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[1] In the Description of Work the title of this deliverable is "The dynamic effects of GIN creation through offshoring on long-run performance of an innovation in EU MNCs: theoretical framework supported by econometric and multivariate analysis".

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Executive summary

It is a widespread concern that the increasing involvement of EU firms into GINs may erode the knowledge base of the EU economy (the so-called ‘hollowing-out’) and cause long-term negative effects on competitiveness and employment. But economic research have highlighted that internationalisation of R&D and innovation can also have on important positive impact in terms of reverse technology transfer, improved market access and higher efficiency which would in turn boost competitiveness and growth of the EU economy.

This WP aimed at addressing these long-run effects of the offshoring of innovation for the EU economy. To this end, research has been carried out both at the theoretical and empirical level. The latter made use of both case studies and econometric methods at the level of the firm and, in order to achieve a more comprehensive understanding of the aggregate effects of the offshoring of innovation in the EU, we also carried out an econometric investigation at the sectoral and regional level. Overall, results from rigorous economic analyses do not support the pessimistic view. Our different perspectives, methodologies and unit of analyses suggest that the involvement of EU firms, regions and sectors in R&D and innovation activities abroad does not lead to significant decrease in R&D, nor productivity, profitability and employment at home. On the contrary, we find that EU regions which are home to MNC engaging in R&D activities abroad, experience a higher productivity growth, thus a better long run prospective growth, than less outward oriented regions. In details, our results can be summarized as follows.

1. As far as theory is concerned, we built a model of outsourcing, innovation networks and growth which addresses the complex issue of the conditional success of project net- works focusing on a special reason why innovation networks arise, namely to serve the needs of fragmented production. From this angle, causation goes from the decision to outsource production to the emergence of innovation networks, which allows us to study the conditions under which the static gains driving the outsourcing choice may also be associated with dynamic gains due to faster innovation and growth. In so doing, a dynamic model in which fragmented production (“outsourcing”) and complementary innovations (“innovation networks”) may arise simultaneously due to gains from specialization. It is shown that complementary innovations, made possible through outsourcing decisions, are more likely to foster growth in Schumpeterian Mark I sectors, while vertical integration does so in Schumpeterian Mark II sectors.

2. Based on the case studies carried out for WP5 on 18 EU-based MNEs in ICT, automotive and agro-food industries, we assessed whether offshored R&D complement or substitute R&D at home. We gather that in the case of the ICT industry both substitutability and complementarity between R&D in North and South countries occur. The strategic R&D that requires specialised know how and high investments are centralised, mainly at HQ locations, in other European locations outside the HQ and in the US. The applied research and application, and engineering are dispersed and are located near their important markets. In the case of automotive and agro-food industries we observe a greater degree of substitutability rather than complementarity, but still substitution and relocation of R&D from Europe to other markets is rather limited. Therefore, the case study evidence supports the hypothesis that the off-shoring of R&D should not lead to ‘hollowing-out’ EU knowledge base and causing reduction in employment, but rather can concur with other factors in leading to long term growth.

3. Based on an econometric analysis on 365 firms from US, EU and Japan we analysed the relationship between the extent and geographic spread of innovative activities abroad and the market value of those firms. We measured the extent of offshored innovative activities by means of the number of patents granted to foreign affiliates of the sample companies and the spread of such activities using the number of countries where a firm has been granted such patents. Our measure of firm market value is the Tobin Q. Our results are consistent with the idea that better performing firms are more likely to offshore innovation, but this does not seem to affect significantly their profitability. In other words, R&D offshoring does not cause any significant hollowing-out of MNCs knowledge base and profit potential

4. The previous results are based on a relatively small number of large firms (although accounting for a large share of R&D in the EU and elsewhere), so they may fail to provide evidence on the effects at the more aggregate level. Thus, given the relevance of regional policy within the EU, we carried out an econometric analysis at the NUTS2 level. We believe that at this level of analysis we can gather not only the benefits or costs accruing to the firms involved in R&D offshoring, but also on other firms, such as their suppliers and competitors, which could benefit from the (positive or negative) externality. To this end we collected information on the number of cross-border investments (both within and outside Europe) of MNCs based in each of the NUTS2 regions and those from foreign MNC incoming in the region. We then related this measures of inward and outward FDIs to the productivity growth of each region, controlling for a number of country and regional characteristics. Our results suggest that offshoring regions experiment higher productivity growth, although this positive effect fades down when the extent of offshoring is too large. Conversely, incoming MNCs contribute to boost a region's productivity, but only when the number of investments is large enough. Exploiting the information on the type of activity carried out by MNCs abroad, we were able to measure the extent of R&D offshoring by EU MNCs in each NUTS 2 region and find this is positively and significantly associated with regional productivity growth

5. Using novel and comparable data for nine EU15 members over the last decade for 20 industries, which span both the manufacturing and the services sector, we have estimated the effect of service offshoring in general, and offshoring of R&D in particular, on employment. Following previous works, we measure service offshoring as the share of imported private services in the industry's total purchases of intermediate inputs. The results show that the effects are very small and, if anything, weakly positive. The aggregate results are almost entirely driven by offshoring of business services, the largest category in Europe; financial, computer, and R&D service offshoring have instead negligible impacts on the employment level. Finally, we do not find negative effects on any groups of workers; rather, our results suggest imported services to complement with domestic workers with higher skills. The analysis also reveals that service offshoring contributes to making labor demand more elastic, but the economic magnitude of the effect is found to be small also in this case. However, results seems somewhat differ across countries. In countries with weak labour market regulations, labor demand may be adjusted more flexibly by firms, and the effect of service offshoring may end up being larger as a result. Consistent with this argument, we find that service offshoring raises labor demand elasticity only in countries with weak regulations. Using the available information on workers' skills, we also find that in these countries the effect is almost entirely borne by unskilled workers.

1. INTRODUCTION[2]

Research and Development (R&D), together with other core business activities, is usually centralized at the firms’ headquarters in the home country (Patel and Pavitt, 1991; Narula, 2002; Belderbos, Leten, and Suzuki, 2010), but in the last decades research has documented an increase in the internationaliazion of R&D and inventive activity (Guellec and van Pottelsberghe de la Potterie, 2001; Picci, 2010), which was at first mainly motivated by the need to better exploit existing home-based advantages (i.e. by adapting existing products to foreign markets needs), while more recently the need to source complementary assets, talents and competences abroad also became an important motive (Cantwell, 1995; Kuemmerle, 1999; Patel and Vega, 1999; von Zedtwitz and Gassmann, 2002; Le Bas and Sierra, 2002; Narula and Zanfei, 2005; Manning, Massini, and Lewin, 2008; Dunning and Lundan, 2009; Ambos and Ambos, 2011). This offshoring of R&D activities3 is part of the broader emerging phenomenon of Global Innovation Networks (GINs), where domestic and foreign R&D labs (as well as production and marketing departments) of multinational and non-multinational firms interact within and across firms boundaries for the global generation and diffusion of innovation (Ernst, 2002, 2011; Barnard and Chaminade, 2011). The trend towards locating R&D activities abroad have raised concerns that the knowledge base of advanced countries may be ‘hollowed out’, worsening their relative international competitiveness4. At the same time, economic research have highlighted the potential benefits of offshoring R&D in terms of reverse technology transfer and increased competitiveness at home.

1.1 Outsourcing, complementary innovations, and growth

The decision to outsource is often driven by the need to reduce costs, save time, and enhance flexibility. This allows firms to concentrate on activities in which they benefit from some competitive advantage. Given the complexities of today’s technologies. and supplier chains, outsourcing is no longer a concept limited to manufacturing and services (Sabel, 1994; Helper et al., 2000). Today, subcontractors are involved in design issues, doing critical R&D, and have become central in efforts to improve quality. The key to sustain competitive advantage in the global market tends to increasingly hinge on the utilization of creativity and skills of specialized workers and engineers around the world. In particular, single firms in industries experiencing a rapid development of technological progress and knowledge distribution no longer possess the necessary skills to produce significant innovations in all areas of progress (Powell and Brantley, 1992; Powell et al., 1996; Hagedoorn and Duysters, 2002). Such circumstances have led to the rise of networks as the locus of innovation to create the crucial specialized knowledge necessary to improve firms’ competitive position. Outsourcing has created a market for complementary innovations giving rise to a complex network of innovators, i.e. “global innovation networks” (GINs). This has been

[2] This report has been edited by Davide Castellani for Centro Studi Luca d’Agliano (email: davide.castellani@unipg.it), with contributions from Lukasz Grzybowski, Alireza Naghavi and Gianmarco Ottaviano for FEEM, Vandana Ujjal and Pari Patel for SPRU (UoS) and Rosario Crinò for Centro Studi Luca d’Agliano.

[3] [R&D] Offshoring is defined as the location or transfer of [R&D] activities abroad. It can be done internally by moving services from a parent company to its foreign affiliates (sometimes referred to as ‘captive’ or ‘in-house’ offshoring), or to third (unrelated) parties (referred to as international or offshore outsourcing) UNCTAD (2006). Due to data limitations, the analysis carried out in this work will refer to ‘captive’ R&D offshoring only.

[4] See, for example, Lieberman (2004) for the US, and Kirkegaard (2005) or Pro Inno Europe (2007) for Europe.

possible through a simple division of labor, which in turn has instigated a division of knowledge creation. Against this background, lies the question whether the success of project networks can be taken for granted in all sectors and under all circumstances. There are good reasons to suspect that may not be the case as the role of innovation in determining growth, performance, and hence industrial dynamics differs greatly across sectors. Within this project[5] we address the complex issue of the conditional success of project networks from a specific angle focusing on a special reason why innovation networks arise, namely to serve the needs of fragmented production. From this angle causation goes from the decision to outsource production to the emergence of innovation networks, which allows us to study the conditions under which the static gains driving the outsourcing choice may also be associated with dynamic gains due to faster innovation and growth. In so doing, they develop a dynamic model in which fragmented production (“outsourcing”) and complementary innovations (“innovation networks”) may arise simultaneously due to gains from specialization. Their aim is to not only explain how sectoral differences contribute to organizational form, but also capture the dynamic growth aspects by discussing how these sectors could evolve over time. In order to study the interaction between firm organization and innovation, propose an analytical framework that combines some key features of two well-established approaches to the study of economic growth on the one side, and the boundaries of the firm on the other. As in Grossman and Helpman (1991), the situation is one in which firms enter the market by buying the blueprints of horizontally differentiated products developed by independent labs. These are perfectly competitive and finance their R&D activities in a perfect capital market. While blueprints are protected by infinitely lived patents, technological knowledge is not fully appropriable giving rise to learning externalities that reduce the cost of R&D as experience in production cumulates through time. Differently from the dynamic model of Grossman and Helpman (1991) but in the wake of the static model of Grossman and Helpman (2002), production processes come in two types: vertically integrated and fragmented (“outsourcing”). These processes are split in two stages: upstream intermediate production and downstream final assembly. Integrated production as well as each stage of fragmented production require their own blueprints. Hence, firms enter the market as vertically integrated firms, intermediate suppliers, and final assemblers by buying the corresponding blueprints. There are no economies of scope in innovation, so upstream and downstream blueprints are created independently. There are, however, gains from specialization in terms of production as fragmentation is more efficient than integration. While integrated production processes are less efficient, they are, nonetheless, ready to run without additional burdens for the firms acquiring the corresponding blueprints. Fragmented processes face, instead, search- ing and matching frictions between intermediate suppliers, and final assemblers as well as customization costs. The three types of blueprints also face different technological opportunities (as captured by relative R&D costs), which therefore play an important role in determining firms’ organizational choices as in Malerba and Orsenigo (1996, 1997).

Fragmented processes also incur contractual frictions as additional relation- specific investments are required in order to make matched upstream and down- stream blueprints perfectly compatible with each other. The underlying idea is that full compatibility between upstream and downstream blueprints requires reciprocal customization, which firms are willing to incur only after being matched. As in Grossman and Helpman (2002), we make the realistic assumption that contracts are incomplete due to the lack of ex post verifiability of the quality of deliverables by third parties,

[5] In particular, the contribution by Alireza Naghavi (alireza.naghavi@unibo.it) and Gianmarco Ottaviano at FEEM. See Naghavi and Ottaviano (2010).

which implies that relation-specific investments give rise to hold-up problems. The core our results is that, albeit demonstrating a channel through which the outsourcing of production may breed innovation, their model reveals a tension between the static and dynamic implications of outsourcing that prevents this from always being the case. The reason is that the production decision is made weighting the higher searching and contracting costs of outsourcing against the missed specialization gains of vertical integration. In so doing, it does not take into full account its effects on the incentives to innovate. As a result, the static gains from specialized production may sometimes be associated with a slow down of innovation and growth. In particular, outsourcing is chosen and accelerates growth when there are substantial gains from specialization and the bargaining power of intermediate suppliers and final producers reflect the relative incentives of labs to create the corresponding blueprints. When this is the case, search and hold-up frictions are minimized. Thus, when specialized intermediate suppliers have a larger role in innovation than final assemblers, a higher supplier bargaining power in an outsourcing relation induces growth. Examples of such sectors can be found in Scherer (1982), which identifies sectors that in the United States are net sources of R&D for other sectors (computers, instruments), and sectors that are net users of technology (textiles, metallurgy).

1.2 R&D offshoring and productivity

Aggregate productivity dynamics can be explained by changes in productivity at the level of the firm (the within-component of productivity growth) and by reallocation of resources across incumbents and through entry and exit (the between-component) (Bartelsman and Doms, 2000). The literature on the effects of R&D offshoring has focussed on the within-component, and has provided already a certain amount of empirical evidence at the firm-level (see section 2.2). R&D offshoring increases firms' productivity by augmenting their stock of knowledge. The growing need for enhanced innovation capability is leading firms to expand technology sourcing and interaction with different and geographically dispersed actors (Narula and Zanfei, 2005). On the one hand, R&D labs abroad are needed to be able to quickly and effectively adapt products to the need and specificities of local markets. Eventually, innovation developed for the local markets can be decontextualized and become part of the knowledge base of the multinational firms and exploited elsewhere Zanfei (2000). On the other hand, R&D offshoring is needed to gain access to crucial inputs such as knowledge and technology complementary to those developed at home, as well as and highly qualified and/or lower cost R&D personnel (Manning, Massini, and Lewin, 2008; Cantwell, 1995; Chung and Yeaple, 2008; Puga and Trefler, 2010). However, R&D offshoring does not necessarily imply that knowledge and productivity at home increase. First, offshored labs need to be able to actually extract knowledge from foreign locations, and this may need time and investments in order to establish relations with actors in the host innovation system (Narula and Michel, 2009). Second, the firm must be able to manage reverse knowledge transfers (from the offshored labs back to the headquarters and the rest of the company), which may require the adoption of sophisticated mechanisms for the dissemination and integration of both explicit and tacit knowledge (Gupta and Govindarajan, 2000).

One less explored channel through which R&D offshoring can affect aggregate productivity in the home region is through the reallocation of market shares. As a matter of fact, theoretical and empirical work tend to agree that offshoring allows to sell more, thanks to the fact that offshoring firms can charge lower prices or adapt products to local needs (Grossman and Rossi-Hansberg, 2008; Barba Navaretti, Castellani, and Disdier, 2010). Provided that offshoring firms are the relatively more productive ones (Helpman, Melitz, and Yeaple, 2004), regional productivity would increase even in the extreme case where no firm increases its own productivity, simply because offshoring firms increase their market share.

R&D offshoring may also have indirect effects on the productivity, size and entry/exit of other firms in the home region. This mechanism is similar to the spillover effects which has been analysed at length with reference to inward FDI and foreign-owned firms (Castellani and Zanfei, 2006). By opening R&D labs abroad, multinational firms may close down activities in the home country, thus disrupting linkages with local firms and institutions. This shrinks the activities of local firms, which may ultimately be forced to exit. Alternatively, if R&D offshoring enables some reverse knowledge transfer, domestic counterparts may also benefit of some positive externalities, via labour mobility, imitation or inter-firm linkages.

In sum, R&D offshoring affects home productivity through a variety of channels, and only some of them are observable at the level of individual firms. An aggregate perspective allows to evaluate the net effects of such different transmission channels. Furthermore, the effects of offshoring are most likely relatively confined in space and, thus, the regional level would more appropriate than the country level to capture them[6] . Admittedly, the drawback of this type of analysis is that we cannot pin it down to the various channels[7] .

Empirical studies available in the literature, have shown that As in productivity differences among EU regions, largely depend on the role of agglomeration economies, technology and human capital (e.g. Ciccone, 2002; Paci and Usai, 2000), but Gambardella, Mariani, and Torrisi (2008) show that the productivity of European regions is explained by some measure of openness[8] .

Other studies have investigated the effect of R&D offshoring on knowledge production at home. In this line of research, Criscuolo, Narula, and Verspagen (2005) and Criscuolo (2009) find evidence of reverse technology transfer for European firms using patent citation data, while Piscitello and Santangelo (2010) and D'Agostino, Laursen, and Santangelo (2010) support the hypothesis that patenting activity in OECD countries and regions benefit from offshored R&D activities in Emerging economies (BRICKST). Using firm-level data, from the Spanish Technological Innovation Panel (Nieto and Rodriguez, 2011) find a positive relation between offshoring and innovation performance, with a greater effect on product than on process innovations and through captive offshoring than offshore outsourcing. Similar results have been reported from a survey on 158 EU companies. According to R&D managers of the interviewed firms companies have benefited from R&D offshoring as far as i) the ability to choose successful R&D projects, ii) length of time it takes to commercialise an innovative idea, iii) the cost efficiency

[6] First, the smaller the units of observation, the easier it would be to appreciate the direct effects of FDI, which may be more diluted in more aggregate data. Second, indirect effects may be enhanced by the geographic proximity, which can be important for transmitting knowledge as face-to-face communication (Audretsch and Feldman, 2004). Third, in the presence of transport costs, vertical linkages (which foster pecuniary and knowledge externalities) occur between closely-located suppliers and customers (Venables, 1996).

[7] Aggregating micro-level information would help us obtaining sharper answer (see Altomonte and Colantone, 2009). Unfortunately, this does not appear as a viable alternative at the moment since the available firm-level data comparable across countries (e.g. from Amadeus) provide a rather poor match with aggregate data (and for a few countries), but it is on the agenda for future research.

[8] Gambardella, Mariani, and Torrisi (2008) measure regional openness as the share of hotels in total population and the share of the population which speaks a second language.

of product innovation processes or iv) the ability to learn about R&D conducted by other firms are considered (Pro Inno Europe, 2007).

A fruitful line of research have also focussed on outward investments and productivity, mainly from a firm-level perspective. Many studies in this field have provided evidence that investing abroad may foster output growth and further reinforce productivity of investing firms (Barba Navaretti, Castellani, and Disdier, 2010; Debaere, Lee, and Lee, 2010; Griffith, Harrison, and Reenen, 2006).

1.3 Foreign knowledge creation and corporate performance

The relationship between foreign technological activities and performance of firms has been surprisingly neglected in the literature on international business. This is partly a reflection of the difficulties in being precise about the magnitude of the economic value of all technological activities (foreign or home-based) because of the long time period over which returns may be observed. The little evidence on the positive association between R&D internationalisation and innovation performance has stressed that large firms are able to appropriate considerable efficiency gains as a result of such internationalisation, mainly arising from the interaction between the ownership advantages of MNCs and the location advantages of regions. For example Cantwell (1995) argues that MNCs will locate in different countries and regions to exploit differential advantages in production and in R&D. The contention is that managerial efficiency of multinationals drives them to internationalize their technology through ‘asset augmenting’ investments rather than extend production through ‘asset exploiting’ investments alone.

Empirical evidence shows that overseas R&D geared toward technology sourcing can have a positive impact on parent operations and productivity (Griffith et al., 2006). Whether this occurs depends firstly on successful intra-firm reverse technology transfers from the subsidiary to the parent. Efficient transfer and integration of knowledge within MNCs are affected by organizational and technological distance and also by the existence of organizational inertia (Criscuolo and Narula, 2007). Further positive impact is also more likely to be realized if the MNC becomes embedded in the host country’s productive and innovative networks (Iwasa & Odagir, 2004). Thus local embeddedness is shown to have a positive impact on foreign subsidiary performance and innovation (Andersson et al., 2002). Anecdotal evidence also suggests that advancements in communications infrastructures further facilitate management of dispersed R&D. Many firms now seek to move some of the more routine work to cheaper locations, which can then be monitored by the parent company on an almost continuous basis. Zhu (2004) formalises these arguments by using a theoretical model to show that firms attempt to reap economies of scale and scope with R&D centres located in cheap labour countries.

The general literature on the relationship between intangible R&D assets and economic value of the firm has not considered separately the international dimension of R&D. Studies such as Hall and Trachtenberg (2001) show that the quality of the knowledge created (as measured by citation weighted patents) has a positive influence on the market value of US firms. This builds on the early work of Grliches (1981) which showed a positive relationship between R&D expenditures of a firm its economic value. More recently Hall et. al. (2005) show that three complimentary aspects of knowledge stocks, i.e., R&D intensity, patents to R&D ratio, and average citations received by these patents, significantly raise the market value of a firm. Similarly, Bloom and Van Reenan (2002), using a sample of UK firms found that patent stocks did have a positive and statistically significant impact on firm-level productivity and market value for UK firms. These studies underline the fact that technological change yields improvements in productivity over a long period of time but also suggest the relative scale of R&D relative to physical investment and the size of the total patent stock to be important variables capable of influencing market value directly. Moreover Nesta and Saviotti (2006) show that the stock market values the coherence of the knowledge base of biotechnology firms, i.e. the extent to which the different technological capabilities of biotech firms are related to each other.

One of the few studies examining the impact of internationalisation of knowledge creation on the market value of firms is that by Criscuolo and Autio (2008). They analyse the geographic distribution of pharmaceutical and chemical MNC’s scientific publications and relate them to their market value. Their main conclusion is that adoption of a geographically dispersed network of research units is conducive to higher market valuation. A small number of studies report superior innovative performance as a result of foreign R&D. For example Penner-Hahn & Shaver (2005) show that Japanese Pharmaceutical MNCs with foreign R&D have a higher level of patenting compared to purely domestic counterparts. More recently, Bernhard et al., (2008) compared the innovative performance of foreign-owned and domestically owned firms in five European countries and finds that foreign ownership is not related to differences in innovation input, but yields higher innovation output and labour productivity. However the study by Singh (2006) shows that simply dispersing R&D in a number of locations does not contribute to firm’s patents quality. But when innovative teams subsequently build on knowledge from different locations, this is likely to result in patents with higher value (Singh, 2006).

1.4 The impact of R&D and service offshoring on employment

This section contains a brief review of the evidence on service offshoring and labor demand in developed countries. Due to space constraints, and given the empirical nature of the chapter, we do not cover the theoretical studies on service offshoring. The latter deal with the effects on productivity, wages, and welfare more in general. The interested reader can refer, in particular, to Bhagwati et al. (2004), Samuelson (2004), Deardorff (2005), Markusen (2005), Antras et al. (2006), Baldwin (2006), Baldwin and Robert-Nicoud (2007), Markusen and Strand (2008), Grossman and Rossi-Hansberg (2008) and Rodriguez Clare (2010). The reader can also refer to Feenstra and Hanson (2003), Hijzen (2005), Crinò (2009) and Feenstra (2010) for more detailed and comprehensive surveys of the theoretical and empirical literature on service offshoring.

A first set of empirical studies have tried to quantify the number of service jobs potentially at risk of offshoring in the industrialized countries. To this purpose, these studies have computed how many workers are currently employed in service occupations with ‘tradability’ characteristics. Among other attributes, these occupations require little face-to-face contact with final consumers, depend substantially on information and communication technologies and perform routine tasks (Autor et al., 2003; Levy and Murname, 2004; Blinder, 2006). The main message from these studies is that the fraction of jobs potentially at risk of being offshored is large. The available evidence suggests, in fact, that between one-fifth and one-fourth of domestic employment in the US, the EU and other developed countries, is in tradable occupations. Hence, a substantial share of workers in the industrialized world is facing the potential risk of being offshored in the near future. See, in particular, Bhardan and Kroll (2003), Dossani and Kenney (2004), Garner (2004), Van Welsum and

Reif (2005), Van Welsum and Vickery (2005), Jensen and Kletzer (2005, 2008), Blinder (2006, 2009), Kroll (2007), Moncarz et al. (2008), Blinder and Krueger (2009) and Kletzer (2009).

The high number of jobs potentially at risk of relocation should certainly induce not to overlook the service offshoring phenomenon. At the same time, however, further empirical evidence suggests that the actual impact of service offshoring on the employment levels has so far been small in many industrialized countries. Three pieces of evidence support this consideration.

First, looking at the subset of firms that have laid off workers during the first half of the past decade, offshoring has accounted for only 2-4% of the job separations in the US (Bhagwati et al., 2004; Mankiw and Swagel, 2006), and for similar shares in the EU and Japan (Kirkegaard, 2007).

Second, employment in tradable occupations has increased (rather than decreased) in the US over the last decade, and growth has been particularly pronounced in more skilled and higher wage occupations (Mann, 2003; Kirkegaard, 2004; Jensen and Kletzer, 2005; Moncarz et al., 2008).

Third, the existing econometric studies show that the effects of service offshoring on total employment have generally been small until now. In some cases, the effects have even been found to be weakly positive, suggesting that service offshoring may have actually increased total employment slightly, by boosting productivity and expanding the scale of firms' operations. See Amiti and Wei (2006), Liu and Trefler (2008) and Blinder and Krueger (2009) for the US; Amiti and Wei (2005) and Hijzen et al. (2007) for the UK; Hijzen and Swaim (2007) and OECD (2007a,b) for the OECD countries; Görg and Hanley (2005) for Ireland; Jensen et al. (2006) for Denmark; Crinò (2010a) and Falzoni and Tajoli (2011) for Italy.

A related, but smaller, number of contributions have investigated the effects of service offshoring on the skill and occupational composition of labor demand. By and large, these studies show that service offshoring shifts the composition of labor demand in favor of more skilled workers. The effect reflects the fact that the imported services complement with high skilled domestic labor, and may sometimes also substitute for less skilled domestic labor. See Geishecker and Görg (2008) for the UK, and Crinò (2010a, 2011) for Italy and other European countries. In addition, recent evidence for the US shows that service offshoring also changes the occupational composition of labor demand at given skill level. In particular, controlling for the level of education, service offshoring penalizes occupations with stronger tradability attributes and favors less tradable jobs (Crinò, 2010b).

The studies mentioned so far are closely related to the first part of this chapter, which investigates the effects of service offshoring on the location of labor demand. The chapter contributes to this literature by providing novel, and extensive, empirical evidence for a large and representative set of Western European countries. In addition, thanks to the richness of the available data, the chapter can investigate several sources of heterogeneity in the effects of service offshoring, most of which have remained largely unexplored in the empirical literature. Along with the effects on different skill groups of workers, in fact, the chapter studies the implications of service offshoring for individual countries and explores differences in the effects across types of offshored services.

A further contribution of the chapter is to study how service offshoring affects the wage elasticity of labor demand. To the best of our knowledge, none of the existing contributions have dealt with this issue. Several studies exist, instead, on the effects of trade liberalization and globalization more in general. According to Rodrik (1997), these phenomena may make labor demand more elastic, mostly by raising product market competition. Yet, the available evidence is not conclusive; see, among others, Greenaway et al. (1999), Slaughter (2001), Barba Navaretti et al. (2003), Barba

Navaretti and Venables (2004), Bruno et al. (2004), Hasan et al. (2007), Görg et al. (2009) and Hakkala et al. (2010). A few other studies have specifically dealt with the effects of material offshoring. They have found some evidence that material offshoring contributes to making labor demand more elastic. Material offshoring mostly works by allowing countries to access new and cheaper inputs, which enlarge the possibilities for firms to substitute domestic labor. The effect has been found both in the US (Senses, 2010) and in the OECD countries (OECD, 2007a). In this latter case, it has been found to be stronger in economies with weak labor market regulations, where firms have greater flexibility to adjust their mix of domestic and foreign inputs (Hijzen and Swaim, 2010).

2 THE RELATIONSHIP BETWEEN R&D ABROAD AND AT HOME: CASE STUDIES EVIDENCE[9]

According to the empirical literature cited above both complementarity and substitutability between R&D activities in North and South countries is possible. However, in econometric studies, the characteristics of particular MNEs and industries cannot be taken into account to the level of detail as can be done based on interviews with MNEs' representatives in North and South countries. This section contributes to the literature by compiling detailed information from interviews to conclude on the extent of substitutability and complementarity for selected MNEs and industries.

We provide an assessment of the strategic considerations which drive location choices for R&D activities and the impact these strategies have on the competitiveness of firms by analysing results from the case studies carried out by the INGINEUS partners in WP5 in three different industries: ICT, automotive and agro-food. The ability of firms to compete and generate profits has consequences on production and employment in both developed and emerging countries. We therefore conclude on whether policy makers should be concerned with strategies followed by firms which are active in these industries.

We use the case studies to provide answers to the following questions. First, what are the strategic drivers of R&D off-shoring in different industries. Second, which type of R&D activity is off-shored by firms in these industries. Third, we analyze the relationship between the activities which are off-shored and those which are retained in home country. We refer to this relationship as complementarity or substitutability between R&D activities in different geographic locations. Finally, we conclude on the effects which different strategies may have on production and job creation.

The results of the interviews can be summarised as follows. In general, the decision to off-shore R&D activity is driven by three main factors: (i) access to the emerging market (Demand); (ii) access to the local pool of skills (Supply); or (iii) institutional and environmental issues (Institutional). The demand factors can be related to expanding market size or absorbing knowledge from local markets and hence developing new products to increase sales. The supply factors can be related to access to local resources at a lower cost or to access to resources which are not available in home country at all. There may be also motives to get access to local networks and knowledge

[9] This section builds on a contribution by Lukasz Grzybowski (lukasz@mushroomski.com) for FEEM, based on case studies put together by Vandana Ujjual for WP5 of the INGINEUS project.

hubs. The institutional factors are related to regulation of IPR, product and labour markets as well as political stability. It should be noted that demand and institutional drivers can be also considered to be cost factors. Because of economies of scale expanding market size results in lower average cost of production. On the other hand, R&D tax subsidies directly reduce cost of R&D.

Using the methodology proposed by Ronstadt (1984) the following types of R&D facilities can be identified: technology transfer unit (TTU); indigenous technology unit (ITU); global technology unit (GTU); and corporate technology unit (CTU).[10] The first one is linked to manufacturing units and established to adapt a products and processes to local conditions in host countries. The second one is established to develop new and/or improved products for local markets drawing on local technology. The third one is established to develop new products for the global market and the fourth one to generate basic technology of a long term nature for corporate use. Alternative methodology was proposed by Kuemmerle (1996), which categorized global R&D activities into two groups: home-base-exploiting (HBE) R&D, and home-base-augmenting (HBA) R&D.[11] In this paper we use different classification which objective is to make it possible to directly link R&D off-shoring strategies to potential effects on employment in home countries.

Demand factors are relatively more important when MNEs use local resources to: (a) adapt products developed in North countries to local needs through cheaper design implementations that are different from that in advanced countries but do not compromise on quality (b) develop completely new products in South locations to be sold in these markets only. Supply factors are relatively more important when MNEs: (c) develop completely new products in South locations which are also rolled out globally.

We submit that the cases (a) and (b) give rise to "R&D complementarity", in which off-shored R&D activity results in manufacturing of products which are primarily sold in the Southern countries and therefore there is no direct competition between these products and products manufactured in the North countries. In such case, some R&D activity needs to be located in the South countries because market-specific knowledge is required to successfully market the products. A higher level of R&D investments in South countries generates sales and profits which also enable more core R&D in the North countries. New products developed in the North countries again stimulate R&D investments to adapt these products to demands of the South countries. Hence, the complementarity between products manufactured in the North and South countries is reflected in the complementarity in R&D investments in North and South, which reinforce each other. Overall, stimulating off-shoring R&D in such case may result in greater profits of MNEs. At the macroeconomic level the production and employment by these firms should increase in both South and North countries.

Case (c) should give rise to "R&D substitutability", since off-shored R&D activity results in manufacturing of products which are sold in both South and North countries. The products manufactured in the South countries are substitutes and directly compete with products manufactured in the Northern countries. In such cases, the decision to locate R&D activity in the South countries is driven to a greater extent by access to skills and lower costs rather than by

[10] Ronstadt, R.C. (1984). “R&D abroad by U.S. multinationals.” In: Stobaugh, R. & Wells Jr., L.T. (Ed.). Technology crossing borders: the choice, transfer, and management of international technology flows. Boston: Harvard Business Press, Part 3: Management of Technology, chap. 11, p.241-264.

[11] Kuemmerle, W. (1996) “Home Base and Foreign Direct Investment in R&D,” Unpublished Ph.D. Dissertation, Boston: Harward Business School.

market-specific knowledge. A higher level of R&D investments in the South countries generates sales and profits in both North and South countries but due to competition profits may be lost on other production based in the North countries. In result, R&D investments may be reduced in the North countries. Hence, the substitutability between products manufactured in the North and South countries is reflected in substitution between R&D investments in North and South. Overall, the decision to off-shore R&D is driven by greater profits of MNEs but at the macroeconomic level there may be reduction in production and employment in North countries.

The R&D complementarity/substitutability between products manufactured in the North and South countries is to some extent determined by the characteristics of the industry. Based on the interviews with MNEs, in the case of ICT industry, we observe both substitutability and complementarity between R&D in North and South countries. In the case of automotive and agro-food industries we observe a greater degree of complementarity rather than substitutability. We conclude therefore that, at this point of time, there seems to be rather limited substitution and relocation of R&D from Europe to other markets. The off-shoring of R&D should not lead to substantial reduction in employment in these industries in Europe. There is however a role for the policy makers to stimulate R&D investments both in North and South countries. In industries in which complementarity can be observed, policies which aim to limit off-shoring of R&D investments can be harmful because MNEs may lose global market share. On the other hand, policy makers should create favourable environment for R&D investments in North countries in industries in which there is substitutability.

2.1 Case studies

The case studies were conducted within WP5 of the INGINEUS (Impact of Networks, Globalisation, and their INteraction with EU Strategies, 2009-2011) project and coordinated by Vandana Ujjal for SPRU (University of Sussex). Detailed interviews were conducted by various teams within the INGINEUS project to enhance the understanding of strategies that MNEs pursue with respect to the location of their R&D activities and the functions which different locations play in the global production chain. These case studies provide insights into the way firms in different industries internationalize their R&D activities and on how these feed back onto R&D activities at home. While the determinants of R&D offshoring are extensively discussed in WP5, here we exploit the same cases to highlight the impact of those strategies on R&D in the home countries (in the EU). Obviously, the sample cannot be considered to be representative for the whole industries in question but it may be used as an illustration of certain strategic patterns.

The interviewed firms are world's leading MNEs in the three sectors of ICT, automotive and agro-food. Selected MNEs are leading players in respective industries in terms of revenues market share and are among leading spenders on R&D in the EU. These firms also have established R&D subsidiaries in emerging countries.

The MNEs selected for in-depth case study were: (i) NSN, Ericsson and Philips in the ICT; (ii) Volvo and Fiat in the automotive sector; and (iii) two anonymous companies, Company I and Company II, in the agro-food sector. Table (1) provides key facts about scale of activity of interviewed companies. Selected MNEs have origins in different EU countries. In the case of the ICT industry, all three MNEs interviewed have their HQs in three different countries. Also in the automotive industry, two MNEs have HQs in two different EU countries. On the other hand, in the agro-food sector, there were four MNEs interviewed which are among main players in this sector in

Denmark. Two of these MNEs were however less internationalized in terms of R&D and are not further discussed in this paper. The details on the way the interviews were conducted are discussed in WP5 report of the INGINEUS project prepared by Vandana Ujjual. Table 2.1 presents basic information related to R&D activity of interviewed MNEs.

Table 2.1: Basic information on the case study firms

Company	Description	R&D activities
Philips	• Headquarter in Netherlands • Employs 119,000 people in more than 60 countries • Sales of EUR 25.5 billion in 2010: 28% in North America, 33% in Western Europe and 33% in Emerging Markets	• About 12,388 people employed in R&D • In 2010, the R&D investment amounted to EUR 1.6 billion (6.3% of sales)
Nokia Siemens Network	• Joint venture between Nokia of Finland and Siemens of Germany. • Headquarters in Finland and Germany • Employs about 60,000 people and operates in more than 150 countries • Sales were EUR12.6 billion in 2010	• About 16,000 people employed in R&D • In 2008, 16.3% of sales was spent on R&D
Ericsson	• Headquarter in Sweden • Employs 82,500 people in 175 countries • In 2009, the total sales were EUR 22.7 billion	• About 20,800 people employed in R&D • In 2010, the R&D investment amounted to 15% of sales
Fiat	• Headquarter in Italy • Employs 190,000 people and has 188 production plants • In 2010, the sales were EUR 35.6 billion: 25% in Italy, 35% in Europe, 20% in the Mercosur area, 10% in North America and 10% in the rest of the world (mainly Asia)	• About 14,000 people employed in R&D • In 2009, the R&D investment was EUR 1.69 billion (4.7% of sales)
Volvo	• Headquarter in Sweden • Employs about 90,000 people with production facilities in 19 countries • In 2010, the sales were EUR 29.5 billion: 39% in Europe, 18% in North America, 11% in South America, 25% in Asia and 7% in the rest of the world.	• In 2010, the R&D investment was EUR 1.5 billion (4% of sales)
Company I	• Headquarter in Denmark • 54% of employees are placed outside Denmark, and the company serves their customers in 120 countries	• In 2010, the R&D investment amounted to 6% of revenues
Company II	• Headquarter in Denmark	• In 2010, the R&D investment amounted to 14% of revenues

2.2 Complementarity vs. substitution of home and foreign R&D: results from the case studies

Table 2.2 summarizes the R&D internationalization strategies undertaken by interviewed MNEs. The results can be summarized as follows.

In the case of ICT industry, similar R&D internationalization patterns can be observed in all three MNEs which were interviewed: Phillips, NSN and Ericsson. Both substitutability and complementarity can be observed in R&D location decisions. On the one hand, MNEs realize that there is a growing supply of engineering skills in South the countries. These engineers have similar skills to their colleagues based in North countries or can be easily trained up to that level and at the same time the cost of their employment is much lower. Hence, the availability of skills is an important driver of R&D location. Many products developed in Southern countries are thus sold globally including North markets. In such case, there is competition between products manufactured in North and South and therefore some substitutability between R&D activities. On the other hand, another critical location driver is the market growth and potential. In this case, MNEs in ICT sector develop new low-cost products and designs or adapt products developed in North countries to local needs in South markets. In such case, there is complementarity between R&D in North and South because products manufactured in these two regions do not compete directly with each other.

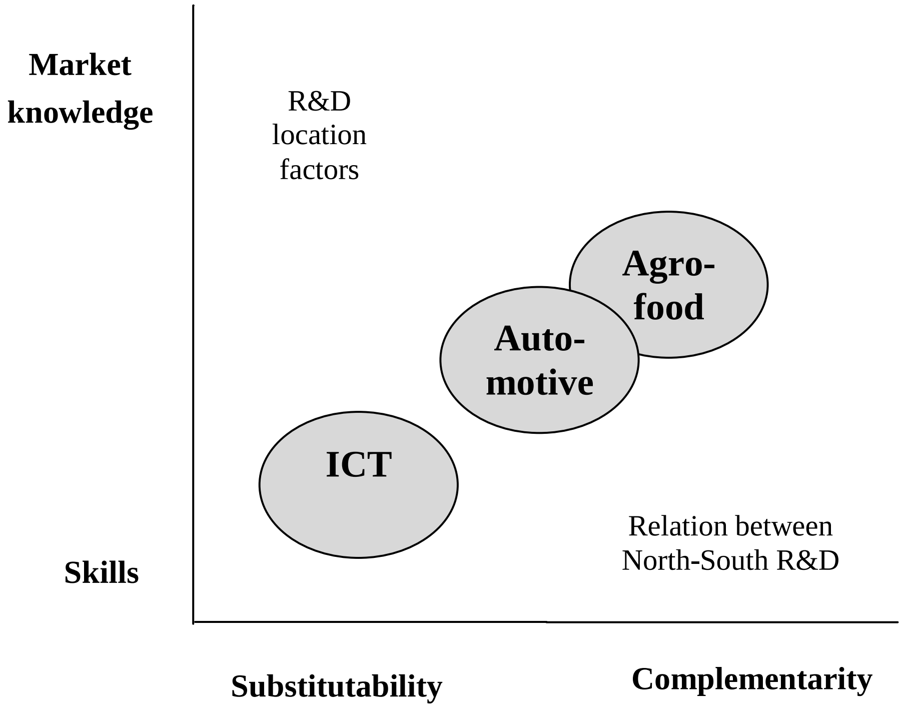
The MNEs in automotive industry seem to follow the strategy of developing standardised products/technologies in leading markets which are then rolled out globally but with certain important local adaptations in functionality and design. In Volvo, strategic development is centralised and based mainly in Europe, with some R&D activity in the US and Japan. New solutions and products are developed mainly in Europe, while applied research and applications are carried out in Europe, US, Japan, India, and to a smaller extent in Australia and Brazil. Centres based in Brazil and India mainly customize products to local needs. The center in India was located there due to cost factor and skills but also because of the market. Also, in the case of Fiat, key activities are based in the HQ in Italy due to high investment costs and economies of scale. Centres in Southern countries mainly customize basic technologies to local needs, occasionally developing specific capabilities, the main location drivers being closeness to the markets and access to competencies and knowledge The company needs to respond quicker to market needs which is only possible when it has some R&D activity located close to the market. Overall, situations in which automotive products developed in Southern countries compete directly with products manufactured in North countries are rather rare. Hence, the R&D activity in automotive industry has complementary character. The extent of substitutability is much smaller than in the ICT industry.

In the case of agro-food industry, Company I internationalized R&D to seek supplementary skills and specialists' input. But its location decision was also driven by closeness to the market, and whether it already had some production in the location. A sound legal system in the country of destination was also important. The products are basically developed for local markets whereby both suppliers and customers are engaged in the development process. In the case of Company II, some R&D sites evolved from their existing global production network (as in the case of China), while others were part of a strategy of accessing supplementary knowledge capacities in new research areas (as in the case of India). The locations in South countries are centres of excellence for global R&D operations.

Table 2.2: Synthetic representation of R&D organization and strategies

	R&D organisation	R&D strategies	Conclusions on strategies
Philips	• Four legs: Philips Research, Applied Technologies, Philip’s	• The location of 6 research labs was driven by supply factors • Since 1990s market driven R&D	Complementarity / Substitution

	incubators, and IP & Standards with centres worldwide	• Open innovation strategy • Products developed for world market • In Bangalore (India): consolidation of software operations in single location outside Eindhoven	
Nokia Siemens Network	• 25 R&D centres	• The location is driven by factors: innovation capability, flexibility of workforce, legal framework and costs • Close to key markets • Products are developed for world market	Complementarity / Substitution
Ericsson	• 25 R&D centres worldwide	• The location is driven by access to competencies and markets • Products are developed for world market • Open innovation strategy	Complementarity / Substitution
Fiat	• 117 R&D centres research or development focused • 48 centres in home country, 33 in other regions in Europe, 15 in North America, 10 in Mercosur, 11 in the rest of the world	• Key activities are based in HQ location due to high investment costs • Location drivers are closeness to the markets and access to competencies and knowledge • Quicker response to market needs • Local centres mainly customize basic technologies to local needs, occasionally developing specific capabilities	Complementarity
Volvo	• 50% of R&D is performed in Sweden, the rest in Europe, USA, Asia and South America	• Strategic development is centralised and based mainly in Europe, and some in the US and Japan • New solutions and products are developed mainly in Europe • Applied research and applications are carried out in Europe, US, Japan, India, and to smaller extent in Australia and Brazil • Centres in Brazil and India mainly customize to local needs • Location in Banglore primarily due to cost factor and skills, but recently also market	Complementarity
Company I	• 5 R&D centres in Europe, US and China	• Internationalize to seek supplementary skills, specialists input • The presence of customers, and whether the company already has some production in the location and on a sound legal system • Product development for local markets engaging with supplies and customers	Complementarity
Company II	• 10 R&D locations on 5 continent	• Some R&D sites evolved from their existing global production network (China) while others are part of a strategy of accessing supplementary knowledge capacities new research areas (India) • center for excellence for the global R&D operations	Complementarity



2.3 Concluding remarks

In summary, the decision to offshore R&D activity is driven by two main factors: (i) access to the local pool of skills and (ii) access to the emerging market. Globalization of innovation is due to the distributed nature of scientific and technical knowledge, to allow MNEs to become embedded in regional innovation hubs and to be present in some of the most important markets. The MNEs used local resources to: (a) adapt products developed in North countries to local needs through cheaper design implementations that are different from that in advanced countries (b) develop completely new products in South locations to be sold in these markets only or (c) develop completely new products in South locations which are also rolled out globally.

The importance of location drivers and implemented strategies differ depending on industry. Based on the interviews of MNEs in the case of ICT industry, we observe both substitutability and complementarity between R&D in North and South countries. The strategic R&D that requires specialised know how and high investments are centralised, mainly at HQ locations, in other European location outside the HQ and in the US. The applied research and application, and engineering are dispersed and are located near their important markets. In the case of automotive and agro-food industries we observe a greater degree of substitutability rather than complementarity. We conclude therefore that at this point of time, there seems to be rather limited substitution and relocation of R&D from Europe to other markets. The off-shoring of R&D should not lead to substantial reduction in employment in these industries in Europe.

3 THE EFFECTS OF FOREIGN PATENTING ON LONG TERM FIRM PROFITABILITY[12]

While there are a large number of studies examining MNCs’ strategies and motivations for R&D internationalisation , there are very few that analyse the impact of internationalisation on firm performance. This work aims to fill this gap. It seeks to understand the relationship between international technology creation undertaken by large R&D spending corporations and their economic performance. In particular we are interested in the question whether firms that source their technology globally are able to achieve superior economic performance. By undertaking an econometric analysis of the causal relationship between internationalization of technology and economic performance of MNCs that are at the forefront of technology creation, we aim to provide a better understanding of the phenomena of global R&D.

Our analysis is based on some of the world’s largest technologically active companies, with their headquarters in the EU, Japan and the US. These companies account for a large proportion of both corporate R&D spending worldwide and total EPO patenting. Specifically, we analyse the impact of foreign knowledge creation on firm performance by distinguishing between: the **volume** of foreign technology creation as compared to the **spread** of such activities. We hypothesise that these are two different aspects of international technology creation and relate to firm-level profitability and certain innovation characteristics differently. Further, by comparing this relationship, for our sub-sample of MNCs located in the three regions: North America, Europe and Japan, this paper is able to unravel the heterogeneity in the relationship across these 3 regions. Our findings have important implications for national and regional policy as well as for innovation policy on stimulating greater foreign technology creation activity at large.

This paper is structured as follows: Section 2 presents a brief discussion of the literature on internationalisation of R&D, specifically on the relationship between international R&D and the impact on long term profitability and thus sets the stage. Section 3 discusses data and methodology. The main results of the econometric analysis are presented in Section 4. and Section 5 presents our assessment and discussion.

3.1 Data, sample and methodology

Past research on international location innovative activities of large firms has been based on three sets of measures: *Official national R&D Surveys, Patent Statistics* and *Other ad-hoc firm-level surveys*. In general each of these measures has some strength and some weaknesses (Patel and Pavitt, 2000). For example R&D is only one input into the innovation process and its relative importance differs according to industrial sector and size of firm. The propensity to use patents to protect technological leads varies according to the area of technology (and size of firm). Ad-hoc surveys are not easily replicable and are difficult to compare over time.

In this work we use patent statistics as they offer the level of detail required map the geographic distribution of knowledge creation at the firm level. The aim is to make the best available use of patent data while, at the same time, minimizing their main shortcomings. We use the country

[12] This section is based on a contribution from Vandana Ujjual (V.Ujjual@sussex.ac.uk) and Pari Patel at SPRU (University of Sussex, UK).

address of the inventor as a proxy measure for the location of international technological activity underlying that patent. This is not necessarily the country from which the patent application was filed. In the case where more than one country address appears on the same patent, we attribute the patent to each country[13]. This is of course an underestimation of the extent of foreign technology creating activities, as some of these activities may result in no patents at all. However, given the homogeneous nature of the sample, one would expect the propensity to patent across firms to be very similar.

The data set has been compiled from PATSTAT (October 2009), supplied by the European Patent Office. For each patent application at the EPO we have extracted information on the *name of the company* making the application, the *priority year*, the *IPC class*, and *country of origin of the inventor*. The main difficulty with the primary data is that many patents are granted under the names of subsidiaries and divisions that are different from those of the parent companies, and are therefore listed separately. In addition the names of companies are not unified, in the sense that the same company may appear several times in the data, with a slightly different name in each case. Consolidating patenting under the names of parent companies can only be done manually on the basis of publications such as '*Who Owns Whom*'. In the present study we have consolidated firms on the basis of the on-line version of *Hoovers*. Also from this source we obtain information on the *country address of the headquarters* and the *principal product group* of the firm.

3.1.1 Construction of the Sample

The dataset used in this paper consists of 363 large firms headquartered in Europe, USA and Japan[14]. These firms are classified into 11 different sectors according to their principal product group. The dataset is constructed by matching two databases, i.e., that based on patent data available from the EPO and on financial data available from Compustat over the period 1991-2006. Since the patent data are more infrequently observed than financial data, we divided the data into two sub-periods, viz. 1991-96 and 2001-06. We thus have a balanced panel of data for 363 firms for 2 time periods distributed over 11 industrial sectors. The creation of matched dataset of financial and patent data involved several stages.

The first stage involved the selection of the top patenting firms at the EPO. We began with a long list of some 3000 firms with patent applications in the priority years 1991- 2006 which were checked against the on-line version of the *Hoovers* database to check for company affiliations. The identified firms were then compared to the 2000 companies included in the EU R&D Scoreboard for 2007[15]. This process resulted in 970 firms which can be regarded as the most technologically active firms in the world as together they account for more than 85% of corporate R&D (as reported in the EU Scoreboard of 2007) and more than 70% of all EPO patents in the period 1991-2006.

In the second stage these firms were matched to the data from *Standard and Poor’s Compustat* database. This resulted in 656 firms in the three regions of USA+, EU and Japan for the period 1991-2006, which had some financial data which could be matched to the patent data. For a substantial proportion of these firms financial data supplied by *Compustat* were incomplete. Particularly, there were missing values for *R&D expenditures (R&D)*, *capital expenditures*, *market*

[13] In other words we use the ‘whole’ count approach as opposed to ‘fractional’ counts.
[14] This includes 15 Swiss firms and 2 Norwegian firms classified as European, and 3 Canadian firms which are classified as American.
[15] See http://iri.jrc.ec.europa.eu/research/scoreboard_2007.htm.

value and *sales* for some years. An exercise was undertaken to fill in the gaps in the data. In the first instance all observation that had *market value* and/or *sales* values missing for the entire period 1991-2006 were omitted from the final sample. In cases where *sales* were missing for only for one or two years, the average values were computed. Missing values for R&D expenditures were estimating using all publicly available information: UK and EU Company R&D Scoreboards, Annual financial reports from Company websites, etc.

Another major task undertaken was to convert all data to common currency, the euro, as the data provided by *S&P* were in national currency. The conversion to euros prior to 1999 was achieved by using the average annual exchange rate given by the European Central Bank. For companies based in non-Eurozone countries (US, Japan, UK, Sweden, Denmark, Switzerland and Norway) the average annual exchange rates provided by EUROSTAT were used post 1999[16].

Table 3.1: Composition of the sample

	USA+	Europe	Japan	All Firms
No. of Firms	140	95	128	363
Proportion of sample	38.50%	26.20%	35.30%	100%

3.1.2 Construction of the variables

Dependent Variable- In order to analyse the effect of international technology creation on firm performance, we use a measure of long-term profitability as our dependent variable, which is *Tobin's Q*. In this, we follow previous studies that have analysed the effect of technology on firm performance[17]. *Tobin's Q* is simply the market value of a firm divided by the book value of its capital assets. Here market value is defined as the sum of (a) the common equity (share price multiplied by the number of outstanding shares), (b) long term debt (at market value) and (c) value of other securities such as preference shares. The underlying rationale is that if the firm has some intangible assets such as knowledge capital then this ratio will be above one, reflecting the long term innovation potential of a firm[18]. The advantage of using this indicator as a measure of performance is that it takes into account all available information about the firm over a span of time, including knowledge drawn from foreign locations. Since we are dealing with large firms this is likely to be a better measure than the average of short-term profits and to reflect more fully the effect of the knowledge capital of the firm, including knowledge drawn from foreign locations.

Explanatory variables- We use the following set of explanatory variables to asses the impact of international technology creation on the market value of large firms:

- Patent statistics to construct the explanatory variables as a proxy for the foreign technology creating activities in large firms. Here we distinguish between two aspects of foreign technology creation:

[16] http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tec00033, Description by Eurostat: "Exchange rates are the price or value of one country's currency in relation to another. Here the exchange rates are those for the euro published by the European Central Bank. Before 1999 the exchange rates are those of the ECU, as published by the European Commission".
[17] See Hall (2001) for the reasons why market value is a good indicator of firms' long term performance.
[18] However in the long run we would expect the market value of a firm is equal to the book value of its assets.

i) The volume international knowledge creation, (the number of patents granted from foreign locations), and

ii) The spread of such activities, (the number of foreign locations from which patents are drawn).

The rationale for the two measures is that the management implications of spreading knowledge creation over many locations are different from that of managing a limited number of locations.

The measure of the firm's foreign patent stock relative to its capital assets is the variable employed to capture the volume of foreign patents (*fpatstock*). For the spread of international knowledge creation, we use the number of locations the foreign patents are drawn from (*fpatloc*). In order to achieve this we only include locations with 5 patents or more over a 5 year period. This is a measure of the dispersion of technological activity and shows whether for a specific firm such activities of are concentrated in one particular country or located in multiple countries. We expect these variables to influence market value positively.

- The R&D stock[19] normalised by the book value of capital assets (rdstock). We expect this variable to reflect the knowledge capital of the firm and influence market value positively.

- The domestic patent stock of the firm (dpatstock) relative to the book value of capital assets. We expect this variable to influence market value positively.

We use the perpetual inventory method for calculating the capital stock of a company (the denominator in Tobin's Q (see for example Hall et al., 2001). We use the annual capital investment data provided by *Compustat*, which in turn are based on company annual financial reports. The rate of depreciation used is 15% and the initial year is 1991 (this is the first year for which we have investment data).

3.2 Descriptive analysis

Here we show that the strategies for technology internationalisation by increasing the volume of foreign technology creation (foreign patents) can be contrasted with that for spread of foreign technology creation (foreign patents). Table 2 presents the international technology creation activity by region. The volume and spread of international patents and the patent stock are given for the two periods (1991-96 and 2001-06). It is evident that European firms are highly internationalised in terms of volume and spread of international technology creation compared to USA+ (USA and Canada) and Japanese firms. The foreign patent stock of the EU firms has also shown the highest rate of growth. In 2001-06 the European MNCs realised almost half of its total patents (46%) from outside its home country. For the USA+ and Japanese MNCs, the share of foreign patents was around 23%. This can be compared to the figures from the UNCTAD survey, where the share of foreign R&D spending by MNCs in 2004-2005 was highest for the European TNCs (41%), the share of US firms was 24% and Japanese firms had the lowest share (15%) (*UNCTAD- World Investment Report, 2005*).

[19] All the variable available from the balance sheet data are flow variables. In order to convert them into stock variables, we follow the methods used in Hall et al (2001). All stocks (e.g. R&D stock, capital stock) are constructed from the underlying flow data (viz. R&D expenditure, Investment expenditure) using an annual depreciation rate of 15%. Thus only 85% of investment in year 1 gets added to investment in year 2 to calculate the capital stock due to investment in year 1 and 2.

Table 3.2: Trends in foreign technology creation by region

Region	N	fpatstock			fpatloc		Patent Stock		
		2001-06	1991-96	Growth Rate %	2001-06	1991-96	2001-06	1991-96	Growth Rate %
EU	95	46.12	35.73	29.07	7	4	663	329	101.5
		(82.07)	(60.03)		(6.4)	(3.9)	(1137)	(548)	
USA+	140	23.16	22.24	4.13	5	3	323	208	55.28
		(31.32)	(34.24)		(4.2)	(3.3)	(440)	(330)	
Japan	128	22.88	19.85	15.26	1	1	330	186	77.41
		(36.89)	(34.70)		(1.6)	(1.09)	(542)	(329)	
All Firms	363	29.07	24.93	16.60	4	3	415	232	78.87
		(52.02)	(43.02)		(4.9)	(3.3)	(731)	(401)	

The correlation between the variables is presented in the Table 3 below. The Table presents the correlation for the entire sample as well as for the firms across the three regions. The correlation between the two measures fpatstock and fpatloc is only moderately positive at 0.24 for the full sample. However, across the three regions, a large foreign patent stock co-exists with many locations for the European firms, while there is no correlation in the case of Japanese firms (see Table below). This suggests that different types of activities and motivations may be at play in the different regions.

The positive correlation between the volume measures of foreign technology creation and the long term profitability measure suggests that extensive international technology creation can translate into superior market performance only if the strategy is based on increasing the volume of foreign technology creation (fpatstock) and not with respect to the greater spread of foreign technology creation. This is true in the case of all firms except for the European firms (see Table 3). For European MNCs none of the foreign technology creation strategies is resulting in greater Market value.

Table 3.3: Means, standard deviations and correlations for the period 2001-06

All firms

		1	2	3	4	5
1	fpatloc	1				
2	fpatstock	.24*	1			
3	dpatstock	-0.05	.29*	1		
4	rdstock	.15*	.42*	.33*	1	
5	TobinQ	0.08	.24*	.21*	.7*	1
	Mean	4.2	0.04	0.35	1.3	15
	Std. Dev.	4.9	0.13	0.99	1.5	20

US

		1	2	3	4	5
1	fpatloc	1				
2	fpatstock	.26*	1			
3	dpatstock	-0.09	.26*	1		
4	rdstock	0.03	.48*	.37*	1	
5	TobinQ	-0.02	.23*	.18+	.73*	1
	Mean	4.9	0.06	0.4	1.7	23
	Std. Dev.	4.2	0.2	1.5	1.9	28

Europe

		1	2	3	4	5
1	fpatloc	1				
2	fpatstock	.43*	1			
3	dpatstock	0.07	.34*	1		
4	rdstock	.31*	0.17	.28*	1	
5	TobinQ	0.14	0.1	.36*	.55*	1
	Mean	7	0.04	0.26	1.1	12
	Std. Dev.	6.4	0.06	0.33	1.2	12

Japan

		1	2	3	4	5
1	fpatloc	1				
2	fpatstock	-0.11	1			
3	dpatstock	-0.13	.99*	1		
4	rdstock	0.03	.22*	.22+		

5	TobinQ	-0.07	.36*	.36*	.65*	1
	Std. Dev.	1.6	0.03	0.47	0.9	10
	Mean	1.2	0.02	0.35	0.9	8.6

* Correlation is significant at the 0.01 level (2-tailed), + Correlation is significant at the 0.05 level (2-tailed)

It is also evident from the Table above that the firm’s R&D spend (rdstock) compared to domestic as well as foreign patent stock is rather more important in order to achieve greater market performance. This is consistent across all regions. At the same instance, we see that the strong positive correlation between the rdstock and the volume of foreign technology creation (fpatstock) is visible only in the case of the Japanese and USA+ MNCs. For the European MNCs on the other hand, there is strong positive correlation between the spread of foreign technology creation and R&D spending (rdstock). This suggests that it is important to understand the direct and indirect effect of foreign technology creation on the MNC’s market performance. This is explored by undertaking the econometric analysis where we assess how foreign technological activities affect the market’s valuation of a firm.

3.3 Estimation of the impact of foreign knowledge creation on the long term profitability of firms

In this section we will assess how foreign technological activities affect the market’s valuation of a firm. Previous studies on technology have used *TobinQ* as a dependent variable and found that intangible R&D assets of a firm influence this ratio positively. For example Hall and Trachtenberg (2001) show that citation weighted patents has a positive influence on the market value of US firms and Grliches (1981) showed that the R&D expenditures of a firm influence the market value positively. In this paper we hypothesise that the impact of global R&D activity on firm performance depends on the kind of technology internationalisation strategy. The results suggest that the strategy to enhance the volume of foreign knowledge creations by MNEs is seen to have an impact on their long term profitability which is different from that for a strategy focussed on increasing the spread of such activities.

The preliminary analysis based on the correlation between *rdstock* and foreign technology creation variables and market value as discussed above, suggests certain underlying dynamic relation between these variables. Hence the intention here is to determine the direct and indirect effects of foreign technology creation on the market value of firms. To assess this, we estimate the one-way fixed effects linear regression model described by equations (1) and (2) below. We follow the specification used in previous literature, which examines the extent to which knowledge capital affects the Tobin Q. The subscripts i and t stand for firm and time period respectively while ν_{ijt} is a random error term with constant variance.

$$TobinQ_{it} = \delta_0 + \delta_1 rdstock_{it} + \delta_2 fpatstock_{it} + \delta_3 dpatstock_{it} + \varsigma_1 (fpatstock \times rdstock)_{it} + \varsigma_2 (dpatstock \times fpatstock)_{it} + \psi_j + \nu_{it} \quad (1)$$

$$TobinQ_{it} = \beta_0 + \beta_1 rdstock_{it} + \beta_2 fpatloc_{it} + \beta_3 dpatstock_{it} + \gamma_1 (fpatloc \times rdstock)_{it} + \gamma_2 (fpatloc \times dpatstock)_{it} + \eta_j + \nu_{it} \quad (2)$$

The direct effects of foreign technology creation on long-term profitability are measured by the significance of δ_2 and β_2 while γ_1 and γ_2 as well as ζ_1 , and ζ_2 capture the strength of the indirect effect of foreign technology creation on market value through its augmentation of the existing knowledge capital of the firm (viz. its technological capacity and current R&D expenditures) and its effect on productive efficiency respectively.

Table 4 presents the results of estimating the equations (1) and Table 5 presents the results for equation (2). Columns (1) consider the direct effects alone while columns (2) report the results of estimating the full unrestricted equation, with the indirect effects included. The first point to emerge from this analysis is that the effect of foreign patent stock on market performance is weak and unstable. In the direct effects version of the model the coefficients are all statistically insignificant. When indirect effects are included in the model (column 2), the results for the US firms indicate that both the direct and indirect effect of international patent activity on the market value is statistically significant. For these firms *fpatstock* has a positive effect but the indirect effect via R&D stock is negative. This indicates that US firms with relatively high levels of R&D capital are less likely to economically benefit from foreign knowledge creation than those with lower levels of such capital. In the case of the Japanese firms the foreign patent variable has a positive but statistically insignificant effect on market value but the indirect effects are positive and significant. This indicates that Japanese firms with high R&D capital will most likely benefit from foreign knowledge creation than those with lower R&D capital.

With respect to the spread of the international technology creation, the estimation results indicate a negative impact on the market value. This suggests that a greater extent of dispersion of such activities in many international locations by the firm is seen to negatively affect their market value. Specifically, in the case of Japanese firms, there is both a direct and indirect negative effect. Japanese firms with less dense overall patent stock that are spread over geographically dispersed locations tend to face greater difficulty in achieving greater returns. So for Japanese firms that do not have an extensive patent portfolio, it is important to internationalise gradually, by initially focussing in few locations to undertake such activity.

Table 3.4: The impact of the intensity of foreign technological activity on MNCs long-term profitability Using *fpatstock* variable Dependent Variable: *TOBINsQ*

Parameter	(1) Direct Effects only			(2) Direct & Indirect Effects		
	USA	*EUROPE*	*JAPAN*	*USA*	*EUROPE*	*JAPAN*
constant	7.397***	15.36	.790	4.75***	18.36	1.945**
rdstock	8.86***	2.658	6.82***	10.52***	.385	4.87***
dpatstock	.088	-2.917	.761	-.367	-10.62	-2.789
fpatstock	-1.992	-15.66	48.703	21.381**	-61.45	42.142
rdstock * fpatstock				-3.98***	40.78	65.46***
dpatstock * fpatstock				.238	33.88	-3.121

******* significant at the 1% , ** significant at the 5%, * significant at the 10%

Table 3.5: The impact of the spread of foreign technological activity on MNCs long-term profitability Using *fpatloc* variable Dependent Variable: *TOBINsQ*

Parameter	Direct Effects only (1)			Direct & Indirect Effects (2)		
	USA	*EUROPE*	*JAPAN*	*USA*	*EUROPE*	*JAPAN*
constant	8.12***	14.42	1.491**	9.33***	14.5*	1.321*
rdstock	8.77***	2.38	6.90***	7.99***	-1.33	6.437***
dpatstock	-.097	-4.670	4.47***	.123	8.075	6.673***
fpatloc	-.168	.142	-.681**	-.615*	.348	-.282
rdstock * fpatloc				.188	.523	.327
dpatstock * fpatloc				.460	-2.99	-2.973**

******* significant at the 1% , ** significant at the 5%, * significant at the 10%

4 THE IMPACT OF R&D OFFSHORING ON THE PRODUCTIVITY GROWTH OF EU REGIONS[20]

In order to investigate whether offshoring of R&D affects regional productivity, we gather data on international investment projects, from which we are able to build unique measures of outward (and inward, which will be used as controls) foreign direct investment (FDI) in R&D, as well as in manufacturing and other business activities, at the regional level (NUTS 2), for the countries of the European Union (EU-27). We then estimate regressions of productivity growth as a function of the lagged number of international R&D projects, controlling for a measure of inward FDIs, as well as other regional characteristics and country fixed effects. We find that offshoring regions have higher productivity growth and a positive correlation emerges between the number of R&D projects abroad and the home region productivity. Inward investments are also positively associated with regional productivity growth, but only above a certain thresh- old.

The rest of the paper is organized as follows: Section 2 presents the related literature; Section 3 provides details on the characteristics of the data and focuses on how the main variables of interest have been measured and constructed, while Section 4 illustrates the econometric specification and results. Section 5 concludes the paper.

[20] This section builds on contributions by Davide Castellani (davide.castellani@unipg.it) and Fabio Pieri for Centro Studi Luca d’Agliano. See Castellani and Pieri (2011a and b) for details.

4.1 Data and variables

4.1.1 Data sources

We exploit an original database, which has been compiled recovering data from different sources. Data refer to European regions, at the NUTS 2 level: this level of analysis has been chosen for three main reasons. First of all, it is suitable for taking into ac- count the within-country heterogeneity (in terms of labour productivity, foreign direct investments and the other observed and unobserved characteristics); second, it allows for comparable units across different countries; finally, more information is available on other regional characteristics at this level of disaggregation[21].

4.1.2 Labour productivity

The dependent variable is the labour productivity, which has been computed as the ratio of the regional gross valued added (at basic prices in millions of euro) obtained from the EU Regional Database developed and maintained by Eurostat[22] , while data on employment at the regional level come from the European Regional Database, developed by Cambridge Econometrics (release 2006). Value added has been deflated using nationwide indexes, available in the Growth and Productivity Accounts database developed by EU KLEMS23 (releases 2008 and 2009). The last year for which information on value added are available in the Regio database is 2006. The time structure of our data imposes some constraints on the empirical analysis. In particular, regional productivity is observed only up to 2006, while information on foreign investments are available for the period 2003-2008. Thus, if we want to assess the econometric relationship between the latter and the former, we are left with four years of data: 2003, 2004, 2005 and 2006.

Figure 1 provides a graphical representations of the variables measuring the labour productivity in levels and growth at the NUTS 2 level. Labour productivity levels are clearly higher in the core regions of the EU-15, while decline in Southern European regions and reach minimum values in the regions of EU-12 countries. As for the growth rates, rather similar patterns are observed in regions belonging to the same country mainly in EU-12 countries, but also in Italy, France and Spain; while in Germany and UK productivity growth displays a remarkable within-country variability. In order to account for possible biases stemming from these country patterns in productivity growth, country dummies will introduced in our estimated equation.

4.1.3 Measures of offshoring

Data on offshoring have been recovered from *fDi Markets*, an online database maintained by fDi Intelligence —a specialist division of the Financial Times Ltd—, which monitors crossborder investments covering all sectors and countries worldwide. Relying on media sources and company data, *fDi Markets* collects detailed information on cross- border greenfield investments (available

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[21] See Table A.3 in the Appendix for the detailed list of regions, that have been considered in the econometric analysis.
[22] See the Eurostat web page http://epp.eurostat.ec.europa.eu/portal/page/portal/region cities/.
[23] See the web page of the EU KLEMS project at http://www.euklems.net/.

since 2003)[24]. *fDi Markets* data are based on the announcement of the investment and provides daily updated data. For each investment project, fDi Markets reports information on the investment (e.g., the leading industry sector of the investment), the home and host countries, and regions and cities involved, and the investing company (e.g., location, parent company). The database is used as the data source for FDI project information in UNCTAD’s World Investment Report and in publications by the Economist Intelligence Unit. This source tracked 60,301 worldwide investments projects appeared on publicly available information sources in the period 2003-2008.

One of the limitations of the *fDi Markets* database is that it collects planned future investments. Some of these projects may not actually be realized or may be realized in a different form from the one originally announced. However, the database is regularly updated and projects which have not been completed are deleted from the database. In this regards, data on the projects related to the early years of the series should be more reliable than data regarding the last years of the series. We tackle this issue by dropping the last two years of data, so we use information on foreign investments from 2003 to 2006. Our measures of offshoring is then built as the number of outward investment projects from each region in each year of the period 2003-2006. We have also built measures of inward investments at the regional level, to control for possible confounding effects due to the fact that regions engaged in outward internationalization may also be those attracting more foreign multinationals. Admittedly, the count of investments projects may not be an accurate proxy of offshoring activity, since it does not weights investments for the value of the capital involved. However, the correlation coefficients (0.82 and 0.83), reported in Table 1, between the distribution of investments projects by EU countries and the actual distribution of FDI flows, as reported by UNCTAD, reassures us that data on investment projects are actually a good proxy for FDI flows. As expected, almost 90% of EU outward investments are made from EU-15 countries, while inward investments are split more evenly among EU-15 and EU-12 countries: United Kingdom, Germany and France result to be the leading countries both in terms of inward and outward FDIs in the period which goes from 2003 to 2006. As for the inward investments, Poland, Romania, Hungary, Czech Republic and Bulgaria show a good performance[25].

Unfortunately, official statistics on inward and outward investments at the regional level are not available, so we cannot benchmark *fDi Markets* data as this finer geographical level. However, a casual inspection based on Figure 3(a) highlight some expected patterns. In particular, they appear highly concentrated in a limited number of clustered regions within each country, including the regions around the major cities.

Exploiting the information on the main business activity involved in each of the international projects in the *fDi Markets* database, Figure 3(b) reports the share of R&D offshoring projects over the 2003-2008 period, while Figure 3(c) shows, for comparison, the share of outward investments in manufacturing activities. In line with the idea that R&D offshoring is still a limited, although increasing phenomenon, only a relatively small number of regions have some

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[24] A team of in-house analysts search daily for investment projects from various publicly available information sources, including, Financial Times newswires, nearly 9,000 media, over 1,000 industry organizations and investment agencies, data purchased from market research and publication companies. Each project identified is cross-referenced against multiple sources, and over 90% of projects are validated.

[25] A careful inspection reveals that the number of projects overestimates inward FDIs to some New Member States, such as Poland, Romania, Bulgaria, Hungary and Czech Republic, probably due to the fact that these countries received a large number of relatively small-scale investments projects.

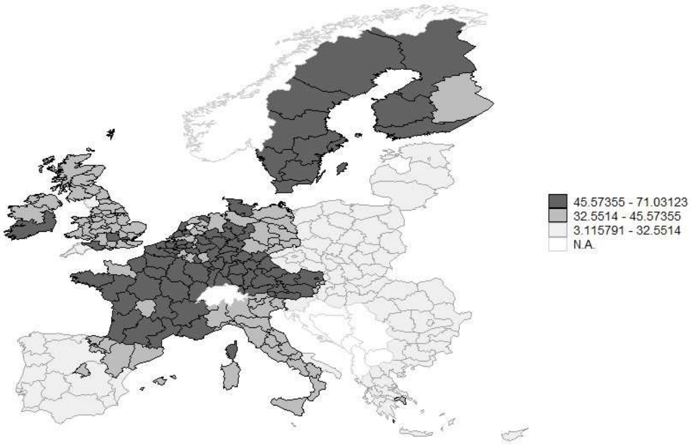
R&D offshoring activity, while manufacturing offshoring is much more pervasive and accounts for a larger share of total outward investments in each region, while R&D are usually a small portion.

Table 2 and A.1 provide some basic statistics for the variables later used in the econometric analysis. As concerns offshoring, Table 2 shows that, on average, from each region about 12.75 offshoring and 9.28 incoming projects per year have been recorded. However, the distribution of the number of projects is highly skewed: more than 25% of regions have no offshoring and more than 10% would not attract any inward investment. This skewness is even more evidence in the case of R&D offshoring, who is carried out by slightly more than 10% of the regions (the 90^{th} percentile is equal to 1).

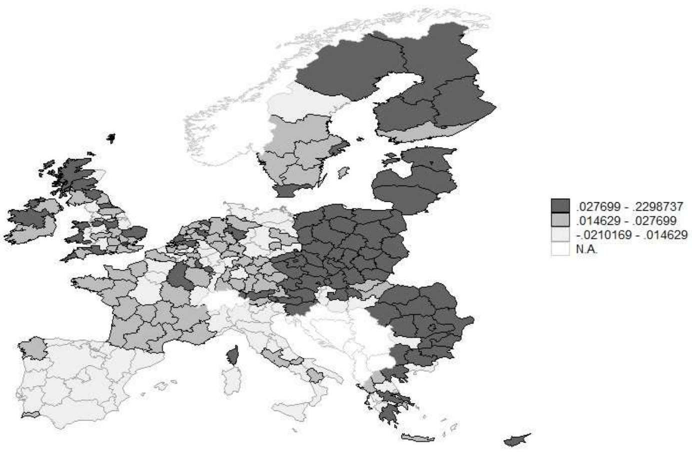
Table 1: fDi Markets projects vs. UNCTAD Flows, 2003-2006

	Outward			Inward	
Country	# proj.	flows	Country	# proj.	flows
Germany	22.2	11.7	United Kingdom	16.0	25.8
United Kingdom	20.3	16.3	France	9.2	15.2
France	13.8	17.6	Germany	8.3	8.1
Italy	6.3	5.7	Poland	6.5	3.0
Netherlands	5.9	13.7	Spain	6.2	7.2
Sweden	5.9	4.7	Romania	5.9	1.7
Austria	5.1	2.0	Hungary	5.4	1.4
Spain	4.6	11.7	Czech Republic	4.1	1.5
Finland	3.1	0.3	Bulgaria	4.1	1.1
Belgium	2.5	7.9	Ireland	4.1	-1.6
Denmark	1.9	1.4	Italy	3.9	5.9
Ireland	1.4	2.7	Sweden	3.2	3.4
Slovenia	1.1	0.1	Netherlands	3.1	5.1
Greece	0.9	0.4	Belgium	2.9	10.8
Latvia	0.9	0.0	Slovakia	2.6	0.8
Estonia	0.6	0.1	Lithuania	2.4	0.2
Portugal	0.5	1.2	Austria	2.2	1.9
Luxembourg	0.5	1.0	Denmark	1.9	1.2
Poland	0.5	0.7	Latvia	1.7	0.2
Czech Republic	0.5	0.1	Estonia	1.5	0.4
Hungary	0.4	0.4	Portugal	1.3	1.5
Lithuania	0.4	0.0	Greece	1.1	0.6
Cyprus	0.2	0.1	Finland	0.9	1.2
Romania	0.2	0.0	Slovenia	0.8	0.2
Slovakia	0.1	0.0	Luxembourg	0.4	2.7
Bulgaria	0.1	0.0	Cyprus	0.3	0.3
Malta	0	0.0	Malta	0.2	0.2
Total	100	100		100	100
Pearson corr. coefficient	0.82			0.83	

Figure 1: Regional patterns of labour-productivity level and growth, 2003-2006 (average)

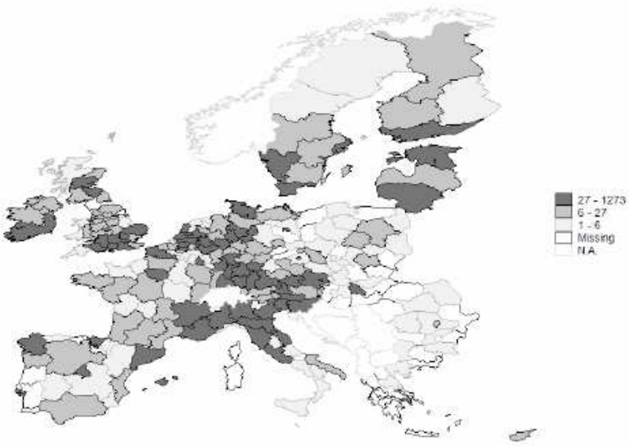


(a) Labour productivity (level)

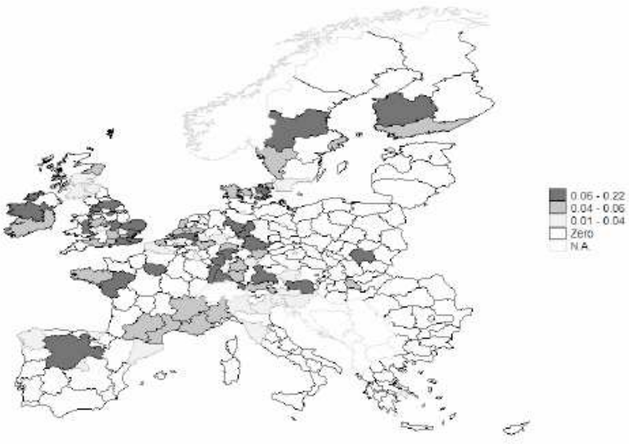


(b) Labour productivity (growth)

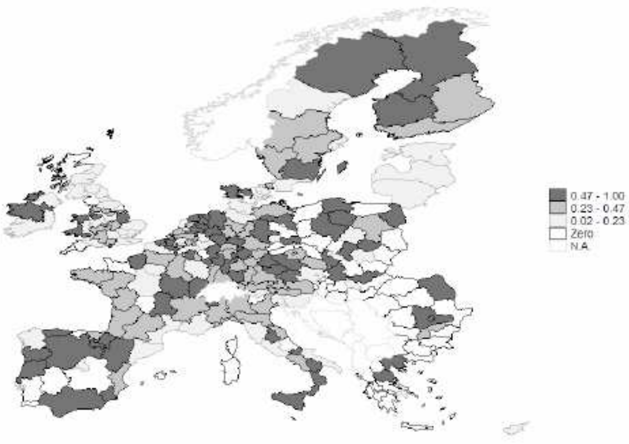
Figure 2: Regional distribution of offshoring projects, 2003-2006



(a) Total number of offshoring projects



(b) Share of R&D projects



(c) Share of manufacturing projects

Table 2: Descriptive statistics, 2003-2005

variable	mean	p10	p25	p50	p90	p95	p99	max
OFF	12.75	0	0	2	30	55	129	404
OFF^{rd}	.54	0	0	0	1	2	12	29
OFF^{manuf}	3.14	0	0	1	8	13	33	90
INW	9.28	0	1	4	23	35	75	209

4.2 Econometric analysis

We estimate the effect of offshoring on the home region productivity growth, control- ling for inward FDIs, the growth of capital-labour ratio, country-fixed effects and other regional characteristics. However, the skewness of the foreign investments variables induces us to model their effect as a combination of two dummy taking value equal to ‘0’ for those observations (region/year) where no investments have taken place (OF F (d) and I N W (d)) and two continuous variable (OF F (n) and I N W (n)) taking the value equal to the number of investments in the case of non-zero investments, and ‘0’ otherwise. This specification allows to distinguish the effect of a region being generally involved in offshoring, which is captured by the dummy variable, from the effect of the extent of offshoring, which is captured by the continuous variable.

The estimated equation then becomes:

$$\begin{aligned}\Delta y_{ij,t} = \alpha + \beta\Delta kl_{ij,t} + \Delta \mathbf{x_{ij,t}}\delta + \\ + \gamma^{d} OFF(d)_{ij,t-1} + \gamma^{n} OFF(d)_{ij,t-1} \cdot OFF(n)_{ij,t-1} + \\ + \lambda^{d} INW(d)_{ij,t-1} + \lambda^{n} INW(d)_{ij,t-1} \cdot INW(n)_{ij,t-1} + \\ + \eta_j + \tau_t + \Delta\epsilon_{ij,t}. \quad (1)\end{aligned}$$

where $kl_{ij,t}$ indicates the (log of the) capital-labour ratio, $\mathbf{x_{ij,t}}$ is a vector of other regional characteristics, such as the level of human capital, the stock of technological cap- ital, the regional industrial composition and the degree of concentration/diversification of the regional industry. We also include a vector of time effects, τ_t , to control for factors affecting all regions in the same way in a given year; while η_j is introduced in order to capture the country-specific trends in labour productivity. We make the hypothesis that foreign investments affect productivity with one-year lag[26].

[26] This specification can be though as deriving from one in levels, once accounted for regional fixed effects by first-differencing. See (Castellani and Pieri, 2011) for more details.

Table 3: The effect of offshoring on EU regional productivity growth (OLS regressions)

	(1)	(2)	(3)	(4)
$OFF(d)_{t-1}$	0.0065***	0.0059**	0.0062***	0.0056**
	(0.0025)	(0.0024)	(0.0024)	(0.0024)
$OFF(n)_{t-1}$		-0.0001***	-0.0002***	-0.0002***
		(0.0000)	(0.0001)	(0.0001)
$OFF(n)^{rd}_{t-1}$			0.0014**	
			(0.0006)	
$OFF(n)^{man}_{t-1}$				0.0002
				(0.0002)
$INW(d)_{t-1}$	-0.0052**	-0.0055**	-0.0055**	-0.0057**
	(0.0023)	(0.0023)	(0.0023)	(0.0023)
$INW(n)_{t-1}$		0.0003***	0.0003***	0.0003***
		(0.0001)	(0.0001)	(0.0001)
$\Delta_{t,t-1}kl$	0.2234***	0.2416***	0.2429***	0.2412***
	(0.0809)	(0.0803)	(0.0803)	(0.0802)
Constant	0.0206***	0.0214***	0.0222***	0.0215***
	(0.0038)	(0.0036)	(0.0036)	(0.0036)
Country dummies	Yes	Yes	Yes	Yes
N. observations	769	769	769	769
N. regions	265	265	265	265

We estimate Equation 1 by OLS, and the results are reported in the columns (1) and (2) of Table 3. In this case we are left with three pooled cross-sections of first-differenced equations: 2004-2003, 2005-2004 and 2006-2005 In this and the following regressions we report robust standard errors clustered by regions to control for the lack of independence of observations referring to the same region over time

OLS estimates of equation 1 are reported in column (1) and (2) of Table 3. To be precise, in column (1) we estimate only the effect of the two dummies taking value 1 if a region has at least one outgoing or incoming investment project (respectively), while in column (2) we also estimate the effect of the number of investments. Results support that offshoring regions have a 0.6 percentage points higher productivity growth, while regions receiving inward investments appear to have lower productivity growth. Column (2) helps qualify this result: while the positive effect of offshoring is slightly decreasing in the number of investments, a higher number of incoming multinationals is associated with higher productivity growth. We performed a number of robustness checks, which we do not report here to save space27 . In particular, (i) we tested (and

rejected) that offshoring may have contemporaneous effects on productivity growth, and that past offshoring may be endogenous with respect to current productivity growth ;(ii) we included controls for spatial dependence, as well as regional characteristics (in levels) –including population, a dummy for regions hosting the country capitals, the level of education, employment density, patenting activity, sectoral specialization– none of which change the results significantly.

From Equation 1, it is possible to compute the threshold number of offshoring investments above which the overall effect is negative, and the number of inward investments above which the overall

[27] The reader can refer to (Castellani and Pieri, 2011) for details.

effect is positive. In particular, taking the partial derivative of labour productivity growth with respect $OFF(d)$

$$\frac{\partial \Delta y}{\partial OFF(d)} = \gamma^d + \gamma^n \cdot OFF(n). \tag{2}$$

The effect of offshoring will be positive as long as

$$OFF(n) > \frac{-\gamma^d}{\gamma^n}. \tag{3}$$

As for the effect of inward investments, the same calculation would yield that the effect is positive for

$$INW(n) > \frac{-\lambda^d}{\lambda^n}. \tag{4}$$

In particular, taking Specification (2) as a reference, with $\gamma^{--d} =$ -0.0059 and $\gamma^n =$ 0.00013, the marginal effect of offhoring would be positive for a number of outgoing project smaller or equal to 44.6. From Table 2 we gather that this is between the 90^{th} and 95^{th} percentile, meaning that less than 10% of the regions actually experience a negative effect of offshoring on productivity growth. Conversely, the threshold for inward investments is 18.2, which is between the 75^{th} and 90^{th} percentile, suggesting that about one-quarter of regions benefit from incoming multinationals.

The effect of R&D offshoring (as opposed to offshoring of manufacturing or other activities) on regional productivity is investigated augmenting the specification (1) with the number of outward investment in R&D and in manufacturing. In formal terms, our estimated equation takes the following form:

$$\begin{aligned}\Delta y_{ij,t} = \alpha + \beta \Delta kl_{ij,t} + \Delta \mathbf{x_{ij,t}} \delta + \\ + \gamma^d OFF(d)_{ij,t-1} + \gamma^n OFF(n)_{ij,t-1} + \gamma^{ba} OFF(n)^{ba}_{ij,t-1} \\ + \lambda^d INW(d)_{ij,t-1} + \lambda^n INW(n)_{ij,t-1} + \eta_j + \tau_t + \Delta\epsilon_{ij,t}.\end{aligned} \tag{5}$$

where *ba* denotes the business activity (i.e. R&D or manufacturing).

Results reported in column (3)-(6) Table 3, show that R&D offshoring is associated with significantly higher productivity growth, while the effect of offshoring production is not different from the overall effect. It is worth mentioning that the magnitude of the effect of R&D offshoring is remarkable: our estimates suggest that comparing two regions that have the same degree of offshoring (and everything else constant), if we let one have an additional R&D project abroad in one year, this region would experience a rise in productivity growth by 0.14 percentage points the next year.

So far we have considered as offshoring also investments between regions of different countries but within Europe. Let us now overcome this assumption and focus on the effects of R&D offshoring towards countries outside Europe, as opposed to offshoring within the area. Table 4 presents some descriptive statistics of R&D offshoring both intra and extra Europe. Rather interestingly, less than one-third of R&D offshoring projects are directed towards other European countries (both within and outside the EU), so the bulk of investments is actually directed to non-European countries. As already stressed in a report for the EU (Pro Inno Europe, 2007) the main non-European recipients of

R&D offshoring are China and India, then are developed countries and other South-East-Asian countries. Other developing countries, which include important destinations such as Brazil and Russia, attract also a considerable number of projects. In Table 5 we assess the effect of offshoring R&D within Europe versus non-European countries. Results suggest that offshoring R&D within Europe does not bring significantly different productivity gains than offshoring R&D outside Europe: both the coefficients are is similar in magnitude, but they are rather imprecisely estimated. When we consider R&D offshoring towards specific areas, we find that the effect on productivity growth is always positive, including the case of China, but in most cases it is imprecisely estimated. The effect is larger and significant in the case of R&D offshoring toward South-East-Asian countries. Conversely, regions offshoring R&D more intensively towards India experience a significantly lower productivity growth. This be explained by a number of concurrent factors. For example, it could signal that offshoring towards India substitute for R&D activities in the home regions, thus decreasing productivity, that reverse technology is less effective from Indian affiliates or that investing in India is not associated with firm growth at home (and thus reallocation of market share to offshoring firms). At any rate, a closer inspection of the patterns of R&D offshoring in India is necessary, in order to better grasp the reasons for the peculiar effect that these investments have on European regions' productivity growth.

Table 4: Descriptive statistics on R&D offshoring, 2003-2006

variable	mean	p50	p90	p95	p99	max
OFF^{rd}	.549	0	1	2	12	29
$OFF^{rd\text{ - }intra\ europe}$	.171	0	0	1	4	9
$OFF^{rd\text{ - }extra\ europe}$	.377	0	1	2	10	20
$OFF^{rd\text{ - }developed}$	.071	0	0	0	2	5
$OFF^{rd\text{ - }china}$	.104	0	0	1	3	6
$OFF^{rd\text{ - }india}$	.074	0	0	0	2	6
$OFF^{rd\text{ - }south\ east\ asia}$	.047	0	0	0	2	5
$OFF^{rd\text{ - }others}$	.079	0	0	0	2	7

Table 5: The effect of offshoring on EU regional productivity growth (OLS regressions)

	(1)	(2)
$OFF(d)_{t-1}$	0.0062***	0.0058**
	(0.0024)	(0.0024)
$OFF(n)_{t-1}$	-0.0002***	-0.0002***
	(0.0001)	(0.0001)
$OFF(n)_{t-1}^{rd\text{ - } intra\ europe}$	0.0015	0.0022
	(0.0019)	(0.0020)
$OFF(n)_{t-1}^{rd\text{ - } extra\ europe}$	0.0014	
	(0.0010)	
$OFF(n)_{t-1}^{rd\text{ - } developed}$		0.0020
		(0.0025)
$OFF(n)_{t-1}^{rd\text{ - } china}$		0.0029
		(0.0019)
$OFF(n)_{t-1}^{rd\text{ - } india}$		-0.0061***
		(0.0022)
$OFF(n)_{t-1}^{rd\text{ - } south\ east\ asia}$		0.0045***
		(0.0016)
$OFF(n)_{t-1}^{rd\text{ - } others}$		0.0010
		(0.0021)
$INW(d)_{t-1}$	-0.0055**	-0.0059**
	(0.0023)	(0.0023)
$INW(n)_{t-1}$	0.0003***	0.0003***
	(0.0001)	(0.0001)
$\Delta_{t,t-1}kl$	0.2429***	0.2462***
	(0.0804)	(0.0810)
Constant	0.0222***	0.0221***
	(0.0036)	(0.0036)
Country dummies	Yes	Yes
N. observations	769	769
N. regions	265	265

4.3 Concluding remarks

In recent years, multinational firms have increasingly resorted to offshoring of R&D activities, in order to cope with the need to integrate differentiated sources of knowledge and implement a faster and cheaper innovative process. This is part of the broader phenomenon of Global Innovation Networks (GINs), where domestic and foreign R&D labs (as well as production and marketing departments) of multinational and non-multinational firms interact within and across firms boundaries for the global generation and diffusion of innovation. This process has increasingly involved emerging countries and raised fears that the knowledge base in advanced economies may be 'hollowed out'. At the same time, economic research has emphasized that R&D offshoring may actually strengthen the home economies, by allowing some form of reverse technology transfer, firm growth and spillovers. This paper investigates a part of this story, focussing on 'captive' offshoring of R&D28 and investigating to what extent productivity growth in 265 EU regions (NUTS 2) is affected by the propensity (and extent) of firms in the regions to set up facilities abroad, with special reference to the creation of R&D labs. Our results suggest that offshoring regions experience a higher productivity growth, but this positive effect fades down with the number of investment projects carried out abroad. However, these 'decreasing returns' to offshoring do not seem to occur in the case of R&D. In fact, our estimates suggest that one additional R&D offshoring project is associated with a significantly higher regional productivity growth the next year. This is effect is positive regardless of whether offshoring occurs within Europe or towards other emerging or advanced countries (with the exception of India).

Although more research is needed in order understand the channels and conditions underlying the positive effect of R&D offshoring on productivity growth at home, our study sends a reassuring message to EU policymakers, since it supports the idea that carrying out R&D abroad (even in China and other emerging economies) strengthens - rather than 'hollows out' - European sources of competitiveness.

5 SERVICE OFFSHORING AND LABOR DEMAND IN EUROPE[29]

Over the last decade, technological progress has sharply reduced the cost of trading services internationally (see, in particular, Freund and Weinhold, 2002; and Head et al., 2009). This has allowed firms to transfer an increasing number of service activities to foreign locations (UNCTAD, 2004; OECD, 2007b). The labor market implications of this new phenomenon, which is known as *service offshoring*, have become an important concern in many industrialized countries. Notwithstanding the increasing attention by media and politicians (see, in particular, Bhagwati et al., 2004; Amiti and Wei, 2005; Trefler, 2005; and Mankiw and Swagel, 2006), data constraints have complicated econometric research until now. In this chapter, we aim to shed new light on the labor market implications of service offshoring, by providing novel, and extensive, empirical evidence on how it affects the demand for labor in Western European countries. To make the terminology clear, we will define service offshoring as the foreign relocation of service activities, via foreign direct investment or arm's length contracts with unaffiliated parties (Helpman, 2006).

We study two main channels through which service offshoring may affect labor demand. First, service offshoring may induce a parallel shift in the demand schedule. Second, it may change, and possibly increase, its slope (wage elasticity). The first effect may occur because the imported services usually interact with domestic labor, either substituting for or complementing with it in the production process. Service offshoring may thus induce firms to re-optimize their employment decisions, thereby changing the level of domestic employment *ceteris paribus* (Amiti and Wei,

[28] Thus we do not address the various aspects of GINs, such as the outsourcing of R&D, or the establishment of collaborative linkages with firms in foreign countries (with or without having a local R&D lab or other firm's facilities).
[29] This section builds on a contribution by Rosario Crinò (rosario.crino@eco.unibs.it) for Centro Studi Luca d'Agliano. More details in Crinò (2012).

2005, 2006). Furthermore, service offshoring may affect firms' productivity and scale of operations, with an additional impact on the employment level (see Olsen, 2006; Crinò, 2008; Daveri and Jona Lasinio, 2008; Görg et al., 2008; Amiti and Wei, 2009; Hijzen et al., 2010; and Görg and Hanley, 2011).

The second effect may instead occur because service offshoring increases the flexibility with which firms can potentially substitute domestic workers with foreign inputs (see, e.g., Hijzen and Swaim, 2010; and Senses, 2010). A higher elasticity, in turn, implies a greater volatility of wages and employment in response to economic shocks, a lower bargaining power of workers and a larger incidence of non-wage labor costs on employees (Rodrik, 1997). In principle, this effect requires the simple 'threat' of offshoring, and not also a large current impact on the employment level. These two channels may thus offer complementary explanations for why concerns about service offshoring are mounting in Western Europe.

To investigate these issues empirically, we use novel and comparable data for nine EU15 members over the last decade. For each country, we have information on 20 industries, which span both the manufacturing and the services sector. Following previous work by Amiti and Wei (2005, 2006, 2009), we measure service offshoring as the share of imported private services in the industry's total purchases of intermediate inputs. To construct this indicator, we use the Import Matrices recently released by Eurostat, which contain official information on the imports of different services in each industry. The use of Import Matrices allows us to relax the assumptions that would be needed to construct the indicator using Input-Output tables and economy-wide service imports, as done in most of the existing literature (see Feenstra and Jensen, 2009 for a discussion on this point). In addition, the Import Matrices allow us to build disaggregate indicators for specific types of imported services, and this enables us to explore heterogeneity in the effects of service offshoring across different activities. We complement these data with industry-level information on employment, hours worked, wages, skills, and several other characteristics of the production technology, drawn from the EUKLEMS database (O'Mahony and Timmer, 2009).

The empirical approach we use to study how service offshoring affects the location and the elasticity of labor demand is based the on estimation of conditional (on output) and unconditional labor demand functions. We derive these functions from the cost minimization and profit maximization processes of the representative firm in each country and industry. Following Feenstra and Hanson (1996, 1999, 2003), Amiti and Wei (2005, 2006), and Crinò (2010b, 2011), we condition both optimization processes on service offshoring. This means that firms choose employment optimally for a given level of this variable and re-optimize their employment decisions when the latter changes. As a consequence, the labor demand functions depend on service offshoring and shift parallel when this variable changes. The conditional demand functions capture the shift at constant output, because they are conditioned on the level of industry production. Instead, the unconditional demand models also capture the indirect effect of service offshoring passing through changes in the scale of operations. Hence, this framework makes the analysis of the first issue fairly straightforward. Following Hamermesh (1993), we choose a log-linear representation for both demand models. The reason is that, with this formulation, the parameters can be interpreted directly as elasticities. Moreover, the analysis of the second issue becomes straightforward as well: the effects of service offshoring on labor demand elasticity can in fact be gauged by simply adding to the model an interaction term between log wages and service offshoring.

We start by analyzing the effects of service offshoring on the location of labor demand, making use of the entire sample of countries. The results show that the effects are very small and, if anything, weakly positive. We present several extensions of the baseline models in order to discuss other important factors usually studied in the literature. In particular, we control for technological change, for other phenomena related to globalization, for differences in union coverage across countries, and for unobserved shocks at the country and industry level. We also use different estimation approaches, in order to show how the results would change if we departed from the simple fixed-effect estimation used as a benchmark. In particular: we estimate the models in first differences with fixed country-industry effects, so as to account for common trends in offshoring and labor demand; we use Instrumental Variables to take care of possible endogeneity of the regressors, especially wages and service offshoring; and finally, we use lagged regressors, long differences, and estimators for dynamic panel data, so as to deal with the possible sluggish adjustment in labor demand. In all cases, the results confirm the evidence emerged from the baseline estimates.

We then investigate whether the effects of service offshoring are heterogeneous across types of services, countries and skill groups of workers. We find that the aggregate results are almost entirely driven by offshoring of business services, the largest category in Europe; financial, computer, and R&D service offshoring have instead negligible impacts on the employment level. We also detect some cross-country heterogeneity in the sign of the effects, although their economic magnitude is always small. Finally, we do not find negative effects on any of three different skill groups of workers; rather, our results suggest imported services to complement with domestic workers with higher skills.

In the last part of the chapter, we turn to the effects on labor demand elasticity. We first discuss the aggregate results obtained on the pooled sample of countries. They suggest service offshoring to make labor demand more elastic, but the economic magnitude of the effect is found to be small also in this case. Next, we study the individual countries separately and find heterogeneity in the sign of the effect across them. Building on recent work by Hasan et al. (2007) and Hijzen and Swaim (2010), we explore one potential explanation for such heterogeneity: the difference in labor market regulations across countries. In countries with weak regulations, in fact, labor demand may be adjusted more flexibly by firms, and the effect of service offshoring may end up being larger as a result. We therefore re-estimate the models separately on two sub-samples of countries characterized, respectively, by strict and weak Employment Protection Legislation. We find that, consistent with this argument, service offshoring raises labor demand elasticity only in countries with weak regulations. Using the available information on workers’ skills, we also find that in these countries the effect is almost entirely borne by unskilled workers.

The remainder of the chapter is organized as follows. Section II briefly reviews the evidence on service offshoring and labor demand. Section III describes the data set, provides stylized facts on service offshoring and labor demand in Western Europe, and reports preliminary evidence on the relationship between the two phenomena. Section IV introduces the empirical models and explains the estimation approaches. Section V presents and discusses the results. Finally, Section VI briefly concludes.

5.1 Data and preliminary evidence

In this section, we first describe the data set and the main variables used in the empirical analysis. Then, we provide stylized facts on service offshoring and labor demand in Western Europe. Finally, we report preliminary evidence on the relationship between the two phenomena.

5.1.1 Data and variables

The empirical analysis is based on two samples of countries. The first sample comprises seven Western European economies and spans the period 1995-2006. The second sample includes nine Western European countries and covers the years 1995, 2000 and 2005. The structure of the two samples is dictated by the availability of Import Matrices, which are used to construct the service offshoring indicators as explained below. Overall, the two samples are largely representative of the European Union. According to population figures from Eurostat, for instance, the nine countries in the second sample account for about 60% of the EU27 population in 2005. For each country, both samples include information on 20 industries, classified according to NACE (Rev. 1). Out of these industries, 13 are in the manufacturing sector and seven are in the services sector. The list of countries and industries is reported in Table 1. Note that the 20 industries account for more than 60% of each country's private sector employment in the year 2005.

Table 1 - Composition and Coverage of the Estimation Samples

Industries			
NACE	**Description**	**NACE**	**Description**
15, 16	Food, bev., tobac.	30-33	Electrical, optical equipment
17-19	Text., leath., footwear	34, 35	Transport equipment
20	Wood and cork	36, 37	Manufacturing, nec
21, 22	Pulp, paper, print., publ.	50	Wholesale and retail, motor vehicles
23	Coke, ref. petr. and nucl. fuel	51	Wholesale, except motor vehicles
24	Chemicals	52	Retail, except motor vehicles
25	Rubber and plastics	60-63	Transportation and storage
26	Other non metall. min. prod.	64	Post and telecommunication
27, 28	Basic metals and fabr. met. prod.	70	Real estate
29	Machinery, nec	71-74	Other business activities

Country	Sample	% of Private Sector Employment in the 20 Industrie
Belgium	9-Country Sample	75,0
Denmark	Both	77,0
Finland	Both	78,0
France	Both	76,0
Germany	Both	79,0
Italy	Both	74,0
Netherlands	Both	78,0
Spain	Both	64,0
Sweden	9-Country Sample	80,0

Source: EUKLEMS

The main variables used to estimate the labor demand functions come from EUKLEMS, a large data set issued by 18 European institutions within the Sixth EU Framework Program (O’Mahony and Timmer, 2009). In particular, EUKLEMS provides us with industry-level information, comparable across countries, on the following variables: total number of employees (L); total number of hours worked (H); yearly and hourly wages (W); hours worked and hourly wages for workers with at least a bachelor's degree (high skilled, HS), for workers with either upper secondary or vocational education (medium skilled, MS), and for workers with no formal qualification (low skilled, LS); gross output (Y) and output prices (P^Y); average prices of intermediate inputs (P^I), and disaggregate prices of material (P^M), service (P^S) and energy inputs (P^E); capital stock (K) and, for a subset of countries, capital prices (P^K). To pool the data meaningfully across countries, we express the nominal figures in PPP, using the deflators provided by EUKLEMS. Moreover, we convert in Euros the data for Sweden and Denmark, using exchange rates from the ‘International Financial Statistics’ published by the International Monetary Fund.

Following Amiti and Wei (2005, 2006, 2009), we proxy for service offshoring using the share of imported private services in total input purchases. The underlying idea is the following: the output of offshored services has to be imported in Western Europe to enter the production process with other inputs; hence, this indicator will be higher the greater the intensity of service offshoring. The typical problem encountered by previous studies in constructing this proxy was the lack, or limited disaggregation, of service import data at the industry level. To sidestep this problem, Amiti and Wei (2005, 2006, 2009) have proposed to estimate these figures, by combining Input-Output tables with data on service imports at the *economy-wide* level. In recent years, however, national statistical institutes and Eurostat have made available detailed Import Matrices, which contain official data on service imports for individual industries. We make use of these matrices to construct the indicators of service offshoring employed in this chapter.[30]

As shown in Table 2, the Import Matrices are obtained from Eurostat for all of the countries except Italy and Spain, in which cases they are gathered from the national statistical institutes. The same table also shows that, for all countries except Belgium and Sweden, the Import Matrices are available in most of the years between 1995 and 2006; for Belgium and Sweden, instead, the Import Matrices are only available for the years 1995, 2000 and 2005. Accordingly, the 7-country sample spans the entire period 1995-2006, with values for the missing years being linearly interpolated.[31] The 9-country sample, instead, only covers the years 1995, 2000 and 2005, and always uses official data.

Table 2 - Import Matrices

Country	Availability	Source
Belgium	1995, 2000, 2005	Eurostat
Denmark	1995, 2000-2006	Eurostat
Finland	1995-2006	Eurostat
France	1995, 1997, 1999-2006	Eurostat
Germany	1995, 2000-2006	Eurostat
Italy	1995-2006	National Statistical
Netherlands	1995-2002, 2004-2006	Eurostat
Spain	1995-1997, 1999, 2000, 2002-	National Statistical
Sweden	1995, 2000, 2005	Eurostat

For each industry in the two samples, the Import Matrices report the value of imports of four types of services: financial and insurance services, computer services, research and development services, and other business services. Let M^{s}_{cit} denote imports of service *s* by industry *i* in country *c* and year *t*. Summing up these figures across the four services, we obtain the time series of total service imports at the industry level, $IMPS_{cit}$:

[30] The Import Matrices are part of the Input-Output Accounts of each country. They adopt a common industrial classification (ESA95) and are thus comparable across economies.

[31] In order to make sure that the empirical results are not driven by the interpolation, all of the specifications estimated on this sample include a dummy equal to 1 for the interpolated observations.

$$IMPS_{cit} = \sum_{s=1}^{4} M_{cit}^{s}$$

Finally, to construct the main proxy for service offshoring (*SOS*) we normalize *IMPS* by the value of total input purchases (*NE*). These latter data come from the Use Matrices of the Input-Output Accounts of each country. Formally,

$$SOS_{cit} = \frac{IMPS_{cit}}{NE_{cit}} \quad (1)$$

Using inputs as the denominator of equation (1) makes the offshoring proxy comparable with those of previous studies, in particular, Amiti and Wei (2005, 2006, 2009). This normalization, however, may be sensitive to the substitution between imported and domestically-purchased services, and may lead us to underestimate the change in service offshoring when the imported services substitute for those produced in-house (in this case, in fact, *IMPS* and *NE* increase by the same amount). We therefore check that the main results are robust with respect to changes in the normalization by using industry output as an alternative denominator of equation (1), building on previous work by Hijzen et al. (2005) and Crinò (2011). The corresponding proxy for service offshoring is called *SOS_Y*.

In order to investigate whether the effects of service offshoring are heterogeneous across types of services, we decompose the proxy in equation (1) into four disaggregate indicators, which correspond to the four services mentioned before. In particular, we construct the following variables:

$$SOS_{cit}^{FIN} = \frac{M_{cit}^{FIN}}{NE_{cit}}, SOS_{cit}^{R\&D} = \frac{M_{cit}^{R\&D}}{NE_{cit}}, SOS_{cit}^{COMP} = \frac{M_{cit}^{COMP}}{NE_{cit}}, SOS_{cit}^{OTHBUS} = \frac{M_{cit}^{OTHBUS}}{NE_{cit}} \quad (2)$$

where the superscripts *FIN*, *R&D*, *COMP* and *OTHBUS* stand for, respectively, financial and insurance, research and development, computer, and other business services.

Finally, for comparison, we also construct an equivalent proxy for material offshoring (*MOS*), by using the information on imported material inputs contained in the Import Matrices. This indicator includes imports of all material inputs and therefore captures a broad concept of offshoring (Feenstra and Hanson, 1999, 2003). Appendix Table A1 contains the names, definitions, and sources of all the variables used in the econometric analysis. It also contains descriptive statistics obtained on the two samples of countries.

5.1.2 Stylized facts

Table 3 reports information on the level and changes in the service offshoring indicators for the 7-country sample, the 9-country sample and each economy separately. For comparison, the table also reports the same information for the material offshoring indicator. Note that service offshoring is still a limited phenomenon in Western Europe, although its importance is growing over time. In fact, service imports account for about 2% of input purchases on average and have increased by 1 percentage point (p.p.), or 64%, between 1995 and 2006. The largest increases have occurred in the Netherlands, Sweden and Denmark (about 1.7 p.p.), followed by Spain (1.5 p.p.), Germany, Finland and Belgium (approximately 0.7 p.p.). Consistent with previous studies, e.g. OECD (2007b), our data also show that service offshoring is still lower than material offshoring, and that the latter has increased as well over time. In particular, material imports account for about 20% of input purchases on average and have grown by 2 p.p., or 10%, between 1995 and 2006.

Table 3 - Offshoring Indicators

	Mean	Δ 95-06		Mean	Δ 95-05		Mean	Δ 95-05		Mean	Δ 95-06		Mean	Δ 95-06		Mean	Δ 95-06	
	%	p.p.	%	%	p.p.	%	%	p.p.	%	%	p.p.	%	%	p.p.	%	%	p.p.	%
	7-Country Sample			*9-Country Sample*			*Belgium*			*Denmark*			*Finland*			*France*		
SOS	1,9	0,9	64,3	2,1	1,0	62,6	2,5	0,6	26,6	1,8	1,8	255,4	2,5	0,8	28,4	1,2	-0,1	-8,8
SOS^{OTHBUS}	1,3	0,5	50,3	1,3	0,3	30,2	1,6	0,4	33,5	1,1	1,0	167,6	1,9	0,1	5,1	0,8	0,2	25,8
SOS^{COMP}	0,1	0,1	332,4	0,1	0,1	172,1	0,3	0,0	-7,7	0,3	0,3	580,1	0,1	0,3	990,0	0,0	0,0	160,6
SOS^{FIN}	0,3	0,1	41,8	0,3	0,1	27,0	0,3	0,1	31,6	0,4	0,3	441,0	0,2	-0,2	-63,4	0,3	-0,4	-68,3
$SOS^{R\&D}$	0,2	0,2	130,1	0,4	0,5	304,4	0,3	0,0	18,1	0,1	0,2	-	0,3	0,5	266,5	0,1	0,1	64,7
MOS	19,9	2,0	10,4	21,2	0,7	3,5	29,7	-0,5	-1,7	26,8	2,0	7,7	20,2	2,4	12,3	15,7	2,8	19,7

	Mean	Δ 95-06		Mean	Δ 95-06		Mean	Δ 95-06		Mean	Δ 95-06		Mean	Δ 95-05	
	%	p.p.	%	%	p.p.	%	%	p.p.	%	%	p.p.	%	%	p.p.	%
	Germany			*Italy*			*Netherlands*			*Spain*			*Sweden*		
SOS	1,0	0,8	185,9	1,4	0,3	24,1	3,5	1,6	59,9	2,0	1,5	118,3	2,9	1,7	95,1
SOS^{OTHBUS}	0,5	0,4	141,1	0,9	0,4	46,6	2,2	0,4	22,9	1,8	1,3	123,7	0,4	-1,2	-100,0
SOS^{COMP}	0,2	0,2	345,0	0,1	0,1	351,8	0,1	0,0	58,1	0,0	0,0	-82,5	0,2	0,2	155,2
SOS^{FIN}	0,1	0,1	864,9	0,3	-0,1	-35,4	0,5	0,7	574,3	0,2	0,1	165,5	0,3	-0,2	-43,2
$SOS^{R\&D}$	0,2	0,1	104,6	0,1	0,0	-9,6	0,7	0,4	75,6	0,1	0,0	60,7	2,0	2,9	1742,4
MOS	15,8	2,9	20,1	15,9	2,7	17,3	26,6	-3,5	-11,9	18,0	4,7	29,6	20,9	0,3	1,6

Author's calculations based on Eurostat and the statistical offices of Italy and Spain. See Table 2 for the availability of Import Matrices used to construct the offshoring indicators, and Table A1 for names and definitions of all variables. The 7-country sample spans the period 1995-2006. The 9-country sample covers the years 1995, 2000 and 2005.

Looking at the disaggregate indicators of service offshoring reported in Table 3, a clear fact emerges: most of service offshoring in Western Europe is made of imports of business services. These services, in fact, account for 1.3% of total input purchases on average, approximately two-thirds of overall service offshoring. Across countries, the share of business services in total input purchases ranges between 0.4% in Sweden and 2.2% in the Netherlands. Business services have also driven the growth in overall service offshoring, as they have increased by about 0.4 p.p. since 1995. The fastest increases have taken place in Denmark and Spain (approximately 1 p.p.); in Sweden, instead, the share of business services in total input purchases has declined by 1.2 p.p.. The remaining services generally constitute a smaller share of overall service offshoring. In particular, they account for about 0.2% of total input purchases on average. An interesting exception is represented by R&D services in Sweden, which account for about 2% of total input purchases in that country.

Table 4 provides details on the geographical origin of service imports in Western Europe. In particular, the table reports intra- and extra-EU27 import shares constructed using data from Eurostat. Because the geographical data are available only for a few recent years and the information on individual service categories only for some countries, the table is constructed for the year 2007 and the group "All services" refers to total service imports. The table clearly shows that most of the service imports come from other European economies, especially from other EU27 countries. Note, in fact, that more than 60% of the imports originate within the EU27 and that those coming from outside mainly originate in other European countries. North America and Asia account for smaller, albeit non-negligible shares (12 and 9%, respectively). The picture is similar across types of services, although the share of North America is substantially higher for R&D and computer services. In addition, the picture is similar across the individual countries, with the exception of Swedish imports of R&D services, which mostly come from North America.

Table 4 - Geographical Origin of Service Imports

	Intra-EU27	Extra-EU27	*of which*	Other Europe	North Americ	Latin Americ	Asia	Africa	Oceania
					All Countries				
All Services	60,3	39,7		12,8	11,8	1,7	9,3	3,6	0,4
Other Business Services	65,1	34,9		10,4	14,1	0,8	7,3	2,0	0,5
Computer	65,5	34,5		7,3	18,5	0,3	7,5	0,6	0,3
Finance and Insurance	64,7	35,3		18,3	10,5	0,6	5,0	0,5	0,2
Research and Development	53,0	47,0		8,5	27,1	0,8	9,0	0,9	0,7
					Denmark				
All Services	54,9	45,1		9,6	14,3	2,7	13,4	4,1	0,9
Other Business Services	68,6	31,4		12,2	12,5	1,0	5,0	0,5	0,3
Computer	67,9	32,1		14,2	11,4	0,2	6,0	0,3	0,1
Finance and Insurance	66,7	33,3		7,9	16,9	4,5	3,7	0,2	0,1
Research and Development	63,0	37,0		16,1	15,3	0,7	3,6	0,4	1,0
					France				
All Services	52,0	48,0		12,6	12,0	2,8	11,4	8,5	0,7
Other Business Services	59,8	40,2		10,7	17,7	0,9	7,3	3,2	0,5
Computer	61,4	38,6		3,2	29,4	0,3	5,2	0,5	0,0
Finance and Insurance	53,7	46,3		24,3	12,3	1,8	6,4	1,0	0,5
Research and Development	56,9	43,1		10,4	20,9	0,9	7,4	2,9	0,6
					Italy				
All Services	62,5	37,5		13,7	8,8	2,4	7,7	4,3	0,6
Other Business Services	71,3	28,7		10,5	7,8	0,7	4,5	4,9	0,3
Computer	82,4	17,6		4,1	10,3	0,1	2,4	0,1	0,6
Finance and Insurance	83,1	16,9		8,0	6,3	0,3	1,7	0,7	0,0
Research and Development	75,0	25,0		10,1	11,5	0,0	3,4	0,0	0,0
					Spain				
All Services	67,1	32,9		9,4	10,4	4,4	5,5	2,9	0,3
Other Business Services	-	-		-	-	-	-	-	-
Computer	-	-		-	-	-	-	-	-
Finance and Insurance	-	-		-	-	-	-	-	-
Research and Development	-	-		-	-	-	-	-	-

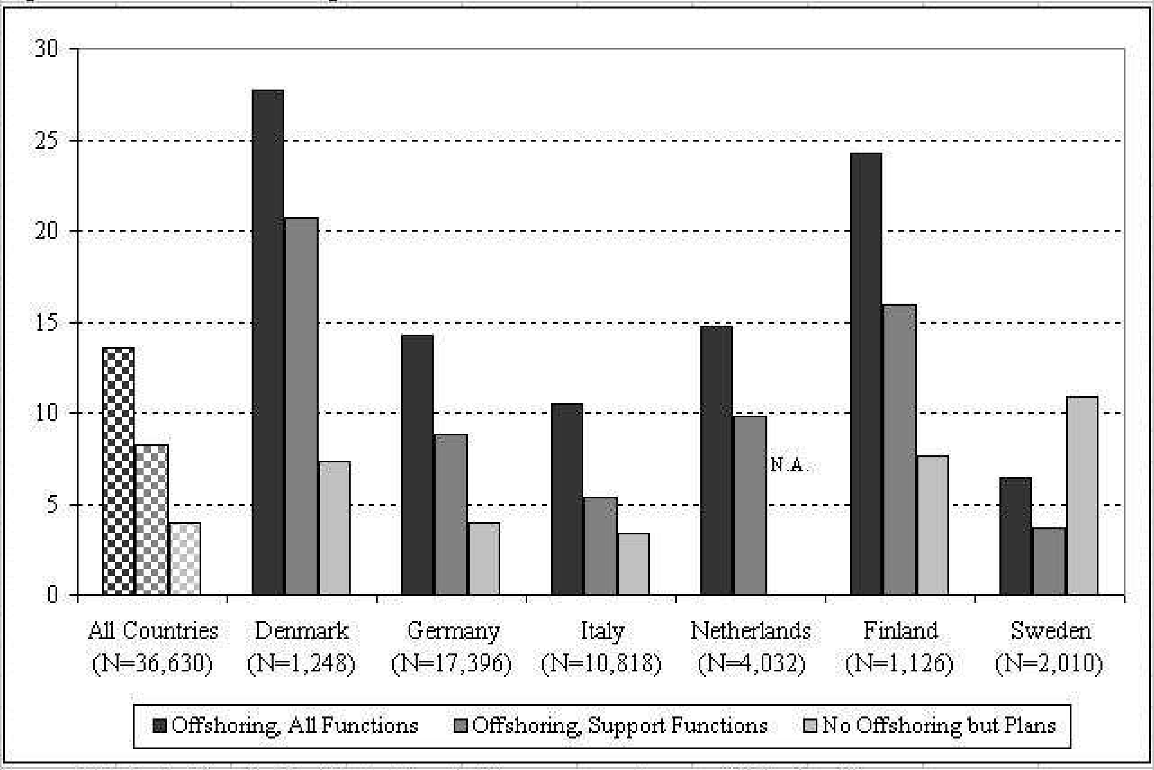
	Intra-EU27	Extra-EU27	*of which*	Other Europe	North Americ	Latin Americ	Asia	Africa	Oceania
					Belgium				
All Services	71,5	28,5		10,1	8,4	0,9	5,3	3,6	0,3
Other Business Services	75,2	24,8		8,1	12,2	0,8	3,0	0,6	0,2
Computer	80,0	20,0		2,7	12,3	0,3	3,6	0,9	0,1
Finance and Insurance	75,1	24,9		9,7	9,0	0,8	4,4	0,6	0,4
Research and Development	42,2	57,8		4,0	46,5	0,6	6,0	0,4	0,2
					Finland				
All Services	64,0	36,0		13,8	11,7	0,7	8,4	0,4	1,0
Other Business Services	-	-		-	-	-	-	-	-
Computer	68,0	32,0		6,6	14,2	0,3	9,6	1,1	0,2
Finance and Insurance	-	-		-	-	-	-	-	-
Research and Development	56,4	43,6		26,2	-	-	17,3	0,0	-
					Germany				
All Services	58,0	42,0		15,3	12,6	0,0	11,6	2,5	0,0
Other Business Services	59,0	41,0		12,1	16,3	1,1	9,9	1,0	0,6
Computer	56,7	43,3		9,3	22,8	0,6	10,1	0,3	0,2
Finance and Insurance	59,7	40,3		24,4	10,2	0,2	5,1	0,1	0,2
Research and Development	59,3	40,7		6,4	24,7	1,0	7,6	0,5	0,4
					Netherlands				
All Services	61,3	38,7		10,9	13,7	2,4	9,1	2,0	0,7
Other Business Services	68,4	31,6		8,2	13,8	0,0	7,9	1,2	0,5
Computer	71,0	29,0		4,9	13,1	-	8,8	1,5	0,6
Finance and Insurance	64,8	35,2		13,1	11,9	-	8,9	1,2	0,2
Research and Development	53,7	46,3		2,1	26,8	-	16,8	0,4	0,1
					Sweden				
All Services	62,0	38,0		15,2	14,9	0,6	5,9	0,7	0,8
Other Business Services	65,4	34,6		8,9	15,8	0,9	7,4	1,3	0,3
Computer	69,6	30,4		9,2	17,8	0,2	2,8	0,1	0,3
Finance and Insurance	45,7	54,3		30,0	19,0	0,3	4,3	0,5	0,3
Research and Development	35,9	64,1		3,9	49,7	1,6	6,4	0,7	1,9

Reported figures are the share of each region (indicated in columns) in the total imports of each service category (indicated in rows). *All services* includes imports of all types of services. *Extra-EU27* is computed as total imports minus intra-EU27 imports. *Other Europe* is computed as Extra-EU27 imports minus the sum of imports from the other regions. Data refer to the year 2007. Source: Eurostat

Additional information on the incidence and main features of service offshoring in Western Europe can be retrieved from a recent survey conducted by Eurostat on a large sample of European firms involved in offshoring activities. The survey was run in the year 2006 and contains information on the offshoring strategies of more than 54,000 firms with at least 100 employees, in 12 European countries between 2001 and 2006. Out of the 12 countries surveyed by Eurostat, six are also included in our samples.

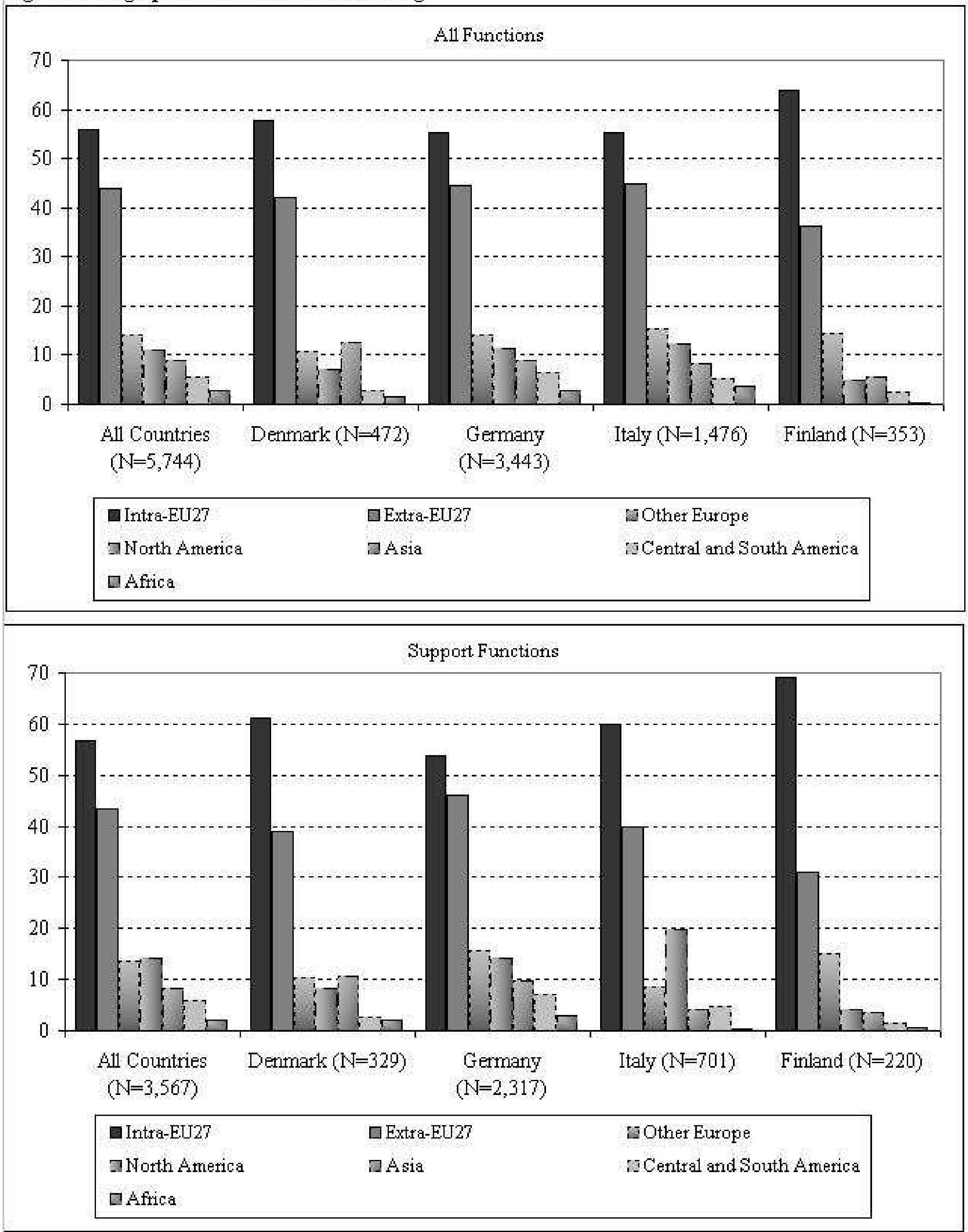
Although the two data sources are not fully comparable, Figure 1 confirms that the incidence of service offshoring (as proxied by offshoring of support functions) is still lower than that of other types of offshoring. Nevertheless, a non-negligible share of firms in all countries mentions that they plan to undertake offshoring activities in the near future. Similarly, Figure 2 confirms that the largest share of service offshoring cases takes place in other EU27 countries; the bulk of cases involving extra-EU27 countries occurs instead in other European economies and in North America. Finally, Figure 3 provides information on the offshoring modes (FDI vs. arm’s length contracts) chosen by European firms. This information cannot be retrieved from the import data, because they mix up the two offshoring modes. Note that the majority (70%) of offshoring firms delocalize their activities to related parties abroad (i.e., through FDI), and that this figure is similar both for total offshoring and for offshoring of support functions.

Figure 1 - Incidence of Offshoring



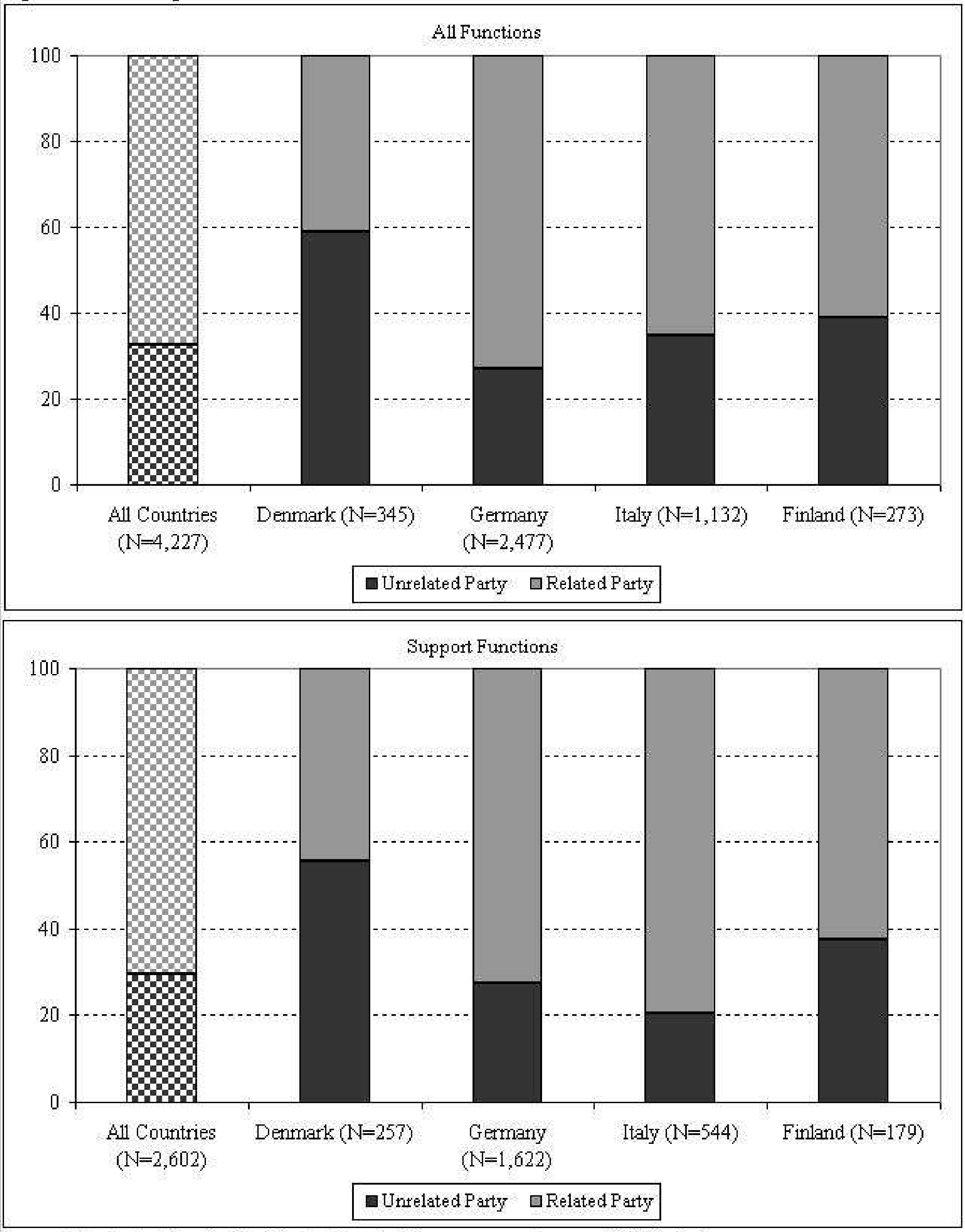
Source: Author's calculations based on Eurostat. Reported figures are percentages over all interviewed firms.

Figure 2 - Geographical Distribution of Offshoring



Source: Author's calculations based on Eurostat. Reported figures are percentages over all offshoring cases.

Figure 3 - Offshoring Modes



Source: Author's calculations based on Eurostat. Reported figures are percentages over all offshoring firms.

The remaining part of this section describes some key features of the behaviour of labor demand in Western Europe. In particular, Table 5 reports the level and changes in total employment and hours worked for both the 7-country and the 9-country sample, as well as for each individual economy. The table also decomposes total hours worked across three groups of employees, distinguished by educational level: high skilled workers, medium skilled workers and low skilled workers. Note that, over the period under scrutiny, total employment and hours worked have slightly increased in our samples, by about 14 and 8% respectively. The increase has taken place in all countries except Germany, where total employment has risen but hours worked have remained almost constant. As for the skill composition of labor demand, medium skilled workers make the lion's share (66%) of total hours worked in the last year of the samples, whereas high and low skilled workers account for 13 and 21%, respectively. The picture is similar across the individual countries. Over time, the composition of hours worked has shifted in favor of more skilled workers. In fact, the number of hours worked by low skilled employees has declined everywhere (except in Germany), whereas hours worked by medium and high skilled employees have always increased.

Table 5 - Employment, Hours Worked, and Labor Demand Elasticities

	7-Country Sample			9-Country Sample			Belgium			Denmark			Finland			France		
	1995	**2006**	**Δ 95-06**	**1995**	**2005**	**Δ 95-05**	**1995**	**2005**	**Δ 95-05**	**1995**	**2006**	**Δ 95-06**	**1995**	**2006**	**Δ 95-06**	**1995**	**2006**	**Δ 95-06**
L	45531	52736	15,8	48935	55686	13,8	1576	1736	10,2	1175	1284	9,2	871	1071	23,1	9906	11221	13,3
H	89975	98428	9,4	96235	######	8,2	2930	3210	9,6	1909	2141	12,2	1689	2010	19,0	17856	18813	5,4
H^{HS}	7050	12816	81,8	7665	13363	74,3	313	462	47,3	88	169	91,2	446	600	34,7	1837	2995	63,0
H^{MS}	59701	64505	8,0	63135	67694	7,2	1322	1779	34,6	1105	1313	18,9	724	987	36,3	11072	12493	12,8
H^{LS}	23223	21107	-9,1	25434	23022	-9,5	1295	970	-25,1	716	659	-7,9	520	422	-18,7	4946	3325	-32,8
$\varepsilon_{L,w}$	-0.192*	-0.323**		-0.216**	-0.307***		-0.336	-0.383		-0.672**	-0.680***		-0.337**	-0.455***		-0.133**	-0.228*	
Std. Err.	[0.112]	[0.127]		[0.096]	[0.089]		[0.214]	[0.233]		[0.222]	[0.234]		[0.128]	[0.132]		[0.057]	[0.115]	
Obs.		1680			1980			220			240			240			240	

	Germany			Italy			Netherlands			Spain			Sweden		
	1995	**2006**	**Δ 95-06**	**1995**	**2006**	**Δ 95-06**	**1995**	**2006**	**Δ 95-06**	**1995**	**2006**	**Δ 95-06**	**1995**	**2005**	**Δ 95-05**
L	17852	18771	5,1	7614	9107	19,6	3231	3851	19,2	4883	7430	52,2	1828	1968	7,6
H	30109	29874	-0,8	21689	24200	11,6	5609	6209	10,7	11114	15182	36,6	3330	3435	3,2
H^{HS}	1971	2375	20,5	1160	3020	160,3	360	752	108,9	1188	2905	144,5	301	559	86,0
H^{MS}	19164	18020	-6,0	20164	21017	4,2	4689	5071	8,1	2783	5604	101,4	2113	2267	7,3
H^{LS}	8974	9479	5,6	365	163	-55,5	559	386	-31,0	7143	6673	-6,6	916	608	-33,6
$\varepsilon_{L,w}$	0.071	-0.078		-0.772**	-0.617		-0.320**	-0.185		-0.893*	-1.062**		-0.200**	-0.133*	
Std. Err.	[0.115]	[0.138]		[0.326]	[0.405]		[0.153]	[0.114]		[0.467]	[0.462]		[0.068]	[0.069]	
Obs.		240			240			240			240			220	

Author's calculations based on EUKLEMS. The number of employees is in thousands, hours worked are in millions. Labor demand elasticities refer to the pre-2001 and post-2001 sub-periods and are estimated from a log-linear, conditional labor demand function including three intermediate inputs (materials, services and energy) and the capital stock, with variables in 5-year moving averages and 5-year differences. The specifications also include a full set of year dummies. Standard errors are corrected for clustering at the country-industry level. ***, **, *: indicates significance at the 1, 5, and 10% level respectively. See also notes to previous tables.

The bottom part of Table 5 reports estimates of the wage elasticity of labor demand for two sub-periods, pre-2001 and post-2001. For the sake of the exposition, methodological details on estimation are postponed to Section III.3. The estimated elasticites show that labor demand has flattened out over the sample period. On average, in fact, the absolute value of the elasticity has increased by about 50%, from 0.2 to 0.3. As for the individual countries, the elasticity of labor demand has increased everywhere except in Italy, the Netherlands and Sweden.

To sum up, these stylized facts show that the incidence of service offshoring in Western Europe has increased since the mid-1990s, although the phenomenon is still limited in size compared to the offshoring of production stages. There is no evidence of large drops in employment and hours worked over the same time period: if anything, employment and hours worked have moderately increased in all countries. At the same time, the composition of labor has shifted in favour of more skilled workers, and labor demand has become more elastic. While many factors could have been responsible for these changes in the labor market, in the next sections we attempt to shed some light on the possible role played by service offshoring.

5.1.3 *Preliminary evidence*

This section contains preliminary evidence on the relationship between service offshoring and labor demand in Western Europe. In particular, using a simple reduced-form approach, the section discusses the correlation of the change in service offshoring between the endpoints of the sample with the change in several proxies for the location, skill composition and elasticity of labor demand over the same time period.

To start off, panel a1) of Table 6 reports the results of a simple regression of the change in total employment during the entire period on a dummy equal to 1 for the country-industry pairs in which the growth of service offshoring has been higher than the sample median. The estimated coefficient is positive but not significant. Panel a2) replaces the fast growing offshoring indicator with the actual change in service offshoring over the sample period. The coefficient of this variable is positive and precisely estimated. Panel b1) and b2) use the change in hours worked (instead of the change in total employment) as the dependent variable, in order to allow for possible adjustments also along the intensive margin. Note that the results are very similar to those discussed before. Overall, these simple regressions suggest that, in countries and industries with more sustained growth in service offshoring, employment and hours worked have increased slightly faster than elsewhere.

Table 6 - Preliminary Evidence: Service Offshoring and Employment Levels

	7-Country Sample		9-Country Sample	
	Coeff.	Std. Err.	Coeff.	Std. Err.
a) Total Employment, Whole Sample, Aggregate Service Offshoring Indicator				
a1) Indic: High Growth in SOS	0,071	[0.059]	0,041	[0.044]
a2) ΔSOS	0.029**	[0.013]	0.023**	[0.010]
b) Total Hours Worked, Whole Sample, Aggregate Service Offshoring Indicator				
b1) Indic: High Growth in SOS	0,077	[0.052]	0,054	[0.039]
b2) ΔSOS	0.031**	[0.013]	0.026**	[0.010]
c) Total Employment, Individual Countries, Aggregate Service Offshoring Indicator				
c1) ΔSOS (Belgium)	-	-	0,029	[0.026]
c2) ΔSOS (Denmark)	0.104**	[0.020]	0.094**	[0.016]
c3) ΔSOS (Finland)	0.026*	[0.014]	0.029**	[0.013]
c4) ΔSOS (France)	-0.220*	[0.088]	-0.195*	[0.083]
c5) ΔSOS (Germany)	0.153*	[0.074]	0,134	[0.080]
c6) ΔSOS (Italy)	-0,113	[0.140]	-0,080	[0.123]
c7) ΔSOS (Netherlands)	-0.028*	[0.013]	-0.023*	[0.010]
c8) ΔSOS (Spain)	0,025	[0.015]	0,018	[0.013]
c9) ΔSOS (Sweden)	-	-	0,019	[0.029]
d) Total Employment, Whole Sample, Disaggregate Service Offshoring Indicators				
d1) ΔSOS^{OTHBUS}	0.057**	[0.018]	0.040**	[0.014]
d2) ΔSOS^{COMP}	0,179	[0.129]	0,116	[0.085]
d3) ΔSOS^{FIN}	-0,005	[0.049]	0,020	[0.039]
d4) $\Delta SOS^{R\&D}$	0,003	[0.019]	0,000	[0.013]
e) Hours Worked by Each Skill Group, Whole Sample, Aggregate Service Offshoring Indicator				
e1) ΔSOS (High Skilled Workers)	0.052**	[0.023]	0.043**	[0.018]
e2) ΔSOS (Medium Skilled Workers)	0.042*	[0.022]	0,024	[0.016]
e3) ΔSOS (Low Skilled Workers)	0.032**	[0.016]	0.025**	[0.011]

In each panel, the dependent variable is the change in the corresponding employment indicator between the endpoints of the sample. ΔSOS is the change in service offshoring over the same time period. The indicator for high growth in service offshoring is a dummy equal to 1 if ΔSOS is higher than the sample median and 0 otherwise. Standard errors are heteroskedasticity robust. ***, **, *: indicates significance at the 1, 5, and 10% level respectively. See also notes to previous tables.

Panel c) repeats the specifications in panel a2) on each individual country. The estimated coefficients are positive in six of the nine economies, and precisely estimated in two of them. Negative and significant coefficients are found for France and the Netherlands, whereas in the case of Italy the estimated coefficient is negative but not significant. Overall, these results show that the correlation between service offshoring and employment is weakly positive in the majority of countries, consistent with the aggregate findings discussed before. Nevertheless, these results also suggest that some heterogeneity exists across the nine countries, and that in some of them employment has actually fallen in the fast-growing-offshoring industries.

Panel d) replaces the aggregate indicator of service offshoring with the disaggregate indicators for the four services, in order to explore potential heterogeneity across offshored activities. The estimated coefficients are generally positive, although they are precisely estimated only in the case of other business services, which is the largest component of the aggregate measure of service offshoring as shown in Section III.2. On average, therefore, none of the offshored services is found to be significantly associated with employment losses.

In panel e), we analyze the relationship between changes in service offshoring and changes in hours worked by high, medium and low skilled workers. The estimated coefficients are positive in all cases, although they are larger and more precisely estimated for high skilled workers. Hence, on average, faster increases in service offshoring are associated with slightly larger increases in hours worked, especially for more educated workers.

Finally, we study the relationship between changes in service offshoring and changes in labor demand elasticity. To this purpose, we estimate the following three specifications of a log-linear, conditional labor demand function over the entire samples:

$$\ln L_{cit} = \beta_0 + \beta_W \ln W_{cit} + \sum_{r\in\{M,S,E\}} \beta_r \ln P_{cit}^r + \beta_Y \ln Y_{cit} + \beta_K \ln K_{cit} + u_{cit}$$

$$\ln L_{cit} = \beta_0 + (\beta_W^{95} + \beta_W^{01} \cdot T^{01}) \cdot \ln W_{cit} + \sum_{r\in\{M,S,E\}} \beta_r \ln P_{cit}^r + \beta_Y \ln Y_{cit} + \beta_K \ln K_{cit} + u_{cit}$$

$$\begin{aligned}\ln L_{cit} = {} & \beta_0 + (\beta_W^{95} + \beta_W^{01,LSOS} \cdot T^{01} + \beta_W^{01,HSOS} \cdot T^{01} \cdot HSOS) \cdot \ln W_{cit} + \\ & + \sum_{r\in\{M,S,E\}} \beta_r \ln P_{cit}^r + \beta_Y \ln Y_{cit} + \beta_K \ln K_{cit} + u_{cit}\end{aligned}$$

where *L* is total employment, *W* is yearly wage, *P* is the price of non-labor inputs (materials *M*, services *S* and energy *E*), *Y* is output, *K* is capital stock and *u* is a random error term. The variable T^{01} is a dummy equal to 1 for all of the years since 2001, whereas *HSOS* is the indicator for country-industry pairs with fast growing service offshoring used before. The first model yields the average wage elasticity of labor demand over the entire sample, which is equal to β_W. The second model distinguishes this elasticity between the pre-2001 sub-period (β_W^{95}) and the post-2001 sub-period ($\beta_W^{95} + \beta_W^{01} \cdot T^{01}$). Finally, the last model distinguishes the elasticity for the second sub-period between slow-growing-offshoring industries ($\beta_W^{95} + \beta_W^{01,LSOS} \cdot T^{01}$) and fast-growing-offshoring industries ($\beta_W^{95} + \beta_W^{01,LSOS} \cdot T^{01} + \beta_W^{01,HSOS} \cdot T^{01} \cdot HSOS$). All the models are estimated with variables in 5-year moving averages and 5-year differences and include a full set of year dummies; standard errors are corrected for clustering at the country-industry level.

The results are reported in Table 7. Column (1) shows the average wage elasticity, which is approximately equal to -0.23. This value is well within the range of estimates found in the empirical literature (see Hamermesh, 1993). Columns (2) and (3) report the elasticities for the first and second sub-period, which are equal to those shown in Table 5. As already mentioned, these figures imply that labor demand elasticity has increased over time. Finally, columns (4) and (5) show that the increase has been relatively larger in the fast-growing-offshoring industries than in the other sectors.

Table 7 - Preliminary Evidence: Service Offshoring and Labor Demand Elasticity

	7-Country Sample				
	Average Elasticity	Elasticity 1995-2000	Elasticity 2001-2006	Elasticity 2001-2006, Low Growth	Elasticity 2001-2006, High Growth
	(1)	(2)	(3)	(4)	(5)
$\varepsilon_{L,W}$	-0.224*	-0.192*	-0.323**	-0.221*	-0.500***
	[0.118]	[0.112]	[0.127]	[0.124]	[0.133]
	9-Country Sample				
	Average Elasticity	Elasticity 1995-2000	Elasticity 2001-2005	Elasticity 2001-2005, Low Growth	Elasticity 2001-2005, High Growth
	(1)	(2)	(3)	(4)	(5)
$\varepsilon_{L,W}$	-0.239**	-0.216**	-0.307***	-0.165*	-0.434***
	[0.095]	[0.096]	[0.089]	[0.096]	[0.098]

The elasticities in column (1) are estimated from a log-linear, conditional labor demand function including three intermediate inputs (materials, services and energy) and the capital stock, with variables in 5-year moving averages and 5-year differences. The elasticities in columns (2) and (3) are obtained by adding an interaction term between log wage and a dummy equal to 1 for all of the years since 2001. The elasticities in columns (4) and (5) are obtained by interacting this latter term with the indicator for high growth in service offshoring. All specifications include a full set of year dummies. Standard errors are corrected for clustering at the country-industry level. ***, **, *: indicates significance at the 1, 5, and 10% level respectively. See also notes to previous tables.

Overall, these preliminary results do not support the view that the increase in service offshoring in Western Europe has been associated with large employment losses. If anything, the correlation between changes in employment and changes in service offshoring is weakly positive across the countries and industries in our sample. This correlation is driven by offshoring of business services and is stronger for workers with higher skill levels. Finally, some heterogeneity exists across countries, but is not dramatic.

These preliminary results also suggest, however, that the growth in service offshoring has been to some extent related with the observed increase in labor demand elasticity over the sample period. In the next sections, we use a more structural approach to investigate all of these issues in more detail.

5.2 Empirical models and estimation approaches

We estimate conditional and unconditional labor demand functions, derived from the cost minimization and profit maximization processes of the representative firm in each country and industry. As in the existing literature (in particular, Feenstra and Hanson, 1996, 1999, 2003; Amiti and Wei, 2005, 2006; and Crinò, 2010b, 2011), we let both optimization processes depend on service offshoring. This means that firms choose employment optimally for a given level of this variable and, hence, that the labor demand functions depend on it. When service offshoring changes, firms re-optimize over employment and the labor demand functions experience a parallel shift. The conditional demand functions capture the shift at constant output. The unconditional demand functions, instead, also account for the scale (productivity) effects of service offshoring.

The cost and profit functions of the representative firm are

$$C(W,\mathbf{P}',Y,K,\mathbf{Z}') = \min_{L,M,S,E} W \cdot L + \sum_{r\in\{M,S,E\}} r \cdot P^r \text{ s.t. } Y = f(L,M,S,E,K,\mathbf{Z}') \quad (3)$$

$$\Pi(W,\mathbf{P}',P^Y,K,\mathbf{Z}') = \max_{L,M,S,E} P^Y \cdot f(L,M,S,E,K,\mathbf{Z}') - W \cdot L - \sum_{r\in\{M,S,E\}} r \cdot P^r \quad (4)$$

where $\mathbf{P}$ is the vector of non-labor input prices and $\mathbf{Z}$ is a vector of shift-factors including service offshoring. Country, industry and time subscripts are omitted to save on notation. As in previous studies (e.g., Berman et al., 1994), we assume capital to be a quasi-fixed factor and thus include its stock rather than its price in the specification of both functions. This choice is dictated by two considerations. First, capital price data are known to be measured with error. Second, they are not available for one of the countries in our sample, France. In the next section, however, we show that the results are not driven by this methodological choice, by performing robustness checks using the capital price data available for the remaining economies.

Applying Shephard's lemma to equation (3) and Hotelling's Lemma to equation (4), we obtain the conditional and unconditional input demand functions, respectively. In particular, the conditional labor demand function is equal to

$$L = f(W,\mathbf{P}',Y,K,\mathbf{Z}') \quad (5)$$

while the unconditional labor demand function is equal to

$$L = f(W,\mathbf{P}',P^Y,K,\mathbf{Z}') \quad (6)$$

In order to make the models empirically operational, we follow most of the existing literature and choose log-linear specifications for equations (5) and (6). This has the advantage that the estimated parameters can be interpreted directly as elasticities (Hamermesh, 1993). Formally, equation (5) becomes

$$\ln L = \beta_0 + \beta_W \ln W + \sum_{r\in\{M,S,E\}} \beta_r \ln P^r + \beta_Y \ln Y + \beta_K \ln K + \sum_{z\in\mathbf{Z}} \beta_z z \quad (7)$$

while equation (6) becomes

$$\ln L = \beta_0 + \beta_W \ln W + \sum_{r\in\{M,S,E\}} \beta_r \ln P^r + \beta_{P^Y} \ln P^Y + \beta_K \ln K + \sum_{z\in\mathbf{Z}} \beta_z z \quad (8)$$

Note that, if $\beta_{SOS} > 0\,(< 0)$, an increase in service offshoring shifts the demand function outward (inward) and thus raises (lowers) employment *ceteris paribus*. Note also that, because the conditional labor demand function in equation (7) depends on output, the effects of service offshoring estimated from it do not account for changes in the scale of operations. The latter are instead captured by the effects estimated from the unconditional labor demand function in equation (8).[32]

Another advantage of the log-linear formulation is that the models can be immediately extended to study the effects of service offshoring (or any other shift-factor) on the *wage elasticity* of labor demand. This can be done by adding interaction terms between log wages and service offshoring (or any other shift-factor) to equations (7) and (8). The latter therefore modify as follows:

$$\ln L = \beta_0 + \beta_W \ln W + \sum_{r \in \{M,S,E\}} \beta_r \ln P^r + \beta_Y \ln Y + \beta_K \ln K + \sum_{z \in \mathbf{Z}} \beta_z z + \sum_{z \in \mathbf{Z}} \beta_{W,z} \ln W \cdot z \qquad (9)$$

and

$$\ln L = \beta_0 + \beta_W \ln W + \sum_{r \in \{M,S,E\}} \beta_r \ln P^r + \beta_{P^Y} \ln P^Y + \beta_K \ln K + \sum_{z \in \mathbf{Z}} \beta_z z + \sum_{z \in \mathbf{Z}} \beta_{W,z} \ln W \cdot z \qquad (10)$$

Note that, if $\beta_{W,SOS} > 0\,(<0)$, an increase in service offshoring makes labor demand less (more) elastic. Offshoring mainly affects labor demand elasticity by expanding the flexibility with which firms can potentially substitute domestic labor with foreign inputs (Senses, 2010). Furthermore, the elasticity estimates may be seriously biased by shocks to product demand if industry output is not controlled for (Hasan et al., 2007). For these reasons, when studying the effects of service offshoring on the elasticity of labor demand, we only focus on the conditional labor demand function in equation (9) and discard the unconditional labor demand function in equation (10).

Turning to the estimation approach, our baseline results are obtained with fixed effects, in order to account for unobserved heterogeneity at the country-industry level. In addition, we always control for time dummies, in order to account for macroeconomic shocks that are common to all countries and industries. We also perform a large array of sensitivity checks by using alternative estimators, so as to take care of possible concerns with these baseline estimates. In particular, we control for common trends in service offshoring and labor demand, by estimating the models in first differences with fixed country-industry effects. Moreover, we account for possible endogeneity of the explanatory variables (especially wages and service offshoring) by using Instrumental Variables. Finally, we take care of possible delayed adjustments in labor demand, by using lagged regressors, long differences, GMM (Arellano and Bond, 1991) and bias-corrected least-square-dummy-variables estimators for dynamic panel data (Bun and Kiviet, 2003; Bruno, 2005a,b).

[32] The elements of $\mathbf{Z}$ in equations (7) and (8) are not expressed in logarithms, because the main shift-factor used in our analysis (service offshoring) is measured in percentages. In some of the robustness checks presented below, the additional control variables enter instead in logs. We mention these cases when they occur. Note, also, that we do not impose price homogeneity of degree zero on the demand functions. Because this property is generally rejected by our data, imposing it would exacerbate bias due to measurement error (Clark and Freeman, 1980).

5.3 Results

This section presents the empirical results. We first investigate the effects of service offshoring on the location of labor demand. Then, we turn to the effects on the elasticity.

5.3.1 The effects of service offshoring on the location of labor demand

We start by discussing the baseline estimates of equations (7) and (8). Next, we present a set of extensions of the benchmark models, which allow us to discuss other important factors usually studied in the literature. Finally, we explore heterogeneity in the effects of service offshoring across types of services, individual countries and skill groups of workers.

Baseline estimates

The baseline estimates of equations (7) and (8) are reported in Table 8. Columns (1)-(8) are obtained on the 7-country sample, whereas columns (9)-(10) are based on the 9-country sample. For each sample, the table reports estimates of both the conditional labor demand function (columns (1)-(4) and (9)) and the unconditional labor demand function (columns (5)-(8) and (10)). For each type of function, the estimates obtained on the 7-country sample encompass four specifications, which differ in the choice of intermediate input prices and controls for capital. In what follows, we first explain these differences in detail and comment on the coefficients of the technology variables. Then, we discuss the coefficient of the main variable of interest, service offshoring.

Columns (1) and (5) estimate the benchmark models presented in Section IV. As expected, the coefficient of log wage is negative and significant, suggesting that labor demand is downward sloping. The wage elasticity of labor demand ranges between -0.1 and -0.2, in line with existing estimates (see Hamermesh, 1993). The coefficients of log output and log capital are both positive, implying that larger scale of production and greater capital investment increase the use of labor. As for the intermediate inputs, only the coefficient of log energy prices is statistically significant; its negative sign suggests energy to be a complement of labor in production. Columns (2) and (6) replace the prices of energy, materials and services with the log average price of intermediate inputs; this makes the specification similar to those used in previous work by, e.g., Hasan et al. (2007) and Hijzen and Swaim (2010). The coefficient of intermediate input prices is not very precisely estimated, while those of wages, capital and output remain largely unchanged.

Columns (3) and (7) exclude intermediate inputs altogether, as in Amiti and Wei (2005, 2006). The implicit assumption is that the price of intermediates is a function of time, and thus gets absorbed by the year dummies. Apart from a slight increase in the absolute value of the wage elasticity, there is no noteworthy change in the previous results. A similar picture emerges from columns (4) and (8), in which the capital stock is replaced by the log capital price; the wage elasticity is however imprecisely estimated in the unconditional demand model. Finally, the estimates obtained on the 9-country sample (columns (9) and (10)) are similar to those based on the 7-country sample. In addition, they deliver a significant coefficient for the log price of material inputs; its positive sign suggests that these inputs substitute for labor in production.

Table 8 - The Effect of Service Offshoring on Labor Demand: Baseline Specifications

	7-Country Sample								**9-Country Sample**	
	Conditional Demand Functions				Unconditional Demand Functions				Cond. Demand	Uncond. Demand
	3 Interm. Inputs	Ov. Interm. Inp.	No Interm. Inpu	Price of Capital	3 Interm. Inputs	Ov. Interm. Inp.	No Interm. Inpu	Price of Capital	3 Interm. Inputs	3 Interm. Inputs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\ln W$	-0.199***	-0.174**	-0.210***	-0.176*	-0.083*	-0.083*	-0.098**	-0,101	-0.263***	-0.200***
	[0.075]	[0.077]	[0.078]	[0.096]	[0.043]	[0.045]	[0.050]	[0.075]	[0.055]	[0.045]
$\ln P^M$	0,121			0.143*	0,049			0,115	0.161**	0.149***
	[0.078]			[0.077]	[0.066]			[0.079]	[0.073]	[0.057]
$\ln P^S$	-0,018			-0,040	0,008			-0,070	-0,034	-0,047
	[0.056]			[0.062]	[0.051]			[0.062]	[0.056]	[0.049]
$\ln P^E$	-0.102**			-0.131**	-0.092*			-0,089	-0.159***	-0.142***
	[0.047]			[0.057]	[0.052]			[0.067]	[0.047]	[0.051]
$\ln P^I$		0.155*				-0,112				
		[0.085]				[0.211]				
$\ln Y$	0.326***	0.323***	0.307***	0.466***					0.340***	
	[0.085]	[0.080]	[0.085]	[0.097]					[0.070]	
$\ln P^Y$					0.169**	0,250	0.141*	-0,057		0,021
					[0.085]	[0.211]	[0.085]	[0.109]		[0.072]
$\ln K$	0.437***	0.474***	0.464***		0.639***	0.646***	0.652***		0.412***	0.572***
	[0.074]	[0.073]	[0.072]		[0.067]	[0.068]	[0.067]		[0.063]	[0.064]
$\ln P^K$				0.507**				0.876***		
				[0.234]				[0.241]		
SOS	0.009**	0.008*	0.007*	0.010**	0.011**	0.010**	0.010**	0.014**	0.013***	0.017***
	[0.004]	[0.004]	[0.004]	[0.005]	[0.005]	[0.004]	[0.004]	[0.006]	[0.005]	[0.006]
Obs.	1679	1680	1680	1439	1679	1680	1680	1439	540	540
R-squared	0,52	0,52	0,51	0,45	0,45	0,44	0,44	0,26	0,53	0,44

The dependent variable is the log number of employees. All specifications control for country-industry and year effects. The specifications estimated on the 7-country sample also include a dummy equal to 1 for the interpolated observations. Standard errors are corrected for clustering at the country-industry level. ***, **, *: indicates significance at the 1, 5, and 10% level respectively. See also notes to previous tables.

Having shown that the results for the technology variables are robust across different models, we now turn to the coefficient of service offshoring. Note that, independently of the specification and the estimation sample, the coefficient of *SOS* is weakly positive. The point estimates are larger for the unconditional demand functions, suggesting that service offshoring may induce some positive scale effects that end up raising labor demand. However, the size of the estimated effect is generally small: a 1 p.p. increase in service offshoring (which corresponds to the actual change in *SOS* during the sample period) is associated with a 1% increase in domestic employment.

Overall, this first set of results suggest that service offshoring has not induced any large loss of domestic employment in Western Europe. It may have actually increased employment slightly through positive scale effects. This evidence is largely consistent with some of the studies on service offshoring and labor demand reviewed in Section II.

Extensions

We now present several extensions of the baseline models, which allow us to discuss other important factors usually studied in the empirical literature. To start off, we enlarge the set of shift-factors to include proxies for technological progress. Faster technical change may in fact ease the international relocation of service activities and, at the same time, have a direct effect on labor demand. The main results are reported in Table 9. In order to save space, we only show the coefficients of the shift-factors obtained on the 7-country sample. Columns (1)-(4) include the log prices of software (P^{SOFT}) and information and communication technologies (P^{IT}, P^{CT} and P^{ICT}). With the exception of software prices, the coefficients of these variables are not well identified and their inclusion leaves the results on service offshoring almost unchanged. Columns (5) and (6) use alternative proxies for technical change, namely, an index of TFP growth (*TFP*) and the ICT share of total capital compensation (*ICT*). These proxies are employed in the literature when information on high-tech prices is lacking (see, among others, Berman et al., 1994; and Feenstra and Hanson, 1999, 2003). While both variables generally enter the specifications with significant coefficients, they do not overturn the previous findings on service offshoring. Finally, column (7) flexibly proxies for technical change by adding a full set of country-industry-specific time trends. Note that the coefficient of *SOS* turns negative but is very small and imprecisely estimated.

Table 9 - The Effect of Service Offshoring on Labor Demand: Adding Controls for Technological Progress

	Price of Software	Price of Information	Price of Communication	Price of ICT	TFP Growth	ICT share of Capital	Country-Industry-Specific Time
Conditional Demand Functions	(1)	(2)	(3)	(4)	(5)	(6)	(7)
SOS	0.009**	0.010**	0.011**	0.011**	0.010**	0,007	-0.000
	[0.005]	[0.005]	[0.005]	[0.005]	[0.004]	[0.004]	[0.002]
$\ln P^{SOFT}$	0.195***						
	[0.073]						
$\ln P^{IT}$		0,072					
		[0.060]					
$\ln P^{CT}$			-0,066				
			[0.068]				
$\ln P^{ICT}$				-0,007			
				[0.038]			
TFP					-0.089**		
					[0.037]		
ICT						0.003**	
						[0.001]	
Obs.	1439	1427	1427	1439	1679	1679	1679
R-squared	0,53	0,52	0,52	0,52	0,53	0,53	0,96
Unconditional Demand Functions	Price of Software	Price of Information	Price of Communication	Price of ICT	TFP Growth	ICT share of Capital	Country-Industry-Specific Time
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
SOS	0.012**	0.013**	0.014***	0.012**	0.011**	0.010*	-0,003
	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.002]
$\ln P^{SOFT}$	0.235***						
	[0.086]						
$\ln P^{IT}$		0,070					
		[0.064]					
$\ln P^{CT}$			-0.159*				
			[0.081]				
$\ln P^{ICT}$				0,059			
				[0.039]			
TFP					0,035		
					[0.038]		
ICT						0.002*	
						[0.001]	
Obs.	1439	1427	1427	1439	1679	1679	1679
R-squared	0,48	0,46	0,47	0,46	0,45	0,46	0,96

Results are based on the 7-country sample. The dependent variable is the log number of employees. Only the coefficients of the shift-factors are reported. Standard errors are corrected for clustering at the country-industry level. ***, **, *: indicates significance at the 1, 5, and 10% level respectively. See also notes to previous tables.

Next, we discuss the role of other concomitant factors. To begin with, in columns (1)-(6) of Table 10, we control for other aspects of globalization that may be correlated with service offshoring and exert independent effects on labor demand. Column (1) controls for material offshoring (*MOS*), whose coefficient is negative, small and not always precisely estimated (consistently, e.g., with Amiti and Wei, 2005). At the same time, the main evidence on service offshoring remains largely unchanged. Column (2) controls for import penetration, by including the import share of each country's GDP (*IMPEN*), whereas column (3) controls for trade openness, by including the average ratio of imports and exports over GDP (*OPEN*). These variables are defined at the country level due to lack of data for detailed industries, and can be separately identified from the time dummies because there is enough cross-country variation in every year. Note that the coefficients of *IMPEN* and *OPEN* are weakly negative, and that the results for service offshoring do not change. Column (4) controls for service inshoring (i.e., the relocation of foreign services in Europe), by adding the share of service exports over GDP (*INSH*). Column (5) controls instead for multinational firms' activities, by adding the GDP share of inward and outward FDI (*IFDI* and *OFDI*, respectively). None of these variables is statistically significant and the evidence on service offshoring is not affected. Finally, column (6) controls for international immigration (a possibly complementary mode to source foreign services), by adding the immigrants' share of each country's population (*MIGSTK*). This variable is available only for the years 1995, 2000 and 2005. The coefficient of this control is small and not significant, and the results for service offshoring do not show noteworthy changes.

Table 10 - The Effect of Service Offshoring on Labor Demand: Adding Controls for Other Concomitant Factors

	Conditional Demand Functions							
	Material Offshoring	Import Penetration	Trade Openness	Service Inshoring	FDI	Immigratio n	Union Density	Country-Time and Industry-Time
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SOS	0.009**	0.010**	0.010**	0.010**	0.010**	0.013**	0.010**	0,003
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.005]	[0.004]	[0.003]
MOS	-0,002							
	[0.002]							
IMPEN		-0.005*						
		[0.002]						
OPEN			-0.005**					
			[0.002]					
INSH				-0,006				
				[0.004]				
IFDI					0,001			
					[0.001]			
OFDI					0,000			
					[0.001]			
MIGSTK						0,003		
						[0.006]		
UNDENS							0,004	
							[0.005]	
Obs.	1679	1679	1679	1679	1679	420	1679	1679
R-squared	0,52	0,52	0,53	0,52	0,52	0,57	0,52	0,81
	Unconditional Demand Functions							
	Material Offshoring	Import Penetration	Trade Openness	Service Inshoring	FDI	Immigratio n	Union Density	Country-Time and Industry-Time
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SOS	0.010**	0.012**	0.012**	0.012**	0.011**	0.016**	0.011**	0,004
	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.007]	[0.005]	[0.004]
MOS	-0.004**							
	[0.001]							
IMPEN		-0,004						
		[0.003]						
OPEN			-0.005*					
			[0.003]					
INSH				-0,009				
				[0.005]				
IFDI					0,001			
					[0.001]			
OFDI					0,000			
					[0.001]			
MIGSTK						0,007		
						[0.007]		
UNDENS							0,002	
							[0.005]	
Obs.	1679	1679	1679	1679	1679	420	1679	1679
R-squared	0,46	0,45	0,46	0,46	0,45	0,48	0,45	0,78

Results are based on the 7-country sample. The dependent variable is the log number of employees. Only the coefficients of the shift-factors are reported. Standard errors are corrected for clustering at the country-industry level. ***, **, *: indicates significance at the 1, 5, and 10% level respectively. See also notes to previous tables.

Next, we control for union density. Service offshoring may in fact grow with union coverage, if the latter contributes to making domestic labor relatively more expensive. In column (7), we therefore add the union members' share of population (*UNDENS*), constructed using data from the OECD and the World Development Indicators. Note that the main results are unaffected. Finally, in the last column of Table 10, we account for any time-varying factor that cannot be precisely measured or is unobserved, by including a full set of country-time and industry-time effects in place of the year dummies. The coefficient of service offshoring remains positive, but is now smaller and not well identified.

Finally, we discuss alternative empirical approaches and estimation methods. The results are reported in Table 11. To begin with, column (1) re-estimates equations (7) and (8) using hours worked as the dependent variable, and replacing yearly wages with hourly wages. Interestingly, the effects of service offshoring on the intensive margin are very similar to those on the extensive margin discussed so far. Column (2) replaces *SOS* with *SOS_Y*. The coefficients of this variable are still weakly positive, suggesting that the main evidence on service offshoring does not crucially depend on how the service imports are normalized. Column (3) re-estimates the model in first differences and column (4) also includes country-industry fixed-effects, which control for common trends in labor demand and service offshoring. The coefficient of *SOS* drops in size, and is now virtually equal to zero. Column (5) makes a first move towards addressing the possible sluggish adjustment in labor demand, by adding to the specification the first lag of all the regressors, so as to allow their effects not to be instantaneous. Note that both the current and the lagged coefficients of *SOS* are small and weakly positive. Columns (6) and (7) go a step further in this direction, by re-estimating the model in long differences (5-year and 11-year differences, respectively). The coefficients of service offshoring remain weakly positive. Columns (8) and (9) deliver similar, albeit less precise, evidence, by addressing the same issue through the use of GMM estimators and biased-corrected least-square dummy variables for dynamic panel data. Finally, column (10) tackles the potential endogeneity of the explanatory variables, by reporting Instrumental Variable estimates using the first two lags of all the regressors as instruments. Endogeneity may be especially relevant for service offshoring, as the latter may be chosen by firms together with labor demand. Endogeneity may also be crucial for wages, unless each industry's labor supply is perfectly elastic as assumed so far. Nevertheless, the Instrumental Variables estimates are very close to the OLS estimates.

Table 11 - The Effect of Service Offshoring on Labor Demand: Alternative Empirical Approaches and Estimation Methods

	Conditional Demand Functions									
	Hours Worked	SOS_Y	1-Year Difference	1-Year Differences with	Lagged Regressors	5-Year Difference	11-Year Difference	AB - GMM	Bias-Corrected	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
SOS	0.012***		0,001	-0,001	0.007*	0.009**	0.022***	0,000	0,000	0.011**
	[0.004]		[0.001]	[0.001]	[0.004]	[0.004]	[0.008]	[1.050]	[0.002]	[0.004]
SOS_Y		0,006								
		[0.005]								
SOS (*t-1*)					0.005*					
					[0.003]					
AR1 Test (*p*-value)								0,87		
AR2 Test (p-value)								0,98		
Hansen *J* (*p*-value)								1,00		0,14
F-Stat. (min.-max.)										10.02-6391.35
Obs.	1679	1679	1539	1539	1539	979	139	1539	1679	1399
R-squared	0,49	0,51	0,31	0,57	0,54	0,51	0,59	-	-	0,47
	Unconditional Demand Functions									
	Hours Worked	SOS_Y	1-Year Difference	1-Year Differences with	Lagged Regressors	5-Year Difference	11-Year Difference	AB - GMM	Bias-Corrected	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
SOS	0.014***		0,001	-0,002	0.007*	0.010**	0.028***	0,001	0,000	0,009
	[0.005]		[0.001]	[0.001]	[0.004]	[0.004]	[0.010]	[0.414]	[0.003]	[0.005]
SOS_Y		0,010								
		[0.007]								
SOS (*t-1*)					0.006*					
					[0.003]					
AR1 Test (*p*-value)								0,00		
AR2 Test (p-value)								0,40		
Hansen *J* (*p*-value)								1,00		0,10
F-Stat. (min.-max.)										50.75-4287.55
Obs.	1679	1679	1539	1539	1539	979	139	1539	1679	1399
R-squared	0,45	0,44	0,25	0,54	0,47	0,44	0,50	-	-	0,42

Results are based on the 7-country sample. Only the coefficients of service offshoring are reported. The dependent variable is the log number of employees, except in column (1) where it is the log number of hours worked. The instruments used in column (10) are the first two lags of all the explanatory variables; estimation is performed with GMM. Standard errors are corrected for clustering at the country-industry level, except in column (8), where they are heteroskedasticity robust, and in column (9), where they are obtained using 50 bootstrap replications. ***, **, *: indicates significance at the 1, 5, and 10% level respectively. See also notes to previous tables.

To sum up, the results so far suggest that service offshoring has exerted small, and possibly weakly positive, effects on overall labor demand in Western Europe. Next, we explore potential heterogeneity in these effects across types of offshored services, individual countries, and workers with different skill levels.

Heterogeneity

We start by re-estimating the conditional and unconditional labor demand models using the four disaggregate indicators of service offshoring in place of *SOS*. Table 12 reports the results for the key specifications presented in the previous sections. The estimated coefficients are weakly positive, and close to those of *SOS*, in the case of offshoring of other business services (SOS^{OTHBUS}), whereas they are very small and imprecisely estimated for the remaining service categories (SOS^{COMP}, SOS^{FIN} and $SOS^{R\&D}$). These results imply that the aggregate findings discussed before are to a large extent driven by offshoring of business services, which constitutes the bulk of service offshoring in Western Europe. Offshoring of other service categories has instead a negligible effect on labor demand. More in general, these results suggest that none of the service categories considered in this chapter has so far caused sensible reductions in European employment.

Table 12 - The Effect of Service Offshoring on Labor Demand: Disaggregate Indicators of Service Offshoring

	Conditional Demand Functions										
	7-Country Sample										9-Country Sample
	Baseline	SOS_Y	Price of Software	Material Offshori	Service Inshorin	Union Density	Country-Time and Industry-Time	Hours Worked	11-Year Differenc	IV	Baseline
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
SOS^{OTHBUS}	0.018**		0.016**	0.017**	0.018**	0.018**	0,008	0.019**	0.033**	0.023**	0.023***
	[0.007]		[0.007]	[0.007]	[0.008]	[0.007]	[0.005]	[0.008]	[0.015]	[0.009]	[0.007]
SOS^{COMP}	-0,001		0,009	-0,004	0,007	0,004	0,023	0,015	0,032	-0,025	0,024
	[0.032]		[0.033]	[0.032]	[0.033]	[0.031]	[0.016]	[0.031]	[0.094]	[0.030]	[0.032]
SOS^{FIN}	0,012		0.028*	0,007	0,014	0,012	-0,007	0,019	0,026	0,010	0.029*
	[0.012]		[0.016]	[0.013]	[0.012]	[0.012]	[0.016]	[0.012]	[0.029]	[0.009]	[0.017]
$SOS^{R\&D}$	-0,005		-0,006	-0,005	-0,006	-0,005	-0.009**	-0,003	-0,009	0,002	-0,005
	[0.006]		[0.006]	[0.006]	[0.006]	[0.006]	[0.004]	[0.006]	[0.015]	[0.006]	[0.007]
SOS_Y^{OTHBUS}		0.027**									
		[0.012]									
SOS_Y^{COMP}		-0,032									
		[0.056]									
SOS_Y^{FIN}		-0,018									
		[0.022]									
$SOS\_Y^{R\&D}$		-0,009									
		[0.008]									
Obs.	1679	1679	1439	1679	1679	1679	1679	1679	139	1399	540
R-squared	0,53	0,52	0,54	0,53	0,53	0,53	0,82	0,50	0,60	0,46	0,55

	Unconditional Demand Functions										
	7-Country Sample										9-Country Sample
	Baseline	SOS_Y	Price of Software	Material Offshori	Service Inshorin	Union Density	Country-Time and Industry-Time	Hours Worked	11-Year Differenc	IV	Baseline
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
SOS^{OTHBUS}	0.018**		0.016*	0.017**	0.019**	0.017**	0,008	0.019**	0.031*	0.025**	0.029***
	[0.009]		[0.009]	[0.008]	[0.009]	[0.009]	[0.006]	[0.009]	[0.016]	[0.011]	[0.009]
SOS^{COMP}	0,037		0,045	0,032	0,048	0,040	0,027	0.053*	0,118	0,007	0,038
	[0.028]		[0.029]	[0.028]	[0.029]	[0.027]	[0.018]	[0.027]	[0.077]	[0.028]	[0.027]
SOS^{FIN}	-0,006		0,013	-0,014	-0,002	-0,005	-0,012	0,004	0,003	-0,006	0,015
	[0.014]		[0.017]	[0.015]	[0.014]	[0.014]	[0.016]	[0.013]	[0.031]	[0.011]	[0.018]
$SOS^{R\&D}$	-0,001		-0,002	-0,001	-0,002	0,000	-0,007	0,001	0,014	-0,005	-0,005
	[0.006]		[0.007]	[0.008]	[0.007]	[0.007]	[0.007]	[0.007]	[0.018]	[0.006]	[0.006]
SOS_Y^{OTHBUS}		0.030**									
		[0.014]									
SOS_Y^{COMP}		0,050									
		[0.052]									
SOS_Y^{FIN}		-0.051*									
		[0.026]									
$SOS\_Y^{R\&D}$		-0,005									
		[0.010]									
Obs.	1679	1679	1439	1679	1679	1679	1679	1679	139	1399	540
R-squared	0,46	0,45	0,48	0,47	0,47	0,46	0,78	0,45	0,51	0,43	0,46

The dependent variable is the log number of employees, except in column (8) where it is the log number of hours worked. Standard errors are corrected for clustering at the country-industry level. Only the coefficients of service offshoring are reported. ***, **, *: indicates significance at the 1, 5, and 10% level respectively. See also notes to previous tables.

Next, we estimate the baseline specification of equations (7) and (8) individually on each country, in order to unveil potential heterogeneity in the effects of service offshoring across the nine economies. The results are reported in Table 13. The estimated coefficients are positive in half of the countries and negative in the remaining cases, which reveals that some heterogeneity does exist in the sign of the effects across economies. Note, however, that the coefficients of *SOS* are often imprecisely estimated and generally small in absolute value. Overall, this suggests the effects of service offshoring to be moderate also in the individual economies, which is largely consistent with the aggregate evidence discussed before and with some of the existing empirical studies.

Table 13 - The Effect of Service Offshoring on Labor Demand: Individual Countries

	Conditional Demand Functions								
	Belgium	Denmark	Finland	France	Germany	Italy	Netherlands	Spain	Sweden
SOS	0.039*	0.032***	0,011	-0.079***	0,033	-0.047*	-0,005	0,004	-0,007
	[0.019]	[0.010]	[0.007]	[0.026]	[0.034]	[0.024]	[0.006]	[0.003]	[0.008]
Obs.	60	240	239	240	240	240	240	240	60
R-squared	0,52	0,71	0,53	0,70	0,66	0,37	0,71	0,80	0,83
	Unconditional Demand Functions								
	Belgium	Denmark	Finland	France	Germany	Italy	Netherlands	Spain	Sweden
SOS	0,031	0.052***	0,011	-0.137***	0,023	-0,018	-0,006	-0.005*	-0,002
	[0.021]	[0.014]	[0.008]	[0.030]	[0.035]	[0.034]	[0.007]	[0.003]	[0.010]
Obs.	60	240	239	240	240	240	240	240	60
R-squared	0,51	0,60	0,51	0,66	0,62	0,41	0,63	0,86	0,80

The dependent variable is the log number of employees. The specifications include the same regressors as in columns (1) and (5) of Table 8. Only the coefficients of service offshoring are reported. Standard errors are corrected for clustering at the industry level. ***, **, *: indicates significance at the 1, 5, and 10% level respectively. See also notes to previous tables.

Finally, we discuss the effects on workers with different educational levels. To this purpose, we estimate equations (7) and (8) separately on high, medium and low skilled employees. There are two main differences between these models and the benchmark specifications presented in Section IV. First, the dependent variables are hours worked by each skill group, rather than total employment. Second, the yearly wage is replaced by the hourly wages of the three skill groups. Table 14 reports the results. Interestingly, the estimated coefficients of service offshoring are small and weakly positive for all educational groups, suggesting that the aggregate results discussed before generally apply to workers with different skill levels. Note, also, that the estimated effects tend to be larger, and more precise, for more skilled workers. Consistent with previous work by Crinò (2011), this suggests imported services to complement especially with high domestic skills.

Table 14 - The Effect of Service Offshoring on Labor Demand: Estimates by Skill Group										
	Conditional Demand Functions									
	7-Country Sample									9-Country Sample
	Baseline	SOS_Y	Price of Software	Material Offshori	Service Inshorin	Union Density	Country-Time and Industry-Time	11-Year Differenc	IV	Baseline
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
High Skilled Labor										
SOS	0.013**		0.012*	0.013**	0.013**	0.015***	0,009	0.026**	0.053***	0.013*
	[0.006]		[0.006]	[0.006]	[0.006]	[0.005]	[0.005]	[0.011]	[0.018]	[0.007]
SOS_Y		0.020**								
		[0.010]								
R-squared	0,56	0,56	0,56	0,56	0,56	0,59	0,74	0,39	0,06	0,65
Medium Skilled Labor										
SOS	0,010		0,008	0,011	0,009	0,011	0,006	0.021*	0.020*	0,006
	[0.007]		[0.007]	[0.007]	[0.007]	[0.007]	[0.004]	[0.012]	[0.011]	[0.007]
SOS_Y		0,005								
		[0.009]								
R-squared	0,45	0,44	0,50	0,45	0,46	0,45	0,82	0,47	0,23	0,45
Low Skilled Labor										
SOS	0,012		0,010	0,012	0,011	0,011	0,005	0,012	-0,024	0,006
	[0.008]		[0.007]	[0.007]	[0.007]	[0.007]	[0.004]	[0.015]	[0.017]	[0.009]
SOS_Y		0,004								
		[0.010]								
R-squared	0,63	0,63	0,61	0,63	0,64	0,64	0,86	0,46	0,53	0,68
Obs.	1675	1675	1435	1675	1675	1675	1675	135	1115	540
	Unconditional Demand Functions									
	7-Country Sample									9-Country Sample
	Baseline	SOS_Y	Price of Software	Material Offshori	Service Inshorin	Union Density	Country-Time and Industry-Time	11-Year Differenc	IV	Baseline
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
High Skilled Labor										
SOS	0.018***		0.017***	0.016***	0.017***	0.019***	0.011**	0.036***	0.050***	0.020***
	[0.005]		[0.005]	[0.005]	[0.005]	[0.004]	[0.005]	[0.010]	[0.014]	[0.007]
SOS_Y		0.029***								
		[0.007]								
R-squared	0,55	0,55	0,55	0,55	0,55	0,57	0,73	0,35	0,18	0,63
Medium Skilled Labor										
SOS	0.015***		0.014**	0.015***	0.015***	0.016***	0.008*	0.037***	0.029***	0.017**
	[0.006]		[0.006]	[0.006]	[0.005]	[0.006]	[0.004]	[0.011]	[0.009]	[0.007]
SOS_Y		0,017								
		[0.011]								
R-squared	0,46	0,45	0,50	0,46	0,47	0,46	0,80	0,51	0,09	0,44
Low Skilled Labor										
SOS	0.016**		0.015**	0.015**	0.015**	0.014**	0,005	0,023	-0,008	0,012
	[0.007]		[0.007]	[0.007]	[0.007]	[0.007]	[0.005]	[0.015]	[0.017]	[0.009]
SOS_Y		0,012								
		[0.012]								
R-squared	0,62	0,61	0,59	0,62	0,62	0,63	0,85	0,45	0,60	0,65
Obs.	1675	1675	1435	1675	1675	1675	1675	135	1115	540

The dependent variable is the log number of hours worked by each skill group. Standard errors are corrected for clustering at the country-industry level. The instruments used in column (9) are the third and fourth lags of all the explanatory variables. Only the coefficients of service offshoring are reported. ***, **, *: indicates significance at the 1, 5, and 10% level respectively. See also notes to previous tables.

A large number of studies use a slightly different approach to investigate whether the effects of offshoring are heterogeneous across workers with different skill levels. Specifically, they use a translog specification to model the cost function in equation (3), derive a system of variable-cost share equations through Shephard's lemma, and estimate this system by Seemingly Unrelated Regressions or Iterated Three-Stage Least Squares. These studies include Morrison and Siegel (2001), Falk and Koebel (2001, 2002), Ekholm and Hakkala (2005), Hijzen et al. (2005), Becker et al. (2009) and Crinò (2011).

Table 15 uses the same approach. The results are broadly consistent with those obtained in Table 14 using log-linear demand functions. In fact, for none of the groups are the estimated coefficients of service offshoring significantly negative. Moreover, the coefficients of *SOS* tend to be larger, and more precisely estimated, for domestic workers with higher skills.

Table 15 - The Effect of Service Offshoring on Labor Demand: Variable-Cost Share Equations for Three Skill Groups

	7-Country Sample								9-Country Sample
	Baseline	SOS_Y	Price of Software	Material Offshoring	Service Inshoring	Union Density	11-Year Differences	I3SLS	Baseline
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
High Skilled Labor									
SOS	0.050***		0.064***	0.047***	0.059***	0.059***	0.085**	0.081***	0.079**
	[0.017]		[0.018]	[0.017]	[0.017]	[0.017]	[0.042]	[0.027]	[0.034]
SOS_Y		0.076***							
		[0.029]							
Medium Skilled Labor									
SOS	0.268***		0.231***	0.273***	0.245***	0.268***	0.393**	0.307***	0.190**
	[0.040]		[0.042]	[0.041]	[0.040]	[0.040]	[0.170]	[0.054]	[0.082]
SOS_Y		0.282***							
		[0.068]							
Low Skilled Labor									
SOS	-0.010		-0,005	-0.010	0,008	-0,015	0,013	-0,043	0,036
	[0.025]		[0.026]	[0.025]	[0.024]	[0.024]	[0.111]	[0.034]	[0.056]
SOS_Y		-0,027							
		[0.041]							
Obs.	1676	1676	1436	1676	1676	1676	136	1396	540
Gen. R-squared	0,75	0,75	0,82	0,75	0,77	0,76	0,98	0,52	0,77

The dependent variables are the variable-cost shares of the three skill groups. Only the coefficients of service offshoring are reported. The system of equations also includes an intermediate input demand function, whose coefficients are not reported. Estimation is performed by Seemingly Unrelated Regressions (columns (1)-(7) and (9)) and Iterated Three-Stage Least Squares (column (8)). Variables are deviated from country-industry averages, except in column (7). Asymptotic standard errors are reported in square brackets. ***, **, *: indicates significance at the 1, 5, and 10% level respectively. See also notes to previous tables.

5.3.2 The effects of service offshoring on labor demand elasticity

The previous section shows that service offshoring exerts small effects on the level of labor demand in Western Europe. This section investigates a different channel through which service offshoring may affect domestic workers, namely, by changing, and possibly increasing, the wage elasticity of labor demand. As mentioned in the introduction, service offshoring may make labor demand more elastic, by expanding the flexibility with which firms can potentially substitute domestic workers with foreign inputs (Hijzen and Swaim, 2010; Senses, 2010). A greater elasticity, in turn, implies a higher volatility of wages and employment in response to economic shocks, a lower bargaining power of workers and a larger incidence of non-wage labor costs on employees (Rodrik, 1997). Importantly, the simple threat of service offshoring may be sufficient to flatten out labor demand. Hence, this effect is not incompatible *a priori* with the small changes in the employment levels induced by service offshoring until now, which we have documented in the previous section.

In order to study this issue, we start by estimating equation (9) on the whole sample of countries. The results are reported in Table 16. Beginning from the baseline specification in column (1), note that the coefficient of the interaction term between service offshoring and log wages is negative and precisely estimated. This result is generally robust across the remaining specifications. In particular, it remains qualitatively unchanged when normalizing imported services with industry output (column (2)), when accounting for concomitant factors related to technical change, globalization and union density (columns (3)-(7)), when using hours worked instead of total employment (column (8)) and when estimating the model in long differences or with Instrumental Variables (columns (9)-(10)). Overall, this suggests that service offshoring may make labor demand more elastic. Nevertheless, the effect is not large in economic terms. The point estimates imply, in fact, that a 1 p.p. increase in *SOS* raises the absolute value of the wage elasticity by approximately 0.01.

Table 16 - The Effect of Service Offshoring on Labor Demand Elasticity

	7-Country Sample										9-Country Sample
	Baseline	SOS_Y	Price of Software	Material Offshorin	Service Inshorin	Union Density	Country-Time and Industry-Time	Hours Worked	11-Year Differenc	IV	Baseline
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
lnW	-0.178**	-0.184**	-0.132*	-0.211**	-0.199**	-0,134	-0.077**	-0.174**	-0.257***	-0.239**	-0.264***
	[0.075]	[0.075]	[0.075]	[0.098]	[0.087]	[0.101]	[0.034]	[0.084]	[0.095]	[0.101]	[0.057]
lnP^M	0,114	0,107	0,101	0,122	0,109	0,110	0,094	0,118	0,248	0,212	0.160**
	[0.076]	[0.076]	[0.077]	[0.077]	[0.079]	[0.077]	[0.067]	[0.078]	[0.156]	[0.216]	[0.073]
lnP^S	-0,004	-0,006	-0,040	-0,008	-0,026	-0,001	-0,087	-0,027	-0,076	0,147	-0,034
	[0.055]	[0.056]	[0.055]	[0.055]	[0.057]	[0.056]	[0.055]	[0.058]	[0.087]	[0.097]	[0.057]
lnP^E	-0.108**	-0.098**	-0,053	-0.114**	-0,069	-0.098**	0,047	-0,067	-0.204***	-0,099	-0.159***
	[0.046]	[0.046]	[0.055]	[0.046]	[0.053]	[0.044]	[0.055]	[0.046]	[0.076]	[0.087]	[0.047]
lnY	0.339***	0.336***	0.306***	0.341***	0.312***	0.342***	0.345***	0.306***	0.415***	0.573***	0.340***
	[0.083]	[0.085]	[0.088]	[0.083]	[0.082]	[0.082]	[0.078]	[0.087]	[0.103]	[0.148]	[0.069]
lnK	0.427***	0.428***	0.375***	0.420***	0.445***	0.423***	0,095	0.447***	0.416***	0.303**	0.413***
	[0.072]	[0.075]	[0.074]	[0.074]	[0.072]	[0.077]	[0.062]	[0.077]	[0.089]	[0.119]	[0.065]
SOS	0.104**		0.135***	0.111***	0.154***	0.111***	0.086***	0.122***	0.149***	0,085	0,009
	[0.041]		[0.044]	[0.042]	[0.046]	[0.042]	[0.029]	[0.046]	[0.048]	[0.066]	[0.043]
SOS*lnW	-0.009**		-0.012**	-0.010**	-0.014**	-0.010**	-0.008***	-0.010**	-0.012***	-0,007	0,000
	[0.004]		[0.004]	[0.004]	[0.004]	[0.004]	[0.003]	[0.004]	[0.004]	[0.006]	[0.004]
SOS_Y		0.128*									
		[0.075]									
SOS_Y*lnW		-0,011									
		[0.007]									
lnP^{SOFT}			1.489*								
			[0.857]								
lnP^{SOFT}*lnW			-0,125								
			[0.083]								
MOS				-0,014							
				[0.018]							
MOS*lnW				0,001							
				[0.002]							
INSH					-0.060*						
					[0.035]						
INSH*lnW					0,006						
					[0.004]						
UNDENS						0,014					
						[0.013]					
UNDENS*lnW						-0,001					
						[0.002]					
Obs.	1679	1679	1439	1679	1679	1679	1679	1679	139	1119	540
R-squared	0,53	0,52	0,54	0,53	0,54	0,53	0,82	0,50	0,60	0,42	0,53

The dependent variable is the log number of employees, except in column (8) where it is the log number of hours worked. Standard errors are corrected for clustering at the country-industry level. The instruments used in column (10) are the third and fourth lags of all the explanatory variables. ***, **, *: indicates significance at the 1, 5, and 10% level respectively. See also notes to previous tables.

Table 17 re-estimates the baseline specification individually on each country. Not surprisingly, the coefficients are less precise than before. Interestingly, however, there is heterogeneity in the sign of the interaction terms across economies. In particular, the coefficients of these terms are negative in five countries and positive in the remaining four. Recent work by Hasan et al. (2007) and Hijzen and Swaim (2010) suggests that such heterogeneity may be linked to the difference in labor market regulations across countries. In countries with weak regulations, in fact, firms may have greater flexibility to adjust their mix of domestic and foreign inputs and the effects of service offshoring may end up being larger as a result.

Table 17 - The Effect of Service Offshoring on Labor Demand Elasticity: Individual Countries

	Belgium	Denmark	Finland	France	Germany	Italy	Netherlands	Spain	Sweden
lnW	-0.396*	-0,190	-0,166	-0.311**	-0,006	0,197	-0,178	-0,568	0,028
	[0.211]	[0.164]	[0.146]	[0.111]	[0.021]	[0.187]	[0.125]	[0.399]	[0.083]
SOS	-0,026	0,422	0,176	-1.160**	1.109***	1,682	-0,022	-0,343	0,125
	[0.627]	[0.306]	[0.135]	[0.540]	[0.209]	[1.202]	[0.124]	[0.482]	[0.112]
SOS*lnW	0,006	-0,046	-0,015	0.107*	-0.103***	-0,163	0,001	0,035	-0,015
	[0.059]	[0.036]	[0.012]	[0.054]	[0.019]	[0.113]	[0.011]	[0.048]	[0.013]
Obs.	60	240	239	240	240	240	240	240	60
R-squared	0,52	0,72	0,55	0,71	0,71	0,41	0,71	0,80	0,84

The dependent variable is the log number of employees. The specifications include the same regressors as in column (1) of Table 16. Only the coefficients of log wages, service offshoring and their interaction are reported. Standard errors are corrected for clustering at the industry level. ***, **, *: indicates significance at the 1, 5, and 10% level respectively. See also notes to previous tables.

In order to investigate this source of heterogeneity, in Table 18, we re-estimate the baseline specification on two sub-samples of countries: those with strict labor market regulations and those with weak labor market regulations. Countries with strict regulations are those for which the index of Employment Protection Legislation (EPL) constructed by Nickell (2006) is above the sample median. Consistent with our expectations, and with the previous findings by Hasan et al. (2007) and Hijzen and Swaim (2010), the interaction term between log wages and service offshoring is negative and statistically significant only in the sub-sample of countries with weak EPL, where firms may have greater flexibility to substitute domestic labor with foreign inputs.

Table 18 - The Effect of Service Offshoring on Labor Demand Elasticity: Countries with Strict and Weak EPL

	7-Country Sample		9-Country Sample	
	Strict EPL	Weak EPL	Strict EPL	Weak EPL
lnW	-0.223***	-0.165*	-0.260***	-0.257***
	[0.076]	[0.099]	[0.079]	[0.087]
SOS	-0,007	0.092*	-0.153*	0.096**
	[0.127]	[0.047]	[0.085]	[0.043]
SOS*lnW	0,000	-0.008*	0.015*	-0.008*
	[0.012]	[0.005]	[0.009]	[0.004]
Obs.	720	959	240	300
R-squared	0,49	0,56	0,46	0,60

The dependent variable is the log number of employees. The specifications include the same regressors as in column (1) of Table 16. Only the coefficients of log wages, service offshoring and their interaction are reported. Standard errors are corrected for clustering at the country-industry level. ***, **, *: indicates significance at the 1, 5, and 10% level respectively. See also notes to previous tables.

Finally, Table 19 reports separate results for the three skill groups of workers, using the 7-country sample to save space and maximize degrees of freedom. The estimates show that, in countries with strict EPL, service offshoring does not raise the elasticity of labor demand for any of the three skill groups of workers. In countries with weak EPL, instead, service offshoring exerts no effect on workers with high and medium levels of skills, but raises the elasticity of labor demand for those with low levels of education.

Table 19 - The Effect of Service Offshoring on Labor Demand Elasticity: Estimates by Skill Group

	Strict EPL			Weak EPL		
	High Skilled	Medium Skilled	Low Skilled Labor	High Skilled	Medium Skilled	Low Skilled Labor
lnW^{HS}	0,183	-0,104	-0,095	-0.903***	-0.206*	-0,147
	[0.176]	[0.094]	[0.144]	[0.116]	[0.105]	[0.121]
lnW^{MS}	-0.651**	-0.348**	0,281	0.756***	0.514**	-0,489
	[0.294]	[0.169]	[0.267]	[0.233]	[0.237]	[0.355]
lnW^{LS}	0,019	-0,011	0,106	-0,028	-0.463*	0,206
	[0.047]	[0.014]	[0.073]	[0.222]	[0.250]	[0.311]
SOS	0,029	-0.101***	-0.220*	0.077*	-0,006	-0.116***
	[0.089]	[0.037]	[0.123]	[0.042]	[0.037]	[0.044]
SOS*lnW^{HS}	0,088	0,031	0.110*	0,003	0,017	0,086
	[0.056]	[0.029]	[0.057]	[0.046]	[0.058]	[0.074]
SOS*lnW^{MS}	-0,088	-0,025	-0,063	-0,051	0,017	0.182*
	[0.085]	[0.035]	[0.113]	[0.071]	[0.073]	[0.095]
SOS*lnW^{LS}	-0,021	0,018	-0,003	0,023	-0,033	-0.250***
	[0.040]	[0.018]	[0.058]	[0.042]	[0.043]	[0.050]
Obs.	716	716	716	959	959	959
R-squared	0,59	0,46	0,79	0,71	0,59	0,61

Results are based on the 7-country sample. The dependent variable is the log number of hours worked by each skill group. Only the coefficients of log wages, service offshoring and their interactions are reported. Standard errors are corrected for clustering at the country-industry level.***, **, *: indicates significance at the 1, 5, and 10% level respectively. See also notes to previous tables.

5.4 Concluding remarks

This chapter studied the effects of service offshoring on the location and elasticity of labor demand, using novel and comparable data for nine Western European countries between 1995 and 2006. The empirical results showed that, in the aggregate, service offshoring exerts small, and possibly weakly positive, effects on the level of labor demand. These effects are mostly driven by offshoring of business services, whereas offshoring of other services has a negligible impact on labor demand. Some heterogeneity exists across countries in the sign of the effects, but the economic magnitude of the latter is always small. Finally, skilled workers are more likely to complement with imported services than unskilled workers; however, neither for this latter group are the effects of service offshoring significantly negative.

As for the second topic, the results show that service offshoring makes labor demand more elastic. Nevertheless, the economic magnitude of this effect is small as well. Interestingly, the effect depends on the strictness of labor market regulations in each country. In particular, the elasticity of labor demand rises with service offshoring only in countries with weak regulations, and this effect is mostly borne by low skilled workers.

Taken together, these findings support the main message from previous studies, according to which the ‘fear of service offshoring’ (Amiti and Wei, 2005) is probably exaggerated. At the same time, however, they suggest that specific types of government policies may help alleviate this fear and mitigate the adjustment costs faced by some groups of workers. In particular, improved access to on-the-job training and higher education may help low educated and poorly qualified individuals upgrade their skills and thereby make them more complementary with imported services (OECD, 2005). Similarly, EPL may reduce the negative effects of service offshoring on the wage elasticity of labor demand, especially for low skilled workers.

In conclusion, we mention a possible avenue for future research related to this chapter. Service offshoring may have different implications for individual employees, depending on their educational level and other characteristics such as gender, race, occupation, labor market experience and geographical mobility. The chapter does not study these factors, due to its focus on more aggregate effects. Nevertheless, the studies on service offshoring based on micro-level data are still very limited. Among them are the recent works by Liu and Trefler (2008) and Blinder and Krueger (2009) for the U.S., and by Hijzen et al. (2007) and Geishecker and Görg (2008) for the U.K.. The increasing availability of worker-level data sets will offer a great opportunity to expand the number and geographic coverage of these studies, thereby improving our understanding of the labor market implications of service offshoring in the industrialized countries.

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7 APPENDIX: TABLE A1

Table A1 - Variables and Descriptive Statistics

Name	Definition	Source	7-Country Sample Obs.	7-Country Sample Mean	7-Country Sample Std. Dev.	9-Country Sample Obs.	9-Country Sample Mean	9-Country Sample Std. Dev.
lnL	Log number of employees	EUKLEMS	1680	11,9	1,5	540	11,7	1,4
lnH	Log number of hours worked	EUKLEMS	1680	19,3	1,4			
lnH^{HS}	Log number of hours worked by high skilled workers	EUKLEMS	1680	16,8	1,7	540	16,6	1,6
lnH^{MS}	Log number of hours worked by medium skilled workers	EUKLEMS	1680	18,9	1,6	540	18,7	1,6
lnH^{LS}	Log number of hours worked by low skilled workers	EUKLEMS	1680	17,6	1,8	540	17,5	1,7
lnW	Log yearly wage	EUKLEMS	1680	10,1	0,8	540	9,9	1,0
lnW	Log hourly wage	EUKLEMS	1680	2,7	0,8			
lnW^{HS}	Log hourly wage of high skilled workers	EUKLEMS	1680	3,2	0,8	540	3,0	1,0
lnW^{MS}	Log hourly wage of medium skilled workers	EUKLEMS	1680	2,8	0,7	540	2,6	0,9
lnW^{LS}	Log hourly wage of low skilled workers	EUKLEMS	1676	2,4	0,9	540	2,3	1,0
Csh^{HS}	Cost share of high skilled workers	EUKLEMS	1676	4,8	5,2	540	4,6	4,8
Csh^{MS}	Cost share of medium skilled workers	EUKLEMS	1676	19,0	10,5	540	18,3	10,5
Csh^{LS}	Cost share of low skilled workers	EUKLEMS	1676	6,1	5,2	540	6,5	5,2
lnP^{M}	Log price of material inputs	EUKLEMS	1680	0,1	0,3	540	0,1	0,3
lnP^{S}	Log price of service inputs	EUKLEMS	1679	0,1	0,3	540	0,1	0,3
lnP^{E}	Log price of energy inputs	EUKLEMS	1680	0,2	0,3	540	0,2	0,3
lnP^{I}	Log price of intermediate inputs	EUKLEMS	1680	0,1	0,1			
lnP^{Y}	Log price of output	EUKLEMS	1680	0,1	0,1	540	0,1	0,2
lnP^{K}	Log price of non-ICT assets	EUKLEMS	1440	0,1	0,1			
lnP^{SOFT}	Log price of software	EUKLEMS	1440	0,0	0,2			
lnP^{IT}	Log price of computing equipment	EUKLEMS	1428	-1,1	0,6			
lnP^{CT}	Log price of communication equipment	EUKLEMS	1428	-0,1	0,2			
lnP^{ICT}	Log price of ICT assets	EUKLEMS	1440	-0,5	0,4			
lnY	Log real output	EUKLEMS	1680	23,6	1,8	540	23,3	1,9
lnK	Log volume index of non-ICT capital services	EUKLEMS	1680	0,1	0,2	540	0,1	0,2
ICT	ICT share of total capital compensation	EUKLEMS	1680	14,2	13,0			
TFP	Index of TFP growth	EUKLEMS	1680	1,1	0,3			
SOS	Share of imported services in total input purchases	Eurostat	1680	1,9	2,2	540	2,1	2,3
SOS^{OTHBUS}	Share of imported business services in total input purchases	Eurostat	1680	1,3	1,5	540	1,3	1,6
SOS^{COMP}	Share of imported computer services in total input purchases	Eurostat	1680	0,1	0,3	540	0,1	0,3
SOS^{FIN}	Share of imported financial and insurance services in total input purchases	Eurostat	1680	0,3	0,4	540	0,3	0,4
$SOS^{R\&D}$	Share of imported R&D services in total input purchases	Eurostat	1680	0,2	0,9	540	0,4	1,3
MOS	Share of imported material inputs in total input purchases	Eurostat	1680	19,9	14,4			
SOS_Y	Share of imported services in total output	Eurostat and EUKLEMS	1680	1,0	1,3			
SOS_Y^{OTHBUS}	Share of imported business services in total output	Eurostat and EUKLEMS	1680	0,7	0,7			
SOS_Y^{COMP}	Share of imported computer services in total output	Eurostat and EUKLEMS	1680	0,1	0,1			
SOS_Y^{FIN}	Share of imported financial and insurance services in total output	Eurostat and EUKLEMS	1680	0,1	0,2			
$SOS\_Y^{R\&D}$	Share of imported R&D services in total output	Eurostat and EUKLEMS	1680	0,1	0,7			
IMPEN	Imports over GDP (country-level)	WDI	1680	34,0	11,7			
OPEN	Average imports- and exports-to-GDP ratio (country-level)	WDI	1680	35,6	12,6			
INSH	Service exports over GDP (country-level)	WDI	1680	8,0	3,5			
IFDI	Net inward FDI over GDP (country-level)	WDI	1680	3,3	3,8			
OFDI	Net outward FDI over GDP (country-level)	WDI	1680	4,7	4,8			
MIGSTK	Immigrants' share of population (country-level)	WDI	420	7,4	3,6			
UNDENS	Union members' share of population (country-level)	OECD and WDI	1680	36,6	25,4			