior, which belong to big international banking groups, compared to the big traditional banks.

With all these there are studies that shown that "during the financial crisis the foreign banks borrowed further geographically close countries or where there existed borrowing term relationships, so the foreign banks have differentiated behaviors, they cannot be all included in

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[20] Ralph de Haas, Iman Van Lelyveld- *Multinatonal Banks and the global financial crisis: weathering the perfect storm?*, European Bank for Reconstruction and Development, 2011, WP 135, page 1

the same category. The behavior of the foreign banks during the crisis in the host countries differs according to the circumstances in which the bank mother and the subsidiary were, as well as the characteristics of the host country's economy"[21].

Stijn Claessens and Neeltje van Horen (2012) tested a number of 3615 banks, of which 1198 had foreign shareholders, from 118 countries, if the decrease of credit was bigger for the traditional/domestic banks. In 2008, crediting was not different for the two categories of banks, but from 2009, when the economic crisis became global and already affecting the banking operations, the foreign banks reduced the lending more than the traditional ones did, with around 6%.

When the two researchers concluded that the foreign banks from the Organization for Economic Co-operation and Development (OECD) decreased lending since 2008 and from 2009 the banks from non-OECD kept the same trend. Instead, if the banking system of the host country was dominated by foreign banks, then these had registered a growth in lending with 1% compared to traditional banks[22].

A change of the banking is needed and already underway, either voluntarily, or because of the conditions imposed by the Governments for the support granted. The banks will have to respect stricter regulations- Basel III, to adapt itself to the dynamic economy, slowed down by the crisis.

Financial integration has proved to be double edged, the financial institutions group depending upon evolutions from areas outside the group, either the subsidiaries are affected, or the main bank is the one that transmits shocks to the multinational bank. Thus, the cooperation of national supervisory authorities is required, or a creation of an integrated supervision system, which lets the multinational banks operate in a network of branches and subsidiaries, with the most efficient capital allocation.

The banks from emerging countries could then enter the international market, being on way better financial positions, and their importance as foreign investors increasing at the same time. In other words, the foreign banks that we currently know are in a competition with the ones

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[21] Ralph de Haas, Neeltje Van Hore- *Running for the exit: international banks and crisis transmission*; European bank forReconstruction and Development, 2011, WP 124

[22] Stijn Claessens, Neeltje van Horen- *Foreign banks and the global financial crisis: Investment and lending behavior*, 2012 VOX

from emerging countries, announcing a substantial change in the future in the landscape of international banks.

"In the future the international banks will expand, most probably towards emerging areas, such as Asia and South America because these areas will have the biggest growth. It depends though, as how the future financial regulations will be for the financial integration. Conditions too stringent towards capital that leads to credit constraint could provoke multinational banks' withdrawal from foreign markets, in order to maintain the relations from the mother/main market"[23].

5.2. The financial effect towards the Romanian and Danish NIS

The next part will consist of presenting a quick and meaningful history of how the financial system felt the impact of the global crisis in the two analyzed countries: Romania and Denmark. The second part is going to show how the impact of the crisis on the National Innovation System explaining how the financial system is closely linked with it.

5.2.1. The evolution of the financial system in Romania and Denmark during crisis

After **Romania** joined the European Union (1st of January 2007), the loans exploded in volume, especially the one for population. At the end of 2007 the credit balance both for population as well as nongovernmental grew at alarming rates, almost double than the previous year.

Besides the status of the European Union member and the free markets access in Europe, Romania's credit increase both to population and companies can be justified by the strong economic development in that period. In 2008 Romania had the biggest economic growth in the EU, around 7 to 10% (according to different analysts)[24], marking a record for the country as well. However, this just before the crisis hit Romania, leading to an uncontrollable situation for some firms, economic growth suffering a big loss a short period after.

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[23] Jan Schildbach-*Home, sweet home*, Deutsche Bank Research, 2011, page. 20
[24] https://tradingeconomics.com/romania/gdp-growth-annual

Figure 1: The situation of the credit balance provided to population and nongovernmental credits between December 2004- December 2009 (millions RON)
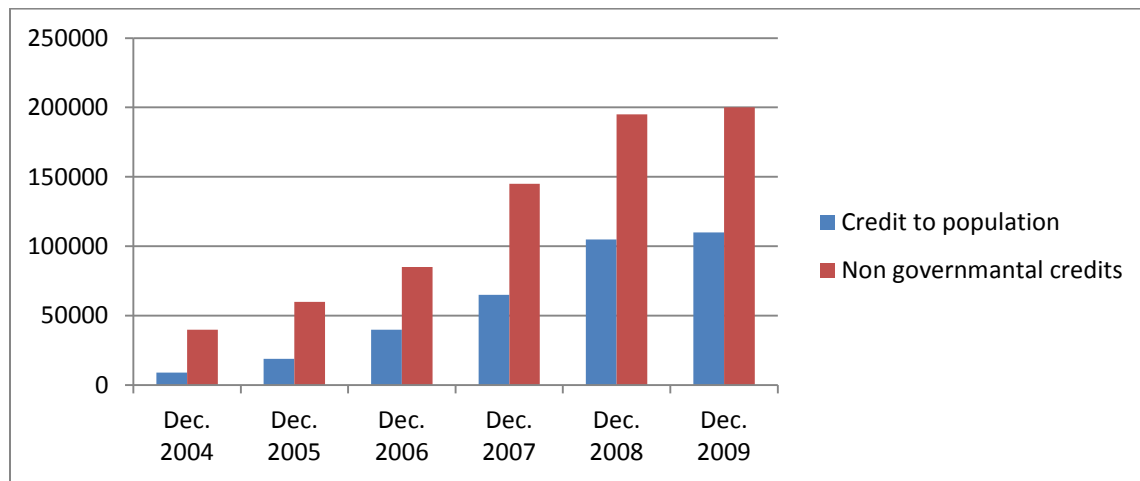
Source: Created after Monthly newsletters of Central Bank[25]

The effects of the international financial crisis began to manifest in the Romanian banking system around autumn 2008, through a speculative attack on the national currency (RON). At the same time, The National Bank took a series of measures to temper the banking lending. Before the actual implementations of these regulations, the banks were throwing with all their forces in the fight of granting loans to individuals.

As we can see from the next chart, the growth rhythm of credit balance provided to population has diminished especially during 2009 going down.

The evolution of the figure can be applied to the economic agents in the country, as the credit offered by banks to companies reduced drastically due to the increase of the rate of interests. While the crediting system had an increased rate of interest, the one for deposits decreased in percentage, making it difficult, almost unrewarding and unsafe (due to uncertainty or financial bankruptcy) for firms to keep large amounts of money at the bank.

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[25] http://www.bnr.ro/PublicationDocuments.aspx?icid=1182

Figure 2: Variation of the credit balance provided to households/population during January 2008-November 2009 (mil. RON)
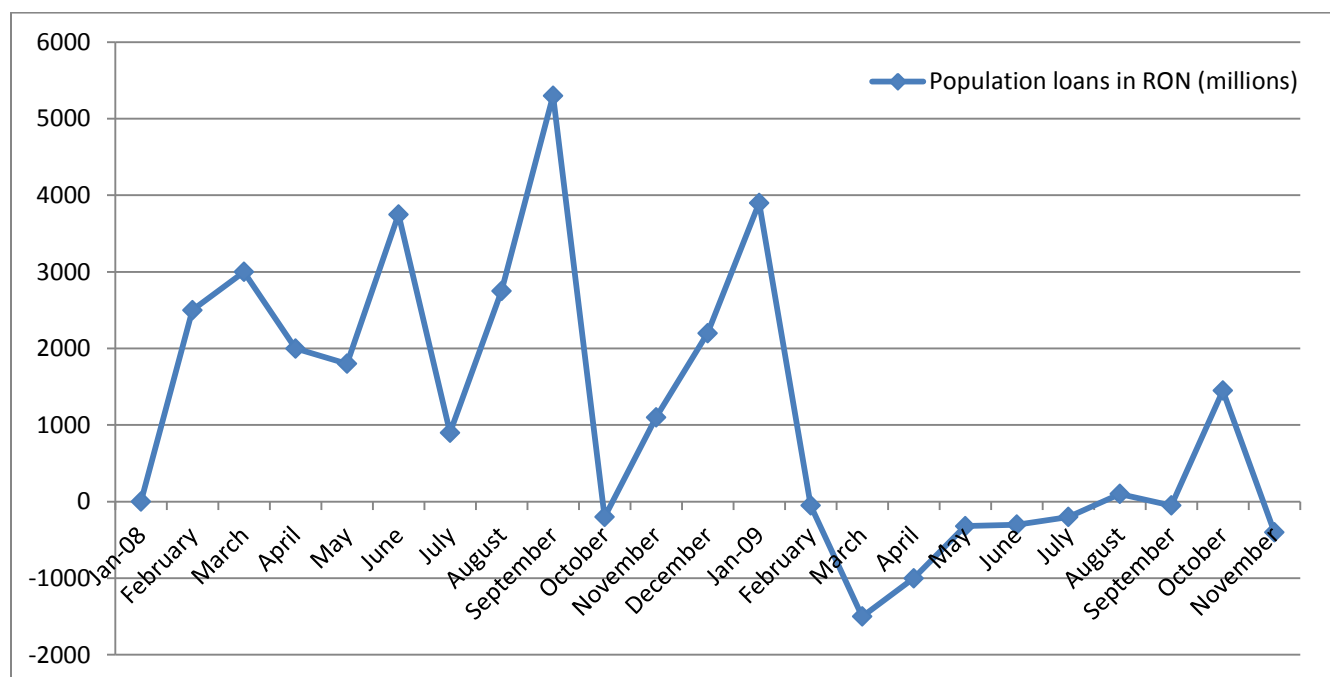
Source: Created after Monthly newsletters of Central Bank[26]

At the same time, the 2009 year brought a growth in the Non- Performing Loan (NPL). "A loan is nonperforming when payments of interest and principal are past due by 90 days or more, or at least 90 days of interest payments have been capitalized, refinanced or delayed by agreement, or payments are less than 90 days overdue, but there are other good reasons to doubt that payments will be made in full[27]". Because of this, the percent of unpaid credits/loans out of total grew from 4.62% in May 2008 to 11.47% in May 2009 and 13.3% in August. Also, the coverage of overdue loans by provisioning declined continuously, from 123% in august 2008 to 107% in August 2009.

The banks in the system, as a result of the liquidity crisis manifested in the first part of 2009, have increased the interest rates for term deposits, phenomenon which increased their volume.

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[26] http://www.bnr.ro/PublicationDocuments.aspx?icid=1182
[27] http://www.imf.org/external/pubs/ft/bop/2005/05-29.pdf page 4.

Thus, during September 2008- September 2009, the deposits attracted from the population increased with 16.26% by maintaining the loans granted relatively balanced, for the same period. In this context, the credits/deposits ratio went down from the maximum of 124.7% to 117.5%. With all this, the savings in Romania continued to stay low compared with many other countries in the region.

Table 2: The amount of banking deposits per capita (euro/inhabitant)[28]

Romania	1.034
Turkey	1.196
Bulgaria	1.549
Poland	2.281
Hungary	2.764
Czech Republic	5.870

The situation from late 2009 doesn't differentiate too much with the one that's in place 2 years later. Unfortunately, the crisis has seriously affected Romania as we can see from the following chart. The country is in the lowest position out of all compared, bank deposits per capita not being "well handled".

The behavior of population was pretty much similar to the rest of the world: as it was an uncertainty period, a lot of people tried saving money, even though the national currency has depreciated from other reference currencies such as USD and EUR.

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[28]http://ziuadecj.realitatea.net/Document_Files/Articole/00073845/bqxfs_110911_Romanian%20households%20September%202011.pdf

Figure 3: Bank deposits per capita May 2011(€)[29]
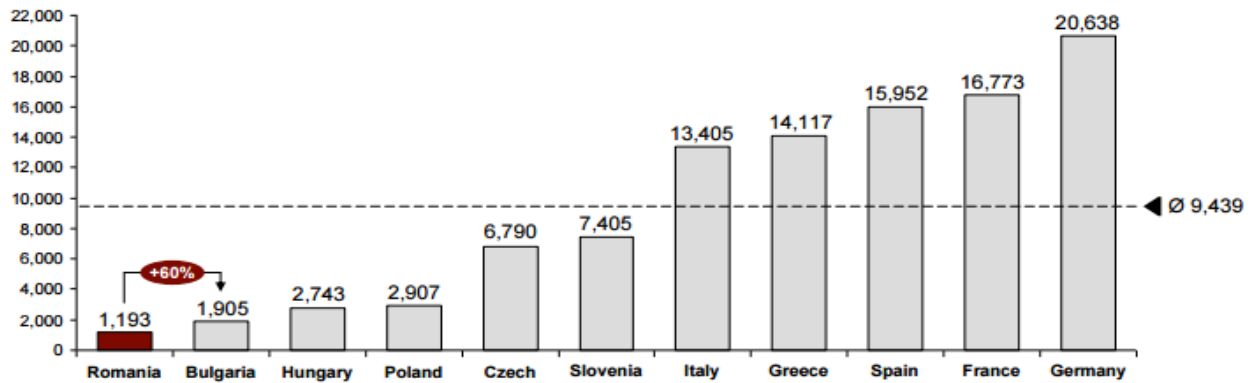
In the hope of maintaining financial stability, as EU wanted, starting with 15th of October 2008 the coverage level for deposits to individuals has increased to 50000€, while the one for companies remained the same, around 20000€. This measure was more about image and harmonization with the EU's requirements, because even with the coverage level of 20000€, 99.2% of the deposits were covered; the total value meant 60% of all the deposits in the system.

By boosting household credits and related economic sectors, the government launched in 2009 a program called "The First House". Through this program, the state, with the help of National Credit Guarantee Fund for Small and Middle Enterprises, engaged in issuing guarantees on behalf and account of the state in favor of banks which grant loans to individuals for buying a house.

National Credit Guarantee Fund for Small and Middle Enterprises received in 2009 around 11500 applications in "The First House" program, the total value of guarantees granted summing up 485mil€ out of the maximum approved level of 1 billion €.

From the perspective of banks headquarters networking, the effects of international financial crisis were felt from the first five months of 2009, 37 banking units being closed and 2077 employees coming out of the system, compared to the end of 2008, when the historic maximum of these indicators occurred. The values continued to fall in the following months, getting to the point where in September 2009 a number of 6464 banking units, with 90 less units

[29] page 24 :
http://ziuadecj.realitatea.net/Document_Files/Articole/00073845/bqxfs_110911_Romanian%20households%20September%202011.pdf

than at the end of 2008 and 68462 employees, with 3138 less than December 2008. Most of these employees belonged to small and medium banks.

Even though the financial system had its difficulties as the crisis appeared, the Romanian financial system acted surprisingly strong, especially the banking sector.

There wasn't any bankruptcy registered in the banking sector, compared to other countries, more economically developed. The reason for that is the majority of the foreign banks in the Romanian banking system. The headquarters pumped money to subsidiaries in areas where there was a cash shortage and quickly redressed the situation.

In **Denmark**, the impact of the crisis is similar, as we will see from the upcoming figure. The banks were not offering loans as big in volume as before, the lack of liquidity moving to the economic agents as well.

The amount of loans to the SMEs consisted mostly of short term loans, their volume slightly decreasing since the crisis appeared. The short term loans are a result of the firms cash shortage.

The long term loans for the SMEs were drastically reduced in the period of the crisis, reaching only half of the volume in 2009 compared to 2007. After 2011 the climate started being stable again and the long term loans exploded, reaching almost 50 000 mil DKK in 2014, more than in the 2 previous years combined.

Figure 4: Loans to Small and Medium Enterprises (mil DKK)
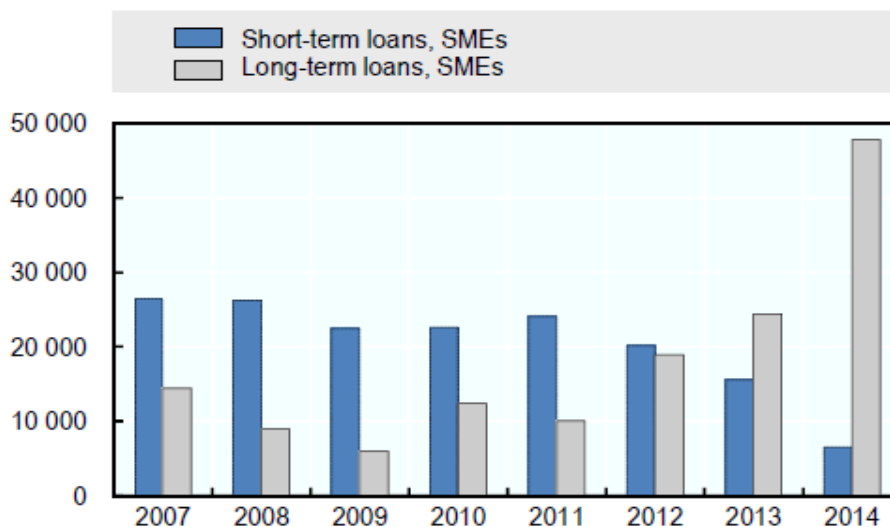
The next figure shows the evolution of the capital formation in the EU 27 on a 10 year period, presenting the effects of the financial crisis in the national economy in the last two. Capital formation mainly consists of investment in assets like machinery and buildings.

We can see that in the beginning of 2006 the annual percentage change had a significant boost, the growth of capital formation being at its peak. Shortly after the events in the US mortgage market, every sector suffered an asset loss in value, leading to insufficient funds and a decision not to invest in fixed assets for that period.

The sector that suffered the most was the non-financial corporations, the loss of capital formation being bigger than the previous year growth.

Figure 5: Growth of capital formation by sector, EU-27 (%)
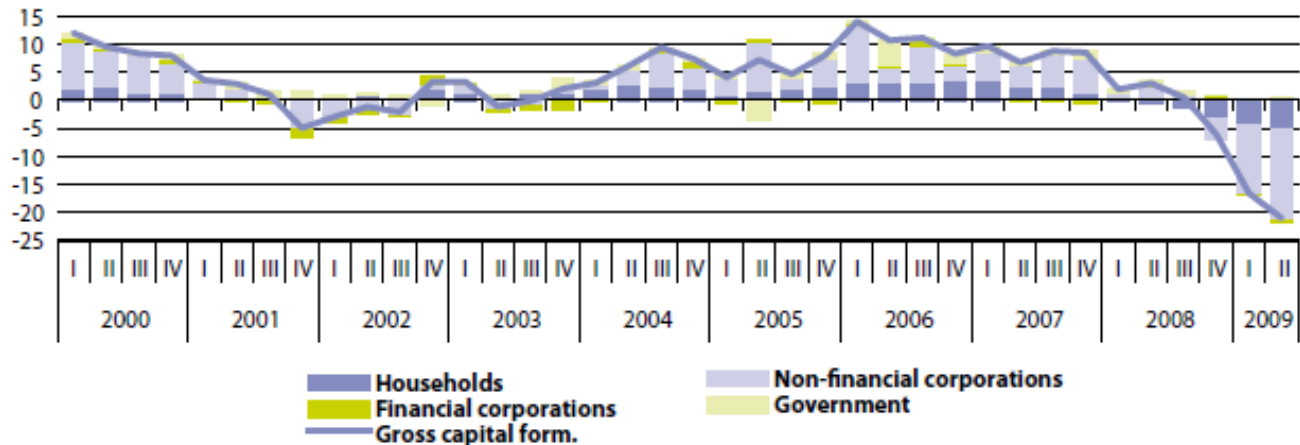
Even though the previous graph focuses on asset investing, it accurately represents the general economic situation in all European countries. The graphic numbers may slightly differ but the evolution is the same in most of the countries.

All participants to the national economy felt the struggle. As presented earlier, the population and the economic agents were offered lots of favorable credits with good rates of interest by financial institutions that were too focused on the quick earnings, tried to improve the profit but ignoring the rules and didn't pay attention to the high risks.

5.2.2. How was the National Innovation System affected in both countries?

The first example of how the crisis influenced the innovation of firms in the European countries is the **the Innobarometer survey**, which contains 27 states of the EU, and also includes Norway and Switzerland, consisting of how firms innovate giving the economic situation (recession).

There are a total of 5238 companies from Europe that participated in the survey based on 3 criteria: country, size and activity sector. The Innobarometer, a survey made on April 2009 had the following 2 questions:

1. "Compared to 2006, has the amount spent by your firm on all innovation activities in 2008 increased, decreased, or stayed approximately the same?
2. In the last six months has your company taken one of the following actions [increased, decreased or maintained the innovation spending] as a direct result of the economic downturn?"

An adapted illustration of the survey (see appendix) regarding the 2 previous questions can be found in the upcoming figure.

The blue represents the trend based on a 3 years period (2006, 2007 and 2008) of a firms spending towards innovation, simply named "firms' innovation expenditures 2006-2008. The second, red, brings up the effects of the crisis towards innovation in firms.

Therefore, we can say that this figure is showing the investment in innovation on a short and a medium term (1 and 3 years).

Figure 6: Firms' innovation expenditures: comparison between the three years before the crisis and in response to the crisis[30]
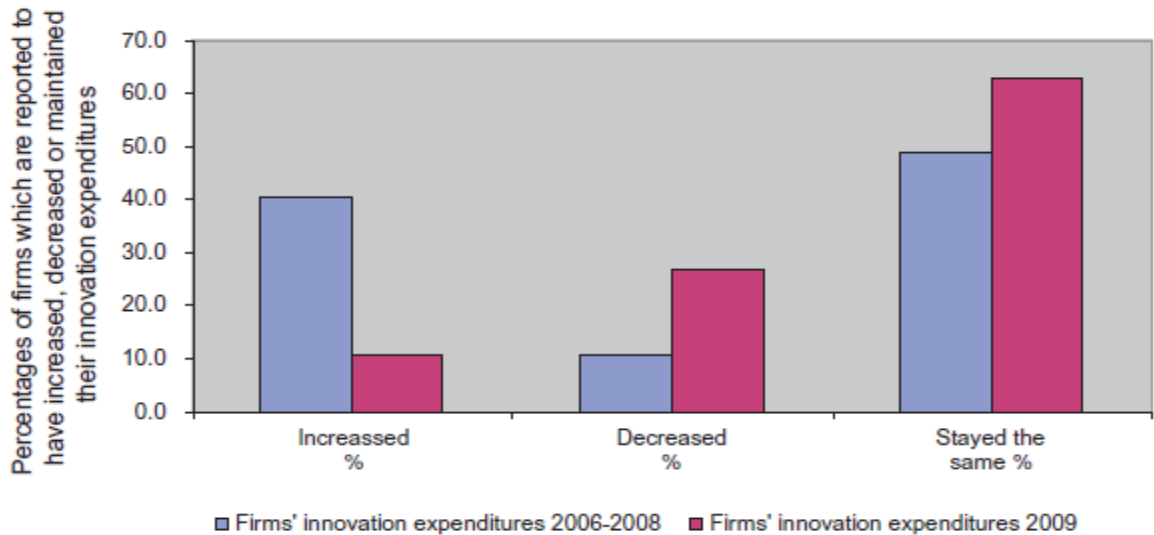
The innovation expenditures on the 2006-2008 period means the percentage of firms that increased or decreased the innovation investments in the previously mentioned period, also stated as before the crisis/ the pre-crisis innovation investments.

The innovation expenditures in 2009, on the other hand, are bringing up the effect of the crisis towards how much firms spent on innovation. This shows how the crisis affected the innovation performance of firms being also considered a response to/ as a result of the crisis.

We can how the crisis influenced the firms' innovation expenditures by looking at the previous figure.

In the 2006-2008, the percentage of firms that have increased their innovation expenditures is slightly over 40%, while when the crisis hit, the amount of firms increasing their innovation spending went down to a bit over 10%.

At the same time, the amount of firms that decreased their innovation spending went up from around 10% in the period before the crisis to more than 26% during the crisis.

However, an interesting fact is that there was a huge amount of firms that maintained their level of innovation spending, from around 50% before the crisis, to more than 60% after the crisis appeared.

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[30] Adapted after Innobarometer survey table, see Appendix

Figure 7 is split into 4 categories. On the X-axis we have the innovation performance of countries in the 2006-2008 years period, which was presented in the previous figure, answering the 1st question of the survey regarding the evolution of the innovation performance (increased, decreased or maintained).

The strength of the National System of Innovation is represented through the Y-axis. The InnoStruct Performance was realized by Filippetti and Archibugi based on European Innovation Scoreboard 2008's data[31].
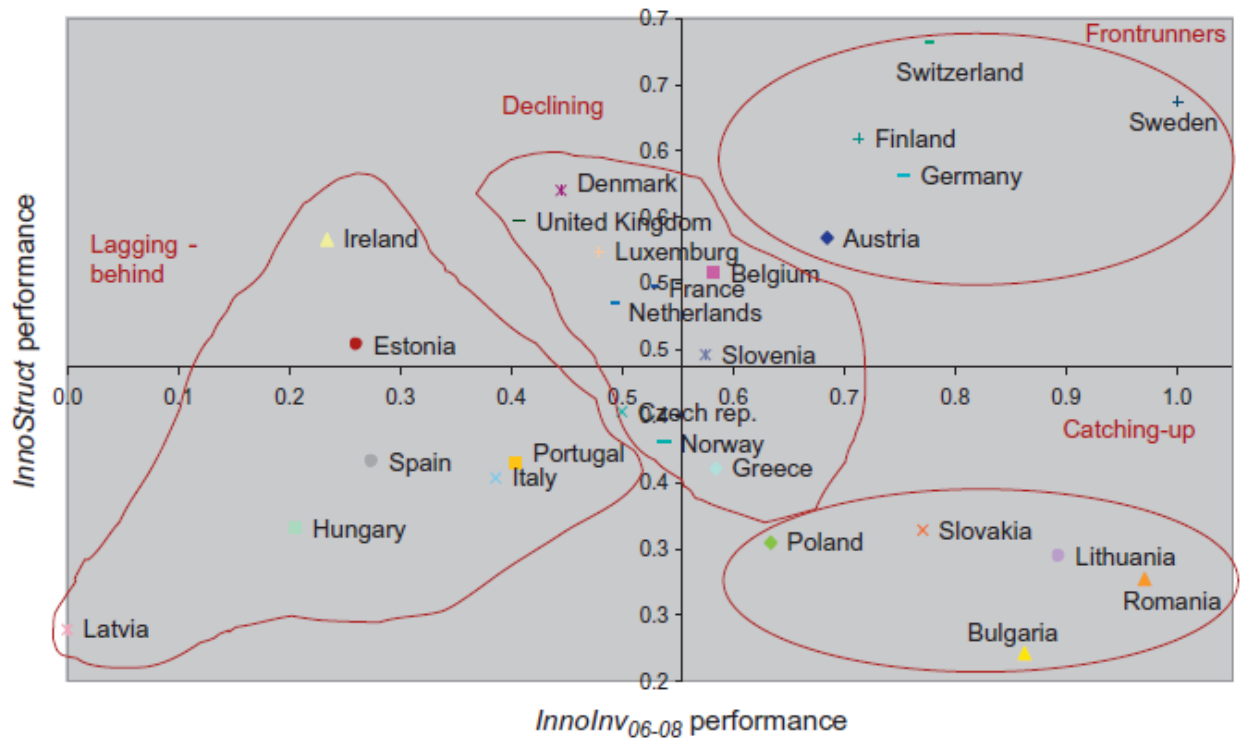

Figure 7: Innovation performance 06-08 and NSI strength[32]

The four categories that divide the figure can be explained as:

1. The *frontrunners*: in this section we find 5 countries: Sweden, Switzerland, Germany, Finland and Austria.

They were in the top in the previous figure as well, which showed the innovation performance in the 06-08, but what helped countries like Germany, Finland and Austria get to an even better top position is the strength of their National System of Innovation,

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[31] See appendix, table nr. 2
[32] Resulted after previous figure and EIS data (table 2 appendix)

compared to those that fell behind. Therefore, the constantly increasing innovation expenditures together with the strong structure of innovation performance in each country consolidate their position in the first category.

2. The *catching-up*: in this circle we find another 5 countries, all of which are new members of the EU: Romania, Lithuania, Bulgaria, Slovakia and Poland.

The first 4 countries were present on the top in the previous figure as well, meaning that they increased their investments a lot more than the average relative of the previous period. The reason why they fell behind countries like Germany, Austria is the National Innovation System.

Even though the countries have innovated and constantly spent money on innovation, the strength of their NSI is weak compared to the one from the previous states, bringing them the place in the 2nd category.

3. The *declining*: Here we find the most amount of countries. By looking at the figure we can see that they are around the average of innovation performance as well as innovation system strength.

Their main characteristic is that they have a strong National System of Innovation, similar to the first category, but they have a weaker innovation performance in the 06-08 years period, the innovation expenditure being increased less.

Above the average we can find: Denmark, UK, Luxembourg, Belgium, France, Netherlands and Slovenia, while shortly below the average countries like Czech Republic, Norway and Greece.

4. The *lagging-behind*: in the last category we find the following countries: Ireland, Estonia, Portugal, Italy, Spain, Hungary and Latvia.

Two of them are new members of the EU: Hungary and Latvia, while we also have big countries like Italy and Spain. All the states in this category are characterized by a weak innovation expenditures performance as well as a weak National System of Innovation.

Even though we have this kind of classification based on the strength of the NSI in each country and the innovation performance of firms, we cannot say that these results are to be set in stone.

The frontrunners are mainly there because of the National Innovation System's strength which is trying to make up for the inactivity towards innovation performance which some firms have. This means that the countries can't just sit back and relax, thinking they'd be on top forever. Firms in these countries still need to have a good innovation performance by continuously investing in innovation.

Considering the fact that the catching-up countries have developed a good innovation performance during the presented period, they are still going to develop it further in the same manner, so that they don't fall in a lower bracket. Furthermore, having a weak National System of Innovation in all these countries, the most important thing is trying to improve the NSI at least until it reaches a higher level, similar to the systems from the first category.

The declining countries need to undoubtedly on innovation performance. Even though they are characterized through a strong National System of Innovation, they need to make sure that the firms are going to focus on innovation development and expenditure, even more than firms from the frontrunners group.

Countries that are in the last category will probably still be in that position at least for a couple of years, as the difference between them and the other competitors is pretty big. There is a permanent struggle into improving the National System of Innovation in those countries as well as the low innovation performance, which needs to increase drastically.

Both previous figure, number 7, and the following one, noted number 8 have been realized by Filippetti, A., Archibugi,D. in the research paper: *Innovation in times of crisis: National Systems of Innovation, structure, and demand*. (2010), and have only been used as an additional example in order to present the innovation situation in the European countries.

Having analyzed the situation before the crisis, let's have a look on what happens when the crisis hit.

Figure 8: Innovation performance and NSI strength after the crisis[33]
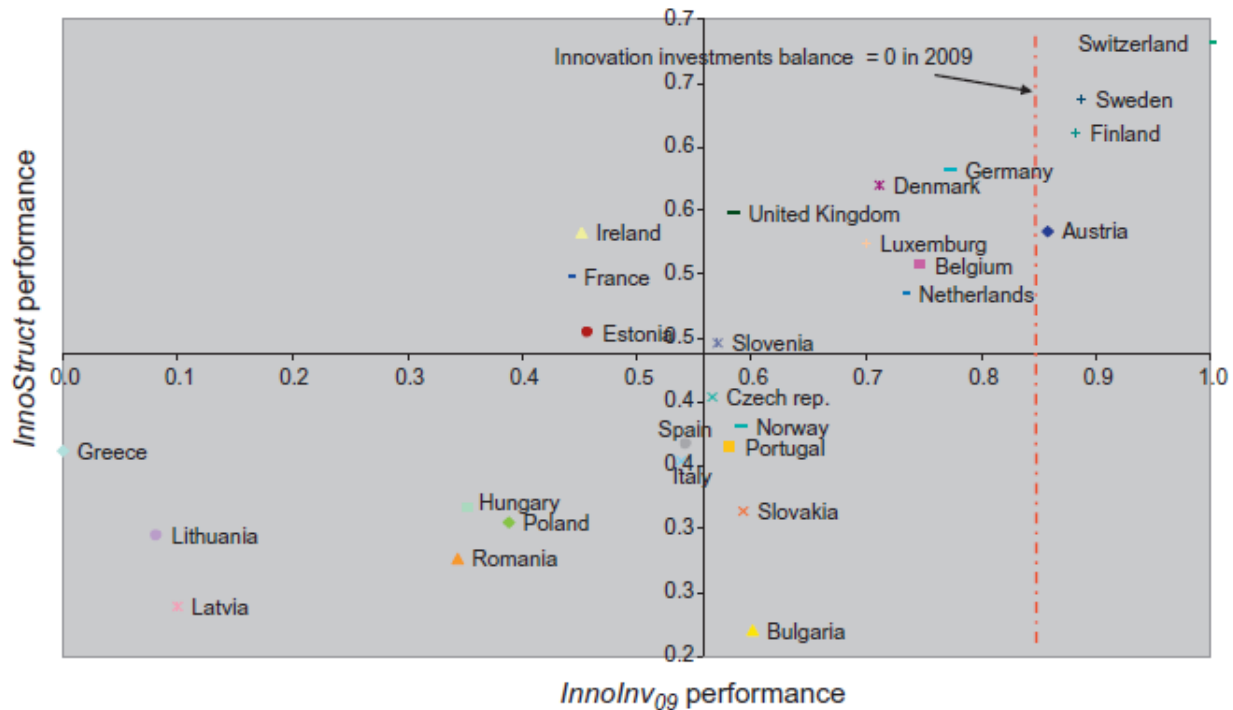
Here, we see that the relationship between the behavior of firms towards innovation and the NSI strength is deeper, even than in the previous figure, as the frontrunners have a significant gap between its followers.

By looking at the previous figures, we observe that the **effects of the crisis among European countries is uneven**, otherwise it would have looked similar. This why we have countries like Lithuania, Romania, Poland, which were previously in a much better position, in the lower left part of the figure.

Also, the countries that moved upper right part of the figure are countries like UK, Denmark, Belgium or Netherlands, which were in a much worse situation in the previous figure, because of the strength of their National Innovation System. We can see that the InnoStruct, or the **structure is very important**, because the least affected by the crisis where these countries with a strong NIS, compared to the ones that were the most affected, presented earlier, that have a weak National System of Innovation.

[33] Resulted after table 1 and table 2 in the appendix

This is even more cleared when compared to the 2006-2008, as the companies were continuously improving their investment towards innovation, despite the fact that their NIS was weak.

For more details of how the Innovation Systems are organized in Romania and Denmark, data from Eurostat and OECD has been analyzed in a larger period, before, during and after crisis. This includes **budget appropriations**, **R&D expenditure** (also **funding sources**), R&D **personnel**, **firms' innovation activity** and **level of cooperation**. All the following graphics/charts have been created after a thoroughly analysis of several indicators from Eurostat.

In order to measure the support of the government for R&D activities, data from the **government budget appropriations or outlays on research and development** (GBAORD) is a perfect match.

By looking at the name, we notice "budget appropriations", therefore, is it clear that the term brings up a budget provision and not expenditure. It is also important to mention that, alongside the government establishments, the following sectors are financed: *higher education, business enterprise and private non-profit*.

Figure 9: Total GBAORD as a percentage of GDP in the EU-27, Romania and Denmark 2006-2011
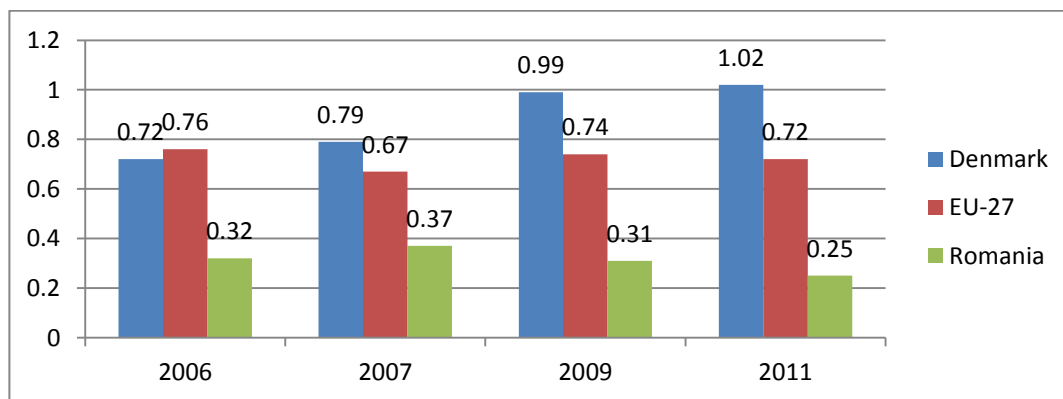
Source: Own figures based on data collected from Eurostat

In the government budget appropriations for R&D as percent of GDP we find an interesting situation. The period of time consists of pre-during and after-crisis year. It is an important start point in comparing two or more countries as it shows the political and general

views towards research and development and innovation in the country. From the figure we can clearly see that Denmark invests a lot more in R&D (remember this is a budget appropriation and not actual investing rate/amount) than Romania. Since 2006, Denmark has steadily increased the GBAORD, from 0.72% to more than 1% of the GDP in 2011, leaving behind the EU-27 average level. The situation in Romania looks concerning, the GBAORD is lower than half of the EU - 27, and much lower than Denmark's. This represents the government's lower interest concerning R&D in the analyzed period.

Moving on from budget scenarios to actual numbers, a better way is to view the R&D in volume, by **the amount of expenditure**. For a general an accurate comparison between the two countries, data collected from the **OECD** regarding R&D expenditure fits in brilliantly. In the 2006-2011 period, the percent of GDP for R&D in Denmark rose from 2.4% to 3%, from 6000 million USD to 7000, while in Romania the percent of the GDP was struggling around 0.45-0.5% with expenditure deviations from 1417 to 2000 mil USD (data.OECD.org).

The next figures consists of R&D expenditure in mil EUR and in mil Purchasing Power Standards (PPS), adjusted by the price levels and exchange rates in each of the two countries for a better result.

Also, the 4 sectors mentioned earlier: *government, business enterprise, higher education and private non-profit* are part of the figure, each showing their own expenditure.

On figure 10 we have the amount in million EUR of expenditure for Research and Development by Sector of performance in Denmark. The expenditure structure is balanced throughout the whole 4 analyzed years, the business enterprise sector having the majority. An interesting thing is that the R&D expenditure in the government sector has slowly decreased, while the business enterprise sector constantly grew, spending more than double than the higher education sector. Even though almost insignificant, the private non-profit sector is present, having around 30 million EUR invested in R&D.

Figure 10: R&D expenditure in Denmark by sector of performance 2006-2011 (million EUR)
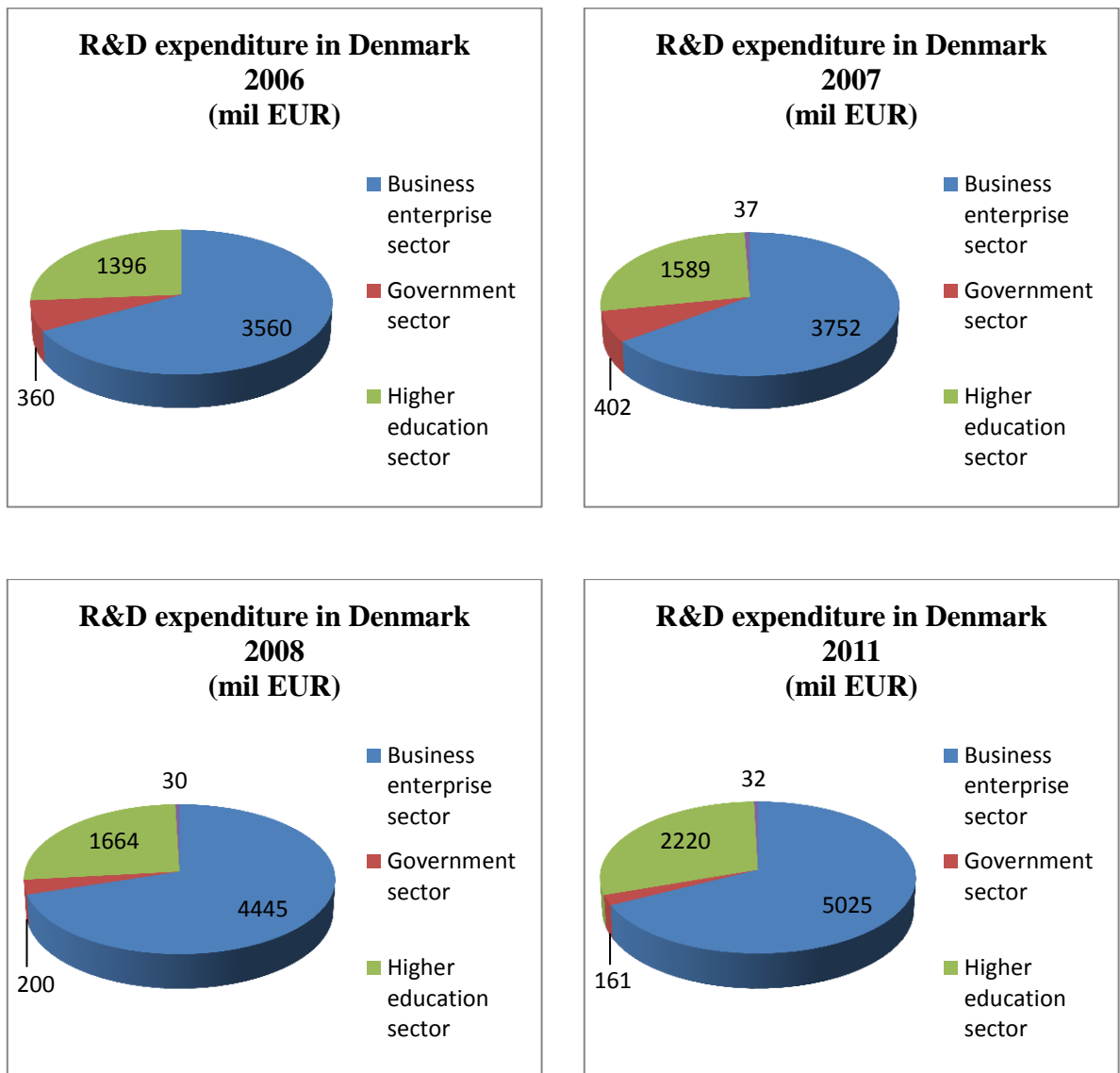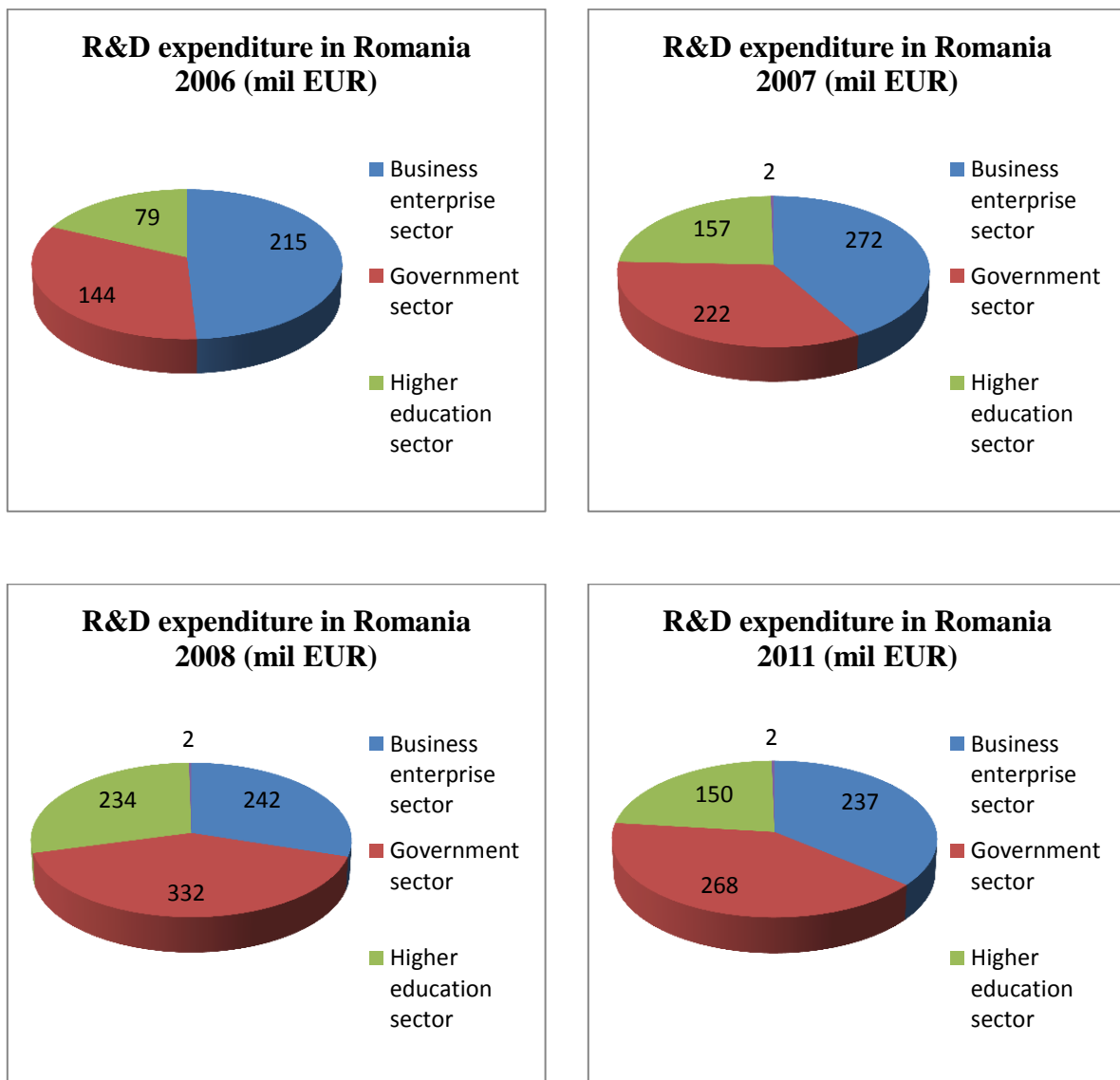

Source: Realized after Eurostat Science, Technology and Innovation in Europe 2010 edition.

In Romania, the R&D expenditure by sector of performance is a lot different, as we can see from the next figure, figure 11. Before the actual system shock from the crisis, the majority of the expenditure belonged to the business enterprise sector. After the crisis appeared we clearly see that most of the expenditure in R&D was realized in the government sector, the high education sector increasing as well.

This is a result of government policies towards innovation and renewable energy. We saw previously that the government budget appropriations in Romania were low compared to the EU-27. Giving the status of a new member of the EU, the country has several criteria and requirements to fulfill in order to reach the EU level. I consider that investing in R&D is a good solution, even though it is done by the government.

Figure 11: R&D expenditure in Romania by sector of performance 2006-2011 (million EUR)


Source: Realized after Eurostat Science, Technology and Innovation in Europe 2010 edition.

If we look at the numbers from the 2 previous figures, the difference is huge. For example, in 2007, Romania had spent a total of 653 million EUR, while Denmark spent almost 9 times more, with a total of 5870 million EUR. Denmark spent in the high educational sector more than double than Romania in all sectors.

By the volume of the expenditure we can clearly see that Denmark has spent a lot more on R&D than Romania, but in order to have an accurate situation, the Purchasing Power Standards (PPS) will measure it in a more comparable manner.

Figure 12: R&D expenditure comparison between Romania and Denmark 2007 (millions of PPS)
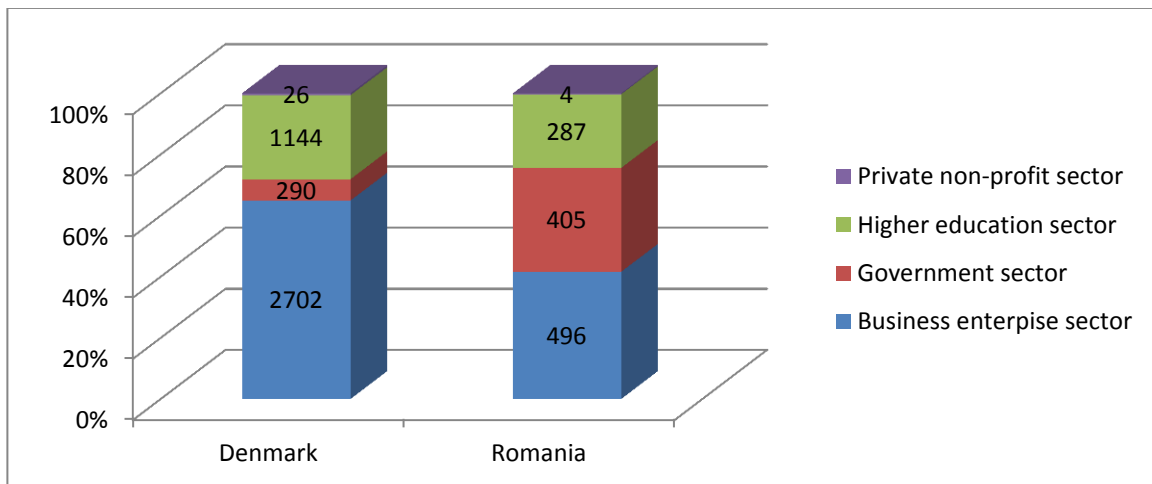
This figure illustrates a better and more realistic comparison between the two countries. The R&D expenditure in 2007, in millions purchasing power standards it's adjusted in a manner to accurately spot any differences.

If previously, the difference between R&D expenditure in million EUR was more than 9 times between Denmark and Romania; in this figure we find out that the real difference is actually only 3.5 times higher, favoring Denmark. The total amount in purchasing power standards spent by Denmark on research and development in 2007 was 4162, while in Romania it summed up 1192.

In this figure we can also better compare the performance of each sector from both countries. The business enterprise sector expenditure on R&D in Denmark was 5 times bigger than in Romania, having as well, the majority of the 4 sectors. It is interesting to see again the

influence of the government expenditure in R&D, surprisingly adjusted to the PPS, the one in Romania is bigger in volume than the one in Denmark. A similar difference to the business sector is maintained in the high educational sector, as Denmark's expenditure is 3 times bigger in volume.

Figure 13: R&D expenditure by source of funds as percentage of total 2006-2007
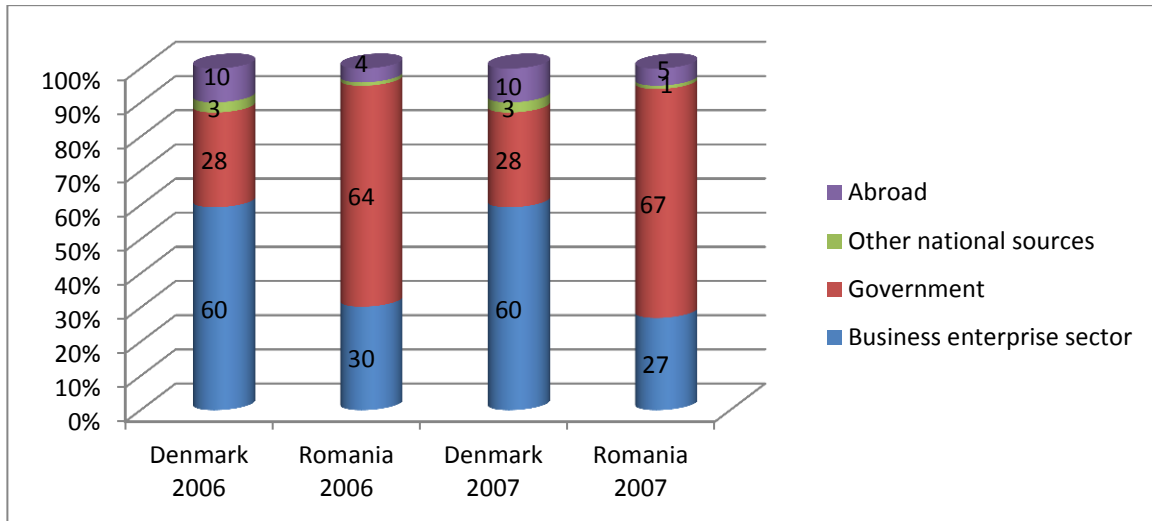
In figure 13 we have a different view of the research and development expenditure, by source of funds. The analyzed period is between 2006-2007, before and in the beginning of the crisis, while figure 14 consists of a period during and after the crisis.

Therefore, we see where the money spent on the research and development came from. The format is somewhat similar to the previous figures, in million EUR and PPS, in the way that the business sector is still dominant in Denmark, as well as in Romania where it's the government. However, the situation is different; the other two sources are new, compared to the previous sectors.

In figure 13 we see that the funding for R&D consists mainly from business enterprise sector in Denmark, with 60% in the analyzed period, compared to only around 30% in Romania. The majority of funding that went for R&D expenditure in Romania was from the government, to different local and regional development programs. The last 2 sources are R&D expenditure coming from abroad, summing 10% in Denmark and 5% in Romania and other national sources, with 3% in Denmark and 1% in Romania, are almost insignificant compared to the other 2.

Figure 14: R&D expenditure by source of funds as percentage of total, ranked by R&D intensity (R&D expenditure as % of GDP), Denmark 2008 and 2011
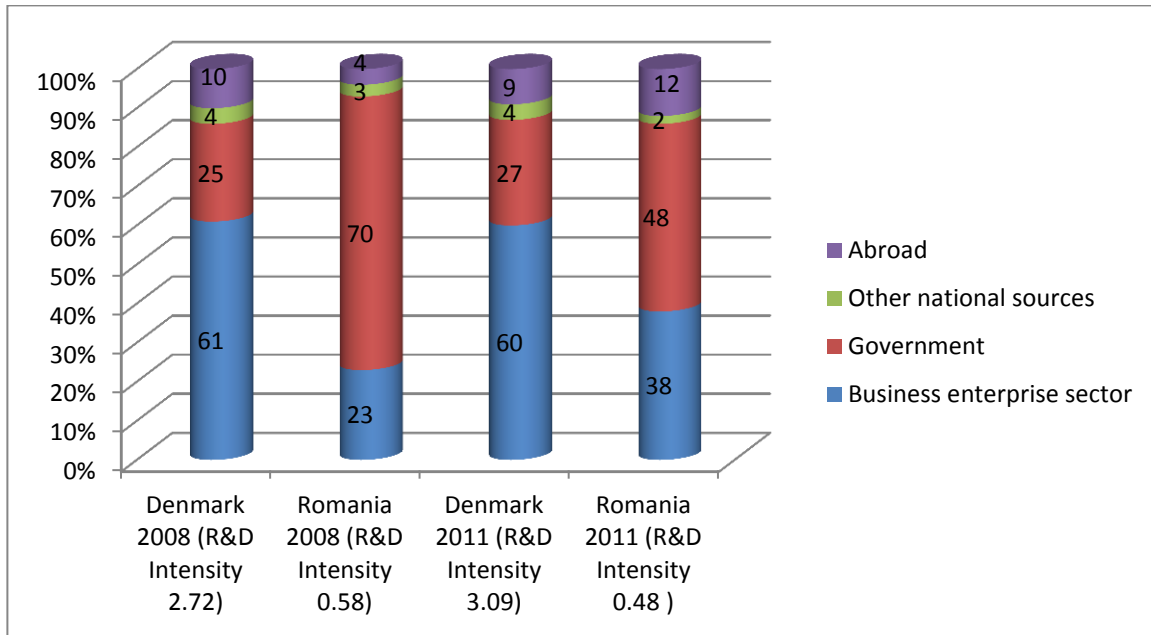
If before the crisis the funding for R&D in Romania was highly dominated by the government, in figure 14 we see that the situation is slightly changing, from 70% in 2008 to 48% in 2011. Also the business sector in the country is growing, from 23% to 38% in 2011. In my opinion this is a good evolution, as I consider that the business sector should have the majority in R&D expenditure as well as by source of funds, a situation which we find in Denmark.

Going back to the early situation presented of the European countries concerning innovation, we remember that the effects of the crisis on Romania were bigger than on Denmark, because of the InnoStruct, the strength of the national innovation system. Having the same period of time being analyzed I consider that Romania is doing a good job trying to strengthen its NIS, that's why we have the government as a majority in R&D expenditure, and by source of funds. I believe that after a period of time the investments in governments R&D, the role of the institutions won't be on the same intensity, and naturally, the business sector will replace it, becoming dominant.

However, given the analyzed period and the crisis' impact, it seems that the R&D intensity is suffering, an example being the indicator having a decrease from 0.58 as % of GDP

in 2008, to 0.48% in 2011. In Denmark, we can say that the research and development system is healthy as it has been allocated more money, from 2.72% in 2008 to 3.09% in 2011.

A situation of the employees conducting research& development activities is also necessary in order to see how the studied countries behaved during the analyzed period. Whether they are researchers or simply research and development personnel, they are the ones that have the significant amount of knowledge. The amount of knowledge gathered by the company is then used in innovation activities, such as: product innovation, process innovation, organizational innovation or market innovation.

A general level of difference between the two countries can be observed also by looking at the amount of the researchers. According to OECD, the total number of researchers per 1000 employees in the period 2006-2011 rose up in Denmark from 10 to 14, while in Romania only 2 out of a thousand fit in this category, the number slightly falling. However, if we compare the number of government researchers, Romania has 30 to 35% compared to Denmark with less than 5% (data.oecd.org). We can say that it's a similar situation as the previous one regarding the expenditure by source of funds, where Romania also had more expenditure as percent of GDP dominant on the government section.

Figure 15: R&D personnel by sector of performance as percentage of total 2007-2011

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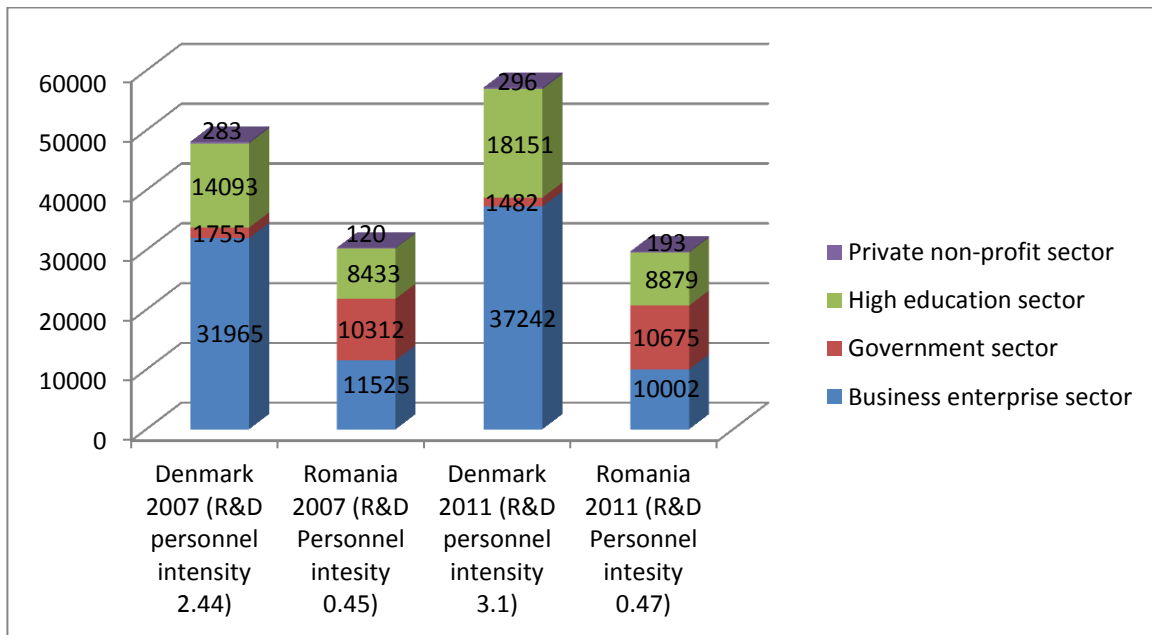
The situation of the research and development personnel, grouped by sector of performance as percentage of total is shown in figure 15. Even though the working population in Romania is way bigger than in Denmark, the amount of R&D personnel is favorable to Denmark.

While Denmark had an increase in R&D personnel from 2007 to 2011, mostly in business sector and high education sector as well as in R&D personnel intensity, from 2.44% to 3.1%, in Romania the situation remained approximately the same in the analyzed period.

Figure 16: Average annual growth rate (AAGR) of R&D personnel 2005–2011
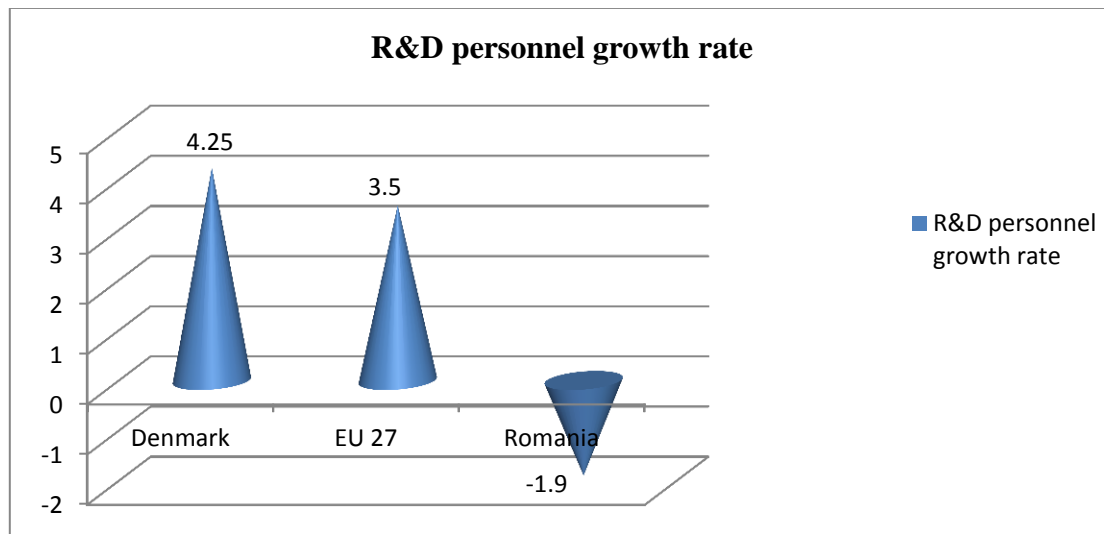
In figure 16 we have the research and development growth rate on a larger period, from 2005-2011. Denmark has an average annual growth rate of 4.25% compared to 3.5% of the EU-27, while Romania is on the negative side, having 1.9% less every year. It is important to mention that in the case of Romania was a period of unstable climate, having a boom right before entering the EU in 2007, and a decrease in economic growth as a result of the crisis.

The innovation process is very complex and contains a lot of elements which are interconnected. For example, the European Innovation Scoreboard is using a total number of 25 innovation indicators in order to fully capture the innovation processes. The following list provides additional details as well as where the indicators can be found.

Table 3: European Innovation Survey indicators

| INPUT – Innovation drivers	
1.1	S&E graduates per 1000 population aged 20-29	Eurostat
1.2	Population with tertiary education per 100 population aged 25-64	Eurostat, OECD
1.3	Broadband penetration rate (number of broadband lines per 100 population)	Eurostat, OECD
1.4	Participation in life-long learning per 100 population aged 25-64	Eurostat
1.5	Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)	Eurostat
INPUT – Knowledge creation		
2.1	Public R&D expenditures (% of GDP)	Eurostat, OECD
2.2	Business R&D expenditures (% of GDP)	Eurostat, OECD
2.3	Share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditures)	Eurostat, OECD
2.4	Share of enterprises receiving public funding for innovation	Eurostat (CIS 4)
INPUT – Innovation & entrepreneurship		
3.1	SMEs innovating in-house (% of all SMEs)	Eurostat (CIS 4)
3.2	Innovative SMEs co-operating with others (% of all SMEs)	Eurostat (CIS 4)
3.3	Innovation expenditures (% of total turnover)	Eurostat (CIS 4)
3.4	Early-stage venture capital (% of GDP)	Eurostat
3.5	ICT expenditures (% of GDP)	Eurostat, World Bank
3.6	SMEs using organisational innovation (% of all SMEs)	Eurostat (CIS 4)
OUTPUT – Applications		
4.1	Employment in high-tech services (% of total workforce)	Eurostat
4.2	Exports of high technology products as a share of total exports	Eurostat
4.3	Sales of new-to-market products (% of total turnover)	Eurostat (CIS 4)
4.4	Sales of new-to-firm products (% of total turnover)	Eurostat (CIS 4)
4.5	Employment in medium-high and high-tech manufacturing (% of total workforce)	Eurostat, OECD
OUTPUT – Intellectual property		
5.1	EPO patents per million population	Eurostat, OECD
5.2	USPTO patents per million population	Eurostat, OECD
5.3	Triadic patent families per million population	Eurostat, OECD
5.4	New community trademarks per million population	OHIM, Eurostat, OECD
5.5	New community designs per million population	OHIM, Eurostat, OECD

Source: Eurostat- Science, technology and innovation in Europe 2009 edition, page 129.

Another subject of the analysis was made by consulting the Community Innovation Surveys, which observers the innovation activity in Europe. In the beginning the CIS were realized every four years, but lately it went for a shorter period time, to every 2 years.

The information presented next is similar with what was presented in the beginning of the chapter, the difference is, that on this part, the situation strictly reflects the performance of the two analyzed countries and not the whole EU.

In the next figure we the situation of the firms that had technological innovation concluding in product or process innovation as percent of all enterprises, in 2006 and 2008.

Figure 17: Enterprises with technological innovation (product, process, ongoing or abandoned), regardless organizational or marketing innovation in CIS 2006 and CIS 2008
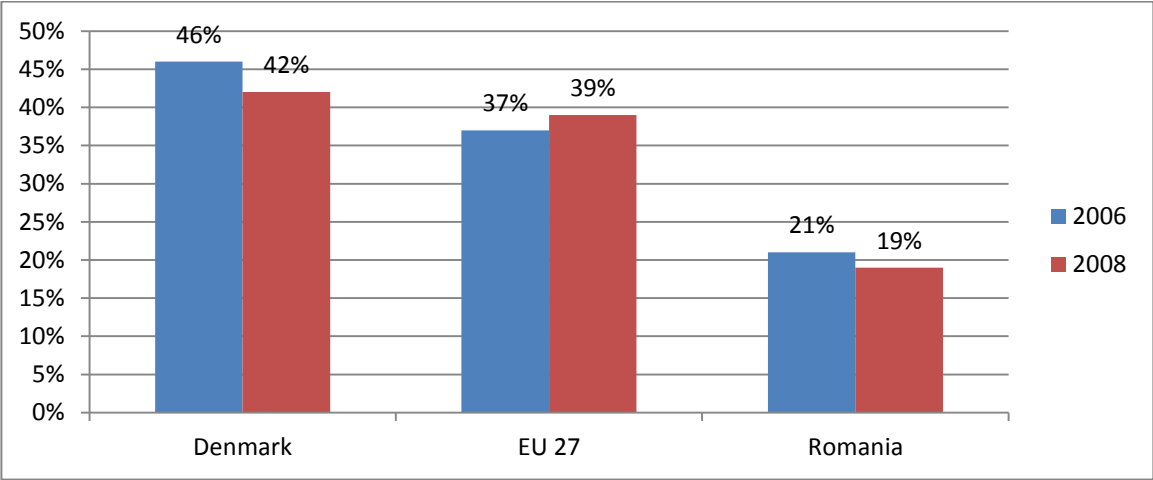
Taking in consideration only the technological innovation, around 46% of the companies in Denmark have done product or process innovation in 2006, the amount slightly decreasing in 2008 to 42%. In Romania the percent of firms with technological innovation was half, compared to Denmark and EU average, 21% in 2006, decreasing as a result of the crisis to 19% in 2008.

Figure 18: Enterprises with innovation activity (product, process, ongoing or abandoned, organizational and marketing innovation) as a percentage of all enterprises
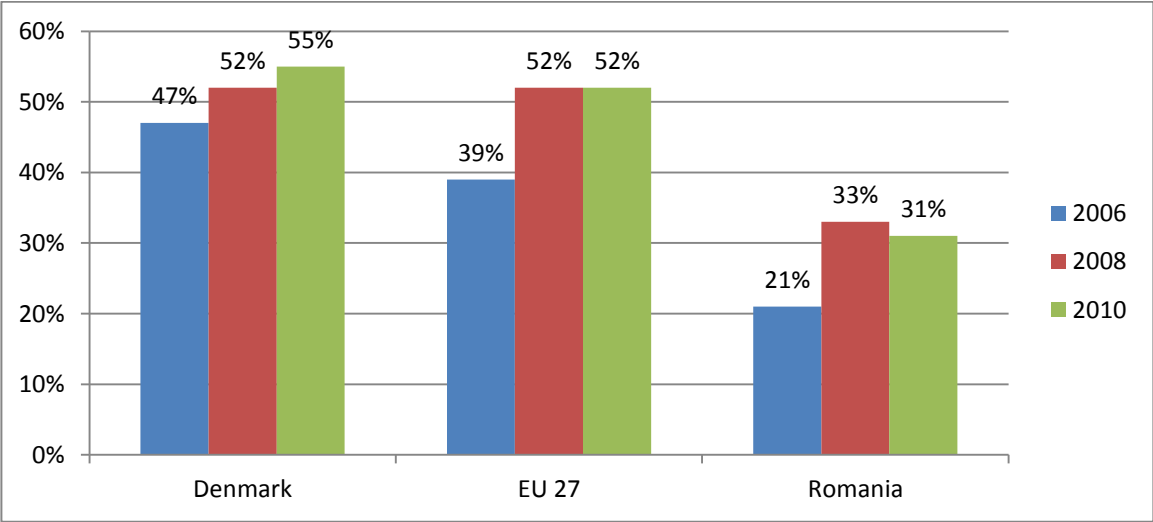
Having a broader perspective of innovation activity done by enterprises, Figure 18 brings up all innovation activities: product, process, organizational and marketing innovation. The period analyzed is from 2006 to 2010, every 2 years. In Denmark we see that the percent of the companies out of the total that have done product, process, organizational and marketing innovation is increasing from 47% to 55%, more than half of the enterprises, having better numbers than the EU-27. In Romania we can see that it's a period of struggle, only 21% of the companies having innovated in 2006, surprisingly, the amount growing when the crisis appeared, but still decreasing a bit after.

Figure 19: Product and/or process innovative enterprises in CIS 2008 and CIS 2010
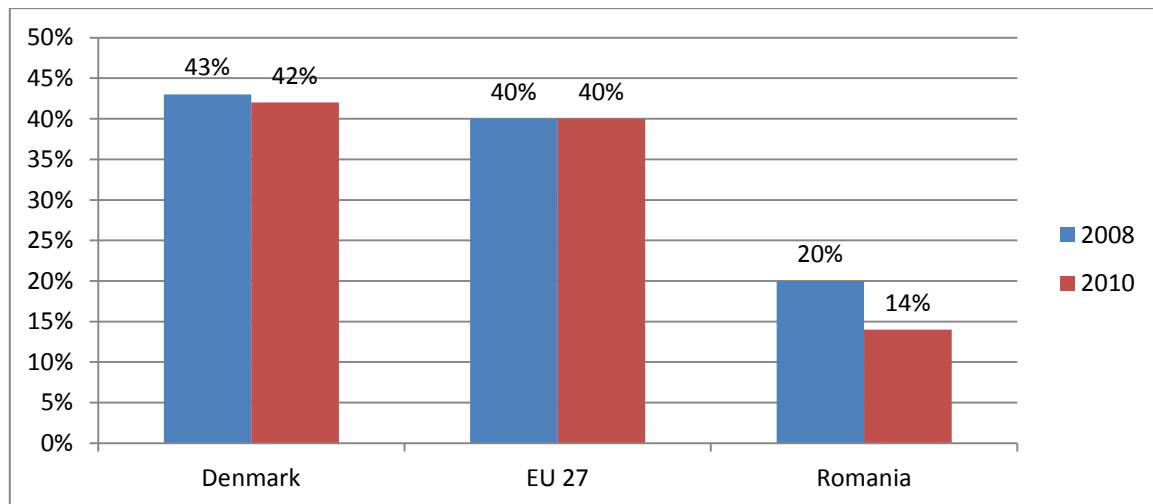
Extracting out organizational and marketing innovation, we have the situation of the product and/or process innovation in firms represented in figure 19. More than 40% of the companies, which is the EU average, are product or process innovative in Denmark in 2008 and 2010, while in Romania the crisis seems to affect the innovation activity, dropping from 20% to 14% of the total firms.

Another aspect that needs to be taken in consideration is the cooperation of firms, especially between the innovative ones. Before 2007, most of the European countries were in the no-cooperation area. We can see in figure 20 that the situation has changed drastically, especially for Denmark. It seems that the appearance of the crisis made Danish companies to cooperate more in terms of innovative activities, especially in 2008, even though the amount fell almost

back where it was before. The Danish level was higher than the European average in the analyzed period, while the Romanian level looks to be catching up with the countries in the region.

Figure 20: Enterprises with any type of co-operation as a percentage of innovative enterprises, 2006-2010
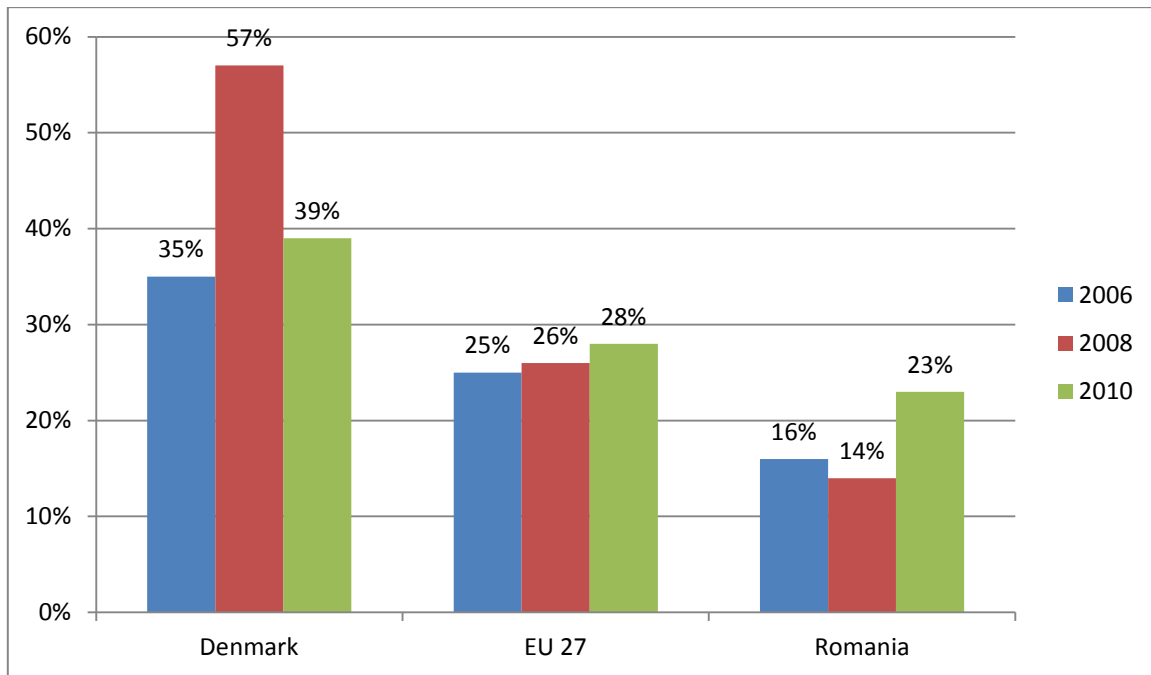
As previously we remember that the Romanian research and development expenditure was mainly dominated by the government sector, the next illustration presents the public financial support for innovation as percentage of innovative activities in 2008 and 2010.

Almost 10% of innovative firms received any kind of public financial support for their innovation activities. Other types of public financial support were received from: local and regional authorities, central government, European Union, the 6th and the 7th framework programs.

Most of the financial support decreased during the analyzed period with the exception of the central government, which has increased from 4.8% to 6.1% out of all innovative firms. As a result, the local and regional authorities offered public funding to 2- 3% of the innovative firms, around 5% of the innovative firms accessed programs for innovation activities from European

Union , while around 1-2% benefited from financial support that includes the 6th and the 7th framework.

Figure 21: Innovative enterprises that received public financial support for innovation activities, as a percentage of innovative enterprises, Romania 2008 (*Denmark no data)
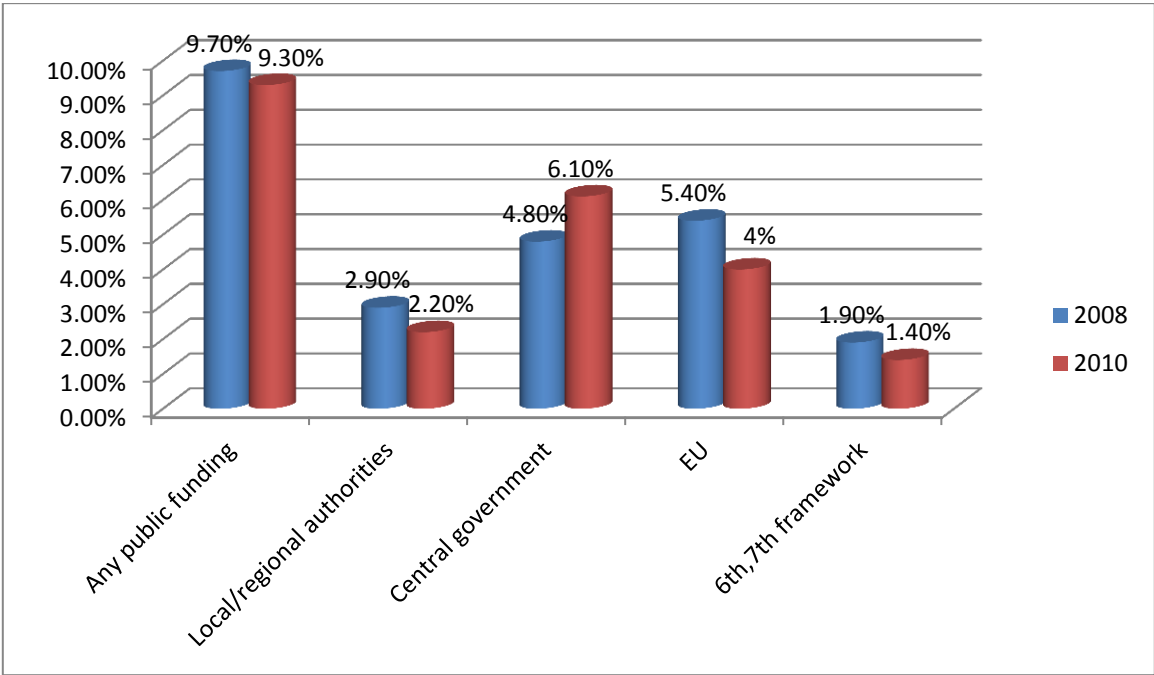
Conclusions

The purpose of this paper was to analyze the effects of the economic crisis upon the National Innovation System in Denmark and Romania.

In order to do that we defined the concepts of innovation, which is: "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations", and a NIS, which contains: "all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring- the production system, the marketing system and the system of finance present themselves as subsystems in which learning takes place".

From this we moved on deducing that every aspect which produces knowledge and where learning takes place is part of the National Innovation System. In this category we had participants of both public and private sector, such as: firms, institutions, research centers, universities, etc.

We explained how the crisis started from the American mortgage market and spread to Europe as well and how that financially influenced Denmark and Romania in a negative manner, starting from a cash shortage of banks which moved to the firms too, and other aspects such as the rise of unemployment rate due to layoffs.

The financial crisis also had repercussions on the innovation activities in Europe. Many companies reduced their innovation activities as well as expenditure, a situation which was present in analyzed countries as well. The financial capabilities decreased and firms were less likely to innovate, especially in big projects. Most of the companies tried to cover the asset value loss and did not focus on big innovation projects. The least affected countries were those that had a strong economy as well as a strong innovation system, being able to adapt to new circumstances.

In comparison to the 2 National Innovation Systems, most of the expenditure for R&D in Romania is oriented or done by the government sector, while in Denmark the Business enterprise sector has the biggest share. Also, the amount of money invested is huge in favor of the Danish system due to favorable policies and a higher level of knowledge towards innovation activities.

The Romanian innovation system seems to get better as the institutional set-up, which also contains the government expenditure as part of it, is helping the firms with much financial support for innovation activities, which was delayed during the crisis.

The innovation culture is weaker in Romania fact that comes out from the R&D personnel growth rate as well, Romania having a decrease compared to Denmark, who has an increase in the analyzed period.

Also, the innovation activity in firms in Romania is much more reduced than in Denmark in most of the cases in the analyzed period, fact that illustrates a low level of collaboration between companies and between companies and institutions. However, the situation looks to improve.

Therefore, even though the financial system in Romania had a strong position and didn't suffer a lot, unlike other countries in the region, its repercussions were still felt on the innovation system. On the same situation, even though the Danish innovation system was most of the time at the European level, or above, the financial system affected the sources of funding, banking loans decreasing not only in Denmark but in Romania as well.

As a result, we can confirm that the financial system, especially the banking sector, which was also part of the analysis, needs to be closely supervised and not ignore the fundamental rules. The risks which the bankers took, some of them unconsciously, had repercussion not only on the economic and financial sectors, but also on the innovation one. As we give again the example of Schumpeter, many entrepreneurs (which are an essential part of the innovation system) depend on financial support in the beginning of their economic activity, and through it, for innovation.

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The following two tables have been used as a source of inspiration from the following article mentioned in the references list as well: Filippetti, A., Archibugi,D., Innovation in times of crisis: National Systems of Innovation, structure, and demand. Res. Policy (2010).

Table nr 1 contains data extracted from the Innobarometer survey made by the European Commission in 2009 and adapted for scientific research. More information about the survey can be obtained by accessing the official analytical report of the European Commission here: http://ec.europa.eu/public_opinion/flash/fl_267_en.pdf

Table 1
Results from the two questions[a] from the *Innobarometer 2009*[b].

Country	Question no. 1 (2006–2008)				Quesiton no. 2 (2009)			
	Increased %	Decreased %	Stayed the same %	Total	Increased %	Decreased %	Stayed the same %	Total
Austria	40.8	5.8	53.4	100	11.2	10.7	78.1	100
Belgium	40.1	9.4	50.5	100	12.0	17.6	70.5	100
Bulgaria	52.6	10.1	37.3	100	11.9	25.7	62.3	100
Czech rep.	40.3	13.1	46.6	100	13.8	29.6	56.5	100
Denmark	35.2	10.4	54.4	100	17.2	24.9	57.9	100
Estonia	32.0	14.9	53.1	100	7.9	29.6	62.5	100
Finland	42.7	6.4	50.9	100	16.7	14.8	68.5	100
France	35.3	7.0	57.7	100	7.0	29.7	63.2	100
Germany	43.2	5.2	51.5	100	10.3	14.4	75.3	100
Greece	45.8	15.0	39.2	100	2.0	49.3	48.7	100
Hungary	36.0	21.3	42.7	100	4.6	32.2	63.2	100
Ireland	30.8	14.9	54.3	100	9.9	32.1	58.0	100
Italy	35.8	13.4	50.8	100	8.9	26.1	65.0	100
Latvia	27.3	21.2	51.5	100	9.2	51.0	39.8	100
Lithuania	54.9	11.0	34.2	100	6.3	49.1	44.6	100
Luxemburg	31.9	5.6	62.5	100	8.6	16.9	74.5	100
Netherlands	35.6	8.7	55.7	100	10.4	16.8	72.8	100
Norway	35.8	6.9	57.3	100	12.9	27.2	59.8	100
Poland	46.1	13.3	40.6	100	8.2	33.8	58.0	100
Portugal	37.2	14.0	48.8	100	13.4	28.2	58.4	100
Romania	56.4	9.2	34.4	100	10.7	38.8	50.5	100
Slovakia	48.6	9.9	41.5	100	16.5	30.7	52.7	100
Slovenia	39.5	9.1	51.3	100	5.1	20.6	74.2	100
Spain	28.8	11.2	60.0	100	10.1	27.2	62.7	100
Sweden	54.2	5.8	40.0	100	14.8	12.6	72.6	100
Switzerland	47.8	8.9	43.4	100	17.5	9.0	73.5	100
United Kingdom	32.9	9.6	57.5	100	8.5	23.2	68.4	100

Source: author's elaboration on *Innobarometer 2009*

[a] Question no. 1: *"Compared to 2006, has the amount spent by your firm on all innovation activities in 2008 increased, decreased, or stayed approximately the same (adjust for inflation)?"*. Question no. 2: *"In the last six months has your company taken one of the following actions [increased, decreased or maintain the innovation spending] as a direct result of the economic downturn?"* (question made on April 2009).

[b] With respect to the *Innobarometer 2009*, the results are been re-scaled to make them comparable across countries.

Table nr 2 contains data extracted from the European Innovation Scoreboard 2008, published on January 2009. More information about the comparative analysis of innovation performance can be found on the official report: http://www.eas.ee/images/doc/sihtasutusest/uuringud/innovatsioon/european_innovation_scoreb oard_2009.pdf

Table 2
Indicators for the *InnoStruct* of the European *Innovation Scoreboard 2008.*

Dimension	Indicators
Human resources	S&E and SSH graduates per 1000 population aged 20–29 (first stage of tertiary education)
	S&E and SSH doctorate graduates per 1000 population aged 25–34 (second stage of tertiary education)
	Population with tertiary education per 100 population aged 25–64
	Participation in life-long learning per 100 population aged 25–64
	Youth education attainment level
Finance and support	Public R&D expenditures (% of GDP)
	Venture capital (% of GDP)
	Private credit (relative to GDP)
	Broadband access by firms (% of firms)
Firm investments	Business R&D expenditures (% of GDP)
	IT expenditures (% of GDP)
	Non-R&D innovation expenditures (% of turnover)
Linkages and entrepreneurship	
	SMEs innovating in-house (% of SMEs)
	Innovative SMEs collaborating with others (% of SMEs)
	Firm renewal (SME entries plus exits) (% of SMEs)
	Public-private co-publications per million population
Throughputs	EPO patents per million population
	Community trademarks per million population
	Community designs per million population
	Technology Balance of Payments flows (% of GDP)
Innovators	SMEs introducing product or process innovations (% of SMEs)
	SMEs introducing marketing or organisational innovations (% of SMEs)
	Share of innovators where innovation has significantly reduced labour costs (% of firms)
	Share of innovators where innovation has significantly reduced the use of materials and energy (% of firms)
Economic effects	Employment in medium-high & high-tech manufacturing (% of workforce)
	Employment in knowledge-intensive services (% of workforce)
	Medium and high-tech manufacturing exports (% of total exports)
	Knowledge-intensive services exports (% of total services exports)
	New-to-market sales (% of turnover)
	New-to-firm sales (% of turnover)

Source; European Innovation Scoreboard 2008