Empirical essays on labour productivity in EU manufacturing

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Thesis title:

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Date:
July 2015

Universitat de Barcelona

To my parents, my brother, Clàudia, Éric and Àlex

Acknowledgements

There are many people whom I thank for their support and help in the preparation of this thesis. To them I dedicate these lines.

First of all, I would like to express my deepest and heartfelt gratefulness to my advisors Josep Lladós and Raúl Ramos, whose contribution in stimulating suggestions, encouragement, support and dedication helped me to complete this dissertation. They have been always available to clarify my doubts despite the busy schedules. It has been a great opportunity to learn from their research expertise. I am also very thankful to my tutor Núria Bosch, for her support and confidence.

I extend my sincere word of thanks to all and each one of the members of the Business and Economic Studies of the Universitat Oberta de Catalunya. Thank you so much for being there sharing laughs and tears. Particularly, thank you very much from the bottom of my heart to the head of our Department, Àngels Fitó; for her confidence, support and positive attitude. I also want make my gratefulness extensive to all the members of the Universitat Oberta de Catalunya, with whom I might have shared some moments during this long journey.

I also thank the support of my former colleagues of the Econometric Department and Public Finance Department of Faculty of Economics of the Universitat de Barcelona. At this point, specifically, I want to express my thankfulness to Alex Esteller. I am also grateful for the valuable comments and support of Jose García. Additionally, I want to thank the help and advice of Jordi Roca, from the UB-Economics.

Finally, I owe a lot to my family and my friends. They have been an important pillar, without their love and encouragement I probably would not have been able to finish this thesis.

Thank you so much to all of you for being there and walking with me along this long and winding road to the end of the thesis!

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Chapter 1: Introduction

1.1. Background and motivation

The European Union (EU) manufacturing's share in gross domestic product (GDP) has continuously declined over a number of years reaching its trough in the mid of 2009 (Veugelers, 2013 and European Competitiveness Report, 2013). The financial crisis that began in 2008 accelerated this decline. Whereas EU manufacturing recovered earlier from its dip in 2009 than the United States (US), since the end of 2011, EU has been lagging behind. The recovery in the two previous recessions since 1990 was also faster in the US than in EU. Despite its decreasing and small share of value added and employment, manufacturing industry is still playing an important role in the EU economy, being a driver of exports, research and development (R&D) and innovation. In contrast to the reduced domestic demand due to public and private debt problems, demand for EU exports has grown. As Veugelers (2013) affirms, a new and decisive discussion on the future of manufacturing has arisen in Europe, the United States and Japan. In comparison to services, EU manufacturing is relatively reducing its weight in GDP, but the crisis that started in 2008 has changed the perceptions of the role of the manufacturing industry. It brought back into the center of the scene the benefits of a strong and stable manufacturing base.

The fact that some EU countries with a large and stable manufacturing base have better overcome the crisis and also recovered earlier has redeemed the reputation of manufacturing industry. To have a dynamic manufacturing sector is considered again a prerequisite for an innovative and fast-growing economy (Reiner, 2012; Fürst 2013. As the European Commission (2010) states "a vibrant and highly competitive EU manufacturing sector is a key element for solving societal changes ahead and for a more sustainable, inclusive and resource-efficient economy".

As Dhèret (2014) states de-industrialisation is no longer perceived as a natural process of economic development and the focus on the services sector has somewhat faded away due to several factors. The high volatility of financial markets and the recent bursting of the financial sector have obviously contributed to revive the interest in manufacturing. This change is also explained by some strong evidence showing that manufacturing is an essential pillar of the economy as "additional final demand in manufacturing generates around half as much additional final demand elsewhere in the economy" (European Competitiveness Report, 2013).

Innovation and specialised service inputs are becoming key factor in manufacturing production. Particularly, specialized service inputs increased their relevance for product differentiation and quality improvements of manufactures allowing companies to charge higher prices and to generate higher value added. All this is indicative for the increasing interlinkages between manufactures and services, so the discussion is no longer on which of these sectors should become the key driver of economic growth, but how to collaborate efficiently.

So, among the main arguments in favour of a strong manufacturing base are that manufacturing industry is an important source of innovation and technological progress, and, too, because of its increasing interlinkages with services. Furthermore, manufactures tend to invest more in innovation activities than services industries. Indeed, according to European Competitiveness Report (2013), manufacturing represents the major source of investment in R&D (65.3% between 2008 and 2010), a key source of exports (67% of Europe's exports) and a main driver for employment in other sectors, including services (each additional job in manufacturing creates 0.5-2 jobs in other sectors). Another common argument for the relevant role of manufacturing is that labour productivity growth is higher in this sector than in the rest of the economy. This argument is strongly related to that of innovation, because R&D and innovation nourish technological progress and labour productivity growth. It also shows the particularity that the sector of origin of technological progress is not necessarily the one that benefits most intensively from new technologies.

Since labour productivity growth is considered a key source of economic growth, it is easy to understand that not quite a few authors have examined and are still interested in its performance in manufacturing industry (Fabricant, 1942; Solow, 1956 and 1957; Jorgenson (Dir.), 1995 and 1996; Jorgenson *et al.*, 2005; Bernard, *et al.*, 1996; Mas *et al.*, 2012; Roth and Thum, 2013; Muntean; 2014). Since 1995 the rate of labour productivity growth in Europe fell throughout the period, with the exception of two brief positive spells during the peaks of the business cycle at the

end of the 1990s and around 2006–2007. Finally, during the Great Recession in 2008-09, the EU saw a decline in labour productivity parallel to the contraction of the economy.

Before the crisis that started during 2007-2008, the debate on labour productivity slowdown indicated that Information and Communication Technologies (ICT) capital accumulation was the main explanation for the underperformance of EU labour productivity (Rincon *et al.*, 2012; Timmer *et al.*, 2010; O'Mahony and Vecchi, 2009; Van Ark *et al.*, 2008; Jorgenson and Vu, 2005; Inklaar *et al*, 2005; Stiroh, 2002). The benefits of the modern knowledge economy differ greatly between advanced economies. Slower adoption of ICT technologies in the EU in contrast to the US, specifically in services sectors was considered for a long time as the major reason for it. The hypothesis was that, as a consequence of this lag, it would take some time for its benefits to materialize in EU. But several years later after the "ICT revolution", the EU has only not caught up with the US, but the productivity gap has grown. Several authors (Brynjolfsson and Hitt, 2000; O'Mahony and Vecchi, 2009) demonstrated that too low investment in the skills and the absence of organizational changes necessary to reap the benefits of ICT technologies were the main explanation for it. Lower investment rates in intangible assets (R&D, design, human and organisational capital, etc.) are likely to explain this behaviour of labour productivity in EU, as these factors affect countries' absorptive capacity, i.e. their ability to take advantage of the technology developed elsewhere (international technology transfers) (European Competitiveness Report, 2013).

Although the recession which began in 2008 had a global impact, some countries have been recovering faster than others. EU seems to have difficulties in recovering and these are not homogenous across the countries. The continent has been divided between a "centre" with a strong industry, and a "periphery" with a weak industry and great difficulties for recovery (Pianta, 2013). This polarization is evident in Eurostat data on industrial production. With 2010 data equal to 100, in June 2013 Germany's index was 110.2, Austria's 105.8, Denmark's 106 and France's 102.6. Conversely, Italy's index was 96.9, Spain's 95.9, Portugal's 95.3 and Greece's 93.7 (Eurostat, 2013). While countries like Romania, Poland, Slovakia and the Baltic states have already exceeded their pre-recession peak of industrial output, not quite few Member States have reached their previous levels. Concretely, those countries in Southern Europe are still displaying difficulties to overcome the consequences of the recession and start their recovery. Several factors slow the recovery in the south of Europe like private sector deleveraging, the gradual reduction of public deficits, a weak business environment and comparatively high borrowing costs. All these factors together with the convenience to reduce high external debt levels are

indicative that presently the main source of growth should come from the external sector, ie from exports of goods and services (Vihriäla and Wolff, 2013).

Despite the decline in the 2000s has been similar in France and Belgium, the level in southern Europe is lower. In contrast, northern Europe and Germany, in particular, maintained a strong a stable manufacturing base. The constant share of manufacturing in Germany stands out as exceptional and can likely be ascribed to successful integration of German industry into the European and global value chain. Traditionally, southern Europe's exports have been more concentrated than the EU as a whole in services, tourism in particular, in relation to manufacturing. In addition, non-manufactured goods represent the bulk of exports from the south than from the north of Europe. In comparison to the EU as a whole the share of service exports was less than 1% greater. The difference between the southern European member states relative to EU as a whole is mainly explained by the larger weight of non-manufacture goods in total exports. As far as the manufacturing sector is one of the key sectors promoting exports performance and an important source of growth, and taking into account that internal demand keeps weak, manufacturing's competitiveness needs to be improved so that growth through exports can be guaranteed. The strong export growth in parts of southern Europe since the crisis is an indication of the potential of the firms in the region. But they face an uneven playing field compared to competitors in the north because of the south's structural shortcomings and because of current tight financing conditions. Action by policymakers is required to overcome these obstacles.

So according to Dhéret's criteria (2014), the "centre" has largely preserved its industrial base and increased its exports to the "periphery", while Europe's periphery is heading toward a spiral of losses of income, jobs, production and exports. As Dhéret (2014) states, this proves the comparative resilience of some EU countries, as for example Germany, with a strong industrial base to the economic recession. It demonstrates how important it is for a country to have a strong and "healthy" industry, specifically manufactures, not only to promote productivity growth, but to face periods of crisis. In contrast, in southern Europe the crisis has worsened the situation of countries like Spain, which initially already displayed a poor performance of manufacturing. The issue is not so much to attain an homogenous manufactures map through the EU, but in a context of existing heterogeneity in EU member states' manufactures to achieve a strong and stable manufacturing base. To this end the design and implementation of strategic industrial policy measures at regional, national and EU level becomes a key factor to attain a broad and diversified manufacturing base.

At the end of the crisis and in front of the persistence of the difficulties to improve labour productivity performance in manufacturing, still a great number of authors are devoted to examine the causes of it. Recent studies (Strobel, 2012; Mas *et al.*, 2012; Timmer *et al.*, 2011; Timmer *et al* 2010; Hao *et al.*, 2009) have tried to find explanations to the declining trend of labour productivity growth in EU countries over the last two decades. They are not mutually exclusive and range from lower growth contributions from investment in information and communication technology, R&D and innovation, the relatively small share of technology–producing industries, the investment in intangible assets, the competition and slower multifactor productivity growth (viewed as a proxy for advances in technology and innovation).

The findings of many of these authors coincide in the established view that the growing role of ICT and continued improvements in human capital are important drivers of labour productivity growth. But despite the apparent importance of the "knowledge economy" macroeconomic performance appears unaffected: investment rates are flat and labour productivity has slowed.

In response, several studies found evidence that increased investment in intangible assets explain a large share of the unexplained labour productivity growth and thus for economic growth (Corrado *et al.*, 2005, 2006, 2009; Marrano and Haskel, 2006; Van Rooijen-Horsten *et al.*, 2008; Fukao *et al.*, 2009; Hao *et al.*, 2009; Marrano *et al.*, 2009; Mc Morrow *et al.*, 2010; Edquist, 2011; Strobel, 2012).

The changing nature of the global economy has placed a novel attention on intangible capital as a new source of growth (Muntean, 2014; Dal Borgo *et al.*, 2013; Goodridge *et al.*, 2013 and Jona-Lasinio *et al.*, 2011). The structural and technological changes associated with the rapid progress in ICT, the rising role of the service sector and the emergence of new business models made intangible investment a key element of global competition.

Corrado *et al.* (2005) were one of the first authors to prove that intangible capital is an essential driver of economic growth. They extended the standard growth accounting model to identify the contribution of intangible capital to economic growth. The findings showed that it is a main driver of labour productivity growth and an important contributor to capital deepening. But the problem is that it is being treated as current expense in the national accounts rather than as an investment. Consequently, this results in an understatement of investment in the economy providing a partial picture of the main sources of growth.

After the Great Recession, many countries are troubled about their economic growth performance, this leads policy makers to look for solutions which are mainly focused on new sources of economic growth and employment creation. Some countries are concerned about their unbalanced economic growth with some sectors declining excessively and others taking too strong a role in overall economic growth. In other countries the concerns are about a decline in manufacturing production, the loss of opportunities in catching up with ICT technologies and knowledge. All this explains the resurgence of a renewed interest in manufacturing industry and for the so-called new industrial policy. Countries require industrial policy measures that address concrete needs, promote technologies and investment in strategic industrial manufacturing branches in order to strengthen them (European Commission, 2014). This change is also explained by some strong evidence showing that manufacturing is an essential pillar of the economy as "additional final demand in manufacturing generates around half as much additional final demand elsewhere in the economy" (European Competitiveness Report, 2013).

The former is sustained by the fact that manufacturing industry is considered the core driver of economic growth - in 2012, the European Commission published a new industrial policy communication, which starts from the premise that *"Europe needs industry"* (European Commission, 2012). Identifying the right policies to support the manufacturing sector's contribution to Europe's future growth requires an understanding of the changing role of manufacturing industry in Europe's growth agenda. In this context it is important to implement both homogeneous as well as country-specific industrial policy measures for the EU member states aiming a stable and balanced performance of economic growth.

Against this background and as long as labour productivity in manufacturing is one of the main sources of economic growth and competitiveness (Veugelers, 2013; European Competitiveness Report, 2013; Mas *et al.*, 2012), the objective of the present thesis is to analyze the underperformance of labour productivity growth in manufacturing in EU member states and the existence of persistent differences among them in the last decades. As a consequence, this turns out in regional disparities within EU which results in the so-called "center-periphery", "east-west" or "north-south" pattern (Petrakos *et al.*, 2011), referring to more and less advanced areas. The importance of industrial structures is widely recognized, although the potential of industrial policy measures to modify that structure remains discussed (Crafts, 2010 and Owen, 2012). Industrial policy measures have not been always successful when they seek to alter the production structure towards branches that are expected to offer better results in terms of labour productivity growth (European Competitiveness Report, 2013). This opens a door to the debate about the objectives and tools of EU industrial policy. The aim is to know the factors

responsible for this poor performance that hinders a recovering from the Great Recession. This would allow designing industrial policy measures to improve the behaviour of labour productivity growth.

The motivation is threefold, first we determine and assess the magnitude of labour productivity differences as well as the role of industry specialization in explaining these differences.

Secondly, to deepen the analysis, we investigate if the differences in labour productivity and its persistence arise from different production structures, if it is a problem of productivity differences itself or a combination of both. The existence of different production structures would explain the presence of differentiated production systems that may have led to different regional growth patterns.

Thirdly, as long as the benefits of modern knowledge differ greatly between advanced economies, we want to examine the contribution of investment in intangible assets to labour productivity growth in manufacturing. Intangible assets are considered as knowledge capital, so if we take into account that knowledge is one of the main drivers of economic growth and competitiveness it is interesting to examine their influence on labour productivity performance (Corrado *et al.*, 2014; Falk, 2013; Baldwin *et al.*, 2012;). The purpose is to identify which single or combinations of intangible assets' investment are essential drivers of labour productivity growth.

To obtain an answer for our objective becomes key in helping to design strategic industrial policy measures aiming to improve the performance of labour productivity growth, economic growth and competitiveness.

1.2. Objectives

Taking into account the previous exposition, the main objective of the present thesis is to analyze the underperformance of labour productivity growth in manufacturing in EU member states and the existence of persistent differences among them in the last decades in comparison to behaviour of other advanced economies as United States (Timmer *et al.*, 2010). In order to find out the weaknesses that deprives from recovering from the crisis that started in 2008.

This objective can be decomposed into three sub-objectives. So first, we conduct a comparative analysis of differences in labour productivity growth in manufacturing and next, we try to find out if the differences in labour productivity are due to changes in the industrial structure, to labour productivity deficiencies itself or a combination of both. Finally, in the context where knowledge is an important driver of economic growth and competitiveness in advanced economies, and as intangible assets are considered as "knowledge capital" (Falk, 2013), we examine the role of investment in intangible assets as contributor to labour productivity growth. The purpose is to identify which intangible assets contribute most to labour productivity growth.

As said before manufacturing in Europe has been divided in a "centre" and in a "periphery", this is indicative for existence of a differentiated production model in manufacturing in southern and northern Europe. For this reason, we think it may be interesting to center the analysis of labour productivity in manufacturing on the "centre" and the "periphery" of the EU and more concretely in two benchmark member states representing each one. With this aim, in the next two chapters of the thesis we will take Germany as benchmark for the "centre" and Spain for the "periphery". So, analysis in the first and in the second part of the dissertation is focused on Germany and Spain, but the results and conclusions obtained can be extended to the EU member states belonging to the "centre" and the "periphery". Furthermore, in chapter 4 we implement an analysis in two steps, first considering the whole set of 9 EU member states and, second, dividing the sample into two groups. In both cases, the aim is deepen in the analysis in order to find an answer for the differentiated behaviour that allows to identify the investment in different intangible assets types the contribute most to labour productivity growth. In doing so, it might permit to discriminate between industrial policy measures addressing specific characteristics of each group and measures at EU level. This would result in greater efficacy and efficiency in the consecution of the aimed objectives.

1.3. Structure of the thesis

The rest of the thesis is organised in four chapters. This section presents a summary of the three chapters that make up the main body of the present thesis. Each one coincides with each specific objective which purpose is to provide an answer to the main question of the thesis. The thesis ends with chapter 5 where the main conclusions and future research are presented.

Chapter 2: An Analysis of Differences in Labour Productivity in Manufacturing. Displaying the need for a resurgence of industrial policy: Spain vs Germany, 1993-2007

In chapter 2, in order to find out if differences in productivity arise mainly from distinct production structures, if they are mainly due to an intrinsic problem of the industrial productivity itself or a combination of both of them, a comparative analysis of industrial labour productivity between Spain and Germany in the pre crisis period between 1993 and 2007 is undertaken. As said before, Spain and Germany are chosen as benchmark countries, for the "periphery" and for the "centre", respectively. The objective is to know which are the main factors preventing the continued labour productivity growth in Spanish manufacturing, impeding the recovery of the present crisis. Bearing this in mind, we want to determine the existence of differences between Spanish and German manufacturing labour productivity, to assess its magnitude and the role of industry specialization. Results indicate that it is mainly a problem of productivity itself. To a less extent industry specialization plays a little role, although its influence is increasing. The main contribution of that chapter is that the differences in labour productivity can be mainly attributed to productivity itself and not so much to manufacturing industry structure differences.

Chapter 3: Labour productivity and Industrial Specialization

In order to advance in the comparative analysis of manufacturing labour productivity between Spain and Germany in the period 1993-2007 already started in chapter 2, the objective of this chapter is to investigate the sources of the persisting differences. To identify if they can be attributed to changes in the sectoral structure or to differences in productivity itself between sectors may help in finding an answer. So we implement an analysis from two complementary perspectives in order to obtain a more complete explanation. It consists of decomposing aggregate productivity differences into different sources, but each implementing a different methodology. Here again results confirm that it is mainly an intrinsic problem of productivity differences, but we have obtained information of the magnitude. Manufacturing's specialization is becoming an influencing variable, although to a lesser degree. The main contribution of this chapter is that differences in industry structure do not totally justify the gap in productivity. It explains to what extent is Spain lagging behind Germany, displaying significant labour productivity differentials and showing difficulties to change its productive structure at a faster pace.

Chapter 4: The contribution of intangible assets to labour productivity growth in manufacturing industries in EU member states, 1995-2010.

As long as intangible capital is considered a main component of knowledge playing an important role as driver of labour productivity growth, the aim of this chapter is to investigate the contribution to labour productivity growth of investment in different single intangible asset types in this case. The analysis is implemented for manufacturing taking a sample of 9 European member states between 1995 and 2010. We have extended the sample in order to provide higher variability and richness to the study resulting from the different characteristics of the countries considered and also to overcome the reduced availability of more detailed information for Spain and Germany. With the purpose of identifying the existence of a differentiated behaviour in terms of labour productivity growth and intangibles' investment, we split the sample into two groups. If affirmative, this would permit to define more concrete industrial policy measures addressing each group resulting in a better labour productivity performance. Results indicate that it is reasonable. The main findings can be summarized as follows: all the considered intangible assets are significant for labour productivity growth except for *software* in both groups*;* and for *R&D* in group 1. *Vocational training* and *advertising & marketing* are the ones which contribute individually most to labour productivity growth. The implications of these findings for the design of industrial policy measures are that common measures should be combined with specific ones focusing on the particular needs in terms of intangibles investment of each country. This chapter is a contribution to the literature of investment in intangibles due to the fact that identifies which of the different intangibles are the main drivers of labour productivity growth in EU member states in manufacturing, between 1995 and 2010, shows the existence of heterogeneous effects of investment in intangibles in the considered EU sample and its implications for industrial policy in European Union.

Chapter 5: Concluding remarks and future research

This chapter 5 contains the main findings and conclusions the conclusions drawn from empirical analysis for each of the objectives are presented, highlighting the main contributions and limitations arising there from and future research with the intention of overcoming, enhance and project the present work.

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Chapter 2: An analysis of differences in labour productivity.[1]

2.1. Introduction

The crisis which started in 2008 is affecting most countries with different levels of intensity. Although it started in the financial sector, its impact has spread throughout the whole economy. Since the early 1990s the European Union economy has gone through two business cycles and is now in the downward phase of a third one. The troughs of the manufacturing cycles in EU occurred first in 1993 and then at the end of 2001. They were characterised by negative growth rates in manufacturing output. But in some countries the situation has been exacerbated by pre-existing low sectoral performance (European Commission, 2009). That seems to be the case with Spain. Joining the European Union (EU) in 1986 played at least an important role in shaping Spain into what it is today (Mas *et al.*, 2012). It benefited from the inflow of funds of the EU, which contributed definitively to Spanish economic growth and to its modernization. Consequently, one would have expected a better performance and a faster recovery of Spanish economy in front of the recent economic crisis. Spain's recovery patterns seem to be mostly affected not only by macroeconomic imbalances, but also by its difficulty to improve internal competitiveness.

As long as labour productivity is one of the drivers of internal competitiveness, this chapter focuses on its performance. In particular, we conduct a comparative analysis of industrial labour productivity between Spain and Germany in the previous years of the crisis, 1993-2007. As said in the Introduction two great groups of member states can be identified, one displaying a weaker manufacturing base – "periphery"- and another one with a stronger manufacturing base – "centre". In our analysis Spain is representative for the "periphery" and Germany for the "centre". The purpose is to identify the determinants that hinder the continued growth of productivity in Spanish industry, depriving from recovering of the present crisis. To this end, we aim to determine the existence of differences between industrial productivity in Spain and Germany, to assess its magnitude and the role of industry specialization. The motivation is to find out if differences in productivity arise

[1] Chapters 2 and 3 of this dissertation have been merged into one article that has been accepted for publication in Hacienda Pública Española/Review of Public Economics, 212-(1/2015), 97-126.

mainly from distinct production structures, if they are mainly due to an intrinsic problem of the industrial productivity itself or a combination of both of them. There is now a vast amount of literature focusing on the explanation and impacts of the economic crisis at the macroeconomical level, with little emphasis on the sectoral patterns in relation to structural change and sectoral productivity growth (Martínez Álvarez, *et al.*, 2013 and Timmer *et al.*, 2011).

The results confirm that it is mainly an intrinsic problem of productivity itself. Industry specialization is becoming an influencing variable, although to a lesser degree. So, the main contribution of this chapter is that differences in industry structure do not totally justify the gap in productivity.

The remainder of this chapter is organized as follows. After the introduction, the second section contains a brief description of the dataset. The third section describes the evolution of German and Spanish per capita gross value added (from now on GVApc) for the whole economy and for manufacturing. The aim is to see if both countries converge in total and in industrial GVApc, reducing their gap. Furthermore, in order to assess if labour productivity is one of the main determinants of GVApc, we undertake the decomposition of GVApc (Raymond and Garcia-Greciano, 1994; Lladós-Masllorens, 2002; Mas *et al.*, 2012). The results confirm that differences in productivity are significant and persistent in the considered time period. The fourth section is devoted to the analysis of the productive structure in each country and of the differences in their composition. To this end, we proceed to calculate an index of structural inequality that will conclude whether or not there has been a convergence between the two production structures. Section 2.5 summarizes the main findings and conclusions.

2.2. Data

To carry out this study we use the EU KLEMS Growth and Productivity Accounts (henceforth EUKLEMS; http://www.euklems.net)[2] which contain internationally comparable data for output and inputs. This database includes a wide range of measures on output growth, employment, skill creation, capital formation and multi-factor productivity at the industrial level for EU member states from 1970 until 2007.

As Timmer *et al.* (2007a and 2007b) states the main advantage of EU KLEMS database is that it allows going beyond the aggregate level of economy to analyse the

[2] More detailed explanation on the methodology followed to define and to obtain the variables is contained in http://www.euklems.net.

productivity performance of individual industries and their contribution to aggregate growth.

The data used in this paper covers the period from 1993 to 2007 for Spain and Germany. In all figures, tables and formulae *E* stands for Spain and *Ger* for Germany. Our analysis is implemented both at aggregate level as well as for individual branches of manufacturing industry. The dataset used here consists of 23 goods-producing industries that correspond to the 2-digit ISIC Revision 3.0. For a list of industries, see table 2.A.1.

Data on Population (*P*) and Labour force (*LF*) are obtained from Eurostat, both are annual averages expressed in millions. Labour force is defined as population in working age between 15 and 64 years and is necessary to compute the rate of employment and the rate of activity of the whole economy (in the next section). The rest of variables used in this paper are provided by EUKLEMS. Our output measure is gross value added at basic prices 1995=100, labour productivity is defined in terms of hours worked as well as all the variables needed for the analysis, where appropriate. All monetary variables are expressed in Euros 1995 =100.

2.3. Main sources of Gross Value Added per Capita in Manufacturing

In this section we examine the following aspects: on the one hand, if differences in per capita income of the Spanish and German total economy have become less and if this is also the case for manufactures between 1993 and 2007.

On the other hand, we examine whether or not labour productivity per hour is one of the main determinants of differences in gross value added per capita among manufacturing industries in Spain and Germany. Furthermore, in order to check if differences in labour productivity between Spain and Germany are significant and persistent in time, we will carry out a static and a dynamic analysis.

With this aim, we take as a reference a rather useful decomposition of per capita income, which have been applied by several authors such as Raymond and García-Greciano (1994), Lladós-Masllorens (2002) and Mas *et al.* (2012):

$$\frac{GVA_T}{P} = \frac{GVA_T}{GVA_I} \times \frac{GVA_I}{H_I} \times \frac{H_I}{L_I} \times \frac{L_I}{LF} \times \frac{LF}{P} \tag{2.1}$$

where GVA_T stands for gross value added of the total economy; P for total population and LF represents the labour force of total economy, that is the population of working ages from 16 to 65. GVA_I for gross value added in the manufacturing industry; H_I is total hours worked; L_I is total employment (in people). All these variables are related to manufactures (denoted with subindex I).

Therefore, the term on the left-hand side of (2.1) measures per capita income of total economy which can be decomposed into five ratios displayed on the right-hand side. These are as follows: the first one is per capita income of total economy over per capita income of manufacturing (GVA_T/GVA_I) which indicates to what extend total economy value-added is determined by manufactures' value added; the second one ($GVA_I/H = LP$) measures labour productivity in terms of hours worked; the third one (H_I/L_I) total hours worked per employed person; the fourth one (L_I/LF) the employment rate and the last component (LF/P) is the activity rate.

Let us start by examining briefly the left hand-side part of equation (2.1). Figure 2.1 displays the evolution of GVA_T/P in both countries, in it we can appreciate the gap and its persistence between Spain and Germany. Although data contained in table 2.1 panel (c) row (1) indicate a slight approximation: in 1993 the ratio between Spain's and Germany's GVA_T/P was 50.8% and increased in 2007 up to 55.8%, from this we can conclude that it did not alter the trend of the Spanish per capita income.

Figure 2.2 shows the differences between Spain and Germany each for per capita income of total economy and of manufacturing taking 1993 =100**.** As long as per capita income, both for the whole economy and for manufactures, display a similar growth pattern with small differences, this can be interpreted in the sense that the total economy's per capita income performance is determined mainly by the manufacturing sector. Looking at figure 2.2 we can appreciate that other sectors different from manufactures are the drivers of the total economy's per capita income.

Table 2.1. Gross Value-Added per Capita Decomposition in Manufacturing. Spain and Germany, 1993-2007

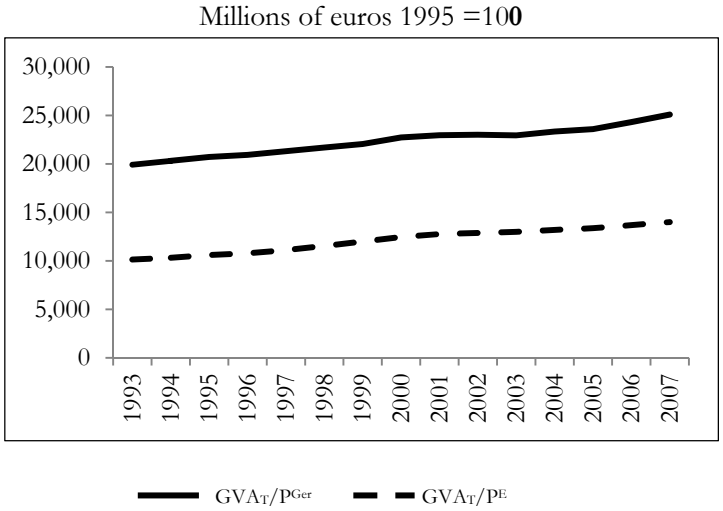
Millions of euros 1995 =100 (average annual growth rates in %)

	1993	1999	2003	2007	1993-2007[c]	1993-1998[c]	1999-2002[c]	2003-2007[c]
(a) Spain								
GVA_T/P	10,126	11,992	12,989	14,000	2.3	2.6	2.4	1.9
GVA_T/GVA_I[a]	5.3	5.1	5.4	5.9	0.7	-1.1	1.5	2.3
Labour productivity (LP)	17.0	18.7	19.7	21.2	1.6	1.5	0.9	1.9
Number of hours worked by engaged person (H_I/L_I)	1,754	1,739	1,673	1,612	-0.6	0.2	-0.7	-0.9
Employment rate (L_I/LF)[a]	0.1	0.1	0.1	0.1	0.4	1.8	0.5	-1.5
Activity rate (LF/P)[a]	0.7	0.7	0.7	0.7	0.2	0.3	0.1	0.1
(b) Germany								
GVA_T/P	19,924	22,064	22,945	25,093	1.6	1.7	1.4	2.2
GVA_T/GVA_I[a]	4.4	4.6	4.6	4.3	-0.1	0.9	0.3	-1.7
Labour productivity (LP)	26.6	32.1	36.1	43.2	3.5	3.4	2.8	4.5
Number of hours worked by engaged person (H_I/L_I)	1,514	1,501	1,452	1,456	-0.3	-0.1	-1.1	0.1
Employment rate (L_I/LF) [a]	0.2	0.1	0.1	0.1	-1.3	-2.4	-0.1	-0.5
Activity rate (LF/P) [a]	0.7	0.7	0.7	0.7	-0.2	-0.1	-0.4	-0.1
(c) Ratio Spain/Germany[b]								
GVA_T/P	50.8	54.3	56.6	55.8	140.4	154.2	168.5	83.7
GVA_T/GVA_I	122.2	109.6	117.0	137.2	-964.5	-124.6	572.7	-136.7
Labour productivity (LP)	64.1	58.4	54.4	49.2	45.4	44.1	33.2	43.1
Number of hours worked by engaged person (H_I/L_I)	115.9	115.9	115.2	110.7	218.5	-252.6	66.7	-1,328.1
Employment rate (L_I/LF)	56.9	72.9	75.2	72.2	-34.8	-73.3	-343.7	318.7
Activity rate (LF/P)	98.5	100.5	102.7	103.6	-76.7	-258.3	-31.9	-60.6

Notes: (a) Figures in %; (b) Weight Spain over Germany in %; (c) Average annual growth rate in %.

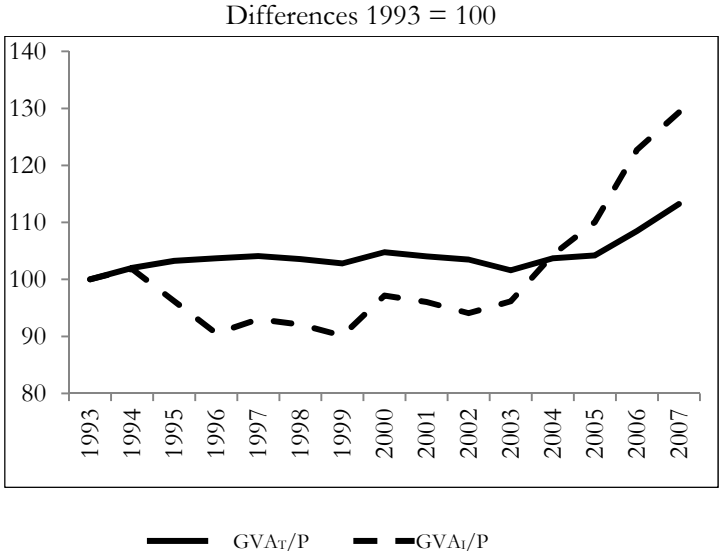
Source: EU KLEMS (2009), www.euklems.net , Eurostat, http://ec.europa.eu/eurostat/web/national-accounts/data/database and own calculations.

Figure 2.1. GVA per Capita in total Economy. Germany and Spain, 1993-2007



Source: EU KLEMS (2009), www.euklems.net, Eurostat, http://ec.europa.eu/eurostat/web/national-accounts/data/database and own calculations.

Figure 2.2. GVA per Capita decomposition. Spain minus Germany



Source: EU KLEMS (2009), www.euklems.net Eurostat, http://ec.europa.eu/eurostat/web/national-accounts/data/database and own calculations.

In figure 2.2 it can be appreciated how differences in GVA_I/P between Spain and Germany are rapidly increasing whereas the gap in GVA_T/P is growing slower. Specifically from 2002 onwards the manufactures' per capita income differences started to soar. The same happened to the GVA_T/P a little later but with less intensity.

Data in table 2.1 show that the slight approximation in total economy per capita income can't be attributed to manufactures' productivity because ratios decreased, at the beginning of the period this ratio was 64.1% and at the end 49.2% (table 2.1. panel (c) row (3)). In the whole period Spanish GVA_T/P grows at an average annual rate of 2.3% while Germany's rate is 1.6% (table 2 panels (a) and (b)). This faster growth of the Spanish economy does not shorten the distance in relation to Germany, on the contrary, the difference in GVA_T/P has become greater. Looking at its performance in the three subperiods (table 2.1 panel (c) row 1 columns 7 to 9), it can be appreciated that Spain's growth rates are approximately 54-68% higher than the German ones, except for the subperiod of 2003-2007. The boom of the Spanish construction sector has played here a key role in boosting economic growth.

The main reading of this behaviour is that Spain seems to have neglected its manufacturing industry in terms of investments in technological capital in key sectors and also in human capital. This may explain why now obviously the Spanish manufacturing industry is not able to generate value added at the same rate as the German one. That means the German manufacturing industry has undergone the necessary adjustments in contrast to Spain, which seems as if it is not able to overcome historical problems and thus lost weight in the overall economy (see also table 2.1).

And now let examine the right-hand-side of expression (2.1) that is to analyze the sources of differences in gross value added per capita in manufacturing industries. At first we will look at the status quo at the beginning and at the end of the considered period in order to compare both and also to assess the differences among both industries. Afterwards we study the variables' evolution that is from a dynamic point of view.

Table 2.1 presents the contribution of each component of (2.1) in levels for the years 1993 and 2007, as well as their growth rates for 1993-2007. In panel (a) and (b) we have the figures for each industry and in panel (c) we can see the ratio Spain over Germany (that is (a)/(b)) in percentage. The data show that the differences between

the two countries are substantial and confirm that labour productivity is one of the main drivers of per capita income together with the number of hours worked per employed person (H_I/L_I) in both industries in the whole period. Furthermore both manufacturing industries show a considerable dispersion among the variables and the subperiods. Differences in labour productivity increases its importance, while number of hours worked reduces it. The behaviour of the rest of variables plays a little role in industrial per capita income.

In table 2.1 panels (a) and (b), we can see that not only German values are significantly higher than the Spanish ones, but the gap between both industries has increased, displaying a persistent trend (panel c). Germany's productivity grows at 3.5% while Spain only at a 1.6%, showing a sluggish behaviour in contributing to value added growth (table 2.1 panels (a) and (b)). This reflects the greater capacity of German industry to generate value added. This ability can be explained either by an increased production efficiency, by a greater qualification of human capital, by a larger stock of capital (it incorporates more technical progress) or a combination of all these factors. Taking a look at the weights of the different variables (table 2.1 panel (c)) that intervene in decomposition, we see that all of the Spanish components have lost weight in relation to Germany considering the whole period. The only exception is the employment rate and to a less extent the activity rate. In contrast, we appreciate a slight approximation in per capita income of total economy, which cannot be attributed to manufactures as figures in table 2.1 show.

In fact, if we look at the employment rate in both industries, they are similar, though somewhat smaller in Spain. This is indicative of less specialization of the Spanish economy in the industrial sector. The total number of hours worked per engaged person in Spanish industry is slightly larger than the German, while the employment rate is a bit smaller. There are engaged persons working in the Spanish industry, but they work more hours than their German counterparts. Thus one would expect then a higher industrial value added than observed. A possible explanation for this fact is that in Spain the proportion of hours worked in the industrial sector in relation to total hours worked in all sectors of production is lower than in Germany. This lower relative importance of the manufacturing sector in the Spanish economy, along with a reduced ability to generate value added and a lower productivity show that Spanish industry suffers inefficiencies that prevent to progress at the same rate as the German industry.

The figures analyzed allow us to answer the first question posed, productivity is one of the main factors explaining the gap between the Spanish and German per capita income as well as to confirm the hypothesis of the existence of significant differences in productivity between Spanish and German industries.

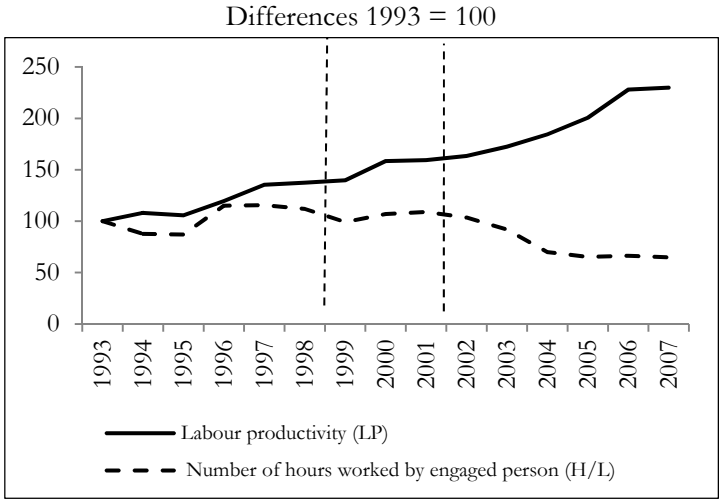
This was the situation at different concrete moments of the period examined, 1993, 1999, 2003 and 2007. But which has been the evolution between 1993 and 2007 and different subperiods: 1993-1998, 1999-2002 and 2003-2007? The variables for these subperiods (table 2.1) are expressed in percentage average annual growth rates. The aim is to confirm the significance and persistence of the differences between Spain and Germany.

From this table, we can see that over the whole period both countries show significant dispersion in their growth rates, particularly Germany. In the subperiods, labour productivity is still one the main variables explaining the performance of GVA_T/P in manufacturing. In the period 1993-1998 both GVA_T/P and employment in Spain grew at a very fast rate, while in Germany both variables showed a sluggish pace. At this point it's important to say that Germany's industry is undertaking an adjustment mainly due to German reunification, which lasts approximately from 1993 to 2002. Subperiod 1999 to 2002 is characterized by a slowdown in productivity and the rest of determinants of per capita income. This trend is not only maintained but worsened in the case of Spanish industry with the exception of labour productivity in the last subperiod, 2003-2007. On the contrary Germany increases its per capita gross value added and labour productivity significantly, while the other determinants show a slight improvement. Spain presents a very poor performance in labour productivity although the severe employment destruction in the last subperiod.

Figure 2.3 displays the differences between Germany and Spain taking 1993 =100. The most striking fact is how from 1993 on up to 2007 the gap in labour productivity grows at a rapid pace. Its performance confirms again that it is one of the main determinants of the differences in per capita income in manufacturing and that these differences are persistent.

Summarising, labour productivity is one of the most important factor explaining differences in industrial per capita income between both countries, that they are significant and persistent in the whole period 1993-2007. The rest of the components show no major differences.

Figure 2.3. GVApc, Labour Productivity and Number of Hours Worked by Engaged Person. Spain minus Germany, 1993-2007



Source: EU KLEMS (2009), www.euklems.net and own calculations.

2.4. Changes in Manufacturing Specialization

Up to now, we have seen that there are no signs indicating a reduction of the gap in manufacturing labour productivity between Spain and Germany from 1993 to 2007. The question posed in this section is if the differences in the manufacturing industry specialization among both countries justify the existing differences in manufacturing labour productivity. To this end, we implement two kind of analysis. Firstly, we start by focusing on the productive structure in each country and then we compare them looking at the differences in their composition. To this aim we make use of two indexes (Pérez García *et al.*, 2006) to compute the share of each manufacturing branch value added in total manufacturing value added[3].

In this section we start analysing separately how the composition in the productive structure in terms of sectoral GVA over the total manufacturing GVA of the Spanish and the German manufactures has changed in the considered time period, that is from 1993 up to 2007. To this end, the weight of each manufacturing branch in total manufacturing in terms of value added is computed. What we want to check is if these manufacturing industries have changed its productive structure

[3] The same exercise has been replicated using sectoral labour's share with similar qualitative results.

composition from low-performing productivity branches to high-performing ones in the considered period,

Then the next step is to compare them in order to see to which extent they have similar productive structures or no. So, if a country's manufacturing industry displays a higher weight of high-performing productivity sectors than the other one, this would mean that the first country is more competitive and more capable to generate value added.

Firstly, we compare the compositional differences between the same manufacturing sector at two points in time (t = 0 and t= T) using a structural change index L_{0T}. This provides us information about the presence of changes in the productive structure of each manufacturing industry. According to Pérez García *et al.* (2006), L_{0T} index is defined, as follows:

$$L_{0T} = \frac{1}{2}\sum_{j=1}^{N}\left|X_{jT} - X_{j0}\right| \times 100 \qquad (2.2)$$

where X_{j0} is the weight of sector *j* in total manufactures in the initial period *0* and X_{jt} is the weight of sector *j* in total manufactures in the final period *T*. The index L_{0T} measures therefore the magnitude of change of sectoral specialization between these two periods and takes larger values, the more intense the change. Specifically, the index is bounded between 0 and 100 and expresses in terms of percentages the changes in the composition of production.

Secondly, we compare both manufacturing structures to see if they show up differences among them and, if affirmative, to detect whether there has been an approach between them or not in the considered period.

To this end, we compute the index of differences in manufactures' composition (L_{AB}) which is identical to L_{0T} but referred to two industries, *A* and *B*, in the same period. It is computed according to (2.3):

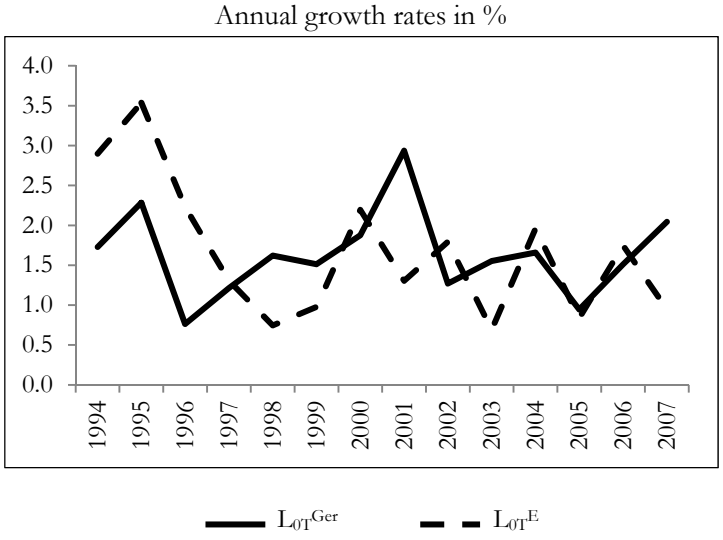
$$L_{AB} = \frac{1}{2}\sum_{j=1}^{N}\left|X_{jA} - X_{jB}\right| \times 100 \qquad (2.3)$$

In (2.3) X_{jA} is the weight of sector *j* in total manufactures *A* at a given moment of time and X_{jB} is the corresponding value for sector *j* in manufactures *B*. L_{AB} index is bounded between 0 and 100 and measures the magnitude of the differences in sectoral specialization between manufactures *A* and *B*. It takes larger values, the

lower the similarity. In this analysis, country *A* is Spain (*E*) and *B* is Germany (*Ger*), so henceforth L_{AB} will be $L_{E\text{-}Ger}$.

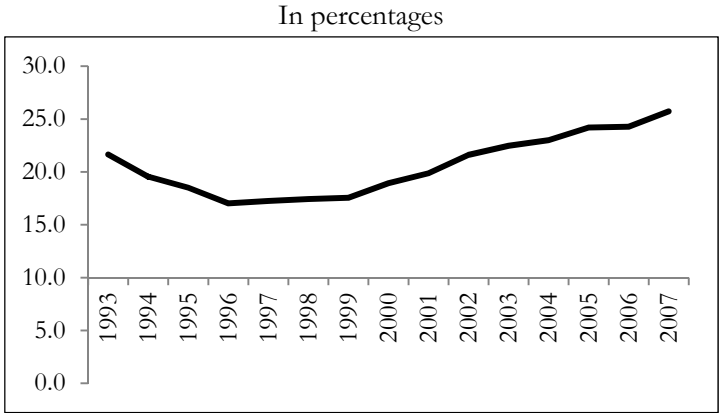
Figures 2.4 and 2.5 each offer an overview of the behaviour of both indexes, respectively L_{0T} (L_{0T}^{Ger} for Germany and L_{0T}^{E} for Spain) and $L_{E\text{-}Ger}$. In particular, figure 2.4 shows the performance of structural change index L_{0T}^{E} for Spain and L_{0T}^{Ger} for Germany, here we observe that both manufacturing industries show a great variability, indicating that both have implemented changes in its production composition. But the small values of the index L_{0T} indicate that they haven't been significant. Figure 2.5 displays the evolution of the index of differences in manufactures' composition $L_{E\text{-}Ger}$, in it we can appreciate how the differences between Spain and Germany have grown from 21.6% to 25.7%. More concretely, the declining trend of the index of differences in manufactures' composition $L_{E\text{-}Ger}$, changes with the entrance in force of the Economic and Monetary Union (EUM), since that moment differences in manufacturing composition start growing.

Figure 2.4. Structural change index L_{0T}



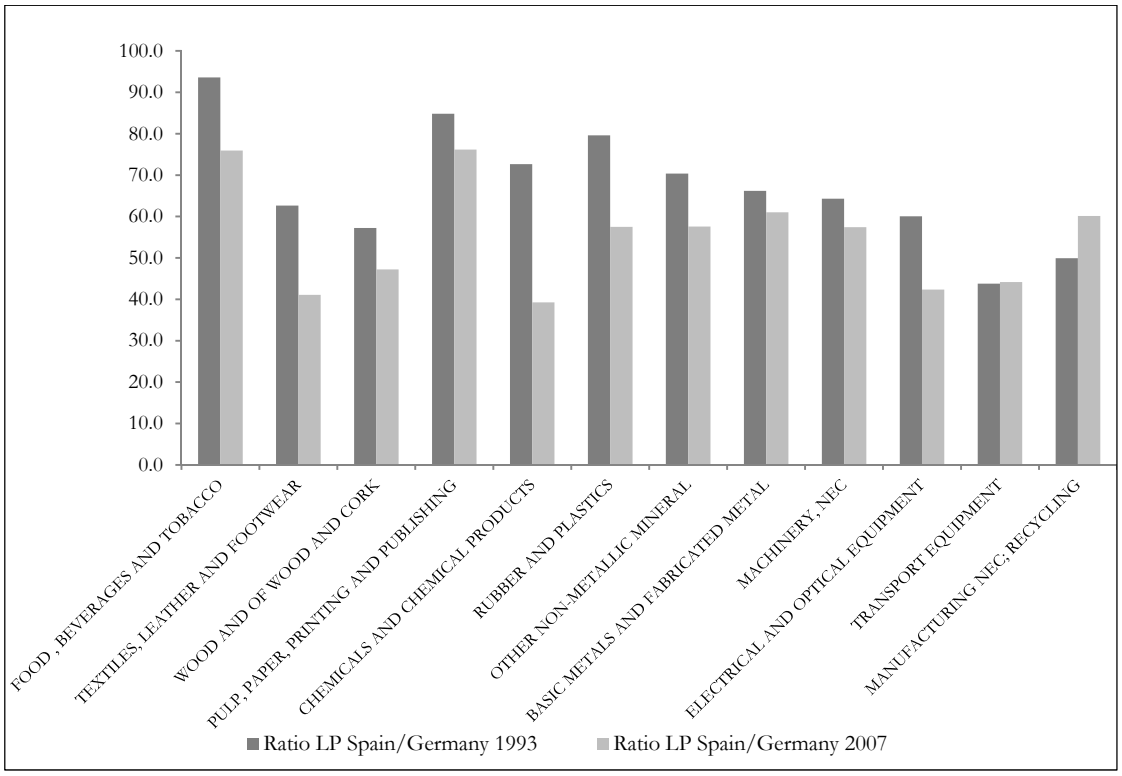
Source: EU KLEMS (2009), www.euklems.net and own calculations.

Figure 2.5. Index of differences in industries' composition, L $_{E\text{-}Ger}$.



Source: EU KLEMS (2009), www.euklems.net and own calculations.

Figure 2.6. Ratio Labour Productivity Spain/Germany (in %) 1993 and 2007



Source: EU KLEMS (2009), www.euklems.net and own calculations

Table 2.2. Labour Productivity. Spain - Germany, 1993-2007

	1993[a]	1999[a]	2003[a]	2007[a]	1993-2007[b]	1993-1998[b]	1999-2002[b]	2003-2007[b]
a) Spain								
TOTAL	*17.0*	*18.7*	*19.7*	*21.2*	*1.6*	*1.5*	*0.9*	*1.9*
FOOD, BEVERAGES AND TOBACCO	19.5	18.3	19.4	17.3	-0.9	-1.5	1.4	-2.9
TEXTILES, LEATHER AND FOOTWEAR	11.6	11.1	11.3	13.0	0.8	-0.8	0.6	3.6
WOOD AND OF WOOD AND CORK	11.1	12.4	11.6	13.5	1.4	1.6	-2.4	3.9
PULP, PAPER, PRINTING AND PUBL.	21.4	21.9	24.3	26.6	1.6	-0.4	2.5	2.3
CHEMICALS AND CHEMICAL PROD.	27.5	32.0	33.7	33.8	1.5	2.7	1.1	0.0
RUBBER AND PLASTICS	22.7	22.8	23.3	24.7	0.6	-0.4	-0.5	1.5
OTHER NON-METALLIC MINERAL	19.6	21.8	22.6	25.7	2.0	1.9	0.0	3.2
BASIC METALS & FABRICATED METAL	17.5	19.1	19.9	21.4	1.5	1.2	1.3	1.8
MACHINERY, NEC	17.4	20.0	21.4	22.4	1.8	2.6	1.1	1.1
ELECTRICAL AND OPTICAL EQUIP	17.0	21.0	22.4	25.3	2.8	4.1	0.7	3.1
TRANSPORT EQUIPMENT	14.7	22.6	21.7	26.0	4.1	7.9	-2.4	4.4
MANUFACTURING NEC; RECYCLING	10.0	11.1	11.4	12.7	1.7	1.7	1.2	2.7
b) Germany								
TOTAL	*26.6*	*32.1*	*36.1*	*43.2*	*3.5*	*3.4*	*2.8*	*4.5*
FOOD, BEVERAGES AND TOBACCO	20.8	22.4	22.0	22.7	0.6	0.8	-0.4	0.8
TEXTILES, LEATHER AND FOOTWEAR	18.5	21.8	26.4	31.7	3.8	3.3	4.7	4.6
WOOD AND OF WOOD AND CORK	19.5	22.7	27.7	28.6	2.7	2.6	4.5	0.8
PULP, PAPER, PRINTING AND PUBL.	25.2	31.5	30.1	34.9	2.3	4.0	-1.9	3.7
CHEMICALS AND CHEMICAL PROD.	37.8	53.0	66.0	86.1	5.9	6.0	6.4	6.6
RUBBER AND PLASTICS	28.6	32.0	35.0	43.0	2.9	2.4	2.6	5.1
OTHER NON-METALLIC MINERAL	27.8	34.4	39.5	44.7	3.4	3.4	2.3	3.1
BASIC METALS & FABRICATED METAL	26.4	31.6	33.9	35.1	2.0	3.1	1.8	0.9
MACHINERY, NEC	27.0	32.5	34.3	39.0	2.6	4.5	2.7	3.2
ELECTRICAL AND OPTICAL EQUIP	28.3	33.3	41.1	59.7	5.3	1.4	3.2	9.3
TRANSPORT EQUIPMENT	33.5	39.4	48.2	58.8	4.0	3.5	4.7	4.9
MANUFACTURING NEC; RECYCLING	20.0	22.6	22.0	21.2	0.4	2.5	-0.7	-1.0
(c) Ratio Spain/Germany (in %)								
TOTAL	*64.1*	*58.4*	*64.8*	*49.2*	*45.4*	*44.1*	*33.2*	*43.1*
FOOD, BEVERAGES AND TOBACCO	93.6	81.7	88.1	76.0	-136.8	-177.6	-316.2	-375.6
TEXTILES, LEATHER AND FOOTWEAR	62.7	51.1	42.8	41.1	21.5	-23.5	12.8	77.7
WOOD AND OF WOOD AND CORK	57.2	54.5	41.7	47.2	50.0	61.5	-53.0	501.9
PULP, PAPER, PRINTING AND PUBL.	84.8	69.6	80.7	76.2	67.0	-11.1	-127.5	61.6
CHEMICALS AND CHEMICAL PROD.	72.7	60.5	51.1	39.3	25.2	44.5	17.6	0.6
RUBBER AND PLASTICS	79.6	71.4	66.4	57.5	20.3	-18.0	-18.5	29.3
OTHER NON-METALLIC MINERAL	70.4	63.4	57.2	57.6	57.8	54.3	1.7	105.2
BASIC METALS & FABRICATED METAL	66.2	60.4	58.8	61.0	71.5	38.3	72.9	203.9
MACHINERY, NEC	64.3	61.7	62.4	57.4	69.2	57.4	42.2	35.4
ELECTRICAL AND OPTICAL EQUIP.	60.1	63.1	54.5	42.4	53.2	288.7	23.8	32.7
TRANSPORT EQUIPMENT	43.8	57.3	45.0	44.2	101.6	225.7	-51.0	90.0
MANUFACTURING NEC; RECYCLING	49.9	49.0	51.9	60.1	421.3	70.0	-180.9	-270.5

Notes: (a) Thousands Euro per Hour; (b) Average annual growth rate in %.

Source: EU KLEMS (2009), www.euklems.net and own calculations.

The main conclusion is that Spain has not undergone significant changes in its composition of production, concentrating its production in less productive branches which are thus less exposed to competence in comparison to Germany. This is confirmed in terms of labour productivity in figure 2.6 and table 2.2, the data indicates that particularly traditional productive activities intensive in labour, as Food, beverages and tobacco and Textiles, leather and footwear, display a significant drop in labour productivity. Despite the fact that between 1993 and 2007 the rate of employment in Spain increased significantly and that capital accumulation was an important contributor of value added (Mas *et al.*, 2012; Pérez *et al.*, 2006), Spanish manufacturing shows little ability to generate value added and an unfavourable manufacturing's specialization. In fact, Spain displays a higher average growth rate of capital services (3.0%) than Germany (1.2%)[4] in the considered period. This indicates that it is not mainly a matter of factors' accumulation, but of a poor labour productivity performance.

Figure 2.6 displays the ratio of labour productivity between Spain and Germany for 1993 and for 2007 for each manufacturing branch. In all branches Spain loses weight in front of Germany, particularly in high and medium performing productivity branches as Chemicals and Chemical Products and Electrical and Optical Equipment. The ratio is remains unchanged in Transport Equipment and increases in Manufacturing NEC; Recycling. This behaviour reinforces the above mentioned conclusions. Having a look at table 2.2 panel (c) data show how the labour productivity ratio between Spain and Germany has decreased between 1993 and 2007, from 64% to 49%. Spanish labour productivity has lost weight in relation to the German one, despite having grown at annual rate of 1.6% in the considered period, it doesn't achieve to approach the German growth rate (3.5%). Although Spain manufacturing industry is still focused on medium to low technology branches, it is not able to achieve a sustainable productivity growth also in these branches (for example see Textiles, leather and footwear, Basic metals and fabricated metallic products). The data reveal how Spanish manufactures are still mainly specialized less technology intensive sectors, which have exhausted their advantages and need to develop new strategies to increase their competitiveness (Trullén, 2007). So new strategies are needed to promote improve labour productivity performance in high and medium technology manufacturing branches like Transport equipment (Aerospace), Chemicals and Chemical Products and Electrical and Optical Equipment.

[4] EU KLEMS (2009), www.euklems.net and own calculations.

2.5. Conclusions

In this chapter we have analyzed the sources in labour productivity differences between the Spanish and German manufacturing industry in the period 1993-2007. To this end we posed several questions in order to single out the factors that may determine this gap, taking Germany as the benchmark country. The first one was to confirm that the Spanish and German differences in per capita income of the total economy are reducing whereas on the contrary the one in manufacturing industry does not. Data shows that this is not the case: Spanish and German differences in per capita income of the total economy remained relatively stable until the last subperiod, when they started to increase (figure 2.2). Albeit the strong increase of the employment rate and of capital accumulation (Mas *et al.*, 2012) in Spanish manufacturing in the considered period, the ability to generate value added remains low.

Per capita income differences between Spanish and German manufacturing industry are growing, particularly in the last subperiod. Spanish per capita income in manufacturing industry is losing weight in relation to Germany. The gap between per capita income of the Spanish and German in total and manufacturing industry is increasing. Next, we carried out a decomposition analysis of per capita income in order to assess the influence of labour productivity The results obtained confirmed that not only that the differences in productivity were one of the main determinants, but that they were also significant and persistent along the considered period.

Differences in sectoral specialization could explain differences in productivity, and, in fact, our results have shown that Spain's manufacturing industry is characterized as a traditional one, where low and medium technology branches generate the greatest part of value added. In contrast, in Germany the bulk is on the high and medium technology branches. Despite the investment in capital stock incorporating new and advanced technologies, the low skills of workers and the absence of adequate measures promoting human capital formation may explain this poor ability in generating value added (Corrado *et al.*, 2014; Corrado *et al.*, 2012; Mas *et al.*, 2012, Timmer *et al.*, 2010 and Pérez *et al.*, 2006). Thus results point to the fact that labour productivity differences are not so much related to an issue of factors' accumulation. Low skilled human capital implies lower absorptive capacity of workers and thus lower ability to benefit from new capital stock investments incorporating technical progress. In addition the low technological content of new employment created in manufacturing could be another determining factor explaining this behaviour. All this might explain why the impact job creation and increasing capital accumulation on labour productivity in Spain is scarce.

The results obtained in this chapter raise the question for a need of a change in industrial policy (Legarda and Hidalgo, 2011; Myro, 2012 and 2014; Trullén, 2007; Valero, 2013), specifically to implement strategies based on "focusing" in manufacturing industry branches of high knowledge economy or programs with a strong technological component (Martínez *et al.* 2014; Trullén, 2007). Spain's manufacturing industry is still mainly specialized in medium to low-technology sectors. The specialization in low-technology sectors implies a lower propensity to innovation. The industrial strategy of the so-called European engines, such as France and Germany, postulates the increasing specialization in technology and knowledge intensive industries. This "focusing" strategy was followed in the past by Japan and the United States, and is behind the development of new technologies such as ICT, biotechnology and nanotechnology.

The role of industrial policy is to rule changes in production and, in particular, to enable processes to substantially increase productivity. It is relevant to point out that the period between 1993 and 2007 was a time of less interventionism by the government and of a more industrial market driven policy. As noted by the European Commission (2005), the health of the manufacturing sector is essential for economic growth. In addition the industry has spillover effects that far outweigh the services, particularly regarding intermediate consumption.

As a consequence of the economic crisis the Spanish government, in order to improve manufacturing labour productivity performance, is committed to generate qualified employment -of high-technological level-, to improve competitiveness in foreign markets and to increase the weight of the industrial sector, focusing mainly on manufactures, in national GDP (Martínez et al.; 2014;. Myro, 2014; Rodríguez, 2012 and Trullén; 2007).

Already in the period between 1993 and 2007 the proposed industrial policy in Spain aimed to support and implement these priorities, but as we can see in the present without obtaining a better performance of manufacturing labour productivity. Probably, this is due to the fact that it coincided with a time characterized by a less government's interventionism and consequently the kind of industrial policy measures implemented.

In order to promote labour productivity growth in Spanish manufacturing, there is a need for a resurgence of an active industrial policy.

The results obtained may shed some light on why Spanish economy is showing up difficulties for recovering from the present crisis. This opens a door to new

questions on further determinants of aggregate productivity changes that will be explored in further research.

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2.7. Appendix 2.A

Table 2.A.1. Industry taxonomy and ISIC classification

	Branches	ISIC classification revision 3.0
1	Food and beverages	15
2	Tobacco	16
3	Textiles	17
4	Wearing Apparel, Dressing And Dying Of Fur	18
5	Leather, leather and footwear	19
6	Wood and of wood and cork	20
7	Pulp, paper and paper	21
8	Printing, publishing and reproduction	22
9	Pharmaceuticals	244
10	Chemicals excluding pharmaceuticals	24x
11	Rubber and plastics	25
12	Other non-metallic mineral	26
13	Basic metals	27
14	Fabricated metal	28
15	Machinery, NEC	29
16	Office, accounting and computing machinery	30
17	Electrical machinery and apparatus, nec	31
18	Radio, television and communication equipment	32
19	Medical, precision and optical instruments	33
20	Motor vehicles, trailers and semi-trailers	34
21	Other transport equipment	35
22	Manufacturing nec	36
23	Recycling	37

Source: EU KLEMS (2009), www.euklems.net and own elaboration.

Chapter 3: Decomposition of labour productivity: the role of sectoral structure

3.1. Introduction

Up to now, we have seen that there are no signs indicating a reduction of the gap in manufacturing labour productivity between Spain and Germany from 1993 to 2007. The question posed in this section is if the differences in the manufacturing industry specialization among both countries justify the existing differences in manufacturing labour productivity.

As said in chapter 2 since the early decade of the 1990s the European Union (EU) economy has gone through two business cycles and is now in the downward phase of a third one. First in 1993 and afterwards at the end of 2001 manufacturing cycles in EU suffered two troughs, displaying negative growth rates in manufacturing output. Particularly, in southern EU member states the situation has been exacerbated by pre-existing low sectoral performance (European Commission, 2009), like in Spain.

All this raises the question if governments can play a positive role in boosting their countries' manufactures, especially high-performing productivity manufacturing branches, so now a growing number of authors are speaking of a resurgence and renewed interest in industrial policy (Dhéret, 2014; Pianta, 2013; O'Sullivan *et al.*, 2013; Crafts and Hughes, 2013 and Aghion *et al.*, 2011). The role and design of industrial policy is being revisited intending to reinforce rather than mitigate the impact of competition policy and to provide useful guidelines for EU competition authorities.

As in chapter 2 we continue our analysis focusing on two countries' manufacturing industries representative each one of the periphery and the centre, respectively Spain and Germany. The results are intended to show the need to adopt industrial policy measures that promote high-performing productivity manufactures and also to provide information for its design and implementation in the future.

The objective of this chapter is to go a step further in the comparative analysis of manufacturing labour productivity between Spain and Germany in the previous years of the crisis, 1993-2007 in order to know the origins of the persisting differences. The motivation is to identify the causes of the productivity gap between the German and the Spanish manufacturing industries in the time period 1993-2007. With this aim we study whether they are due to changes in the sectoral structure or to differences in productivity itself between sectors. Thus we undertake an analysis from two complementary perspectives in order to go a step further. Both consist of a decomposition of aggregate productivity differences into different sources, but each implementing a different methodology with the aim to obtain a more complete explanation. The first one consists in decomposing these differences into a rate effect and a level effect in the same way as Fernández Casillas and Mate Rubio (1994) do. The second involves the decomposition of aggregate productivity differences into three explanatory components: structural change or industry mix[5], productivity differential and allocative following the methodology of Esteban (1972, 1994 and 2000) and will be computed in levels.

Spanish manufacturing value added is losing weight in the total economy's value added in the between 1993 and 2007 (table 3.1, panel (a) row 2: in1993 the ratio GVA_T/GVA_I represented 5.3% in front of 5.9% in 2007). That means the manufacturing industry is no longer the main driver of GVA in total economy. For sure the building industry became the main source of total economy's GVA and employment growth in the Spanish economy during the expansion years. Almost all Spanish manufacturing industries experienced a very slow productivity growth. The absence of a more active industrial policy in this period has become clear, as well as the absence of measures aiming to control real estate loans. No doubt that the overfunding of the building industry had an opportunity cost in terms of the industrial and service sectors' development. So, what it is required now is not only an active industrial policy, but one oriented towards high-performing productivity manufacturing industries, not just more manufactures. Thus there is a need for an industrial policy that meets these new requirements.

The results confirm that it is mainly an intrinsic problem of productivity itself. Manufacturing industry's specialization is becoming an influencing variable, although to a lesser degree. Thus the main contribution of this chapter is that differences in industry structure do not totally justify the gap in productivity.

[5] The terms *industry mix*, *structural change* or *specialization* component are equivalent and are used indistinctly in this paper and making reference to the manufacturing industry and not to the whole industry as in Esteban (1972 and 2000).

As said before, all this is indicative for the need to design and to implement a different industrial policy programmes in Spain. All in all, definitions of industrial policy have at their core a concern with economic growth, and especially with productivity growth. The general principles of industrial policy are simple enough. It should favour the evolution of knowledge, technologies and economic activities in directions that improve economic performances, social conditions and environmental sustainability (Callejón and García-Quevedo, 2011; García-Quevedo and Afcha, 2009 and Trullén, 2007).

The remainder of this chapter is organized as follows. After the introduction, section 3.2 contains a brief description of the dataset. Section 3.3 and 3.4 are devoted to the analysis of labour productivity growth and industry specialization. To this end, we implement two types of analysis. The first one in Section 3.3, where we decompose labour productivity changes into rate and level effects, and the second one in section 3.4, we decompose those changes into the following three components: structural change or industry mix, productivity differential and allocative. Section 3.5 summarizes the main findings and conclusions.

3.2. Data

As in chapter 2 to carry out this analysis we use the EU KLEMS Growth and Productivity Accounts (henceforth EUKLEMS; http://www.euklems.net) which contain internationally comparable data for output and inputs. So the same explanations on the database are valid for the present is chapter, for this reason we do not reproduce them here.

The data used in this chapter covers the period from 1993 to 2007 for Spain and Germany. In all figures, tables and formulae *E* stands for Spain and *Ger* for Germany. Our analysis is implemented both at aggregate level as well as for individual branches of manufacturing industry. Here again, the dataset used here consists of 23 goods-producing industries that correspond to the 2-digit ISIC Revision 3.0. For a list of industries see table 2.A.1.

Our output measure is gross value added at basic prices 1995=100, labour productivity is defined in terms of hours worked as well as all the variables needed for the analysis, where appropriate. All monetary variables are expressed in Euros 1995 =100.

3.3. Decomposition of aggregate Productivity Changes in Rate and in Level Effect

Here we implement the same methodology used by Fernández Casillas and Maté Rubio (1994) in their decomposition of aggregate productivity change analysis, but for the Spanish and German manufacturing. Aggregate average productivity is affected over time by changes in productivity within sectors and movements in output and employment or hours worked across sectors with different levels of average productivity. We analyse to what extent the existing gap in aggregate productivity in manufacturing industry between Spain and Germany is explained by changes in the sectoral structure (*level effect*), by productivity changes within sectors (*rate effect*) and by a small interaction effect (*residual*) consequence of the other two changes.

This methodology (Fernández Casillas and Maté Rubio, 1994) is interesting because it allows not only to study the aggregate productivity changes inside an industry, but its main advantage is that it permits to compute and compare directly two industries. This will show us some useful evidences for our analysis, which may be conclusive. To carry out this study we take the same data as those in the former sections (see Chapter 2.2). The results are examined for total manufacturing as well as for the different manufacturing branches. We depart from the following expression (3.1) where the aggregate productivity (*LP or* γ) growth can be decomposed in the rate effect (β), the second is the level effect (ν) and the last term is the interaction effect (θ).

$$\gamma_{it} = \beta_{it} + \vartheta_{it} + \theta_{it} \tag{3.1}$$

where $\gamma_{it} = \frac{\Delta LP}{LP_t}$; $\beta_{it} = \sum_i q_{it}\left(\frac{\Delta LP_i}{LP_{it}}\right)$; $\upsilon_{it} = \left[\left(\frac{LP_{it}}{LP_t}\right) - 1\right]\Delta S_i$; $\theta_{it} = \sum_i q_{it}\left[\frac{\Delta LP_i}{LP}\right]\left[\frac{\Delta S_i}{S_i}\right]$

Substituting all three effects in expression (3.1) we obtain the following expression.

$$\frac{\Delta LP}{LP_t} = \sum_i q_{it}\left(\frac{\Delta LP_i}{LP_{it}}\right) + \left[\left(\frac{LP_{it}}{LP_t}\right) - 1\right]\Delta S_i + \sum_i q_{it}\left(\frac{\Delta LP_i}{LP_{it}}\right)\left(\frac{\Delta S_i}{S_{it}}\right) \tag{3.2}$$

Before turning to the discussion of the results it is convenient to point out two aspects. Firstly, the amount of the different effects is influenced by the degree of manufactures' disaggregation and, secondly, for any degree of disaggregation we

depart from computing the average productivities of subsectors that may be very different among them.

The empirical results are displayed in table 3.1. At a first glance, the figures in panel (a) and (b) confirm that the *rate effect*[6] is the main determinant of aggregate productivity differences in both manufactures in the whole period as well as in all the subperiods. As far as productivity is an indicator of efficiency of how inputs are allocated and combined in order to obtain an output, the results are indicative for the relevance of this effect as main driver of aggregate productivity and of economic growth. Here again we can appreciate the poor performance of Spanish manufacturing when it comes to be efficient and to generate value added. Comparing the results of the *level effect*[7] in the first and in the last subperiod, we observe how it experienced a slightly increase (from -0.1 to 0.8) in its importance in Spain (table 3.1) whereas the opposite happens in Germany (from 0.5 to -0.2). This is indicative of a small change in the production structure, confirming the results obtained in the previous section. Interaction effect (*residual*) is so small that is worthless to comment, being null its impact on productivity growth. Again we see that the subperiod 1999-2002 is one of slow progress of the three determinants and for thus also for productivity growth. Taking a look at panel (c) data confirm that the differences in aggregate productivity growth are mainly due to rate effect, rather than to *level effect*. So, we can conclude that the differences in manufactures' specialization do not justify the existing gap in productivity among both manufacturing.

In order to complete our analysis, in the next section 3.4, we will apply the second methodology to decompose aggregate productivity differences into the following three components: *structural change*, *specialization* or *industry mix*, *productivity differentials* and *allocative*. The objective is to confirm our hypothesis that changes in manufactures' specialization do not justify productivity differences between Spanish and German manufacturing industries. This time instead of computing growth rates (dynamic analysis), we will implement the present analysis taking the variables in level (static analysis). We aim to complement the dynamic point of view with the static one, in order to get a more complete view of our study.

[6] The *rate effect* is the part of aggregate productivity that results from changes in average labour productivity *within* sectors. It is the amount of aggregate change that would have occurred if each sector's share of total hours worked by engaged person remained constant.

[7] The *level effect,* also called *intersectoral composition effect*, is the part of the variation in aggregate productivity explained by the change in the structure of total hours worked by engaged person, plainly employment. Put in another way, it reflects the change in aggregate productivity due to variations in employment in manufacturing industry, remaining sectoral productivities constant.

Table 3.1. Decomposition of aggregate productivity change. Manufacturing industry: Spain and Germany, 1993-2007

Average annual growth rates in %

	1993-2007	1993-1998	1999-2002	2003-2007
(a) Spain				
Rate effect β^{E}_{t} (a)	22.2	7.8	1.9	7.1
Level effect ν^{E}_{t} (b)	1.4	-0.1	0.9	0.8
Interaction effect θ^{E}_{t} (c)	1.0	0.4	0.1	-0.3
Δ Productivity/ Productivity γ^{E}_{t} = (a) + (b) + (c)	24.6	8.1	2.8	7.7
(b) Germany				
Rate effect β^{Ger}_{t} (a)	61.9	17.7	8.5	19.7
Level effect ν^{Ger}_{t} (b)	1.2	0.5	0.2	-0.2
Interaction effect θ^{Ger}_{t} (c)	-0.8	0.0	0.0	-0.1
Δ Productivity/ Productivity γ^{Ger}_{t} = (a) + (b) + (c)	62.2	18.1	8.6	19.4
(c) Ratio Spain/Germany				
Rate effect$(\beta^{E}_{t}- \beta^{Ger}_{t})$ (a)	35.8	44.2	21.9	36.3
Level effect $(\nu^{E}_{t} - \nu^{Ger}_{t})$ (b)	116.8	-20.4	501.1	-460.3
Interaction effect $(\theta^{E}_{t}- \theta^{Ger}_{t})$ (c)	-123.6	-985.0	-201.9	220.8
Δ Productivity/ Productivity $(\gamma^{E}_{t}-\gamma^{Ger}_{t})$ = (a) + (b) + (c)	39.5	44.7	32.5	39.5

Source: EU KLEMS (2009), www.euklems.net and own calculations.

3.4. Decomposition of aggregate productivity changes in three components: Structural change, productivity differential and allocative

As we have seen from different perspectives (chapter 2.4 and chapter 3.3), the industrial dimension seems to play an important role in labour productivity performance. Here we want to enforce the conclusions driven from the latter decomposition of aggregate productivity changes in three components following the methodology applied by Esteban (1972, 1994 and 2000).

In 1972 Esteban modified the standard decomposition into two factors extending it to the sum of three components: *structural change* or *industry mix*, *productivity differential* and *allocative*. The first part reports on the percentage of growth attributable to the industry mix in each region. The second measures the part due to the fastest growth

of the region at the sectoral level (possibly caused by increased productivity). Finally, the third component measures the covariance between the first two components. This can be interpreted as the contribution to regional growth resulting from their specialization in those activities in which the region is more competitive. His model has been widely accepted as there have been many researchers who still have used it with modifications (Herzog and Olsen, 1977; Tervo and Okko, 1983, Ledebur and Moomaw, 1983; Arcelus, 1984).

Although this kind of analysis, known as shift-share analysis, was originally conceived as a technique to analyze regional employment dynamics, its extension is immediate to decomposition of interregional differentials aggregate productivity. Here we will apply this methodology with the aim to decompose the difference in the level of average labour productivity between Spain and Germany. Since in this paper the comparison is between two manufacturing industries - Spain and Germany - manufacturing industries instead of regions will be discussed. When computing differences between both manufactures, again we take Germany as a benchmark. At this point it is important to advice in order to avoid any misunderstandings that we will use the term *industry mix* referred specifically to manufacturing industry, not to the whole industry.

The objective is to examine whether the slower productivity growth is due to a lesser redistribution of factors towards branches with higher productivity levels and/or higher productivity growth (*structural change* or *industry mix* effect), or if it is a consequence of an overall slower growth of productivity at manufacturing industry level (*productivity differentials*). The following expression reflects the gap between average productivity between country *i* and the reference or benchmark country decomposed into three components. Each of these components of the aggregate includes a source causing productivity differences (Esteban; 1972, 1994 and 2000).

$$x_i - x = \mu_i + \pi_i + \alpha_i \tag{3.3}$$

In order to determine the relevance of specific *productivity differentials* and/or *industry mix* in manufacturing, we contrast each manufacturing branch against a benchmark, one endowed with sectoral productivities and *industry mix* equal to a manufacturing industry average. Thus, the peculiarities of the Spanish manufacturing branches will be captured by the differences between the Spanish and the benchmark industry mix and between the Spanish and the benchmark sectoral productivities. To this end, we simulate for Spain the aggregate productivity that it would have had, if it deferred from the benchmark standards in one respect only. The difference with respect to the benchmark German productivity gives the contribution of each of

these components in explaining the gap between Spanish actual and benchmark German aggregate productivity.

Table 3.2 shows results for a few key years over time, as well as the average for the whole period. Firstly, in panel (a) we see the differences between both manufactures and, secondly, in (b) we have computed these differences as a percentage of labour productivity in the manufacturing industry of reference. Let us start by looking at panel (a), all three effects display a growing trend in the differences between both industries in the whole period, showing a significant increase between the 2003 and 2007.

Table 3.2. Shift-share analysis. Spain - Germany, 1993-2007

(a) Shift-share components

In percentage

	1993	1999	2003	2007	Average
Industry mix[a]: $\mu^{E}_{i} = \Sigma i\ (p^{E}_{it} - p^{Ger}_{it}) * x^{Ger}_{it}$	-1.4	-2.0	-2.3	-4.0	-2.1
Productivity differential[b]: $\pi^{E}_{i} = \Sigma i\ (x^{E}_{it} - x^{Ger}_{it}) * p^{Ger}_{it}$	-8.8	-11.8	-14.9	-20.4	-13.0
Allocative[c]: $\alpha^{E}_{i} = \Sigma i\ (p^{E}_{it} - p^{Ger}_{it}) * (x^{E}_{it} - x^{Ger}_{it})$	0.7	0.5	0.7	2.5	0.7
Average productivity difference $(x^{E}_{it} - x^{Ger}_{it}) = \mu_i + \pi_i + \alpha_i$	-9.6	-13.4	-16.5	-22.0	-14.9

(b) Weight of each component μ_i^E, π_i^E y α_i^E on the productivity differential

In percentage

	1993	1999	2003	2007	Average
Industry mix: $\mu^{E}_{i} = \Sigma i\ (p^{E}_{it} - p^{Ger}_{it}) * x^{Ger}_{it}$	15.1	14.9	13.9	18.3	14.7
Productivity differential: $\pi^{E}_{i} = \Sigma i\ (x^{E}_{it} - x^{Ger}_{it}) * p^{Ger}_{it}$	91.9	88.5	90.1	93.0	90.0
Allocative: $\alpha^{E}_{i} = \Sigma i\ (p^{E}_{it} - p^{Ger}_{it}) * (x^{E}_{it} - x^{Ger}_{it})$	-7.0	-3.5	-4.0	-11.3	-4.8
Average productivity difference $(x^{E}_{it} - x^{Ger}_{it}) = \mu_i + \pi_i + \alpha_i$	100	100	100	100	100

Notes: (a) μ_i is the so-called *industry mix, specialization* or *structural change effect* of country *i* and measures the productivity differential between two countries due to the production structure of their industries, under the hypothesis that sectoral productivities are the same as in the reference country. (b) π_i is the *productivity differential*, *country* or *within-industry* effect and shows the growth of labour productivity that would have occurred even without any structural change or difference in the industrial specialization.
(c) a_i is called *allocation*, *interaction* or *dynamic effect* and is positive if the industry is specialized with respect to the mean of the reference country/industry in sectors where productivity is higher than that of the benchmark industry, and negative if below.

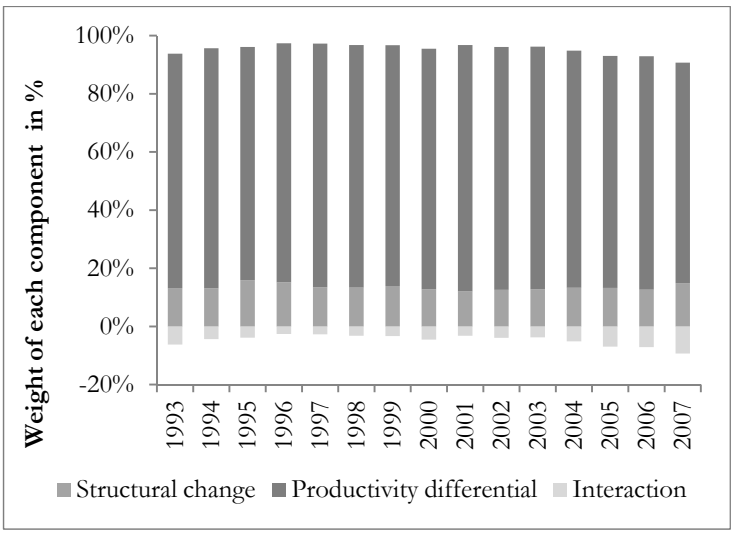
Source: EU KLEMS (2009), www.euklems.net and own calculations

Productivity differentials component is the main explaining factor of aggregate productivity differences; Spain seems not to be able to reverse this trend of increasing differences, even in the expansive stage of the economic cycle. Concerning the *structural change* or *industry mix* it is also negative but significantly smaller, although the gap is increasing in time and gaining importance in explaining the performance of aggregate productivity differences. The *allocative* component a_i shows a similar behaviour as the other two effects, but their figures are considerably smaller. Hence as they do have an almost null influence explain the differences in productivity changes, we ignore them.

In figure 3.1 the performance for all the years is displayed, confirming our interpretation of the results. The overall image is that Spain is lagging behind Germany, showing a poor performance of the *productivity differentials* component and to a lesser degree lacking ability to change its productive structure or *industry mix* component in a faster rhythm. Differences in labour productivity are cross-sectional as well as within sectors, indicating that it is not an isolated problem of few branches, but of the whole manufacturing. As said already before in chapter 2, the increasing investment in capital stock and, particularly in ICT capital, which in this period showed up as main drivers of GDP growth together with the increasing employment rate indicate that labour productivity differences cannot be mainly attributed to factors' accumulation (Corrado *et al.*, 2014; Corrado *et al.*, 2012; Mas *et al.*, 2012). In the considered period the increased employment rate is characterized by being made up mainly of low skilled workers (Mas *et al.*, 2012). In order to assimilate and to take advantage of the new technologies and knowledge embedded in new capital stock, it is relevant that human capital attains a certain level of absorptive capacity (European Competitiveness Report, 2013). If we consider that it is not the case in Spain's manufacturing, this might explain the lower ability to generate value added and thus to improve labour productivity growth. In every branch Spain's manufacturing is specialized in the production of a variety of goods both with less technological content and quality in contrast to Germany, which give rise to an adverse quality gap (Lladós-Masllorens and Fernández-Sirera, 2004). The process of differentiated vertical unfavourable specialization together with the fact that Spanish manufacturing is still mainly specialized in low to medium technology intense branches might explain to some extent the persistent differences in labour productivity between Spain and Germany. Consequently, all this has a negative impact on Spain's competitiveness in the international markets in contrast to Germany. Although this is the most immediate conclusion of both decomposition methodologies implemented here, the results suggest that manufacturing industry

specialization (*structural change* or *industry mix* component) in Spain is changing, but its rhythm or speed of change is maybe too slow lagging behind Germany.

Figure 3.1. Weight of each component μ_i^E, π_i^E and α_i^E on the productivity differential (in %). Spain and Germany, 1993-2007



Source: EU KLEMS (2009), www.euklems.net and own calculations.

3.5. Conclusions

In this chapter we have analyzed the sources in productivity differences between the Spanish and German manufacturing industry in the period 1993-2007. The countries chosen for this study are representative of the existent polarization in European manufacturing, that of a "periphery" and of a "centre". Where the "periphery" is composed of the so-called weak countries whose manufactures are displaying difficulties in their productivity performance and thus in their competitiveness and economic growth. On the contrary, the countries belonging to the "centre" have a large and strong manufacturing base.

Despite all the efforts and advances undertaken in the context of the Economic and Monetary Union (EMU), there are still existing significant disparities in manufacturing performance in the EU preventing from being homogenous in this regard. Presently, the EU is characterized, on the one hand, by a group of member states like Germany with strong manufacturing bases maintaining a robust position on global markets, whose model is clearly export-oriented and, on the other hand, by another group displaying relatively high commercial deficits (France, Spain,

Portugal, Greece, Italy) and with less diversified manufacturing industrial sectors (Dhéret, 2014).

Major drivers of competitiveness, be it productivity level, capacity to export, or the structure and diversity of the manufacturing base, have evolved in different ways across the territory. For instance, comparing levels of labour productivity across Europe confirms the presence of huge differences between EU countries.

To this end and in order to define and to design the base for industrial policy measures focused on manufactures, we posed several questions in order to single out the factors that may determine this gap, taking Germany as the benchmark country, representative for the "centre" and Spain, for the "periphery".

Differences in sectoral specialization could explain differences in productivity, and, in fact, our results have shown that Spain's manufacturing industry is characterized as a traditional one where low and medium technology branches generate the greatest part of value added, while in Germany the bulk is on the high and medium technology branches, but the situation is changing although very slowly. In addition, if we take into account that the creation of employment in the considered period is characterized mainly by low skilled workers, this would explain the poor labour productivity performance resulting in the production of low quality goods in comparison to Germany. These differences in the goods' quality, the so-called *quality gap* (Lladós-Masllorens and Fernández-Sirera, 2004) as a result of an unfavourable manufacturing specialization might shed some light on the causes hindering Spain's a from a better performance of economic growth and competitiveness in the international markets. So, this is indicative that it is not a matter of factors' accumulation (Mas *et al.*, 2012).

The results obtained may shed some light on why Spanish economy is showing up difficulties for recovering from the present crisis. But they also show up the need to identify and to design policy measures or initiatives to overcome the difficulties the Spanish manufacturing industry has in order to improve its productivity and to support manufacturing-based industrial competitiveness. These measures could be both horizontal as well as specific addressed to concrete manufacturing sectors, depending on their difficulties. Industrial policy measures focused on manufactures coordinated with other measures concerning human capital, information and communication technologies, as well as improving the competitiveness should aim to reduce the gap between the "periphery", Spain, and the "centre", Germany.

So, a different policy perspective is needed, addressing not only at the European level but at the national and regional level to end the depression and rebuild sustainable economic activities in a less polarized continent. Decisions on the future of the manufacturing industrial structure in Europe have to be brought back into the public domain.

3.6. References

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Chapter 4: Intangible assets and labour productivity growth

4.1. Introduction

As explained in chapter 1, since 1995 the rate of labour productivity growth in Europe has been declining almost in the whole considered period, with the exception of two short positive time spans coinciding with the upswing of the business cycle at the end of the 1990s and around 2006–2007. Finally, during the Great Recession in 2008-09, the European Union (EU) saw a decline in labour productivity parallel to the contraction of the economy.

As a consequence, many authors have tried to find explanations to the declining trend of labour productivity growth over the last two decades. (Corrado *et al.*, 2005, 2006, 2009; Marrano and Haskel, 2006; Van Rooijen-Horsten *et al.*, 2008; Fukao *et al.*, 2009; Hao *et al.*, 2009; Marrano *et al.*, 2009, Mc Morrow *et al.*, 2010; Edquist, 2011; Strobel, 2012; Mas *et al.*, 2012; Timmer *et al.*, 2010; Timmer *et al.,* 2011). They found evidence that increased investment in intangible assets explain a large share of the unexplained labour productivity growth and thus for economic growth.

The nature of the impact of the inclusion of intangible capital in the growth accounting model is similar across the countries for which the estimates are available. It determines an increase in labour productivity growth and in the contribution of capital deepening, and a decrease in total factor productivity (TFP) growth. But intangible expenditure is currently treated as current expense in the national accounts rather than as an investment. This determines an understatement of investment in the economy and an incomplete picture of the main sources of growth.

The aim of this chapter to explore the contribution to labour productivity growth of investment in different single intangible asset types in manufacturing industry for a set of 9 European member states between 1995 and 2010. The results should help us to identify which single or mix of intangible assets types are the main drivers of labour productivity growth in order to define and establish adequate industrial policy measures to promote a better economic performance. The purpose is not to demonstrate if investment in intangibles contributes to labour productivity growth,

as Muntean (2014), Roth and Thum (2013), Ilmakunnas and Piekkola (2014) and Corrado *et al.* (2014) among others have already shown. But we want to go a step further and identify which single intangible assets belonging to the different categories of intangibles are major drivers of it. This may help to define strategies to improve labour productivity performance for industry. We also analyze a longer time period (1995-2010) than other authors like Corrado *et a*l. (2013), they examine the period 1995-2007, Strobel (2012), who examines the period 1992-2005 and Hao *et al.* (2009) just examine one year: 2004.

In particular, in this chapter we use the estimates of intangible capital for the European countries produced by the INTAN-Invest database for the period 1995-2010. Following Hao *et al.* (2009) as well as Corrado *et al.* (2005, 2006, 2009), we will consider that intangible assets can be classified into three groups which include computerised information, innovative property and economic competencies. We focus on manufacturing industry in contrast to many other studies (Dal Borgo *et al.*, 2013; Edquist, 2011; Hao *et al.*, 2009) that examine the business or the market sector. The reasons to concentrate our research in manufacturing industry are related to the particular situation of the countries analysed.

All this happens in a context where the increasing importance of intangible capital as a major driver of labour productivity growth (Muntean, 2014; Corrado *et al.*, 2012; Dal Borgo *et al.* 2012; Equist, 2011), thus enhancing economic growth and competitiveness, is fully recognized. Until now, in chapter 2 and 3 we have seen that labour productivity differences are persistent, that to some extent differences in sectoral specialization could explain them and that they cannot be attributable mainly to factors' accumulation. In the context of the knowledge economy and with the aim of going a step further against this background, it is interesting to investigate the role of intangible investment labour productivity.

In contrast to chapter 2 and 3 where we have examined the performance of labour productivity growth focusing on two benchmark countries, Spain and Germany, each one representative for the so-called "periphery" and "centre" according to Dhéret (2014) and Pianta (2013), respectively, here we want to take a bigger sample. Thus we have extended it in order to provide a more complete and diverse view resulting from the different countries' characteristics to the study. At the same time, we also overcome the reduced availability of more detailed information for Spain and Germany.

In the last years investment has shifted from tangible to intangible capital, but depending on the countries the contribution of intangibles investment to labour productivity growth is larger or lower than of tangibles (Falk, 2013). So different

intangible investments' strategies might lead to differentiated contributions to labour productivity growth which results in countries displaying a better performance than others. This fact would explain the generation of two groups of countries.

For the sample of EU member states chosen here, we examined it was possible to group them. Figure 4.1 provides evidence for the differentiated behaviour of the set of 9 EU member states considered in the present study. Attending to the performance of standardised gross value added (GVA) average growth and labour productivity growth it is possible to classify the sample in two groups. The first one displays positive values for both variables and thus a better performance than the second one, with negative values. Due to the fact that until recently intangibles have been considered as an expense and not as an investment in the growth accounting framework, it is interesting to examine to what extent intangibles investment can provide an explanation for such a differentiated behaviour between countries. If affirmative, separating countries in different groups taking into account their specific characteristics and problems in manufacturing industry should permit to design concrete policy measure obtaining better results in terms of efficacy and efficiency.

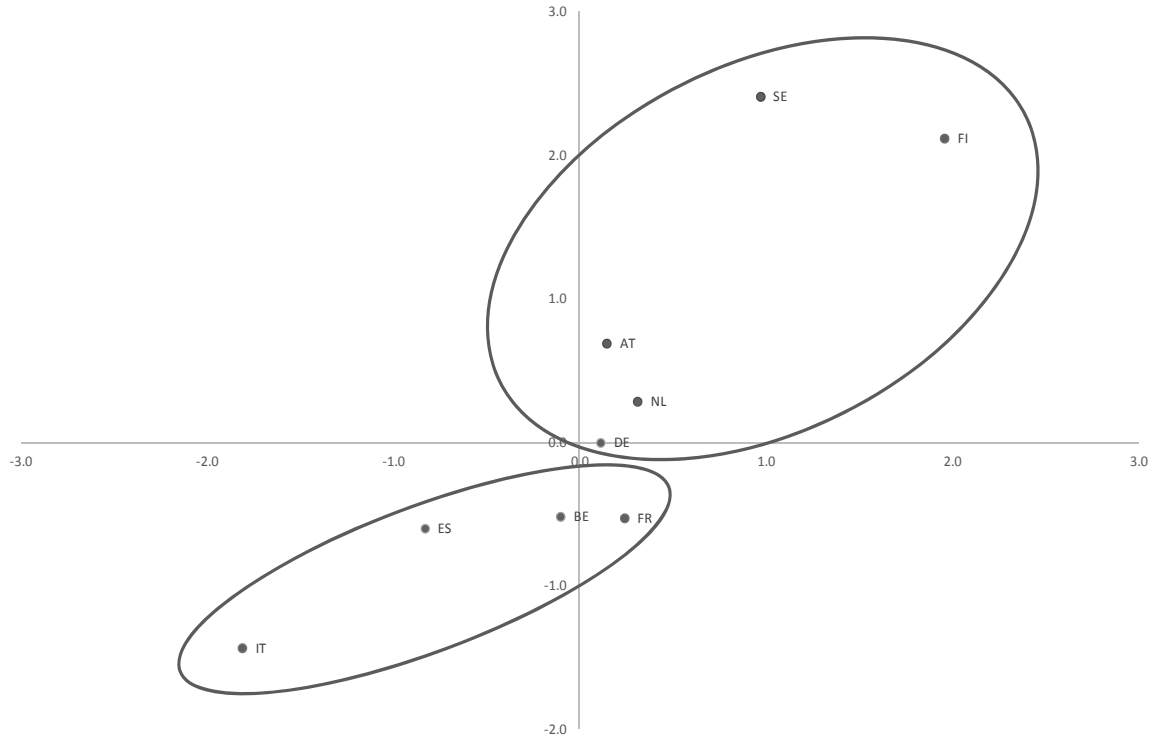
All this explains the resurgence and renewed interest in industrial policy and on how to design and implement targeted but also homogeneous (Dhéret, 2014; Pianta, 2013; O'Sullivan *et al.*, 2013).

Taking all this into account, the research questions that we try to answer in this paper are the following:

- Which of the different intangible assets better explain manufacturing labour productivity growth in the EU countries between 1995 and 2010?
- Are there heterogeneous effects of investment in intangible assets on labour productivity growth in the different considered EU countries?
- Which are the implications in terms of industrial policy?

The rest of the paper is organized as follows: Section 4.2 briefly summarizes some of the literature background on intangibles and productivity growth. Section 4.3 presents a description of the data and the empirical evidence. Section 4.4 concludes indicating the main policy implications and the next steps in our research.

Figure 4.1. Standardised GVA average growth (vertical axis) and labour productivity growth (horizontal axis) in manufacturing industry, 1995-2010



Source: Author's calculations on EUKLEMS (2012 release) www.euklems.net and Eurostat http://ec.europa.eu/eurostat/web/national-accounts/data/database

4.2. Background literature

There is an extensive literature on intangible investment, addressing issues as its measurement, the convenience to capitalize and to include them in the national accounting system as well as their contribution to labour productivity growth (Corrado *et al.*, 2005; Marrano *et al.*, 2009; Chun *et al.*, 2012; Goodridge *et al.*, 2013; Baldwin *et al.*, 2012; Miyagawa and Hisa, 2013).

Results of Van Ark's *et al.* (2009) study analyzing the reasons for the slow labour productivity growth in EU member states suggest that it might be explained by the differences in the accumulation on intangible assets which play a complementary role to information and communication technologies (ICT) capital. Intangible assets have been largely ignored in national accounts due to the difficulty for measuring it.

Research on this issue undertaken by Corrado *et al.* (2005, 2006; 2009) marks the beginning of a number of studies measuring intangible investment and showing the relevance of intangible capital for labour productivity growth. Departing from Nakamura's (1999, 2001) analysis, they developed expenditure-based measures of a large range on intangible for the United States (US). The contribution of labour composition and physical, or tangible, capital deepening to labour productivity has been well researched. In contrast, until recently, intangible assets were not considered as contributors to labour productivity growth. Similar studies have been conducted in Canada, (Muntean, 2014), Japan (Fukao *et al.*, 2009), Australia (Barnes and McClure, 2009) and Europe (Corrado *et al.*, 2013; Goodridge *et al.*, 2013; Roth and Thum, 2013; Jona-Lasinio *et al.*, 2011; Jalava *et al.*, 2007).

Until recently, spending on intangible assets was counted as an intermediate expense in the systems of national accounts rather than as investment in intangible capital. Corrado *et al.* (2009) indicate that specific features of some intangible assets, such as nonrivalness and the lack of verifiability, visibility and appropriability of returns explain the fact that the majority of intangible assets are disqualified as capital. These authors, however, argue that these distinct features do not make intangible assets an intermediate good. (Muntean, 2014, p.23)

Corrado *et al.* (2006) argue that the reason for treating intangibles as capital is that any use of resources that reduces current consumption in order to increase it in the future can be considered as an investment. It is not so long since computer software is now treated as capital in the national accounts of many countries, whereas many other intangibles, as for example research and development (R&D), are currently not. Intangible assets are generally defined as assets that provide future benefits but

do not have a physical embodiment, such as software, research and development R&D, market and consumer research.

Despite their uniqueness, intangible assets share basic common characteristics of physical capital. As any other type of capital, intangibles are used in production of goods and services and provide future benefits. As investment in physical capital, investment in intangible assets represents foregone current consumption for the benefit of greater future consumption.

Thus, intangible assets should be classified as capital and spending on intangibles should be counted as investment rather than operational or intermediate expenses. Otherwise, the aggregate level of output would remain underestimated. This potentially creates distortions in business investment and resource allocation. In addition, effectiveness of public policy may also be adversely affected if investment and capital in the economy are measured imprecisely. These distortions could ultimately lead to a decline in productivity and economic growth.

At present, the major challenge is to measure investment and intangible assets' stocks as well as its contribution to labour productivity growth (Muntean, 2014). As Jona-Lasinio *et al.* (2011) state, there is a large number of studies on intangible investment and its appropriate measurement and contribution to labour productivity growth. The problem is that most of them focus only on some assets (R&D capital, for example) leaving outside other elements such as organizational capital or brand equity. But some authors, as Sichel (2008), went a step further in implementing new approaches to measuring intangibles as financial market valuation, direct expenditure data and other performance measures.

Taking into account a possible revision of the national accounting framework, Corrado *et al.* (2005) proposed a broader definition for innovation in order to examine its impact on labour productivity growth. For this purpose, they have grouped the various items that constitute the knowledge of the firm into three basic categories: i) computerised information, ii) innovative property and iii) economic competencies.

Computerized information includes knowledge which is embedded in computer programs and computerised databases. Innovative property includes the *scientific* knowledge embedded in patents, licenses, and general know-how, as well as "the innovative and artistic content in commercial copyrights, licences and designs" (Corrado *et al.*, 2005, pp. 23–26).

The economic competencies category is defined as "the value of brand names and other knowledge embedded in firm-specific human and structural resources" (Corrado *et al.*, 2005, p.28). It includes expenditures on advertising, market research, firm-specific human capital, and organizational capital. These measures try to capture a range of knowledge assets that firms invest to run their business, which are key to encourage labour productivity growth. Examples of those are an increase in the selling potential of a product, the development of processes and a productive environment for the actual physical production of a good.

Brynjolfsson *et al.* (2002) showed the positive relationship between computerized information, here in particular via an interaction effect with organizational capital, on labour productivity growth. Other authors as Lichtenberg (1993), Coe and Helpman, (1995), Park, (1995) and Guellec and van Pottelsberghe de la Potterie (2001) did the same with certain dimensions of innovative property (scientific R&D), demonstrating its contribution to labour productivity growth.

The single dimensions of economic competencies, namely brand names, firm-specific human capital, and organizational capital are also relevant in stimulating labour productivity growth.

Following Roth and Thum (2013) *Brand names* should positively affect labour productivity growth since an important aspect of today's products is the "image" attached to them. The ownership of a brand that is appealing to customers permits a seller to acquire a higher margin for goods or services that are like those offered by competitors. Expenditure on market research compromises, next to expenditure on advertising, an important part of the investment in brand equity (Cañibano *et al.*, 2000).

Another important asset of a firm is *Firm-specific human capital.* Cañibano *et al.* (2000) stress that a firm with more competent employees is likely to acquire higher profits than competitors whose workers are less skilled. In this regard, Abowd *et al.* (2005) argue that the value of companies will increase if the quality of their human resources increases.

Organizational capital of a firm is another relevant dimension of economic competencies. In an era where goods become more and more sophisticated and production processes are becoming more complex, the management of the production process that involve highly technological physical capital is key factor for firm. Organizational capital is defined by Lev and Radhakrishnan (2005, p. 75) as "an agglomeration of technologies-business practices, processes and designs and

incentive and compensation systems—that together enable some firms to consistently and efficiently extract from a given level of physical and human resources a higher value of product tan other firms find possible to attain." They (Lev and Radhakrishnan, 2003, 2005) considered it the only competitive asset truly owned by a firm, while the others are tradable and thus available for every firm that wants to invest in them.

The recent empirical evidence shows that intangible capital contributes significantly to labour productivity growth, which is ultimately reflected in economic growth. There is a vast amount of literature showing and examining it for the different types of intangibles and from different points of view. Belhocine (2009) finds that in Canada, if spending on intangible assets is not included in aggregate investment, real gross domestic product (GDP) growth is on average underestimated by 0.1 percentage point per year from 1999 to 2001. It is underestimated by about 0.25 percentage point for 2004 (Muntean, 2014, p. 23).

Corrado *et al.* (2009) indicate that in the US, if investment in intangibles is not included, GDP growth is underestimated by about 0.25 percentage point per year from 1995 to 2002. Further studies on the contribution of intangibles to labour productivity growth like the one undertaken by Van Ark *et al.* (2009) focusing on the market sector in the US and selected European countries for the 1995-2006 show that intangible capital deepening contributed on average 0.83 percentage point in the US and 0.72 percentage point in the larger European countries (Muntean, 2014, p. 23). Dal Borgo *et al.* (2013) showed that for the period 2000 to 2008 intangible capital deepening accounted for a 23% of growth in market sector value added in United Kingdom (UK), a larger contribution than computer hardware (12%).

Ilmakunnas and Piekkola (2013) demonstrate that investment in organizational capital influences positively labour productivity growth. The results obtained by Yallwe and Buscemi (2014) who discuss the contributions of intellectual assets to labour productivity growth are also positive.

Recent data obtained by Corrado *et al.* (2013, p. 278) show that the rate of tangible investment in the EU15 declined sharply from 2007 to 2009, while the rate of intangible investment remained about flat. In the US, intangible investment fell. Across Europe there are small differences by regions, and intangible investment relative to tangibles held up better in recent years on both continents. All told, the shift to intangible investment from 1995 to 2009 is a striking trend.

In this context, there are still many issues that have not been tackled yet in the literature[8]. The present paper contributes to advances in this topic by considering how the single categories of intangible investment influence labour productivity growth in the manufacturing industry and which combinations are more appropriate than others. To our knowledge, such kind of analysis has not been implemented nor for the manufacturing industry using data covering the Great Recession.

4.3. Data and empirical evidence

4.3.1. Data

To carry out this study we use the EU KLEMS Growth and Productivity Accounts, July 2012 release (henceforth EUKLEMS)[9] which contain internationally comparable data for output and inputs. This database includes a wide range of measures on output growth, employment, skill creation, capital formation and multi-factor productivity at the industrial level for EU member states from 1970 until 2010. Concretely, the EU KLEMS data used in this paper are: value added, value added deflator, number of employed workers and number of hours worked by employed.

Our output measure is gross value added at basic prices 2005=100, labour productivity is defined in terms of hours worked as well as all the variables needed for the analysis, where appropriate. Total hours worked by persons engaged are expressed in millions of hours. These variables All monetary variables are expressed in Euros 2005 =100.

As Timmer *et al.* (2007a and 2007b) state, the main advantage of EU KLEMS (from now on EUKLEMS) database is that it allows going beyond the aggregate level of economy to analyze the productivity performance of individual industries and their contribution to aggregate growth.

Here we take from EUKLEMS database *Gross value added* at basic prices and *Total hours worked by persons engaged* are expressed in millions of hours. Labour productivity is defined in terms of hours worked as well as all the variables needed for the

[8] For instance, Roth and Thum (2011) propose to consider a wider dimension of intangible capital in the national accounting framework in order to achieve a more accurate assessment of the labour productivity growth performance and thus of economic growth. Jona-Lasinio et al. (2011) also identifies the need to analyse to what extent investment in intangibles influences labour productivity growth on the long run as the time span considered by most studies is quite short.

[9] For a detailed description of the data, see Timmer *et al.* (2007 a, b) and http://www.euklems.net.

analysis, where appropriate. All monetary variables are expressed in millions of Euros 2005 =100.

Data on investment in intangibles stems from the database INTAN-INVEST[10]. For more information on the source and details for measurement of intangible assets see Corrado *et al.* (2014a and 2014b). Corrado *et al.* (2006) distinguish three classes of intangible assets:

(i) *Computerized information*: software and databases[11];
(ii) *Innovative property*: (scientific & non-scientific) R&D, design (including architectural and engineering design), product development in the financial industry, exploration of minerals and production of artistic originals.
(iii) *Economic competencies*: firm investment in reputation, human and organizational capital.

Concerning investment in intangibles we include all the variables belonging to these three classes of assets for which data are available for the considered period[12].

Data on Gross fixed capital formation (investment in tangible assets) are obtained from Eurostat.[13]

The data used in this paper covers the period from 1995 to 2010 for a set of nine EU member states (Austria, Belgium, Finland, France, Germany, Italy, Netherlands, Spain and Sweden). The reasons to analyze these countries are related to data availability on intangible assets. However, an adequate geographical coverage of the EU15 is provided as they cover both members of the core and the periphery that, as have highlighted before, is relevant for the analysis of manufacturing productivity growth during the considered period.

Table 4.1 displays the list of variables considered in the present analysis while more detailed information of variable definition and sources are provided in Appendix 4.A.1. Appendix 4.A.2 also provides some descriptive statistics of the dataset used.

[10] http://www.INTAN-Invest.net
[11] Concerning *Computerised information*, its major component is software, the other component is databases and covers expenses of software developed for a firm's own use. It includes mainly three components: own use, purchased, and custom software (Corrado *et al.*, 2005). According to Corrado *et al.* (2014b) as far as only data of software are available in INTAN-Invest database, we take this variable as representative one for computerised information.
[12] For more details see the source documentation Corrado et al. (2014b).
[13] http://ec.europa.eu/eurostat/web/national-accounts/data/database

4.3.2. Empirical evidence

In order to estimate the contribution of investment of intangible assets to labour productivity, a log-linear Cobb-Douglas production function has been used as the starting point. As in Roth and Thum (2013), a reduced form equation in which the independent variable is the growth rate of investment in intangible asset and the dependent variable is labour productivity growth can be easily derived from this theoretical model. The analysis is undertaken in growth rates, thus all variables are expressed in terms of logarithmic differences.

In particular, the change in the log of labour productivity of manufacturing in country *i* between time *t* and *t-1* (LP_{it}-LP_{it-1}) is explained by the change of the different of intangible assets between time t and t-1,(X_t-X_{t-1}). The model is enlarged with country fixed effects (C_i) that will account for potential unobserved heterogeneity and also with period effects (Y_t) accounting for common shocks in the considered countries, while U_{it} is a random error term.

$$LP_{it} - LP_{it-1} = \beta_0 + \beta_1(X_t - X_{t-1}) + C_i + Y_t + U_{it} \quad (4.1)$$

The number of countries considered is 9 and the time period analyzed involves 15, so it is balanced panel with 135 observations.

The analysis is implemented in two steps. Firstly, we start the analysis by introducing one by one the single intangible assets types belonging to each of the above defined classes of intangible assets in order to find out if they are significant or not and if, affirmative to what extent they are contributors to labour productivity growth. Secondly, we combine the significant independent variables and introduce in the equation in order to find out how well or not they work together in increasing labour productivity.

Table 4.1. Variable description

Variable description	**Acronym (1)**
Gross value added	VA
Total hours worked by persons engaged	H_EMP
Gross value added, price indices	VA_P
Labour productivity	LP
Total investment. Gross Fixed Capital Formation	GFCF
Investment in tangible assets. Gross Fixed Capital Formation	TC
Investment in intangible assets. Gross Fixed Capital Formation	IC
Computer software	SW
Innovative Property (2)	INN_PROP
Economic Competencies (3)	ECON_COMP
Scientific R&D	R&D
New architectural and engineering designs, New product development costs in the financial industry Entertainment, Artistic and Literary Originals and Mineral Explorations	ARCH_DES_NFP_MIN_ART
Market research and Advertising expenditure	ADV_MKT
Training	TRAIN
Organizational Capital	ORGCAP

Notes:

1. All monetary variables are expressed in constant prices (2005 = 100) per Total hours worked by persons engaged.
2. INN_PROP = R&D + ARCH_DES_NFP_MIN_ART
3. ECON_COMP = ADV_MKT + TRAIN + ORGCAP

Source: Own elaboration on Corrado, Carol, Jonathan Haskel, Cecilia Jona-Lasinio and Massimiliano Iommi (2014). "Internationally comparable macro-estimates of investment in intangible assets at the industry level: INTAN - Invest" available at www.INTAN-Invest.net.

Table 4.2 reports the estimation results for all countries between 1995 and 2010. The analysis starts by estimating the contribution of both investment in intangible and tangible assets to labour productivity growth. According to other studies Hao *et al.* (2009), Roth and Thum (2013) and Corrado *et al.* (2014a) here too intangible assets contribute significantly to labour productivity growth in contrast to tangible capital which turned out not to be significant in our model (table 4.2, column 1). Concretely in the 1995-2010 period, intangibles contributed on 0.16 percentage point (table 4.2, column 2) with and adjusted R-square value of 0.60.

The first step is to introduce each single intangible asset type in the estimation equation. When introducing one by one the variables in order to identify those intangible assets that are significant for labour productivity growth, we find out that all an unexpected result, which is that investment in *software* has no influence on labour productivity labour growth (table 4.2, column 3). All the other assets included in the analysis have a positive influence on labour productivity growth. One possible explanation maybe that a minimum level of investment in software has been already achieved, so that additional investment is no significant. Perhaps it is the same that happened with the digital technologies, what matters is the use, not the endowment. Once everyone is provided with the software, now the difference lies strictly in its strategic use. When combining it with investment in *organizational capital* it turned out not be have any impact on labour productivity growth on contrary to the results obtained by Brynjolfsson *et al.* (2002).

In this context, another unexpected result is the reduced influence of the single intangible components belonging to the category *innovative property*. Investment in *scientific R&D* (from now on *R&D*) is significant, but on the contrary to what one would have expected, shows little influence in promoting labour productivity growth (table 4.2, column 4: 0.10 percentage points and is statistically significant at a 5% level, not at 1%). A similar conclusion can be drawn from the other asset type*, architectural and engineering design, product development in the financial industry, exploration of minerals and production of artistic originals*, its contribution to labour productivity growth is somewhat higher (table 4.2, column 5: 0.13 percentage point) than *R&D*. These two asset types when considered jointly as in column 9 (table 4.2) reveal themselves again as moderate contributors to labour productivity growth in contrast to *economic competencies*.

Turning now to the third category of intangible assets, *economic competences*, and the variables included in it, the most relevant variable is *vocational training* (table 4.2, column 7). Among all the other variables considered in this paper *vocational training*

contributes the most to labour productivity growth (0.30 percentage points). It is by far the most significant variable among all the other considered in this study jointly with *advertising and marketing* (table 4.2, column 6), whose impact is of an annual growth rate of 0.17 percentage points on the dependent variable. The other intangible asset considered in this group is *organizational capital* (table 4.2, column 8), whose impact on labour productivity growth is similar to *R&D*, 0.11 percentage points. All three assets types are statistically significant at 1% level and display an adjusted R-square value between 0.60 and 0.62, which is an acceptable fit. These results provide a positive answer to our first research question on which intangible asset are significant for labour productivity growth.

As Cañibano *et al.* (2000) demonstrated, the ownership of a brand that is attractive for the customers allows the sellers to obtain a higher margin for goods or services which are similar to those offered by the competitors. Thus the development of a brand becomes a key element in obtaining future benefits. Expenditure on market research and advertising constitutes an important part of the investment in brand equity (Roth and Thum, 2013). Presently, the management of the production process involves highly technological physical capital which requires high qualified workers. In such a context, the quality of the training of the workers becomes relevant. As far as goods become more elaborated and incorporate more high intensity technology, production processes are turning out more complex. Thus the training of the workers becomes crucial. As Cañibano *et al.* (2000) and Abowd *et al.* (2005) argue, a firm with better qualified workers is expected to obtain higher profits than other ones with less skilled employees. And also a firm with high qualified human resources will have a higher value than other companies with less qualified employees (Roth and Thum, 2013).

The second step is to combine the different significant assets with other assets belonging to their category and afterwards with other belonging to the other intangible asset categories. When trying to assess the combined influence of more than one variable, we have to say that it only works when including two variables, not more, and only two equations are accepted, specifically columns 9 and 10 (table 4.2). In both *R&D* is introduced in the model, once combined with *architectural and engineering design, product development in the financial industry, exploration of minerals and production of artistic originals* and the other one with *advertising & marketing*.

Again this last variable shows up as an important driver, it contributes to an annual growth rate of 0.16 percentage points of labour productivity. In both equations *R&D* leads to an annual growth rate of 0.07 percentage points of the dependent variable, but is only at a statistically significant level of 10%, when all the other

variables are statistically significant at a 1% level. Adjusted R-square value is respectively, 0.61 and 0.62 percentage points, that is a good fitting.

According to our data, real investment in intangible assets per hour worked grew at an average rate of 4.1 per cent from 1995 to 2010 (see Appendix 4.A.2). *Software*, although belonging to *computerized information*, one of the smallest categories of intangibles, was the fastest growing category in 1995-2010. It grew at an average annual rate of 8.7 per cent, followed by *organizational capital* with an average annual growth rate of 4.5 per cent. *R&D* as well as *architectural and engineering design, product development in the financial industry, exploration of minerals and production of artistic originals* grew at 4.2 percent, respectively.

In terms of investment per hour worked for the sample of countries considered in this study these figures indicate that *computerized information* and *innovative property* represent the major part of investment in intangible assets. Thus, one may think that they are also major contributors to labour productivity growth in the 1995-2010 period.

But as we have seen before, estimations results do not provide support for it. On average, each of the asset types *R&D* as well as *architectural and engineering design, product development in the financial industry, exploration of minerals and production of artistic originals* belonging to *innovative property* contributed each one 0.07 and 0.12 percentage point (table 4.2, column 9) to labour productivity growth. In contrast, the components of *economic competences* are the ones which contribute most to labour productivity growth, particularly, *vocational training* (table 4.2, column 7: 0.30 percentage points). Surprisingly, investment in *vocational training* shows lower growth rates. The same can be said for *advertising & marketing* the second major driver of labour productivity growth after *vocational training*, although the average investment rate is a bit higher. This raises the question on how to invest strategically in those intangible assets that are major contributors to labour productivity growth. In fact, higher investment rates in intangible assets do not necessarily imply that those assets become major drivers of labour productivity growth.

Up to here we have answered the first research question; our results show that *vocational training* and *advertising & marketing* are the intangible assets that explain better labour productivity growth in manufacturing industry in the considered EU member states between 1995 and 2010.

Table 4.2. Estimation results for all countries, 1995-2010

LP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
TC	-0.01									
	(0.33)									
IC		0.16***								
		(0.00)								
SW			0.01							
			(0.67)							
R&D				0.10**					0.07*	0.07*
				(0.04)					(0.11)	(0.10)
ARCH_DES_NFP_MIN_ART					0.13***				0.12***	
					(0.00)				(0.00)	
ADV_MKT						0.17***				0.16***
						(0.00)				(0.00)
TRAIN							0.30***			
							(0.00)			
ORGCAP								0.11***		
								(0.01)		
Constant	0.02***	0.04***	0.03	0.02***	0.02***	0.02***	0.02***	0.02***	0.02***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Total panel (balanced) observations	135	135	135	135	135	135	135	135	135	135
Adjusted R-squared	0.58	0.60	0.57	0.59	0.61	0.62	0.61	0.60	0.61	0.62
Cross-section effects specification	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Period effects specification	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Periods included	15	15	15	15	15	15	15	15	15	15
Cross-sections included	9	9	9	9	9	9	9	9	9	9

Notes: Sample: 1996 2010. Robust standard errors are given in parenthesis. *** p<0.01, **p<0.05, *p<0.1.
Source: Author's calculations on EUKLEMS (2012 release) www.euklems.net, Invest-Intan (2014) www.INTAN-Invest.net and Eurostat http://ec.europa.eu/eurostat/web/national-accounts/data/database.

The second research question aims to examine if there are there heterogeneous effects of investment in intangible assets in the different considered EU member states on labour productivity growth. As shown in the introduction, figure 4.1 provides evidence for a differentiated behaviour between the set of 9 countries, both in terms of gross value added and labour productivity. This allows us to divide our sample in two groups, one with higher values of both average growth in gross value added and labour productivity - group 1 - and another one - group 2 – with lower values. The resulting groups of countries are:

- Group 1: Austria (AT), Finland (FI), Germany (DE), Netherlands (NL) and Sweden (SE)
- Group 2: Belgium (BE), France (FR), Italy (IT) and Spain (ES)

Here again we reproduce the analysis undertaken in step 1 and 2. The aim is to analyze if different intangible investments' strategies lead to a differentiated labour productivity growth and thus to a differentiated ability in generating gross value added. This would shed some light in explaining why some countries display a better performance labour productivity growth than others. We expect the latter allows us to discriminate when defining and implementing policy measures to improve the performance of labour productivity growth. It would permit to design concrete and targeted industrial policy measures, particularly, for the countries lagging behind the ones showing up a better performance. This will permit us to answer the third research question concerning the implications of a differentiated behaviour in terms of industrial policy. If affirmative, classifying the countries in different groups attending their specific characteristics and needs in manufacturing industry should permit to design concrete policy measure obtaining better results in terms of efficacy and efficiency.

Considering the estimation results for group 1 (table 4.3), again here *investment in intangibles* reveals as a driver (table 4.3, column 2: 0.26 percentage points) of labour productivity growth in front of *investment in tangible assets*, which turns out not be significant (table 4.3, column 1). Considering the rest of variables individually, the results show that *advertising & marketing* (table 4.3, column 6: 0.24 percentage points), followed by *organizational capital* (table 4.3, column 8: 0.22 percentage points) and by *architectural and engineering design, product development in the financial industry, exploration of minerals and production of artistic originals* (table 4.3, column 5: 0.20 percentage points) are the ones which are significant at a level of 1% and are major contributors to labour productivity growth. *Vocational training* is significant too, but a level of 10% (table 4.3, column 7: 0.20 percentage points). All the other variables considered in

this study, either individually or combined with others, are rejected, because they are not significant.

One possible explanation may be the specific characteristics of the manufacturing industry of the countries included in this group. For example, that in the considered period just investment in this kind of intangible assets are relevant and not others, maybe because the needs are different and they already have invested enough in the other assets types. Attending to the countries included in group 1, these are countries that have promoted or fostered more *R&D* (Van Ark *et al., 2*009). Again here the contribution of investment in *software* seems to be not relevant.

Examining the estimation results for group 2 (table 4.4) they are similar to the ones obtained for all the countries in table 4.2, but the adjusted R-square values here are somewhat lower, that is between 0.33 and 0.51. Here too, *tangible investment* seems to have no influence on labour productivity growth. Increasing investment in *vocational training* (table 4.4, column 7: 0.45 percentage points) contributes most to labour productivity growth, followed by far by *advertising & marketing* (table 4.4, column 6). The same happens when considering this variable with other intangible assets as investment in *R&D* (table 4.4, column 11: 0.42 and 0.07 percentage points, respectively), *architectural and engineering design, product development in the financial industry, exploration of minerals and production of artistic originals* (table 4.4, column 12: 0.37 and 0.10 percentage points, respectively) and *advertising & marketing* (table 4.4, column 13: 0.38 and 0.12 percentage points, respectively). In contrast to group 1 here some combination of variables in an equation works out well together, but only when two variables are included, for more than two variables the equation is rejected. Following the same reasoning as in group 1, maybe here the countries considered need much more vocational training, and thus it is why this variable is so significant for labour productivity growth.

The results obtained do provide an affirmative answer to the second research question, thus it is possible to identify heterogeneous effects of investment in intangibles on labour productivity growth. They also provide a positive evidence for classifying the sample of countries in two groups, although inside each group the countries display also a differentiated behaviour. But in any case, the proposed grouping seems reasonable to our purpose.

Table 4.3. Estimation results for Group 1: Austria, Finland, Germany, Netherlands and Sweden

LP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TC	-0.01							
	(0.68)							
IC		0.26***						
		(0.00)						
SW			0.04					
			(0.41)					
R&D				-0.06				
				(0.50)				
ARCH_DES_NFP_MIN_ART					0.20***			
					(0.00)			
ADV_MKT						0.24***		
						(0.00)		
TRAIN							0.20*	
							(0.08)	
ORGCAP								0.22***
								(0.00)
Constant	0.04***	0.03***	0.03***	0.04***	0.03***	0.03***	0.03***	0.03***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Total panel (balanced) observations	75	75	75	75	75	75	75	75
Adjusted R-squared	0.73	0.78	0.73	0.73	0.78	0.78	0.75	0.79
Cross-section effects specification	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Period effects specification	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Periods included	15	15	15	15	15	15	15	15
Cross-sections included	5	5	5	5	5	5	5	5

Notes: Sample: 1996 2010. Robust standard errors are given in parenthesis. *** p<0.01, **p<0.05, *p<0.1.
Source: Author's calculations on EUKLEMS (2012 release) www.euklems.net, Invest-Intan (2014) www.INTAN-Invest.net and Eurostat http://ec.europa.eu/eurostat/web/national-accounts/data/database.

Table 4.4. Estimation results for Group 2: Belgium, France, Italy and Spain

LP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
TC	-0.01												
	(0.34)												
IC		0.21***											
		(0.00)											
SW			0.00										
			(0.96)										
R&D				0.08**					0.07*	0.08**	0.07*		
				(0.07)					(0.13)	(0.07)	(0.09)		
ARCH_DES_NFP_MIN_ART					0.13***				0.11***			0.10*	
					(0.02)				(0.03)			(0.07)	
ADV_MKT						0.14***				0.14***			0.12***
						(0.00)				(0.01)			(0.01)
TRAIN							0.45***				0.42***	0.37***	0.38***
							(0.01)				(0.01)	(0.03)	(0.02)
ORGCAP								0.06*					
								(0.13)					
Constant	0.02***	0.01***	0.02	0.02***	0.01***	0.01***	0.01***	0.02***	0.01***	0.01***	0.01***	0.01**	0.01***
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.03)	(0.06)	(0.03)
Total panel (balanced) observations	60	60	60	60	60	60	60	60	60	60	60	60	60
Adjusted R-squared	0.35	0.46	0.33	0.39	0.42	0.45	0.44	0.37	0.44	0.48	0.46	0.47	0.51
Cross-section effects specification	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Period effects specification	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Periods included	15	15	15	15	15	15	15	15	15	15	15	15	15
Cross-section included	4	4	4	4	4	4	4	4	4	4	4	4	4

Notes: Sample: 1996 2010. Robust standard errors are given in parenthesis. *** p<0.01, **p<0.05, *p<0.1.
Source: Author's calculations on EUKLEMS (2012 release) www.euklems.net, Invest-Intan (2014) www.INTAN-Invest.net and Eurostat http://ec.europa.eu/eurostat/web/national-accounts/data/database.

The findings support that differences in intangibles investment may explain the heterogeneity among the groups but also inside them. Group 1 is composed of member states that display a higher labour productivity growth and a greater ability in generating value added in front of group 2 which shows lower values (see figure 4.1). Inside each group intangible investments' figures displays a differentiated behaviour too. For example, in group 2 there are countries like Belgium and France which are doing an effort in increasing intangibles investment but its labour productivity growth is still beyond the average in the considered period (see Appendix 4.A.2). Thus results reflect the different needs in terms of investment in intangibles aimed to promote labour productivity growth of the countries pertaining to this group. The same can be said for the countries belonging to group 1 although they are above the average. As a consequence, it is difficult to propose homogenous industrial policy measures for the countries belonging to each group aiming to improve their performance. This leads us to the third research question concerned about the implications of the obtained results in terms of industrial policy. For this reason different policy measures attaining to the differentiated needs in terms of intangible investment of the considered EU member states should be implemented. For sure common measures can be designed for each group of countries, but to obtain better positive results, they should be complemented with other specific measures focusing on the concrete problems of each member state.

The main findings can be summarized as follows: all the considered intangible assets are significant for labour productivity growth with the only exception of *software* in both groups*;* and, specifically, *R&D* in group 1. Among the variables considered significant, *vocational training* and *advertising & marketing* are the ones which contribute individually most to labour productivity growth. As far as the image of the products is an important aspect, it is a reasonable result that advertising and marketing are an important driver of labour productivity growth.

Concerning the splitting of the sample in order to identify such a differentiated behaviour in terms of labour productivity growth and intangibles' investment between the groups, but homogeneous enough within them that allows proposing comprehensive policy measures for each group; results indicate that it is reasonable, but difficult. So they provide a positive answer to the second

research question. The implications of these findings for the design of industrial policy measures are that common measures should be combined with specific ones focusing on the particular needs in terms of intangibles investment of each country. A plausible explanation is provided by the heterogeneity of the characteristics of the different countries included in each group. Such diversity within each group needs concrete targeted solutions to problems shown up by each country to improve their labour productivity growth's performance. Thus it is difficult to label the considered groups according to investment in intangibles or to a geographic criterion, for example, in order to design a single common industrial policy for the whole sample.

4.4. Conclusions

The present paper has explored the influence of different intangibles assets' investment on labour productivity growth using international comparable panel data on manufacturing industry for 9 EU member states within a panel analysis between 1995 and 2010.

Three findings have emerged according to the three posed research questions. First, empirical analysis reveals that all single intangible assets are significant contributors to labour productivity growth in these countries and period, except for *software*. A plausible explanation maybe that once a certain level of investment in software has been already achieved, additional investment is not so significant. In fact as shown in table 4.A.2 countries belonging to the so-called "periphery" display a strong growth in *software* investment. Perhaps it is the same as with digital technologies: what matters is the use, not the endowment. Once the necessary requirements of software have been achieved, then the difference lies strictly in its strategic use. More concretely, in relation to the first research question, results obtained exhibit that the contribution of *economic competencies* - specifically *vocational training* and *advertising and marketing* - is the most important followed by that of *innovative property* to labour productivity growth. According to Bresnahan *et al.* (2002), organizational change should accompany ICT adoption in order to boost labour productivity growth. In the 1995-2010 period, *computerized information* –specifically, *software*- reveals not to be statistically significant for labour productivity growth. It appears that, although being the intangible asset showing the highest investment rates

between 1995 and 2010, this does not turn out to be a significant contributor together with *organizational capital* to labour productivity growth.

According to the European Competitiveness Report (2013), in the EU too little has been invested in the skills and organizational changes necessary to reap the benefits of ICT technologies. Lower investments in intangible assets (R&D, human capital, etc.) are likely to explain slow labour productivity growth as these factors affect a country's absorptive capacity, i.e. its ability to take advantage of technology developed elsewhere (international technology transfers). Given that the bulk of technological innovations is concentrated in a few leading countries, improvements by the lagging countries in the absorptive capacity will be needed in order to assimilate foreign technologies. The empirical results show that ICT plays a key role in reducing inefficiencies in the use of resources. In addition, more upstream regulation significantly increases the efficiency gap. In other words, administrative restrictions imposed on service market competition have widespread negative effects on production efficiency.

These results provide strong support for the hypothesis that a more competitive business environment reduces the efficiency gap. More flexible product market regulations, largely concentrated in key service-providing industries, are likely to raise efficiency levels across the whole economy. Regulatory changes in the labour market should also be tailored to restore the necessary balance between regular and temporary workers.

Concerning the second research question posed, there are heterogeneous effects of investment in intangible assets on labour productivity growth in the different considered EU countries. Splitting the sample of EU member states in two groups permits to identify a significant differentiated behaviour between groups. But the characteristics of the countries inside each group are not homogenous enough to define only common measures addressing the improvement of labour productivity growth. The technological endowment and capabilities of the EU member states explain to a great extend their heterogeneous dynamics of convergence. Moreover, different studies show that the country's dummy estimates on regional convergence tend to be significant, but they display very different coefficients indicating the presence of different steady states linked to the intrinsic characteristics of each country (Petrakos *et al.*, 2011 and Bosa *et al.*, 2010). This sustains that measures

promoting investment in intangibles at EU level should be accompanied by specific measures focusing each country's needs for the purpose of promoting labour productivity growth. This fact provides the answer to the third research question on the implications in terms of industrial policy, which is an immediate consequence of the second research question and thus strongly related with it.

In light of these findings the following conclusions can be drawn. First, related to our first research question, more importance should be paid to the intangibles category *economic competencies*. As Muntean (2014, p.37) states, empirical studies of intangible capital (Van Ark *et al.*, 2009; Jona-Lasinio *et al.*, 2011; Thum and Roth, 2011 and 2013) indicate that other categories of intangibles, such as *vocational training*, *advertising & marketing* (brand equity) and *organizational capital* also contribute significantly to labour productivity growth. This contribution should not be ignored. Here too, our results are in line with Muntean (2014). Concerning *vocational training*, skills feature as a major policy element in the *Europe 2020* agenda. The European Commission (2010) implemented an overall strategy for improving education and training systems via anticipation and investment in human capital supported by EU financial instruments, tools to monitor skills and training needs and trends, and specific initiatives to bring together the relevant actors. There are significant differences in skills achievements and in the effectiveness of vocational training systems across member states. The contribution of apprenticeships to supporting industrial competitiveness is widely recognised. Large differences in skills achievements and in effectiveness of *vocational training* systems across member states correlate with acute unemployment in crisis-hit member states. To invest in this intangible asset will influence positively *advertising and marketing* and *organizational capital*, as far as human capital is strongly related to these intangible assets. So, higher skills will result in an improved performance of these two assets.

As in Roth and Thum (2013), our results also show that *innovative property* is not the main driver of labour productivity growth as expected from the guidelines of the *Europe 2020 Strategy* (European Commission, 2010), but *economic competencies*.

For a long time R&D activities have been traditionally viewed as a main driver of innovation, as a result, they have been disproportionately encouraged by

governments in front of other intangibles assets that now have been revealed as equally or more relevant than R&D to labour productivity growth. One of the main criticisms to measure innovation through investment in R&D is that it does not seem to be a valid indicator for a country's innovativeness. For sure that it is an appropriate indicator in countries like Germany with a strong manufacturing industry, but not in those countries with a high specialization in service activities, like UK. As Muntean (2014) affirms, governments around the world provide significant support for innovative activities in the manufacturing industry. The *Lisbon Strategy* and the *Horizon 2020 Strategy* points out the importance of R&D and innovation explicitly. But as the *Horizon 2020 Strategy* recognizes intangible capital is the major determinant of innovation followed by R&D, which has revealed to be no longer such an important driver of innovation as initially, considered. Thus it is important to target precisely the different innovation measures in the *Horizon 2020 Strategy* in order to obtain best results when it comes to foster innovation in the EU. Further analysis examining the contribution of the different categories of intangibles to labour productivity growth has shown their importance in it and that focusing solely on R&D might provide a complete view of innovation.

Our second conclusion related to the second and third research question is that European countries differ significantly in how heavily they invest in intangible assets (Corrado *et al.*, 2012) and this is also reflected in their differentiated contribution to labour productivity growth as our results show. This hinders drawing a common pattern in their behaviour when it comes to define a unique policy measure to improve labour productivity growth by means of increasing intangible investment. It requires a new model of innovation and technological change helping countries to make a better use of their own innovative capabilities (Timmer *et al.*, 2011). Investment in intangible assets as *advertising and marketing*, *vocational training* and *organizational capital*, as well as other intangible investments are closely related to each country's needs, concretely, they are specific to individual firms. It is the firm that receive most of the benefits of such changes. Overall, according to our results, it can be concluded that the level of intangible investment in some countries, group 2 (figure 4.1 and table 4.A.2 in Appendix 4.A), seems to be insufficient when compared to group 1.

In this context, the main conclusion concerning the implications in terms of industrial policy is that homogeneous policy measures at EU level should be

combined with specific measures focusing on the member states' needs when it comes to promote intangible investment. In other words defining the same industrial policy measures for the different countries might not result in the expected objectives. By nature, capital investment is highly volatile and very sensitive to changes in economic conditions of the different countries. The tides and waves of investment usually follow business cycle expansions and downturns. This requires that policy measures should be designed focusing on the specific needs of investment in intangibles of the singles countries. As Blind and Georghiou (2010) state, research and innovation policy as well as other innovation-related policies should be coordinated at regional, national and European levels to maximise the benefits and minimise the cost. The commitment to innovation and the recognition that a knowledge- driven approach is fundamental to meeting the goals of economic recovery, social development and sustainability has led to a number of promising initiatives. There is evidence that Europe is not exploiting its innovation potential and that significant barriers are rooted in a lack of coordination between different policy initiatives and regulatory frameworks in both vertical and horizontal dimensions. The vertical issue concerns coordination and effective subsidiarity among the European, national and regional levels, while the horizontal is concerned with bringing together the policies and institutions rooted in sectoral and regulatory domains but which are critical for innovation and the effective functioning of markets.

As a result of recent research and analyzes, the Organisation for Economic Cooperation and Development (OECD) (OECD 2013a, 2013b, 2013c, 2013d), recommend to update the present policy frameworks in order to take into account the relevance of intangible capital. Evidence suggests that the solution for the innovation deficit of some European countries, such as Spain and Italy consists not only of raising R&D expenditure across all types of industries of the EU member states (Piekkola, 2011). To do this, policies need to address specific barriers to innovation. First, a general innovation policy is necessary to improve the environment for innovation. For example, measures facilitating the interaction among innovators and addressing the lack of young firms in young R&D intensive sectors. These measures should aim to ease the interaction of the players in the innovation system and to guarantee a healthy competition. Second, policy measures that tackles concrete barriers that new firms have to deal with in new sectors, like the access to external financing for highly innovative projects.

Furthermore, the OECD proposes the following measures: that the accumulation of intangible capital should be promoted through product market liberalization; bankruptcy regimes should also be acquiescent in front of business failures; a focus on broad concepts innovation, and labour market reforms. The OECD also warns that public policy to maximize the growth potential of knowledge-based capital may have ambiguous effects and trade-offs may emerge with other policy goals. Therefore, more investigation is needed to go a step further in the analysis of the measurement and the understanding of intangibles, refining the estimates of the contribution of intangibles to labour productivity growth for the single branches that conforms the manufacturing industry. This is crucial for the design of policy measures focusing on the different sectors in manufacturing industry, so that governments will have a more complete understanding of the state of manufacturing industry investment in intangibles; and whether support measures are needed to spur and promote such investment (Muntean, 2014, p. 37 and OECD 2013a, 2013b, 2013c, 2013d).

4.5. References

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4.6. Appendix 4.A.

Table 4.A.1. Data sources and variable description, 1995-2010

Variable description	Acronym (1)	Source	Measurement unit
Gross value added	VA	EU-KLEMS www.euklems.net	€, millions, 2005
Total hours worked by persons engaged	H_EMP	EU-KLEMS www.euklems.net	Millions
Gross value added, price indices	VA_P	EU-KLEMS www.euklems.net	2005 = 100
Labour productivity	LP	EU-KLEMS www.euklems.net	€, millions, 2005
Total investment. Gross Fixed Capital Formation	GFCF	http://ec.europa.eu/eurostat/web/national-accounts/data/database	Million euro, chain-linked volumes, reference year 2005 (at 2005 exchange rates)
Investment in tangible assets. Gross Fixed Capital Formation	TC	http://ec.europa.eu/eurostat/web/national-accounts/data/database	Million euro, chain-linked volumes, reference year 2005 (at 2005 exchange rates)
Investment in intangible assets. Gross Fixed Capital Formation	IC	INTAN-INVEST www.INTAN-Invest.net	€, millions, 2005
Computer software	SW	INTAN-INVEST www.INTAN-Invest.net	€, millions, 2005
Innovative Property (2)	INN_PROP	INTAN-INVEST www.INTAN-Invest.net	€, millions, 2005
Economic Competencies (3)	ECON_COMP	INTAN-INVEST www.INTAN-Invest.net	€, millions, 2005

Table 4.A.1. Continued

Variable description	Acronym (1)	Source	Measurement unit
Scientific R&D	R&D	INTAN-INVEST www.INTAN-Invest.net	€, millions, 2005
New architectural and engineering designs, New product development costs in the financial industry Entertainment, Artistic and Literary Originals and Mineral Explorations	ARCH_DES_NFP_MIN_ART	INTAN-INVEST www.INTAN-Invest.net	€, millions, 2005
Market research and Advertising expenditure	ADV_MKT	INTAN-INVEST www.INTAN-Invest.net	€, millions, 2005
Training	TRAIN	INTAN-INVEST www.INTAN-Invest.net	€, millions, 2005
Organisational Capital	ORGCAP	INTAN-INVEST www.INTAN-Invest.net	€, millions, 2005
Business Sector Value Added Deflator	p_intan	INTAN-INVEST www.INTAN-Invest.net	(2005=1)
Harmonised Software Deflator	soft_def	INTAN-INVEST www.INTAN-Invest.net	(2005=1)

Notes:

1. All monetary variables are expressed in constant prices (2005 = 100) per Total hours worked by persons engaged.
2. INN_PROP = R&D + ARCH_DES_NFP_MIN_ART
3. ECON_COMP = ADV_MKT + TRAIN + ORGCAP

Source: Own elaboration on Corrado *et al.* (2014). "Internationally comparable macro-estimates of investment in intangible assets at the industry level: INTAN - Invest" available at www.INTAN-Invest.net.

Table 4.A.2. Labour productivity growth and Investment in Intangibles, 1995-2010

Average annual rate of change

	LP	TC	IC	SW	R&D	ARCH_DES_NFP_MIN_ART	ADV_MKT	TRAIN	ORGCAP
Austria	2.8	2.4	4.1	12.0	6.9	2.1	4.5	2.4	3.6
Belgium	2.5	-4.1	5.6	9.6	3.2	5.3	6.3	2.8	5.5
Finland	4.8	-12.2	4.7	12.0	8.7	5.9	4.2	1.8	6.2
France	2.8	8.2	5.1	13.2	3.8	5.4	2.7	3.3	5.8
Germany	2.9	0.6	3.1	7.6	3.5	2.7	1.2	2.1	4.6
Italy	0.8	0.6	2.4	4.5	3.0	3.5	1.8	0.4	3.2
Netherlands	2.9	-5.2	4.8	8.8	1.3	4.5	2.7	-0.2	6.4
Spain	1.7	-3.2	3.5	11.6	6.3	5.4	3.0	0.5	3.4
Sweden	5.8	-5.1	6.1	9.4	3.8	6.6	3.7	3.7	6.5
Average	3.0	-7.4	4.1	8.7	4.2	4.2	2.9	1.8	4.5

Source: Author's calculations on EUKLEMS (2012 release) www.euklems.net, Invest-Intan (2014) www.INTAN-Invest.net and Eurostat http://ec.europa.eu/eurostat/web/national-accounts/data/database

Chapter 5: Concluding remarks and future research

5.1. Concluding remarks and policy implications

This dissertation has examined the poor performance of labour productivity growth in manufacturing for a sample of European Union (EU) member states in the last decades in view of the existence of persisting differences among them. The motivation was to investigate the causes that hinder labour productivity to recover from the crisis that started in 2008 and attain a stable growing pace. Chapters 2 and 3 were devoted to investigate the existence of labour productivity differences, to assess their magnitude and analyze the role of industry specialization as well as to determine to what extent theses differences arise from changes in the production structure, from labour productivity itself or a combination of both. Chapter 4 analyzed which of the different intangible assets contribute most to labour productivity growth. This last chapter summarizes the main findings and concluding remarks as well as their limitations. Industrial policy implications are also described and future research on this topic is proposed.

Chapter 2 started the analysis by focusing on the concern of the productivity slowdown in manufacturing since the mids 1990s and the persisting heterogeneity in its performance among EU member states (Mas *et al.*, 2012; Timmer *et al.* 2010). A comparative analysis between Germany and Spain, respectively as representatives for the centre and the periphery, is undertaken in order to determine the existence of these differences and obtain information on the determinants that deprive labour productivity in manufacturing from a better performance, to assess its magnitude and also the influence of industry specialization. Results show that differences are significant and persistent and that it is mainly a problem of productivity itself. Despite an increasing employment rate and a strong capital accumulation,

Spain's manufacturing ability to generate value added is poor in comparison to Germany. This indicates that it is not a problem of factors' accumulation (Corrado *et al.*, 2014; Corrado *et al.*, 2012; Mas *et al.*, 2012) and that this difficulty to improve labour productivity performance is both intersectoral and also intra-sectoral. To a lesser extent industry specialization influences this performance, albeit its displays a growing trend. Thus differences in industry structure do not provide a full explanation of the existing differences in labour productivity.

Next, since behaviour of economy is mainly the result of the aggregation of different sectors and of labour productivity dynamics (Martino, 2014, Mas *et al.*, 2012), in chapter 3 we have examined to what extent aggregate labour productivity changes arise from sectoral structure changes, from labour productivity differentials or a combination of both in Spain and Germany. Findings were expected to point out the need to implement industrial policy measures in order to foster high-performing productivity in manufacturing branches as well as to obtain information for the design of efficient and strategic industrial policy measures (Dhéret, 2014; Pianta, 2013 and O'Sullivan *et al.*, 2013). Results have confirmed that differences arise mainly from labour productivity differentials itself and to a lesser extent from structural changes.

Chapter 4 was devoted to investigate and to assess the role of different intangible assets on labour productivity growth in manufacturing. To this end, we have implemented the analysis for a set of 9 EU member states. A closer study of the data has allowed us to identify a differentiated behaviour among them both in terms of gross value added growth and labour productivity growth. As a consequence, to deepen the analysis we have split the sample into two groups with the aim to study their differentiated evolution. Investment in intangibles assets have shown up as important contributors of labour productivity growth (Corrado *et al.*, 2005, 2006, 2009 and 2013; Muntean, 2014; Ilmakkunas and Piekkola, 2014 and Roth and Thum, 2013). The intention was to go a step further and determine which intangible asset type belonging the different intangibles' categories are the main contributors of it. We expected results would shed some light on designing strategic and efficient industrial policy measures helping in attaining a better performance of labour productivity growth. Findings indicated that *vocational training* and *advertising and marketing* are the main drivers of labour productivity growth. They also confirm that grouping the sample of 9 EU member states into two

groups allows identifying a differentiated behaviour among them. But, at the same time, results also support for the presence of heterogeneity inside each group.

From the study implemented in this dissertation several conclusions can be drawn. Firstly, differences in labour productivity can be mainly attributed to productivity itself and not so much to manufacturing industry structure differences. Secondly, differences in industry structure do not totally justify the gap in productivity. Taking Spain as benchmark for countries belonging to the so-called "periphery" (Dhéret, 2014), it can be concluded that some of them may have difficulties to change its productive structure at a faster pace. Our results have shown that Spain's manufacturing industry is characterized as a traditional one, where low and medium technology branches generate the greatest part of value added. In contrast, in Germany the bulk is on the high and medium technology branches, but the situation in Spain is changing although very slowly. In the analyzed period the employment rate and the capital stock in Spanish manufacturing increased significantly in comparison to German manufacturing (Corrado *et al.*, 2014; Corrado *et al.*, 2012; Mas *et al.*, 2012). From this we can conclude that labour productivity differences are not Mainly a matter of factors' accumulation. Against this background, one would have expected a better performance of labour productivity in Spain and a greater ability to generate value added. But on the contrary, Spanish labour productivity remains poor; differences with Germany have grown. In contrast to Germany, Spanish manufacturing shows up an unfavourable specialization in some more knowledge-intensive activities thus limiting the potential to improve labour productivity performance and international competitiveness. Furthermore, as a consequence Spain's manufacturing produces lower quality goods than Germany, which can be mainly attributed to the fact that employment created in the considered period consists mainly of low skilled workers (Mas *et al.*, 2012). This may explain the reduced ability to generate value added, the poor performance of labour productivity and the existing quality gap (Lladós-Masllorens and Fernández-Sirera; 2004) in comparison to Germany regarding the goods produced. A plausible explanation is the reduced absorptive capacity of new technologies by low skilled workers, who occupy the new created positions, which results in difficulties to produce medium to high quality goods. As a consequence, Spain's competitiveness in the international markets is affected negatively. At this point, it is important to point out that our findings indicate that the differences in labour productivity

are cross-sectional as well as within sectors, indicating that it is not an isolated problem of few branches, but of the whole manufacturing. All this hinders them from attaining a better performance of labour productivity growth and thus catching up with the "centre" (Dhéret, 2014). Thirdly, intangibles assets belonging to the category *economic competencies* are the main drivers of labour productivity growth, but its importance is not homogenous across the member states of the sample. The existence of heterogeneous effects of investment in intangibles indicates that this fact should be taken into account when it comes to design industrial policy measures in European Union.

All this highlights the need for a new industrial policy (European Commission, 2014; O'Sullivan *et al.*, 2013; Veugelers, 2013; Crafts and Hughes, 2013) new in the sense that it should combine measures addressing specific difficulties of the EU member states as well as common ones. This is a consequence of the changing nature of global manufacturing which can be concreted as stated by O'Sullivan *et al.* (2013) in the declining share of manufacturing activities in OECD countries, the increasing competition from emerging economies; growing demands for resource-efficient manufacturing; the complexity and importance of global manufacturing chains and the accelerating pace of technological change. The decline in manufacturing has affected almost all manufacturing sectors, albeit with different intensity and with different explanations: demand effects, productivity effects and/or trade effects. As Dhéret (2014) states, despite the creation of the Economic and Monetary Union, the EU has been characterized by significant divergences in manufacturing performance and there is no doubt that the Economic and Monetary Union is far from being homogenous in this regard. Nowadays, the EU is composed, on the one hand, of strong manufacturing bases in countries like Germany which hold a robust position on global markets and whose model is clearly export-oriented and, on the other hand, Member States with relatively high commercial deficits (France, Spain, Portugal, Greece, Italy) and in some cases, little diversity in their manufacturing industrial sectors.

Although EU is showing a reversion of this trend, recovery remains modest. The agenda's *Europe 2020* major objective is to promote growth and competitiveness to achieve a stable and strong manufacturing base. The increasing interdependencies between manufacturing value chains, production technologies and services sectors generated a complex network which difficult the design of industrial policy measures.

Against this background the challenge for the EU manufacturing is to attain and maintain a broad and well-diversified manufacturing base in Europe, taking into account the strengths and weaknesses of the member states' manufacturing (European Competitiveness Report, 2013). The role of industrial policy -be horizontal or vertical- is to rule changes in production and, in particular, to enable processes to substantially increase productivity. As noted by the European Commission (2005 and 2014), the health of the manufacturing sector is essential for economic growth. In addition the industry has spillover effects that far outweigh the services, particularly regarding intermediate consumption.

Traditionally, *market failures* and *structural coordination problems* (O'Sullivan *et al.*, 2013; Andreoni and Scazzieri, 2013; Lin, 2012) centered the discussion on industrial policy as main rationales for government intervention. Recently, arguments for industrial policy measures have been enriched and reformulated embracing notions of *systems failure*, these are related to dynamics of innovation and technical change. The systems approach results from the coordination problems that arise from the promotion of development, awareness and implementation of new technological opportunities (Crafts and Hughes, 2013).

These problems indicate that the design of industrial policy measures should take into account broader industrial dynamics, going beyond the firm, sector and macroeconomic levels. This explains why policy makers use the term "new industrial policy".

So, when it comes to design industry policy measures and taking into account the results and conclusions obtained in this dissertation study, in line with other authors as Veugelers and Cincera (2015), European Commission (2014), O'Sullivan *et al.* (2013) and Owen (2012), the proposed key elements for a new industrial strategy are as follows:

1. Strengthen the internal market and increase the participation in global value chains (GVC)

Strengthening the internal market by providing the necessary infrastructures, establishing a stable and predictable regulatory and institutional framework that favour entrepreneurship and innovation, integrate capital markets, promotes training and citizens' mobility and completes the internal market for services as a driver of industrial competitiveness (European Commission, 2014 and Veugelers and Sapir, 2013) will allow to increase and benefit from the participation in Global value chains (GVC). GVC implies upstream and downstream interconnections which results in a greater interdependence among countries. This growing interconnectedness limits the benefits of national policies, requiring more coordinated policies at international level. To this end, industrial policy measures should focus on establishing the adequate framework to consolidate and expand the internal market. It is important to guarantee internal and external openness for the integration into international production networks. As global production networks rely on logistics and communication chains, it is necessary to eliminate barriers in sectors such as transport, communications and telecommunications, energy, finance and business services. In this context, to promote the single market in these areas is a necessary condition, due to the fact that progress is still to be made, specifically in the energy and services markets.

2. Aid to promote the competitiveness of strategic cross-sectoral manufacturing- based activities.

First of all, it is relevant to go beyond the manufacturing firms, sectors and macroeconomic framework and focus on cross-sectoral manufacturing-based activities. The concrete measures are expected to influence across multiple sectors and along different supply chains of the manufacturing systems. To this end, it is relevant to determine which activities are strategic ones and to identify their significant features. These are namely the international market orientation, high technological intensity, high value added, high productivity, ability to generate employment and high quality industrial network, energy efficiency and sustainability. Secondly, it might be necessary to promote structural changes in manufacturing. Thus in order to achieve changes in the productive structure, industrial policy measures should address a reduction of entry barriers. This can be materialized in providing support to new companies, in helping in the development and the marketing of new products

as well as to identify new markets or market niches (European Competitiveness Report, 2013).

3. Promoting innovation and R & D:
As long as innovation and R&D directly affect the internal and external competitiveness and growth of manufacturing, a significant increase in both of them is needed. There are still differences among member states in terms of stock of knowledge as well as in the capacities to leverage knowledge into growth. Results obtained in this thesis emphasize the importance of investment in intangible assets as drivers of labour productivity growth and the heterogeneity existent among member states. The increase in innovative effort cannot succeed without a backing up the most innovative sectors, generating major technological externalities, such as biotechnology, nanotechnology, space, incorporating an ambitious plan to attract foreign investment. Innovation policy should improve the environment for innovation by setting the adequate institutional framework in order to further the integration of European capital, labour and product and services markets. That is, to ease the interaction of the players in the innovation system and at the same time to guarantee a healthy competition (Veugelers and Cincera, 2015).

4. The maintenance and expansion of the training and qualification of all workers.
A good example to follow is the one carried out by Austria and Germany with its system of dual vocational training, further reducing youth unemployment (Heymann and Vetter, 2013). Results obtained in this dissertation display vocational training as one of the main drivers of labour productivity growth. As jobs are shifting from classic routine activities towards higher value-added positions, skills requirements are higher. As a consequence adjustment difficulties are likely to arise resulting in job losses affecting heavily certain countries and manufacturing sectors. In front of this, effective measures as facilitating the attainment of new skills are needed to soften the impact and reallocate the displaced workers. Improving the functioning of labour markets and promoting education and training becomes key policy measures.

5. Measures to support entrepreneurs and SMEs.
It is well known that the size of the company affects its productivity, innovation capacity, commercial and productive internationalization as well as the cost of funding. The main lines of action should intend to achieve the objectives of promoting entrepreneurship and improving access to finance.

6. To promote the internationalization of businesses to international markets in order to improve manufacturing external competitiveness.
To build a modern and competitive industrial sector is necessary to promote the internationalization of its actors. This means to pay attention the development of the tradable sector.

All in all, industrial policy measures at EU level should guarantee that Europe attains a broad and diversified manufacturing base in order to preserve manufacturing capabilities. To this end, it is important to ensure that the industrial structure is well-equipped to develop new areas of activity. All these measures imply a change in the production structure in order to improve labour productivity and, furthermore, display the need to focus on sectors with competitive advantages and high growth potential in both value added and technological innovation. As Myro (2014) says, to implement all these industrial policy measures major changes in the nature, structure and competitive framework of the businesses as well as in their technological, educational and international promotion environment are required in order to set the base for a sustainable productivity growth and to achieve greater competitiveness.

Previous analysis in this thesis has some limitations. First, it would have been of interest to extent the investigation by considering a broader time span, as Great Recession is so recent, nowadays it is difficult to assess its impact with more detail. For this reason it would be interesting to replicate the analysis some years later in order to get a broader perspective of its consequences and its recovery path. Concerning chapter 2 and 3 it would have been interesting to deepen the analysis of the difficulties that Spanish manufacturing has in combining the creation of new jobs with positive labour productivity gains by examining the influence of labour market regulations and the protectionist behaviour (Mas *et al.*, 2012). A comparative analysis examining which kind of measures are being implemented in both manufactures to improve human capital and to what extent they are successful as well as to identify and to evaluate sectoral policy measures enhancing structural change in manufacturing (Martino, 2014; Aghion *et al.*, 2011) might have been helpful in obtaining information on how to overcome the difficulties to reverse the trend in the Spanish case. As shown in chapter 4, detailed study on cross-country labour productivity performance requires international comparability of

national statistics. The increasing role of ICT, intangible capital and market services in economic growth in the last decades renewed the attention to measurement issues (Corrado *et al.*, 2005, 2006, 2009 and 2014; Timmer *et al.*, 2010; Griliches, 1992; Schreyer, 2008; Sichel, 1997; Triplett and Bosworth, 2008). As measurement and comparability problems of ICT and intangible assets investment, output measurement of market services among others arose, a big effort has been done in this field by improving and updating databases and measures. But still some issues remains unsolved as for example, to obtain internationally comparable data at more disaggregated level for manufacturing as well as for market services (Timmer *et al.*, 2010). Thus as new and more updated databases are available we think it may be interesting to go a step further with the present study. In chapter 4 we have shown how single or combined intangible assets are important drivers of labour productivity growth. Second, the limitation in this case stems from the fact that intangible assets' measurement still faces great challenges as for example the choice of depreciation rates, investment price deflators, incomplete data on business expenditures as training and firm-specific human capital and management capital and the fact that that the existing accounting strategy and techniques of expenditures on intangible assets vary among firms (Yallwe and Buscemi, 2014; Baldwin et al. 2012; Al-Twaijry, 2009).

5.2. Future research

Related to the analysis of the performance of labour productivity growth there are a number of areas where greater emphasis on further research is required. For instance, in a context of increasing interlinkages between the manufacturing and services, where manufacturing production depends more and more on innovation and specialized service inputs (European Competitiveness Report, 2013), we think might be of interest to include in the analysis the services sector. There are more drivers for a highly productive and competitive manufacturing sector than merely R&D and innovation. Manufacturing companies are becoming more dependent on sophisticated services inputs with the purpose to differentiate products and charge higher price-cost mark-ups. This highlights the fact that goods and services often complement each other (Nordås and Kim, 2013). To include services sector would provide more detailed information on the factors that hinders a faster

recovery from the crisis. Not doing this would provide just a partial view of labour productivity performance in manufacturing.

Another interesting issue for future research is to examine in more detail the measurement of intangibles by manufacturing sectors and firms, with a breakdown of worker characteristics as skill levels (Timmer and Van Ark, 2005). This is essential for any performance-based analysis. Ilmakkunas and Piekkola (2014) have shown that savings in labour costs explains how organizational capital improves the profitability of high-productivity firms. They demonstrate that the share of labour costs promotes investment in intangible capital at long-term and it is supposed to vary by type of sector and by type of work.

Furthermore, to focus on the components of investment in intangible assets, the interactions among them as well as with other drivers of labour productivity growth are required (Al-Twaijry, 2009; Bresnahan *et al.*, 2002; Brynjolfsson *et al.*, 2002) for a better understanding of their interlinkages and for the design of industrial policy measures. To this end it is relevant to improve the measures of intangible assets and to refine the estimates of the contribution of intangibles to labour productivity growth.

In front of the persisting differences in labour productivity performance among EU member states it is essential to continue investigating the causes in order to identify concrete measures to improve this underperformance of the so-called "periphery". As pointed out in chapters 2 and 3 it is mainly a problem of productivity itself, although a slight change in production structure is taking place. Lower investments in intangible assets (R&D, human capital etc.) may explain to some extent why they are lagging behind the "centre" as these variables influence the countries' absorptive capacity, that is, their ability in taking advantage of the technology developed by other countries. For these laggard countries it is necessary to develop a minimum degree of absorptive capacity to assimilate and exploit the foreign knowledge in the production of their goods. This will permit them to narrow the gap with the "centre" and boost labour productivity. Furthermore, it affects negatively their competitiveness in the international markets due to the lower quality of the goods produced generating differences in the quality with respect to the ones produced by manufacturing industries specialized in medium-high technology branches In this context, it would be interesting to analyze to what extent the

resulting quality gap might influence negatively external trade and competitiveness. Differences in this indicator between countries are largely explained by differences in the capacity for innovation and productivity (Lladós-Masllorens and Fernández-Sirera, 2004).

Against this background it important to assess to what extent regulatory framework may condition the efficiency with which resources are used in production. In the last decade the ability to exploit existing resources has turned out as essential drivers of productivity gains in many mature economies (Van Ark *et al.*, 2012). For this reason it is important to understand the underpinnings of the regulatory environment in determining technical efficiency and labour productivity. To examine to what extent the institutional framework and laws as well as the EU regulatory settings impose restriction in the product, labour and financial markets as well as the role of intangible assets, absorptive capacity and the dynamics of structural change may shed some light on the causes for the hetereogeneous labour productivity performance among EU member states (Piekkola, 2011; European Competitive Report, 2013; Veugelers, 2013 and Veugelers and Cincera, 2015).

To broaden and deepen the analysis of labour productivity performance by considering a bigger sample of countries is another objective for future research. It would provide more complete information relevant for the design of measures addressing a positive behavior and thus resulting in strong and stable economic growth and improved competitiveness.

Finally, another topic for future research is to examine the efficiency and effectiveness of industrial policy measures in achieving a better labour productivity performance. Martino (2014) and Petrakos *et al.* (2011) suggest that EU policies intended to promote convergence and cohesion have failed. Agglomeration economies, geography, economic integration and structure are important contributors of economic growth and of labour productivity growth (Petrakos *et al.*, 2011). For these reason to identify which policies have contributed to the persistence of underperformance and which have improved it becomes essential to single out the most effective and efficient. In this context, it is relevant to pay special attention on measures addressing structural reforms and their impact.

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