**Universidade de Aveiro**
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Departamento de Economia, Gestão e Engenharia Industrial

**Diogo Rafael Espinhal Ferraz**

# The Economic Role of Small Knowledge Intensive Firms in European Countries

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Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Economia, realizada sob a orientação científica da Doutora Elisabeth Pereira, Professora Auxiliar do Departamento de Economia, Gestão e Engenharia Industrial da Universidade de Aveiro

Dedico este trabalho à minha família pelo incansável apoio.

**o júri**

presidente

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Venho por este meio agradecer à minha orientadora Professora Elisabeth Pereira pela ajuda.

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**palavras-chave** SKIFs, Inovação, Países Europeus, PME, Crescimento Económico**.**

**Resumo**

Crescimento inteligente, sustentável e inclusivo é a base da actual Estratégia Europeia 2020, sendo atribuído às pequenas e médias empresas (PMEs) um papel chave para a sua consecução. Partindo da relevância que as PMEs assumem na economia dos países europeus, este trabalho tem como objetivo investigar a relação entre as s*mall knowledge intensive firms* (SKIFs) e as variáveis macroeconómicas como o produto interno bruto (PIB) e as despesas em investigação e desenvolvimento por parte das empresas, instituições e estado. Para atingir este objectivo, foram analisados vários países europeus, para o período entre 2008 e 2012, através de análise gráfica e qualitativa, dados em painel e análise de *clusters*. Os resultados obtidos, através deste estudo, permitem inferir que, para os vários países europeus estudados, existe uma relação positiva entre crescimento das SKIFs e os valores de crescimento do PIB e do BERD. O grande contributo deste estudo é a realização de uma comparação direta entre SKIFs e variáveis macroeconómicas.

**Keywords** SKIFs, Innovation, European Countries, SMEs, Economic Development

**Abstract**

Smart, sustainable and inclusive growth is the basis for European 2020 strategy, small and medium enterprises (SMEs) being the backbone of European countries economies, this study aims to investigate the relation between small knowledge intensive firms (SKIFs) variables and gross domestic product (GDP) and business expenditure on research and development (BERD). To achieve this, European member states are analysed in the period of 2008 to 2012 using graphical analysis, panel data and clusters analysis. Through this study it can be seen that countries that have growth in SKIF values also have growth in GDP and BERD. The big contribution of this study is that a direct relation of SKIF to country variables is made.

# Table of Contents

# List of Acronyms

BERD – Business Expenditure on Research and Development

EU – European Union

EC – European Commission

gBERD – growth of Business Expenditure on Research and Development

GDP – Gross Domestic Product

GDPpc – Gross Domestic Product per capita

gGDP – Growth of Gross Domestic Product per capita

gSKIFEMP – Growth of SKIF Employment

gSKIFENT – Growth of SKIF Enterprises

gSKIFPROD – Growth of SKIF Productivity (in percentage)

GVA – Gross Value Added

HMHTM – High and Medium High Tech Manufacturing SMEs

HMHTMemp – Share of HMHTM SME employment in total SME employment (in percentage)

ICT – Information and Communication Technologies

KIF – Knowledge Intensive Firm

KIS– Small and Medium Knowledge Intensive Service

R&D – Research and Development

SKIF – Small and Medium Knowledge Intensive Firms

SMEs – Small and Medium Enterprises

US – United States of America

VA – Value Added

# List of tables

# List of Figures

# 1 Introduction

Research and development (R&D) is a key factor in European policy, being an important issue to the strategy for European 2020 related to Innovation and Growth (European Union, 2013). According to this strategy, innovation will create job opportunities for all, especially for young people; get the economy back on track; make companies more competitive in the global market; solve the challenges of an ageing population; secure resources like food and fuel; fight global warming; and improve smart and green transport. The low expenditure in R&D explains half of European Union (EU) gap with the United States (US), in 2010 when the executive summary of Europe 2020 policy was published, according to the EU Commission (2010:14) *"EU expenditure on R&D was below 2% while in US was 2.6% and in Japan 3.4%"*. In order to improve R&D expenditure, one of the flagships of European 2020 strategy was creating the Innovation Union which main goals are to improve innovation conditions such has EU patent and enhance joint programing with member states regions.

The back bone of European economy are Small and Medium Enterprises (SMEs), these are a key driver for economic growth, innovation, employment and social integration according to the EU Annual Report on European SMEs (Gagliardi et al., 2013). From the same report, it can be observed that 99.8% of the European enterprises are considered SMEs, which are responsible for approximately 2 in every 3 employed persons in the private sector in Europe and also contribute in over half (57.3%) of the value added at factor costs by European enterprises. The programme Horizon 2020 actively supports SMEs with the goal of optimizing research, development and innovation environment for SMEs.

The relevance assumed by the European Commission (EC) about SMEs and the strategy of a competitive European economy based on smart, sustainable and inclusive growth leads to the importance of small and medium knowledge intensive firms (SKIFs) in the European context. Most of the studies about SKIFs are generally about either internationalization properties of SKIFs, or about how SKIFs influence SMEs, however are scarce the studies that investigates the influence of knowledge intensive business services on European regions, and relate SKIFs directly with macroeconomic variables, such has Gross Domestic Product (GDP) or Business Expenditure on R&D (BERD). Therefore, the main objective of this thesis is to research the SKIFs proxy indicators and EU Countries GDP per capita and BERD. For this purpose it will be analysed 24

member states, from 2008 to 2012, through a comparative and econometric analysis to study the relation between SKIF and macroeconomic variables. The database was retrieved from Eurostat, and is similar to the one used in Gagliardi et al. (2013). To complement this data it is used a database from 27 member states on the period 2009 to 2011 provided by Ecorys. This thesis started being developed in the year 2013, in Finland, during my stay at the University of Eastern Finland in Kuopio trough one year of *Campus Europae* mobility.

In this study were developed three different analyses. On the first analysis, it is used the Ecorys database where values for employment and value added growth of Knowledge Intensive Services (KIS) and High and Medium High Tech Manufacturing (HMHTM) were compared to SME numbers and then to GDP values. On the second analysis, the sample consists on EU-24 countries retrieved mainly from Eurostat, the base data is the same as in Gagliardi et al. (2013), after describing the evolution of SKIFs proxy variables such as number, employment, value added and productivity with this values it was made two panel data analysis having as dependent variables the growth rate of GDP and the growth rate of BERD respectively. On the third analysis, the sample is the same as in the second one and a cluster analysis is made to see where each country locates individually and if there are relevant differences between the cluster's groups.

The structure of this thesis is as follows. After this introduction, on chapter 2 will start by defining a SKIF and its environment, unlike traditional studies, since this study has three different analyses with two different databases, chapter 3 is divided in three sections which are as follows: section 3.1 gives an overview of SKIFs employment related to SMEs and GDP; section 3.2 is about the factors underlying the growth of SKIFs and their influence on GDP and BERD growth; and section 3.3 is about spatial patterns of SKIFs. In each one of the three sections is presented the data, methodology and results for each analysis made. Chapter 4 concludes this study.

# 2 Literature Review

## 2.1 The concept of Small and Medium Knowledge Intensive Firms (SKIF)

To study the economic role of the Small and Medium Knowledge Intensive Firm (SKIFs), first is needed to begin by its concept. To define a SKIF, two main aspects have to be combined, the size, and the knowledge intensive. Due to these, SKIFs can have several definitions. About the size, in Europe the SMEs are defined according to the European Recommendation 2003/361[1]. This recommendation considers a SME as an enterprise that have to abide three criteria, the first one is relating to employed workers, the enterprise has to have less than 250 employees; the second criteria is related to optional restrictions, enterprises either have to have a total turnover of less than 50 million or a total balance sheet of less than 43 million, this option on the second criteria is given gives this choice in order for firms in different types of activity to be treated fairly, for example trading enterprises have, by nature a high number of sales that may not reflect their wealth. And, the third criteria is related to the independence of companies. To be an independent enterprise, the enterprise in question has to have a holding of less than 25% of the capital or voting rights (whichever is the higher) in one or more other enterprises outside its own and/or outsiders do not have a stake of 25% or more of the enterprise in question.

On table 2.1 it can be seen that there are a lot of different definitions for SME, which will translate in a lot of different definitions for SKIF depending where the study is made or the country in analysis, on this case the database for the study is countries from EU, meaning, it will be based on European statistics about SMEs therefore the chosen definition will be the one used in Europe.

[1] *in* http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:124:0036:0041:EN:PDF

**Table 2.1 Different SME's definitions around the world**

| Country | SME CRITERIA |
|---|---|
| Australia[2] | Has to have 199 employees or fewer |
| Canada[3] | Has to have fewer than 500 employees |
| China[4] | Has to employ less than 2000 people, or with annual revenue less than RMB 300 million (45,681,292.63€), or with total assets less than RMB 400 million (around 60,908,390.17€) |
| Egypt[5] | Has to have fewer than 50 employees |
| India[6] | Investment in plant and machinery does not exceed Rs.10 crore (around 1,518,000.00 €)<br>For services industry :<br>Investment in equipment does not exceed Rs. 5 crore (around 759000.00€) |
| Japan[7] | Manufacturing: ¥300 million or less and 300 or fewer employees<br>Wholesale ¥100 million or less and 100 or fewer employees<br>Service industry ¥50 million or less and 100 or fewer employees<br>Retail ¥50 million or less and 50 or fewer employees |
| Kenya[8] | Has to have fewer than 100 employees |
| New Zealand[9] | Has to have 19 or fewer employees |
| Nigeria[10] | 1-Asset base between N5 million (around 23,821.41€) and N500 million (around 2,382,140.54€),<br>2-a staff strength between 20 and 300 employees |
| Russian Federation[11] | The subjects of small business sector are:<br>1. Commercial organizations. Legal entities, in which:<br>• The share of participation of the Russian Federation and federal subjects ownership, municipal ownership, ownership of public and religious organizations, charity and other funds does not exceed 25 percent of the authorized capital (the share according to the above partners of ownership are not totalled). The share of one or several legal entities, that are not small entrepreneurship, should not exceed 25 percent of authorized capital (if several founders are founders, their share are totalled);<br>• The average number of employees (including part-time workers and persons working under sub-contracts) does not exceed the following maximum levels:<br>- in industry, building and transport - 100 employees;<br>- in agriculture, science and technological field: 60 employees;<br>- in retail trade and consumer services: 30 employees;<br>- in other field of activities: 50 employees.<br>2. Farm enterprises;<br>3. Persons, who perform entrepreneurial activities, but are not legal entities (individual entrepreneurs) |
| United States of America[12] | Criteria based on industry, ownership structure, revenue and number of employees (the later for example in some circumstances may be as high as 1500, although the cap is typically 500. |

Source: Based on several sources presented on the footnotes at the end of the page, own elaboration.

[2] Australian industry (2014)
[3] Industry Canada (2012)
[4] Wang (2008). http://adbi.adb.org/files/2008.09.23.cpp.paper.china.sme.dev.mngt.pdf Consulted in March 2015
[5] Elasrag (2011)
[6] Small and Medium Business Development Chamber of India. Retrieved 16/03/2015, from http://www.smechamberofindia.com/About_MSMEs.aspx.
[7] Small and Medium Enterprise Agency, Ministry of Economy, Trade and Industry (2013).
[8] . Waweru (2007).
[9] Ministry of economic development (2011).
[10] Central Bank of Nigeria (2010)
[11] United Nations (2003)
[12] Code of Federal Regulations 121.201 Retrieved 15-03-2015, from http://www.ecfr.gov/cgi-bin/text-idx?rgn=div5;node=13%3A1.0.1.1.17#se13.1.121_1201

After defining the size component of SKIFs in this study, it is needed to present the concept of a KIF. In this case, there are also different definitions. It has superseded the terms 'high-technology firm' and 'technology-based firm' in studies about software firms but this is not enough to define what a knowledge intensive firm is, Alvesson (1995) defined a KIF as '*a company where most work can be said to be of an intellectual nature and where well-qualified employees form the major part of the workforce*'. Elkjaer (2000:344) sees a KIF as 'a company of knowledge workers' where 'human competencies are the main assets'. According to Robertson and Hammerlsey (2000:241) '*KIFs have always been in the business of managing knowledge – knowledge being their primary asset and source of competitive advantage'*. Autio et al. (2000) define knowledge-intensity as the extent to which a firm depends on the knowledge inherent in its activities and outputs as a source of competitive advantage, a view accepted by McNaughton (2001). Some examples of knowledge-intensive fields include software (McNaughton, 2001), law, accountancy, management consulting, advertising (Robertson & Hammersley, 2000), engineering and computer consulting firms (Elkjaer, 2000).

According to Wymega et al. (2012) KIS sectors function as a facilitator, carrier or source of innovation, and through their symbiotic relationship with client firms, some KIS function as co-producers of innovation. The growing role of services and its complementarity with the more traditional manufacturing sectors suggest that productivity growth in KIS. Several studies have divided KIF into high and medium high tech manufacturing (HMHTM) and KIS. On the present study are considered SKIF the companies that joint both of these two concepts.

As a summary, in this thesis a SKIF will be considered a firm with less than 250 employees and which knowledge is their main asset or source of competitiveness, while it's easy to get data about SMEs in the case of SKIFs it is more difficult to know when to consider if a firm is knowledge intensive so for data analysis purposes, the European Commission indicated which sectors would be considered knowledge intensive and which wouldn't, presented in Annex A2.

The SKIFs use knowledge as their main source of advantage, they operate in environments with rapid changing technology, they invest a lot in research and ever shortening product life cycles meaning they have to be constantly innovating otherwise they would easily disappear from the market, their environment is highly competitive which may be a driver to seek strategic alliances and network relationships this environment is also marked by strong rivalry which is also a driver for innovation.

Based on the SKIFs definition four characteristics gain relevance, explicitly or implicitly: the size (be smallness), the knowledge-intensity, the environment and the entrepreneur. The following sections of this chapter serve to provide more insight in terms of these characteristics.

## 2.2 The main characteristics of SKIFs

### 2.2.1 The importance of SMEs in European economy

The SMEs play an important role in innovation (Almeida, 1999) and have been described as agents of change (Audretsch, 1999), creators of radical innovation (Acs et al., 1999) and carriers of new ideas (Carlsson, 1999).

Despite their lower individual visibility, SMEs collectively play an important role in the economy. SMEs represent an important source of dynamism in the economy, accounting for a large share of both gross job gains and gross job losses each year. SMEs are often said to be a conduit that introduces new and innovative products and processes into the economy (Acs et al., 1999) due to serving specialized market segments that large firms may find unprofitable, by adopting flexible production processes that are capable of offering personalized products. SMEs also play an important role in the early stages of the product life cycle; taking advantage of their close relationships with their customers, SMEs are often better positioned to take the basic technical innovations made by large firms and turn them into new products.

The following figures (2.1 to 2.4) analyse the importance of SMEs compared to large enterprises (LEs).

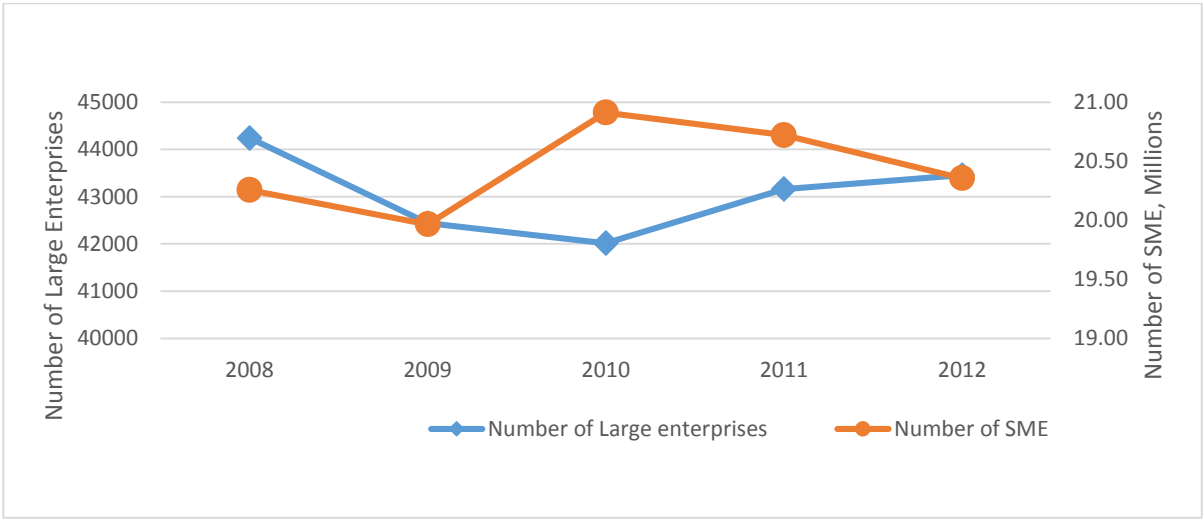


**Figure 2.1 Number of LEs and SMEs**

Source: Eurostat, own elaboration

In terms of demography of companies, Figure 2.1 shows that European SMEs follow a different path from LEs. In 2008-2009, the number of LE dropped by almost 1,800 units to near 42400. Their number began to grow again only in 2010 and by the end of 2012 had not yet recovered to its 2008 level.

The number of SMEs grew between 2009 and 2010 by almost 1 million firms, after a relatively small drop in 2008-2009. From 2010 onwards, the total number of SMEs started to fall, in 2012, the number of SMEs returned to the levels of 2008.

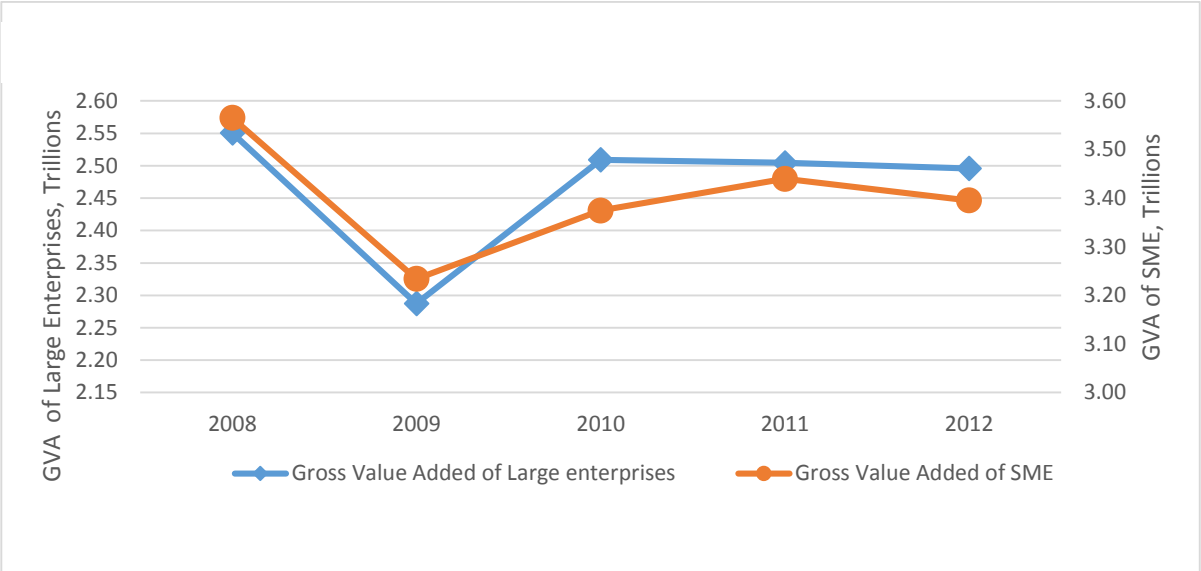


**Figure 2.2 VA of LEs and SMEs**

Source: Eurostat, own elaboration

The Figure 2.2 shows that the dynamics of value added was similar for SMEs and LEs; in 2009, LE lost around 10% (260 billion euros) of value added relating to the previous year; SMEs lost marginally less in percentage terms (9%), but consistently more in absolute terms: €330 billion. After the dip in 2009, the value added recovered but only sluggishly throughout 2010. All companies were hit in 2012: the output loss of SMEs was 1.3%, while LEs lost 0.3% of the value added with respect to the previous year.

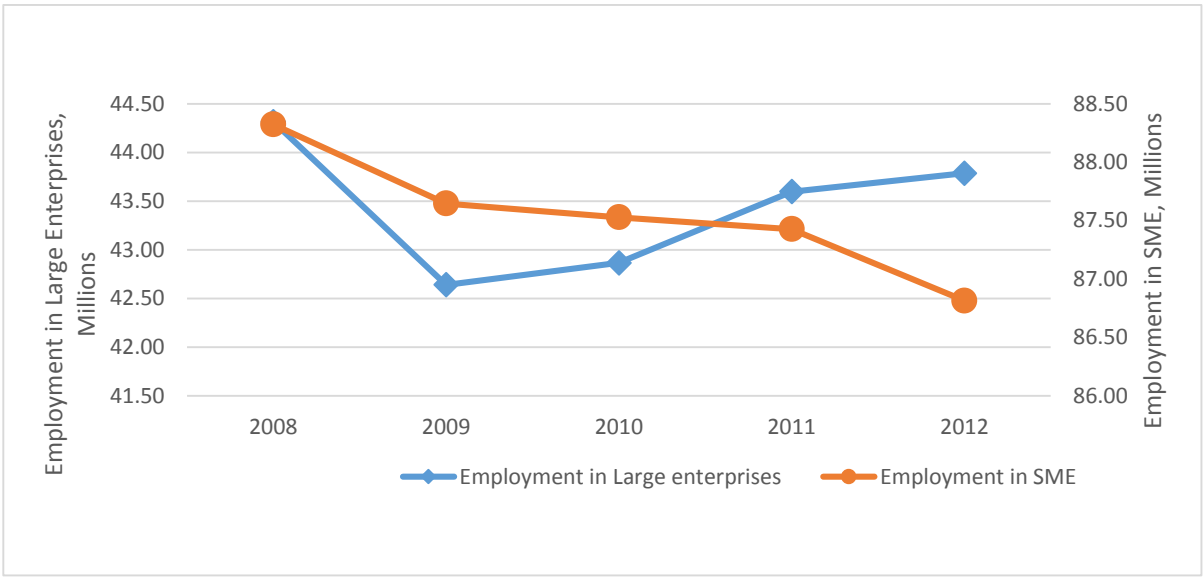


**Figure 2.3 Number of person employed in LEs and SMEs**

Source: Eurostat, own elaboration

The Figure 2.3 shows the employment by SMEs proved to be more resilient to crisis than employment by large firms. In only one year, 2008-2009, large firms lost approximately 1.7 million jobs, whilst SMEs lost around 680,000 jobs, the period of 2010-2012 however proved rather challenging for SMEs. At the EU-27 level, employment in SMEs did not exhibit a particularly pronounced swing, but during the whole period of 2008-2012, it showed a declining trend, while employment in large firms showed signs of recovery.

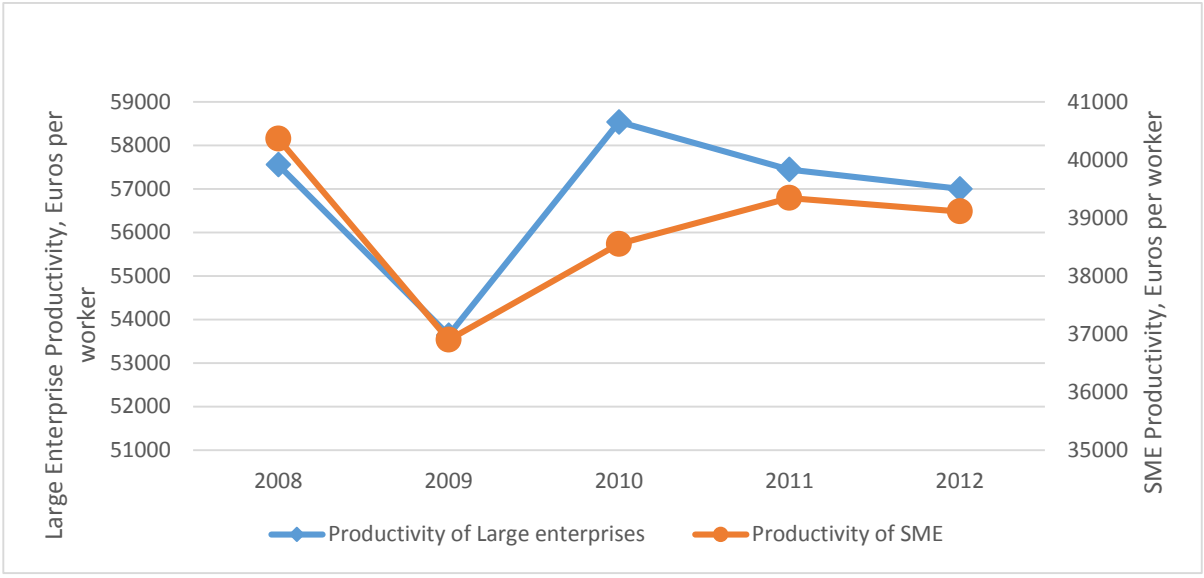


**Figure 2.4 Productivity of LEs and SMEs**

Source: Eurostat, own elaboration

The Figure 2.4 shows that productivity per worker by both SMEs and LEs droped significantly in 2008-2009, and then grew in 2009-2010 resulting in, for LEs, the levels of 2010 beeing higher than the levels of 2008, after 2010 the productivity in LEs started to drop wilhe on SMEs the producitvity levels continued to rise in 2010-2011 and then droping by 0.6 % on 2011-2012.

The same kind of comparisson as in the previous figures was made in Figure 2.5 between SKIFs and Large Knowledge Intensive Firms (LKIFs). The results in terms of trend where quite similar, the main diference was on employment which as follows :

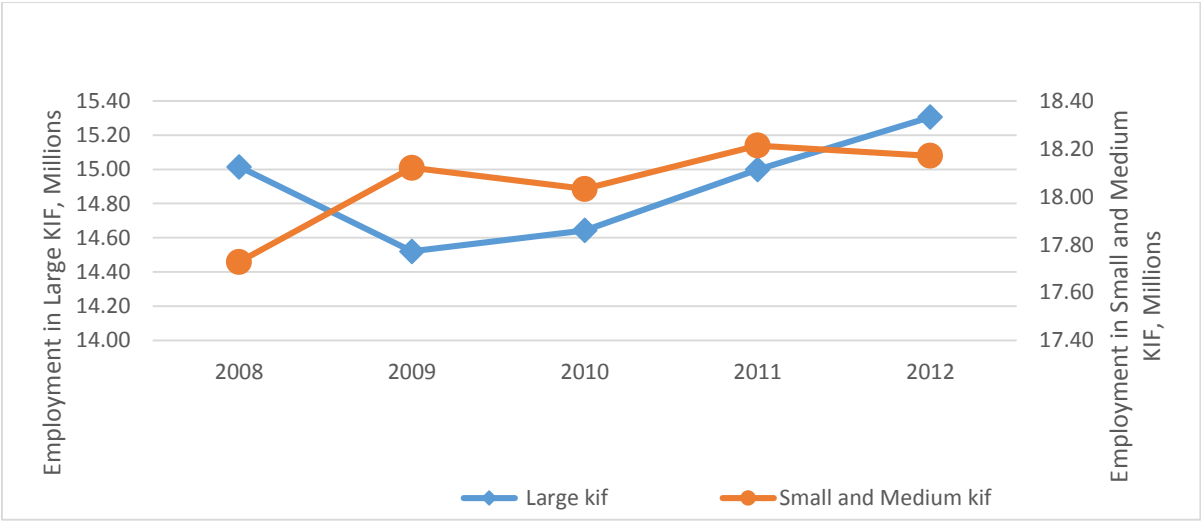


**Figure 2.5 Number of persons employed in Large KIFs enterprises and SKIFs**

Source: Eurostat, own elaboration

In the Figure 2.5 can be seen that on LKIFs there was a dip in employment in 2008-2009 after that employment on LKIFs showed a growing trend. On SKIFs it can be seen that the employment grew by 0.4 million people on the crisis period, 2008-2009, showing a shacky yet growing trend during the whole period.

### 2.2.2 Knowledge intensity, innovation and competitiveness

Innovation is very important for the sustainability and survival of SKIFs, this is supported from their own definition; since on the concept of knowledge intensive firm, knowledge is their main source of competiveness that they have to be constantly innovative.

According to the Oslo Manual (OECD, 2005:46) innovation is defined as 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"*.

A more common description to innovation is creating something new or make a significant improvement to something existent. This something can be a product, a process, marketing or organization that adds value to society, governments or markets.

However, there are different ways of classifying innovations. Booz et al (1980) distinguish innovations between the ones that are new to the company and those that are new to the market. The innovation's calcification of Booz et al. (1980) is focused on the impact of the innovation and label it as incremental, semi-radical or radical. Other authors classify innovations as belonging to product, process, or market paradigms (Francis & Bessant, 2005). Schumpeter for example even though it's from a book written in 1934, classifies innovation in the following five cases and this definition is current to date and is very clear and detailed (Schumpeter 1934:66):

> "*This concept covers the following five cases: (1) The introduction of a new good – that is one with which consumers are not yet familiar – or a new quality of a good. (2) The introduction of a new method of production, that is one not yet tested by experience in the branch of manufacture concerned, which need by no means be founded upon a discovery scientifically new, and can also exist in a new way of handling a commodity commercially. (3) The opening of a new market that is a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed*

> *before. (4) The conquest of a new source of supply or raw materials or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created. (5) The carrying out of the new organization of any industry, like the creation of a monopoly position (for example through trustification) or the breaking up of a monopoly position.*"

The SKIFs tend to born global or internationalize at a fast rate. ICT-intensive firms internationalize faster and more extensively than less ICT-intensive firms. It seems that ICT is important, making it possible for small, technology advanced firms with strong international visions to follow niche strategies in international markets. It is then, reason to conclude that ICT plays an important role in small firm internationalization–both as a channel for opportunity identification and as a powerful tool in the execution of an international strategy (Aspeund & Moen, 2004).

Service innovations in the sense of developing a new production process usually exist because SMEs are networking and connecting along the value chain to enhance production processes. In addition, knowledge-intensive business services, in collaboration with their customers, can improve the technology used and the business models applied.

Van Ark et al. (2008) attributes the productivity gap between Europe and the U.S. mainly to market services, which include distribution services (retail, wholesale and transport), financial and business services. Half of the gap is due to distribution services, but the other half to financial and business services.

For innovation in knowledge-intensive business services certain skill sets must be available, such as networking with clients and experience with contact and integration with customers.

The importance of KIFs to economy is in great part justified not only because of their own added value but also due to high spillover effects. Spillover effects on innovation occurs when an innovation by one specific firm causes unintended benefits to other firm or opens new market segments knowledge. The occurrence of spillover is one of the main reasons why governments should oriented their policies to incentive firms to innovate.

For his side Griliches (1979) commented that although a firm's R&D investment reduces its own production costs, costs of other firms also decline as a result of R&D spillover, furthermore Jaffe (1986) shows that when the potential R&D spillover pool increases by 1%, profits of other firms increase by 0.3%, through these and other studies it can be concluded that R&D produces benefits

to third party firms, one of the reasons being that the result of R&D is usually easy to copy/steal/reverse engineer.

When comparing SMEs to SKIFs, SKIFs where more resilient to 2008-2009 crisis has shown by Figure 2.6, SKIFs number grew from 2008 to 2010 while SMEs number decreased from 2008-2009.

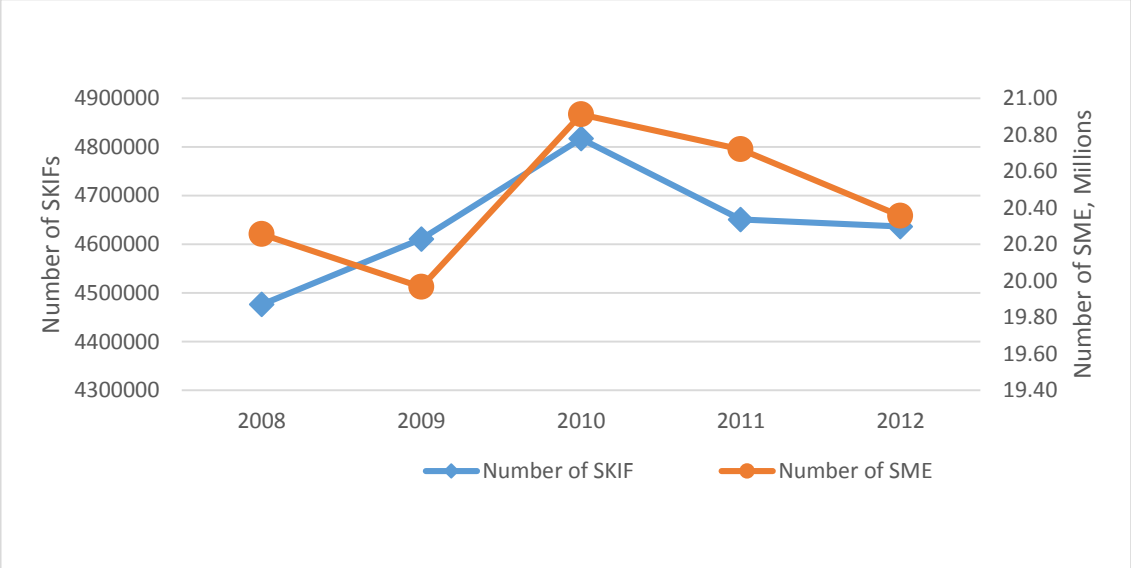


**Figure 2.6 Number of SKIFs and SMEs**

Source: Eurostat, own elaboration

### 2.2.3 The importance of the entrepreneur

In small companies usually the entrepreneur is the main decision maker, his knowledge intent and personal contacts highly influence the direction/performance of the company, being driven by the entrepreneur makes these kind of firms form an important seedbed out of which innovation experiments flow to be tested in the wider economic context meaning entrepreneurs take risks in markets or processes that big firms may not be willing to take. Entrepreneurial actions have a huge contribution to economic development and disturbance (Schumpeter, 1934).

Entrepreneurs are the ones that take risks of implementing untested ideas or trying niche segments entrepreneurs usually have a mind-set of, quoting James Goldsmith "*The ultimate risk is not taking a risk*", a person is an entrepreneur only when "*carries out new combinations*" and loses that character has soon has built up their own business. According to this definition being an entrepreneur is not a profession and is not a lasting condition (Schumpeter, 1934).

Schumpeter (1934:93-94) explained the motivation of the entrepreneur with the following sentence:

> *"First of all, there is a dream and the will to found a private kingdom, usually, though not necessarily, also a dynasty… Then there is the will to conquer: the impulse to fight, to prove oneself superior to others, to succeed for the sake, not of the fruits of success, but of success itself…Finally, there is the joy of creating, of getting things done, or simply of exercising one's energy and ingenuity"*.

The entrepreneur's plans are based on expectations, which are created by himself, this is corroborated by White (1999:93) with the citation "*an image of future markets is available not through sight but through insight*".

### 2.2.4 The environment and internationalization context of SKIFs

The most studied internationalization models applied to SKIFs currently are the Uppsala Model (Johanson & Wiedersheim-Paul, 1975), the Network Theory (Johanson & Mattsson, 1988) and the International Entrepreneurship Theory (McDougall & Oviatt, 2000). In their study, Masum and Fernandez (2008) concluded that almost all firms tend to base their foreign endeavour on networking, for gathering market knowledge and information in particular; SMEs heavily on network relationships. SKIFs are no exception, they are highly involved in international markets and for these good network relations are needed (Prashantham & Berry, 2004). Network relations refer to all the relationships that the firm has with customers, suppliers, competitors, alliance partners, universities, government bodies, industry associations and others. The personal relations of the entrepreneur also count for these network relations. (Katz et al., 2004) since most authors consider the Network Theory as essential for the study of the concept of SKIFs in the economy.

The concept of Network Relationships was first presented in the 1980s as an internationalization model by (Johanson & Mattsson, 1988) as stated in Ojala (2009:51) when it became evident that most of the firms used various networks to facilitate and improve their internationalization activities (Johanson & Mattsson, 1988). The main difference between incremental internationalization models, for example the Uppsala Model, and the Network Model, is that the Network Model is not gradually progressing in nature (Johanson & Wiedersheim-Paul, 1975). Also in the Network Model there is nothing about psychic distance or about the countries in which a firm is entering into. Instead, it conceptualizes internationalization as being related to relationships establishment and building (Johanson & Vahlne, 2003). According to Johanson and Mattsson (1988), a company is dependent on resources controlled by other companies and can get

access to these resources by developing its position in a network. In these networks, firms have common interests in developing and maintaining relationships with each other in a way that provides them mutual benefits (Johanson & Mattsson, 1988, 1992; Johanson & Vahlne, 2003).

According to this model, internationalization occurs when a firm starts to develop relationships with another firm in a foreign country. There are two different approaches to the network internationalization, active and passive networking (Ojala, 2009): in active networking, the initiative is taken by the seller, whereas in passive networking the initiation comes from the buyer's direction.

The efficacy of Network relationships is based in the different established relationships. These can be divided into formal relationships, informal relationships, and intermediary relationships (Ojala, 2009). The literature concerning this conceptualization division could differ according different authors. Formal relationships are the relations hierarchically established within the firm as well as the relations with stakeholders defined in the tasks of each work position, and informal relationships are the relations established outside the hierarchical defined tasks for inside and outside the company, as relations between friends, orders follow outside the defined tasks from the company, etc. For Birley (1985) formal relationships are related to financial sources available whereas informal relationships refer to contacts between other business actors, friends, and family members. By other way, the study of Dubini and Aldrich (1991) suggests that extended (formal) relationships consist of relationships between all the employees of each firm whose role is boundary-spanning, whereas personal (informal) networks are related to all persons that an entrepreneur can meet directly. The simple discretion is: the formal relationship refers to the relationship with other business actors, whereas informal relationships are related to social contacts with friends and family members. In the intermediary relationship, there is a third party that connects the buyer and the seller.

Ojala (2009) found that SKIFs are actively seeking for opportunities in the foreign markets and, thereafter, develop new networks or utilize existing networks to reach these opportunities and Jenssen and Nybakk (2013) stated that smaller knowledge-intensive firms have fewer resources and less information-gathering and information-processing capacity than larger firms that are less knowledge intensive; thus, SKIFs that seek to be innovative must develop a larger and more diverse set of external relationships.

For further information about the network relations theory and influence on SKIFs, innovation and overall SKIFs environment the papers on table 2.2 have various different types of analyses and complete literature reviews about this subject, on this paper this notion was just briefly introduced.

**Table 2.2 Reference studies for innovation and network relationship on SKIFs**

| Author | Object of the study | Methodology |
|---|---|---|
| Huggins and Weir (2012) | How small knowledge-intensive business service (KIBS) firms manage their knowledge-based processes, or what are termed "intellectual assets". | Likert Questionnaire Creation of a model |
| Jenssen and Nybakk,(2009) | Relationship between external relations and innovation in small and knowledge-intensive Norwegian firms. | Likert questionnaire OLS |
| Jenssen and Nybakk (2013) | Considering the effect of inter-organizational networks on innovation in small, knowledge-intensive companies. | Literature review Creation of a base model |
| Katz et al.(2004) | Provide an overview of the network approach to small groups. | Survey on Literature review |
| Ojala (2009) | Analyse firms activities in developing network relationships, their focal network relationships, and the impact of these relationships to the market and entry mode choice of knowledge-intensive SMEs when they enter a psychically distant market for their products. | Case study |

Source: Own elaboration

## 2.3 The importance of SKIFs in modern economies

SKIFs are important for modern economy due to their contribute to innovation, employment and technological development; has seen earlier in this thesis a SKIF will bring positive benefits mainly to the innovation area duo to being a knowledge intensive firm on top of being a SME which historically have been described has agents of innovation. According to the Wymega et al. (2012) knowledge-intensive service sectors function as a facilitator, carrier or source of innovation, and through their symbiotic relationship with client firms, some KIS function as co-producers of innovation.

The KIS sector also can be considered as an important driver of employment growth (Schricke et al., 2011). For other side, the productivity of SMEs involved in both high-and medium high-tech manufacturing and knowledge intensive sectors was above that of SMEs (Wymenga et al., 2012), and the average growth rate of VA by SMEs in EU countries with above average KIS shares is higher in this period than the EU average and that of the group of countries with below average KIS SME shares (Wymenga et al., 2012).

So, SKIFs create a large proportion of new jobs and contribute both to innovation and technological change (Jensen & Nybakk, 2009), as well as they are key players in the renewal of economy (Jensen & Nybakk, 2013).

For Gagliardi et al. (2013:22*)"the SME sector has acted as a buffer for the economic crisis in Europe, where the SMEs of the manufacturing sector are struggling to improve their performance in the context of declining share of manufacturing value-added in GDP , and SMEs active in the services sector are set on an upward productivity trend, especially in the segment of knowledge-intensive services".*

# 3 Empirical Chapter: Data, Methodology and Results

The main objective of this study is to investigate the influence of SKIFs on macroeconomic indicators. With this propose, three different analyses are made.

On the first analysis the aim is to study the SKIFs composing sectors, Knowledge Intensive Services (KIS) and the High and Medium High Tech Manufacturing firms (HMHTM) and their influence on SMEs variables[13], like gross value added and employment growth. In this part it is also compared the countries with high employment shares of SKIF per SME and the country GDPpc. To this analysis were considered the 27 EU member states, from 2009 to 2011, using the data from Wymenga et al. (2012) provided by Ecorys. This preliminary analysis goal is to demonstrate the positive influence of SKIF on SME and also on Gross Domestic Product (GDP). The section 3.1 develops this first analysis and presents an overview of the data the description, the methodology, and a discussion and analysis of the results obtained.

On the second analysis the aim is to study the relation between SKIF variables[14] growth and GDP or BERD growth, by other way, how SKIF variables contribute to macroeconomic growth. To this analysis were considered 24 EU member states[15], from 2008 to 2012, using an EU firms Database provided by EU also used on Gagliardi et al. (2013) and Eurostat. With this aim a Panel Data was applied. In section 3.2, the second database is presented followed by methodology and results.

The third analysis aims to complement the second one, by seeing how the different countries are grouped in clusters according to SKIFS properties. With this propose a Cluster Analysis was done. The countries, the period under analysed are the same as in the previous one, as well as the database. Meaning that in section 3.3 the database of 3.2 is showed in another perspective.

Although the first analysis is very different from the other two, they even have a different database, the purpose of these three different analysis is to provide a better overview of SKIFs influence in macroeconomic values, they all lead to similar conclusions but each adds different information found relevant to this study and conclusions presented.

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[13] SKIFs are usually divided in Knowledge Intensive Services (KIS) and in High and Medium High Tech Manufacturing firms (HMHTM) and as shown on annex A2. Most of the previous studies on SKIFs field study them divided by these two categories, and their relation with SMEs.

14 Number of employers, number of enterprises and productivity

15 This Database doesn't contain values for Denmark, Greece and Germany.

## 3.1 Overview of SKIFs employment related to SMEs and GDP

### 3.1.1 Data description

The data on the present section is used to make a preliminary analysis. It separates SKIFs in Small and Medium Knowledge Intensive Services (KIS) firms and the Small and Medium High and Medium High Tech Manufacturing (HMHTM) and relates them to SMEs, and contains EU 27 member states from 2009 to 2011, it was calculated an average of the growth over 3 years (2009-2011) of the percentage share of KIS SME employment in total SME employment and the same for HMHTM employment and then compared it with the average growth of total SME employment and SME value added, the goal of this analysis is to get an idea of the weight KIS and HMHTM firms have on SMEs, the base data was provided by ECORYS and is the same as the one used in Wymenga et al. (2012).

From the table A1, in annex, it can be seen that every country that had above average growth in employment in both small and medium knowledge intensive services (KIS) and high and medium high tech manufacturing (HTHTM) also had an above average growth in SME value added and employment during 2009-2011, except Slovenia that had a negative growth in employment but an above average growth in value added by SMEs.

To have a broader point of view the countries were split into two groups and considering their share of KIS/HMHTM employment on total SME employment it is calculated the average growth in value added by SMEs and the average growth in employment by SMEs for member states with above average KIS/HMHTM employment values and for member states with below KIS/HMHTM employment average values firms.

For this section gVA - means percentage growth in value added by SMEs; gEMP - percentage growth in total SME employment; GDP average – average of real gross domestic product per capita in euro per habitant; KISemp - percentage share of KIS SME employment in total SME employment HMHTMemp - percentage share of HMHTM SME employment in total SME employment SKIFemp above/below: group of member states that have both KISemp and HMHTMemp above/below average.

### 3.1.2 Discussion of Results

According to table 3.2.3, most of the analysed studies only compare knowledge intensive firms variables with SME variables, so following the most conventional studies it was reached similar results as Wymenga et al. (2012), where member states with higher shares had higher growth on SMEs values, in this analysis the conclusions for growth of employment and KIS shares per SME was different. Additionally for this analysis, since the aim of the study is to compare SKIFs with macroeconomic variables, table 3.1.4 and 3.1.5 serve to see the SKIFs influence on GDP.

The tables displayed below are based on the database provided by ECORYS with the aim to see analysis the effects of SKIFs on SMEs. The results in the tables are showed in percentages. If the KIS, HMHTM and SKIF influence positively SMEs then it can be inferred that on average a country with higher SKIFs values will also have higher SME values, and by connecting SKIFS to SMEs it can be expected that SKIF effects on national economies will have the same signal as SME effects on national economies which will be tested on chapter 3.2.

**Table 3.1.1 KIS share and gVA and gEMP of SMEs**

| | gVA % | gEMP % |
|---|---|---|
| KISemp above | 2,3 | 0,05 |
| KISemp below | 1,39 | 0,33 |
| EU 27 Average | 1,83 | 0,20 |

Source: Own elaboration, based on Annex A1 table A1.1

On Table 3.1.1 EU states with an above average share of KIS employment tend to have higher value added growth by SMEs, surprisingly tough they tend to have less employment growth of SMEs.

**Table 3.1.2 HMHTM share and gVA and gEMP of SMEs**

| | gVA % | gEMP % |
|---|---|---|
| HMHTMemp above | 3,07 | 0,96 |
| HMHTMemp below | 0,96 | -0,22 |
| EU 27 Average | 1,83 | 0,20 |

Source: Own elaboration, based on Annex A1 table A1.1

Based on Table 3.1.2 EU member states with an above average share of HMHTM employment tend to have higher value added growth by SMEs, and also they tend to have more employment growth of SMEs.

**Table 3.1.3 SKIF share and gVA and gEMP of SMEs**

| | gVA % | gEMP % |
|---|---|---|
| SKIFemp above | 2,98 | 0,42 |
| SKIFemp below | 1,50 | 0,13 |
| EU 27 Average | 1,83 | 0,20 |

Source: Own elaboration, based on Annex A1 table A1.1

Based on Table 3.1.3 member states with an above average share of SKIF employment tend to have above average value added growth by SMEs, and also they tend to have above average SMEs employment growth.

**Table 3.1.4 SKIF share and GDP**

| | GDP average |
|---|---|
| SKIF above | 25840 |
| SKIF below | 14777 |
| EU 27 average | 21470,37 |

Source: Own elaboration, based on Annex A1 table A1.2

Through Table 3.1.4 EU member states with an above average number of SKIFs tend to have above average real GDP per capita.

**Table 3.1.5 HMTM share GDP**

| | GDP average |
|---|---|
| HMHTM above | 24750 |
| HMHTM below | 19541 |
| EU 27 average | 21470,37 |

Source: Own elaboration, based on Annex A1 table A1.2

Since the percentage of each member state KIS SME was much higher than the percentage of HMHTM SME, it was also checked if the GDP was higher for members with an above average HMHTM checking Table 3.1.5 it can be seen that the conclusion is similar.

## 3.2 Growth of SKIFs factors and their influence on GDP and BERD growth

### 3.2.1 Data description

The data retrieved for parts 3.2 and 3.3 was data on SMEs in Europe, the initial database is available on the European commission website and is the same as the one used in European Commission annual report on SMEs 2013. The initial aim of the present study was to make an analysis based on the EU27 countries but since there was missing data on Denmark, Greece and Germany the study will focus on the analysis of EU 24 countries from 2008 to 2012; the earliest year is 2008 due to NACE rev 2 being implemented since 2008, to transform the database into SKIFs data the points in NACE rev 2 (see annex A2) were used, but due to data unavailability, the points K- financial and insurance activities; O- public administration and defence, compulsory social security; P- education; Q- human health and social work activities; and R- arts, entertainment and recreation, are not included.

To understand the variables there are basic definitions that need to be mentioned:

- g stands for growth rate it is calculated with the formula :

$\frac{\mathrm{t}-t_{-1}}{t_{-1}}x100$ where t is the year

- SKIF Small (or Medium) Knowledge Intensive Firm

Repeating the definitions given on chapter 2 a SKIF is a firm with less than 250 employees and which knowledge is their main asset or source of competitiveness.

- ENT- number of enterprises

The number of enterprises in a given year

- EMP- employment

In the Eurostat database total employment is the number of persons of 15 years and above who performed any work at all, in the reference period, for pay or profit (or pay in kind), or were

temporarily absent from a job for such reasons as illness, maternity or parental leave, holiday, training or industrial dispute. Unpaid family workers who work for at least one hour, as well as work related to auto-consumption connected with the production process should be included in the count of employment, although many countries use a higher hour limit in their definition. Professional members of the armed forces should be included among persons employed.

- VA -Gross Value added

Gross value added (VA) is equal to final output minus intermediate consumption, plus subsidies minus taxes linked to production measured in millions of euros.

- PROD -Productivity

Productivity is commonly defined as a ratio between the output volume and the volume of inputs. In other words, it measures how efficiently production inputs, such as labor and capital, are being used in an economy to produce a given level of output.

For this study it was considered important to see the productivity of SKIFs in euros per worker so the formula to make this variable was:

$$\frac{VA*1000000}{EMP}$$

According to Krugman (1994:11) *"Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker."*

- BERD Business Expenditure on Research and Development

This variable is derived from Gross domestic expenditure on R&D (GERD) includes expenditure on research and development by business enterprises, higher education institutions, as well as government and private non-profit organizations. To reach a conclusion about SKIFs influence to national economies

- GDP - Real gross domestic product per capita

Levels of GDP per capita are obtained by dividing GDP at current market prices by the population; growth in the production of goods and services is a basic determinant of how the economy fares. By allocating total production to each head of population, shows the extent to which the total

production of a county can be shared by its population. The growth in real GDP per capita indicates the pace of income growth per head of the population. As a single composite indicator it is a powerful summary indicator of economic development. Note that it does not directly measure sustainable development but it is a very important measure for the economic and developmental aspects of sustainable development.

The variables used in the study are aggregations of the previous concepts; for example gSKIFENT is the growth in the number of SKIF enterprises.

It wasn't found a study that could compare SKIFs variables to country GDP variables so for the expected results an induction that if SME variables influences GDP in a positive way and SKIF influences SME values in a positive way then SKIF influence GDP in a positive way was made.

Prior to the results it's assumed that employment and productivity will have a positive and most relevant influence on the dependent variables due to most studies being made use employment and productivity for their econometric estimations, and there statements such has that employment share in knowledge intensive services has a positive trend with GDP (Schricke, 2012). Tables 3.2.1 and 3.2.2 serve has a summary to the expected signal of influence of the independent variables on the dependent one and table 3.2.3 shows a list of papers important to base the assumptions on the expected signal. However, none of them covers the entire scope of this study, for example (Schricke, 2012) study only the influence of knowledge intensive services by regions and Gagliardi et al. (2013) studies the influence of SMEs in general for national economies briefly referring to SKIFs positive effects.

**Table 3.2.1 Expected effects on growth of Gross Domestic Product**

| Variables | Equation | Expected signal |
|---|---|---|
| gSKIFPROD | GSKIFPROD=$(\frac{x_t - x_{t-1}}{x_{t-1}})$*100<br>With $x = \frac{VA*1000000}{EMP}$<br>VA and EMP retrieved from the database and selecting only SKIFs according to NACE Rev 2 | Positive effect on GDP, higher growth rate of SKIF productivity will translate in higher growth rate of GDP |
| gSKIFEMP | gSKIFEMP=$(\frac{x_t - x_{t-1}}{x_{t-1}})$*100<br>With $x = EMP$ | Positive effect on GDP, higher growth rate of SKIF employment will translate in higher growth rate of GDP |
| gSKIFENT | GSKIFPROD=$(\frac{x_t - x_{t-1}}{x_{t-1}})$*100<br>With $x = ENT$<br>ENT retrieved from the database and selecting only SKIFs according to NACE Rev 2 | Will have a positive effect on GDP, the higher the growth rate of the number of SKIF enterprises the higher the growth rate of GDP. |

Source: Own elaboration

## Table 3.2.2 Expected effects on growth of Business Research and Development

| Variables | Expected signal |
|---|---|
| gSKIFPROD | Positive effect on BR&D, higher growth rate of SKIF productivity will translate in higher growth rate of BR&D |
| gSKIFENT | Will have a positive effect on gBERD, the higher the growth rate of the number of SKIF enterprises the higher the growth rate of BR&D. |
| GSKIFEMP | Positive effect on BR&D growth |

Source: Own elaboration

## Table 3.2.3 Reference Studies

| Author | Object | Methods | variables |
|---|---|---|---|
| Gagliardi et al. (2013) | provide an overview of the current status of European SMEs, their structure, their contribution to employment and to the wealth of the European Union;<br><br>To analyse how and to what extent SMEs are recovering from the economic crisis and what the outlook is for the SME sector in the future. | Regression, Cluster analysis | Number of enterprises<br>Value added<br>Employment |
| Innovation Union (2011) | is the economic structure and KIF in Europe becoming more knowledge intensive | Graphic analysis | Employment<br>R&D<br>BERD |
| Kuusisto and Meyer (2003) | explore the role of services<br>in relation to technology development and innovation | Cluster analysis | BERD<br>Employment<br>Labour productivity<br>Services imports and exports |
| Marzocchi and Gagliardi (2013) | Present country-level indicators showing the variation between 2008 and 2012 of number of SMEs, employment by SMEs and SME value-added. | grouping service sectors activities | Number of enterprises<br>Value added<br>employment |
| Saarenketo et al. (2003) | Identify how development of knowledge and capabilities may contribute to the rapidity and extensiveness of internationalization. | Development of a model | Model variables (not relevant to country study of SKIF) |
| Schricke et al. (2012) | give an insight into service activities in Europe | Cluster analysis | KIS employment share<br>GDP per capita<br>BERD<br>Share of pop with edu3 (age 25-64)<br>Growth of GDP |
| Wymenga et al. (2012) | Provide an overview of the current status of European SMEs.<br>Insights into the key drivers of growth and competitiveness, such as the role of high-tech manufacturing and knowledge-intensive service | Regression, Cluster analysis | Number of enterprises<br>Value added<br>Employment |

Source: Own elaboration

After defining the variables they will now be described with standard descriptive statistics, correlation and then an analysis based on the figures in Annex 3.

**Table 3.2.4 Descriptive statistics of variables**

| | gSKIFENT | gSKIFVA | gSKIFEMP | gSKIFPROD | gBR&D | gGDP |
|---|---|---|---|---|---|---|
| Mean | 6,0 | 0,4 | 0,8 | -0,4 | 6,8 | -0,6 |
| Median | 0,8 | -0,1 | -0,2 | 0,1 | 3,9 | 0,4 |
| Standard deviation | 42,9 | 13,5 | 7,9 | 11,1 | 19,2 | 4,4 |
| Min | -21,27 | -26,1 | -14,1081 | -21,0 | -18,711 | -15,7 |
| Max | 412,7 | 80,2 | 54,7 | 69,6 | 108,2 | 9,6 |

Source: Own elaboration

It can be observed in table 3.2.4 that only gSKIFPROD and gGDP have a negative mean value on the period analysed, this is probably due to the 2008-2009 financial crises, has it can be seen by the median that is positive on these two variables.

**Table 3.2.5 Correlation between variables**

| Correlation | gSKIFVA | gSKIFENT | gSKIFPROD | gSKIFEMP | gGDP | gBERD |
|---|---|---|---|---|---|---|
| gSKIFVA | 1 | | | | | |
| gSKIFENT | 0.3724 | 1 | | | | |
| gSKIFPROD | 0.8306 | -0.0310 | 1 | | | |
| gSKIFEMP | 0.5350 | 0.7310 | -0.0238 | 1 | | |
| gGDP | 0.5420 | 0.0836 | 0.4585 | 0.2998 | 1 | |
| gBERD | 0.1732 | 0.3587 | 0.2205 | 0.3437 | 0.3591 | 1 |

Source: Own elaboration

On table 3.2.5 we can see that the correlation between variables is low with the exception of gSKIFPROD and gSKIFVA, gSKIFVA was not used in the models due to low statistical significance and high correlation with gSKIFENT.

On the figures of Annex 3 (A3) EU average was a variable created for comparative reasons, this EU average is the average of the 24 EU countries analysed.

**Number of Enterprises:** (in Figures A.3.1, A3.4, A3.7, A.3.13)

Relating to the number of SKIF enterprises; it can be observed Italy has the highest number of both SKIF and SMEs but it has a negative trend, Sweden has the highest share of SKIFs per SME with a positive trend; Slovakia was the country with the most growth in SKIF number from 2009

to 2010 (over 400%) it can be seen that this growth was both in SKIF and SME number due to the decrease on the share of SKIFs per SME.

Most countries have a low number of SKIFs partly due to their low number of SMEs one huge exception to this is Estonia who is the country with the lowest shares of SKIF per SME.

The period with highest growth in SKIF numbers was from 2009-2010 although it was highly influenced by Slovakia growth, it can be seen that this period had the highest growth for five other countries.

On average of the countries analysed the growth in SKIF enterprise number was positive, the only negative period was 2010-2011.

On average of the countries analysed the share of number of SKIF per SME has a positive trend.

**Value Added:** (in Figures A.3.2, A.3.5, A.3.8, and A.3.14)
Relating to the gross value added by SKIF it can be seen that UK and France have the highest gross value added and even though the UK has the highest share, part of the low gross value added of some countries can be explained by the low gross value added of all SMEs.

On average, the share of the gross value added by SKIFs has been increasing over the years analysed. In 2008-2009 most countries had a loss on gross value added by SKIFs, the only exception was Netherlands. In 2009-2010 most countries grew in gross value added by SKIFs, the exceptions where Estonia, Latvia and Netherlands although this decrease was not very high (bellow 5%). The highest growth observed was by Lithuania which grew 80% from 2011 to 2012; although now as high as the 2009-2010 period the average growth for this period is positive.

**Employment:** (in Figures A.3.3, A.3.6, A.3.9, and A.3.15)
Relating to the Employment in SKIF, in European average the employment of SKIFs has been more or less constant on European SKIFs while it as slight downward slope on all SMEs.

The country with highest number of SKIF employment is the UK which is also the country with the highest share in the number of persons employed by SKIFs per SME.

There was an increase in employment from 2009-2010 the country with the highest increase in the number of persons employed by SKIFs was Slovakia.

The average shares of number gross value added and employment have been increasing over the last years for the countries analysed.

**Dependent Variable Figures:**

About GDP per capita, in Figures A.3.11 and A.3.12, from the data in these figures it can be seen that Luxembourg is the country of the sample with the highest GDP per capita; only Poland and Sweden had a positive GDP per capita growth in 2008-2009 this was due to the financial crisis.

Relating to business expenditure on R&D, in Figures A.3.10 and A.3.17, aside from 2008-2009 investment on business R&D is increasing for the average of the countries analysed.

In Figure 3.2.1 EU 24 countries growth increased from 2008-2009 to 2009-2010 on all variables; Gent was the variable to achieve the highest growth of 25% this high value was in part due to Slovakia huge growth in SKIF numbers on this period which was over 400 % as mentioned above; in 2010-2011 only GDP had an increase in the growth rate, still BERD was the variable that grew more , over 10%, also on this period SKIFs had a decrease in productivity and number ; in 2011-2012 the SKIFs number and productivity went back to positive growth their GVA saw a higher growth then on the previous period and while BERD had a lower growth rate this rate was still the highest, GDP and employment on SKIFs had a slightly negative growth.

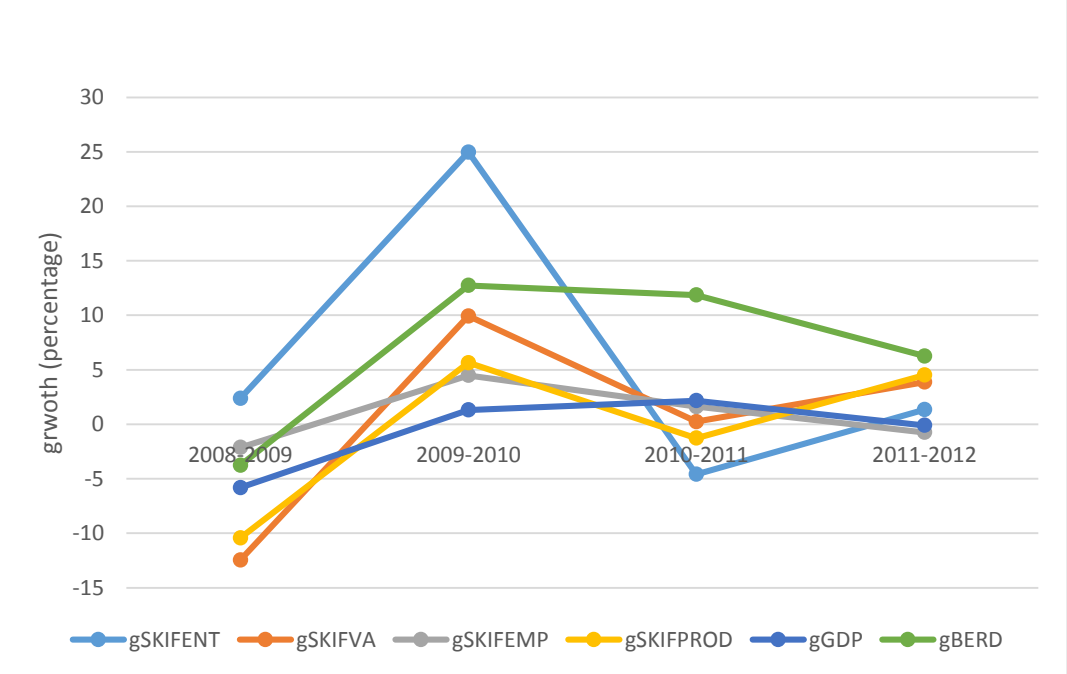


**Figure: 3.2.1 European Union 24 average growth**

Source: Own elaboration

### 3.2.2 Panel data methodology

After the overview follows a econometric analysis with a database provided by European commission mentioned on the last chapter, two different dependent variables are considered in order to provide insight on which SKIF component brings the most benefit to national economies.

Originally the analysis was meant to have 120 observation but due to absolute values failure in the ADF test the variables are transformed into growth rates, this caused a loss of 24 observations the proceedings followed for estimation and testing can be found on Park (2011).

It's observed variables for N units, called the cross-sections, for T consecutive periods:
$(Y_{it}, X'_{it})$
i = 1 . . . N, with N the cross-sectional dimension.
t = 1 . . . T, with T the temporal dimension.
→ Panel of size N×T
On this case N is the countries (24) T years (4) giving a sample of 96 (24*4)

The basic OLS estimator was

$$Y_{it}=\beta_0 + X'_{it}\beta + \varepsilon_{it} \quad (1)$$

With
t= 1 . . . T time periods and
i = 1 . . . N cross-sectional units.
The $X'_{it}$ is the observed part of the heterogeneity.
The $\varepsilon_{it}$ contains the remaining omitted variables.

Since looking at the variables it was suspected to exist cross section fixed effects the following estimation was made

LSDV=Least Squares Dummy Variable estimation

$$Y_{it}= \beta_0 + \alpha 1 D1i + \ldots + \alpha n Dni + X'_{it}\beta + \varepsilon_{it} \quad (2)$$

With $D_{ji} = 1$ if i = j and zero if i ≠ j.

The regression was built assuming the following assumptions to be valid:
$E(\varepsilon_{it}) = 0$.

$V(\varepsilon_{it})$ = σ2 for all i.

$\varepsilon_{it}$ and $\varepsilon_{js}$ are independent for all i ≠ j or t≠ s

$\varepsilon_{it}$ and $X'_{jit}$ are independent for all j, i and t.

$\varepsilon_{it}$follows a normal distribution for all i.

αi (i=1….n) is the unknown intercept for each entity (n entity-specific intercepts)

The intercept ($\beta_0$) is the average of individual group intercepts, while a dummy coefficient is the deviation of the group intercept from the averaged intercept

∑ αi (i=1….n)=0

The independent variables are not expressed as an exact linear function of the others, in other words, there are no inter-correlations among the explanatory variables.

To test the normality, a histogram-normality test was run, which simultaneously perform the Jarque-Bera statistic found in annex 4.

In order to check if/how SKIF growth influences GDP and BERD growth, 4 models were created with the 2 different dependent variables, model 1 and 3 uses the equation (2) and model 2 and 4 uses equation (1) as its basis, to check for redundant fixed effects a F-test to the dummy variables was made, to test if there are random effects Hausman test is used; the results of each will be presented along with model results. Figure 3.2.2 provides a big picture of the estimation process.

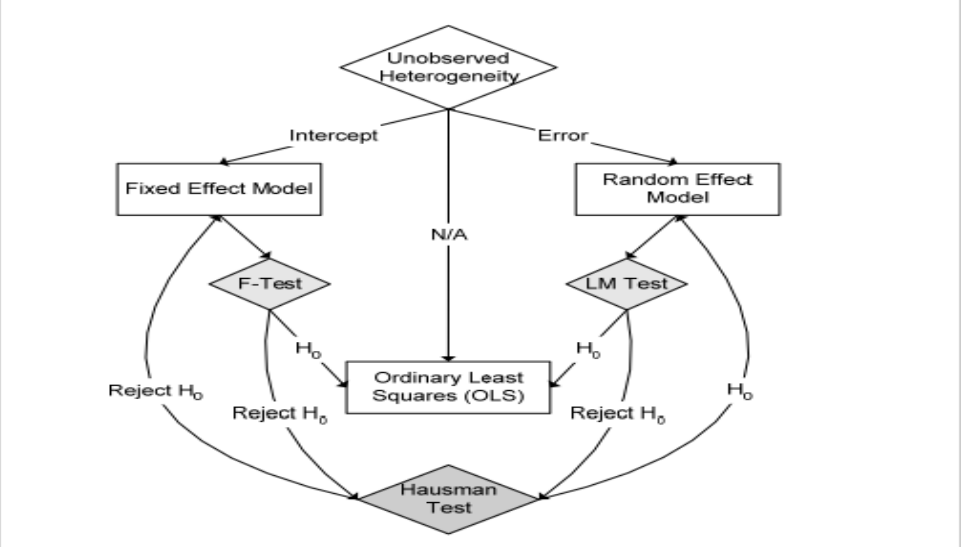


**Figure 3.2.2 Panel data estimation process**

Source: Adapted from Park (2011)

### 3.2.3 Panel data results

In the Panel data analysis it was found some interesting results although it is hard to support them due to the lack of literature analysing SKIF variables with country variables.

**Table 3.2.6 Dependent Variable: GDP growth[16]**

| Variable | Model 1 | Model 2 |
|---|---|---|
| Constant | -0.5700*** | -0.8979*** |
| | (0.1910) | (0.2077) |
| gSKIFPROD | 0.2293*** | 0.2367*** |
| | (0.0235) | (0.0251) |
| gSKIFEMP | 0.3459*** | 0.2915*** |
| | (0.0468) | (0.0460) |
| gSKIFENT | -0.0382*** | -0.0256*** |
| | (0.0077) | (0.0084) |
| Austria | -0.2378 | |
| Belgium | -0.1415 | |
| Bulgaria | 0.4372 | |
| Cyprus | -0.4668 | |
| Czech Republic | -1.9732 | |
| Estonia | 1.3229 | |
| Finland | -0.7958 | |
| France | -0.8214 | |
| Hungary | -1.0415 | |
| Ireland | 0.1635 | |
| Italy | -0.6242 | |
| Latvia | 2.2055 | |
| Lithuania | -2.5015 | |
| Luxembourg | -1.8757 | |
| Malta | 0.5213 | |
| Netherlands | -0.1771 | |
| Poland | 3.5366 | |
| Portugal | -0.8074 | |
| Romania | 0.7709 | |
| Slovakia | 2.5329 | |
| Slovenia | -1.4776 | |
| Spain | -0.3331 | |
| Sweden | 2.8853 | |
| United Kingdom | -1.1016 | |
| R-squared | 0.713 | 0.5605 |
| F-statistic | 6.5943*** | 39.107*** |
| Adjusted R-squared | 0.6049 | 0.5462 |
| Cross section F | 1.6117* | |

Standard errors in parenthesis; Statistical significance: * <.1, ** <.05, *** <.01
Source: Own elaboration

[16] gSKIFPROD is the percentage growth of SKIF productivity, gSKIFEMP is the percentage growth of SKIF employment and gSKIFENT is the percentage growth of SKIF enterprises.

The results for Hausman test was a chi square of 3.2796 with a p-value of 0.3505 meaning that it's not appropriate to use a random effects model. The influence that the independent variables have on GDP growth is not very high but due to their high statistical significance and the statistical significance of the model itself conclusions can be drawn.

According to the model 2 in table 3.2.6 an increase in the productivity growth will cause an increase in GDP growth (0.237 for each 1% increase), employment has more impact on gGDP, an increase in the employment growth will cause an increase in the GDP growth (0.292% for each 1% increase), this goes according the expected sign and theory that more employment will cause more GDP, these variables go according to the expected sign and are statistically relevant. On the case of the growth in the number of enterprises a 1 % increase in gSKIFENT will cause a decrease in the gGDP by 0.03% making the growth in the number of SKIFs the less relevant variable on the model however it has a negative sign meaning that according to the model an increase in the growth of the number of enterprises will cause a decrease in the GDP growth.

This doesn't go according to the expected sign, where it was assumed that an increase in the number of enterprises would cause an increase in the growth of the GDP, both employment and productivity have a positive influence on GDP growth, while enterprise numbers have a residual and negative influence on GDP growth. From this results one conclusion might be that for SKIFs to drive economic growth by themselves it is better to focus government budget on policies to improve quality of the labour force therefore improving productivity since has seen previously SKIFs rely heavily on qualified work force (aka Knowledge workers) and policies to facilitate labour flows rather than focus funds to facilitate the creation of new firms.

On the model 1 the fixed effects, show how each country intercept differentiates from the mean, we can see that many of them have values close to zero which can partly explain the cross section F test having a p-value of .06 meaning it's up to the reader to decide if they are relevant or not, the conclusions of this study don't change because the sign of the independent variables doesn't change (from model 1 to model 2).

**Table 3.2.7 Dependent Variable: BERD growth[17]**

| Variable | Model 3 | Model 4 |
|---|---|---|
| Constant | 6.6959*** | 3.4229*** |
| | (0.6219) | (0.8384) |
| gSKIFPROD | 0.2409*** | 0. 2529*** |
| | (0.0756) | (0.0866) |
| gSKIFEMP | 0.5083*** | 0. 4369** |
| | (0.1913) | (0.2062) |
| gSKIFENT | -0.0399 | 0.0161 |
| | (0.0547) | (0.0496) |
| Austria | -4.1282 | |
| Belgium | -4.3608 | |
| Bulgaria | -2.0009 | |
| Cyprus | 28.150 | |
| Czech Republic | -17.527 | |
| Estonia | 25.866 | |
| Finland | -9.0954 | |
| France | -4.2563 | |
| Hungary | 3.7600 | |
| Ireland | -1.8748 | |
| Italy | -4.7052 | |
| Latvia | -3.1547 | |
| Lithuania | -1.6424 | |
| Luxembourg | -11.528 | |
| Malta | 5.7757 | |
| Netherlands | 2.3285 | |
| Poland | 12.348 | |
| Portugal | -9.2626 | |
| Romania | -3.4893 | |
| Slovakia | 8.9512 | |
| Slovenia | 11.061 | |
| Spain | -9.4218 | |
| Sweden | -5.9368 | |
| United Kingdom | -5.8566 | |
| R-squared | 0.6197 | 0.1448 |
| F-statistic | 4.3247*** | 5.1943*** |
| Adjusted R-squared | 0.4764 | 0.1169 |
| Cross-section F | 3.5527*** | |

Standard errors in parenthesis; Statistical significance: * <.1; ** <.05; *** <.01

Source: Own elaboration

The results for Hausman test was a chi square of 0.3954 with a p-value of 0.8206 meaning that it is more appropriate to use the fixed effects model, the F test on the fixed effects dummy's also comes to support this when choosing between model 3 and model 4.

[17] gSKIFPROD is the percentage growth of SKIF productivity, gSKIFEMP is the percentage growth of SKIF employment and gSKIFENT is the percentage growth of SKIF enterprises.

Similar to models 1 and 2, it can be seen that the influence that the independent variables have on gBERD growth is not very high but due to their significance, (although not as high as model 1 and 2 for example employment growth is no longer statistically significant at 1%), and the significance of the model itself it allows to draw conclusions about the sign.

According to the model 3, in table 3.2.7, an increase in the productivity growth will cause an increase in BERD growth,( 0.238% for each 1% increase) this goes according the expected sign and theory that more productivity will cause more BERD, on the case of employment it was observed that a 1 % increase in gSKIFEMP will cause an increase in the gBERD by 0.35% meaning a according to the model an increase in the employment growth will cause an increase in the GDP growth, this goes according the expected sign, on the case of the growth pm the number of SKIFs we can't draw any conclusion since gSKIFENT didn't yield statistically relevant results. The fixed effects shows how each country intercept differentiate from the mean, unlike the one from model 1 we can see that in terms of gBERD country specific characteristics have more impact.

From these results, it can be concluded that some SKIF variables influence macroeconomic variables (GDP and BERD) with a growth in employment and productivity of SKIFs will have a positive effect on the economy causing both GDP and R&D to grow with these results it can be observed that the growth in SKIF number of enterprises is not really relevant this is an interesting find which can lead to policies implications.

## 3.3 Spatial patterns of SKIFs

### 3.3.1 Custer analysis

The cluster analysis is an analytical technique that aims to classify a sample of entities, individuals or objects, in a smaller number of mutually exclusive groups based on similarities between entities Hair et al. (1995). Grouped objects in the same cluster are quite similar to each other, so that the resulting groups are characterized by a large internal homogeneity and high external heterogeneity. Allowing them to classify and simplify the sample data and identify relationships between different entities Hair et al. (1995).

There isn't a procedure that is unanimous to all researchers to determine the exact number of clusters. Therefore, the choice made should be based on the nature and the objectives pursued by the study, focusing on theoretical concepts and practical considerations (Hair et al, 1995). Thus, as there is no hierarchical aggregation procedure that is considered the best, it is recommended to use several methods simultaneously, and if they yield similar results, then it is possible to conclude the existence of "natural" clusters (Maroco, 2003). Meaning, factors obtained were exposed to different procedures to obtain clusters and the obtained results were similar.

The interpretation of clusters may be made using the discriminatory analysis, and analysis of the variance multivariable and univariable or Kruskal-Wallis. The differences between clusters of the different variables under study were analysed using the Kruskal-Wallis method and the Chi-square tests.

The variables were subjected to a hierarchical cluster analysis, which was used as a measure of similarity between intervals/cases the square of the Euclidian distance, and as agglomeration the Ward's method [18], with the aim of maximizing homogeneity in each cluster by minimizing the variance within each group and to avoid the problem of "chaining" of observations that might occur in other clustering methods (for example the shortest distance (Single linkage) method selected by default in software SPSS) Hair et al. (1995). The Ward method retains the clusters, from all possible, to minimize the sum of squared errors (Maroco, 2003).

[18] In the method of Ward the distance between two clusters is the sum of the squares between two clusters added all variables. At each step in the agglomeration process, the internal sum of squares of each cluster is minimized in all partitions, obtained by combining two clusters from a previous stage. This procedure tends to combine clusters with a small number of observations Hair et al. (1995).

The software SPSS was used to obtain clusters analysis applied to the present study. The SPSS provides the values of closeness among the items that form the clusters, given by the coefficient of agglomeration. A sharp increase in the value of this coefficient generally indicates the number of clusters that should be retained (Hair et al., 1995). For confirmation, the number of clusters suggested by this indicator was then faced with a visual choice made to the Dendogram, which allows to perform a visual inspection of the outliers Hair et al. (1995), also provided by SPSS.

By observing the Dendogram in figure 3.3.1 and the relative variation of the coefficients of agglomeration, the latter presented in annex A5 it was chosen to be five clusters. This clustering procedure aims to detect possible patterns and types of European Countries according to their knowledge-intensive sectors. The analysis includes characteristic of European countries, such has the GDP and BERD per capita – as well as industrial characteristics – such as SKIF variables and their shares per SME. Variables refer to the year 2012 for more detail see table 3.3.1.

**Table 3.3.1 Cluster variables**

| Variable | Unit |
|---|---|
| Number of SKIF enterprises | Number of enterprises |
| SKIF Gross Value added | Millions of Euros |
| Number of persons employed in SKIFs | Number of enterprises |
| Productivity of SKIFs | Euros per worker |
| GDP | Euros per inhabitant |
| BERD | Euros per inhabitant |
| Share of SKIF enterprises per SME | Percentage |
| share of GVA of SKIFs per SME | Percentage |
| Share of Number of persons employed on SKIFs per SME | Percentage |

Source: Own elaboration

### 3.3.2 Cluster Analysis Results

From the 5 clusters obtained, cluster 1 is composed by 6 west and north Europe countries Austria, Belgium. Finland, Luxembourg and Netherlands. Cluster 2 is the biggest cluster of the sample with 10 Eastern Europe countries; Bulgaria, Czech Republic, Estonia, Hungary ,Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. Cluster 3 and 5 are the smallest clusters of the sample, they are composed only by 2 countries; Cyprus and Ireland (3); Malta and Portugal (5). Cluster 4

is composed by 4 countries; France, Italy, Spain and United Kingdom of Great Britain and Northern Ireland. It is the Cluster with highest share of SKIF VA per SME.

It can be verified that cluster 1 has the highest share of SKIF enterprises per SME and SKIF employment per SME and it is also the cluster that presents highest GDPpc and BERDpc followed by cluster 4 which presents also high shares ( above 20%) and second highest GDPpc and BERDpc, Cluster 5 and 2 are the clusters with lowest shares followed by the lowest BERD and GDP respectively, even though Cluster 3 is the cluster where there are less SKIF enterprises it is the cluster where SKIFs have high productivity making it the second cluster with most productivity on the sample.

**Table 3.3.2 Cluster Analysis**

| Clusters | Country | SKIFENT | SKIF VA | SKIF EMP | SKIF PROD | GDPpc | BERDpc | share ent | share VA | Share emp |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Austria | | | | | | | | | |
| 1 | Belgium | | | | | | | | | |
| 1 | Finland | | | | | | | | | |
| 1 | Luxembourg | | | | | | | | | |
| 1 | Netherlands | | | | | | | | | |
| 1 | Sweden | 119179 | 24045 | 417969 | 64488 | 36267 | 695 | 29 | 26 | 24 |
| 2 | Bulgaria | | | | | | | | | |
| 2 | Czech Republic | | | | | | | | | |
| 2 | Estonia | | | | | | | | | |
| 2 | Hungary | | | | | | | | | |
| 2 | Latvia | | | | | | | | | |
| 2 | Lithuania | | | | | | | | | |
| 2 | Poland | | | | | | | | | |
| 2 | Romania | | | | | | | | | |
| 2 | Slovakia | | | | | | | | | |
| 2 | Slovenia | 90083 | 5133 | 286316 | 18792 | 11770 | 128 | 18 | 23 | 18 |
| 3 | Cyprus | | | | | | | | | |
| 3 | Ireland | 20324 | 7049 | 20792 | 61204 | 20050 | 225 | 19 | 25 | 18 |
| 4 | France | | | | | | | | | |
| 4 | Italy | | | | | | | | | |
| 4 | Spain | | | | | | | | | |
| 4 | United Kingdom | 567554 | 114939 | 2080299 | 53835 | 25200 | 281 | 23 | 27 | 22 |
| 5 | Malta | | | | | | | | | |
| 5 | Portugal | 69760 | 4849 | 181603 | 27357 | 13900 | 96 | 19 | 22 | 17 |

Source: Own elaboration

# 4 Conclusion

The European Strategy 2020 reinforces the relevance of SMEs as a key driver for economic growth, innovation, employment and social integration. The relevance assumed by the EC about SMEs and the strategy of a competitive European economy based on smart, sustainable and inclusive growth leads to the importance of small and medium knowledge intensive firms (SKIFs) in the European context. Most of the studies about SKIFs are generally about either internationalization properties of SKIFs, or about how SKIFs influence SMEs, however are scarce the studies that researches the influence of knowledge intensive business services on European regions, or relate SKIFs directly with macroeconomic variables. Based on this, the present study intents to contribute to increase the scientific knowledge about this field considered so relevant to the progress of EU member state economies.

So, the purpose of this thesis was to study the importance of SKIFs to the development of European national economies. For this reason SKIF number growth, employment growth and productivity growth where regressed against GDPpc growth and BERD growth.

Some main conclusions can be draw from the findings of the study. Through the analysis conducted on section 3.1. it can be concluded that countries with above average share of employment and/or value added of SKIF have SMEs with higher employment and/or value added growth and also higher GDP; with the exception of countries that only have knowledge intensive services employment share higher than average, these had a growth in SME employment lower. Although to confirm this a deeper study should be made; it might mean that if we focus too much on increasing employment for KIS firms in the future we can aggravate the employment situation of Europe. SKIF are highly beneficial to national European economies, the average GDP per capita of the countries that have above average share in SKIFs per SME is 25840€ which is approximately 15% higher than the EU 27 average and 43% higher than the average of the countries with bellow average share of SKIF employment.

The principal findings about the growth of SKIFs' factors and their influence on GDP and BERD growth, presented in section 3.2. it allows to confirm that SKIF Productivity and Employment growth has positive effects on both GDP and expenditure on BERD growth, surprisingly tough the growth in the number of SKIFs had a negative influence in the growth of GDP it was a small negative influence and could be related to the period in analysis, but still it can make one wonder;

are SKIF numbers important to achieve economic growth or should the focus be on increasing SKIFs productivity and employment conditions.

The cluster analysis can confirm, in part, the previous obtained findings. The clusters with highest average of shares are also the clusters with higher GDPpc and BERDpc, in fact if we order them by average of the shares of SKIF values and by BERD we get the same order, and in terms of GDPpc only one cluster changes.

Every analysis points that SKIF employment growth and productivity growth are very beneficial for the member states GDP and BERD growth, since SKIFs are highly dependent on human capital SKIFs benefit with indirect investments for example on education, EU 2020 already attends to this with the goals regarding ERASMUS programs.

Policies installed under the EU 2020 strategy are already in the right direction, however I personally think that investment and support for Services, even Knowledge Intensive Services should be thought more carefully or at least thought of supporting these KIS in a ratio with HMHTM support and development.

One of the limitations problem faced on the development of this thesis was the lack of data due to the recent new NACE rev 2 it would be interesting if a similar study has this one would be made in the years to come and try to include education as a Dependent Variable, I tried to do this in the early development of this thesis yet I didn't have meaningful results. It would also be interesting to conduct a similar study on global levels although this would be very difficult to perform due to the differences in the definitions of SKIFs around the globe mentioned in the literature review part of this thesis.

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# Annex

# A1 Ecorys data analysis

**Table A1.1 Share of KIS and HMHTM employment and growth of SMEs**

| | % share of KIS SME employment in total SME employment | % growth of real value added of all SMEs | % growth of employment of all SMEs | % share of HMHTM SME employment in total SME employment |
|---|---|---|---|---|
| Austria | 16,67 | 3,7 | 1,1 | 4,2 |
| Belgium | 16,13 | 1,5 | 0,1 | 3,6 |
| Bulgaria | 10,93 | 2,4 | -1 | 3,1 |
| Cyprus | 10,17 | 0,3 | -0,8 | 1 |
| Czech Republic | 14,23 | -0,6 | -0,4 | 7,2 |
| Denmark | 16,27 | 1,8 | 0,6 | 5,3 |
| Estonia | 14,27 | 5,9 | 5 | 4,3 |
| Finland | 18,67 | 1,9 | 0 | 6 |
| France | 21,30 | 2,3 | 0,7 | 3,8 |
| Germany | 16,30 | 4,9 | 1,8 | 5,5 |
| Greece | 15,33 | -3,1 | -2,4 | 2,1 |
| Hungary | 18,37 | 2,4 | 0,1 | 4,2 |
| Ireland | 18,70 | -1,7 | -2,1 | 3 |
| Italy | 12,57 | 0,3 | -1,2 | 5,3 |
| Latvia | 13,13 | 0,5 | 2,7 | 2,3 |
| Lithuania | 11,40 | 3,5 | 2,3 | 2,3 |
| Luxembourg | 20,83 | 4,3 | 0,3 | 4,1 |
| Malta | 15,40 | 1,9 | 0,1 | 5,8 |
| Netherlands | 24,47 | 2 | -0,1 | 3,6 |
| Poland | 11,57 | 3,7 | -1,1 | 3,6 |
| Portugal | 12,17 | -0,8 | 1,7 | 2,4 |
| Romania | 12,40 | 2,6 | -0,4 | 3 |
| Slovakia | 13,10 | 1,9 | 1 | 7,7 |
| Slovenia | 16,07 | 2,2 | -1,6 | 6,3 |
| Spain | 13,10 | 0,9 | -0,9 | 2,9 |
| Sweden | 19,13 | 3,4 | 0,6 | 5,4 |
| United Kingdom | 24,83 | 1,2 | -0,8 | 4,1 |
| EU 27 Average | 15,8 | 1,8 | 0,2 | 4,2 |

Source: Own elaboration

**Table A1.2 Share of KIS and HMHTM compared to GDP**

| | % share of KIS SME in total SME | % share of HMHTM SME in total SME | % share of SKIF in total SME | GDP per capita |
|---|---|---|---|---|
| Austria | 25,26 | 1,22 | 26,48 | 32100 |
| Belgium | 23,03 | 0,95 | 23,98 | 29800 |
| Bulgaria | 13,99 | 0,98 | 14,97 | 3700 |
| Cyprus | 11,49 | 0,50 | 11,99 | 18100 |
| Czech Republic | 20,33 | 3,44 | 23,77 | 11600 |
| Denmark | 23,26 | 1,50 | 24,76 | 37500 |
| Estonia | 22,10 | 1,32 | 23,41 | 9100 |
| Finland | 19,71 | 1,93 | 21,64 | 31300 |
| France | 16,03 | 0,88 | 16,91 | 27800 |
| Germany | 21,33 | 2,01 | 23,34 | 30000 |
| Greece | 19,62 | 0,80 | 20,42 | 16200 |
| Hungary | 29,27 | 1,25 | 30,52 | 8900 |
| Ireland | 23,43 | 0,51 | 23,94 | 36500 |
| Italy | 20,55 | 1,30 | 21,85 | 23500 |
| Latvia | 20,50 | 0,98 | 21,48 | 6400 |
| Lithuania | 15,05 | 0,70 | 15,75 | 7700 |
| Luxembourg | 31,02 | 0,30 | 31,32 | 64200 |
| Malta | 18,05 | 5,94 | 23,99 | 13500 |
| Netherlands | 30,93 | 1,60 | 32,53 | 33200 |
| Poland | 17,31 | 1,09 | 18,40 | 8300 |
| Portugal | 20,08 | 0,67 | 20,75 | 14700 |
| Romania | 16,59 | 1,16 | 17,75 | 4600 |
| Slovakia | 17,68 | 2,77 | 20,46 | 9200 |
| Slovenia | 25,71 | 1,90 | 27,61 | 15400 |
| Spain | 17,97 | 0,85 | 18,82 | 20600 |
| Sweden | 25,74 | 1,92 | 27,66 | 35200 |
| United Kingdom | 29,10 | 1,92 | 31,02 | 30600 |
| EU27 average | 21,30 | 1,50 | 22,80 | 21470,37 |

Source: Own elaboration

# A.2 Aggregations based on NACE Rev. 2

## A2.1 Aggregations of manufacturing based on NACE Rev. 2

Eurostat uses the following aggregation of the manufacturing industry according to technological intensity and based on NACE Rev. 2 at 3-digit level for compiling aggregates related to high-technology, medium high-technology, medium low-technology and low-technology.

Please note that in a few cases (R&D, Employment in high-tech and HRST), due to restrictions of the data sources used, the aggregations are only made on a NACE 2-digit level. Therefore a separate list is used for data where only NACE 2-digit level is available.

| Manufacturing Industries | NACE Rev. 2 codes – 3-digit level |
|---|---|
| *High-technology* | **21** Manufacture of basic pharmaceutical products and pharmaceutical preparations<br>**26** Manufacture of computer, electronic and optical products<br>**30.3** Manufacture of air and spacecraft and related machinery |
| *Medium-high-technology* | **20** Manufacture of chemicals and chemical products<br>**25.4** Manufacture of weapons and ammunition<br>**27 to 29** Manufacture of electrical equipment, Manufacture of machinery and equipment n.e.c., Manufacture of motor vehicles, trailers and semi-trailers<br>**30** Manufacture of other transport equipment **excluding 30.1** Building of ships and boats, and **excluding 30.3** Manufacture of air and spacecraft and related machinery<br>**32.5** Manufacture of medical and dental instruments and supplies |
| *Medium-low-technology* | **18.2** Reproduction of recorded media<br>**19** Manufacture of coke and refined petroleum products<br>**22 to 24** Manufacture of rubber and plastic products, Manufacture of other non-metallic mineral products, Manufacture of basic metals<br>**25** Manufacture of fabricated metal products, except machinery and equipment **excluding 25.4** Manufacture of weapons and ammunition<br>**30.1** Building of ships and boats<br>**33** Repair and installation of machinery and equipment |
| *Low-technology* | **10 to 17** Manufacture of food products, beverages, tobacco products, textiles, wearing apparel, leather and related products, wood and of products of wood, paper and paper products<br>**18** Printing and reproduction of recorded media **excluding 18.2** Reproduction of recorded media<br>**31** Manufacture of furniture<br>**32** Other manufacturing **excluding 32.5** Manufacture of medical and dental instruments and supplies |

| Manufacturing Industries | NACE Rev. 2 codes – 2-digit level |
|---|---|
| *High-technology* | **21** Manufacture of basic pharmaceutical products and pharmaceutical preparations<br>**26** Manufacture of computer, electronic and optical products |
| *Medium-high-technology* | **20** Manufacture of chemicals and chemical products<br>**27 to 30** Manufacture of electrical equipment, Manufacture of machinery and equipment n.e.c., Manufacture of motor vehicles, trailers and semi-trailers, Manufacture of other transport equipment |
| *Medium-low-technology* | **19** Manufacture of coke and refined petroleum products<br>**22 to 25** Manufacture of rubber and plastic products, Manufacture of other non-metallic mineral products, Manufacture of basic metals, Manufacture of fabricated metal products, except machinery and equipment<br>**33** Repair and installation of machinery and equipment |
| *Low-technology* | **10 to 18** Manufacture of food products, beverages, tobacco products, textiles, wearing apparel, leather and related products, wood and of products of wood, paper and paper products, printing and reproduction of recorded media.<br>**31 to 32** Manufacture of furniture, Other manufacturing |

Source: Annex 3 of Eurostat indicators on High-tech industry and Knowledge - intensive services

## A2.2 Aggregations of services based on NACE Rev. 2

Following a similar approach as for manufacturing, Eurostat defines the following sector as knowledge-intensive services (KIS) or as less knowledge-intensive services (LKIS), where each is sub-divided in further sub-sectors. Aggregations for services are only made at NACE 2-digit level.

| Knowledge based services | NACE Rev. 2 codes – 2-digit level |
|---|---|
| ***Knowledge-intensive services (KIS)*** | **50 to 51** Water transport, Air transport<br>**58 to 63** Publishing activities, Motion picture, video and television programme production, sound recording and music publishing activities, Programming and broadcasting activities, Telecommunications, Computer programming, consultancy and related activities, Information service activities (section J)<br>**64 to 66** Financial and insurance activities (section K)<br>**69 to 75** Legal and accounting activities, Activities of head offices; management consultancy activities, Architectural and engineering activities; technical testing and analysis, Scientific research and development, Advertising and market research, Other professional, scientific and technical activities, Veterinary activities (section M)<br>**78** Employment activities<br>**80** Security and investigation activities<br>**84 to 93** Public administration and defence, compulsory social security (section O), Education (section P), Human health and social work activities (section Q), Arts, entertainment and recreation (section R) |
| Knowledge-intensive market services (excluding high-tech and financial services) | **50 to 51** Water transport, Air transport<br>**69 to 71** Legal and accounting activities, Activities of head offices; management consultancy activities, Architectural and engineering activities; technical testing and analysis<br>**73 to 74** Advertising and market research, Other professional, scientific and technical activities<br>**78** Employment activities<br>**80** Security and investigation activities |
| High-tech knowledge-intensive services | **59 to 63** Motion picture, video and television programme production, sound recording and music publishing activities, Programming and broadcasting activities, Telecommunications, Computer programming, consultancy and related activities, Information service activities<br>**72** Scientific research and development |
| Knowledge-intensive financial services | **64 to 66** Financial and insurance activities (section K) |
| Other knowledge-intensive services | **58** Publishing activities<br>**75** Veterinary activities<br>**84 to 93** Public administration and defence, compulsory social security (section O), Education (section P), Human health and social work activities (section Q), Arts, entertainment and recreation (section R) |
| ***Less knowledge-intensive services (LKIS)*** | **45 to 47** Wholesale and retail trade; repair of motor vehicles and motorcycles (section G)<br>**49** Land transport and transport via pipelines<br>**52 to 53** Warehousing and support activities for transportation, Postal and courier activities<br>**55 to 56** Accommodation and food service activities (section I)<br>**68** Real estate activities (section L)<br>**77** Rental and leasing activities<br>**79** Travel agency, tour operator reservation service and related activities<br>**81** Services to buildings and landscape activities<br>**82** Office administrative, office support and other business support activities<br>**94 to 96** Activities of membership organisations, Repair of computers and personal and household goods, Other personal service activities (section S)<br>**97 to 99** Activities of households as employers of domestic personnel; Undifferentiated goods- and services-producing activities of private households for own use (section T), Activities of extraterritorial organisations and bodies (section U) |
| Less knowledge-intensive market services | **45 to 47** Wholesale and retail trade; repair of motor vehicles and motorcycles (section G)<br>**49** Land transport and transport via pipelines<br>**52** Warehousing and support activities for transportation<br>**55 to 56** Accommodation and food service activities (Section I)<br>**68** Real estate activities<br>**77** Rental and leasing activities<br>**79** Travel agency, tour operator reservation service and related activities<br>**81** Services to buildings and landscape activities<br>**82** Office administrative, office support and other business support activities<br>**95** Repair of computers and personal and household goods |
| Other less knowledge-intensive services | **53** Postal and courier activities<br>**94** Activities of membership organisations<br>**96** Other personal service activities<br>**97 to 99** Activities of households as employers of domestic personnel; Undifferentiated goods- and services-producing activities of private households for own use (section T), Activities of extraterritorial organisations and bodies (section U) |

Source: Annex 3 of Eurostat indicators on High-tech industry and Knowledge - intensive services

## A.3 – Database related figures

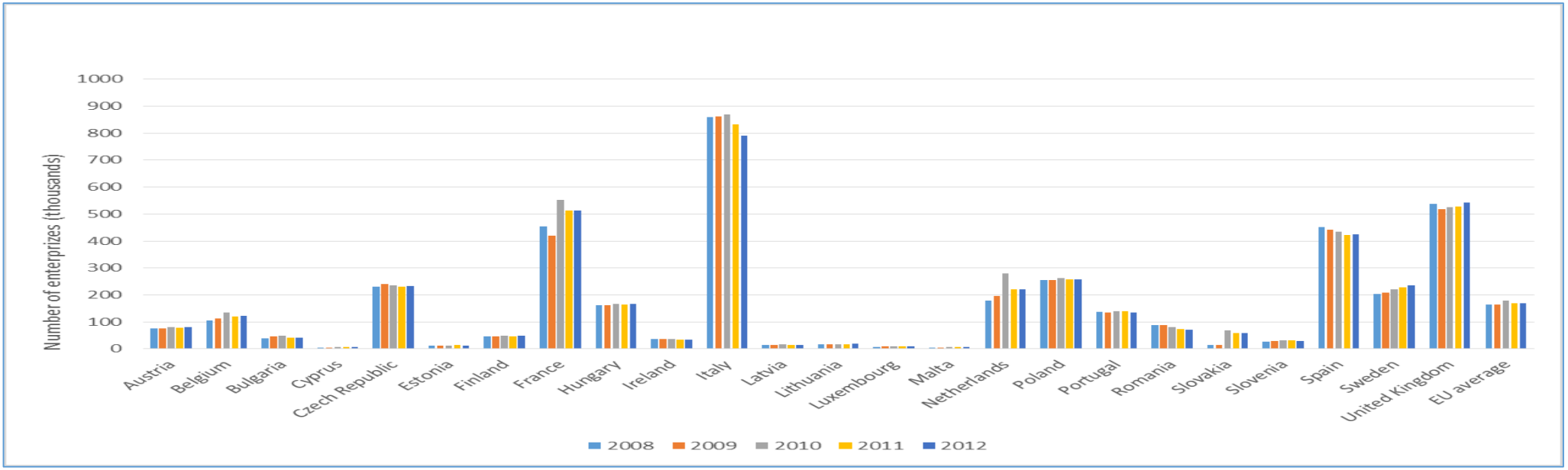



Figure A.3.1 Number SKIFs
Source: Own elaboration

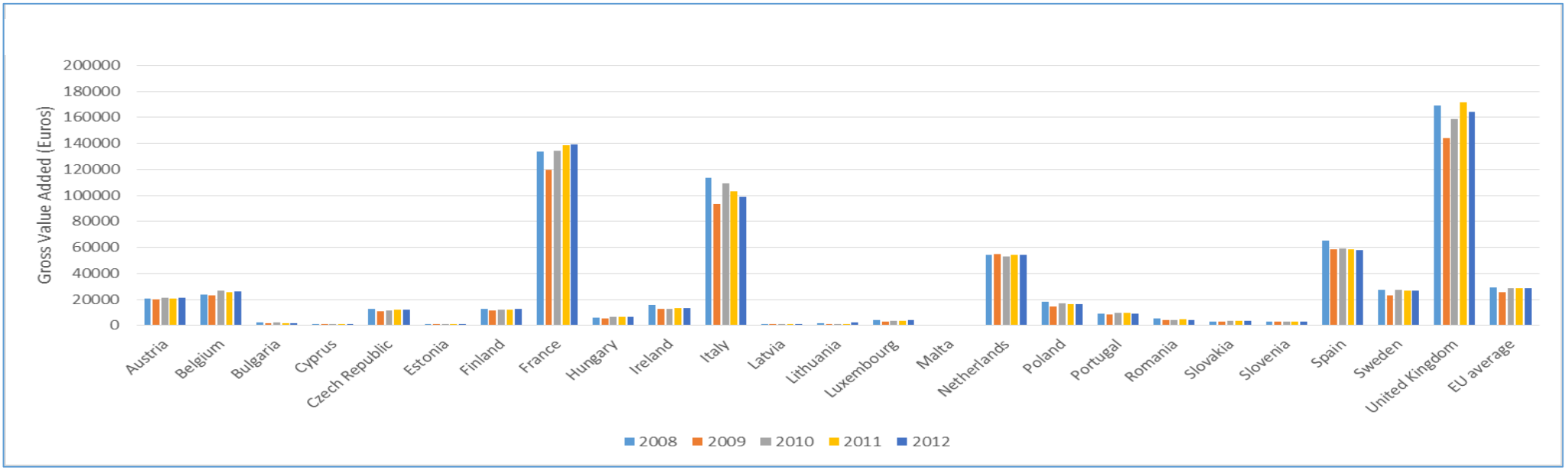



Figure A.3.2 GVA of SKIFs
Source: Own elaboration

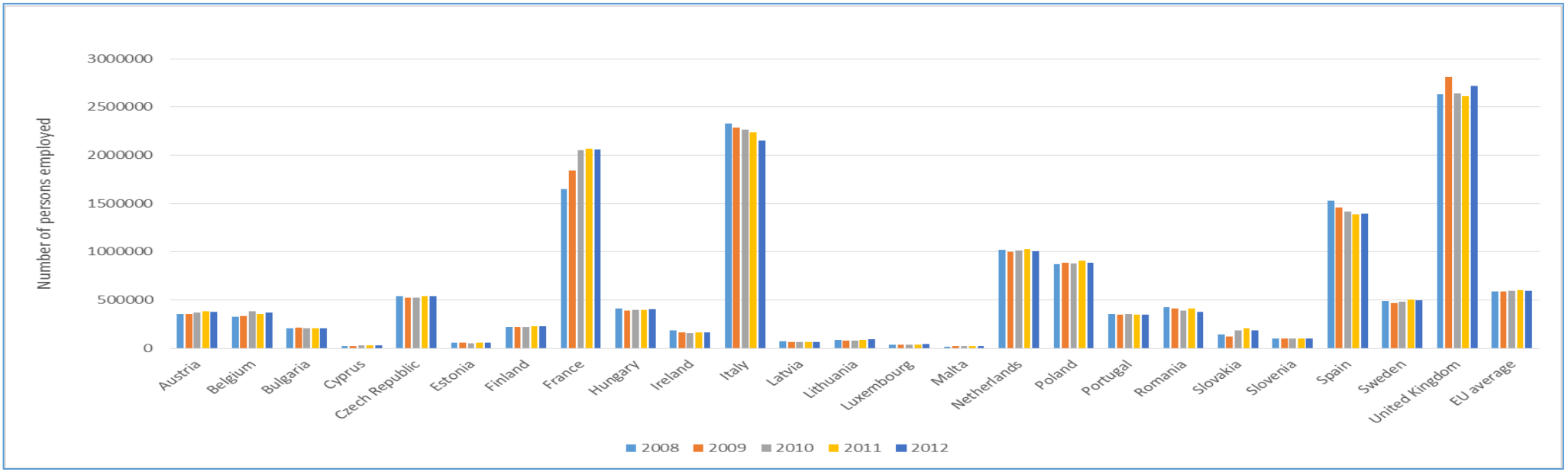



Figure A.3.3 Number of persons employed in SKIFs
Source: Own elaboration

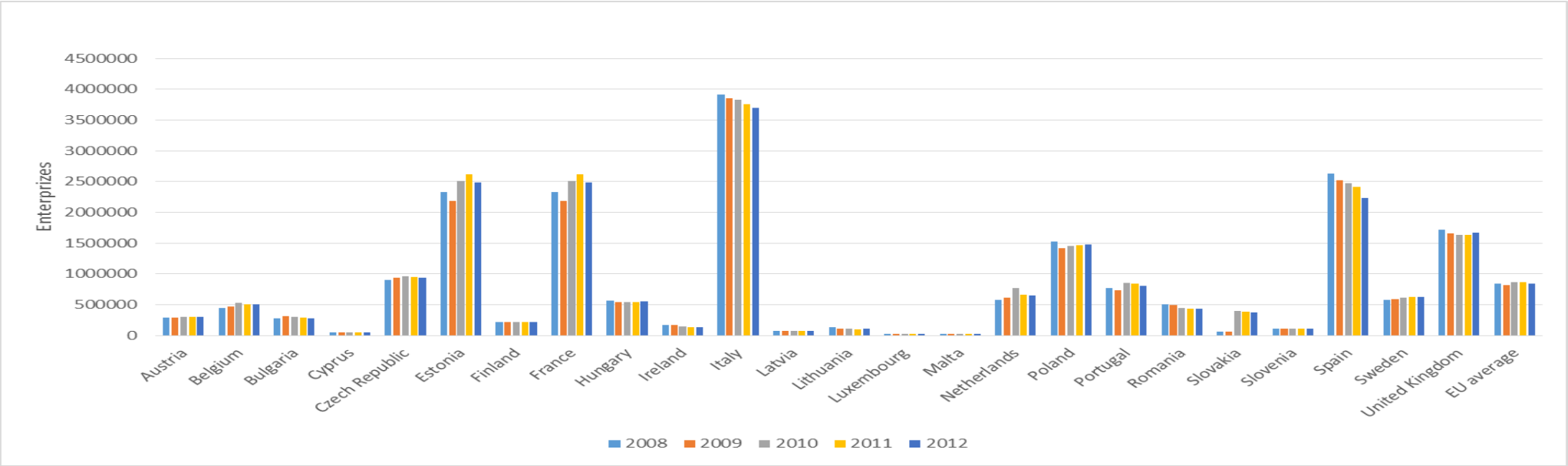



Figure A.3.4 Number SMEs
Source: Own elaboration

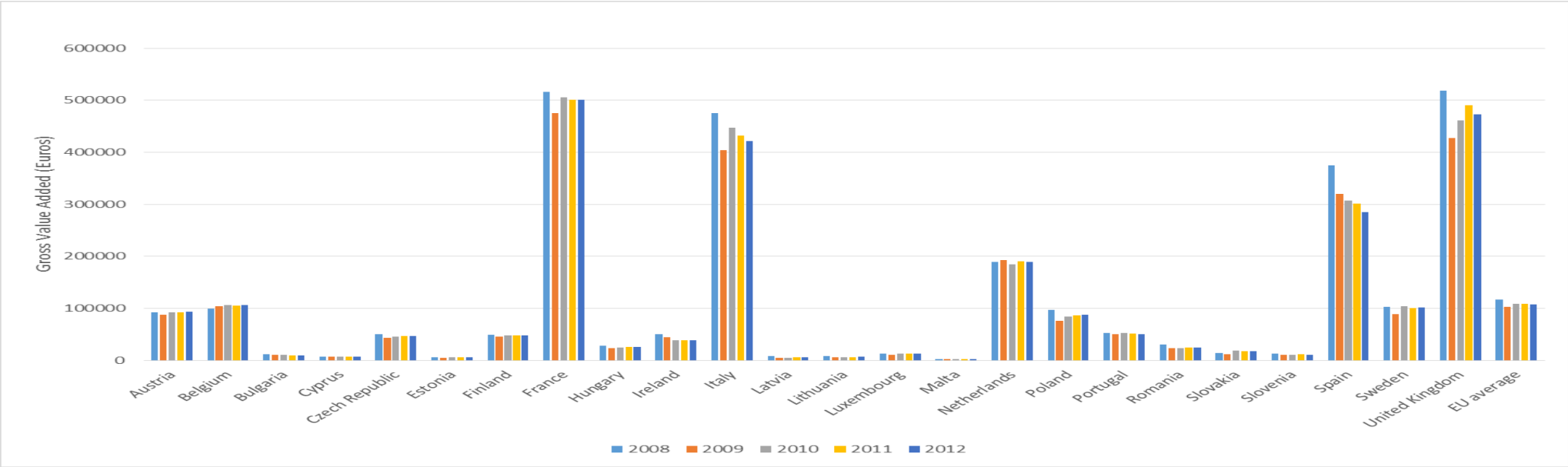



Figure A.3.5 VA of SMEs
Source: Own elaboration

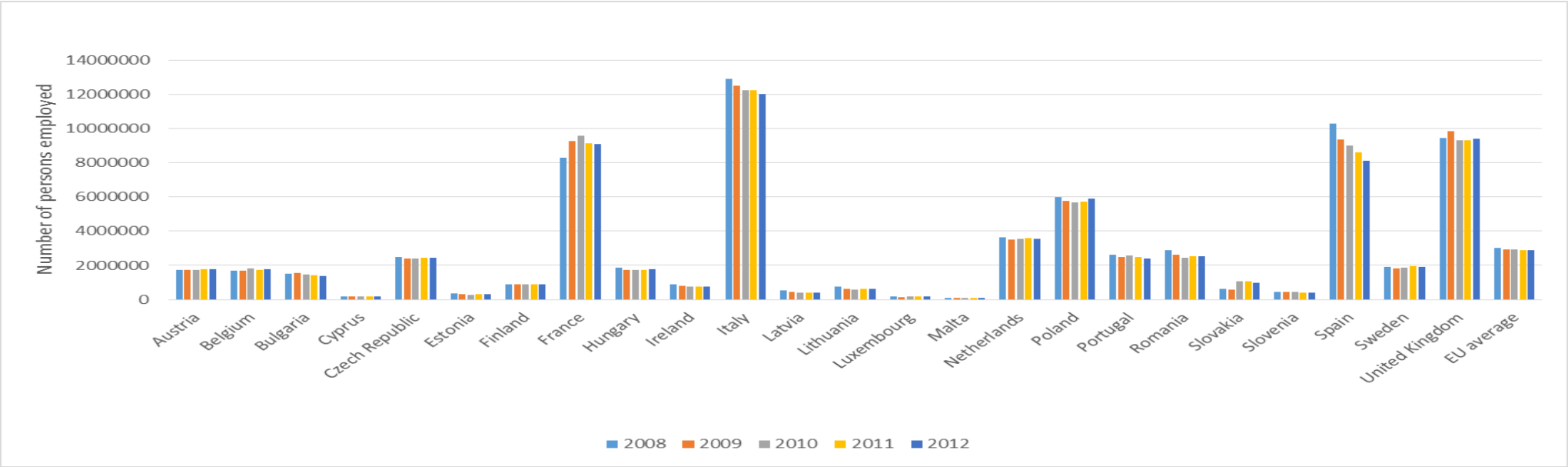



Figure A.3.6 Number of persons employed in SMEs
Source: Own elaboration

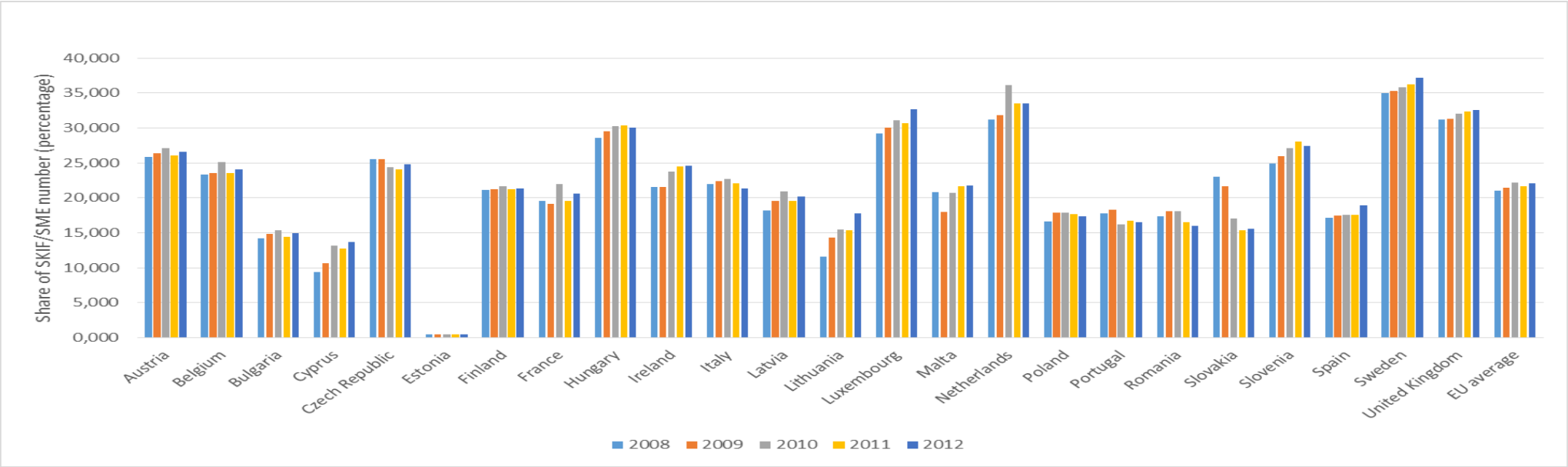



Figure A.3.7 Share of SKIFs per SME
Source: Own elaboration

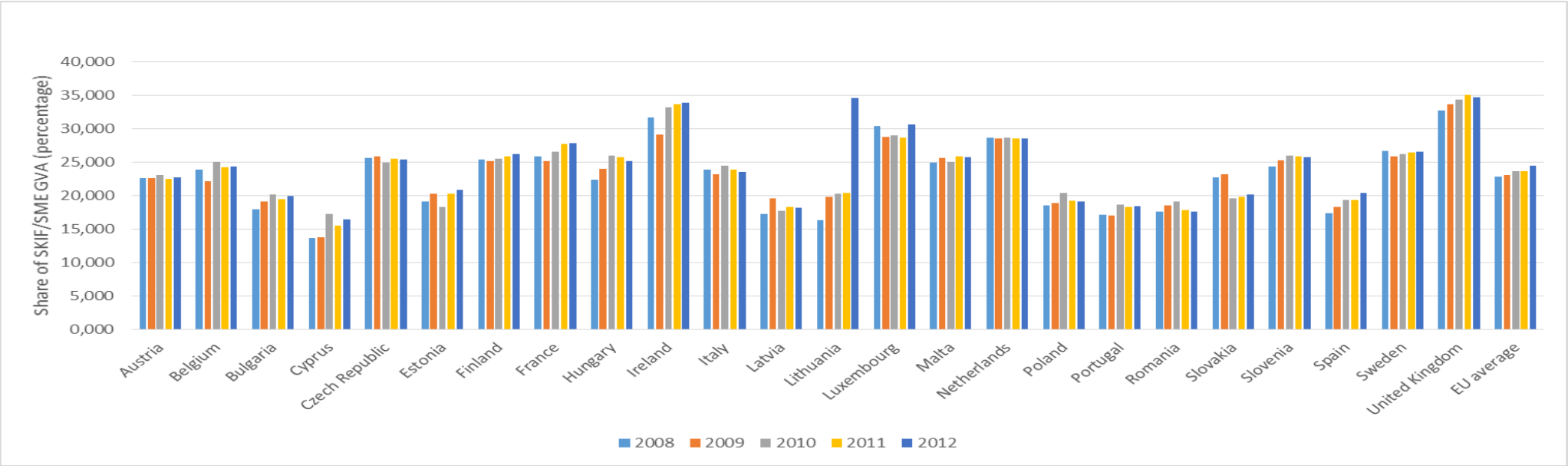



Figure A.3.8 Share of GVA of SKIFs per SME
Source: Own elaboration

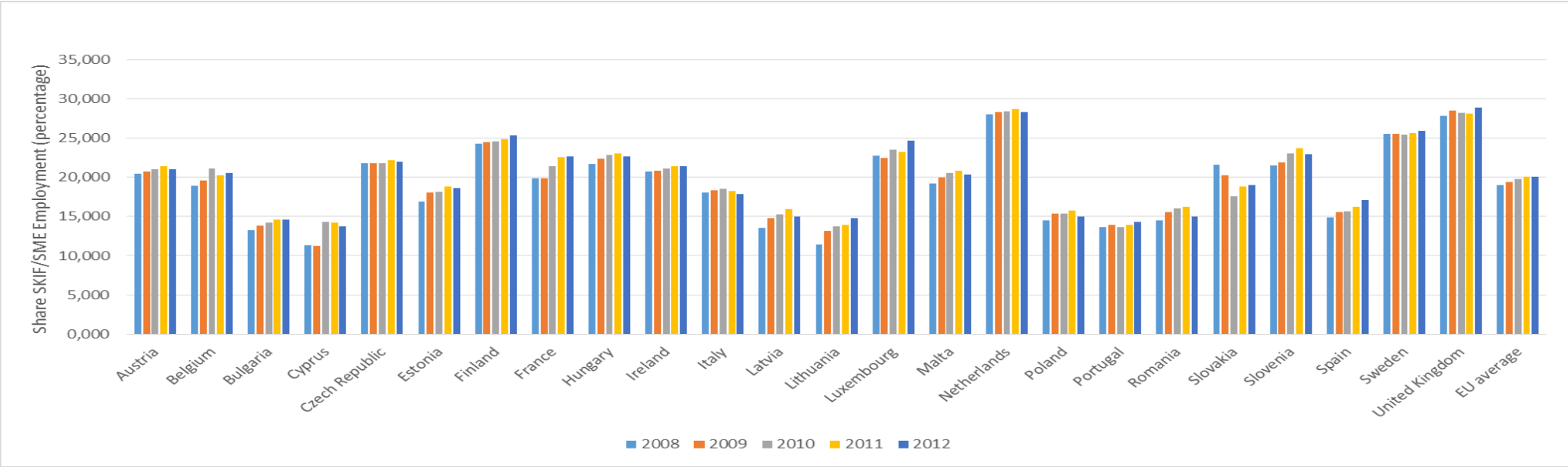



Figure A.3.9 Share of Number of persons employed in SKIFs per SME
Source: Own elaboration

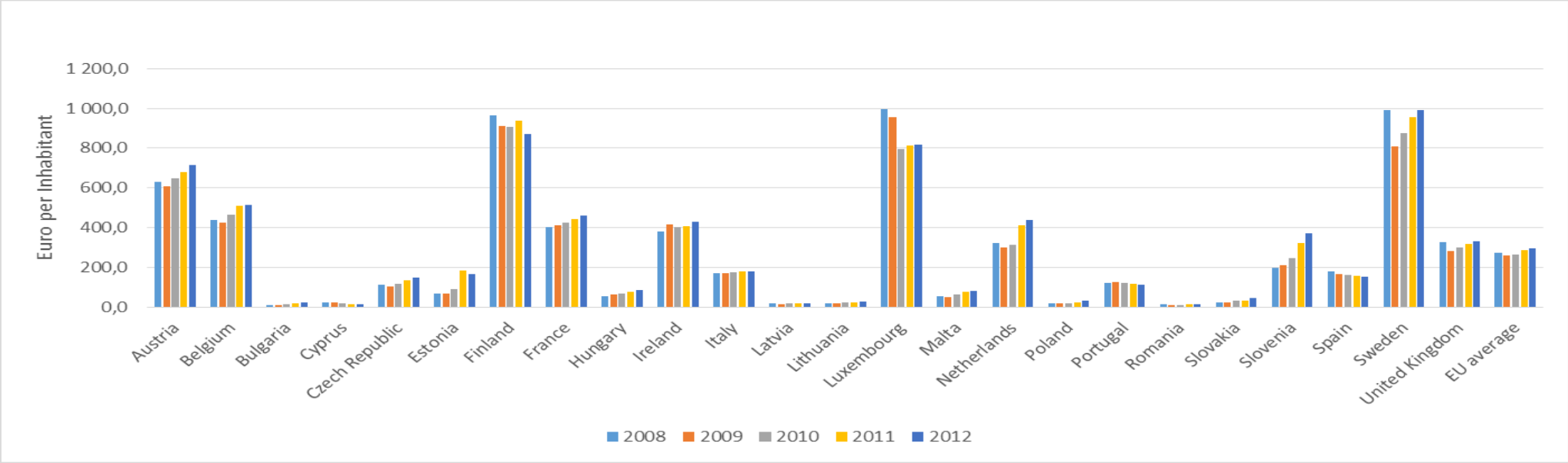



Figure A.3.10 BERD
Source: Own elaboration

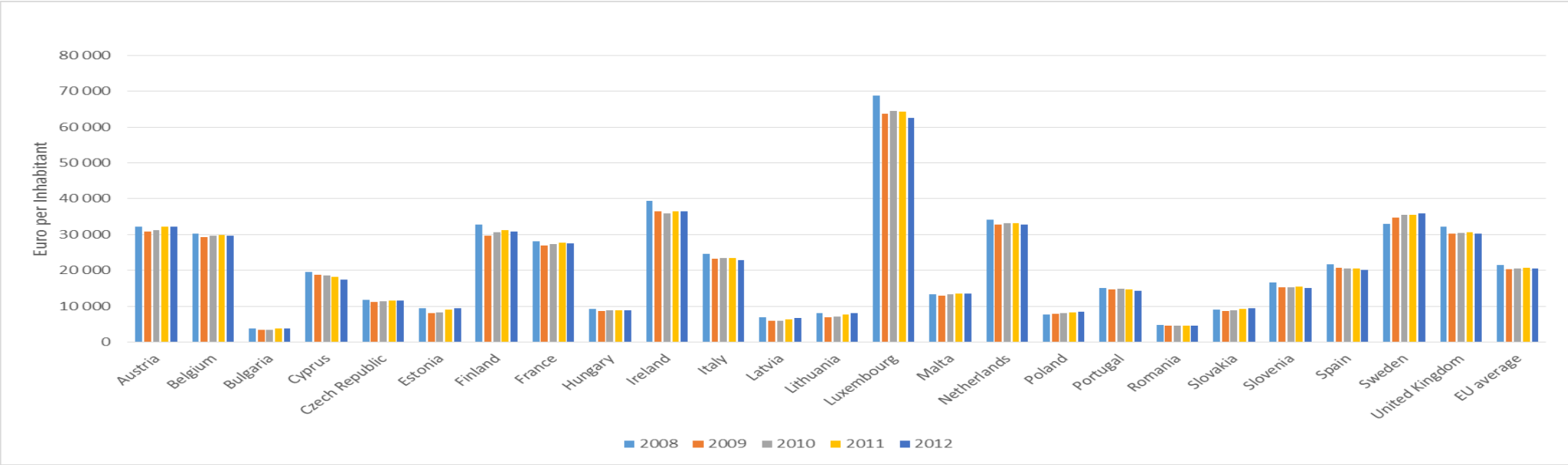



Figure A.3.11 GDP per capita
Source: Own elaboration

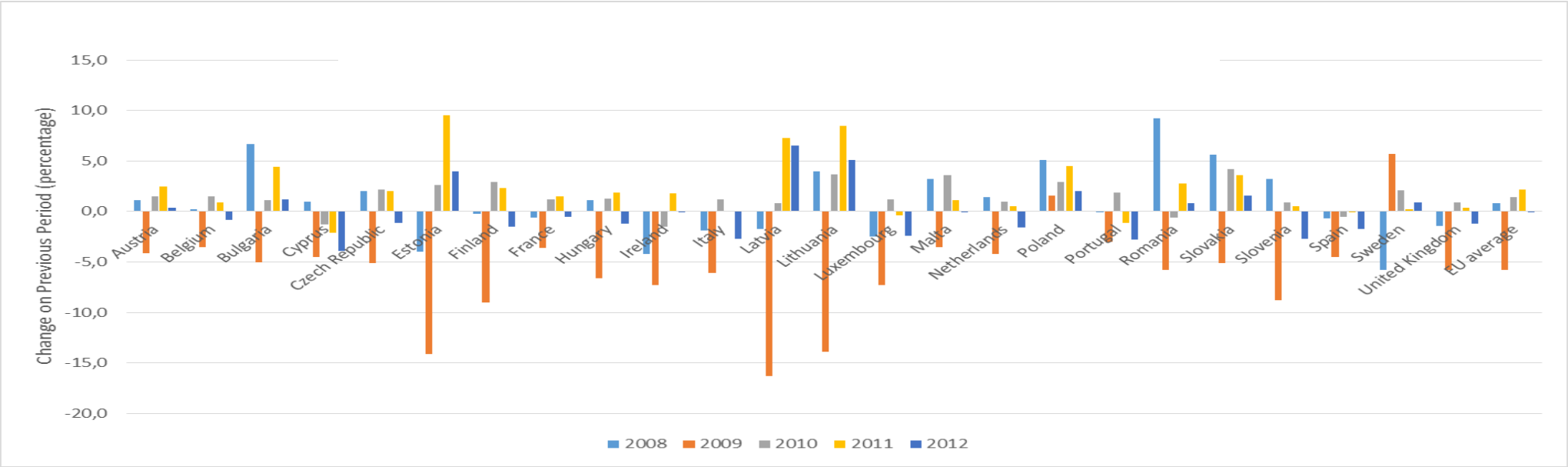


Figure A.3.12 GDP growth
Source: Own elaboration

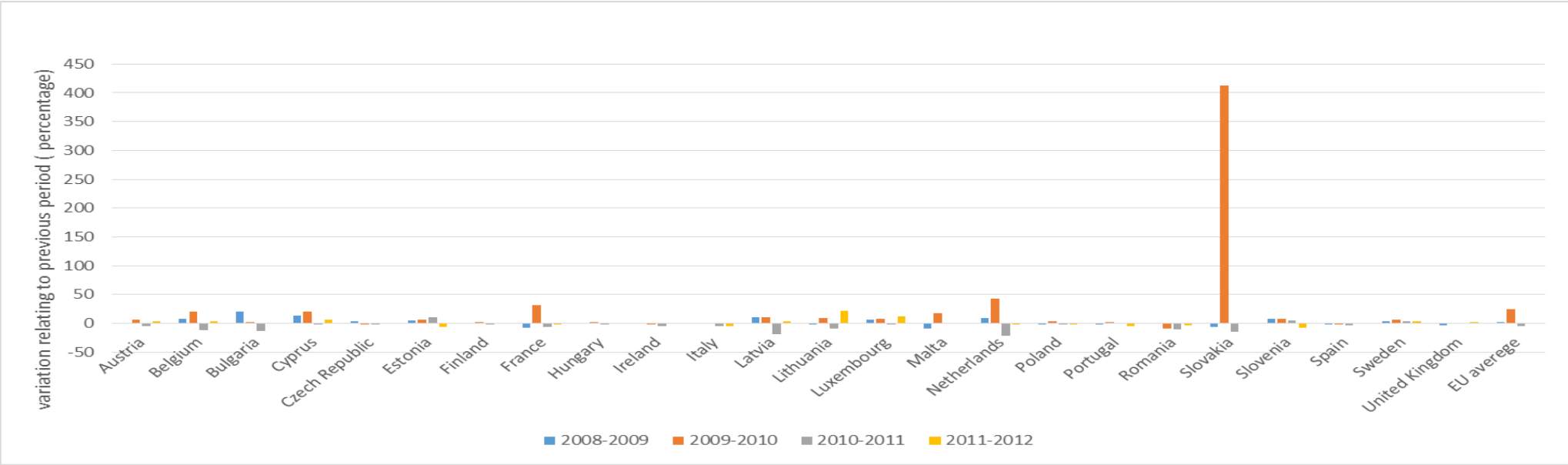



Figure A.3.13 SKIF growth
Source: Own elaboration

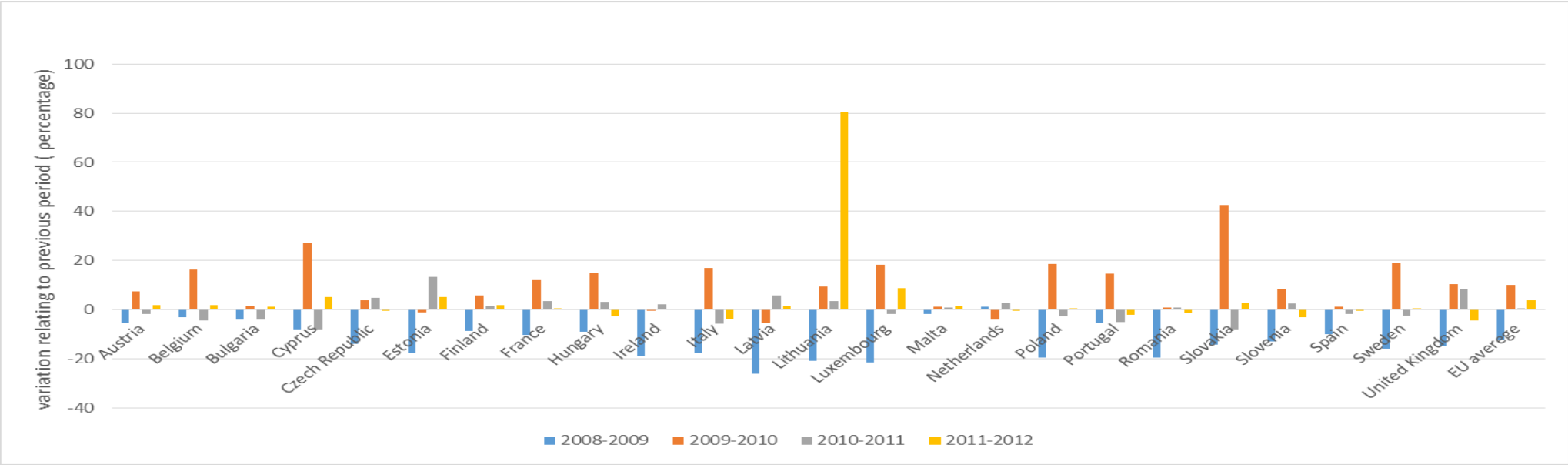



Figure A.3.14 Growth of SKIFs VA
Source: Own elaboration

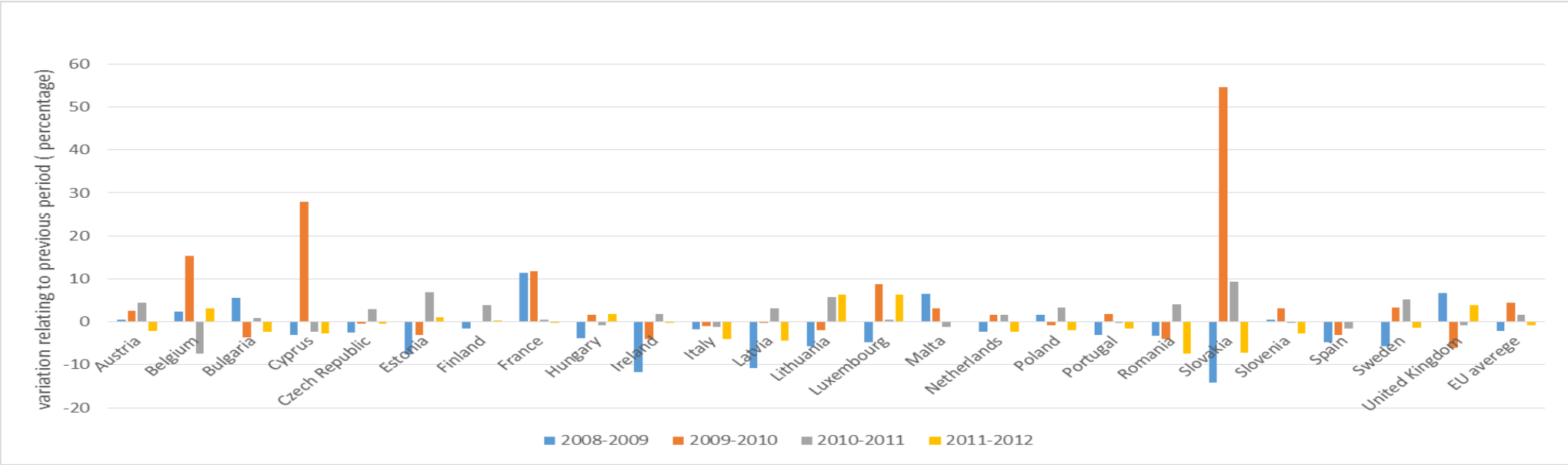



Figure A.3.15 Growth of Number of persons employed in SKIFs
Source: Own elaboration

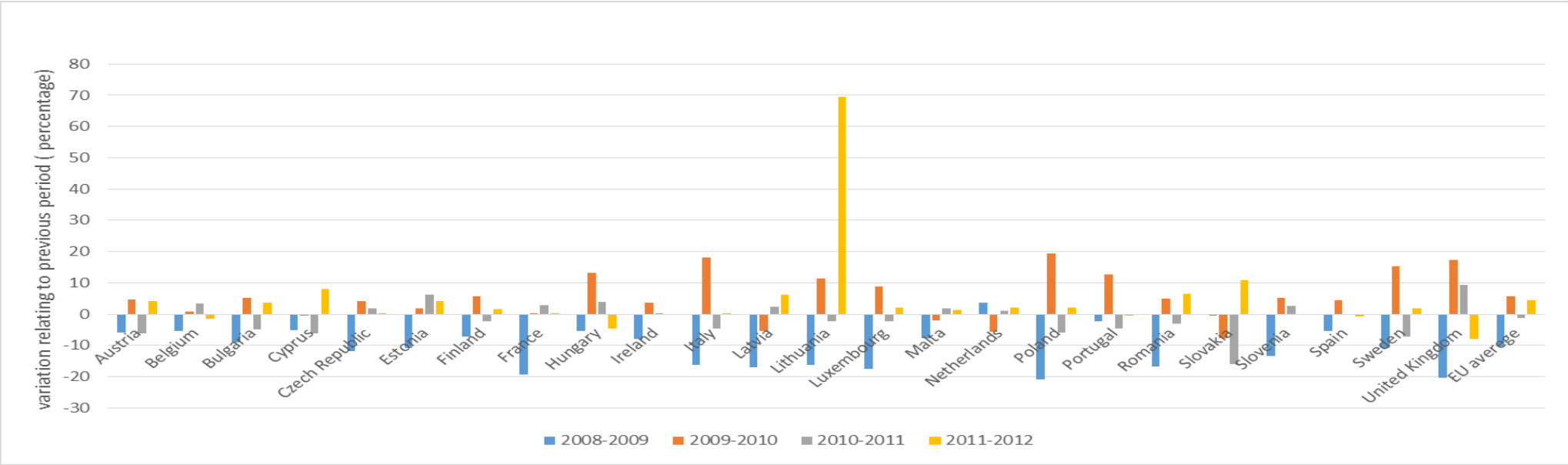



Figure A.3.16 Growth of SKIFs productivity
Source: Own elaboration

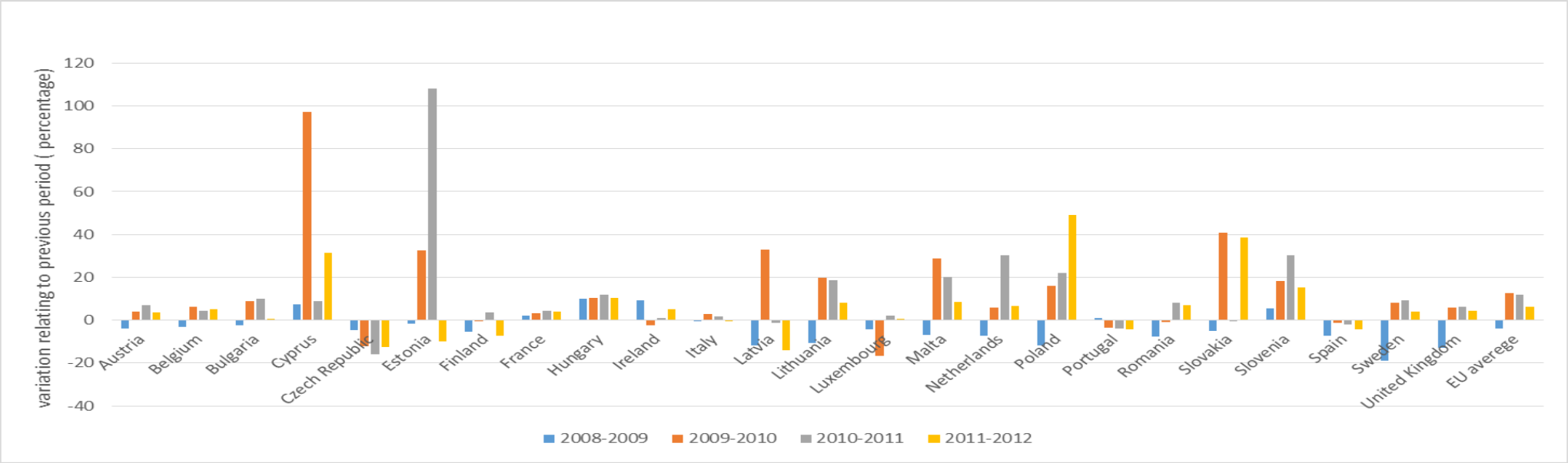



Figure A.3.17 Growth of BERD
Source: Own elaboration

# A.4 – Jarque-Bera test

Jarque-Bera (JB) Test of Normality Jarque-Bera test of normality is an asymptotic test or, more clearly, it is a test that is applicable in large samples only, which does not constitute a worry in this specific case, as the sample selected computes 96 observations. According to Gurajati (2003), pages 148 and 149, the functional form of the test statistic is the following:

$$JB=n\{\frac{S^2}{6}+\frac{(k-3)^2}{24}\}$$

Where n corresponds to the sample size and S and K are the skewness and kurtosis coefficients respectively. Skewness and Kurtosis Coefficients might be represented as:

Where μ2, μ3 and μ4 are the second, third and fourth moments about the mean respectively.

For a normal distribution, skewness "S" is equal to zero and the measure of the kurtosis "K" assumes the value 3.
Under the null hypothesis that the residuals (u) follow a normal distribution, the JB test follows a chi-square distribution with two degrees of freedom. Similar to the previous test, JB statistic test has two hypotheses:

H0: Normal distribution
H1: Not normal distribution (the residuals are not normally distributed)

To test the normality question, a histogram-normality test was run, which simultaneously performs the Jarque-Bera statistic. If the p-value of the Jarque-Bera statistics is low, i.e. if it is less than 5 percent, than the hypothesis of normal distribution of the residuals can be rejected. Conversely, if the p-value is relatively high, the residuals are normally distributed and there is no statistical inference to reject the null hypothesis. The test output is presented below. There is evidence to not reject the null hypothesis in every test.

MODEL 1:

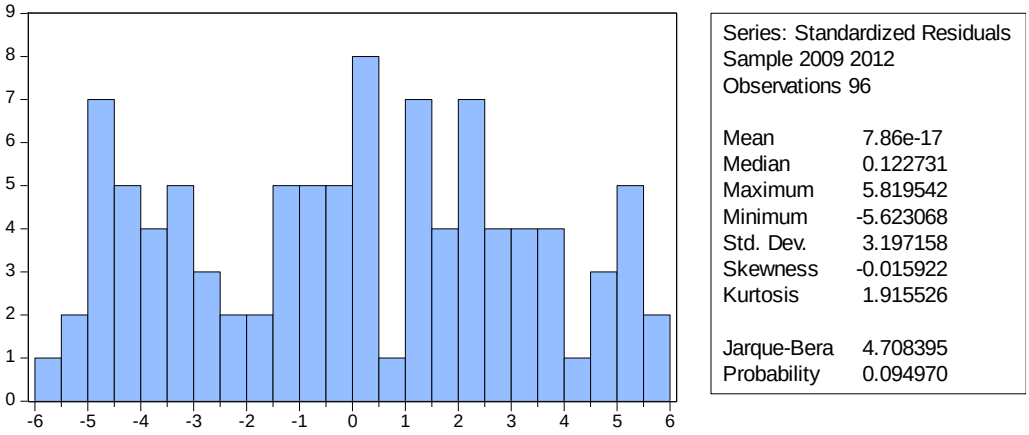
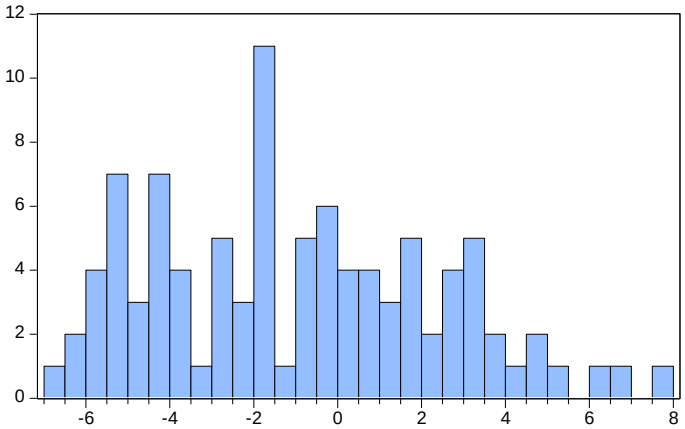



Figure A4.1 Jarque-Bera Model 1
Source: Own elaboration

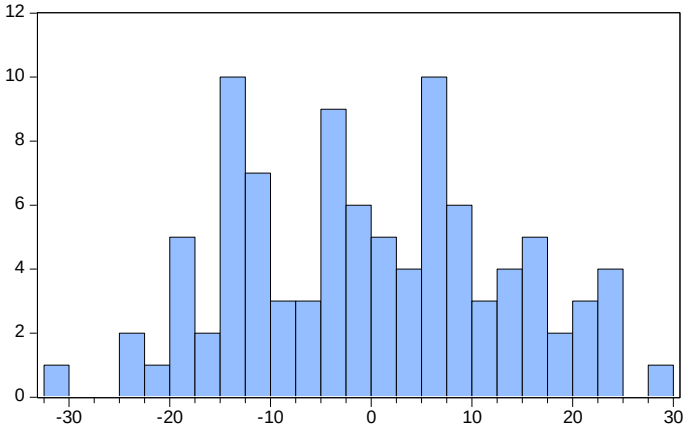



Series: Standardized Residuals
Sample 2009 2012
Observations 96

| | |
|---|---|
| Mean | -0.948701 |
| Median | -1.452390 |
| Maximum | 7.664124 |
| Minimum | -6.525459 |
| Std. Dev. | 3.393285 |
| Skewness | 0.332097 |
| Kurtosis | 2.343463 |
| Jarque-Bera | 3.488780 |
| Probability | 0.174752 |

Figure A4.2 Jarque-Bera Model 2
Source: Own elaboration

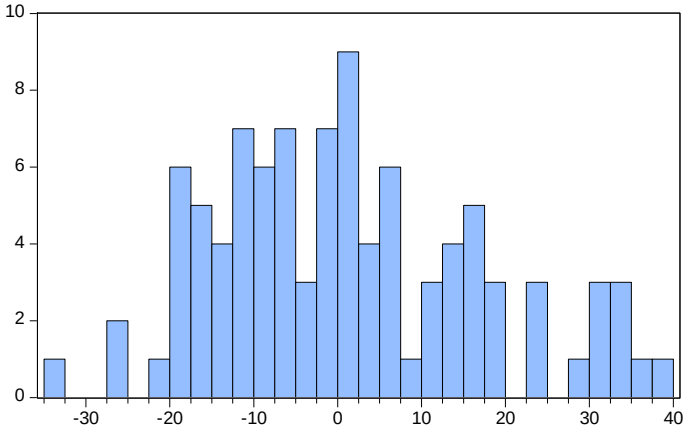
MODEL 2:




Series: Standardized Residuals
Sample 2009 2012
Observations 96

| | |
|---|---|
| Mean | 3.70e-16 |
| Median | -1.214480 |
| Maximum | 28.92784 |
| Minimum | -30.25269 |
| Std. Dev. | 13.20456 |
| Skewness | 0.076998 |
| Kurtosis | 2.179045 |
| Jarque-Bera | 2.790729 |
| Probability | 0.247743 |

Figure A4.3 Jarque-Bera Model 3
Source: Own elaboration




Series: Standardized Residuals
Sample 2009 2012
Observations 96

| | |
|---|---|
| Mean | 1.171874 |
| Median | -0.521783 |
| Maximum | 39.79692 |
| Minimum | -33.67424 |
| Std. Dev. | 16.00549 |
| Skewness | 0.452886 |
| Kurtosis | 2.625674 |
| Jarque-Bera | 3.842165 |
| Probability | 0.146448 |

Figure A4.1 Jarque-Bera Model 4
Source: Own elaboration

# A5 Cluster agglomeration

**Table A5.1 Relative variation of the coefficients of agglomeration**

| Nº of Clusters | Agglomeration Coefficient | Variation in the agglomeration coefficient |
|---|---|---|
| 9 | 110.223 | 13.08% |
| 8 | 124.6337 | 12.33% |
| 7 | 140.006 | 11.15% |
| 6 | 155.624 | 15.21% |
| 5 | 179.289 | 21.34% |
| 4 | 217.547 | 19.94% |
| 3 | 260.926 | 17.72% |
| 2 | 307.241 | 15.54% |
| 1 | 355 | |

Source: Own elaboration

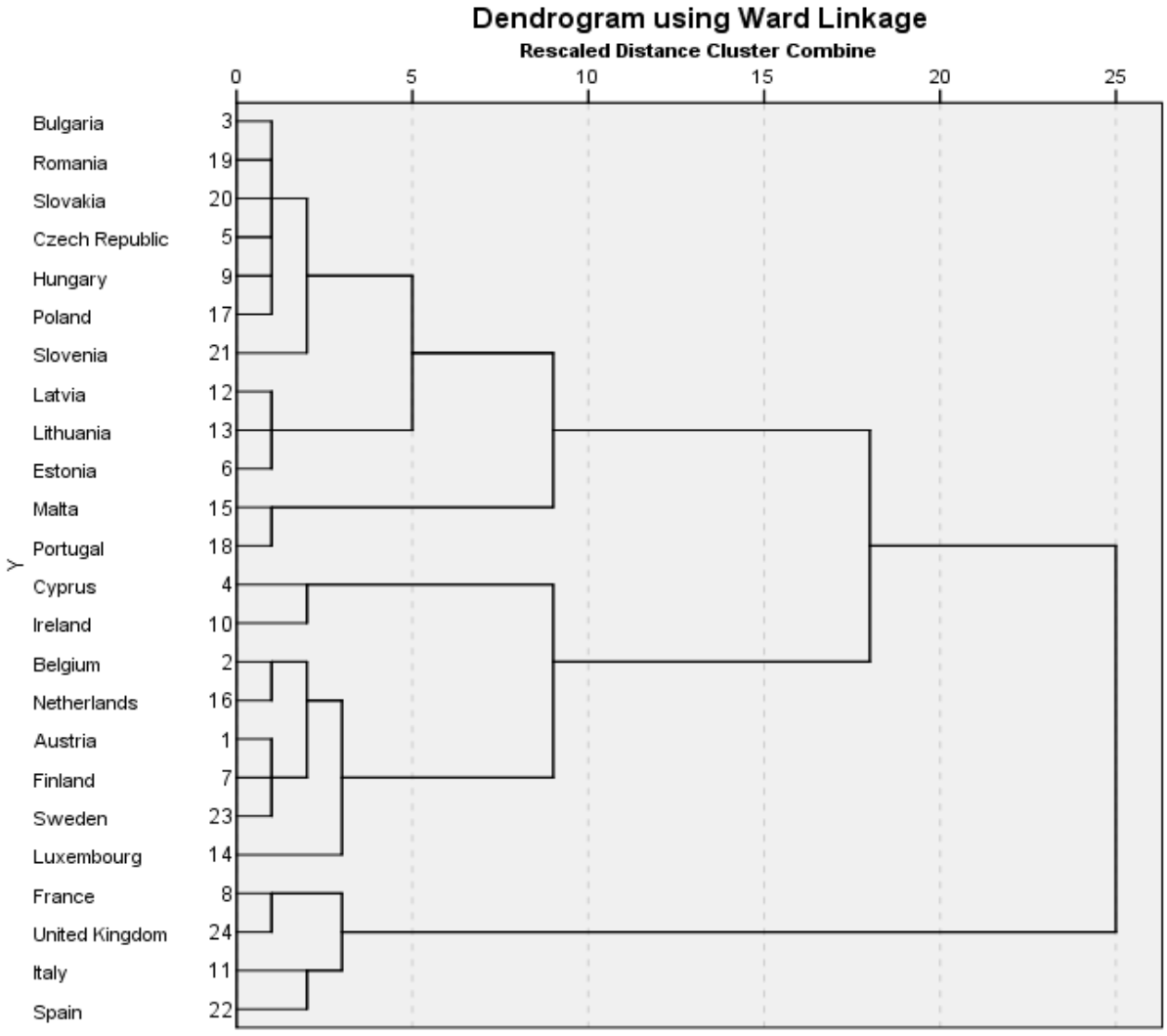



Figure A5.1 Dendogram
Source: Own elaboration