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The relative weight of manufacturing and services in Europe: an innovation perspective

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Abstract

This paper uses an innovation-based taxonomy of both manufacturing and service industries to assess the role of the process of structural change of the last 25 years on the rate of growth in Europe, US and Japan. The empirical analysis exploits the shift-share methodology for a decomposition of aggregate labor productivity growth. A modified version is applied, that allows to interpret whether employment has shifted to higher or lower productivity sectors. The results are discussed in light of the role that the different industries play according to an innovation-based taxonomy.

Keywords: Structural change, Innovation, Growth, Shift-share
JEL codes: O30, O38, O47

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1 Introduction

'Growth' is one of the keywords of the renewed Lisbon EU-agenda. A crucial way to study how economies grow is to look at their sectoral dimension. Which are the successful industries and how do they contribute to aggregate national performance? There is significant empirical evidence that countries are subject to processes of structural change. In time some industries grow and contribute to aggregate growth for a larger share, other industries decline or remain marginal. Recent studies on the determinants of the productivity gap of European countries *vis-à-vis* the US have stressed the role played by their different industrial structures [1]. European countries are less specialized in 'knowledge intensive' industries. Consequently, the Lisbon agenda is now addressing the need for increasing investment in knowledge and innovation.

It is also becoming clear that services are playing an increasingly important role in the economies of most OECD countries. The current process of structural change in Europe is one in which the share of manufacturing in the economy is declining while services are accounting for increasing shares of employment and value added. At the same time manufacturing industries still appear to explain a relevant share of aggregate productivity growth [2].

Recent research is progressing fast in providing a better understanding of the drivers of productivity growth in services. In a Schumpeterian perspective, innovation is the main source of productivity increases. While such a link between innovation and productivity growth has been extensively studied for manufacturing industries, we are only starting to build an understanding of how productivity growth in services is fueled by technological change. Innovation trajectories in services appear to be qualitatively different from the ones characterizing manufacturing, even though a stream of studies in the so-called assimilationist perspective try to show that broader and newer definitions of innovation can apply to both manufacturing and services [3]. Along these lines, Miozzo and Soete [4] have contributed to a first appraisal of cross-sectoral differences in innovation among services. They have also extended the Pavitt taxonomy to services and provided a corresponding analysis of the inter-sectoral knowledge flows. Castellacci [5] has proposed a unified taxonomy which encompasses both manufacturing and service industries and their linkages.

The aim of this paper is *to assess the contribution of both manufacturing and service industries to labor productivity growth using a unified sectoral innovation taxonomy.* If we group sectors by the properties of their technological processes, do we find that the contribution of a group is more crucial to growth? And do the results differ significantly across countries?

The paper presents an empirical analysis using the shift-share methodology, a descriptive technique which has become fare in the studies on structural change. We use a shift-share analysis for a simple test on the impact of structural change on labor productivity growth in European countries, the US and Japan. Specifically, labor productivity growth at the manufacturing level can be decomposed for each group of sectors into two main effects: a within growth effect and a shift effect. The paper brings three main contributions to the existing empirical literature on structural change and growth.

First, the paper uses an innovation taxonomy combining manufacturing and service sectors and argues that the use of such taxonomy provides richer insights into the relative role of sectors than a full blown sectoral analysis. Industrial taxonomies have been used in studies of structural change only within manufacturing [6].

Second, the paper uses a refined methodology which overcomes some of the limitations of the conventional 'shift-share' analysis and enables to interpret the direction of sectoral shift effects.

Third, the paper exploits a new dataset providing industry-level variables for European countries and a couple of other reference countries. The EU KLEMS database [7] has been constructed using national accounts data supplied by national statistical offices. Industry-level variables were built starting from harmonized definitions, industry classifications and aggregation procedures. Also, the database includes industry-level price deflators and employment is measured in terms of hours worked [8].

The following section discusses the theoretical and empirical literature that we build upon. Section 3 introduces the data and explains our methodology. Section 4 discusses the main findings and Section 5 concludes.

2 Structural change and innovation

This work builds upon two strands of literature. The first one is concerned with assessing the link between structural change and growth. The short review in this section will be biased towards those studies that most explicitly address the role of innovation in processes of structural change. The second strand of literature includes studies that have investigated differences in innovation input and output across industries and across countries. Inter-industry differentials in technological opportunities are an important part of the structural change story because they may be seen as the underlying source of differentials in productivity growth. And structural change ultimately relies upon differences in performance across industries.

2.1 Structural change and growth

Many theoretical efforts have been devoted to the understanding of the link between structural change and growth. The main starting point of much theorizing is that processes of structural change in the economy are a necessary condition for economic growth.

A preliminary question concerns the very sources of structural change. On the supply side, structural change may be seen as the result of processes of innovation which lead to productivity increases in certain industries rather than other. The original Schumpeterian idea of innovation as 'creative destruction' describes exactly this process. New varieties of goods and new ways of producing them displace old ones and shift the structure of the economy toward new sectors [9]. On the demand side, income elasticities vary across sectors and channel growth into those sectors for which demand is higher [10]. Overall, economies enjoy a 'structural bonus' when labor shifts to sectors with higher than average productivity [11].

Structural change fundamentally relies on an uneven distribution of productivity increases across sectors. This corresponds to what Hagerber [12] calls the 'mushroom' view of growth. In contrast, a 'yeast' process, with productivity increases uniformly spread across sectors, would not sustain any real process of structural change.

Theoretical investigations of the sources of structural change have been particularly illuminating when documenting the historical phases of development of capitalist economies [13]. In this case, structural change is meant to happen at a rather aggregate level, between broad industries such as Agriculture, Manufacturing and Services (see [14] for a recent contribution). At a finer level of aggregation within manufacturing, processes of structural change may be more difficult to incorporate. In fact, sectoral heterogeneity and corresponding differential sectoral dynamics have not easily been included in mainstream endogenous growth models, except in rather stylized forms [15]. There exist instead a few neo-schumpeterian models incorporating technology- and demand-driven structural change in a multi-sector setting [16, 17, 18].

In terms of the effects of structural change on aggregate economic growth, the current debate seems to focus on the impact of the structural shift to services on the rate of growth. According to the pessimistic vision originally expressed by Baumol [11], the increasing demand for final services will drive down growth by shifting employment to lower productivity activities. Proponents of a more optimistic view stress instead the role of services as intermediate goods and indirect contributors to productivity growth [19, 20].

As for the empirical literature, I will only briefly review here two broad sets of empirical works on structural change and productivity growth. I will focus on studies that are relevant for the analysis in this paper.

First, cross-country explorations of differentials in growth performances have extensively documented the importance of national patterns of specialization in influencing a country's growth path [15, 21]. Recent empirical work has tested the impact of structural change on growth using different methodologies, including the conventional 'shift-share' approach [22, 6]. These empirical tests have key implications for the 'convergence/divergence' debate.

Fagerberg [22] looks at 39 countries and 24 industries for the period 1973-1990. He uses shift-share analysis finding no strong evidence that structural change has contributed, on average, to growth. He finds instead that countries with higher shares of the electronics industry have been characterized by higher productivity growth rates.

Peneder [6] analyzes the period 1985-1998 and performs a shift-share decomposition using different taxonomies of manufacturing industries (factor-input combination, skill requirements and external service inputs). He also runs a panel regression with structural variables and finds that the changes in the shares of technology-driven industries and business services have had a significant impact on income growth in OECD countries in the 90s.

Montobbio [23] provides a general picture of the processes of structural change and suggests significant structural change also in innovative activities. He uses a definition of 'expanding' and 'declining' sectors which classifies patent technological classes in terms of the share of their patents in the total of world patents (see also [24]). He finds, for instance, that while the US, Japan and a few dynamic EU countries have increasing shares in technological classes with a rising weight in world patents, other European countries such as Italy and Spain have increasing shares only in patent classes with a declining weight in world patents. The latter countries are also the ones showing poor aggregate performance in terms of value added growth and labor productivity growth.

Second, a vast literature on Total Factor Productivity growth has also studied how sectoral performances contribute to changes in aggregate productivity. The growth accounting exercises have originally been inspired by the Solow model [25] and have been aimed at assessing the role of the unexplained residual. The most recent and sophisticated exercises have tackled the measurement of technological change in improved ways. In particular, many studies have had a special focus on the role of ICT [26, 27]. Overall, these exercises also confirm that sectors show uneven performances in terms of TFP growth and productivity increases appear concentrated in some industries rather than evenly in the overall economy.

2.2 Sectoral and national differences in innovation

The empirical literature on differences in technological progress across sectors and countries has been inspired by theoretical insights about the sources and procedures of innovation [28].

First, it is a well-established empirical fact that sectors differ in terms of innovation. Not only sectors experience different stages in their industry life-cycle at a given point in time, but more fundamentally some industries simply display larger opportunities than other in terms of technical progress. Nelson and Winter [29] discuss extensively the key dimensions along which technological change may differ and first introduce the idea of 'technological regimes'. Search processes, patterns of incentives, sources of novelty, opportunities and constraints all define the variegated ways in which technological learning and innovation come about in sectors [28, 30]. The degree of cumulativeness of the underlying knowledge also plays an important role. Differences in technological regimes can be linked to emergent properties of industries, such as the level of competition or the processes of entry/exit of firms. The work by Pavitt [31] has represented an important starting point for empirical analysis of sectoral differences. Pavitt's taxonomy, built using firm-level data constructed at SPRU, gives also a comprehensive picture of the knowledge linkages between sectors. Recently, Malerba [32] has proposed a more general idea of 'sectoral systems of innovation', which calls for a systemic approach to understand sectoral differences by including a focus on actors, networks and institutions.

Both theoretical and empirical works discussed so far have a strong focus on manufacturing industries. As for services, innovation-based classifications of services have been proposed following a number of approaches. The OECD only defines two categories of high tech services and low tech service with no further specification (see [33], p.166). Evangelista [34] and Den Hertog [35] propose two different taxonomies and in general different categories have been defined depending on the focus of the analysis [36]. Coombs and Miles [37] identified three main approaches used to build concepts for innovation in services (see also [38] and [39]). The assimilation approach has translated existing concepts to services, the demarcation approach has highlighted the qualitative difference in innovation properties and the integration approach has taken the opportunity for new definitions of innovation applicable to both manufacturing and services. Services do possess certain distinctive features that differentiate them from manufacturing [40]. Among these, the most evident ones are the intangible nature of many service products, their interactive nature as brought by the property of 'co-terminality' and the overall higher information-intensity. The recent development of services has a lot to do with the affirmation of ICT technologies, which not only have made information and knowledge central assets for companies in all industries, but have also reduced the spatial dimension of service provision and facilitated outsourcing of many activities outside the boundaries of manufacturing firms. Along these lines, Miozzo and Soete [4] have proposed an extension of the Pavitt taxonomy for service industries with an explicit focus on the development of ICT technologies.

Second, countries differ in terms of innovation efforts and production. National systems of innovation have been studied extensively both with national case studies and with the formulation of a general theory [41, 42]. Institutions supporting innovation have been highlighted as major determinants of growth and this approach is indeed very much geared toward policy implications. An important point is that national production and technological specialization show a high degree of inertia which should not be underestimated. Nevertheless the last decades have also highlighted examples of major shifts in national specialization patterns.

Few empirical works have tested for the strength of both sector and country effects in explaining heterogeneity in innovation [43]. On the theoretical side, there have been efforts at combining the two strands of theorizing discussed above for a general understanding of cross-country differences in innovation performance. Sectoral and national systems of innovation tend to interact in ways that may explain why a sector is more innovative in a given country than in another [5]. The institutions embodying national systems of innovation may in fact activate inter-sectoral linkages and sustain positive feedback in the whole economy. For instance, the upstream and downstream linkages between sectors, and the links between university and industry may crucially differ between countries. Laursen and Meliciani [44] show that inter-sectoral linkages have an impact on the competitiveness of sectors (export performance in their case) but the key variables vary across the Pavitt groups. As expected, downstream linkages are crucial for specialized suppliers, while upstream linkages are vital for scale intensive sectors.

2.3 An innovation-based taxonomy of manufacturing and service industries

In this paper I use a unified taxonomy of both manufacturing and service industries obtained from merging the taxonomies of Pavitt [31] and Miozzo and Soete [4].

The Pavitt taxonomy groups industries by the properties of the innovations of their firms. It was built from firm-level data and included the following dimensions: sources of technology, type of user, means of appropriation, objective of innovation, nature of innovation, firm size, rate and direction of technological diversification. The taxonomy has been widely used and also re-assessed with more recent data [45]. It defines four sectors[1] with homogeneous firm-level characteristics of innovation:

- Scale intensive (SI): include both complex and consumer durables, and processed raw materials (e.g. metal manufacturing, glass and cement). Firms in these industries tend to devote a high proportion of resources to innovation.
- Supplier dominated (SD): industries where firms mostly produce technologically simple goods (e.g. textiles and leather goods) and have their main sources of innovation in their capital and intermediate components suppliers.
- Science-based (SB): industries include electronics, drugs, bioengineering and all those industries where innovation is directly linked to advances in pure and applied sciences.
- Specialized suppliers (SS): industries include equipment building, design, and mechanical engineering (e.g. machines and machine-tools production), where innovation typically stems from informal activities. Firms in this group tend to be small.

[31] also pays due attention to inter-group technological linkages. Supplier dominated firms receive their technology from science-based firms, but also from scale intensive firms. Specialized suppliers are linked in a bilateral flow with science-based firms and scale intensive ones. Science based firms provide technology for all the other groups.

The taxonomy of services presented by Miozzo and Soete [4] is meant at highlighting both differences in innovation sources and trajectories across sectors but also technological linkages with other service sectors and with manufacturing. Because of these two characteristics, it shares the same broad objectives of the original Pavitt work.

I follow the original classification and allocate service industries to four groups.

1. Supplier dominated services (SDS): they rely on the purchase of capital goods produced in manufacturing sectors for their innovation. They are mostly small companies providing services directly to customers. The activities involved are low-tech ones.
2. Scale intensive services: represent the network infrastructure of the knowledge based economy. Mostly large firms that acquire advanced capital goods from science based and specialized supplier manufacturing firms.

2a. Physical networks (PN): includes transport and wholesale trade

2b. Information networks (IN): includes activities relying heavily on information and its efficient management (finance, insurance)

3. Science-based and specialized suppliers (or Knowledge Intensive Business Services, KIBS): firms that produce their own innovation and rely on formal activities of research, in close connection with their manufacturing counterparts.

Information networks and knowledge intensive business services are "technology intensive, actively engaged in the development and use of data, communication and storage and transmission of information." ([4], p.163).[2]

Both physical and information networks partly rely on capital goods supplied by SB and SI industries to implement innovation, but the innovation they engage in is inherently client-led. User requirements need to be taken into account by manufacturers and this justifies important interaction and knowledge flows between networks services and capital goods suppliers with a considerable amount of relation-specific investment.

Castellacci [5] has proposed a unified taxonomy which merges insights from the two previous ones. The value added of such a taxonomy is that services can be understood as part of the whole innovation system and the overall linkages between manufacturing and services come to the fore. Figure 1 shows the overall picture. The most evident feature is the central role that physical and information networks come to play. They provide the infrastructure, communication means and information channels which are seen to be at the very fundament of a knowledge-based innovation system. At the same time SB and SI industries are at the corners of the systems as important sources of knowledge and technology. SD and SDS industries are instead mainly receptors of knowledge flows. Finally, knowledge intensive business services occupy a crucial place at the intersection of science-based and specialized-suppliers manufacturing.

The taxonomy captures the role of sectors and the linkages between them in a knowledge-based economy. In the last years countries have been reshaping their sectoral specialization in order to gain the most out of the emerging ICT-based regime of growth. In this sense the taxonomy is useful in order to predict the groups of sectors which are expected to have contributed most to productivity growth under the structural change of the last decades. As hinted by the previous discussion, we expect information and physical networks to show the most dynamic productivity performance, while at the same time SB and SI sectors remain essential contributors to growth.

Table 1 shows the classification of industries according to the two taxonomies.[3] Non-market services, including public administration, education, health and social work, have been excluded from this analysis because, by responding only partially to market forces, they follow different patterns of competition and growth.

3 Empirical analysis

3.1 Data

This research uses industrial data from the EU KLEMS project [7]. The study covers 14 European countries for the years 1979-2004. The United States, Japan and an EU-15 aggregate are also included in the analysis as reference benchmarks. For the years considered data are available without missing values only for a reduced list of industries (48 instead of the 62, more disaggregated, industries available for the last 10 years).[4]

The variables of interest for each industry are the value added in constant prices and the total employment, measured by the total hours worked. Hours worked is a better measure of employment when one wants to compare figures across countries. All industry-level variables included in the EUKLEMS database have been built from national statistical offices data using harmonized definitions, industrial classifications and aggregation procedures. For value added data, the level of detail is higher than for the OECD STAN database and this is true for more recent years as well. The EU KLEMS Database uses chain-weighted Tornqvist sectoral price indexes to deflate current value added and obtain value added at constant prices [46]. Such price indexes capture both differences in prices and in the production structure of a country. Aggregation of industries is done by calculating aggregate/group deflators and applying them to the value added measures in current prices. [5]

3.2 A modified shift-share methodology

The groups of industries identified by the merged taxonomy are used to decompose aggregate labor productivity growth along the lines of the shift-share analysis, originally proposed by Fabricant [47]. More specifically, aggregate labor productivity at time t can be written as the weighted sum of the sectoral productivity levels:

$$LP_t = \frac{Y_t}{L_t} = \sum_{i}^{n} \frac{Y_{it}}{L_{it}} \frac{L_{it}}{L_t} \tag{1}$$

where n is the number of sectors (in this case $n = 8$) , Y_{it} and L_{it} are the valued added and employment for sector i at time t, and Y_t and L_t are the respective aggregate levels.

Define $S_{it} = L_{it}/L_t$ as the employment share of sector i at time t. Following van Ark and Timmer [48], the aggregate labor productivity difference between year 0 and year t can be written as:

$$LP_t - LP_0 = \sum_{i}^{n} (LP_{it} - LP_{i0})\overline{S}_i + \sum_{i}^{n} (S_{it} - S_{i0})\overline{LP}_i \tag{2}$$

where $\overline{S}_i$ and $\overline{LP}_i$ are the average labor share and labor productivity between time 0 and time t. This decomposition is invariant to a particular base year.

The first term is a within industry growth effect (Intra) which captures the individual contribution of sectors to aggregate productivity growth taking initial employment shares as weights. The second term is a shift effect (Shift) signaling shifts of labor toward sectors with higher productivity levels. Standard formulations also include an interaction term, called dynamic shift effect, but this term becomes negligible when you consider annual changes, as will be discussed below.

When the price structure changes significantly in the period considered, in the sense that changes in prices differ greatly across sectors, then the identity (1) will not be valid anymore. This is exactly the case for the period 1979-2004, characterized by a huge price decline in the ICT producing sectors. A way out of this is to calculate the decomposition annually, expressing labor productivity in previous year prices, and then sum the intra and shift components over time [49].[6] Note that this procedure would also make the dynamic shift effects become negligible, so that one may concentrate on two main effects.

The interpretation of the total shift effect is straightforward, in the sense that positive aggregate shift effects indicate that labor has shifted to industries with higher than average productivity levels. More problematic is the interpretation of the individual shift contribution for each industry. Clearly, the single shift effect is positive when the labor share increases and negative otherwise. But a negative shift could mean either that labor has shifted to higher or lower productivity industries. Van Ark and Timmer [48] suggest to reallocate all shift effects to expanding sectors only. Positive shift effects can then be interpreted as labor shift to sectors with higher productivity levels. Put it in other terms, the alternative decomposition is able to discriminate the productivity characteristics of those industries that have attracted labor in the period considered.

Define K and J as the sets of industries which have expanded or shrunk in terms of labor shares. Let $\overline{LP}_j$ be the average productivity of shrinking sectors:

$$\overline{LP}_j = \frac{\sum_{i \in J} (S_{it} - S_{i0}) \overline{LP}_i}{\sum_{i \in J} (S_{it} - S_{i0})} \tag{3}$$

The contribution of sector i to labor productivity growth, C_i, can be written as:

$$\begin{aligned} C_i &= C_i^{intra} + C_i^{shift} = (LP_{it} - LP_{i0})\overline{S}_i + (S_{it} - S_{i0})(\overline{LP}_i - \overline{LP}_j) \quad && \text{if } i \in K \\ C_i &= C_i^{intra} = (LP_{it} - LP_{i0})\overline{S}_i && \text{if } i \in J \end{aligned} \tag{4}$$

Another advantage of the chosen methodology is that under the reallocation method the annual decomposition crucially allows industries to expand in some years while shrink in other years.

4 Discussion of the findings

Tables 4 report results for the decomposition when industries are grouped according to the taxonomy discussed before. Components are expressed in percentages and sum to 100. Row totals in each sub-table represent the overall contribution of each group to aggregate productivity growth. The table includes results after reallocating shift effects (Eq. 4). Columns

8-9 report the annual average productivity growth rates and the corresponding value added growth rate. The last two columns indicate the relative size of each sector in terms of share in the manufacturing employment and value added in the last year. For some groups of sectors, especially SB and IN ones, the share in value added is significantly larger than the one in employment. Productivity growth rates and value added growth rates are, in most cases, highly correlated but in many instances the growth of value added is higher than the growth in productivity suggesting that employment has grown even less than value added [33]. As summarized in Figure 2, the EU shows the lower growth figures and especially for SB industries, lags behind the performance of the US in the period considered. In general manufacturing sectors display the higher productivity figures, but some of the services also show high productivity growth, in particular this is the case for Physical and information networks.

The first and most visible result is the major weight of within growth contributions. This is a well-known result within manufacturing and also for the most recent decades. Figure 3 highlights the result for EU, Japan and US. Second, the results point to a significant cross-country heterogeneity in the contributions of the different groups of our taxonomy. Third, major shift effects indicate a significant shift of employment from manufacturing to services.

4.1 Within productivity effects

In almost all countries the scale intensive sector accounts for the largest share of employment and value added in manufacturing. The sheer size of these industries plays an important role in determining their contribution. But its central role for knowledge flows should not be underestimated. The significant investment made in innovation projects spills over to SD industries in the form of intermediate goods, and to upstream SS via user feedbacks. Because of these two mechanisms, the within growth contribution of SI industries is likely to be even higher than what our decomposition can indicate (see below the discussion about the limitations of a shift-share analysis). Notice that this group also includes industries such as Aircraft and spacecraft, Railroad equipment, and Motor vehicles, which all have a high R&D intensity and play a strategic role in countries like Germany, France and Italy.

In some EU countries, and even more so for US and Japan, the contribution of SB industries is also very relevant. These industries include the key ICT producing sectors. Our results confirm the evidence of an uneven specialization in ICT within Europe [27]. In Pavitt's framework SB sectors occupy a central role: they supply technology to production intensive firms in the SD and SI group. They are also crucially connected with SS, by translating advances in science into applications of many kinds which specialized suppliers contribute to use and perfection. Accordingly, what we find is that in most countries SI and SB industries together contribute substantially to aggregate productivity growth and this fits very well their role as knowledge/technology sources for the whole system.

For many EU countries the within growth contribution of the SD sector appears to be quite small, despite the relatively large share in the economy of this group. If we compare the EU aggregate with the US, both manufacturing structures have a similar weight of SD sectors, but the US relies less on their contribution than the EU-15. The contribution in the case of Japan is even smaller. As discussed above, supplier dominated industries are characterized by firms that rely on their intermediate goods providers as the crucial source of innovation. All these sectors, including activities such as Textiles, clothing, wood and paper production represent also low tech industries with low degrees of investment in own R&D efforts. The relative capital intensity and the typically labor-saving innovation trajectories that characterize SD industries would account for higher labor productivity levels. Still there are at least two reasons to justify their disappointing contribution to productivity growth. First, the potential for productivity growth is seriously hampered by the low level of technological opportunities. Second, these industries have suffered mostly international competition from low-cost producers [2].

SS industries display high barriers to entry due to the high level of sophistication of the technology involved. Their within contribution is generally low in Europe, even more so in the US, and this is partly explained by their small share in the economy. Specialized suppliers are critically connected to scale intensive companies through strong and mutual vertical linkages. The usually small SS companies mainly exist as upstream source of technological knowledge to scale intensive activities. And they rely on well-developed science-based industries for a mutual feedback on technical progress.

As for services, IN and PN account together for the largest contribution to aggregate labor productivity growth. The result is interesting because it implicitly confirms the central role that networks services have come to play in the innovation system as discussed from insights of the merged innovation-based taxonomy. In the US the contribution of PN is higher than in Europe and Japan and the result is mostly to be related to the higher productivity growth of the retail trade industry. This one industry has been identified as the main explanation for the aggregate productivity gap of Europe [27]. In general, the most recent estimates, based on growth accounting on the same data used in this paper, show that the largest contribution to the EU-US productivity gap come from distributive trade, equivalent to PN services, and financial and business services, related the IN group [1].

SDS show marginal contributions. This makes sense in the light of their marginal role in the innovation system. Similarly to supplier dominated manufacturing the productivity growth opportunities of this sector are seriously hampered by its low technology content. Low technological opportunities coupled with a general small size ultimately explains its small contribution notwithstanding the fact that the sector accounts for a not so small share of employment and value added.

The results for KIBS demand more cauton. While this sector should grow and prosper in a knowledge-based economy, their measured productivity growth is highly disappointing and their contribution always negative in European countries. Three explanations may be put forward.

First, this may be the result of measurement problems. Some of the measurement issues mentioned in section 4.3, may be most acute for KIBS.

Second, it may be the case that KIBS are still in the process of attaining productivity gains. Fixler and Siegel [51] have suggested that increased outsourcing from manufacturing, one of the main sources of increased employment, has also kept the productivity gap between manufacturing and services high. KIBS activities are probably the services that are most relying on outsourcing, not only from manufacturing but from other services as well (for example banking and finance are seen to outsource their specialized IT activities). In this sense, KIBS could well fit the picture described by Fixler and Siegel [51]: they predict that productivity growth for these services will increase once outsourcing related demand will decrease, hence when activities will not be able to rely on a high level of output and will instead have to become more efficient, hence productive to face increased competition. Hence, one could predict that the next stage in the growth process would come when KIBS services also start show positive productivity growth. This explanation seems to hold if we think about Europe as being one stage behind with respect to the US. The contribution of KIBS is already positive in the US, and one could expect a lag in observing the same for Europe.

Third, KIBS are mostly expected to contribute to aggregate labor productivity growth indirectly by spurring productivity gains in other sectors. In this sense it may not be so alarming that productivity growth has been low, mostly due to a much larger increase in employment than in value added, as long as knowledge has been transferred efficiently to the rest of the economy. A shift-share decomposition is not able to capture indirect effects. Another issue to be considered is the relative small scale of activities in this sector, which is a property similar to what one finds in specialized suppliers in manufacturing. The inability to exploit economies of scale may act as a constraint to productivity growth.

4.2 Shift effects

Thanks to reallocating shift effects to expanding sectors, we are able to correctly interpret the individual shift contributions of the different groups of sectors. For every year in the period considered, non-zero shift effects are associated only to expanding sectors. A positive shift effect for a given group then indicates that over the whole period the group has attracted cumulated yearly increases of employment to higher productivity activities.

Most manufacturing sectors, including SB and SS ones, show zero shift effects, which means that they have simply not been expanding, in any of the years of the period under study. This is in line with the overwhelming evidence pointing to shifts of employment from manufacturing to services. There are two main mechanisms that may be at work [52]. On one hand, the shift of employment to services could be related to the "cost-disease" argument. On the other hand, services are instead more and more seen as playing an active role in the recent trends towards internationalization of activities and outsourcing of business activities. Our results can be used to discriminate between the two hypothesis. Positive shift effects indicate that employment has shifted to activities characterized by higher, not lower productivity. We find this to be true for information networks services. Information networks show the most evident sign of having been able to attract substantial employment shares in the last 25 years. The positive shift effect associated with these services is a common result in all the countries considered, with two of them, Greece and Spain, showing rather impressive values (31 and 12 percentage points respectively). It is not difficult to recognize here the transformation of economies into knowledge-based economies.

At the same time, KIBS display negative shift effects, indicating that these highly specialized services have indeed attracted employment but to activities characterized by lower productivity. We have discussed possible explanation for this in the previous section.

4.3 Measurement issues

The measurement of labor productivity growth is characterized by a number of problems. Measurement errors may affect employment data, value added data and price measures.

The discussion of the results in the previous sections has suggested that the zero or negative productivity growth rates of some of the service sectors could be explained in terms of measurement issues that lead to underestimation. At the same time, there exists no conclusive evidence that measurement problems are heavier for manufacturing than for service industries. The volume edited by Griliches [53] collects a large set of contributions dealing with the challenges involved in the measurement of service sectors. Wölfl [54] presents a test of the effect of three main sources of errors: choice of inputs, measurement of output and aggregation. The assessment of output can indeed be seen as particularly problematic for service industries, for which output may not be consistently defined. Also, the computation of constant price value added has to cope with procedures for the construction of price indexes which often vary substantially across countries. For example, Timmer, Inklaar and van Ark [55] highlight output measurement issues for the retail trade sector.

A final issue concerns the blurring distinction between manufacturing and services [56]. Both firm-level case studies and studies using input-output data, have highlighted the increasing difficulty of assigning activities sharply to manufacturing or service industries. The rising interaction between manufacturing and services has also implications for the way intermediate inputs count in aggregate productivity figure, but this is still an issue open to further research.

4.4 Limitations

The decomposition proposed in this work represents a useful descriptive tool but is not void of shortcomings.

First, it only considers labor as the input of production. The analysis could be extended in the way proposed by Timmer and Szirmai [57]. Their method allows to take into account increasing returns to scale.

Second, demand effects are ignored. Differential income elasticities may increase demand for a group of sectors, but this decomposition only considers shifts in input factors.

Third, a shift-share analysis captures only indirectly the side effects produced by the growth of particular sectors. Spillovers are not taken into account and this likely produces an under-estimation of the sectoral contributions.

Fourth, many insights have been gained from a long tradition of empirical work on the impact of R&D on growth. Since the seminal work of Griliches [58], the direct and indirect effects of R&D have been found to be conducive to productivity growth both at the firm level and at the macro level [59]. The analysis presented here cannot asses these effects but only provide a more general view of the role of groups of sectors with similar R&D intensity.

5 Conclusions

While many recent studies on productivity growth concentrate on the specific role of ICT, we take a broader view at the role of 'knowledge' and innovation in the processes of structural change and growth of the last three decades. This study sheds light on sectors that have crucially contributed to growth in European countries, the US and Japan. We consider the innovation properties of the sectors to better understand how national specialization patterns may impact aggregate performances in the respective countries. The comparative perspective stresses the individual experiences of countries, together with the common features at the European level.

The results confirm a series of findings already highlighted in the literature and add new insights to their understanding.

First, employment has shifted to services and services account for a considerable share of aggregate labor productivity growth.

Second, networks services, in particular information networks, show the highest contribution to aggregate productivity growth. These services occupy a central role in terms of sustaining information diffusion and knowledge sharing across the whole economy, as highlighted by the linkages in the unified taxonomy. This is also evidence that some services have shown substantial productivity growth and have been able to enjoy economies of scale [54].

Third, knowledge-intensive business services show disappointing productivity growth and negative shift effects. This could be partly due to measurement issues, but also partly explained by the fact that at least in Europe these services still depend exclusively upon outsourcing and have not yet developed to a maturity stage in which they will, also in Europe, reap those productivity benefits that they are already showing in the US.

Fourth, even though employment has shifted from manufacturing to services, scale intensive and science-based industries still remain fundamental sources of technologies and knowledge not only within manufacturing but also in the whole system. This role is acknowledged by a substantial contribution to aggregate productivity growth across all countries. Still, their contribution varies substantially across European countries, reflecting existing national specialization patterns.

Finally, supplier dominated sectors in both manufacturing and services have contributed the least to productivity growth and we find evidence that they have lost employment shares at the advantage of sectors that are more active at generating their own knowledge and innovation.

From a methodological point of view, this work has used and discussed a recently proposed modified version of the standard shift-share decomposition. The new methodology overcomes the issues related to the interpretation of shift effects by reallocating all shifts to expanding sectors. In this way, it is possible to evaluate whether labor has shifted toward industries with higher productivity levels.

One way to further analyze the results presented here would be to compare them across countries by relating to the linkages between sectoral patterns of innovation and national systems of innovation. Castelacci [60] has proposed a taxonomy of sectors meant at merging the Pavitt taxonomy with insights from the national innovation systems approach. Among the dimensions considered, the strength of upstream linkages and the strength of university-industry links are found to be significant in characterizing sectors in some EU countries. The higher or lower contribution of certain group of sectors in given countries may indicate strengths or weaknesses in national systems of innovation.

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Notes

[1]To avoid confusion, the term 'sector' is reserved to indicate groups of industries in the taxonomy.

[2]It should be clear that I use a definition of KIBS which may be more restrictive than some definitions used in the literature. While IN services are also knowledge intensive, they have a larger scale than the more specialized and differentiated KIBS discussed in this paper.

[3]Ideally one would build a taxonomy based on existing data and conditional on the actual aggregation level of the industry data. Most often, one wishes to apply an existing taxonomy to a sample of data. This is the second case. I refer to both original papers but I still made some assumptions regarding industries that are not mentioned in the original papers.

[4]I used a list of 51 industries to be able to split some aggregate industries and better assign them to the sectors of the taxonomy. In particular, a limited set of missing values were

filled in order to distinguish between: Pharmaceuticals and Chemicals excl. pharmaceuticals, Insulated wire and Other electrical machinery, Scientific vs non-scientific instruments.

[5]It should be mentioned that a few sectoral deflators have been estimated with a more aggregate deflator but this procedure does not introduce any known bias in the results of a shift-share analysis.

[6]An alternative solution is discussed by Tang and Wang [50].

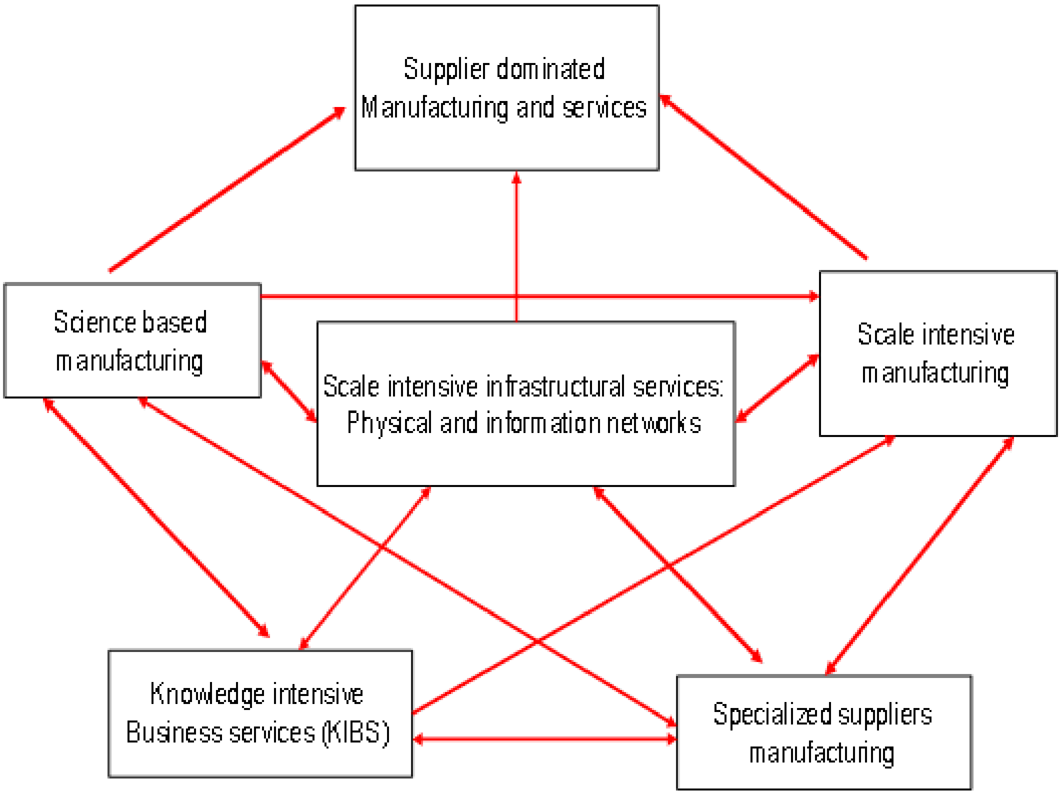

Figure 1: A graphical representation of the linkages between manufacturing and service sectors obtained by combining the taxonomies of Pavitt [31] and Miozzo and Soete [4]. Source: [5].

Table 1: Innovation taxonomy of the manufacturing and service industries.

Industries	ISIC rev. 3	Sector Code
Food, drink & tobacco	15-16	SI
Textiles & clothing	17-18	SD
Leather and footwear	19	SD
Wood & products of wood and cork	20	SD
Pulp, paper & paper products	21	SD
Printing & publishing	22	SD
Mineral oil refining, coke & nuclear fuel	23	SI
Pharmaceuticals	244	SB
Chemicals excl. Pharmaceuticals	24x	SI
Rubber & plastics	25	SI
Non-metallic mineral products	26	SI
Basic metals	27	SI
Fabricated metal products	28	SI
Mechanical engineering	29	SS
Office machinery	30	SB
Insulated wire	313	SD
Other electrical machinery and apparatus	31x	SS
Radio, TV & comm. equipment	32	SB
Scientific instruments	331t4	SB
Other instruments	334t5	SI
Motor vehicles	34	SI
Other transport equipment	35	SI
Furniture, miscellaneous manufacturing; recycling	36-37	SD
Sale, maintenance & repair of motor vehicles ; retail sale of automotive fuel	50	PN
Wholesale trade and commission trade, exc. motor vehicles	51	PN
Retail trade, exc. motor vehicles; repair of personal & household goods	52	PN
Hotels & restaurants	55	SDS
Inland transport	60	PN
Water transport	61	PN
Air transport	62	PN
Supporting & aux. transport activities; activities of travel agencies	63	PN
Communications	64	IN
Financial intermediation	65-67	IN
Real estate activities	70	IN
Renting of machinery and equipment	71	SDS
Computer and related activities	72	KIBS
Research and development	73	KIBS
Other business activities	74	KIBS
Public admin. and defence; compulsory social security	75	Non market services
Education	80	Non market services
Health and social work	85	Non market services
Other community, social and personal services	90-93	SDS

Table 4.1: Decomposition of labor productivity growth, 1979-2004

		Shift-share			**with reallocation**			**Annual growth**		**Share in 2004**	
		Intra	Shift	Sum	Intra	Shift	Sum	LP	VA	Empl	VA
Austria	SD	12.12	-10.09	2.03	12.12	0.00	12.12	3.66	0.93	5.87	5.51
	SI	32.19	-14.84	17.35	32.19	0.04	32.23	4.25	2.54	12.43	15.36
	SB	7.40	-2.79	4.61	7.40	0.02	7.42	5.71	4.27	1.84	2.56
	SS	8.16	-1.62	6.54	8.16	-0.14	8.03	3.58	3.32	4.12	4.65
	SDS	4.63	3.61	8.24	4.63	-1.99	2.64	0.72	1.78	17.84	13.58
	PN	24.15	1.65	25.80	24.15	-0.48	23.67	1.87	2.37	33.03	25.27
	IN	19.78	-2.71	17.07	19.78	2.90	22.68	2.21	2.55	8.69	22.21
	KIBS	-0.01	18.36	18.36	-0.01	-8.78	-8.79	0.08	5.27	16.18	10.86
	Total	**108.43**	**-8.43**	**100.00**	**108.43**	**-8.43**	**100.00**	**2.23**	**2.54**	**100.00**	**100.00**
Belgium	SD	9.96	-7.54	2.42	9.96	0.00	9.96	4.23	1.14	4.88	3.68
	SI	34.22	-16.80	17.42	34.22	0.00	34.22	4.07	2.34	15.94	16.44
	SB	7.43	-1.98	5.45	7.43	0.14	7.57	6.57	4.80	1.79	2.11
	SS	4.05	-3.27	0.78	4.05	-0.03	4.03	2.75	0.65	2.62	2.36
	SDS	3.76	2.55	6.31	3.76	-1.65	2.11	1.71	2.79	10.08	6.77
	PN	12.71	-2.89	9.82	12.71	-0.94	11.77	1.04	0.87	31.38	26.17
	IN	35.93	-6.01	29.92	35.93	2.66	38.59	2.83	2.73	9.85	25.67
	KIBS	0.36	27.52	27.88	0.36	-8.60	-8.24	0.34	5.40	23.45	16.79
	Total	**108.43**	**-8.43**	**100.00**	**108.43**	**-8.43**	**100.00**	**2.34**	**2.37**	**100.00**	**100.00**
Denmark	SD	3.82	-8.57	-4.75	3.82	-0.04	3.78	1.22	-0.79	5.42	4.14
	SI	18.70	-12.33	6.36	18.70	-1.14	17.56	2.37	1.19	12.37	10.71
	SB	12.36	0.79	13.15	12.36	0.16	12.52	6.10	7.17	2.55	3.60
	SS	4.17	-2.06	2.11	4.17	-0.91	3.26	1.38	1.04	5.27	4.14
	SDS	-4.29	7.65	3.36	-4.29	-3.58	-7.87	-0.17	1.44	13.60	9.62
	PN	27.13	-4.14	22.99	27.13	-0.78	26.35	1.59	1.46	34.53	27.95
	IN	40.81	-6.98	33.83	40.81	5.44	46.25	2.06	2.20	10.15	27.56
	KIBS	2.11	20.84	22.95	2.11	-3.96	-1.85	1.10	4.38	16.11	12.28
	Total	**104.80**	**-4.80**	**100.00**	**104.80**	**-4.80**	**100.00**	**1.67**	**1.88**	**100.00**	**100.00**
Spain	SD	9.46	-12.91	-3.45	9.46	-1.01	8.44	1.78	1.16	7.90	4.74
	SI	38.75	-35.14	3.61	38.75	-0.74	38.01	2.24	1.90	15.05	15.95
	SB	5.71	-3.51	2.20	5.71	0.49	6.20	3.65	3.78	1.28	1.27
	SS	8.25	-2.62	5.62	8.25	0.33	8.57	3.37	3.63	2.55	2.57
	SDS	-8.47	19.96	11.48	-8.47	-4.25	-12.72	-0.68	2.45	19.46	17.90
	PN	22.93	-0.14	22.80	22.93	-5.11	17.82	1.27	2.72	34.82	23.75
	IN	29.83	1.24	31.06	29.83	11.69	41.52	1.53	3.32	7.04	23.68
	KIBS	1.30	25.37	26.68	1.30	-9.15	-7.84	-0.92	5.85	11.90	10.14
	Total	**107.75**	**-7.75**	**100.00**	**107.75**	**-7.75**	**100.00**	**1.29**	**2.78**	**100.00**	**100.00**
Finland	SD	8.10	-6.13	1.96	8.10	-0.16	7.94	4.17	1.06	6.76	4.84
	SI	24.93	-7.90	17.03	24.93	-0.20	24.72	4.43	3.13	14.38	16.59
	SB	21.19	3.34	24.53	21.19	0.73	21.92	12.35	16.42	3.67	7.21
	SS	6.32	-0.92	5.40	6.32	-0.42	5.90	4.25	3.77	5.32	4.64
	SDS	0.99	2.77	3.76	0.99	-2.55	-1.56	0.65	2.01	13.68	7.58
	PN	20.96	-1.54	19.42	20.96	-1.86	19.09	2.73	2.57	33.12	25.20
	IN	25.52	-6.24	19.28	25.52	3.26	28.78	3.61	3.48	8.46	24.15
	KIBS	-0.67	9.29	8.62	-0.67	-6.13	-6.79	-0.25	4.79	14.61	9.80
	Total	**107.33**	**-7.33**	**100.00**	**107.33**	**-7.33**	**100.00**	**3.39**	**3.44**	**100.00**	**100.00**

Table 4.2: Decomposition of labor productivity growth, Merged taxonomy, 1979-2004

		Shift-share			**with reallocation**			**Annual growth**		**Share in 2004**	
		Intra	Shift	Sum	Intra	Shift	Sum	LP	VA	Empl	VA
France	SD	7.74	-7.08	0.66	7.74	0.00	7.74	3.79	0.54	4.68	3.28
	SI	15.89	-10.98	4.91	15.89	-0.16	15.73	2.15	0.44	13.92	12.42
	SB	14.79	-1.28	13.51	14.79	0.10	14.88	13.07	11.94	1.81	2.20
	SS	4.88	-3.43	1.45	4.88	-0.04	4.84	3.65	1.36	3.04	2.41
	SDS	-2.10	5.06	2.96	-2.10	-1.91	-4.01	-0.84	0.58	13.71	9.73
	PN	23.88	0.81	24.68	23.88	-0.81	23.07	2.81	2.89	31.01	21.92
	IN	35.11	-3.65	31.46	35.11	4.13	39.23	2.99	3.07	9.32	29.45
	KIBS	1.85	18.53	20.38	1.85	-3.34	-1.49	0.58	3.43	22.51	18.60
	Total	**102.03**	**-2.03**	**100.00**	**102.03**	**-2.03**	**100.00**	**2.42**	**2.44**	**100.00**	**100.00**
Germany	SD	4.85	-7.58	-2.72	4.85	0.00	4.85	2.24	-1.23	4.43	3.35
	SI	21.15	-11.28	9.86	21.15	0.03	21.18	2.32	1.00	17.23	17.44
	SB	7.64	-2.39	5.25	7.64	0.07	7.72	5.35	3.59	2.50	2.86
	SS	8.20	-5.91	2.29	8.20	0.12	8.33	2.37	0.67	6.19	6.65
	SDS	2.41	7.28	9.69	2.41	-1.32	1.10	0.85	2.45	14.52	10.97
	PN	20.93	-1.13	19.80	20.93	-1.07	19.86	2.28	2.18	29.77	18.98
	IN	36.79	1.32	38.12	36.79	4.57	41.36	3.18	3.57	8.35	25.65
	KIBS	-6.60	24.30	17.71	-6.60	2.21	-4.39	-0.30	3.86	17.02	14.11
	Total	**95.38**	**4.62**	**100.00**	**95.38**	**4.62**	**100.00**	**2.25**	**2.19**	**100.00**	**100.00**
Greece	SD	-1.53	-12.47	-14.00	-1.53	-0.34	-1.87	-0.86	-2.18	10.13	4.68
	SI	13.76	-13.63	0.13	13.76	-0.46	13.30	2.05	1.18	12.67	10.43
	SB	0.80	-0.39	0.41	0.80	-0.05	0.75	2.07	1.88	0.61	0.50
	SS	0.57	-0.48	0.09	0.57	-0.49	0.09	0.83	0.71	1.72	0.71
	SDS	17.06	7.00	24.06	17.06	-1.66	15.40	0.02	2.98	17.85	18.33
	PN	37.65	6.26	43.91	37.65	0.70	38.35	1.45	3.20	38.05	30.18
	IN	16.73	24.86	41.59	16.73	30.43	47.16	1.18	3.66	6.65	30.76
	KIBS	-5.53	9.34	3.81	-5.53	-7.65	-13.18	-1.91	3.22	12.32	4.40
	Total	**79.52**	**20.48**	**100.00**	**79.52**	**20.48**	**100.00**	**1.16**	**2.45**	**100.00**	**100.00**
Ireland	SD	12.53	-6.45	6.08	12.53	0.00	12.53	7.29	5.51	5.12	6.58
	SI	42.43	-12.10	30.32	42.43	0.22	42.65	9.00	8.26	13.48	21.49
	SB	10.78	1.65	12.43	10.78	1.77	12.55	7.72	12.40	5.58	7.12
	SS	5.56	-1.85	3.71	5.56	-0.06	5.51	8.93	9.28	2.24	2.49
	SDS	2.39	2.29	4.68	2.39	-4.34	-1.95	1.42	4.37	18.59	8.62
	PN	7.96	0.39	8.35	7.96	-2.36	5.60	1.66	3.44	29.50	17.16
	IN	19.47	5.18	24.65	19.47	1.97	21.44	4.49	7.33	12.41	21.72
	KIBS	-0.96	10.73	9.77	-0.96	2.62	1.67	-0.79	5.18	13.08	14.80
	Total	**100.17**	**-0.17**	**100.00**	**100.17**	**-0.17**	**100.00**	**4.62**	**6.42**	**100.00**	**100.00**
Italy	SD	12.45	-16.59	-4.14	12.45	0.00	12.45	1.80	0.53	9.43	6.30
	SI	25.65	-18.02	7.63	25.65	-0.73	24.92	2.27	1.63	14.25	13.15
	SB	5.54	-2.18	3.37	5.54	0.09	5.64	3.46	2.93	1.97	2.36
	SS	7.75	-4.05	3.69	7.75	-0.36	7.39	1.70	1.40	4.76	4.77
	SDS	-3.54	13.37	9.82	-3.54	-6.91	-10.45	-0.58	1.73	15.42	12.40
	PN	37.09	-10.80	26.29	37.09	-3.40	33.69	1.39	2.08	32.09	23.83
	IN	49.89	-18.22	31.67	49.89	7.10	56.98	1.53	2.43	5.63	24.97
	KIBS	-18.10	39.77	21.67	-18.10	-12.52	-30.62	-2.38	3.48	16.44	12.23
	Total	**116.72**	**-16.72**	**100.00**	**116.72**	**-16.72**	**100.00**	**1.18**	**2.04**	**100.00**	**100.00**

Table 4.3: Decomposition of labor productivity growth, Merged taxonomy, 1979-2004

		Shift-share			**with reallocation**			**Annual growth**		**Share in 2004**	
		Intra	Shift	Sum	Intra	Shift	Sum	LP	VA	Empl	VA
Netherlands	SD	7.17	-6.47	0.70	7.17	-0.08	7.09	2.37	1.47	5.92	4.26
	SI	30.73	-20.34	10.39	30.73	0.06	30.79	3.38	2.29	10.18	13.22
	SB	4.81	-4.16	0.65	4.81	-0.09	4.72	3.18	1.57	1.98	1.39
	SS	4.25	-2.04	2.21	4.25	-0.03	4.21	3.21	2.84	2.16	2.09
	SDS	4.98-	4.49	0.49-	-4.98	-2.08	-7.07	-1.50	0.48	12.33	9.58
	PN	35.11	-3.89	31.22	35.11	-2.52	32.59	2.15	2.99	34.06	26.74
	IN	35.24	-3.75	31.49	35.24	5.19	40.43	2.63	3.54	9.45	25.95
	KIBS	0.17	23.67	23.84	0.17	-12.95	-12.78	-0.57	4.73	23.90	16.78
	Total	**112.49**	**-12.49**	**100.00**	**112.49**	**-12.49**	**100.00**	**1.68**	**2.83**	**100.00**	**100.00**
Portugal	SD	8.99	-7.04	1.95	8.99	-0.95	8.04	2.92	1.38	16.48	8.60
	SI	16.24	-6.24	10.00	16.24	0.66	16.90	2.99	1.54	12.99	12.64
	SB	2.49	-0.63	1.86	2.49	0.32	2.81	4.04	2.66	0.83	1.17
	SS	4.60	-1.29	3.31	4.60	-0.08	4.53	3.67	2.50	2.35	2.19
	SDS	1.89	4.41	6.30	1.89	-5.57	-3.68	2.09	2.54	16.42	11.51
	PN	20.08	2.57	22.64	20.08	-3.86	16.21	2.57	2.23	36.50	26.83
	IN	54.86	-10.40	44.46	54.86	10.21	65.07	5.61	4.68	4.99	27.37
	KIBS	-11.57	21.04	9.48	-11.57	1.68	-9.89	-2.63	4.12	9.44	9.69
	Total	**97.59**	**2.41**	**100.00**	**97.59**	**2.41**	**100.00**	**3.12**	**2.76**	**100.00**	**100.00**
Sweden	SD	5.83	-3.75	2.07	5.83	-0.18	5.65	2.75	1.14	5.84	4.35
	SI	21.17	-5.31	15.87	21.17	-0.64	20.53	3.14	2.36	15.32	15.37
	SB	21.60	-1.19	20.40	21.60	0.35	21.94	9.64	9.24	3.02	4.38
	SS	4.18	-1.48	2.70	4.18	-0.38	3.80	2.54	1.80	4.85	4.56
	SDS	1.87	2.34	4.21	1.87	-3.56	-1.68	0.40	1.47	16.03	8.86
	PN	25.02	-3.71	21.31	25.02	-1.89	23.13	2.30	2.22	30.64	23.57
	IN	24.60	-4.65	19.95	24.60	5.89	30.49	2.11	2.58	8.26	24.55
	KIBS	1.66	11.82	13.48	1.66	-5.53	-3.87	-0.52	3.35	16.06	14.35
	Total	**105.94**	**-5.94**	**100.00**	**105.94**	**-5.94**	**100.00**	**2.30**	**2.59**	**100.00**	**100.00**
UK	SD	5.02	-6.38	-1.37	5.02	-0.33	4.69	2.14	-0.30	4.72	4.07
	SI	21.28	-19.89	1.39	21.28	0.13	21.41	3.49	0.36	10.71	11.02
	SB	8.33	-3.15	5.19	8.33	0.31	8.65	6.95	4.79	1.58	2.20
	SS	4.56	-5.15	-0.59	4.56	-0.01	4.56	3.26	-0.28	2.47	2.18
	SDS	3.27	8.18	11.44	3.27	-4.11	-0.84	0.95	3.26	17.60	12.73
	PN	27.33	-1.16	26.17	27.33	-1.85	25.48	2.64	2.82	30.37	23.64
	IN	24.59	3.75	28.34	24.59	4.53	29.12	2.26	3.50	10.34	25.84
	KIBS	12.96	16.45	29.41	12.96	-6.02	6.94	2.07	5.85	22.21	18.31
	Total	**107.34**	**-7.34**	**100.00**	**107.34**	**-7.34**	**100.00**	**2.47**	**2.64**	**100.00**	**100.00**

Table 4.4: Decomposition of labor productivity growth, Merged taxonomy, 1979-2004

		Shift-share			**with reallocation**			**Annual growth**		**Share in 2004**	
		Intra	Shift	Sum	Intra	Shift	Sum	LP	VA	Empl	VA
EU-15	SD	6.44	-7.52	-1.07	6.44	0.00	6.44	2.21	0.13	6.41	4.95
	SI	23.50	-14.97	8.53	23.50	0.00	23.50	2.91	1.42	13.98	15.02
	SB	8.90	-2.08	6.82	8.90	0.02	8.93	6.56	5.48	1.93	2.70
	SS	6.01	-4.55	1.46	6.01	0.00	6.00	2.64	1.09	3.83	4.31
	SDS	1.05	6.56	7.60	1.05	-3.15	-2.10	0.23	2.21	15.76	10.43
	PN	22.83	-0.71	22.13	22.83	-0.89	21.95	2.10	2.48	31.80	21.13
	IN	33.99	0.47	34.45	33.99	3.98	37.97	2.49	3.23	8.29	27.91
	KIBS	-0.65	20.73	20.09	-0.65	-2.03	-2.68	0.05	4.37	18.00	13.56
	Total	**102.07**	**-2.07**	**100.00**	**102.07**	**-2.07**	**100.00**	**2.13**	**2.53**	**100.00**	**100.00**
Japan	SD	3.73	-4.13	-0.40	3.73	-0.06	3.68	2.54	0.06	6.02	3.34
	SI	13.09	-5.14	7.95	13.09	0.58	13.67	2.08	1.36	12.85	16.19
	SB	15.93	-1.23	14.70	15.93	0.53	16.47	9.48	9.56	2.94	4.67
	SS	10.69	-0.80	9.89	10.69	0.09	10.78	6.28	6.12	4.55	4.13
	SDS	3.10	3.83	6.93	3.10	-3.34	-0.24	1.18	2.31	20.46	10.47
	PN	26.18	-4.19	21.99	26.18	-0.72	25.46	3.53	3.06	32.15	23.55
	IN	29.00	-0.13	28.86	29.00	3.88	32.87	3.36	3.58	7.14	28.87
	KIBS	1.80	8.26	10.07	1.80	-4.50	-2.70	0.53	4.43	13.90	8.78
	Total	**103.53**	**-3.53**	**100.00**	**103.53**	**-3.53**	**100.00**	**3.11**	**3.20**	**100.00**	**100.00**
US	SD	3.30	-4.51	-1.21	3.30	-0.11	3.19	1.74	0.38	4.88	3.63
	SI	13.29	-10.60	2.69	13.29	0.00	13.29	2.32	1.38	10.99	11.78
	SB	21.56	-2.92	18.64	21.56	-0.04	21.52	15.32	14.71	2.49	3.02
	SS	1.70	-2.82	-1.13	1.70	-0.05	1.65	1.40	-0.22	2.08	1.95
	SDS	3.43	3.70	7.14	3.43	-3.39	0.04	0.89	3.04	18.01	9.73
	PN	28.34	-0.22	28.12	28.34	-0.75	27.59	3.10	4.10	30.81	21.56
	IN	25.91	2.83	28.74	25.91	4.25	30.16	2.00	3.37	12.08	32.85
	KIBS	5.81	11.20	17.01	5.81	-3.25	2.56	0.34	4.64	18.67	15.48
	Total	**103.34**	**-3.34**	**100.00**	**103.34**	**-3.34**	**100.00**	**2.33**	**3.43**	**100.00**	**100.00**

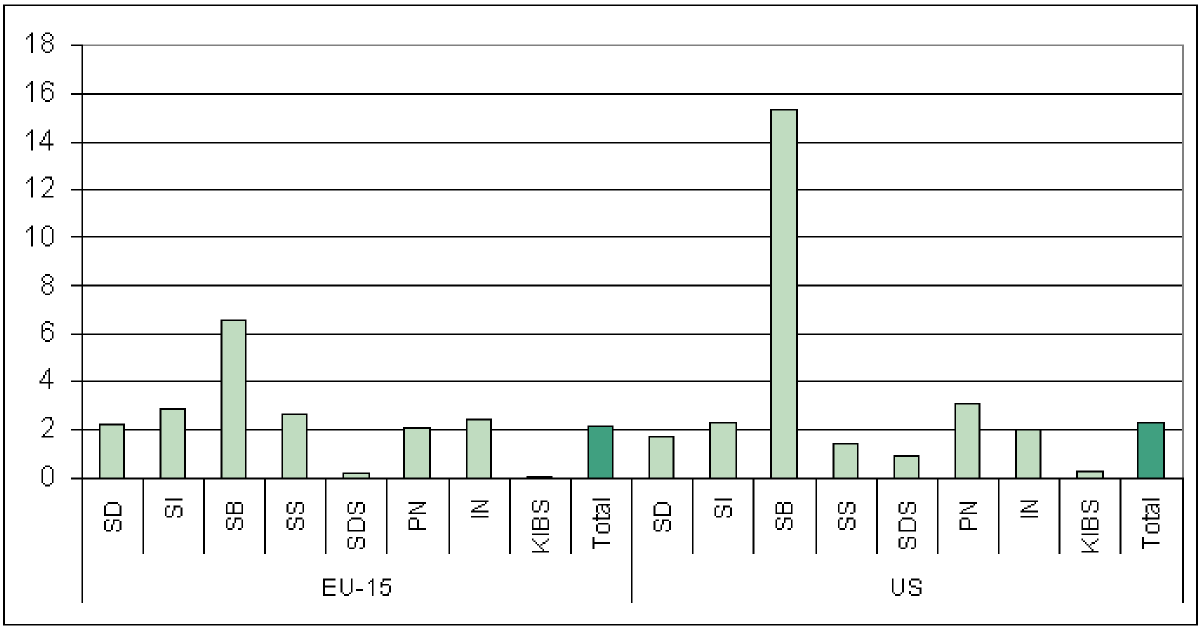

Figure 2: Average annual productivity growth in the sectors of the merged taxonomy, 1979-2004.

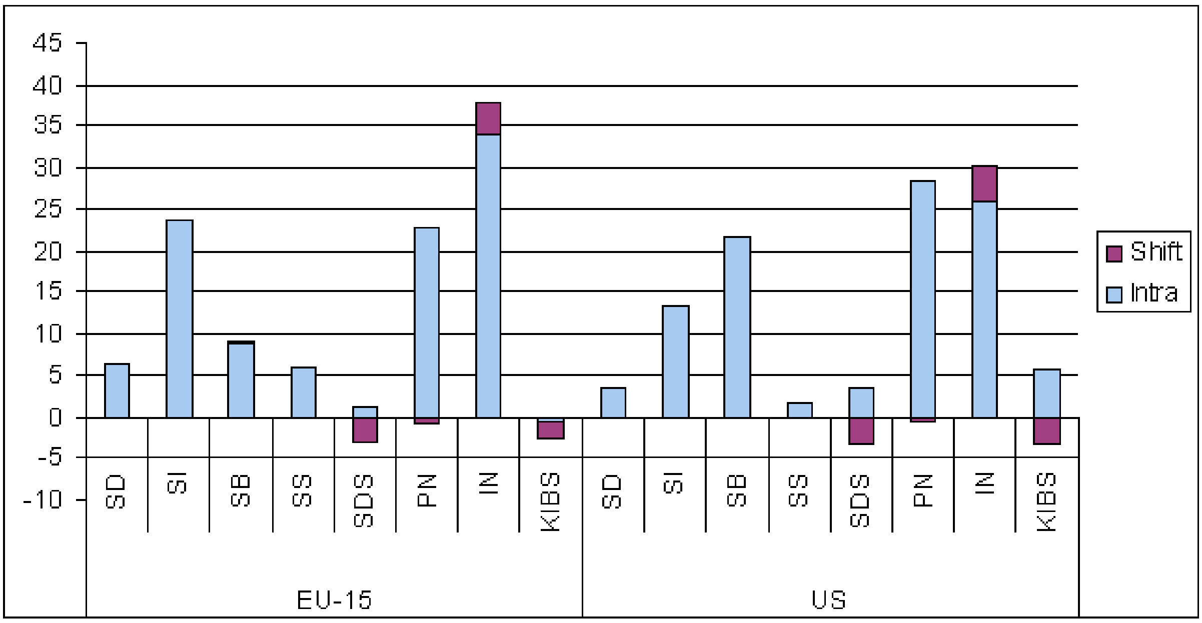

Figure 3: Intra and shift percentage contributions to labor productivity growth as resulting from the modified shift-share analysis.

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