WHAT MAKE THE IMPACT OF THE FINANCIAL CRISIS ON INNOVATION DIFFERENT ACROSS EUROPEAN COUNTRIES?

1. Introduction

In April 2007, New Century Financial, the second largest US sub-prime lender targeting people with poor credit history, filed for bankruptcy. During the two years after that, many other major names of the financial world fell one after another, including Fannie Mae, Freddie Mac, AIG, Lehman Brothers, HBOS, Bradford and Bingley, Northern Rock, RBS, Halifax, to name just a few. The 2007-2009 global financial crisis, also known as the credit crunch, has left behind enormous vestiges in the aftermath that we are still dealing with now.

The financial crisis certainly did not just affect financial institutions. At heart of the problem, the crisis has seriously damaged the world's financial system, which in turn affected the flow of capital around the globe. Firms, especially those which depend on external finance, therefore, also became the victims of the crisis (OECD, 2009, 2010). Campello et al. (2010) survey 1,050 Chief Financial Officers around the world and report that 86% of the surveyed companies have to bypass attractive investment opportunities due to lack of sufficient external finance as a result of the financial crisis. The same study also reveals that firms have to plan deep cuts in spending, especially on high-tech research and development (R&D hereafter) and employment. What do the results of such survey tell us? The effect of the financial crisis is not just tough, it *will* persist. The reason is simple: if innovation activity is affected, it would weaken an important competitive edge of a country and that would have severe long-term consequences (Tidd and Bessant, 2009; Paunov, 2010).

Therefore, it is no surprise that in the aftermath of the financial crisis many governments around the world concern with the questions: how much the financial crisis has affected the country' innovation activities and how the policy responses should address such concern (Claessens et al., 2012). That creates an imperative demand for research that could build up our understanding of the effect of the crisis on innovation. In response to such demand, there is a growing body of the literature that looks at how innovation is affected by the crisis (e.g. Correa et al., 2010; Sidorkin and Srholec, 2010; Archibugi and Filippetti, 2011; Llach et al., 2011). Research in this area generally attracts great attention and is of significant contribution to both the academic literature and the world of practitioners and policy-makers.

The paper focuses on the context of the European Union (the EU hereafter) and seeks to investigate (i) how the 2007-2009 global financial crisis has affected innovation activities of European countries, (ii) what the most and the least affected countries are, and (iii) what makes the impact of the financial crisis unequal across countries. The EU is a key player in the world economy and is among the most seriously affected areas. Therefore, insights about how the financial crisis has affected this part of the world are of significant importance. Due to such importance, the EU has naturally attracted a great deal of effort from researchers to investigate the impact of the financial crisis. To date, it has been documented that the financial crisis has significantly affected innovation activities in European countries and that the effect of the crisis on innovation is different across countries (Archibugi and Filippetti, 2010, 2011; Archibugi et al., 2012, 2013 etc.). This paper seeks to contribute to this literature by exploring the differences across various dimensions of the national systems of innovation of the most and the least affected European countries.

Moreover, the investigation into the possible explanations for the unequal impact of the financial crisis on innovation across European countries is of significant value to policy-makers

in the post-crisis era. Consistently throughout the history of the EU, one of the very bases of the existence of the EU is to establish and foster cohesion, convergence and integration among European countries. The financial crisis creates a chaotic environment in which those core objectives of the EU are challenged. Of particular relevance to the topic investigated in this paper is the convergence issue. What we have known is that there exists a big disparity between a small 'elite' group of EU countries, e.g. Germany, France, Finland..., and the group of weaker states, e.g. Lithuania, Latvia, Hungary... (Pavitt, 1998; Lorenz and Lundvall, 2006). The 'elite' group in general has better infrastructure, technical capability and also better financial ability (European Commission, 2009b), i.e. those factors which are essential to foster innovation. What the EU has been trying to do is to reduce that disparity to create a unified European system of innovation (rather than 27 small systems lie separately next to each other) in the hope to close the gap with its rivals, the US and Japan (Archibugi and Coco, 2005). If we look at that effort through the lens of the financial crisis, the vision of a unified European system of innovation seems less likely to realize since the crisis would affect the weaker countries, with worse scientific and technical infrastructure and greater dependence on outside capital, more severely (Archibugi and Filippetti, 2010, 2011; Archibugi et al., 2012, 2013 etc.). In other words, the financial crisis has been worsening the convergence process in the EU since the weak states are becoming weaker in a faster rate compared to the 'elite' countries. Back to the reason why the EU exists, this is an issue that must attract the EU's utmost priority. And without an understanding of why the financial crisis would affect different EU countries unequally, policy-makers are not ready to tackle it. This paper contributes to such understanding and thus is a valuable contribution.

Based on the European Commission's (2009a) Innobarometer (hereafter the Innobarometer 2009), it is firstly found that the financial crisis does significantly affect innovation activities of European countries, which confirms and reinforces the existing evidence (Correa et al. 2010;

Archibugi and Filippetti, 2010; Campello et al., 2010; Archibugi and Filippetti, 2011; Llach et al., 2011; Archibugi et al., 2012, 2013 etc.). The paper then identifies the countries which are affected the most and the least by the financial crisis. Lithuania and Greece fall within the most affected group while Finland and Austria are the least affected. The main analysis of the paper is then conducted to compare and contrast various characteristics of the most and least affected countries along some important dimensions of the national system of innovation (NSI hereafter). Lithuania and Greece share several common characteristics of the NSI, which are in sharp contrast to the common characteristics shared by Austria and Finland. In particular, significant differences are found between the most and the least affected countries along the dimensions of culture, the quality of the higher education system, the science and technological capabilities as well as the structure of the economy. Those differences could to a large extent explain for the unequal impact of the financial crisis across countries.

The rest of this paper proceeds as follows. In section 2, the relevant literature is reviewed to identify the gap to which this paper aims at contributing to. With insights from the existing literature, section 2 ends with a list of research questions that this paper would seek the answers for. Section 3 and 4 present the analysis of the impact of the financial crisis on innovation activities of European countries and identify which countries are affected the most and the least. Section 5 compares and contrasts the main characteristics of the most and least affected countries. Section 6 provides some concluding remarks.

2. Innovation in crisis times

Despite being the subject of extensive research, there is not yet a generally accepted definition of innovation. However, most of the widely-used definitions have a common ingredient for innovation: ‘newness’ (Johannessen et al., 2001). With ‘newness’ at the core, different types of innovations could be defined by looking at two dimension of the ‘newness’: what is new

and how new? The first dimension, i.e. the answer to the 'what is new' question, distinguishes between product, process, position and paradigm innovation, or the 4Ps. The 'how new' dimension then rates the innovation on a scale with radical and incremental at the two opposite extremes. Tidd and Bessant (2009, p19) define innovation as "the process of turning [new] ideas into reality and capturing value from them". This definition implies innovation would create benefit for firms as well as the countries those firms operate in, and thus normatively it should be encouraged. At firm-level, Hauptly (2008) shows that on average innovative firms offer a superior stock return of 3% per year as compared with the non-innovators. It has also been shown that innovation is positively related to firm's profitability and growth (e.g. Geroski and Machin, 1992; Kleinknecht and Mohnen, 2002; Innovaro, 2008). Furthermore, since the last century economic growth at country-level also depends heavily on innovation activities (Segerstrom, 1991; Baumol, 2002). However, as noted by Neely and Hii (1998), economic performance does not solely rely on innovation, but rather a wide range of other factors.

Despite being important, there are many barriers to innovation. The existing literature has identified a rather long list of the key barriers, including those external to the firm such as poor infrastructure, deficient education system, discouraging legal system, inadequate financial resources to pursue long-term projects etc. and some internal barriers such as organizational procedures, communication structures, conservatism, lack of vision and motivation, unwillingness to change, risk-adverse managers (Howard, 1992; OECD, 1992; Wiig and Wood, 1997; Neely and Hii, 1998; Hadjimanolis, 1999; Madrid-Guijarro et al., 2009; D'Este et al., 2012 etc.).

In general, the literature tends to be conclusive about the significant role of innovation for both firms and countries to thrive sustainably. Therefore, it is not a coincidence that most governments around the world pay a lot of attention to encouraging innovative activities in the

economy (OECD, 2009, 2010). In order to have effective and appropriate policies to encourage innovations, it is important that the governments understand what create a good national system to support innovations. Such area of policy-making is informed by a body of the literature, namely research into the NSI. The concept of NSI is introduced way back to 1841 when Friedrich List, a German philosopher, published his book *The National System of Political Economy*. However, the seminal studies that frame the NSI concept for our nowadays modern economy are Freeman (1987), Lundvall (1992) and Nelson (1993). At heart of research into NSI is the quest for country-specific factors that drive innovations. So far, the literature has identified a handful of NSI factors which are important drivers of innovations. Pinto and Pereira (2012), for example, analyze 64 variables to try describing the NSI of 15 European countries. Archibugi and Michie (1997) cluster NSI factors down to some main dimensions, namely education and training, science and technological capabilities, industrial structure, science and technology strengths and weaknesses, interactions within the innovation system, absorption from abroad, and others which "are rooted in history, and concern the culture, size, language and vocation of a nation".

There is a large body of the literature examining the effect of economic crisis on innovation. This literature owes its origin to the classical Schumpeter's (1939) business cycle. In particular, the Schumpeterians view innovation and economic performance as inter-correlated and they fluctuate depending on the other counterpart in a cyclical manner. The business cycle model specifies a theoretical equilibrium at which the economy is at a stationary state. Such equilibrium is reached when there is no innovative activity. As firms innovate, the economy would leave the equilibrium to develop. Things would keep going on like that until innovation activities reach the marginal limit when the economy starts to fall into the downward trend. Economic downturn would then be responsible for even less innovative activity, until the market becomes so uncompetitive that new firms, with more innovative capacity, are allowed

to enter and compete the non-innovative firms away or the existing firms need to innovate more to survive. With more innovative activities, the economy would start to pick up again. This process whereby innovations increase during economic downturn is often referred to as the Schumpeterian 'creative destruction', or the 'counter-cyclical' hypothesis, which for a long time has dominantly shaped the way we understand how economic crises would affect innovation.

The Schumpeter's business cycle model has passed the test of time to stand as one of the key building blocks in our modern business theories. Nevertheless, there are several subsequent contributions, both to supplement and to challenge the original theory, which make this issue an area of dispute. Mensch (1979) argues that only during economic downturns would more radical innovations be developed since the difficult economic climate might motivate the forerunners to breakthrough to survive. Mensch's depression trigger hypothesis has received a lot of attention and could explain very well the 1970s recession episode. Soete (2009) shows that economic downturns often lead to less skilled labour being sacked to give space for keeping more qualified personnel, a process referred to as 'labour hoarding' which sparks innovative activities. There is also evidence that firms would easily switch resources to R&D during recession to reap future profits when the economy finally gets back to normal (Stiglitz, 1993; Aghion and Saint-Paul, 1998). It is because during recession the opportunity cost of increasing R&D spending (thus having to cut down real investment which could produce immediate profits) is lower than in a boom economy. On the other hand, however, other authors suggest a cyclical hypothesis, i.e. important innovations would appear mainly when the economic climate is conducive due to the very high uncertainty associated with seminal innovations (e.g. Clarke et al., 1981; Van Dujin, 1983; Shleiffer, 1986; Francois and Lloyd-Ellis, 2003). Paunov (2010) presents empirical evidence in support of the hypothesis that

financial crises reduce innovations. Paunov (2010) argues that the increase in financing constraints is mainly responsible for the negative effect of the crisis on innovations.

Currently with 27 member states, including some of the world largest economies, the EU is an important player in the world economy. In 2000, the Lisbon Agenda was devised with the aim to develop a sustainable knowledge-based economy in the EU with innovation as the central motor. With innovation at heart of the policy to foster long-term growth for the EU, it is no surprise that research into innovations in European countries has attracted a lot of attention from the academic community, especially during the last decade (e.g. Andreasen et al., 1995; Cantwell and Iammarino, 1998, 2003; Radosevic, 1999, 2004; Rodriguez-Pose, 1999, 2001; Rodriguez-Pose and Fratesi, 2004; Archibugi and Lundvall, 2000; Borras, 2003; Griffith et al., 2006; Van Vught, 2009, Krammer, 2009).

Of particular relevance to this paper is the body of the literature that examines the effect of the financial crisis on innovations of European countries. Looking at aggregate data at EU-level, the European Union (2011) reports that R&D investment in the EU has dropped significantly during the 2008-2009 period. The report also alerts that some EU countries are affected more severely than the others in terms of having to cut down R&D budget. The OECD (2009, 2010) reached the same conclusion that R&D investment, especially in high risk long-term projects, has reduced markedly in 2008. Correa et al. (2010) and Llach et al. (2011) also provide empirical evidence of the reduction of innovation investment in Europe. Campello et al. (2010) conduct a survey of CFO, including those from firms in the EU, and report that firms have to cut investment in innovation remarkably as a result of the financial crisis. Archibugi and Filippetti (2011) find that the financial crisis has slowed down the convergence process in the EU resulting in a growing disparity in innovative capabilities among EU countries. Sidorkin and Srholec (2010) found that in the context of Eastern and Southern Europe the effect of the

financial crisis is heavier for countries with less innovative firms. Archibugi et al. (2012) provide empirical evidence that the financial crisis has enabled some small and young firms to increase their innovative activities and thus becoming the new challengers to the traditional incumbent firms which are likely to struggle to invest more in innovation during the economic turmoil.

Archibugi and Filippetti (2010) analyze the Innobarometer 2009 in conjunction with some macroeconomic data and find that the financial crisis has affected different European countries differently. In an attempt to explain such difference, they found that the quality of national human resources, the level of dependency on high-tech industries and the development of the financial systems are the key factors that mitigate the effects of the financial crisis on innovations at the national level. This paper builds up on Archibugi and Filippetti (2010) and investigates a larger range of possible explanations for the unequal impact of the financial crisis on innovations across European countries. The paper bases on the established literature on NSI to serve as a framework for the investigation. In particular, the research questions are:

(i) *Does the financial crisis affect European countries?*

(ii) *If yes, which are the most and the least affected countries?*

(iii) *What make the impact of the crisis different across European countries? In particular, do the following factors exaggerate or restrain the impact of the crisis on innovation:*

- *(iii.a) National characteristics*
- *(iii.b) Higher education system*
- *(iii.c) Science and technological capabilities*
- *(iii.d) Structure of the economy*

3. The impact of the global financial crisis on European countries

Although the paper uses data from various sources, the Innobarometer 2009, the eight wave of survey on innovation conducted under the framework of the Flash Eurobarometer (European Commission, 2009a), feeds the very first and most important data for the paper. To examine if the financial crisis has affected European countries, the answers to two questions in the Innobarometer 2009 in each European country are analyzed in a fashion which is in principle similar to the main methodology used by Archibugi and Filippetti (2010). In particular, the answers for the following questions in the Innobarometer 2009 survey will be analyzed:

> Question 3: "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 4: "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?"

The Innobarometer 2009 survey was conducted from 1 to 9 April 2009. Hence, the 'last six months' used in question 4 would refer to the period from October 2008 up to the time when the survey was conducted, and the reference period in question 3 is, as also explained in the Innobarometer 2009, the preceding period going back to 2006. Such time frame matches well with the timeline of the financial crisis. Although the crisis spans over a long period of time, we could easily spot its climax is around July to September 2008, the months where Fannie Mae, Freddie Mac, Lehman Brothers, HBOS, AIG etc. falls unstoppably one after another, which in turn spreads panic around the world and pulls forward enormous measures from politicians, such as the proposal of huge bailout funds in the US and across the globe.

Therefore, the six months period from October 2008 to April 2009 would capture any changes in firms' innovation policies as a result of observing the worst part of the financial crisis.

Question 4 of the Innobarometer 2009 survey is designed to capture the direct impact of the financial crisis while question 3 would provide a reference period immediately before the financial crisis. For each question, the Innobarometer 2009 asks the respondents to pick the most appropriate answer, namely (i) increased, (ii) decreased, (iii) stayed approximately the same, (iv) not applicable since the company has no innovation activity in the reference period or (v) cannot answer for any other reasons.

Archibugi and Filippetti (2010) have analyzed the same dataset to investigate the impact of the financial crisis on European countries. In particular, for each question a measure of 'innovation balance' is constructed by subtracting the percentage of firms answering 'increased' from the corresponding 'decreased' percentage. Archibugi and Filippetti (2010) observe that during the 2006-2008 period, innovation balance is positive in most European countries whereas during the six months since the crisis began, innovation balance is mostly negative. They concluded from such evidence that the financial crisis does affect innovation activities in European countries.

In this paper, Archibugi and Filippetti's (2010) analyses will first be replicated. The 'innovation balance', denoted INBAL, is constructed exactly the same way as in Archibugi and Filippetti (2010) and reported in Table 1. The first 13 columns just reproduce the raw data from the Innobarometer 2009 survey. Columns 14 and 15 are essentially a replication of Archibugi and Filippetti (2010). Column 16 calculates how much INBAL has dropped during the first six months of the financial crisis as compared to the 2006-2008 reference period. In Table 1, we order the data by INBAL during the crisis (column 13). As could be seen from the table, INBAL in the pre-crisis period (column 15) are all positive while the balance is mostly negative in the

crisis (except only for Malta, Austria, Finland, and Sweden). The positive INBAL in the pre-crisis period would imply that in the pre-crisis period more firms increase their innovation investment, and then when the financial crisis started, INBAL falls negative indicating more firms had to cut their budget for innovation. In summary, the evidence tends to suggest that the crisis has negatively affected innovation activities in Europe, which is in line with the established evidence (Correa et al. 2010; Archibugi and Filippetti, 2010; Campello et al., 2010; Archibugi and Filippetti, 2011; Llach et al., 2011; Archibugi et al., 2012 etc.).

[Table 1]

Archibugi and Filippetti's (2010) approach could, however, only give a general impression rather than a more detail understanding of how the crisis actually impacted on innovation. Therefore, the paper takes a step further by looking deeper into the detailed answers to the aforementioned questions in the Innobarometer 2009 (i.e. 'increased', 'decreased', 'stay the same', no innovation'). To perform such analyses, the following steps are done:

(i) The percentages reported in the Innobarometer 2009 are converted back into number of firms.

(ii) The number of firms which provide a 'Not applicable' answer is excluded.

(iii) The percentages for each type of answers (i.e. 'increased', 'decreased', 'stay the same', 'no innovation') are then recalculated (but with the sum excluding 'N/A' firms).

(iv) CI_IN, CI_DE, CI_SA and CI_NO (correspond with 'increased', 'decreased', 'stay the same', 'no innovation'), four measures of the impact of the financial crisis on innovation, is created by subtracting the percentages of each type of answers in the six-month period preceding the conduct of the Innobarometer 2009 (i.e. October 2008 to April 2009 as specified in question 4 of the Innobarometer 2009) by the corresponding

percentages in the reference period (i.e. January 2006 to September 2008 as specified in question 3 of the Innobarometer 2009).

By construct, if CI_IN is negative, and CI_DE, CI_SA, CI_NO are positive, it is evidence of the financial crisis negatively affect innovation. By looking at those measures rather than just INBAL, the paper can reveal more detailed evidence as to whether the crisis actually affect innovation through reducing the number of firms that would expand innovation investment, or increasing the number of firms that cannot increase the budget for innovation, or have to reduce it or even become non-innovative. Table 2 reports the results, which are sorted by CI_IN (column 10). As shown in column 2, in the six-month period immediately after the crisis there are still some firms which are ready to 'swim upstream' to increase rather than decrease innovation budget. However, such number has declined remarkably compared to the reference period. As a result, CI_IN are mostly negative across countries implying the number of innovators (i.e. those which increase their innovation budget) has dropped significantly as a result of the financial crisis (column 10). On the other hand, the number of firms which reduce or remain innovation investment unchanged or even have no innovation at all have increased dramatically as a result of the crisis (columns 11, 12 and 13, respectively). Compared to the results reported in Table 1, some countries (such as Romania, Lithuania, Greece…) are at the bottom of both tables indicating they are negatively impacted by the financial crisis mainly because the number of firms trying to increase innovation investment during the financial crisis has tremendously dropped. Meanwhile, the top spots of Table 1 and 2 do not seem to include the same countries. It implies that a country is less affected by the financial crisis not because they have more firms which are ready to 'swim upstream' to increase innovation spending during the crisis, but it is more because it has less firms having been forced to cut down on innovation activities. Overall, the evidence supplements to Archibugi and Filippetti's (2010) findings suggesting a negative impact of the crisis on innovation activities in Europe.

Essentially, the key problem to the real business world caused by the financial crisis is the difficulty in accessing the necessary finance. Therefore, as Paunov (2010) envisions, it is the difficulty in accessing the crucial finance for innovation that prevents the Schumpeterian 'creative destruction' from happening. The evidence of the heavy impact of the financial crisis on EU innovation activities documented here also amplifies the long-standing warning that the EU is so ill-prepared for a large-scaled financial crisis due to the weaknesses of its policies (Pisani-Ferry and Sapir, 2010).

[Table 2]

4. The most and the least affected countries

For the second research question, two groups of countries are identified: the most affected and the least affected (two countries in each group). Using data generated from section 3, the following criteria are used: (i) the most affected countries are those with 2009 innovation balance in the bottom 5 countries, excluding any countries with positive INBAL, and the balance has dropped the most since 2006; (ii) least affected countries are those with 2009 innovation balance in the top 5 countries, excluding any countries with negative INBAL, and the balance has dropped the least since 2006.

Column 14 of Table 1 shows that in terms of innovation balance, the top five countries are, in order, Sweden, Finland, Malta, Austria and Germany (Belgium also has the same INBAL with Germany at –3.8). Within the top five, we exclude Germany (and Belgium) because of their negative INBAL. Of the remained countries, column 16 of Table 1 shows that Austria and Finland have the smallest decrease in innovation balance. Hence, Austria and Finland are identified as the least affected countries in this paper. The bottom five countries are Ireland, Romania, Latvia, Lithuania and Greece, in the presented order. In addition, column 16 of Table 1 shows that within the bottom five countries, Lithuania and Greece have the largest drop of

innovation balance compared to the reference period. Therefore, within this paper Lithuania and Greece are identified as the most affected countries.

The above simple approach employed to classify the most and least affected countries does suffer from a flaw as it could not look into all components of the innovation balance. To compensate for any possible important omission resulted from such pitfall, however, CI_IN, CI_DE, CI_SA and CI_NO of the least and most affected countries are reviewed to see if they make sense with the simple approach employed. From Table 2, it could be seen that in terms of the number of firms which increase innovation budget, Lithuania has the largest drop (CI_IN is -45.6%) and Greece comes third (CI_IN is -40.9%). In addition, while CI_SA and CI_NO of Lithuania and Greece are not significantly larger than the other countries, their CI_DE, which measures the pressure of the crisis on firms having to reduce their innovation budget, tops the table in the first and second position, respectively. Hence, it seems to suggest that the simple classification of the most affected countries makes sense since it comprises the two countries which have the largest number of firms having to reduce innovation budget and the smallest number of firms that could increase the budget in the crisis. A similar review is then performed for Austria and Finland. It could be noted that CI_DE of Austria and Switzerland are remarkably smaller than the other countries while the other measures are about average. Again, it suggests that the applied classification is reasonable.

5. What makes the impact of the financial crisis different across countries?

The evidence presented thus far has been in line with the existing literature suggesting that the financial crisis does have a significant impact on innovation activities of European countries, and that the impact is unequal across different countries (e.g. Archibugi and Filippetti, 2010, 2011; Archibugi et al., 2012, 2013 etc.). The main focus of this paper is placed on the possible explanations for the unequal impact of the financial crisis on innovation across European

countries. This investigation is done by a comparative analysis in which several characteristics of the most and least affected countries will be compared and contrasted. The comparative analysis will cover four main dimensions of the NSI as outlined by Archibugi and Michie (1997), namely: national characteristics, higher education system, science and technology capabilities, structure of the economy. The design of this test is motivated by the existing literature which suggests that a stronger NSI would ameliorate the negative effect of financial crisis (e.g. Di Caprio et al., 2012).

5.1. National characteristics

To begin with, a range of information is looked at to give a first overall impression of the selected countries. In terms of geographical area, Finland is the largest country (338 thousand km^2), followed by Greece (132), Austria (84) and Lithuania (65). However, according to the newest release of the United Nation, Greece has the largest population (11.2 million), followed by Austria (8.3) Finland (5.3) and Lithuania (3.3). In terms of the size of the economy, the European Union reports that in 2008 (i.e. the time when the financial crisis starts) GDP of Finland, Austria, Greece and Lithuania are 185,670, 282,744, 232,930 and 32,461 (€ million), respectively. Nevertheless, if one looks at the figures at the per inhabitant level, Finnish and Austrian people earns far better than the Greeks and Lithuanians. Another measure of modernity, life expectancy reflect a clear distinction between Finland, Austria and Greece compared to in Lithuania with longer-lived men (77, 78 and 78 compared to 67 years, respectively) and women (83, 84, 83 compared to 78, respectively). Although all four countries are now members of the EU, Lithuania has not joined the Eurozone yet (the country has entered the ERM II to prepare for the entry). All countries have their own official language, except Austria which uses German and Finland which uses both Finnish and Swedish. On average, however, Finnish pupils learn 2.2 more foreign languages, followed by Greece (2.0), Lithuania

(1.8) and Austria (1.1). In terms of political system, the four countries are quite similar with the Republic model (although in Austria it is a Federal Republic). The major religion in all four countries is Christianity.

Given that the paper is investigating about innovation, perhaps the most important difference between the two groups of country is culture. Hussler (2004), Kaasa and Vadi (2010), among others, have found that culture is a major factor that affects innovation capacity in the European context. There is a well-established literature comparing and contrasting the cultural differences between European countries (e.g. Hofstede, 1984; Ronen and Shenkar, 1985; Brodbeck et al, 2000). Ronen and Shenkar (1985) build upon Hofstede's (1984) seminal study to cluster European cultures, of which Austria is in the Germanic cluster, Finland in the Nordic and Greece in the Near East while Lithuania is not classified. Various other studies, using different methodologies and looking at different cultural dimensions, have provided very consistent evidence that such clusters are reliable and sensible (e.g. Sirota and Greenwood, 1971; Ronen and Kraut, 1977; Redding, 1976; Badawy, 1979 etc.). Using Hofstede's classical cultural dimensions, the Near East countries, of which Greece is a typical member, in general have higher power distance and uncertainty avoidance while individualism is typically low and masculinity is about average. Lithuania, although is not a popular countries for cross-sectional studies about culture in European countries, has a very distinctive cultural characteristic compared to the other three selected countries since its modern history is heavily influenced by the USSR after the Second World War (Mockaitis, 2002). Despite being clustered into different groups, the Nordic and Germanic clusters share many similarities, for example in some studies they are grouped into a common cluster called Northern Europe (Griffeth et al., 1980; Haire et al., 1966). Hofstede (1984) also reports that Germanic and Nordic clusters have very similar indices for individualism, uncertainty avoidance and power distance; the only notable difference is across the masculinity dimension.

Brodbeck et al. (2000) bases on Ronen and Shenkar's (1985) to cluster European countries into culture-driven leadership prototypes, and reports that Austria and Finland are in the North West cluster while Greece is in the South East. Lithuania is again not classified. However, Lithuania's nearest cultures, Poland and Russia, are both classified into the same cluster with Greece, the South East. On the leadership prototypicality scale introduced by Brodbeck et al. (2000), Greece scores remarkably higher than other countries along the 'Team Integrator' dimension. The North West countries generally rank higher in the 'Participation' scale which is in sharp contrast to the South East countries. Studies that examine the different between East versus West Europe, such as Trompenaars (1993), Smith et al. (1996), also puts a clear distinction between the two groups of countries considered: Austria and Finland are in the West while Greece and Lithuania are in the East cluster. Smith (1997) also classifies Austria and Finland into the North cluster while Greece is in the South (again Lithuania is not classified in this study).

Overall, the existing literature suggests a remarkable within-group similarity as well as across-group difference between the two groups investigated. For a convenient comparison, Table 3 reports the scores for Hofstede's four cultural dimensions of the four countries. Data for Greece, Finland and Austria is taken from Hofstede (2001), an updated publication of the scores based on subsequent replication studies, while for Lithuania, data is from Mockaitis (2002), a Lithuanian study that replicates Hofstede's (1984) methodology. While masculinity indices are quite indistinguishable between the two groups of countries, the distinctions along the power distance, individualism and uncertainty avoidance are clear. Greece and Lithuania have remarkably higher scores for power distance and uncertainty avoidance, and lower scores for individualism compared to Austria and Finland. By design, power distance reflects how much a culture values authority and hierarchical relationships while individualism measures the tendency of a culture to value individual rights and uncertainty avoidance reflect the extent

to which a culture would accept uncertainty. Taken together in the context of the impact of the financial crisis on innovation, an interesting insight emerges. In high power distance cultures, responsibilities are often concentrated around a few key personnel at the top while subordinates are more likely to simply 'do as ordered' rather than being creative. As in the case of Greece and Lithuania, high power distance is also companioned with low individualism and high uncertainty avoidance which tends to suggest that Greek and Lithuanian companies would try to avoid risky innovative investments when the business environment is not supportive. On the other hand, in low power distance and high individualism cultures as in Austria and Finland, individuals at all level in the companies are more willing to take on responsibilities and more proactive in their job to pursue personal goals. On top of that, low uncertainty avoidance would also suggest Austrian and Finnish companies are more willing to take on risky projects even when the environment is turbulent[1]. Therefore, it does not seem to be a coincidence that that Greece and Lithuania is among the most while Austria and Finland are among the least affected countries, but rather their cultures have actually played a role in either exaggerating (as in the case of Greece and Lithuania) or restraining (as for Austria and Finland) the negative impact of the financial crisis on innovation.

[Table 3]

5.2. Higher education system

In time of crisis, what keeps a country moving ahead in terms of innovation is mainly its human resource. With more innovative people, the effect of the crisis would be expected to be less severe. Makkonen and Inkinen (2012) find that in the context of the EU, education is the main

[1] On the uncertainty avoidance dimension, Lithuania also scores quite low (in fact it is 67, even lower than Austria at 70). We acknowledge that uncertainty avoidance scores do not seem capable to explain the reluctance in Lithuania in taking on risky innovative investments in times of crisis. With that exception acknowledged, we can still draw our main conclusions from this analysis mostly from the sharp contrast between the very high uncertainty avoidance score of Greece and the low scores of Austria and Finland.

driver of innovation and economic development. Therefore, the quality of the higher education systems, from which the 'innovative people' mainly come, plays a crucial role in restraining or exaggerating the impact of the crisis. The paper, hence, compares and contrasts the higher education systems of the most and least affected countries.

The analysis covers both the higher education providers (i.e. the universities) and the system's products (i.e. the students and graduates), and both quality and quantity will be analyzed. To start with, the level of investment in education is considered since it would determine the quality of the system. Data for investment in education (denoted IE) is taken from Eurostat. The paper also analyzes quantitative data about students and graduates in science and technology fields. For such analysis, the paper looks at three further indicators, namely human resources in science and technology (denoted HRST), doctoral students in science and technology (denoted DSST) and doctoral graduates in science and technology (denoted DGST). Data for the first two measures are from the Eurostat and the last one is derived from the European Commission's (2009b) European Innovation Scoreboard (EIS hereafter). EIS has been published annually since 2001 by Pro Inno Europe, a European Commission's initiative to foster cooperation of national innovation across the EU. The EIS uses data from various sources, including the national innovation surveys conducted in each countries and statistics available from the Eurostat as well as others such as the IMF or World Bank. The EIS measures the general strength of a country's innovation ability by a composite measure, namely SII, which aggregates a range of indicators reflecting seven dimensions of innovation, namely human resources, finance and support, firm investments, linkages and entrepreneurship, throughputs, innovators and economic effects. To represent the status of the higher education systems at the time when the crisis starts, data for 2008 is used (except for the EIS where data of the 2009 publication is used since data used for the EIS is lagged one year). If data for the year 2008 of a country is missing, the last available data for that country is used.

Table 4 below reports data on the level of investment in education and the quantity of science and technology personnel produced by the higher education systems of the selected countries. In terms of investment in education, as shown in Table 4, Greece and Lithuania invested significantly less compared to Austria and Finland (4.09% and 4.87% compared to 5.47% and 6.1%, respectively). Besides, the least affected ones generally have higher HRST, DSST and DGST, respectively. Although HRST and DSST of Austria are not significantly higher than Greece and Lithuania, there is a sharp contrast between Finland and the most affected countries. In terms of DGST, the least affected countries are far better than the most affected.

[Table 4]

Malva and Carree (2013) show that it is the quality of academic research, rather than the mere presence of researchers, that affects innovation capacity. To take quality into account as a supplement to the evidence presented earlier, the Times Higher Education's (2012) universities ranking, one of the most popular universities league tables in the world, is analyzed to access the quality of the top universities in the most and the least affected countries. Of course there are various other university rankings beside the Times Higher Education. However, there is existing evidence suggesting top university rankings converge in terms of the methodology employed (e.g. Turner, 2005), thus the resulting rankings are highly correlated (e.g. Dill and Soo, 2005). Therefore, this paper restricts to the use of only the Times Higher Education's (2012) ranking. In particular, the list of top 400 universities ranked by the Times Higher Education (2012) is screened for universities in the most and least affected countries. Finland has five universities in the top 400 universities ranked by the Times Higher Education (2012), namely University of Helsinki (91), Aalto University (301-350), University of Eastern Finland (301-350), University of Tampere (301-350) and University of Turku (351-400). Austria has three: University of Vienna (139), University of Innsbruck (201-225), Karl-Franzens-

Universität Graz (251-275). Greece has only University of Crete (276-300) in the list while Lithuania does not have any. Therefore, based on the Times Higher Education's ranking, there is preliminary evidence that the least affected countries generally have a better higher education system.

Overall, the evidence seems to imply that the least affected countries does have a better higher education system, both in terms of the providers and the products of the system. In time of crisis, such better quality higher education system could restrain the impact of the crisis on innovation.

5.3. Science and technological capabilities

Archibugi and Michie (1997) show that different countries do have different science and technological capabilities (STC hereafter), which in turn would determine how persistent innovation activities are when external shocks are introduced. Applying such intuition, therefore, the paper compares and contrasts the STC of the least and the most affected countries. The analysis covers ten indicators of the STC as follows: (i) High-tech and knowledge-intensive (hi-tech hereafter) trade, (ii) Hi-tech trade as a percentage of the world's volume, (iii) number of employees working in hi-tech industries, (iv) number of hi-tech firms, (v) number of hi-tech patent applications, (vi) total number of patent application, (vii) R&D personnel and researchers as a percentage of total labour force, (viii) total R&D expenditure, (ix) total government's R&D and (x) intangible fixed assets. The first and second dimensions would capture how intensive a country is in terms of acquiring economic returns from innovative activities, both on its own and relatively to other countries. Items (iii) and (iv) provide a reference as to how 'big' the hi-tech industries are in each country. The (v) and (vi) items would tell us how effective innovative activities in each country are in terms of generating the results. Items (vii) and (viii) provide data about the size of R&D activities, to

which item (ix) supplements since the governments could invest in R&D activities that benefit the economy as a whole (rather than just benefiting the firm as with business R&D). Finally, the last item is intangible fixed asset capturing the size of intellectual capital, an important output of innovative activity. Data for all of the above ten indicators is collected from Eurostat and the definitions of the indicators are also the same as stated by Eurostat.

Table 5 presents the above-defined ten indicators of the STC. As shown in column 2 and 3, Austria and Finland have quite a sizable share in the world market for hi-tech products which is much larger than that of Greece and Lithuania. Although Greece has the largest number of people employed in hi-tech industries, which is partly due to the country's larger population, Austria and Finland have by far more hi-tech firms than Greece and Lithuania (42,950 and 46,143 compared to 12,443 and 1958, respectively). The number of registered hi-tech patents and total number of patents in Austria and Finland are significantly higher compared to Greece and Lithuania, ranging from 15 to 100 times larger. The percentage of people working in R&D fields in Austria and Finland is also two to three times higher than in Greece and Lithuania (1.36% and 2.1% compared to 0.72% and 0.78%). In terms of R&D spending, Austria and Finland also exhibit a much larger numbers both in terms of total R&D spending in general and government R&D investment in particular. Finally, in Austria and Finland the value of intangible fixed assets, most of which would reflect the value of innovation projects such as registered patents, trademarks etc. is also higher than in Greece and Lithuania. In a nutshell, the least affected countries remarkably and consistently outperform the most affected countries across the ten dimensions of science and technological capabilities covered. Hence, the evidence implies that the stronger science and technological capabilities in Austria and Finland do play a role in restraining the impact of the financial crisis.

[Table 5]

5.4. Structure of the economy: Industrial structure and firm's size

Innovative activities are more important for some industries (such as industrial and some knowledge-intensive services etc.) and less important for others (such as agriculture etc.). Therefore, if a country is tilted towards certain sectors which are less dependent on innovations to thrive, it is expected that the crisis would have little effects and vice versa. The paper provides a breakdown of EU countries' gross value added (GVA hereafter) into five main sectors, (the rest is grouped to 'Others' classification), namely (i) agriculture, hunting and fishing, (ii) construction, (iii) business activities and financial services, (iv) industry (including energy), and (v) trade, transport and communication services. Such classification is used by Eurostat from which data for this analysis is collected. Table 6 presents and illustrates the shares of different sectors in the gross value added of the selected countries. Although not very clear, a contrast could be observed between the two groups of countries. As compared to Greece and Lithuania, Austria and Finland depends less on trade and transportation to create value added while the relative contributions of industry and financial services are heavier[2].

[Table 6]

In addition, firm's size does matter in defending innovative activities against economic downturns. Archibugi and Michie (1997) argue that most basic innovations, which are typically long-term, highly costly and associated with high uncertainties, are often conducted by large firms. On the other hand, there is also a lot of evidence suggesting that small and medium-sized enterprises (SMEs hereafter) are more likely to be successful in innovation (e.g. Porter, 1980;

[2] Greece and Lithuania also seem to rely more on Agriculture, hunting and fishing compared to Austria and Finland. It might suggest Greece and Lithuania could be less affected by the financial crisis because the agriculture, hunting and fishing sector is less dependent on innovation. However, it is noted that the differences in the weight of the agriculture, hunting and fishing sector in the overall GVA in the interested countries are trivial (the largest is between Lithuania at 3.7% and Austria at 1.7%, representing an only 2% difference).

Lieberman and Montgomery, 1988; Nooteboom, 1994; Vossen, 1998). However, SMEs also typically face with financial constraints, which could be a major problem during a financial crisis episode. In fact, the literature has shown that the 2007-2009 financial crisis has made it extremely difficult for small firms to finance their operations (Cosh et al., 2009; Lamoreaux and Levenstein, 2011). Therefore, it is hypothesized that the more a role SMEs play in a country' economy, the more severe the effect of the financial crisis on innovation would be. Data for this analysis comes from the publicly available database attached to the European Commission (2009c). For each selected country, the paper will collect data and breakdown the number of firms, number of employees and turnovers by firm's size. Following the European Commission's (2009c) classification, micro firms are defined as those with less than 10 employees, small firms are those with 10-49, medium-sized firms with 50-249 and large firms with more than 250 employees. Table 7 reports the breakdown of the number of firms, number of employees and total revenues by firm size. In comparison between the most and least affected countries, a trend is revealed. In terms of the number of SMEs, SMEs dominates in all four countries (more than 99% in all cases). However, there are distinction in terms of employees and turnover generated. Although occupied less than 1% of the total number of firms, large firms in Austria and Finland employ more people (33% and 40% of the total workforce, respectively) as compared to in Greece and Lithuania (13% and 25%, respectively). Besides, large firms in Austria and Finland also generate more turnovers (36% and 52% of total turnover, respectively) while the corresponding numbers in Greece and Lithuania are just 22% and 34%. Higher revenues generated by larger companies generally indicate a country would resist the impact of the financial crisis better thanks to the stronger financial status of those large companies. Thus, it could be concluded that SMEs play a more important role in Greece and Lithuania which could explain why the financial crisis affected these countries more severely.

[Table 7]

6. Conclusions

The global financial crisis which swept through the whole world financial system during the 2007-2009 period has many severe consequences. One of the problems that would cause a long-term negative impact is if the crisis has actually reduced innovation activities. This creates a great demand for research that could provide evidence about the impact of the financial crisis on innovation activities.

This paper investigates how the financial crisis has affected innovation activities in Europe as well as what factors of the NSI exaggerate and mitigate the impacts of the financial crisis across countries. The paper examines the similarities of the NSI factors of the countries of which innovation activities are most affected by the financial crisis, and compare them with the common NSI characteristics shared by the countries which are affected by the financial crisis the least. It is found that the financial crisis has negatively affected innovation activities in Europe. Moreover, the paper provides important evidence that Greece and Lithuania, the most affected countries, are quite different from Austria and Finland, the least affected ones, along four important dimensions of the NSI, namely culture, higher education systems, science and technological capabilities, and structure of the economy. Those sharp contrasts would to a large extent explain why the financial crisis affected different EU member states differently. The insight brought forward by this paper is topically important for EU leaders in drafting policy in the post-crisis era to enhance convergence within the region.

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TABLE 1: INNOVATION BALANCE BEFORE AND DURING THE CRISIS

Country	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?						Compared to 2006, has the amount spent by your firm on all innovation activities in 2008 increased, decreased, or stayed approximately the same						INBAL During Crisis	INBAL Pre-Crisis	INBAL
	N	Increase	Decrease	Same	No Innovation	NA	N	Increase	Decrease	Same	No Innovation	NA			Drop
1	2	3	4	5	6	7	8	9	10	11	12	13	14 = 3 – 4	15 = 9 – 10	16 = 14 – 15
Sweden	200	14.1	12	69.1	4.5	0.3	200	50.5	5.4	37.2	4.4	2.4	2.1	45.1	-43
Finland	203	15.8	14	64.9	5.3	0	203	41.2	6.2	49.2	3.5	0	1.8	35	-33.2
Malta	72	16.1	14.6	51.2	17.6	0.4	72	46.4	3.9	33.2	12.7	3.7	1.5	42.5	-41
Austria	201	10.6	10.1	73.9	3.5	1.9	201	38.8	5.5	50.8	1.7	3.1	0.5	33.3	-32.8
Germany	200	9.4	13.2	68.8	8	0.6	200	42	5.1	50.1	1.7	1.1	-3.8	36.9	-40.7
Belgium	200	8.1	11.9	47.7	27.2	5.2	200	24.8	5.8	31.2	25.2	13	-3.8	19	-22.8
Netherlands	200	9.3	15	65	9.8	1	200	32.6	8	51.1	5.6	2.7	-5.7	24.6	-30.3
Denmark	200	15.3	22.1	51.4	8.9	2.2	200	33.2	9.8	51.2	3.7	2	-6.8	23.4	-30.2
Luxembourg	71	7.8	15.3	67.6	7.1	2.2	71	29.6	6.2	58	1.9	4.3	-7.5	23.4	-30.9
Bulgaria	200	7.7	16.6	40.2	27.4	8	200	34	6.5	24.1	22.7	12.7	-8.9	27.5	-36.4
Slovakia	202	15.1	28.1	48.2	4	4.6	202	46.5	9.5	39.7	1.4	2.8	-13	37	-50
United Kingdom	201	7.7	21.1	62.2	5.9	3.1	201	29.8	8.7	52	4	5.6	-13.4	21.1	-34.5
Slovenia	200	4.6	18.5	66.6	9.3	0.9	200	36.8	8.5	47.8	5.2	1.7	-13.9	28.3	-42.2
Portugal	203	12.7	26.8	55.5	5	0	203	34.8	13.1	45.6	6.5	0	-14.1	21.7	-35.8
Czech Republic	204	12.8	27.4	52.3	4.8	2.7	204	37.5	12.2	43.3	3.8	3.3	-14.6	25.3	-39.9
Italy	200	8.1	23.9	59.5	1.8	6.8	200	33.9	12.7	48.1	1.5	3.7	-15.8	21.2	-37
Spain	200	9.6	25.7	59.3	5	0.4	200	27.4	10.6	57	4	0.9	-16.1	16.8	-32.9
Estonia	200	6.7	25.2	53.1	10.8	4.2	200	28.3	13.2	46.9	3.8	7.8	-18.5	15.1	-33.6
Hungary	202	3.1	21.8	42.8	31.7	0.7	202	23.9	14.1	28.3	29	4.8	-18.7	9.8	-28.5
France	202	6.3	26.6	56.6	10.1	0.3	202	30.9	6.1	50.5	8.3	4.1	-20.3	24.8	-45.1
Poland	201	6.8	28.2	48.4	10.5	6	201	38.9	11.2	34.2	7.4	8.3	-21.4	27.7	-49.1

Cyprus	70	6.2	27.7	57.9	8.3	0	70	37.1	2.6	52.5	7.4	0.4	-21.5	34.5	-56
Ireland	201	9.7	31.3	56.6	1.8	0.5	201	29.6	14.3	52.2	2.5	1.3	-21.6	15.3	-36.9
Romania	201	9.2	33.4	43.4	12.2	1.8	201	49.5	8.1	30.2	9.1	3.1	-24.2	41.4	-65.6
Latvia	200	7.6	41.9	32.7	17.8	0	200	23.6	18.4	44.6	10.1	3.4	-34.3	5.2	-39.5
Lithuania	200	5.4	41.9	38.1	10	4.7	200	45.6	9.1	28.4	5.8	11	-36.5	36.5	-73
Greece	200	1.8	44	43.4	10	0.7	200	42.4	13.9	36.3	6.6	0.8	-42.2	28.5	-70.7

Notes: Columns 1 to 13 reproduce the answers to questions 3 and 4 of the Innobarometer 2009 survey. INBAL is calculated as the percentage of 'increase' answers minus the percentage of 'decrease' answers.

TABLE 2: CHANGES IN THE PERCENTAGES OF FIRMS INCREASE, DECREASE, MAINTAIN THE SAME INNOVATION SPENDING OR HAVE NO INNOVATION BEFORE AND DURING THE CRISIS

Countries	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? (% excluding N/A answers)				Compared to 2006, has the amount spent by your firm on all innovation activities in 2008 increased, decreased, or stayed approximately the same (% excluding N/A answers)				Change			
	Increase	Decrease	Same	No Innovation	Increase	Decrease	Same	No Innovation	CI_IN	CI_DE	CI_SA	CI_NO
1	2	3	4	5	6	7	8	9	10 = 2 - 6	11 = 3 - 7	12 = 4 - 8	13 = 5 - 9
Latvia	7.6	41.9	32.7	17.8	24.4	19	46.1	10.4	-16.8	22.9	-13.4	7.4
Spain	9.6	25.8	59.5	5	27.7	10.7	57.6	4	-18	15.1	2	1
Denmark	15.7	22.6	52.6	9.1	33.9	10	52.3	3.8	-18.3	12.6	0.3	5.3
Belgium	8.5	12.5	50.3	28.7	28.5	6.7	35.9	29	-20	5.9	14.4	-0.3
Ireland	9.8	31.5	56.9	1.8	30	14.5	52.9	2.5	-20.3	17	4	-0.7
Hungary	3.1	21.9	43.1	31.9	25.1	14.8	29.7	30.4	-22	7.1	13.4	1.5
Portugal	12.7	26.8	55.5	5	34.8	13.1	45.6	6.5	-22.1	13.7	9.9	-1.5
Luxembourg	8	15.6	69.1	7.3	30.9	6.5	60.6	2	-23	9.2	8.5	5.3
United Kingdom	7.9	21.8	64.2	6.1	31.5	9.2	55	4.2	-23.6	12.6	9.2	1.9
Estonia	7	26.3	55.4	11.3	30.7	14.3	50.9	4.1	-23.7	12	4.6	7.2
Netherlands	9.4	15.1	65.6	9.9	33.5	8.2	52.5	5.8	-24.1	6.9	13.1	4.1
Finland	15.8	14	64.9	5.3	41.2	6.2	49.2	3.5	-25.4	7.8	15.7	1.8
Czech Republic	13.2	28.2	53.8	4.9	38.7	12.6	44.7	3.9	-25.6	15.6	9	1
France	6.3	26.7	56.8	10.1	32.3	6.4	52.7	8.7	-25.9	20.3	4.1	1.5
Italy	8.7	25.6	63.8	1.9	35.2	13.2	50	1.6	-26.6	12.4	13.8	0.4
Austria	10.8	10.3	75.3	3.6	40.1	5.7	52.5	1.8	-29.3	4.6	22.9	1.8
Bulgaria	8.4	18.1	43.7	29.8	38.9	7.4	27.6	26	-30.6	10.6	16.1	3.8
Cyprus	6.2	27.7	57.8	8.3	37.2	2.6	52.7	7.4	-31.1	25.1	5.1	0.9
Malta	16.2	14.7	51.5	17.7	48.2	4.1	34.5	13.2	-32.1	10.6	16.9	4.5
Slovakia	15.8	29.5	50.5	4.2	47.9	9.8	40.9	1.4	-32.1	19.7	9.6	2.8

Slovenia	4.6	18.7	67.3	9.4	37.4	8.6	48.6	5.3	-32.8	10	18.6	4.1
Germany	9.5	13.3	69.2	8	42.5	5.2	50.7	1.7	-33	8.1	18.6	6.3
Poland	7.2	30	51.5	11.2	42.4	12.2	37.3	8.1	-35.2	17.8	14.2	3.1
Sweden	14.1	12	69.3	4.5	51.8	5.5	38.2	4.5	-37.7	6.5	31.2	0
Greece	1.8	44.4	43.8	10.1	42.7	14	36.6	6.7	-40.9	30.3	7.2	3.4
Romania	9.4	34	44.2	12.4	51.1	8.4	31.2	9.4	-41.7	25.7	13	3
Lithuania	5.7	43.9	39.9	10.5	51.3	10.2	31.9	6.5	-45.6	33.7	8	4

Notes: Columns 1 to 9 convert the raw data from the Innobarometer 2009 into percentages excluding the N/A answers from the total responses. CI_IN (CI_DE, CI_SA, CI_NO) is the difference between column 2 and 6 (3 and 7, 4 and 8, 5 and 9 respectively).

TABLE 3: HOFSTEDE'S CULTURAL DIMENSIONS

	Power distance	Individualism	Uncertainty avoidance	Masculinity
Greece	60	35	112	57
Lithuania	45	50	67	65
Austria	11	55	70	79
Finland	33	63	59	26

Notes: Power distance reflects the extent to which less powerful people accept and expect power to be distributed equally. Individualism reflects the extent to which people take more care of themselves and their own family. Uncertainty avoidance reflects the extent to which people feel uncomfortable with uncertainty. Masculinity reflects the extent to which people prefer achievement, heroism, assertiveness and material reward for success rather than cooperation, modesty, caring for the weak and quality of life. Definitions of variables are reproduced with some minor adjustments from Hofstede (1984).

TABLE 4: HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY

	IE	HRST	DSST	DGST
Greece	4.09	31.7	0.52	0.5
Lithuania	4.87	42.5	0.23	0.68
Austria	5.47	37.8	0.53	1.64
Finland	6.10	50.1	1.36	2.3

Notes: IE is the investment in education as a percentage of GDP. HRST is the percentage of the total labour force in the age group 25-64, that is classified as having either successfully completed an education at the third level in a science and technology field of study or is employed in an occupation where such an education is normally required (HRST are measured mainly using the concepts and definitions laid down in the Canberra Manual, OECD, Paris, 1995). DSST is doctoral students in science and technology fields of study, as a percentage of the population 20-29 year old. DGST is doctoral graduates in science and technology fields of study, as a percentage of the population 25-34 year old. Definitions of variables are reproduced from Eurostat and the European Commission (2009b).

TABLE 5: SCIENCE AND TECHNOLOGICAL CAPABILITIES

	HTTP (%)	HTTV (€mil)	HTE	HTF	HTP	TP	RDP (%)	TRD (€mil)	GRD	IFA (€mil)
1	2	3	4	5	6	7	8	9	10	11
Belgium	1.394	13750	4437	NA	301	1450	1.22	6812.699	1.36	NA
Bulgaria	0.10	1,199	3,353	5,957	4	18	0.48	167	0.80	144
Czech Republic	0.95	9,322	4,995	33,071	23	207	0.97	2,169	1.29	2,217
Denmark	0.49	5,444	2,853	11,940	225	1,251	1.99	6,701	1.64	5,184
Germany	6.95	56,103	38,481	89,537	3,078	22,655	1.25	66,532	1.81	27,540
Estonia	0.06	685	657	1,967	16	34	0.73	208	1.62	95
Ireland	0.86	5,811	2,100	NA	90	321	0.91	2,616	1.25	1,393
Greece	0.33	3,896	4,549	12,443	13	90	0.72	1,342	0.59	2,204
Spain	1.85	18,659	20,243	45,155	246	1,408	0.94	14,701	1.87	14,462
France	3.99	39,309	25,900	NA	1,914	8,578	1.36	41,066	1.65	41,452
Italy	2.04	20,291	23,353	111,803	437	4,648	NA	18,993	1.30	16,706
Cyprus	0.03	350	380	507	1	11	0.30	73	1.00	18
Latvia	0.05	607	1,125	2,397	3	23	0.54	142	0.75	199
Lithuania	0.07	803	1,518	1,958	4	16	0.78	258	0.70	391
Luxembourg	0.39	1,212	202	1,465	5	92	2.18	619	1.21	751
Hungary	0.82	6,061	3,879	35,818	44	178	0.65	1,059	0.87	1,142
Malta	0.06	527	160	29,653	2	6	0.55	33	0.35	112
Netherlands	4.20	17,062	8,513	16,010	781	3,361	1.05	10,502	1.71	11,650
Austria	0.86	8,830	4,076	42,950	177	1,589	1.36	7,548	1.42	4,709
Poland	0.91	10,155	15,758	17,389	30	229	0.44	2,194	0.70	2,772
Portugal	0.42	5,462	5,100	17,508	27	112	0.84	2,585	1.92	2,299
Romania	0.32	3,557	9,369	5,265	15	33	0.31	809	1.01	1,496
Slovenia	0.12	1,357	991	2,916	15	140	1.11	617	1.15	490
Slovakia	0.32	3,741	2,433	8,455	8	34	0.58	305	0.79	845
Finland	0.55	4,325	2,531	46,143	422	1,233	2.10	6,871	1.98	2,731
Sweden	0.94	9,597	4,593	151,485	722	2,696	1.62	12,314	1.55	10,308
United Kingdom	3.76	28,088	29,295	13,736	1,080	5,119	1.10	32,200	1.37	21,157

Notes: HTTP is the trade of hi-tech products and services as a percentage of the world's volume. HTTV is the volume of trade of hi-tech products and services. HTE is the number of employees working in hi-tech industries. HTF is the number of firms in hi-tech industries. HTP is the number of registered hi-tech patents. TP is the total number of registered patents. RDP is the personnel working in R&D fields as a percentage of the total population. TRD is the total R&D spending. GRD is the total R&D spending of the government. IFA is the value of intangible fixed assets.

TABLE 6: CONTRIBUTION OF DIFFERENT SECTORS TO GVA

	Agriculture, hunting and fishing	Construction	Business activities and financial services	Industry (including Energy)	Trade, transport and communication services	Others
Belgium	0.7	5.5	29.4	17.6	22.6	23.8
Bulgaria	6.9	8.4	23.4	22	24.4	14.9
Czech Republic	2.4	6.3	17.1	29.6	24.1	16
Denmark	1	5.4	24.9	20.1	21.1	26.6
Germany	0.9	4.1	29.6	25.7	17.9	22.2
Estonia	2.7	8.6	24.4	20.2	24.8	17.9
Ireland	1.3	7.7	29	23.8	17.5	20.7
Greece	3.2	5.2	19.5	13.4	35.3	25.8
Spain	2.7	11.4	22.8	17	24.4	21.6
France	2.1	6.7	33.7	13.7	19	25.7
Italy	2	6.1	27.6	20.7	22.1	20.9
Cyprus	2.3	9.2	28.3	9.5	27.6	24.1
Latvia	3.1	9.1	23.6	14.1	29.6	21.1
Lithuania	3.7	9.9	16.6	21.5	30.4	17.3
Luxembourg	0.3	5.4	49.2	8.8	20.9	15.3
Hungary	4.3	4.4	23	25.1	21.4	22.5
Malta	1.9	4.3	20.5	17.4	26.8	30.6
Netherlands	1.8	5.8	27.9	19.8	21.2	23.7
Austria	1.7	7.1	23.8	23.2	23.7	20.6
Poland	3.7	7.3	19.5	24.3	26.2	19.1
Portugal	2.4	6.7	23.6	17.3	25.6	24.4
Romania	7.4	11.9	15	25.8	25	14.8
Slovenia	2.5	8.3	22.3	25.5	22.6	18.9
Slovakia	4.2	9.7	17.7	29	24.7	15
Finland	2.9	7.2	22.9	24.8	19.6	22
Sweden	1.8	5.2	25.2	21.6	19.6	26.7
United Kingdom	0.8	6.5	32.8	16.2	21.1	23

TABLE 7: BREAKDOWN OF THE NUMBER OF FIRMS, NUMBER OF EMPLOYEES AND TURNOVER BY FIRM SIZE

	Micro	Small	Medium-sized	SMEs	Large	Total
1	2	3	4	5 = 2 + 3 + 4	6	7
Panel A: Number of firms						
Austria	261,259	31,389	4,848	297,496	1,017	298,513
Belgium	383,336	27,816	4,016	415,168	823	415,991
Bulgaria	255,697	24,890	4,897	285,484	780	286,264
Cyprus	42,207	3,149	456	45,812	65	45,877
Czech Republic	856,261	35,285	7,212	898,758	1,513	900,271
Denmark	185,893	23,479	4,008	213,380	717	214,097
Estonia	37,123	6,205	1,188	44,516	162	44,678
Finland	199,189	12,447	2,362	213,998	602	214,600
France	2,208,562	155,000	23,534	2,387,096	5,050	2,392,146
Germany	1,520,873	257,525	42,777	1,821,175	8,840	1,830,015
Greece	820,021	25,789	3,579	849,389	431	849,820
Hungary	503,171	25,122	4,125	532,418	822	533,240
Ireland	79,924	13,573	2,611	96,108	463	96,571
Italy	3,731,348	189,294	20,151	3,940,793	3,096	3,943,889
Latvia	59,929	10,086	1,877	71,892	240	72,132
Lithuania	113,840	12,021	2,613	128,474	347	128,821
Luxembourg	21,305	2,636	518	24,459	103	24,562
Malta	32,671	1,208	209	34,088	39	34,127
Netherlands	484,160	44,616	7,569	536,345	1,353	537,698
Poland	1,502,959	44,500	15,185	1,562,644	3,105	1,565,749
Portugal	818,685	40,491	5,665	864,841	803	865,644
Romania	389,389	41,500	9,174	440,063	1,802	441,865
Slovakia	42,230	10,577	2,178	54,985	527	55,512
Slovenia	94,696	5,773	1,285	101,754	272	102,026
Spain	2,487,681	184,117	22,048	2,693,846	3,268	2,697,114
Sweden	523,126	26,486	4,661	554,273	968	555,241
United Kingdom	1,420,417	170,372	27,348	1,618,137	5,970	1,624,107
Panel B: Number of employees						
Austria	648,079	594,568	483,839	1,726,486	840,483	2,566,969
Belgium	754,437	544,498	393,946	1,692,881	837,854	2,530,735
Bulgaria	588,637	489,398	484,957	1,562,992	547,681	2,110,673
Cyprus	91,021	58,104	45,784	194,909	38,467	233,376
Czech Republic	1,077,519	693,604	733,587	2,504,710	1,199,348	3,704,058
Denmark	363,124	464,537	387,106	1,214,767	626,593	1,841,360
Estonia	106,002	122,606	112,607	341,215	92,719	433,934
Finland	304,292	247,752	237,646	789,690	533,213	1,322,903
France	3,714,919	3,130,988	2,435,146	9,281,053	5,757,419	15,038,472
Germany	4,288,700	4,843,235	4,288,582	13,420,517	8,762,628	22,183,145
Greece	1,538,632	459,784	312,489	2,310,905	343,810	2,654,715
Hungary	881,142	479,676	406,302	1,767,120	719,477	2,486,597
Ireland	233,851	275,076	256,864	765,791	351,925	1,117,716
Italy	7,292,281	3,351,855	1,935,295	12,579,431	2,961,028	15,540,459
Latvia	150,488	196,453	182,560	529,501	164,144	693,645
Lithuania	217,485	241,469	252,582	711,536	242,271	953,807
Luxembourg	42,129	52,758	52,065	146,952	73,163	220,115
Malta	46,429	20,965	21,105	88,499	26,731	115,230
Netherlands	1,537,007	1,139,399	884,055	3,560,461	1,739,284	5,299,745
Poland	3,295,674	988,919	1,595,013	5,879,606	2,654,220	8,533,826
Portugal	1,395,210	764,746	541,876	2,701,832	615,420	3,317,252
Romania	876,357	821,061	935,751	2,633,169	1,509,794	4,142,963
Slovakia	150,746	179,482	234,273	564,501	453,723	1,018,224
Slovenia	178,670	111,371	133,755	423,796	208,665	632,461
Spain	5,377,223	3,636,271	2,109,383	11,122,877	3,130,652	14,253,529
Sweden	685,631	578,795	501,667	1,766,093	1,005,178	2,771,271
United Kingdom	3,817,765	3,183,757	2,723,685	9,725,207	8,012,260	17,737,467

	Micro	Small	Medium-sized	SMEs	Large	Total
1	2	3	4	5 = 2 + 3 + 4	6	7
Panel C: Turnover (€ million)						
Austria	101,626	127,783	125,263	354,672	202,264	556,936
Belgium	183,955	176,750	163,996	524,700	337,684	862,384
Bulgaria	20,228	23,768	21,699	65,695	35,271	100,966
Cyprus	7,867	7,583	6,467	21,917	4,314	26,231
Czech Republic	73,303	74,132	98,005	245,439	171,960	417,400
Denmark	108,784	101,596	101,616	311,996	153,575	465,571
Estonia	10,587	12,384	12,147	35,118	7,891	43,009
Finland	59,543	55,541	68,540	183,624	197,770	381,394
France	665,549	668,162	592,676	1,926,387	1,536,957	3,463,344
Germany	539,373	756,698	913,395	2,209,466	2,430,931	4,640,396
Greece	115,684	75,692	63,891	255,267	74,070	329,337
Hungary	59,398	49,690	54,073	163,162	114,233	277,395
Ireland	46,292	61,684	84,674	192,650	153,590	346,240
Italy	829,841	664,431	586,291	2,080,563	850,424	2,930,987
Latvia	12,253	15,159	15,189	42,601	10,877	53,479
Lithuania	8,670	15,543	17,660	41,874	21,861	63,735
Luxembourg	14,989	19,675	14,163	48,827	33,467	82,294
Malta	3,344	2,124	1,577	7,044	2,888	9,932
Netherlands	184,016	246,327	309,967	740,309	444,441	1,184,750
Poland	162,233	96,787	161,648	420,667	290,403	711,071
Portugal	90,175	77,816	74,208	242,199	101,641	343,840
Romania	78,390	98,419	90,714	267,523	188,237	455,760
Slovakia	16,541	20,726	27,388	64,654	65,947	130,601
Slovenia	16,444	15,503	19,429	51,376	29,861	81,237
Spain	533,687	544,144	458,704	1,536,534	752,537	2,289,071
Sweden	124,485	124,496	130,976	379,957	299,650	679,607
United Kingdom	554,378	608,141	707,513	1,870,033	1,977,730	3,847,762