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Abstrakt

Diese Forschungsarbeit befasst sich mit den Auswirkungen von agglomerierten Kräften und feststehenden Merkmalen, bezügliche auf deren Wettbewerbsfähigkeit, sowie die Produktivität der in Europa produzierenden Industrie. Das Ziel der Forschung ist, besser zu verstehen wodurch die Produktivität in verschiedenen Ländern angetrieben wird. Bisher wurden bezüglich Unternehmenserfolgs und der Agglomeration meistens nur einzelner Länder in den Fokus genommen, da keine sinnvollen Datensäte für grenzüberschreitende Untersuchungen vorhanden waren. Doch gibt es mittlerweile brauchbare Datensätze. So baut diese Forschungsarbeit auf einem dieser neuen Datensätze auf, nämlich der EFIGE Umfrage. Jene liefert detaillierte Informationen über fast 15.000 Unternehmen in sieben europäischen Ländern. Unter der Heranahme eben dieses Datensatzes wird uns die Durchführung einer der ersten Studien, die die Auswirkungen der Agglomerationskräfte hinsichtlich ihrer Produktivität in einem Supranationalen Szenario analysiert. In der Vergangenheit war die Abgrenzung zwischen den verschiedenen Ländern nicht stark genug hervorgehoben. Eines der wichtigsten Ergebnisse, stellt die starke Heterogenität der Antriebskräfte von Wettbewerbsfähigkeit und Produktivität der einzelnen Länder und Sektoren dar. Genauer gesagt, zeigen die Ergebnisse, dass die *Firmeneigenschaften* die im Zusammenhang mit hoher Produktivität und Wettbewerbsfähigkeit stehen, eher homogen in den einzelnen Ländern oder Sektoren vorzufinden sind. Allerdings scheinen die *Agglomerationskräfte* zu sehr unterschiedlichen Ergebnissen, je nach dem Grad der Analyse (d.h. Land oder Sektor) zu führen. Für die politische Gestaltung sind diese Resultate sehr wichtig. Erstens zeigen sie, dass die Heterogenität der Agglomeration bewirkt, dass politische Initiativen zur Steigerung der Wettbewerbsfähigkeit und Produktivität der Firma mit hoher Wahrscheinlichkeit erfolgreich sind, wenn sie auf die wirtschaftlichen Rahmenbedingungen, die in einem bestimmten Land oder Sektor vorherrschen, zugeschnitten sind. Mit anderen Worten, Politik die darauf ausgelegt ist, spezifisch die Produktivität der italienischen Fertigungsindustrie zu verbessern, könnte auf der anderen Seite die gleichen Ergebnisse in Spanischen Fertigungsregionen hemmen. Ferner ist es essentiell, aufgrund der aktuellen Wirtschaftslage in Europa, (man sehe sich nur mal die Folgen der Finanzkrise und Sparmaßnahmen an, die derzeit implementiert werden) das die Politik effektiv geführt wird. In Zeiten, in denen die verfügbaren Ressourcen für neue politische Initiativen beschränkt sind, ist es wichtig, Maßnahmen effizienter zu gestalten und verschwenderische Ausgaben zu reduzieren. In Summe verbessern die Ergebnisse dieser Forschung das Verständnis der Faktoren, die Produktivität vorantreiben. Diese Ergebnisse können dazu beitragen, die Entscheidungsfindung auf der Unternehmensebene (z. B. wenn es um Standortentscheidungen oder Beantragung von Qualitätszertifikaten geht) zu verbessern. Darüber hinaus rufen die Ergebnisse nach einer sorgfältigen Vorgehensweise, wenn es um die Entwicklung neuer Strategien, welche Wettbewerbsfähigkeit und Produktivität fördern geht. Leider konnten die Ergebnisse nicht erklären, *warum* sich der Antrieb der Produktivität in den einzelnen Ländern Unterscheidet. Daher könnten sich zukünftige Forschungen damit befassen, welche Mechanismen bei der Arbeit in den verschiedenen Ländern tätig sind. Schließlich steht Europa vor großen Herausforderungen bezüglich der Wettbewerbsfähigkeit. Hoffentlich kann diese Studie sich in die Diskussion einbringen und die Wirksamkeit neuer Initiativen zur Verbesserung der europäischen Wettbewerbsfähigkeit in der Weltwirtschaft steigern.

Abstract

This research examines the effects of agglomeration forces and firm characteristics on competitiveness and productivity in Europe's manufacturing industry. The goal of the research is to improve the understanding of the drivers of productivity across different countries. Until now research on firm performance and agglomeration was mostly focussed on individual countries as appropriate cross-country datasets were not available. However, in recent years harmonised cross-country datasets have become more available. This research builds on one of these new datasets, namely the EFIGE survey. This survey provides detailed information on nearly 15,000 firms in seven European countries. This dataset enables us to carry out one of the first studies that analyses the effects of agglomeration forces on firm productivity in a cross-country setting. In the past the distinction between different countries has not been highlighted enough. One of the main results of this study is that there exists a lot of heterogeneity in the drivers of competitiveness and productivity across countries and sectors. More specifically, the findings indicate that *firm characteristics* associated with high productivity and competitiveness are rather homogenous across countries or sectors. However, *agglomeration forces* seem to generate highly diverging results depending on the level of analysis (i.e. country or sector). For policy design these findings are very important. Firstly, the heterogeneity of agglomeration effects indicate that policy initiatives aimed at increasing firm competitiveness and productivity are likely to be more successful if they are tailored towards the economic environment in a particular country or sector. In other words, policies designed specifically to improve productivity in the Italian manufacturing industry might be inapt to achieve the same results in Spanish manufacturing regions. Secondly, the current economic climate in Europe (i.e. the aftermath of the financial crisis and austerity measures currently implemented) makes it essential for policies to be targeted effectively. In times when the available resources for new policy initiatives are limited it is vital to design policies efficiently and reduce wasteful expenditures. In sum, the results of this research increase the understanding of the factors that drive productivity. These results can contribute to improve decision making on the firm level (e.g. think of location decisions or applying for quality certificates). Furthermore, the results call for a more diligent approach when it comes to designing new policies that stimulate competitiveness and productivity. Unfortunately, the findings do not explain *why* drivers of productivity differ across countries. Therefore, future research could explore what mechanisms are at work in different countries. Finally, Europe is faced by major challenges regarding its competitiveness. Hopefully, this study can contribute to the discussion and improve the effectiveness of new initiatives aimed improving Europe's competitive position in the world economy.

Content

Introduction

This paper studies the effects of agglomeration forces and firm characteristics on competitiveness and productivity in Europe's manufacturing industry. The goal is to gain a better understanding of the drivers of productivity. Identifying geographical and firm characteristics associated with high productivity allows us to improve the effectiveness of national and European policies aimed at stimulating productivity and competitiveness.

In 2008 the financial crisis revealed many structural weaknesses in Europe's economy. Meanwhile, numerous challenges such as globalisation, pressure on natural resources and an aging population pose threats to the sustainability of Europe's welfare. For instance, competition from emerging economies and North America is intensifying. Simultaneously, the global financial system is still to be fixed and banks remain extremely cautious in the provision of credit to businesses that want to grow. If Europe wants to overcome these challenges and return to its growth path it is crucial to improve its productivity and competitiveness. Improving both allows Europe to regain its strength and make its current welfare sustainable in the future.

Apart from improving competitiveness the trend of austerity across Europe prioritises the elimination of wasteful expenditure. Austerity measures are implemented to regain the trust and confidence of investors and markets. However, these measures have put a toll upon resources available for programmes that can bring Europe back on its growth path. The results of this research can contribute to more targeted and efficient policy-design and limit wastefulness of valuable funds.

Moreover, this study enables policy-design to be more bespoke to the economic environments they are implemented in. The main findings indicate there is a lot of heterogeneity between countries and sectors. This means policies aimed at improving productivity and competitiveness will only be successful if these differences are taken into account. This finding contrasts to results obtained by researchers from the Bruegel institute using the same dataset (Altomonte, Aquilante, & Ottaviano, 2012). The Bruegel institute advocates the implementation of homogeneous policies as they find successful firms tend to share the same characteristics irrespective of their location and industry. We will discuss this more extensively in the theoretical framework.

The cross-country approach this research takes is novel with respect to former studies. To our knowledge agglomeration and productivity has not been studied in a cross-country setting. In the past the lack of harmonised firm-level cross-country datasets has made similar studies infeasible. Moreover, the differences between sectors have not been highlighted enough in the past.

The main finding of this research is agglomeration effects are an important driver of firm productivity and competitiveness. Firm characteristics associated with high productivity are rather homogeneous irrespective of the country or sector a firm is located in. Conversely, agglomeration economies can have very different effects on firm productivity depending on the analysis level. For example, in Italy belonging to a specialised industrial cluster boosts firm productivity, whereas Spanish firms located in highly specialised regions are on average less productive. Regional diversity is a more important driver of firm productivity in Spain. Similarly, we find that the factors determining productivity in a specific sector can greatly vary. These results suggest that it is vital for policy makers to take the differences in economic environments into account and tailor policy accordingly.

European policy makers can benefit greatly from this increased understanding of the determinants of productivity and competitiveness.

Next, we answer questions which are meant to further increase the readers' understanding of the relevance of the topic and the approach taken. What determines competitiveness? Do agglomeration forces impact upon productivity? And finally, do firm characteristics affect productivity? By starting to answer these basic questions we can move towards the main goal, gaining a better understanding of the drivers of productivity.

What determines competitiveness?

Emerging Asian economies enjoy a competitive advantage due to their favourable low labour costs. In fact, many believe competitiveness is driven by factors such as cheap labour, economies of scale and accommodative exchange and interest rates. Porter (1990) explains why such reasoning is flawed. To start, it is highly unrealistic to think the factors driving competitiveness in emerging markets can also work in Europe. Labour unions will never consent to the reduction of wages and with it welfare. Besides such practical concerns, Porter identifies more fundamental flaws in this form of 'competitiveness'. Pursuing such policies would only create very short-term benefits (disregarding the general reduction in welfare) and does not contribute to building sustainable competitive advantages. Instead, Porter and many other scholars identify *productivity* as the key determinant of competitiveness and the standard of living (Porter, 1990). Recognizing the importance of productivity we want to go deeper into its determinants, focussing especially on agglomeration economies and firm characteristics.

Why agglomeration?

It has long been observed that firms and workers located in concentrated areas of economic activity are, on average, more productive. Furthermore, the European Cluster Observatory estimates 38 percent of the European workforce is employed by companies in highly agglomerated areas (European Commission, 2008). Generally, the habit of firms clustering together cannot be explained without a theory involving localised aggregate increasing returns (Duranton & Puga, 2003). Here the theory of agglomeration economies comes in. Agglomeration and clustering can be explained as the outcome of a trade-off between localised increasing returns and the costs of urban congestion. Sources that generate these increasing returns (or rather productivity gains) can be attributed to improved access to inter-industry information flows (i.e. knowledge spill-overs), the abundance of skilled labour, superior access to specialised services, superior public infrastructure, and better public facilities (Melo, Graham, & Noland, 2009). Melo et al. conducted a meta-analysis on empirical studies to examine the extent of productivity gains brought about by agglomeration economies. Generally all studies have found positive effects of agglomeration economies upon productivity. However, the magnitudes varied greatly depending on country effects, sectors and the specifications. For example, an empirical literature review by Rosenthal and Strange (2004) maintains that the 'consensus view of elasticities' of urban agglomeration is that doubling urban size increases productivity ranging from 3 to 8 percent.

The main prediction of agglomeration theory is that localised concentration of workers and firms increases productivity. Yet, this idea has not been unchallenged. Melitz' (2003) theoretical paper on the impact of trade upon aggregate firm productivity popularised a new theory focussed on 'firm selection'. In his paper Melitz hypothesises that exposure to trade generates a type of Darwinian evolution within an industry. Only the most productive firms are able to enter the export market, they flourish and grow as they increase their market share and profits. Simultaneously, the least productive firms are forced to exit. A reallocation of market share and profits towards the most productive firms increases aggregate industry productivity and results in welfare gains (Melitz, 2003). Later Melitz and Ottaviano (2008) adopted the same model only to extend it by including the effects of market size on firm productivity. They hypothesise market size and trade affect the strength of competition in a market. Again this feeds back into a 'firm selection' mechanism where only the most productive firms are able to survive raising aggregate productivity and lowering mark-up costs (Melitz & Ottaviano, 2008).

At this point it is problematic we have two theories, *agglomeration economies* and *firm selection*, that are both able to explain the observation that economic concentration increases productivity. Fortunately, Combes, Duranton, Gobillon, Puga and Roux (2012) also identified this issue and try to distinguish between both effects. In agglomeration economies *all* firms benefit from sharing, matching, learning and localised natural advantages (Duranton & Puga, 2003). Whereas, under firm selection the weaker firms cannot survive the harsh competition in larger markets (Melitz & Ottaviano, 2008). Combes et al. hypothesise in the latter case there must be a 'cut off' on the left-hand-side (i.e. lower-end) of the productivity distribution. On the other hand, if agglomeration economies play a more important role one should observe a general rightward shift of the productivity distribution in spatial concentrations of economic activity. Combes et al. conducted empirical tests on French firm-level data and *only* find evidence for agglomeration economies. Moreover, they find initially more productive firms to be better equipped to reap the benefits of agglomeration economies as they realised the greatest productivity gains (Combes, Duranton, Gobillon, Puga, & Roux, 2012).

This result is an key reason this study focusses upon the importance of agglomeration forces in firm productivity. We shall see the research by Altomonte, Aquilante and Ottaviano from the Bruegel institute uses the same dataset. Conversely, their research builds upon the Melitz (2003) and Melitz and Ottaviano (2008) theory of firm selection. Interestingly, their approach results in some findings this paper is not able to reproduce. It is quite evident there exists a threshold from where firms start to export. However, it does not imply policy should exclusively focus on enabling firms to reach this threshold. Instead, this study tries to unravel which policies are beneficial for *all* firms. This introduction to the concept of agglomeration economies hopefully gives the reader more insight into why we are taking this approach. In the theoretical framework we discuss more extensively the different theories of agglomeration and new economic geography (NEG) and where they evolved from.

Do firm characteristics impact upon productivity?

The second question we have to explore further is the relation between firm characteristics and productivity. In the study various variables relating to specific firm characteristics are included. For example, firm size, firm age, ownership/management, educated employees (human capital), exporting (learning-by), and quality certificates. Many studies examine the interaction between *specific* firm characteristic and productivity. However, less often the effects of *multiple* firm characteristics on productivity are studied. In case various firm characteristics are included into the analysis, a priori little intuition is provided for their expected effects. Possibly scholars simply take their impact as *common sense*. For example, Wixe (2013) studying the impact of skills and education on productivity includes various firm characteristics into her empirical analysis. Except for *Employee Education*, Wixe fails to formulate any hypotheses or intuition for the effect the factors *Firm Age*, *Employee Age*, *Female Employees* and others (Wixe, 2013). Whilst discussing the results failing to formulate hypotheses makes it very easy to come up with a fitting narrative in retrospect. For instance, ex ante there is no reason to expect female employees in manufacturing to be more productive. However, this is suggested to be the case as a consequence of superior female self-selection in the manufacturing industry, a relationship previously never discussed.

Fortunately, there are several studies that do try to provide intuition and evidence for the effects of firm characteristics on productivity. We have already seen Melitz (2003) relating the ability to export to productivity. Unfortunately, the causality runs in the opposite direction: a firm exogenously endowed with a higher productivity will be able to export, while others exit the market (Melitz, 2003). However, other studies have suggested there might be an effect of learning-by-exporting (Albornoz & Ercolani, 2007). In their paper they find support for the Melitz theory of self-selection, but also find evidence for the existence of learning-by-exporting effects. Interestingly, Keller writes that conventional wisdom today is that learning-by-exporting effects are non-existent (Keller, 2004). These mixed signals should make us careful interpreting the effects of exporting on productivity.

So far this gives some basic intuition for the relationship between firm characteristics and productivity. In the theoretical framework other factors that impact upon productivity are discussed: human capital (Lucas, 1988; Romer, 1990), firm age and size (Kok, Fris and Brouwer, 2006; Feldman, 1999), firm ownership (Barth, Gulbrandsen, & Schøne, 2005) and quality certificates (Corbett, Montes-Sancho, & Kirsch, 2005) and more.

Approach

So how can we actually study productivity at the firm-level? Until recently this was very difficult due to the lack of appropriate cross-country firm-level datasets. Fortunately, in recent years more and more data is becoming available to study this topic.

For this research we use one of these new datasets. The EU-EFIGE/Bruegel-UniCredit dataset (European Firms in a Global Economy: Internal Policies for External Competitiveness) was created with the support of the Directorate General Research of the European Commission. The survey conducted by the Bruegel institute covers nearly 15,000 manufacturing firms in 7 European Union countries. The survey covered various topics ranging from international activities, R&D and innovation, labour organisation, and financing. Furthermore, the data provides anonymised information about the regions and sectors firms are active in. The anonymisation implies that it is known which firms are located in the same region and/or sector, but the actual NUTS and SIC codes are not provided. Despite, the data being censored it remains most valuable for this study as we can generate all relevant variables measuring agglomeration forces. A more thorough description of the data will follow later.

A side-note on productivity

Before continuing it is important to highlight one aspect of this research: the main focus is on absolute productivity and not productivity growth. This has some implications for the expected results. For example, before starting this research I expected a strong correlation between productivity and innovation. While building the theoretical framework it became clear that there is truth in this hypothesis, however, a distinction has to be made between productivity *growth* and *absolute* levels of productivity. In the former case, the literature shows there is a strong relationship between productivity *growth* and innovation. Characteristics associated with highly innovative firms (e.g. often young and relatively small enterprises) do not always conform with the characteristics of firms that are *absolutely* more productive (e.g. big corporations that have managed to survive for a long time). The available data only allows for a rather crude measure of productivity growth, therefore it is more suitable to focus on *absolute* productivity. Nonetheless, productivity *growth* will be included in the study, but is not the major focus. Policy recommendations that follow from this research predominantly aim to stimulate competitiveness rather than innovation.

Structure

The paper is structured as follows. The next section reviews some of the current policy initiatives aimed at improving Europe's competitiveness. This is followed by the theoretical framework. In the second section the EFIGE dataset is presented more extensively and the variable, total factor productivity (TFP), is introduced. In the third section we discuss the methodology. The results are presented in the fourth section. The final section concludes and provides a brief summary of our findings.

To briefly summarise this paper intends to answer the following questions:

- What geographical characteristics are associated with productivity?
- Do firms located in agglomerations perform better than those located elsewhere?
- What firm characteristics are associated with high productivity?
- What firm characteristics are associated with high productivity growth?
- How do country and sector differences affect the results?

Current policy initiatives

As stated before, one of the main motivations for this research is addressing the challenges Europe faces in order to return towards a path of growth and sustain its standard of living. Since the challenges Europe faces have not gone unnoticed it is useful to give an overview of some of the initiatives that have been launched to address them. The European Commission (EC) and the European Investment Bank (EIB) are some of the most important institutions dealing with these issues. One can distinguish between two types of activities. On the one hand active intervention aimed at overcoming the challenges Europe faces, and on the other hand studies aimed at improving policy-design.

Following the Lisbon Strategy (2000-2010), Europe 2020 is the European Commission's new ten-year growth strategy designed to confront the challenges of globalisation, pressure on natural resources, and an aging population. Europe 2020 targets a wide range of objectives – improving employment, innovation, education, social inclusion, and climate/energy – and has translated them into seven *flagship initiatives* (European Commission, 2013) (European Commission, 2010). Although, all targets are interrelated we want to focus on two that are most relevant for improving Europe's competitiveness: "Innovation Union" and "An industrial policy for the globalisation era".

Innovation Union belongs to the pillar smart growth. The main objective is to improve the conditions and access to finance for research and innovation. This ensures innovative ideas can be turned into products and services that create growth and jobs. At the EU level this entails strengthening the EU instruments to support innovation (e.g. structural funds, ERDF, etc.), closer collaboration with the European Investment Bank (EIB) to support innovation funding for small and medium sized enterprises (SMEs), promoting knowledge partnerships and entrepreneurship (European Commission, 2010). At the regional level Member States should provide tax incentives that promote private R&D investment. Furthermore, the supply of science, math and engineering graduates with entrepreneurial skills should be stimulated.

One of the key programmes designed to realise the Innovation Union Europe is Horizon 2020. Horizon 2020 can be seen as the follow-up to the Seven Framework Programme (7FP) under the Lisbon Strategy, only with a larger budget. The programme runs from 2014 until 2020 and has a budget of €80 billion. Horizon targets three main issues: €25 billion to strengthen the EU's position in science (e.g. supporting top level research), €18 billion to strengthen industrial leadership and innovation (e.g. investing in key technologies and access to capital for SMEs), and €32 billion to support miscellaneous goals (e.g. climate change, transport, renewable energy and ageing population). Supporting these issues Horizon aims to further develop the European Research Area and also bridge the gap between research and the market (European Commission, 2013). Policies that improve linkages and EU wide cooperation between industry (especially SMEs) and research institutions are crucial as they strengthen agglomeration forces (European Commission, 2008).

The initiative 'An industrial policy for the globalisation era' belongs to the pillar sustainable growth. Its main target is to improve the business environment for SMEs (e.g. obtaining credit and removing bureaucracy), and to support the development of a strong and sustainable industrial base able to compete globally (European Commission, 2013). At the EU level this also involves the promotion of clusters, reducing transaction costs of doing business in Europe, improving transport and logistics networks, promoting internationalisation, and supporting manufacturers in the transition towards greater energy and resource efficiency. Regionally the focus should be on removing the administrative burden on companies, supporting innovative SMEs, and improving the enforcement of intellectual property rights (European Commission, 2010).

The Programme for the Competitiveness of enterprises and SMEs (COSME) starts in 2014 and will follow-up the Competitiveness and Innovation Framework Programme (CIP) which comes to an end in 2013. COSME is one of the main instruments that will improve industrial policy in the globalised era. For the period 2014-2020 it has a budget of €2.3 billion. The main objectives are: to facilitate access to finance for SMEs, improve the EU's business environment, encourage entrepreneurship, increase sustainable competitiveness of EU companies, and support business to operate abroad. COSME expects to assist 40,000 companies with partnership agreements, resulting in new business products and increased revenue. Furthermore, improved access to finance is expected to increase investment in EU companies by €3.5 billion annually. Overall, the programme should contribute to an annual increase of €1.1 billion in the EU's GDP (European Commission, 2013).

Aside from the EC the European Investment Bank (EIB) provides financing to projects that contribute to achieving EU policy objectives such as competitiveness. The 'knowledge economy' is one of the important initiatives the EIB is supporting. The EIB identifies knowledge generation (i.e. productivity) and R&D main drivers of economic growth (Uppenberg, 2009). One of their key priorities is to invest in projects that strengthen both (Uppenberg, 2010). For example, over the period 2000-2010 the EIB invested €103 billion into R&D, innovation, and education and training, in 2010 alone this was €17 billion (European Investment Bank, 2011).

Next to its financing operations the EIB promotes research on the topic of knowledge creation and R&D that can improve policy design. Initially, it is helpful to understand why productivity and R&D are considered so important for economic growth. Using growth accounting one quickly sees that increases in capital and labour only explain between half and two-thirds of economic growth. This residual is often referred to as knowledge or TFP and measures the efficiency with which inputs can be transformed in output. Increasing knowledge can thus be a propellant of economic growth (Uppenberg, 2009). Secondly, it has been observed that, all else being equal, countries that invest more in R&D experience higher productivity growth (Uppenberg, 2010). The important question then becomes, what policy measures can be taken to increase productivity and R&D investment? The EIB report 'The Knowledge Economy and Europe' tries to answer exactly that question. The results are interesting, yet not always most practical to be implemented from a policy perspective.

Here is a brief overview. New Member States are recommended to adopt best practises from abroad in order to increase their TFP, instead of investing in their own R&D and knowledge creation. Old Member States on the other hand have fewer possibilities to import knowledge and should invest in R&D themselves (Uppenberg, 2010). When it comes to stimulating R&D investment the use of tax credits is suggested to bring investment to a socially optimal level. This should also narrow the R&D investment gap vis-à-vis the US and Japan. However, Mairesse finds that tax credits do increase R&D investment, yet one euro of taxpayers money often leads to less than one euro of additional R&D (Ientile & Mairesse, 2006). Another initiative aims at promoting research collaborations in order to reduce the wastefulness of simultaneous research on similar topics (Uppenberg, 2010). Porter (1990) warns against the unintended effect of such policies. Allowing for collusion in research undermines competition that stimulates firms to achieve a competitive advantage (Porter, 1990). Only if collaboration is aimed at basic scientific research would it be beneficial as rents on such innovations are very hard to appropriate. Similarly, venture capital (VC) and intellectual property (IP) should play a more important role in knowledge creation in Europe. In continental Europe VC financing is much lower than in Anglo-Saxon countries. Start-up companies favour VC as the risky nature of their businesses makes it hard to obtain regular bank credit. Stimulating VC should therefore become a priority. Finally, financial innovations should make it possible to trade such intangible assets such as IP. They then can be used as collateral in obtaining credit. In conclusion, the EIB states a better understanding of knowledge creation (i.e. *productivity*) is essential to sustain Europe's standard of living (Uppenberg, 2010).

It is clear that Europe wants to confront the challenges it faces. We have just seen that there are numerous policy initiatives being implemented aimed to help Europe regain its strengths. The findings in this paper can contribute to the effectiveness of such policy initiatives. By gaining more insight into the process that drives productivity it becomes possible to limit wastefulness and direct investment to those projects that have the biggest impact on productivity and competitiveness.

Theoretical framework

This section describes the theoretical concepts related to productivity, agglomeration forces and firm characteristics. It also introduces new economic geography (NEG), the theory that was first able to explain the spatial co-location of firms. Furthermore, we discuss some critiques of agglomeration theories and review past studies.

Competitiveness

We already mentioned Porter's book *The Competitive Advantage of Nations*. The key message stresses the importance of competitiveness in order to sustain a country's high living standard. Porter identifies innovation as a necessary ingredient for companies that want to realise a competitive advantage. He introduces the *diamond of national advantage*, a system of factors that enables nations to innovate. Interestingly, some of these factors seem closely related to features of agglomeration economies. *Factor conditions* (e.g. the presence of a skilled workforce and infrastructure) are often superior in agglomerated regions. Also*, related and supporting industries* benefit from co-location since shorter communication-lines improve the exchange of new ideas and innovations. Finally, *rivalry* induced by the concentration of firms creates a constant pressure for innovation creating competitive advantages (Porter, 1990).

Porter refers to the diamond in a national context, yet an analogy can easily be made for regions. When a region possesses the right combination of factors specialised skills and assets can accumulate, information generation improves (i.e. knowledge spill-overs), and competition puts pressure on companies to innovate. Porter's theory can quite successfully explain the performance of specific manufacturing regions (e.g. the footwear and tiles industry in Italy) (Porter, 1990). However, he only undertakes case studies and no empirical research is done on the effect of regional factors on productivity.

The impact of location on firm productivity is one of the central elements of this study. Therefore, we continue with a review of new economic geography theories that deal with these questions.

Agglomeration economies

New economic geography

In the introduction we already established that the spatial concentration of economic activity has a positive effect on productivity (and competitiveness). However, the focus was mostly upon this empirical observation and the actual mechanisms driving agglomeration remain blurred. Therefore, we now provide a theoretical model that can explain the geographical patterns of economic activity. Furthermore, we explore the actual mechanisms that benefit firms located in agglomerations.

Ottaviano and Puga give an extensive overview of the different new economic geography (NEG) theories. NEG aims to find better explanations for the observation that very similar regions can generate very different production structures. Traditionally spatial differences have been accounted for by differences in endowments, technologies and policy regimes. However, this fails to explain differences between a priori similar regions (Ottaviano & Puga, 1998). Then, what causes so many firms to agglomerate? Agglomeration happens on many levels. On a small, local level there are clusters and science parks (e.g. the Italian ceramic tile industry in Sassuolo (Porter, 1990) and Silicon Valley in the US). On a larger scale there is Europe's *Hot Banana* that runs from Milan to London. Reasons for co-locating tend to depend on the level of focus. Locally personal interaction and knowledge exchange tends to matter most, whereas in larger agglomerations monetary externalities provide incentives to locate near buyers and suppliers.

In the beginning of the 1990s several scholars (e.g. Helpman & Krugman, 1985; Krugman & Venables, 1990) started to formalise models of trade that could explain differing production structures on the basis of *market access* rather than differences in *comparative advantages* (Ottaviano & Puga, 1998). The Krugman and Venables (1990) model studies the importance of market access. It starts by assuming that there are two regions: a large 'core' country and a small 'peripheral' country. Furthermore, firms experience imperfect competition, increasing returns to scale, and trade costs. There is no comparative advantage as the core and periphery share the same relative endowments, tough, the core has more factor endowments (i.e. representing superior market access). The combination of these features makes it attractive for firms to locate in the core region. Since, in the core firms are able to produce with increasing returns. They export a fraction of their production to the periphery, whilst avoiding trade costs for the products sold in the core market. The key requirement in this model is intermediate trade costs. If trade costs are too low it becomes unattractive for many firms to locate in the core as increased competition raises factor prices. Too high trade costs also make it unattractive to locate in the core, since exported products will be too expensive for the peripheral market (Krugman & Venables, 1990). This model provides intuition as to why agglomerating can benefit firms, but it builds upon the exogenous assumption that regions differ in size. Unfortunately, it fails to explain why initially very similar regions can endogenously change into cores and peripheries.

'Cumulative causation' (i.e. historical accidents that initiate a chain of events) allows us to explain how initially identical regions become so different. Krugman (1991) and Venables (1996) present two different models that show how this process can work. In Krugman's model the same assumptions hold as in Krugman and Venables (1990). However, we now start with two identical regions with two sectors: industry and agriculture. Moreover, only the factors used by industry (i.e. industrial workers) *mobile*, whereas agricultural workers are *immobile*. And finally, industry produces heterogeneous goods, whereas agriculture only produces a homogeneous product. Let's now see how cumulative causation comes into the picture. Imagine for no particular reason that *one* firm decides to move to the other region, what will happen? Initially, the move would reduce profits in the receiving region (competition raises factor prices and reduces product prices). However, the varieties of goods and wages increase in the receiving region attracting more workers. The increase in the number of workers raises local expenditure and alleviates increased competition in the labour market. These factors enable firms to increase profits (increasing returns) and attracts more firms to move to the region. In this model low trade costs induce all firms to concentrate; high trade costs again work against agglomeration (Krugman, 1991). Venables (1996) proposes a different cumulative causation mechanism as it is unrealistic to assume labour is so mobile in Europe. He shows that even without labour-mobility *cost* and *demand linkages* make it attractive for up- and downstream firms to locate proximately. If upstream firms move to areas where there are relatively many downstream firms they will have greater market access. This increases the size of the market for intermediate goods, enabling economies of scale. Similarly, cost linkages influence the downstream firms to locate closer to their intermediate suppliers as this will save them trade costs. Again, unless trade costs are extremely high input and output linkages will generate agglomeration (Venables, 1996).

Until now we have not highlighted an important feature of agglomeration economies, namely congestion. We have seen that agglomeration forces pull firms to locate in the core, yet there are also dispersion forces which reduce the benefits of clustering. Without labour mobility agglomeration inflates wages, making production more expensive. Puga (1999) shows that the relation between trade costs and agglomeration economies becomes non-monotonic when labour is immobile. With mobile labour, wage differentials are eliminated and agglomerations intensify as more workers move there. Conversely, without labour mobility wage differentials persist. The non-monotonic relationship is seen by starting at high trade costs. In this case there will be no agglomeration (as in all prior models). Reducing the trade cost to intermediate levels encourages firms to agglomerate because of cost and demand linkages. However, if trade costs become too low wages differentials causes firms to spread across regions again. In other words, dispersion costs outweigh agglomeration forces (Puga, 1999). So far we mostly focussed on the positive effects of agglomeration economies. It is important to see there exist also downsides. Moreover, in our results we find evidence for dispersion forces reflected in a negative coefficient for localised labour competition.

Knowledge spillovers

This overview of NEG was rather theoretical in relation to the empirical research still to come. The processes that induce firms to co-locate should be much clearer. Nevertheless, the exact mechanisms that make firms located in agglomerations more successful remains to be explained. Therefore, we will now explore the processes going on at the firm level. New growth theory (e.g. Lucas, 1988 & Romer, 1990) finds that differences in growth rates can be explained through *increasing returns to knowledge* (as also identified by the EIB in the introduction). Agglomerations might be one source of such increasing returns. The geographical concentrations of *knowledge* in agglomerations facilitates information search, increases search intensity, improves coordination, and can cause knowledge to spillover. These factors suggest that location plays an important role in boosting innovation, technological progress and economic growth (Feldman, 1999).

Feldman (1999) reviews numerous studies on this topic and discusses some of the mechanisms with which agglomeration leads economic growth and higher productivity. Jaffe (1986) found that a significant amount of research productivity originates from other firms. His work shows that firms benefit from the R&D effort of other firms that are in close technological proximity (Jaffe, 1986). In studies by Jaffe (1989) and Feldman (1994) they modify the knowledge production function by including geography. Using this framework they describe innovative output (e.g. patents or new innovative products) as a function of private R&D expenditure and research expenditure within a region. Jaffe's main finding is that most patents occur in regions that both publicly and privately invest more in knowledge generation (Jaffe, 1989). Feldman instead studies new innovative products and finds that knowledge spillovers are geographically bounded to the region where the new knowledge was created (Feldman, 1994). Studies using the geographical knowledge production function do not discuss the mechanism that drives knowledge spillovers. However, the findings do suggest firms involved with innovation can benefit most by locating in regions where knowledge-generating inputs (e.g. universities, research facilities etc.) are greatest (Feldman, 1999).

A frequently expressed drawback of knowledge spillovers is they are invisible and therefore cannot be measured and tracked. However, Jaffe, Trajtenberg and Henderson (1993) point out they do leave a paper trail in the form of citations. Studying these paper trails they find patent citations are highly localised. This localisation effect fades over time, but only very slowly. Furthermore, there is no evidence that basic research and innovations diffuse more rapidly than others (Jaffe, Trajtenberg, & Henderson , 1993). Studying paper trails shows that the result that knowledge spillovers have geographical limitations still holds.

Feldman (1999) discusses two more channels that facilitate knowledge spillovers: the movement of star scientists and international trade. Aside from trade in goods, foreign direct investment (FDI) is often considered to be an important channel of knowledge spillovers. It is suggested technological knowledge spillovers occur when multinational parents share technology among its international subsidiaries (Keller, 2004). Yet, the evidence whether FDI generates substantial technological externalities for domestic firms is mixed. A survey based on micro-level productivity data by Görg and Greenaway (2003) concluded there is no substantial evidence for FDI spillovers. On the contrary, Keller (2004) explains that more recent micro-level studies do find a positive effect of FDI on productivity, he attributes the differing results to endogeneity problems. Finally, Branstetter (2001) finds using data from the US and Japan that knowledge spillovers are primarily intranational. There is little evidence that firms benefit from research undertaken in a different country (Branstetter, 2001).

Audretsch (1998) more extensively examines the properties of knowledge. He recognises that knowledge has become an essential production factor in advanced economies, but unlike labour and capital it behaves very different. Knowledge possesses two special properties: non-rivalry and non-excludability. These enable knowledge to generate fast economic growth and spread easily. Firstly, the non-rivalry property implies one person's use of a good, in this case *knowledge*, does not diminish another person's usage. This enables increasing returns to scale. Secondly, non-excludability means once an new knowledge is created it is extremely hard to prevent others from using this new knowledge (Blakeley, Lewis, & Mills, 2005). Therefore, knowledge spills over enabling others to benefit from it. Intellectual property rights do make knowledge somewhat excludable, but generally no knowledge is perfectly excludable. How does this relate to agglomerations?

Often knowledge has the property of being tacit (i.e. it cannot be easily codified and transferred), Von Hipple refers to this as *sticky knowledge*, and is only transmitted through frequent and repeated contact (Von Hippel, 1994). Geographic proximity and agglomeration therefore matters a lot for the transmission of knowledge. This explains how small firms are able to be very innovative without having the resources to make significant investments in R&D. Small firms are able to exploit the spillovers of knowledge created in universities or large corporations simply by locating close to them (Audretsch, 1998). Hence, non-excludability can be problematic as it reduces the socially optimal level of R&D investment. Large firms realise they are unable to appropriate the rents from their R&D investments. Unfortunately, this creates a wedge between the private and socially optimal level of investment (Uppenberg, 2010).

Measuring agglomerations

At this point we have learned about the theory (NEG) and mechanisms (knowledge spillovers) that make agglomerations so important. Yet, one important ingredient is missing. In order to run empirical tests we need a method to measure the different types of agglomeration. In the literature there are two main classifications of agglomerations: localisation and urbanisation economies.

Localisation economies, also known as *Marshall-Arrow-Romer* (Marshallian) or specialisation externalities, were first defined by Loesch (1954). They are characterised to be external to a firm but internal to an industry within a geographical region (Loesch, 1954). Feldman gives a more intuitive explanation for Marshallian externalities: 'A local industry agglomeration may increase innovation directly by providing industry specific complementary assets and activities that may either lower the cost of supplies to the firm or create greater specialisation in both input and output markets' (Feldman, 1999). Yet, the empirical evidence for localisation economies is mixed. We also find this in our research, when running regression on our complete dataset Marshallian externalities are always insignificant. However, in our country and industry level analysis we find that that in certain cases specialisation does have a positive impact on productivity. For instance, Italy is well-known for its highly specialised manufacturing regions.

The second type of agglomeration is known as urbanisation economies, often also referred to as *Jacobian* or diversification externalities. They are external to industries yet internal to a geographical region (e.g. cities). Urbanisation effects work through the exchange of complementary knowledge between diverse firms and agents within a geographical region. Jacobian agglomerations don't only reduce search costs, they also increase unforeseen innovation opportunities (Feldman, 1999). For example, new inventions intended for one specific sector might spontaneously find an even more valuable application in a related sector. Geographical proximity facilitates such knowledge to spillover. The empirical evidence for urbanisation externalities is strong. For instance, Jaffe et al. (1993) find that knowledge spillovers are not confined to the industry in which a new technology originated. Instead, nearly 40 percent of citations come from a different patent class than the originating patent (Jaffe, Trajtenberg, & Henderson , 1993). Also Glaeser et al. (1993) find that industries in regions with a more diversified local economy grow faster (Glaeser, Kallal, Scheinkman, & Schleifer, 1992).

Audretsch (similarly to Porter) identifies a third important measurable factor of agglomeration, namely competition. Competition in agglomerations can work as an important driver for innovation. Firms that are faced by fiercer local competition *for new ideas* are more successful at achieving new innovations, which motivates firms to be the first to generate new ideas (Audretsch, 1998). This view contrasts the Marshall-Arrow-Romer model that suggests that local monopoly is more conductive as it maximises the ability of firms to appropriate the economic value of their innovative activity (Audretsch & Feldman, 1999). In our research we find *International Competition* sometimes has positive effect on firm productivity. Conversely, the measure for *Localised Competition* tends to have a negative impact on productivity. A possible explanation is that stronger localised competition measures elevated factor prices for labour instead of competition for new ideas.

Critiques

The theories discussed have not been entirely undisputed. Currently, economies are going through some major developments that seem to defy agglomeration theories. Evidently, these developments are globalisation and telecommunications. This section shows that we do not disregard these matters, only that their importance is often exaggerated.

In the light of globalisation it cannot be ignored that many firms are offshoring and outsourcing parts of their value chain. How can we reconcile this with agglomeration economies? The motive for offshoring rests upon the notion that factor prices and factor productivity widely vary across countries and regions. Jones and Kierzkowski (2005) argue that increasing returns to service linkages (e.g. communication (ICT) and transportation) enables firms to reduce costs by outsourcing fractions of their value chain. They recognise that the unit-costs of transportation typically decline with volume. Therefore, firms can reduce total costs if they re-locate part of their value chain that strongly relies upon production factors that are cheaper or more productive in another region (e.g. relying on unskilled cheap labour) (Jones & Kierzkowski , 2005). Baldwin and Venables (2010) recognise the same and try to model it more formally. They formulate the problem as a trade-off between lower production costs through offshoring against lower transport costs through co-location. The complexity of the problem (e.g. due to differing shapes of value chains) makes it impossible to find the optimal organisation of the value chain. Furthermore, uncertainty and coordination failure makes firms less willing to relocate. This makes offshoring less likely to happen than socially optimal (Baldwin & Venables, 2010).

Similarly, the trend of globalisation has to be recognised. Many firms make use of outsourcing and offshoring due to the *cost benefits* involved. This is a crucial point, the previous studies only focuses on cost factors of offshoring and agglomeration. The discussion ignores other positive externalities agglomeration economies create, such as: information sharing, improved coordination, larger pools of skilled labour, and knowledge spillovers. Moreover, these factors are the ones that impact upon productivity, while offshoring mostly about cost minimisation. It will increase efficiency and productivity by relocating the activities a firm is relatively bad at, yet the decision to offshore is always related to a trade-off over trade costs. Whilst *internal* productivity gains make a firm genuinely more competitive, under offshoring an exogenous change in trade costs can instantly reverse the productivity gain obtained through the relocation of production activities. Finally, there is a more practical argument why outsourcing is not that important in our discussion. Looking at our data only 4 percent of the surveyed firms actively outsource (i.e. 590 firms). Additionally, their average size is much bigger. We do not deny there has not been a recent trend towards outsourcing activities. Yet, the factors discussed suggest it is only feasible for a relatively small group of large companies. Intuitively, this makes sense as the theories just discussed explain that outsourcing is only profitable at large volumes. For smaller firms outsourcing simply is not reasonable.

When it comes to telecommunications many argue that recent rapid developments diminish the importance of location. Especially, the introduction of the internet increases the access to knowledge and speed of diffusion. It is possible to imagine this reduces the importance of agglomeration. However, Glaeser does not believe that this will happen since telecommunications are not a substitute for face-to-face contact. He states: 'Information spillovers continue to be important and telecommunications might end up helping, rather than hurting cities' (Glaeser, 1998). Similarly, Keller explains why telecommunications and the internet cannot create an equal level of technological knowledge in all countries. Firstly, free access to knowledge is not in the interest of the inventor who has incurred R&D costs. This gives him the incentive to keep the technology secret. Secondly, patenting precludes others from using a new technology. Thirdly, even if technological knowledge could move across countries at zero marginal-costs, operating the technology may involve costly investments. Finally, only the broad outlines of technological knowledge can be codified, the rest of the knowledge is 'tacit' and can only be transferred face-to-face (Keller, 2004). These factors show that inventors can be unwilling to let telecommunications increase the access and diffusion of knowledge. Additionally, the nature of knowledge will only enable it to diffuse locally.

Firm characteristics

Next to agglomeration we study the effect of specific firm characteristics on productivity. In order to formulate hypotheses for our analysis it is important to increase our understanding of the effects that firm characteristics have on performance.

Endogenous growth model models (e.g. Lucas, 1988; Romer, 1990) describe how investing in human capital increases productivity growth. Although, we are not focussing on productivity growth it is reasonable to assume that firms with more educated employees are also absolutely more productive. Luintel et al. (2010) studied this topic and found empirical evidence that both human capital and R&D drive productivity levels. They ran their test on panel data covering 16 OECD countries. One of their findings was that productivity is heterogeneous across countries depending on the accumulated stock of knowledge and human capital.

De Kok, Fris and Brouwer (2006) conducted a study on firm age and productivity growth. Young firms on average have lower levels of productivity, though the productivity growth rate of surviving firms is much higher. Furthermore, there is a positive relationship between firm size and productivity due to economies of scale and scope. The relationship between age and productivity becomes less clear for established firms, it is said to depend more on the manufacturing firms product life cycle (de Kok, Fris, & Brouwer, 2006). Also Feldman (1999) discusses the size and age characteristics of (innovative) firms. The main finding is that smaller firms and new start-ups, often financed by venture capital are most innovative. Intuitively this makes sense, new firms can more easily adopt radical innovations, whereas established firms are faced with sunk investment costs in old technologies. This does not imply small firms are more productive, but that they can increase their productivity faster than established firms. In our results we find evidence for this as smaller firms are characterised by higher productivity growth.

Barth et al. (2005) study the effect of family-ownership on firm productivity. They find that family-owned firms are less productive than non-family-owned firms, unless they are managed by a manager from outside the family. They find a productivity gap of around 14 percent and ascribe this to the skill difference between professional and family managers (professional managers come from a larger pool of talent).

Corbett et al. (2005) study the effect of quality certificates, specifically ISO 9000, on firm performance. Rather than studying productivity they focus on the return on assets (ROA). They find that the implementation of ISO 9000 is followed by significant abnormal improvements in financial performance. Even after three years certified firms continue to outperform the non-certified firms in the control group.

Finally, capital deepening can increase productivity even in the absence of technological progress. For example, in China's manufacturing industry productivity growth only sets in after capital deepening. Labour productivity increased tremendously due to the increase in per capita assets (Xingming, 2009). Therefore, we expect firms with a higher capital intensity to be more productive.

The examples just discussed provide evidence and intuition that firm characteristics have an impact on firm performance. In the model we can test whether these factors really contribute to productivity. Furthermore, it allows us to isolate firm effects from agglomeration effects.

Previous empirical work

Before continuing with the methodology it is worthwhile to examine previous empirical work on agglomeration and firm performance. Studies by Paci and Usa) (1999), Audretsch and Feldman (1999), and van der Panne (2004) examine which agglomeration externalities have the greatest impact on innovative activity. Their findings differ remarkably, possibly due to the differences in geographical focus.

Paci and Usai (1999) study the spatial concentration of innovative activity and assess to what extent specialisation (Marshallian) or diversity (Jacobian) externalities affect the innovative output in local industries. Examining the number of patent applications in Italy they find both externalities positively affect innovative output. This shows that diversity and specialisation externalities are not necessarily opposites, as specialisation is a feature of a specific sector within a region and diversity characterises the entire region. Moreover, they find positive evidence for knowledge spillovers since technological activities in a local industry positively influences innovation in similar sectors in neighbouring areas.

Audretsch and Feldman (1999) study the same topic only focussing on the United States and measure new product announcements instead of patent applications. They find that diversity across complementary economic activities is better in promoting innovative output. Specialisation of economic output does not increase innovation. Furthermore, increased localised competition increases the innovative activity in a region.

Van der Panne's research focusses on new product announcements in the Netherlands. Conversely to Audretsch and Feldman, his findings show that regional specialisation and less competition are factors that benefit innovative output most (van der Panne, 2004). The contradictory results these studies bring about shows there is little consensus about the key drivers of innovative output. Similarly, the drivers of productivity might markedly differ between countries, this makes it important to study our topic in a cross-country setting.

It is also important to examine the study the Bruegel institute published using the EFIGE dataset. Altomonte, Aquilante and Ottaviano (2012) wrote a paper on the triggers of competitiveness, especially, with respect to the different stages of international activity. Their research builds upon the idea of firm selection introduced by Melitz (2003) and Melitz and Ottaviano (2008). In the introduction we have already extensively examined this theory and seen how it contrasts with agglomeration theory.

Altomonte et al. (2012) start their research with the assertion that productivity increases with the complexity a firm's international activities. In other words, a firm that is active abroad is more productive than a firm that is not; a firm that exports globally is more productive than one that only exports locally; and finally, firms involved with even more complex activities such as FDI have even higher productivity. Their argument follows the notion of self-selection, international activities with increasing complexity will only be undertaken by those firms with greater competitiveness, which is proxied by the level of total factor productivity.

The study then defines a productivity threshold necessary to be reached before a firm becomes active in the international environment. This approach enables one to identify the firm-characteristics that trigger international activities. It shows that factors related to innovation (human capital and R&D), finance (preferably equity financing), management (less family management and performance based salaries) and ownership structures (belonging to a foreign group) improve the likelihood of becoming active internationally. Interestingly, the study maintains that differences between countries and industries have no impact upon the likelihood of becoming more productive and successful internationally. Firms that are able to become active abroad typically share the same features irrespective of country and industry (Altomonte et al., 2012). This seems to be quite a bold claim and this study finds contrasting evidence. Namely, taking into account agglomeration forces the drivers of productivity strongly differ between countries and industries.

Our study advocates a more diligent approach when designing new policy. Indeed, to an extent there are many firm characteristics that are similar across countries. Yet, the drivers of productivity can vary significantly depending on the country or sector. We shall see that it is crucial to take into account the heterogeneity between countries and sectors when we want to increase the efficiency of new policies.

Data

By now we have gained a good understanding of the theories about agglomeration and firm productivity. However, we still need data that allows us to study this topic. In the past a lack of appropriate data on agglomerations and productivity made it a very complicated topic to study. Fortunately, improved methods of data collection and new initiatives to create standardised cross-country datasets enable previously unthinkable studies. Previously studies on the impact of agglomeration forces on firm performance could only focus on one country (Audretsch & Feldman, 1999; Cainelli, 2008; Paci & Usai, 1999; van der Panne, 2004). Today surveys such as the Community Innovation Survey (CIS) and the European Firms In a Global Economy (EFIGE) open new research possibilities. For example, it is now possible to disentangle country and industry specific effects. For policy design this is extremely valuable, since it is not clear why empirical research based on one country should also hold in the next.

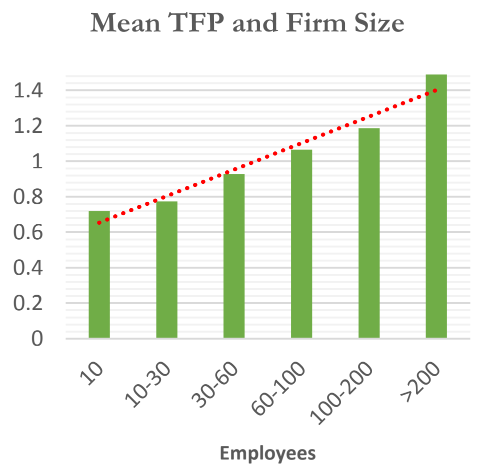
The empirical part of this study uses the EFIGE/Bruegel-UniCredit dataset. The EFIGE dataset is a survey of nearly 15,000 manufacturing firms from 7 European countries (Germany, France, Italy, Spain, United Kingdom, Austria and Hungary). The survey was compiled by the Bruegel think-tank with the support of the 7th Framework programme of the European Commission. The dataset covers nearly 150 topics ranging from:

- Structure of the firms (e.g. ownership, management, domestic/foreign control)
- Workforce (e.g. skills, education)
- Investment, technological innovation and R&D
- International activities
- Market structure
- Financial structure

Surveyed firms have a minimum size of 10 employees. Since the survey was conducted in 2010 most questions refer to 2008 and a few items refer to the period 2007-2009. In order to ensure a representative sample Bruegel followed 3 criteria in data collection. Firstly, for the large countries a target of 3,000 respondents to the survey was required, 500 for small countries (Austria and Hungary). Second, a minimum response rate to key (90 percent) and important questions (70 percent) and an overall response of at least 60 percent was needed. Finally, they made a proper stratification of the sample to ensure representativeness. This involved using 11 NACE industry classifications, NUTS-1 and 2 region identifiers, and size classes (small 10-19, medium 20-49, large 50-249, very large >250 employees). Furthermore, large firms have been *slightly* oversampled in the survey. Large firms play an important role in aggregate competitiveness dynamics, but only represent a small part of the standard population of firms (Altomonte & Aquilante, 2012).

The slight oversampling of large firms will likely generate a slight upward bias for agglomeration effects in our findings. The representative (weighted) mean firm size is 50.5 employees, whereas the unweighted mean is 65.1 employees. We are aware that refraining from applying the weighting procedure to our empirical analysis will cause a slight bias, but there are reasons for doing so. The weights are included to obtain the representative firm sizes. However, running our models with weights will rescale all variables and not only those relating to firm size. For example, there is no reason to assume the distribution of turnover (and many other variables) should vary in the same fashion as firm size varies. Applying weights will therefore not lead to a more representative model. Instead, we describe qualitatively the effects of oversampling large firms and take this into account. Figure 1 shows that: *i)* with increasing firm size the average productivity of firms increases. Furthermore, we know from previous studies and the descriptive statistics in figure 3 (page 25) that *ii)* firms located in agglomerated areas are on average more productive. Taking *i)* and *ii)* together we can only conclude that on average large firms are more likely to locate in agglomerations. Hence, we can expect the slight oversampling of large firms will cause a slight upward bias of the impact of agglomeration forces.

FIGURE 1 RELATION FIRM SIZE AND AVERAGE PRODUCTIVITY



The following tables provide an overview of the distribution of the sample by country, size, sectors and regions.

TABLE 1: THE EFIGE DATASET BY COUNTRY

Country	Number of Firms
Austria	443
France	2,973
Germany	2,935
Hungary	488
Italy	3,021
Spain	2,832
United Kingdom	2,067
Total	**14,759**

Source: EFIGE Survey Dataset. Industry codes not available for 316 firms.

Table 1 shows the distribution of surveyed firms. As previously explained the number of surveyed firms in large countries lies around 3,000 and 500 for smaller countries. In total there are nearly 15,000 firms in the sample.

TABLE 2 DISTRIBUTION OF FIRMS BY COUNTRY AND SIZE CLASS

Class size	Austria	France	Germany	Hungary	Italy	Spain	UK	Total
Employees (10-19)	132	1,001	701	149	1,040	1,036	635	**4,694**
Employees (20-49)	168	1,150	1,135	176	1,407	1,244	805	**6,085**
Employees (50-249)	97	608	793	118	429	406	519	**2,970**
Employees (>250)	46	214	306	45	145	146	108	**1,010**
Total	**443**	**2,973**	**2,935**	**488**	**3,021**	**2,832**	**2,067**	**14,759**

Source: EFIGE Survey Dataset

Table 2 shows the distribution of firm size by country. In order to make the survey representative Bruegel ensured all countries have a similar distribution of the different firm sizes. We only notice that in Germany has a relatively high number of large firms in the sample.

TABLE 3 DISTRIBUTION OF SECTORS BY COUNTRY

sector	AUT	FRA	GER	HUN	ITA	SPA	UK	Total
1	100	964	568	108	687	648	355	**3,430**
2	46	213	350	63	238	463	147	**1,520**
3	22	244	192	40	169	148	122	**937**
4	64	410	371	68	481	223	349	**1,966**
5	13	35	199	22	227	280	262	**1,038**
6	8	107	95	20	108	121	104	**563**
7	8	101	61	14	80	106	54	**424**
8	54	142	103	17	88	212	89	**705**
9	0	3	4	0	8	0	6	**21**
10	67	478	489	68	554	326	371	**2,353**
11	61	276	503	68	381	305	208	**1,802**
Total	**443**	**2,973**	**2,935**	**488**	**3,021**	**2,832**	**2,067**	**14,759**

Source: EFIGE Survey Dataset

Table 3 presents the distribution of sectors by country. Again we see that the sectors are evenly distributed across countries and there are no apparent outliers. Generally, tables 1, 2, and 3 indicate there is no reason to suspect any biases in our results as a consequence of peculiarities in the sampling procedure.

TABLE 4 NUMBER OF REGIONS BY COUNTRY

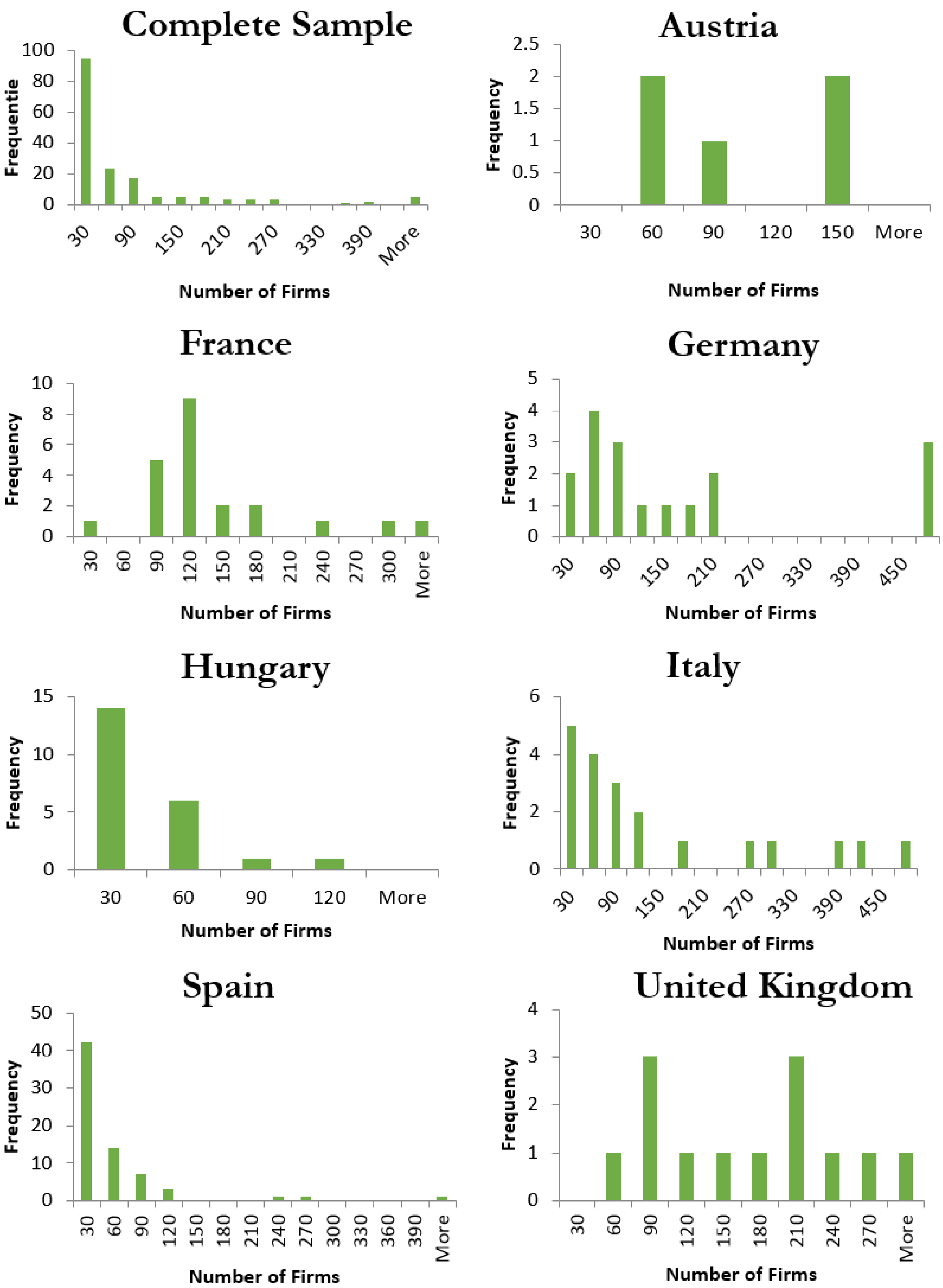
Country	Austria	France	Germany	Hungary	Italy	Spain	UK	Total*
Number of Regions	5	22	17	22	20	69	13	168

** Due to an error in the dataset region 25 is split over Germany, Spain and the UK. There are only 166 regions in the survey.*

Source: EFIGE Survey Dataset

Finally, the number of different regions does show some large differences. It seems that data for Austria is only on the NUTS-1 level, whereas in Spain the survey registered NUTS-2 data on a much smaller unit of measurement. Graph 1 (see next page) shows the histograms of the distribution of firms over regions. One notices rather big differences between countries. The general trend in our complete sample is to have many regions with few firms (peripheries) and a steadily decreasing number of larger regions (cores). However, individual countries sometimes strongly diverge from this pattern. In general this does not necessarily matter as we calculate our agglomeration variables over the complete sample. Thus, if one country simply does not have any peripheral regions the performance of its cores will be compared to the peripheries we observe elsewhere in our sample. However, in the country specific analysis this might be problematic since we do not know the performance of firms that are located in the particular country's periphery. Furthermore, it is rather unrealistic to claim that Austria has no periphery. The quality of this research could therefore be improved if Bruegel updates the EFIGE dataset with NUTS-2 or preferably NUTS-3 regional identifiers. In spite of these shortcomings we still find that agglomeration forces are a strong driver of productivity.

FIGURE 2 HISTOGRAM NUMBER OF FIRMS PER REGION



What makes the EFIGE dataset particularly valuable is that Bruegel integrated the survey with balance sheet data obtained through the Amadeus database managed by Bureau van Dijk. Using this data it was possible to calculate measures of firm productivity for a large part of the surveyed firms. Specifically, the measure of Total Factor Productivity (TFP) is used as the dependent variable in this research. In order to check the representativeness of these measures Bruegel has run correlations between the Amadeus variables and similar measures listed on Eurostat (Altomonte & Aquilante, 2012). Overall, there seems to be a strong correlation between the variables implying that the data is representative.

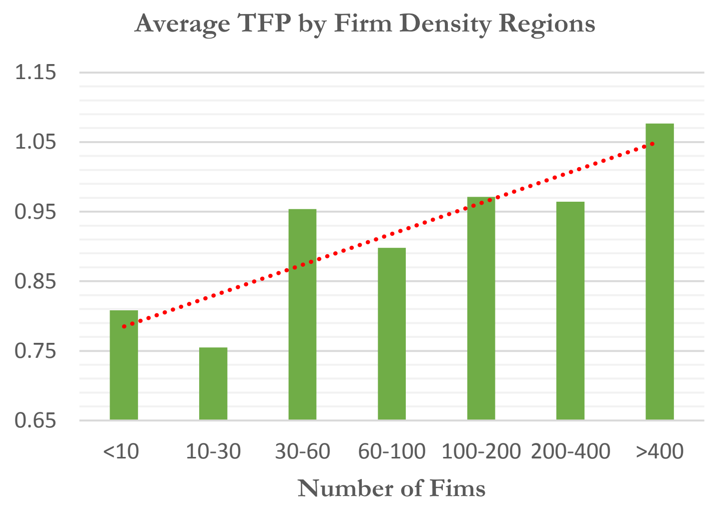
Total Factor Productivity (TFP) was calculated using the Levinsohn and Petrin procedure. TFP literally relates to the *A* in the standard Cobb-Douglas production function used in growth accounting: $Y = A \cdot K^{\alpha} L^{\beta}$. In the function the *A* tells us how efficient a firm is in transferring the inputs capital and labour into output. Unfortunately, it is not possible to directly estimate this equation by running an OLS regression on the firm's factor inputs. Doing so would imply that we assume capital and labour to be exogenously determined variables. However, profit maximising firms do not treat capital and labour as exogenous, rather firms change their input factors over time depending on the economic climate. It is not possible for econometricians to distinguish between changes in input factors due to productivity shocks and other reasons. This implies input factors are correlated with the error term, causing a bias of the OLS estimates. The Levinshohn and Petrin (2003) *semi-parametric production function estimation algorithm* ensures that there is no simultaneity bias that normally affects estimates of firm-level productivity. In the estimation procedure it also takes into account heterogeneous, industry specific production functions. Finally, by pooling the firm-level data across countries and years Altomonte et al. were able to control for country and year fixed effects (Altomonte, Aquilante, & Ottaviano, 2012).

An important aspect of the dataset is that it has been anonymised for confidentiality reasons. Without anonymisation firms would not be willing to provide such highly detailed company specific information. The anonymisation took place across four dimensions. Firstly, all employment levels have been capped at 500 employees in order to make sure that it is not possible to identify an outlier in an industry within a region with only one single company. Secondly, all regions have been anonymised through a randomised regional identifier. This means that we only know which regions belong to which country, but do not know what region this actually represents. The same has been done for industries, such that we have a randomised industry identifier but do not know what the actual industries are. There is a Pavitt industry classification that gives information about the companies that belong to either *Traditional, High Tech, Specialised* or *Economies of Scale* industries. Finally, exact values for firm age and turnover have been changed to categories as opposed to exact values (e.g. firms <6 years and turnover between 15-50 million).

The anonymisation is unfortunate, but understandable. It makes it impossible to augment the dataset by using more regional data from Eurostat on education levels within a region, employment, investment in R&D regionally and many other factors. Also, we cannot compare our findings with evidence of successful clusters in specific industries within the countries in our sample (e.g. is the sector characterised by localisation economies in fact the Italian shoe manufacturing sectors?). Fortunately, the EFIGE survey by itself makes very interesting research possible.

Even though the dataset has been anonymised the basic observation that spatial concentrations of economic activity are more productive can still be clearly seen. Figure 2 shows average TFP by firm density in regions. There is a clearly visible trend that regions with more firms (cores) are more productive than regions that have a more sparse firm population (peripheries). The distribution is made up of 166 regions. The intervals <10 until 100-200 have around 30 observations each. The observations for intervals 200-400 and >400 are less and have 12 and 7 observations respectively.

FIGURE 3 AGGLOMERATIONS AND PRODUCTIVITY



Methodology

The empirical part of this research is divided into two parts. In the first part using a simple OLS regression we study the determinants of absolute total factor productivity (TFP) at the firm level. The results will help us identify which agglomeration externalities (e.g. specialisation, diversity and competition) have the greatest impact on productivity. In addition we are able to see which firm characteristics influence productivity. The robustness of the results is checked by including country, sector, and country-sector fixed effects. This allows to control for sector-specific, country-specific and country-sector-specific unobserved heterogeneity. Finally, the absolute TFP analysis is repeated for each country and sector. Doing so enables us to compare the effects of firm characteristics and agglomeration forces on productivity between sectors and countries.

The second part studies the impact of firm characteristics and agglomeration forces on productivity growth. Since most of the literature focusses on productivity growth rather than absolute productivity it is important for us to also study this relationship. However, this will only be a minor focus since the measure of productivity growth is rather crude. The available data makes it only possible to calculate the growth rate based on the average 2001-2007 TFP to average 2008-2009 TFP.

Measuring agglomeration forces

Having described the two main pillars of the econometric research we now describe how the variables measuring agglomeration forces are generated. In order to measure the different types of agglomeration forces we build upon earlier studies by Audretsch and Feldman (1999), Paci and Usai (1999) and van der Panne (2004). We simply copy their methods in order to study Marshallian (*Specialisation Index*) and *Localised Competition* externalities. For measuring Jacobian (diversity) externalities we use a simple Herfindahl index, instead of calculating the Gini coefficient as other studies do.

The *Specialisation Index* (PS_{ij}) measures the extent of localisation externalities, or rather Marshall-Arrow-Romer externalities. The index measures the specialisation of a sector within a region, relative to the size of the sector in the entire sample. Higher values are associated with more specialisation. Below we see exactly how this variable is generated:

$$PS_{ij} = \frac{[E_{ij}/\sum_i E_{ij}]}{[\sum_j E_{ij}/\sum_i \sum_j E_{ij}]} \quad i = 1,\ldots,11 \text{ sectors} \quad j = 1,\ldots,166 \text{ regions} \qquad E = \text{Employment} \qquad (1)$$

A positive and significant coefficient for this variable in the regression suggests the existence of localisation externalities, and by comparing the size of the coefficients over countries we can infer differences of production structures.

The diversity index (firm Herfindahl index) measures the importance of urbanisation externalities, or Jacobian externalities. The firm Herfindahl index measures the degree of diversity within a sector and region. It is calculated by taking the firm's market share within a sector and region. Next, we take the sum of these market shares by sector and region.

$$Firm\ Herfindahl = \sum_{f \in i,j} \left[\frac{E_f}{E_{ij}}\right]^2 \qquad (2)$$

The Herfindahl index has the property of taking a value between zero and one. High values for the Herfindahl imply low diversity, whilst low values indicate a high level of diversity. A quick reminder, if there is more diversity within a region we hypothesise that there is more room for knowledge exchange and serendipitous innovations (Feldman, 1999). Similarly, we hypothesise that higher diversity enhances productivity.

Finally, the third component of agglomeration forces relates to competition. The localised competition measure was first introduced by Glaeser at al. (1992). The variable measures the number of firms per worker in in sector *i* per region *j* relative to the number of firms per worker in the complete sample.

$$COMP_{ij} = \frac{\left[Firms_{ij} / E_{ij} \right]}{\left[\sum_i \sum_j Firms_{ij} / \sum_i \sum_j E_{ij} \right]} \qquad (3)$$

This coefficient describes the level of labour market competition: higher levels are associated with increased sector-specific local labour competition (Jacobian externality). On the other hand, if we find a low value for competition it suggests a large average firm size and market power (Marshallian externality) (van der Panne, 2004).

Hypotheses

Before we move to the results let us have a quick look at the hypothesised findings. This allows us to get a qualitative sense of the expected findings, making it easier to identify peculiarities. The following table shows the dependent variables and regressors used in the models. The signs indicate our expectations.

TABLE 5 HYPOTHESES DIFFERENT REGRESSION SPECIFICATIONS

	Absolute TFP Analysis	TFP Growth Analysis
Dependent Variable	TFP 2001-07*	TFP Growth†
Regressors	**(+)** Employees*	**(–)** Employees*
	(+) Turnover*	**(+)** Turnover*
	(+) Firm Age*	**(–)** Firm Age*
	(+) Executives/Entrepreneurs	**(+)** Executives/Entrepreneurs*
	(+) University Employees	**(+)** University Employees*
	(+) R&D Employees	**(+)** Investment R&D*
	(?) Local Competition*	
	(–) Firm Herfindahl	
	(?) Specialisation Index	
	(+) Capital Intensity *	
	Dummies	
	(–) Family CEO	
	(+) Bonuses	
	(+) Foreign Competition	
	(?) Exporting	
	(+) Foreign Group	
	(+) Quality Certificates	
	(+) High-Tech	
	(+) Specialised	
	(+) Economies of Scale	

* variable in Logs
† TFP Growth based on difference ln(TFP 2008-09) – ln(TFP 2001-07)

Absolute TFP analysis

In the first model the dependent variable is the average level of TFP over the period 2001-2007. There are two reasons for choosing this as the dependent variable. Firstly, it has about 2,500 more observations than the TFP 2008 variable, providing us with a bigger sample and potentially more variation in the dataset. Secondly, by taking the average of a longer period we automatically identify those firms that are more successful over a longer period. This reduces the volatility of our dependent variable.

In the data section we have shown that densely populated regions tend to be more productive. Only by studying firm level dynamics can we uncover what factors determine the differences in productivity observed. The hypotheses formulated are based on our findings in the theoretical framework. The signs on *Employees*, *Turnover* and *Firm Age* are positive since only firms that are sufficiently productive can survive and grow big and old. When we talk about firm survival our reasoning builds upon firm selection theories where causality runs from productivity to *Employees*, *Turnover* and *Firm Age*. Conversely, the reverse causality also generates positive coefficients. For instance, intuitively it makes sense that bigger firms (i.e. more employees and higher turnover) can benefit from economies of scale. Additionally, studies have shown older firms can benefit from learning effects, making firms more efficient and are less likely to run into trouble when unexpected (Dunne & Hughes, 1994). The signs for *Executives/Entrepreneurs*, university employees and *R&D Employees* are expected to be positive. These factors relate to the quality of human capital and should have a positive impact on productivity. Furthermore, we expect firms that have more capital at their disposal to be more productive due to capital deepening.

Next we include our agglomeration measures. Only for the *Firm Herfindahl* index are we confident to expect a negative coefficient implying more diversity raises productivity. The literature studied did not give enough consensus regarding the *Specialisation Index* and *Local Competition* externalities.

Finally, we include dummy variables for specific firm features into our regression. As we have seen in the theoretical framework we expect *Family CEO*s to have a negative impact on firm productivity. We expect *Bonuses* have a positive impact on productivity at the firm-level. *Foreign Competition* reflects competition for ideas (opposed to factor market competition) and therefore we expect it to stimulate productivity (Audretsch, 1998). The effects of *Exporting* are still unclear. According to the Melitz model exporting is determined by self-selection (Melitz, 2003), whereas Albornoz & Ercolani (2007) find evidence a learning-by-exporting effect. For *Quality Certificates* we expect a positive coefficient. Finally, according to Altomonte et al. (2012) *Foreign Ownership* should increase productivity. The final dummy variables relate to the Pavitt taxonomy for firm classification. We expect *High-Tech*, *Specialised* and *Economies of Scale* firms to all be on average more productive. Moreover, including all indicators allows us to compare the relative performance of the different industry classifications. The indicator for *Traditional* firms is excluded to avoid perfect multicolinearity.

Productivity growth analysis

Although, it will only be a minor focus in this research we will also briefly explore the drivers of productivity change. By taking the difference of the natural logarithm of average TFP in 2008-2009 and 2001-2007 we obtain the growth rate from these averages. This allows us to see which firms managed to become more productive in spite of the global financial crisis. Our expectations slightly change when we focus on TFP change. Namely, in line with the empirical findings regarding the fastest growing and most innovative firms (Feldman, 1999), we also expect small, young innovative companies to have the highest productivity growth. Therefore, the coefficient on firm size (employees) and age is expected to be change signs and become negative. We also include similar firm characteristic variables from the previous model and expect their signs to be similar. Furthermore, we included the variable *R&D Investment* and believe that firms that invest a larger share of their turnover in R&D activities experience higher productivity growth.

It might seem odd that we regress the variables we used to study absolute TFP again in our analysis of TFP growth. Especially, since it does not change most of our hypotheses. Firstly, the reasoning that similar factors (both firm characteristics and agglomeration forces) influence absolute productivity and also productivity growth is ad-hoc. Yet, the study by Altomonte et al. (2012) also includes multiple firm characteristics in their analysis. They hypothesise that firms that possess a certain set of *good* characteristics are more likely to switch to the exporting group. This implies they also assume the firm characteristics have an impact on productivity growth. As for agglomeration economies, we simply assume that they have a similar impact on productivity growth. Nonetheless, the fact we do not have a clear economic foundation to base our hypotheses on implies we should be more cautious with the interpretation of our results.

Robustness

In order to test the robustness of the results we include in various specifications dummy variables for countries, sectors and country-sectors. The dummy variables allow the intercepts for countries, sectors and country-sectors to vary. These fixed effects remove biases from the data that originated from the different means in the country productivities (i.e. there could be spurious correlations due to the fact Hungary has a higher average TFP relative to the United Kingdom). Table 6 shows how the means of total factor productivity vary by country.

TABLE 6 MEANS TFP BY COUNTRY

Country	Mean Ln(TFP)
Austria	.1292573
France	-.0791666
Germany	.2271362
Hungary	.190133
Italy	-.1639538
Spain	-.1981088
UK	.0652945

Source: EFIGE Survey Dataset

Results

We now present the results of the empirical analysis. The first section discusses the absolute TFP analysis. This also includes country and sector specific regressions enabling us to check for heterogeneity in the factors that drive productivity. The second section presents the productivity growth analysis. Although it is not the major focus of this research the findings generally correspond to our expectations.

Absolute TFP analysis

For the absolute TFP analysis we will run two specifications. The first model, the 'big' specification, is meant to get more insight into the firm characteristics driving productivity. Secondly, we run a 'cleaner' model containing less firm characteristics, directing our attention more on agglomeration forces. Characteristics identified in the 'big' model tend to hold relatively well in all sectors and countries (i.e. signs tend not to change, though in some cases coefficients become insignificant due to too few observations). Conversely, agglomeration effects tend to vary more depending on the level of analysis (e.g. country or sector). Running a model with less features makes it easier to analyse the results. Using the 'clean' specification we will then run country and sector specific models. This enables us to examine possible changes in our findings depending on the analysis-level. In case we find differences it is the first step to tailor public policy more efficiently for countries or sectors.

The 'Big' model

The following equation is the specification of the 'big' model. The variables include indicators for firm characteristics, agglomeration forces and numerous dummies for firm characteristics. Additionally, Pavitt classifications are included to examine whether high-tech, specialised or economies of scale firms are more productive. It is important to notice that Entrepreneurs/Executives, R&D employees and University employees are measured in percentages rather than logarithms. We do this to avoid biases and increase the number of observations. Firms without these types of employees would drop out of the regression, which may create a selection bias as it for example excludes all firms without university employees. Using percentages increases the number of observations by about 3,000.

Below is the specification of the 'big' model and Table 7 presents the results. In the first column we state the full regression results, in the following columns we test the robustness of these findings by including country, sector, country and sector, and country-sectors dummy variables. As discussed earlier this allows all intercepts to move freely removing possible spurious correlations. In order to make the findings easier to interpret we have presented all positive and significant findings in *green* and negative significant findings are presented in *red*. Finally, Table 9 presents the interpretation of the non-log coefficients. Using percentages has increased our number of observations, but this is at the cost of no longer interpreting these coefficients as elasticities. For the interpretation we should consider the effect of a 1 standard deviation (s.d) change in X on the percentage change Y (i.e. TFP).

$$\begin{aligned}\ln(TFP_{2001-07}) &= \alpha_0 + \beta_1 X_{\ln(emp)} + \beta_2 X_{\ln(turnover)} + \beta_3 X_{\%ENTRE} + \beta_4 X_{\%R\&D} + \beta_5 X_{\%UNI} \\ &+ \beta_6 X_{\ln(firmage)} + \beta_7 X_{F.Herfindahl} + \beta_8 X_{SpecIndex} + \beta_9 X_{\ln(K.intens)} + \beta_{10} X_{Loc.Comp} + \beta_{11} D_{For.Comp} \\ &+ \beta_{12} D_{For.Group} + \beta_{13} D_{Fam.CEO} + \beta_{14} D_{Bonus} + \beta_{15} D_{ISO} + \beta_{16} D_{Hi.Tech} + \beta_{17} D_{Specialised} + \beta_{18} D_{Scale.Eco}\end{aligned} \quad (4)$$

TABLE 7 FIRM-LEVEL ANALYSIS MANY FIRM FEATURES

VARIABLES	Full TFP Average 2001-2007	Country Dummies TFP Average 2001-2007	Sector Dummies TFP Average 2001-2007	Country & Sector Dummies TFP Average 2001-2007	Sectors by Country Dummies TFP Average 2001-2007
Ln (Employees)	0.112***	0.0973***	0.114***	0.0975***	0.0988***
	(0.00750)	(0.00754)	(0.00743)	(0.00745)	(0.00739)
Ln (Turnover)	0.0602***	0.0648***	0.0622***	0.0678***	0.0669***
	(0.00546)	(0.00540)	(0.00541)	(0.00534)	(0.00529)
% Executives/Entrepreneurs	0.127***	0.111**	0.125***	0.118***	0.127***
	(0.0448)	(0.0464)	(0.0443)	(0.0458)	(0.0458)
% R&D Employees	0.0132	0.0420	0.0153	0.0413	0.0201
	(0.0350)	(0.0344)	(0.0346)	(0.0339)	(0.0337)
% University Employees	0.242***	0.178***	0.251***	0.180***	0.165***
	(0.0353)	(0.0351)	(0.0350)	(0.0346)	(0.0344)
Ln (Firm Age)	0.103***	0.114***	0.106***	0.118***	0.119***
	(0.00967)	(0.00952)	(0.00955)	(0.00938)	(0.00929)
Firm Herfindahl	-0.0917***	-0.156***	-0.0336	-0.109***	-0.126***
	(0.0227)	(0.0232)	(0.0243)	(0.0248)	(0.0253)
Specialisation Index	0.00297	0.00366	0.000843	0.000913	0.00421
	(0.00287)	(0.00284)	(0.00305)	(0.00303)	(0.00320)
Ln (Capital Intensity)	0.0259***	0.0499***	0.0319***	0.0572***	0.0573***
	(0.00580)	(0.00613)	(0.00576)	(0.00609)	(0.00604)
Local Competition	-0.0377***	-0.0322***	-0.0378***	-0.0335***	-0.0285***
	(0.00631)	(0.00639)	(0.00649)	(0.00657)	(0.00667)
International Competition	0.0120	0.0134	-0.00378	-0.00280	-0.00419
	(0.00896)	(0.00890)	(0.00898)	(0.00891)	(0.00884)
Foreign Group	0.0504***	0.0380**	0.0462***	0.0316**	0.0238
	(0.0156)	(0.0155)	(0.0154)	(0.0153)	(0.0153)
Family CEO	-0.0385***	-0.0335***	-0.0385***	-0.0339***	-0.0370***
	(0.00960)	(0.00945)	(0.00948)	(0.00931)	(0.00921)
Bonus	0.0420***	0.0315***	0.0449***	0.0346***	0.0394***
	(0.00990)	(0.00988)	(0.00977)	(0.00973)	(0.00964)
Quality Certificates	0.0347***	0.0226**	0.0217**	0.00876	0.00829
	(0.00943)	(0.00930)	(0.00953)	(0.00938)	(0.00928)
High-Tech	0.142***	0.155***	0.157***	0.165***	0.144***
	(0.0228)	(0.0224)	(0.0288)	(0.0281)	(0.0283)
Specialised	0.0807***	0.0788***	0.0657**	0.0464*	0.0239
	(0.0119)	(0.0118)	(0.0277)	(0.0272)	(0.0271)
Economies of Scale	0.108***	0.108***	0.100***	0.0911***	0.0814***
	(0.0108)	(0.0106)	(0.0148)	(0.0145)	(0.0146)
Constant	-1.048***	-1.223***	-0.627***	-0.750***	-1.531***
	(0.0476)	(0.0700)	(0.126)	(0.134)	(0.353)
Observations	7,435	7,435	7,435	7,435	7,435
R-squared	0.365	0.391	0.383	0.411	0.432

Standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

TABLE 8 INTERPRETATION NON-LOG COEFFICIENTS

Interpretation: Coef.*s.d.	Sample Standard deviation	Full	Country Dummies	Sector Dummies	Country & Sector Dummies	Sectors by Country Dummies
% Executives/Entrepreneurs	0.1031	0.0131	0.0114	0.0129	0.0122	0.0131
% University Employees	0.1338	0.0324	0.0238	0.0336	0.0241	0.0221
Firm Herfindahl	0.1936	- 0.0178	- 0.0302	*	- 0.0211	- 0.0244
Local Competition	0.7797	- 0.0294	- 0.0251	- 0.0295	- 0.0261	- 0.0222

** Not significant*

Examining the results in table 7 we first see that under the robustness checks the majority of our coefficients remain significant. Furthermore, we find evidence for many of the hypotheses made in the previous section. Firstly, regressors relating to the size and age of the company (i.e. *Employees*, *Turnover* and *Firm age*) all are associated with higher productivity. Inspecting the specific types of employees (see Table 8) we find that a 1 s.d. change in *Executives/Entrepreneurs* and *University Employees* causes productivity to increase by around 1 and 3 percent respectively. For manufacturing firms a 1 percent increase in *Capital Intensity* is associated with between 2 and 5 percent higher productivity. Surprisingly, we find that the variable *R&D Employees* is not significant. We assumed that firms that significantly invest in R&D would be more productive, but this seems not to be the case. A good explanation for this observation can be the one that Audretsch provided. Namely, (small) firms that do not have sufficient resources to spend on R&D and therefore benefit from their proximity to (larger) firms that do invest in research. Knowledge spillovers benefit the firms that do not invest in research and make them nearly as productive as firms that do invest in R&D (Audretsch, 1998). A second explanation could be related to our dependent variable *TFP 2001-2007*. The questionnaire relates to 2008, if the responding firm has only invested in R&D in 2008 this will not be reflected in the dependent variable that covers only 2001-2007. The actual impact of these activities on TFP might only be observed in the future.

The factors relating to agglomeration forces: *Firm Herfindahl*, *Specialisation Index* and *Local Competition* also tell an interesting story. The findings only provide evidence for the existence of Jacobian externalities (diversity, firm Herfindahl). A 1 percentage increase in the *Firm Herfindahl* (i.e. implying less diversity) causes productivity to fall between 1 and 3 percent. The *Specialisation Index* is insignificant under all robustness tests, indicating there are no Marshallian (localisation) externalities. This corresponds to the findings by Audretsch and Feldman (1999). Finally, *Localised* (labour) *Competition* is always significant, with a 1 percent increase in competition reducing productivity by between 2 and 3 percent. Formulating our hypotheses we were unsure about the sign of local competition, with existing evidence showing that it can go both ways. Some studies expected that increased competition motivates firms to be more productive (or innovative) than their competitors (e.g. Audretsch, 1998; Porter, 1990). Similarly, local labour competition could also put upward pressure on wages reducing the firms' factor productivity. The negative coefficient could also relate to local market power. Van der Panne (2004) hypothesised that less fierce competition enables the innovator to appropriate the innovation rents.

By including the dummy variables we get a more detailed picture of productive firms. Most signs corroborate with our hypotheses. Only *Foreign Competition* is insignificant. Furthermore, *Quality Certificates* and belonging to a *Foreign Group* lose significance once country-sector fixed effects are included. In the cases that they are significant they do increase productivity by about 2 and 5 percent respectively. In the case of significant dummies the results show that *Bonuses* (i.e. performance based remuneration) increases productivity by roughly 4 percent. As expected having a *Family CEO* is bad for a firms' performance; productivity decreases by nearly 4 percent. Finally, we decided to leave out the dummy variable for *Exporting* firms. In none of the specifications it proved to have a significant impact on productivity, hence we decided to leave it out since it only reduces the degrees of freedom.

The final three dummies relate to the Pavitt taxonomy industry classification. As already mentioned, the classification for *Traditional* industries has been excluded to avoid perfect multicollinearity. In line with expectations *Specialised*, *High-Tech* and *Economies of Scale* firms have positive coefficients and thus are more productive than *Traditional* firms. However, high-tech companies outperform economies of scale and economies of scale perform better than specialised companies. This suggests that directing policy at high technology companies can after all have a positive impact on productivity of European manufacturing firms.

To sum up, the 'big' firm-level specification enabled us to generate a fairly good picture of the features of firms that are associated with higher productivity and competitiveness. Since, our analysis does not use instrumental variables we can technically only treat the findings as correlations rather than causality. However, most findings correspond to the theoretical foundations and hypotheses we previously presented. Therefore, we can conjecture that economic policies could be improved by targeting firms that share the characteristics of productivity we have identified.

The 'Cleaner' model

After having gained more insight into the firm characteristics associated with higher productivity we want to shift our focus more to agglomeration forces. Specifically, we want to investigate whether the narrative changes once we look at individual countries and sectors. Generally, countries can be at different stages on their development paths (e.g. Hungary is still considered a transition country; and in the United Kingdom the economy is rapidly becoming more service oriented). Is it therefore reasonable to assume drivers of firm productivity are the same irrespective of the country it is located in? For example, Altomonte et al. (2012) observe in the United Kingdom that average TFP has barely increased in recent years, whereas in Hungary it changed markedly over the years. They provide a possible explanation by noting the UK economy's competitive advantage has shifted from manufacturing towards services in recent years. However, this does not necessarily imply productivity in the manufacturing sector to have remained stable. At the same time Altomonte et al. argue that firms that are able to export share similar characteristics irrespective of the country or sector they are in. However, is this argument compelling, or is there more heterogeneity in the drivers that make firms productive? The scope of the EFIGE dataset enables us to test whether or not agglomeration externalities are identical across countries. The findings in this section can have great implications for efficient policy design.

Country analysis

Equation (5) gives the simplified specification for identifying potential differences at the country and sector level. As previously stated the number of variables is reduced so that we only focus on important firm characteristics and agglomeration effects. Not only does this make the tables easier to interpret, it also reduces the number of observations we lose when studying smaller countries and sectors. Generally, the relationships between firm characteristics and productivity remains the same. Conversely, major changes can be observed in the signs and strength of agglomeration externalities. In order to verify that the results are robust sector fixed effects have been included, as in the 'big model' the effect of diversity externalities disappear in the full model. In the appendix one can find the regression output without sector dummies.

$$\ln(TFP_{2001-07}) = \alpha_0 + \beta_1 X_{\ln(emp)} + \beta_2 X_{\ln(turnover)} + \beta_3 X_{\%ENTRE} + \beta_4 X_{\%R\&D} + \beta_5 X_{\%UNI} + \beta_6 X_{\ln(firmage)} + \beta_7 X_{F.Herfindahl} + \beta_8 X_{SpecIndex} + \beta_9 X_{\ln(K.intens)} + \beta_{10} X_{Loc.Comp} + \beta_{11} D_{For.Comp} \qquad (5)$$

TABLE 9 REGRESSION BY COUNTRY & INTERPRETATION COEFFICIENTS (INCLUDING SECTOR DUMMIES)

VARIABLES	**Full** TFP Average 2001-2007	**Austria** TFP Average 2001-2007	**France** TFP Average 2001-2007	**Germany** TFP Average 2001-2007	**Hungary** TFP Average 2001-2007	**Italy** TFP Average 2001-2007	**Spain** TFP Average 2001-2007	**UK** TFP Average 2001-2007
Ln (Employees)	0.128***	0.144	0.0571***	0.101***	0.107	0.148***	0.129***	0.0529**
	(0.00730)	(0.230)	(0.0158)	(0.0281)	(0.0730)	(0.0133)	(0.0126)	(0.0254)
Ln (Turnover)	0.0676***	0.204	0.0662***	0.0500**	0.0809	0.0733***	0.0637***	0.0813***
	(0.00541)	(0.167)	(0.0124)	(0.0196)	(0.0538)	(0.00953)	(0.00846)	(0.0185)
% Executives/Entrepreneurs	0.211***	0.198	0.241***	0.288	0.408	0.159	0.157*	-0.115
	(0.0432)	(0.679)	(0.0714)	(0.249)	(0.550)	(0.112)	(0.0806)	(0.171)
% R&D Employees	0.00262	-0.452	0.210**	-0.0306	0.147	0.0180	-0.0749	0.494**
	(0.0347)	(1.673)	(0.0891)	(0.137)	(0.621)	(0.0579)	(0.0472)	(0.194)
% University Employees	0.305***	1.763	0.179**	-0.0489	0.851**	0.111*	0.295***	0.0902
	(0.0348)	(1.781)	(0.0775)	(0.128)	(0.353)	(0.0615)	(0.0579)	(0.116)
Ln (Firm Age)	0.0989***	0.290	0.0432**	0.114**	-0.127	0.102***	0.183***	0.0536
	(0.00956)	(0.353)	(0.0210)	(0.0474)	(0.116)	(0.0155)	(0.0146)	(0.0327)
Firm Herfindahl	-0.0233	-0.393	-0.170**	-0.192	0.0241	-0.206***	-0.0791**	0.0963
	(0.0244)	(0.897)	(0.0820)	(0.142)	(0.225)	(0.0532)	(0.0307)	(0.179)
Specialisation Index	-0.000328	-0.00879	-0.0158	-0.100**	-0.0354	0.0166***	-0.0118**	0.0385
	(0.00308)	(0.282)	(0.0142)	(0.0507)	(0.0294)	(0.00400)	(0.00516)	(0.0286)
Ln (Capital Intensity)	0.0342***	-0.301	0.0830***	0.0530**	0.104*	0.0529***	0.0573***	0.0884***
	(0.00577)	(0.183)	(0.0146)	(0.0257)	(0.0604)	(0.0112)	(0.00912)	(0.0188)
Local Competition	-0.0421***	0.493	-0.0212	-0.280***	-0.181**	-0.0134	-0.0378***	0.0485
	(0.00652)	(0.741)	(0.0199)	(0.105)	(0.0716)	(0.0122)	(0.00857)	(0.0548)
International Competition	-0.000982	0.183	0.00781	-0.0138	0.0957	-0.0139	-0.0147	-0.0532
	(0.00897)	(0.317)	(0.0200)	(0.0387)	(0.102)	(0.0145)	(0.0139)	(0.0384)
Constant	-1.069***	-1.620	-0.292	2.818	-0.281	-1.176***	-1.297***	-1.042***
	(0.0530)	(2.401)	(0.245)	(1.810)	(0.525)	(0.0946)	(0.0814)	(0.209)
Observations	7,435	51	1,543	541	176	2,261	2,398	465
R-squared	0.373	0.491	0.305	0.281	0.403	0.411	0.438	0.274
F-test	209.7	1.448	31.80	9.652	5.230	74.44	92.47	7.973

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Interpretation: *Coef.*s.d.*	Full	Austria	France	Germany	Hungary	Italy	Spain	UK
% Executives/Entrepreneurs	0.022	*	0.034	*	*	*	0.014	*
% R&D Employment	*	*	0.023	*	*	*	*	0.048
% University Employees	0.041	*	0.024	*	0.133	0.013	0.037	*
Firm Herfindahl	*	*	-0.025	*	*	-0.031	-0.018	*
Specialisation	*	*	*	-0.150	*	0.033	-0.018	*
Local Competition	-0.033	*	*	-0.076	-0.162	*	-0.036	*

** Not Significant*

Table 9 presents the results for the country regressions. The first column gives the results for the complete sample using the 'cleaner' specification. We immediately see that the general results found in the 'big' model do not change noticeably (only the *Firm Herfindahl* is insignificant, however this was also the case using sector dummies in the 'big model'). Once we look at the country specific regressions we start to notice substantial changes. First, the fit of the model differs greatly by country. The R^2 for France, Germany and the UK are significantly lower than those for Italy and Spain (we leave out Austria with only 51 observations). Moreover, the number of significant coefficient differs by country. Again the positive and significant coefficients are marked *green* and negative significant ones *red*. This quickly allows us to see whether the size of the coefficients markedly differs by the countries. More importantly, we immediately see which coefficients have changed signs.

Comparing the full regression with the country ones most firm characteristics tend to have the same sign, yet the size of the coefficients does differ markedly. Firstly, it seems most appropriate to leave out Austria and Hungary from the analysis. The smaller number of observations seems to generate either insignificant results or far too big coefficients (in the case of Hungary). At the country level we notice that in France and the United Kingdom *R&D Employment* has a positive impact on productivity. A 1 s.d. change in *R&D Employment* raises productivity by about 2 and 5 percent respectively. Additionally, *Executives/Entrepreneurs* seems to have a stronger impact on firm productivity in France relative to other countries. Increasing *Executives/Entrepreneurs* by 1 s.d. increases TFP by some 3 percent, whereas in Spain this is only 1 percent.

Some of this research's most exciting findings we see when looking at the agglomeration externalities. There is a lot of variation in the strength of agglomeration forces across countries. Moreover, the variable measuring Marshallian externalities (specialisation) suddenly becomes significant, but has a varying sign. First, examining the *Firm Herfindahl* (i.e. diversity index) it became insignificant in the full regression. However, in France, Germany and Italy the impact of a 1 s.d. reduction in a region's diversity causes productivity to drop by around 3 percent. *Local Competition* only has a negative impact on productivity in Germany and Spain. Increased local competition by 1 s.d. causes productivity to drop by between 3 and 8 percent (excluding Hungary). The *Specialisation Index* gives us even most interesting, or rather peculiar, results. Localisation externalities have become statistically significant in Germany, Italy and Spain. In Italy a 1 s.d. increase in the degree of specialisation *increases* productivity by 3 percent. Conversely, in Germany and Spain more specialised regions are worse off, a 1 s.d. increase in specialisation *reduces* firm productivity by 15 and 5 percent respectively.

Although the empirical evidence regarding the existence of Marshallian externalities is mixed previous studies have identified them. Van der Panne (2004) finds they are important for innovative output in the Netherlands, and Paci and Usai (1999) show both Marshallian and Jacobian externalities work in Italy. Furthermore, Porter (1990) describes Italy's industrial clusters, renowned for their intense specialisation. In the case of Italy our findings exactly corroborate with Paci and Usai with both externalities being present. However, these studies hypothesise that specialisation has a positive impact on productivity. We had no inclination to expect that specialisation can also have a negative effect. This heterogeneity is crucial to take into consideration with policy design. The findings suggest policies aimed at strengthening specialised manufacturing clusters in Italy can be very beneficial, yet implementing the same policy in Germany or Spain would be very costly and counter-productive.

To sum up, firm characteristics associated with high productivity tend to be more homogeneous across countries, on the other hand agglomeration externalities are clearly country specific. For policy design these differences need to be taken into account, otherwise it could cause valuable resources to be wasted on inefficient policies.

Sector analysis

Using the same approach we now examine sector specific variation in the drivers of productivity. Unfortunately, the anonymisation of the survey makes it impossible to know the exact sectors we are dealing with. Therefore, the results will just show how drivers differ across the anonymised sectors, meaning that using the results for policy recommendations is alas not possible. Again we use the 'clean' specifications. In order to prevent spurious correlations we include country fixed effects. Without including country fixed effects some of the coefficients measuring agglomeration economies seem very counter intuitive. For example, in certain sectors diversity externalities seemed to reduce productivity; nothing in the literature discussed this possibility and there are no logical intuitive explanations for this observation. Fortunately, after including the country dummies these peculiar findings disappeared. In the appendix the output without country dummies is presented.

$$\ln(TFP_{2001-07}) = \alpha_0 + \beta_1 X_{\ln(emp)} + \beta_2 X_{\ln(turnover)} + \beta_3 X_{\%ENTRE} + \beta_4 X_{\%R\&D} + \beta_5 X_{\%UNI} \\ + \beta_6 X_{\ln(firmage)} + \beta_7 X_{F.Herfindahl} + \beta_8 X_{SpecIndex} + \beta_9 X_{\ln(K.intens)} + \beta_{10} X_{Loc.Comp} + \beta_{11} D_{For.Comp} \qquad (6)$$

Table 10 presents our findings for the sectoral analysis.

Table 10 Regression By Sector & Interpretation Coefficient (Including Country Dummies)

VARIABLES	Full TFP Average 2001-2007	Sector 1 TFP Average 2001-2007	Sector 2 TFP Average 2001-2007	Sector 3 TFP Average 2001-2007	Sector 4 TFP Average 2001-2007	Sector 5 TFP Average 2001-2007	Sector 6 TFP Average 2001-2007	Sector 7 TFP Average 2001-2007	Sector 8 TFP Average 2001-2007	Sector 9 TFP Average 2001-2007	Sector 10 TFP Average 2001-2007	Sector 11 TFP Average 2001-2007
Ln (Employees)	0.107***	0.0976***	0.121***	0.145***	0.120***	0.0705**	0.114***	0.141***	0.0813***	omitted	0.0826***	0.0987***
	(0.00753)	(0.0150)	(0.0193)	(0.0381)	(0.0189)	(0.0279)	(0.0333)	(0.0367)	(0.0306)		(0.0214)	(0.0193)
Ln (Turnover)	0.0698***	0.0599***	0.0793***	0.0500*	0.0704***	0.0809***	0.0844***	0.0429*	0.0892***		0.0920***	0.0703***
	(0.00543)	(0.0104)	(0.0140)	(0.0293)	(0.0139)	(0.0179)	(0.0243)	(0.0254)	(0.0202)		(0.0159)	(0.0143)
% Executives/Entrepreneurs	0.194***	0.189*	0.202	-0.0703	0.0649	0.0217	-0.0852	0.226	0.671***		0.282**	0.181*
	(0.0460)	(0.102)	(0.142)	(0.206)	(0.120)	(0.176)	(0.181)	(0.312)	(0.248)		(0.113)	(0.106)
% R&D Employees	0.0542	-0.0435	0.0633	0.164	-0.0372	-0.0533	0.0745	0.144	-0.164		0.0330	-0.0639
	(0.0347)	(0.0652)	(0.103)	(0.208)	(0.0831)	(0.134)	(0.169)	(0.174)	(0.170)		(0.0965)	(0.0774)
% University Employees	0.258***	0.0231	0.514***	0.210	0.0284	-0.0626	0.314**	0.135	0.0986		0.292***	0.144*
	(0.0348)	(0.0875)	(0.124)	(0.228)	(0.0707)	(0.152)	(0.143)	(0.189)	(0.188)		(0.0898)	(0.0732)
Ln (Firm Age)	0.109***	0.122***	0.120***	0.217***	0.0737***	0.0732***	0.214***	-0.00354	0.264***		0.0666**	0.0933***
	(0.00958)	(0.0172)	(0.0283)	(0.0478)	(0.0249)	(0.0283)	(0.0464)	(0.0485)	(0.0404)		(0.0284)	(0.0232)
Firm Herfindahl	-0.126***	-0.232***	-0.0898	-0.358***	-0.0563	0.108	0.00791	-0.0302	-0.0251		-0.153*	-0.198***
	(0.0234)	(0.0691)	(0.0945)	(0.104)	(0.0710)	(0.0696)	(0.0948)	(0.0873)	(0.0795)		(0.0928)	(0.0602)
Specialisation Index	-0.00133	0.0356**	-0.0264**	-0.0176	0.00585	-0.0332***	0.00733	0.0135	-0.00933		-0.0438*	0.0253
	(0.00284)	(0.0172)	(0.0113)	(0.0212)	(0.0184)	(0.0118)	(0.0247)	(0.0185)	(0.00747)		(0.0229)	(0.0199)
Ln (Capital Intensity)	0.0566***	0.0272**	0.0375**	0.0770**	0.0951***	0.0387*	0.0730**	0.101***	-0.0345		0.0865***	0.0656***
	(0.00615)	(0.0120)	(0.0157)	(0.0350)	(0.0149)	(0.0210)	(0.0314)	(0.0313)	(0.0279)		(0.0178)	(0.0159)
Local Competition	-0.0464***	-0.0206	-0.0355*	-0.0407	-0.0567***	-0.0464**	-0.0204	-0.0113	-0.00717		-0.0994***	-0.0158
	(0.00638)	(0.0193)	(0.0187)	(0.0321)	(0.0176)	(0.0186)	(0.0292)	(0.0340)	(0.0233)		(0.0269)	(0.0189)
International Competition	0.0222**	0.0268	-0.0285	0.0626	-0.0676***	0.00374	0.0589	-0.0201	-0.0395		-0.0398	0.0387*
	(0.00890)	(0.0164)	(0.0293)	(0.0429)	(0.0227)	(0.0283)	(0.0476)	(0.0534)	(0.0339)		(0.0267)	(0.0217)
Constant	-0.637***	-1.649***	-1.296***	-1.134***	-0.556***	-1.228***	-0.954***	-0.592**	-0.728***		-0.372**	-1.044***
	(0.0532)	(0.155)	(0.143)	(0.241)	(0.144)	(0.362)	(0.287)	(0.246)	(0.233)		(0.163)	(0.153)
Observations	7,435	1,729	797	493	910	511	323	244	334		1,169	913
R-squared	0.375	0.323	0.414	0.329	0.475	0.398	0.475	0.479	0.436		0.406	0.476
F-test	262.3	47.98	32.39	13.68	47.44	19.17	16.25	12.21	14.38		46.20	47.88

Standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Interpretation: *Coef.*s.d.*	Full	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Sector 6	Sector 7	Sector 8	Sector 9	Sector 10	Sector 11
% Executives/Entrepreneurs	0.020	0.015	*	*	*	*	*	*	0.044	ommited	0.037	0.019
% R&D Employment	*	*	*	*	*	*	*	*	*		*	*
% University Employees	0.035	*	0.059	*	*	*	0.054	*	*		0.048	0.021
Firm Herfindahl	-0.024	-0.028	*	-0.077	*	*	*	*	*		-0.024	-0.034
Specialisation	*	0.020	-0.036	*	*	-0.045	*	*	*		-0.026	*
Local Competition	-0.036	*	-0.029	*	-0.041	-0.043	*	*	*		-0.056	*

** Not Significant*

Similarly to the country analysis most coefficients relating to firm characteristics are significant, except for *R&D Employment*. The general picture still tells us that older and larger firms with a high turnover have the highest factor productivity. Nonetheless, there are slight differences across sectors. In certain sectors an increase in *University Employees* by 1 s.d. only contributes 2 percent to productivity, whereas in other sectors this increase is nearly 6 percent. Higher *Capital Intensity* is associated with an increase in productivity of between 2 and 10 percent. The results for the full sample suggest that *International Competition* increases productivity by about 2 percent. However, inspecting the underlying sectors we notice only sector 4 to be *negatively* affected by *International Competition*, with productivity falling by nearly 7 percent. The results suggest that this sector could benefit from some form of protection, yet scholars like Krugman would strongly advise against imposing such measures (Krugman, 1993).

Turning to the agglomeration variables the results are most interesting. As we have seen in the case of Spain, Marshallian externalities can have a negative impact on productivity. For sectors 2, 5 and 10 the *Specialisation Index* indicates that an increase in specialisation by 1 s.d. decreases productivity by between 2 and 5 percent. Only in sector 1 does increasing the degree of specialisation increases productivity (by 2 percent). Without including country dummies our measure for diversity, the *Firm Herfindahl* index, showed very peculiar results. Fortunately, after allowing for varying intercepts for different countries the results corresponded again with our theoretical understanding of Jacobian externalities. In sector 1, 3, 10 and 11 a one s.d. decrease in diversity causes productivity to decrease by between 2 and 8 percentage. This suggests that firms belonging to sector 3 benefit far more from locating in a diverse environment (i.e. productivity increase by nearly 8 percent) than firm belonging to different sectors. Similarly to Italy, sector 1 is a special case. In this sector both Jacobian and Marshallian externalities are active. Decreasing diversity by 1 s.d. reduces productivity by nearly 3 percent, whilst increasing specialisation by 1 s.d. causes productivity to rise by 2 percent. Finally, *Localised Competition* consistently has a negative effect on productivity, with a 1 s.d. change in competition being associated with a decrease in productivity of between 3 and 6 percent.

To sum up, the analysis shows that, similar to the country analysis, drivers of productivity differ by sector. In order to improve the efficiency of policy design it is crucial to take account of these differences. For particular sectors more exposure to international competition can increase productivity, whereas, in other sectors this might be very disruptive. Furthermore, in certain sectors it is important to stimulate regional specialisation, whilst other sector prefer diversity. One can think of policy initiatives that encourage business in sectors that thrive under specialisation to co-locate regionally, while creating a climate of diversity when those circumstances increase the likelihood of businesses to flourish.

Generally, the results from both the country and sectoral analysis show that diligence is needed when designing policies that promote firm productivity. At the country and sectoral level the effects of agglomeration externalities on productivity tend to differ. Homogeneous policy aimed at improving productivity would be fruitful if we only look at firm characteristics. Once we include the geographical dimension into the analysis it becomes clear that a more heterogeneous approach is required.

Biases and performance models

It is important to once more address the effect of oversampling larger firms in the sample. The models seem to perform rather well and provide evidence that agglomeration economies are beneficial for firm productivity. Comparing the results to the theories we have studied before we have not discovered any unusual coefficients that cannot be explained by existing literature. Furthermore, the size of the coefficients are reasonably homogeneous across countries and sectors. Only in countries and sectors with fewer observations are the results characterised by more outliers. For instance, from the country analysis it seems that some of the findings for Hungary are overblown relative to the other countries (e.g. a 1 s.d. change in *University Employees* and *Local Competition* results into an increase in productivity by 13 and 16 percent respectively). Generally, the models perform far better under the specifications with more observations (e.g. France, Italy, Spain, Sector 1 and Sector 4).

Total factor productivity growth analysis

So far we have obtained very interesting findings when studying the absolute level of TFP. However, many studies in the theoretical framework focussed on innovative firms. Until now we have found little evidence for the claim that innovative activity is associated with higher productivity. There is a possibility that the choice of our dependent variable, *absolute* total factor productivity, is affecting our results. Using this dependent variable we have identified larger and older companies to be most productive. However, Feldman (1999) explains that small and young innovative companies are known to be most innovative. Hence, in this section we will run the same models using productivity growth as our dependent variable. We calculated a rather crude measure of productivity growth by taking the difference of the natural logarithm of *average TFP 2008-2009* and subtracting the *average TFP 2001-2007* from it. The new model will illustrate which companies were able to experience productivity growth despite going through the worst financial crisis in nearly a century.

The following equation shows the specification for TFP change, in the model we again check the robustness using various country and sector dummies.

$$\begin{aligned} \ln(TFP_{2008-09} - TFP_{2001-07}) &= \alpha_0 + \beta_1 X_{\ln(emp)} + \beta_2 X_{\ln(turnover)} + \beta_3 X_{\%ENTRE} + \beta_4 X_{\%R\&D} + \beta_5 X_{\%UNI} \\ &+ \beta_6 X_{\ln(firmage)} + \beta_7 X_{F.Herfindahl} + \beta_8 X_{SpecIndex} + \beta_9 X_{\ln(K.intens)} + \beta_{10} X_{Loc.Comp} + \beta_{11} D_{For.Comp} + \beta_{11} X_{\%Invest.R\&D} \end{aligned} \quad (3)$$

The results of this model are presented in table 11 and 12.

TABLE 11 TFP GROWTH ANALYSIS

VARIABLES	Full TFP Growth	Country Dummies TFP Growth	Sector Dummies TFP Growth	Country & Sector Dummies TFP Growth	Sectors in Country Dummies TFP Growth
Ln (Employees)	-0.0667***	-0.0550***	-0.0640***	-0.0523***	-0.0529***
	(0.00765)	(0.00783)	(0.00762)	(0.00781)	(0.00777)
Ln (Turnover)	0.0434***	0.0387***	0.0410***	0.0361***	0.0366***
	(0.00567)	(0.00565)	(0.00565)	(0.00564)	(0.00560)
% Executives	0.246***	0.171***	0.251***	0.180***	0.152***
	(0.0451)	(0.0479)	(0.0449)	(0.0478)	(0.0480)
% R&D Employees	0.0110	-0.00206	0.0147	-0.000203	-0.0163
	(0.0377)	(0.0374)	(0.0376)	(0.0372)	(0.0370)
% University Employees	0.126***	0.105***	0.138***	0.115***	0.120***
	(0.0364)	(0.0364)	(0.0364)	(0.0365)	(0.0363)
Ln (Firm age)	-0.100***	-0.106***	-0.0996***	-0.106***	-0.107***
	(0.00994)	(0.00987)	(0.00988)	(0.00982)	(0.00974)
Firm Herfindahl	0.0892***	0.0450*	0.0681***	0.0221	0.0424
	(0.0232)	(0.0239)	(0.0251)	(0.0259)	(0.0265)
Specialisation Index	-0.00359	-0.00586**	-0.00309	-0.00590*	-0.00769**
	(0.00290)	(0.00290)	(0.00314)	(0.00315)	(0.00333)
Ln (Capital Intensity)	-0.0344***	-0.0182***	-0.0365***	-0.0218***	-0.0205***
	(0.00602)	(0.00642)	(0.00602)	(0.00643)	(0.00639)
Local Competition	-0.00457	-0.00875	0.000891	-0.00252	-0.000919
	(0.00637)	(0.00651)	(0.00669)	(0.00684)	(0.00697)
International Competition	-0.0226**	-0.0247***	-0.0102	-0.0129	-0.0131
	(0.00912)	(0.00915)	(0.00925)	(0.00929)	(0.00924)
% Investment R&D	0.0681	0.109*	0.102	0.135**	0.153**
	(0.0659)	(0.0655)	(0.0657)	(0.0653)	(0.0647)
Constant	0.498***	0.492***	0.460***	0.592***	0.449
	(0.0490)	(0.0931)	(0.130)	(0.151)	(0.384)
Observations	7,276	7,276	7,276	7,276	7,276
R-squared	0.039	0.063	0.053	0.075	0.105
F-test	.	.	.	.	.

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TABLE 9 INTERPRETATION COEFFICIENTS

Interpretation: Coef.*s.d.	**Full**	**Country Dummies**	**Sector Dummies**	**Country & Sector Dummies**	**Sectors in Country Dummies**
% Executives/Entrepreneurs	0.0252	0.0175	0.0257	0.0184	0.0156
% R&D Employment	*	*	*	*	*
% University Employees	0.0167	0.0139	0.0183	0.0153	0.0159
Firm Herfindahl	0.0173	0.0087	0.0132	*	*
Specialisation	*	-0.0092	*	-0.0093	-0.0121
Local Competition	*	*	*	*	*
% Investment R&D	*	0.0079	*	0.0098	0.0111

* *Not significant*

Contrary to our previous models the results confirm our hypothesis (and Feldman's observations) that young and innovative companies are able to increase their productivity the fastest. The signs on the variables *Employees, Firm age* and *Capital Intensity* are negative, implying that productivity growth is faster in small young companies. In particular, a 1 percent increase in these variables productivity growth decreases by 5, 10 and 2 percent respectively. Furthermore, firms that experience higher productivity growth tend to have a higher *Turnover*.

Examining the relationship between employee types and productivity growth we still do not find evidence that more *R&D Employees* is beneficial. Increasing the percentage of *Executives/Entrepreneurs* and *University Employees* by 1 s.d. increases productivity growth by about 2 percent. The newly included variable *Investment R&D* is interesting as it proves that putting more resources into research or innovative activity does increase productivity growth by about 1 percent for a 1 s.d. increase. Interestingly, this relationship only appears after including fixed effects indicating that it was initially hidden beneath country and sector specific variation. The significance of R&D investment shows that R&D employment might be an in appropriate measure for studying the innovativeness of firms. Furthermore, the small impact can be explained by going back to the Audretsch argument. By locating close to innovative activity small firms that do not invest in R&D can benefit from other firms' research activities through knowledge spillovers (Audretsch, 1998).

Turning to the agglomeration externalities the findings are somewhat peculiar. In the models with less rigorous robustness tests the results suggest less diversity is associated with higher productivity growth. This result however becomes insignificant once we include country and sector dummies. On the other hand, the coefficients for the *Specialisation Index* indicate that by reducing specialisation by 1 s.d. productivity growth increases by about 1 percent. In the productivity growth model we never find significant coefficients for the *Local Competition* variable. The specifications with fewer dummy variables included suggest that *International Competition* also reduces productivity growth by some 2 percent. Contrary to Porter and other scholars competition does not seem to be a crucial factor stimulating firms to become more productive.

By including this part in our analysis we have gained a more complete picture of the factors associated with high productivity. Changing the focus from *absolute* productivity to productivity *growth* results in very different findings! Policy aimed at promoting those firms that are currently productive to remain so in the future requires completely different targets than stimulating productivity growth among new and small start-ups. This more comprehensive overview gives us a better understanding of how to achieve these differing goals.

Conclusion

Arriving at the end of this study we can state that we have substantially increased our understanding of the workings of agglomeration forces and firm characteristics upon productivity. Using the EFIGE dataset it was possible to study the theoretical concepts empirically and come to our main result. Namely, that even though successful firms often share similar characteristics, once we incorporate geographical factors into the analysis we see that firms operate in less homogeneous environments than we would like to imagine. In particular, by considering countries and sectors separately we observe that drivers of productivity differ markedly. Let us therefore answer the research questions formulated in the introduction.

- Which agglomeration economies are associated with high productivity? Do firms located in agglomerations perform better than those located elsewhere? How do country and sector differences affect the results?

We find positive evidence that agglomeration externalities exist. Over the entire sample the results suggest that Jacobian externalities (*Firm Herfindahl*) are more important drivers of firm productivity than Marshallian externalities (*Specialisation Index*). However, shifting the analysis to individual countries and sectors we observe that in particular cases the effects of specialisation externalities are also beneficial for productivity, with one example being Italy. Additionally, the factor measuring *Local Competition* consistently had a negative impact upon productivity, mostly likely reflecting its increasing effect on factor prices. Conversely, when studying productivity *growth* agglomeration forces tend to behave very differently. The results suggest that firms located in *more* specialised and diverse regions experience *lower* productivity growth. Also, local competition no longer seems to have no discernible impact upon productivity growth.

- What firm characteristics are associated with high productivity? What firm characteristics are associated with high productivity growth?

Studying *absolute* productivity we find that bigger firms are more productive. Older firms with high turnover and many employees seem to have the highest productivity. Unfortunately, this study cannot explain exactly what mechanism makes the firms possessing these characteristics more productive. Either, self-selection causes the most productive firms to survive and grow large; or the economies of scale and learning effects associated with size and age makes these firms more productive. Moreover, we identified more precise firm characteristics that are associated with higher productivity: *University Employees, Executives/Entrepreneurs*, *Bonuses*, *Foreign Group*, *Quality Certificates*. Conversely, firms run by *Family CEO*s are on average less productive. The level of productivity also seems to depend on the industry a firm belongs to, *High-Tech* firms are on average most productive, followed by *Economies of Scale* and *Specialised* industries. Next, what makes firm competitiveness *grow*? The study of productivity growth showed that in general young, small firms that invest in R&D experience the highest productivity growth, simultaneously making them more competitive. Interestingly, both in the analysis of absolute productivity and productivity growth we found that *Executives/Entrepreneurs* and *University Employees* improve productivity.

These findings just discussed can have useful applications. At the firm-level the results can be used to improve decision making (e.g. think of a location decision or considering the benefits of applying for quality certificates, etc.). Moreover, for policy-makers the results can be highly valuable. For instance, they can be used to review old and new policy initiatives and examine whether they are targeted correctly. Especially, in times of crisis and economic downturn it cannot be accepted that public money is invested into projects without a good understanding of the underlying economic principles. Studies such as this one can contribute to the reduction of wastefulness since they enable us to identify ill-targeted policy initiatives.

One peculiar observation is that we do not find compelling evidence for internationally active (e.g. *Exporting*) and innovative firms to be more productive. Altomonte et al. (2012) found abundant evidence that internationally active firms are more productive. Descriptive statistics clearly show that more international activities are associated with higher productivity, yet in our regressions were not able to reproduce this. Secondly, why do we find so little evidence for the effects of R&D upon productivity? One possible explanation lies in the dependent variable. We use the average TFP for the years 2001-2007 and the survey questions were predominately based on 2008. Therefore, if in 2008 a firm states they are involved with R&D, the effects of these activities cannot be observed in the productivity levels prior to when they invested in R&D. It can be imagined that certain firms also invested in R&D before 2008, but in the process of averaging of the data over the period 2001-2007 this relationship might be lost. Since studies reviewed in the theoretical framework provide a vast amount of evidence that investment in R&D increase innovative output, it is unlikely that we find there is no effect upon productivity. A second explanation for only finding minimal evidence for R&D's effect upon productivity could be related to agglomeration and knowledge spillovers. Audretsch (1998) explains that knowledge spillovers enable (small) firms with limited resources to invest in R&D to benefit from their proximity to firms that do have the capacity and funds to invest in R&D. Since knowledge spillovers occur more in spatial concentrations of economic activity it could be the case that this effect is obscured in our analysis. Possibly this explains why we do not find evidence that *R&D Employment* increases firm productivity; and only weak evidence for *R&D Investment*'s positive effect upon productivity growth.

To sum up, the main findings of this research show that drivers of productivity correspond rather homogenously to *firm characteristics* irrespective of the country or sector, however once we examine the geographical dimension and analyse *agglomeration externalities* things start to change. In the past it was not possible to study the effects of agglomeration in different countries as there existed no appropriate standardised cross-country datasets. However, this research shows countries have different economic environments and these differences should be taken into account. Unfortunately, the research does not provide an answer to the question *why* there is such heterogeneity between the impact of agglomeration forces on productivity across countries and sectors. Possibly, future research can explore this issue and find out more about the actual mechanisms that drive productivity growth across countries and sectors. Hopefully, the results of this study can contribute in the discussion vis-à-vis productivity and improve the effectiveness of new policy initiatives that can improve Europe's competitive position in the world economy.

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Appendix

The following tables provide the country and sector analysis without including robustness dummies. We clearly see there are some peculiarities when we leave out country/sector fixed effects.

TABLE 103 REGRESSION BY COUNTRY & INTERPRETATION COEFFICIENTS (NO SECTOR DUMMIES)

VARIABLES	**Full** TFP Average 2001-2007	**Austria** TFP Average 2001-2007	**France** TFP Average 2001-2007	**Germany** TFP Average 2001-2007	**Hungary** TFP Average 2001-2007	**Italy** TFP Average 2001-2007	**Spain** TFP Average 2001-2007	**UK** TFP Average 2001-2007
Ln (Employees)	0.127***	-0.0573	0.0622***	0.110***	0.0612	0.151***	0.129***	0.0604**
	(0.00743)	(0.206)	(0.0160)	(0.0295)	(0.0746)	(0.0135)	(0.0130)	(0.0250)
Ln (Turnover)	0.0663***	0.275*	0.0602***	0.0409**	0.0992*	0.0722***	0.0652***	0.0764***
	(0.00550)	(0.151)	(0.0124)	(0.0206)	(0.0551)	(0.00966)	(0.00873)	(0.0184)
% Executives	0.235***	0.362	0.282***	0.271	0.00109	0.163	0.201**	-0.0384
	(0.0440)	(0.541)	(0.0717)	(0.261)	(0.572)	(0.114)	(0.0830)	(0.169)
% R&D Employees	0.0199	-0.602	0.251***	0.218	0.459	0.0309	-0.0681	0.554***
	(0.0353)	(1.535)	(0.0891)	(0.139)	(0.642)	(0.0589)	(0.0487)	(0.194)
% University Employees	0.328***	2.138	0.168**	0.0582	1.189***	0.107*	0.308***	0.158
	(0.0352)	(1.580)	(0.0782)	(0.131)	(0.358)	(0.0620)	(0.0590)	(0.116)
Ln (Firm age)	0.0966***	0.224	0.0486**	0.0950*	-0.0497	0.0949***	0.175***	0.0529
	(0.00974)	(0.336)	(0.0212)	(0.0486)	(0.119)	(0.0158)	(0.0151)	(0.0325)
Firm Herfindahl	-0.0616***	0.0551	-0.152**	-0.434***	0.0596	-0.176***	-0.0662**	-0.180
	(0.0229)	(0.538)	(0.0593)	(0.127)	(0.199)	(0.0480)	(0.0299)	(0.134)
Specialisation Index	-0.00272	0.0298	-0.00301	-0.00106	-0.0427	0.0169***	-0.0331***	0.0456***
	(0.00288)	(0.198)	(0.0122)	(0.0138)	(0.0290)	(0.00362)	(0.00479)	(0.0163)
Ln (Capital Intensity)	0.0316***	-0.267	0.0857***	0.0365	0.0633	0.0529***	0.0470***	0.0903***
	(0.00584)	(0.174)	(0.0147)	(0.0263)	(0.0604)	(0.0113)	(0.00932)	(0.0187)
Local Competition	-0.0539***	0.0543	-0.00622	-0.311***	-0.190***	-0.0380***	-0.0565***	0.00828
	(0.00629)	(0.339)	(0.0183)	(0.0774)	(0.0689)	(0.0115)	(0.00807)	(0.0436)
International Competition	0.0240***	0.268	0.0301	0.00470	0.193*	0.00653	0.0141	-0.0332
	(0.00896)	(0.284)	(0.0197)	(0.0397)	(0.102)	(0.0145)	(0.0139)	(0.0378)
Constant	-1.058***	-0.319	-0.972***	-0.602**	-0.194	-1.296***	-1.286***	-0.971***
	(0.0477)	(1.311)	(0.106)	(0.241)	(0.449)	(0.0845)	(0.0750)	(0.176)
Observations	7,435	51	1,543	541	176	2,261	2,398	465
R-squared	0.347	0.334	0.280	0.181	0.289	0.384	0.394	0.240
F-test	.	.	.	.	.	.	.	.

Interpretation: *Coef.*s.d.*	Full	Austria	France	Germany	Hungary	Italy	Spain	UK
% Executives/Entrepreneurs	0.0243	*	0.0399	*	*	*	0.0174	*
% University Employees	0.0439	*	0.0226	*	0.1862	0.0129	0.0440	*
% R&D Employment	*	*	0.0273	*	*	*	*	0.0535
Firm Herfindahl	-0.0119	*	-0.0225	-0.0687	*	-0.0263	-0.0153	*
Specialisation	*	*	*	*	*	0.0338	-0.0503	0.0504
Local Competition	-0.0421	*	*	-0.0847	-0.1707	-0.0243	-0.0544	*

* *Not significant*

Table 114 Regression By Sector & Interpretation Coefficient (No Country Dummies)

VARIABLES	Full TFP Average 2001-2007	Sector 1 TFP Average 2001-2007	Sector 2 TFP Average 2001-2007	Sector 3 TFP Average 2001-2007	Sector 4 TFP Average 2001-2007	Sector 5 TFP Average 2001-2007	Sector 6 TFP Average 2001-2007	Sector 7 TFP Average 2001-2007	Sector 8 TFP Average 2001-2007	Sector 9 TFP Average 2001-2007	Sector 10 TFP Average 2001-2007	Sector 11 TFP Average 2001-2007
Ln (Employees)	0.127***	0.116***	0.125***	0.164***	0.152***	0.108***	0.111***	0.137***	0.0490	Omitted	0.130***	0.118***
	(0.00743)	(0.0149)	(0.0185)	(0.0377)	(0.0188)	(0.0272)	(0.0335)	(0.0367)	(0.0313)	Too few	(0.0213)	(0.0203)
Ln (Turnover)	0.0663***	0.0483***	0.0779***	0.0496*	0.0718***	0.0675***	0.0853***	0.0427*	0.100***	obs	0.0869***	0.0672***
	(0.00550)	(0.0108)	(0.0138)	(0.0293)	(0.0145)	(0.0182)	(0.0249)	(0.0254)	(0.0209)		(0.0162)	(0.0154)
% Executives	0.235***	0.0833	0.176	0.000390	0.250**	0.264	-0.0935	-0.146	0.807***		0.323***	0.161
	(0.0440)	(0.0991)	(0.137)	(0.192)	(0.120)	(0.169)	(0.167)	(0.283)	(0.254)		(0.106)	(0.103)
% R&D Employees	0.0199	-0.0582	0.0522	0.0591	-0.0563	-0.111	-0.00117	0.140	-0.101		0.0712	-0.0882
	(0.0353)	(0.0678)	(0.102)	(0.209)	(0.0873)	(0.139)	(0.171)	(0.179)	(0.178)		(0.0975)	(0.0835)
% University Employees	0.328***	0.189**	0.495***	0.357	0.0649	-0.0350	0.392***	0.192	0.202		0.365***	0.303***
	(0.0352)	(0.0894)	(0.122)	(0.226)	(0.0736)	(0.152)	(0.142)	(0.192)	(0.191)		(0.0924)	(0.0766)
Ln (Firm age)	0.0966***	0.104***	0.119***	0.193***	0.0686***	0.0649**	0.199***	-0.00843	0.268***		0.0474	0.0724***
	(0.00974)	(0.0178)	(0.0280)	(0.0472)	(0.0261)	(0.0291)	(0.0472)	(0.0502)	(0.0423)		(0.0293)	(0.0249)
Firm Herfindahl	-0.0616***	-0.0975	-0.101	-0.278***	0.113*	0.120*	0.132	-0.00968	0.0623		0.0303	-0.0680
	(0.0229)	(0.0674)	(0.0908)	(0.0988)	(0.0678)	(0.0644)	(0.0909)	(0.0885)	(0.0808)		(0.0844)	(0.0612)
Specialisation Index	-0.00272	0.0230	-0.0282***	-0.00582	-0.0273	-0.0269**	0.000948	0.0293*	-0.0101		-0.0685***	0.0238
	(0.00288)	(0.0168)	(0.0101)	(0.0208)	(0.0180)	(0.0112)	(0.0231)	(0.0174)	(0.00695)		(0.0235)	(0.0199)
Ln (Capital Intensity)	0.0316***	0.0154	0.0418***	0.0150	0.0557***	0.0246	0.0708**	0.0854***	-0.0547**		0.0456***	0.0110
	(0.00584)	(0.0115)	(0.0146)	(0.0310)	(0.0149)	(0.0205)	(0.0305)	(0.0298)	(0.0260)		(0.0175)	(0.0156)
Local Competition	-0.0539***	-0.0396**	-0.0329*	-0.0227	-0.0716***	-0.0342*	-0.0515*	-0.00732	-0.0405**		-0.171***	-0.0131
	(0.00629)	(0.0189)	(0.0175)	(0.0311)	(0.0181)	(0.0185)	(0.0279)	(0.0341)	(0.0200)		(0.0259)	(0.0179)
International Competition	0.0240***	0.0233	-0.0251	0.0761*	-0.0543**	0.0130	0.0553	-0.00734	-0.0368		-0.0469*	0.0390*
	(0.00896)	(0.0167)	(0.0290)	(0.0422)	(0.0235)	(0.0288)	(0.0483)	(0.0548)	(0.0348)		(0.0271)	(0.0231)
Constant	-1.058***	-0.910***	-1.329***	-1.332***	-1.102***	-0.954***	-1.553***	-1.053***	-1.005***		-0.771***	-0.897***
	(0.0477)	(0.0982)	(0.125)	(0.229)	(0.127)	(0.172)	(0.255)	(0.229)	(0.208)		(0.149)	(0.132)
Observations	7,435	1,729	797	493	910	511	323	244	334		1,169	913
R-squared	0.347	0.258	0.410	0.303	0.410	0.338	0.435	0.425	0.361		0.357	0.383
F-test	.	.	.	.	.	.	.	.	.		.	.

Interpretation: Coef.*s.d.	Full	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Sector 6	Sector 7	Sector 8	Sector 9	Sector 10	Sector 11
% Executives/Entrepreneurs	0.0243	*	*	*	0.0251	*	*	*	0.0529	omitted	0.0428	*
% University Employees	0.0439	0.0175	0.0565	*	*	*	0.0678	*	*	*	0.0603	0.0435
% R&D Employment	*	*	*	*	*	*	*	*	*	*	*	*
Firm Herfindahl	-0.0119	*	*	-0.0597	0.0202	0.0269	*	*	*	*	*	*
Specialisation	*	*	-0.0383	*	*	-0.0368	*	0.0458	*	*	-0.0400	*
Local Competition	-0.0421	-0.0203	-0.0270	*	-0.0519	-0.0316	-0.0531	*	-0.0435	*	-0.0968	*

** Not significant*