EUROPEAN CENTRAL BANK

EUROSYSTEM

WORKING PAPER SERIES

NO 914 / JUNE 2008

EVOLUTION AND SOURCES OF MANUFACTURING PRODUCTIVITY GROWTH

EVIDENCE FROM A PANEL OF EUROPEAN COUNTRIES

by Silvia Giannangeli
and Ramón Gómez-Salvador

EUROPEAN CENTRAL BANK

EUROSYSTEM

WORKING PAPER SERIES

NO 914 / JUNE 2008

EVOLUTION AND SOURCES OF MANUFACTURING PRODUCTIVITY GROWTH

EVIDENCE FROM A PANEL OF EUROPEAN COUNTRIES[1]

by Silvia Giannangeli[2] and Ramón Gómez-Salvador[3]

In 2008 all ECB publications feature a motif taken from the €10 banknote.

This paper can be downloaded without charge from http://www.ecb.europa.eu or from the Social Science Research Network electronic library at http://ssrn.com/abstract_id=1147100.

1 We would like to thank several people for useful discussions and valuable comments, including Gonzalo Camba-Mendez and Neale Kennedy, and participants to an ECB seminar and the Schumpeter 2006 Conference.
2 Sant'Anna School of Advanced Studies, P.za Martiri della Libertà, 33, 56127 Pisa, Italy; e-mail: s.giannangeli@sssup.it
3 Corresponding author: Directorate General Economics, European Central Bank, Kaiserstrasse 29, 60311 Frankfurt am Main, Germany; e-mail: ramon.gomezsalvador@ecb.europa.eu

Address
Kaiserstrasse 29
60311 Frankfurt am Main, Germany

Postal address
Postfach 16 03 19
60066 Frankfurt am Main, Germany

Telephone
+49 69 1344 0

Website
http://www.ecb.europa.eu

Fax
+49 69 1344 6000

The statement of purpose for the ECB Working Paper Series is available from the ECB website, http://www.ecb.europa.eu/pub/scientific/wps/date/html/index.en.html

ISSN 1561-0810 (print)
ISSN 1725-2806 (online)

CONTENTS

Abstract: The study aims at describing productivity growth in the manufacturing sector for a selected panel of five European countries using firm-level data. The paper explores the empirical regularities of firm productivity distribution across countries. In particular, we assess the degree of persistence of firm relative productivity and consider its effect on aggregate productivity improvements. Moreover, the paper analyses the impact of the competitive forces on aggregate productivity growth by disentangling the role of firm learning and market selection. Finally, we estimate the relationship between labour productivity growth and firm-specific factors such as size, age and capital intensity across countries. The paper uses annual account data over the period 1993-2003 from *Amadeus* dataset (Bureau van Dijk) for a balanced panel of manufacturing firms. In line with previous evidence, our analysis shows that firm relative productivity levels are both highly heterogeneous across firms and very persistent over time in all the countries in the sample. With reference to aggregate productivity growth, we find that both labour productivity and total factor productivity changes are mostly driven by firm learning, i.e. within-firm productivity improvements, in most European countries. Conversely, the reallocation of resources spurred by the competitive selection process is found to play a minor role in fostering aggregate productivity growth. Finally, in line with macroeconomic trends, gains in productivity seem to be associated with capital deepening, but also with employment losses.

JEL Classification codes: D24, L11, L60

Keywords: productivity growth ; microdata ; cross-country comparison

Non-technical summary

The study aims at describing productivity growth in the manufacturing sector using firm-level data for a selected panel of five European countries, i.e. Belgium, France, Germany, Italy and Spain. The paper explores the empirical regularities of firm productivity distribution and analyses the role of reallocation of resources on aggregate productivity growth. Both labour productivity and total factor productivity (TFP) are considered.

The study attempts to focus on a number of questions for which the use of micro data can provide new insights to understand productivity developments. In particular we investigate: i) if the distribution of firm productivity diverges across countries; ii) what are the components of productivity growth; and, iii) if there are firm specific factors affecting productivity growth.

We use annual account data over the period 1993-2003 from *Amadeus* dataset (Bureau van Dijk) for a balanced panel of manufacturing firms. The database gathers information on firms that satisfy some country-specific size thresholds. It does not allow distinguishing between new firms and firms that simply enter the sample at a given period but were already operating previously. Similarly, we cannot separate firms' closures from firms that exit the sample because, for instance, they fall below the specified size threshold or are acquired by, or merging with, other companies. We therefore restrict the analysis to continuing firms only.

In line with previous evidence, our analysis shows that firm relative productivity levels are both highly heterogeneous across firms and very persistent over time in all the countries in the sample. With reference to aggregate productivity growth, we find that both labour productivity and total factor productivity changes are mostly driven by firm learning, i.e. within-firm productivity improvements, in most European countries. Conversely, the reallocation of resources spurred by the competitive selection process is found to play a minor role in fostering aggregate productivity growth. The relation between input and output reallocation and productivity dynamics is interesting as it broadly suggest that firms' efficiency gains are generally accompanied by a decrease in the employment share of firms and an expansion in their output share. The regression analysis confirms the fundamental role that capital intensity plays in explaining productivity developments. In line with previous evidence and macroeconomic trends, our econometric analysis shows that gains in productivity seem to be associated with capital deepening, but also with employment losses. Finally, we find that, especially in high-growth periods, productivity gains are mainly concentrated in large and very large firms.

1. Introduction

The study aims at describing productivity growth in the manufacturing sector for a selected panel of European countries using firm-level data. The paper explores the empirical regularities of firm productivity distribution and analyses the role of reallocation of resources on aggregate productivity growth. In particular we investigate: i) if the distribution of firm productivity diverges across countries; ii) what are the components of productivity growth and, iii) if there are firm specific effects affecting productivity growth.

Most of the recent research using longitudinal micro data has emphasized that idiosyncratic factors dominate the distribution of output, employment, investment, and productivity growth rates across establishments.[4] Haltiwanger (1997) shows that sectoral effects as defined at 4-digit ISIC disaggregation account for less than 10% of total variability in these growth rates. Although the empirical literature on firm productivity has grown considerably in the last decade, most of it has focused on single country analyses and the need for cross-country comparisons still comes out clearly. A remarkable exception is the recent effort that OECD pushed in proving a sound basis for cross-country comparisons by creating a consistent longitudinal micro dataset on firms dynamics (Bartelsman et al. 2004; Bartelsman et al., 2005).

The contribution of the paper to the empirical research on productivity dynamics is twofold. Firstly, the paper provides cross-country comparisons on the components and sources of productivity growth in the manufacturing sector for a panel of European countries. Indeed, the existing empirical studies seem to suggest that many of the stylised facts on input, output and productivity dynamics are common across countries, but direct cross-country comparisons, although clearly useful to disentangle possible country-specific effects, are still scarce in the literature.

Secondly, the paper adds evidence at the micro level that can help to better understand the aggregate picture as regards productivity growth in Europe. In fact, the study of the sources of productivity growth has gained interest in recent years, linked to the potential effects that the production and use of ICT related goods may have had in some manufacturing and services industries. In particular, these effects are seen as the main factor to explain the gap in productivity developments between the US and most European countries since the mid 1990s. Many studies have approached this issue using a macro perspective, for instance estimating TFP developments.[5] However, this approach has some limitations, as it is unable to uncover within-sectors drivers of productivity developments and in particular the role of firm-specific factors and the impact of competition among firms. This paper adds evidence at the micro level on both topics.

---

[4] Haltiwanger (1997), Bartelsman and Doms (2000), Ahn (2000) and Foster et al. (2001) review the main findings of this literature.

[5] See, for instance, Gómez-Salvador et al. (2006).

The paper uses annual account data over the period 1993-2003 from the *Amadeus* dataset (Bureau van Dijk) for a balanced panel of manufacturing firms, and describes, at a micro-level, the evolution of labour productivity and investigates its sources in a panel of 5 European countries.

The paper is organized as follows: Section 2 provides a summary of the theoretical motivations of our analysis and summarises the main findings of the empirical research on firm productivity distribution and aggregate productivity growth. Section 3 describes the data and discusses the main measurement issues. Section 4 provides an overview of productivity distribution and shows the empirical findings on the components of productivity growth. Section 5 presents a regression analysis of firm-level productivity growth on a number of firm and sectoral characteristics. Section 6 concludes.

2. Theoretical motivations and empirical evidence

Bartelsman and Doms (2000) and Foster et al. (2001) review the rich literature on productivity dynamics, emphasizing some "lessons" or stylized facts, emerging from longitudinal micro evidence. These lessons point out that, *first*, the cross-sectional dispersion of firm productivity is very large. Although some of the measured dispersion might be due to measurement errors, quality differences in output or transitory idiosyncratic productivity shocks, the robustness of this finding across countries and periods suggests that some structural factors affect the observed dispersion in firm productivity. *Second*, differences among firms' productivity are highly persistent.[6] *Third*, large-scale reallocation of outputs and inputs take place within sectors.[7] *Fourth*, a large portion of aggregate productivity growth is attributable to resource reallocation and, *fifth*, entry and exit play a significant role in the process of productivity growth.[8]

Several theoretical models are invoked by the empirical literature to predict the observed evidence on firms' efficiency distribution and dynamics. In particular, heterogeneity in firm specific productivity levels can be accounted for by several factors including, among others, the speed of diffusion and adoption of new technologies, the uncertainty upon market conditions and firm ability to adapt to a new environment, along with market structure and competitive pressures. Part of the literature has emphasized the effect of entries and exits as major driver of productivity dynamics of the industry. Among others, we recall the so-called "vintage capital" models, which predict that new firms entering the market with new capital equipment technologically outperform existing

---

6 See, among others, Baily et al. (1992), Bartelsman and Dhrymes (1998), and Foster et al. (2002).

7 Davis and Haltiwanger (1999) and Foster et al. (2001).

8 For five year changes Bartelsman et al. (2004) report that for OECD countries entry and exit account for between 20 percent and 50 per cent of the overall productivity growth.

firms and constitute an important channel for productivity improvements in the market (Caballero and Hammour, 1994; Mortensen and Pissarides, 1994; Campbell, 1998).

Although the role of net entry may be important in fostering productivity, another key component for industry dynamics spills from the complex processes of learning and selection among incumbent firms spurred by the competitive forces. Indeed, changes in the distribution of firms' revealed efficiencies are the product of the combined processes of learning by incumbent firms and their differential growth (which is a part of the selection process), in addition to the net effect of entry/exit into/from the industry. In particular, productivity at the industry level may move because incumbent firms either improve their efficiency (they learn) or because the competition forces make more efficient firms to expand their market shares. Nelson's (1981) model of firm learning predicts that productivity differences are the outcome of technological bets. In his model not all firms, when facing the same technological opportunity, decide to adopt and invest on the same technology. Among firms endowed with different technological capabilities some fail and some other succeed, gaining larger market shares and displacing rivals. Renewing the interest in the "creative destruction" process in the Schumpeterian vein (Schumpeter, 1942), the reallocation of jobs and output is seen, in this framework, as the fundamental channel through which more efficient firms tend to displace less productive ones. A related stream of research has proposed different theoretical models of firm learning, building on the assumption that firms enter the market unsure of their efficiency or productivity levels and learn about their true quality through noisy information on profits and costs once in the market. Two of these models became popular as the "passive learning" (Jovanovic, 1982; Lippman and Rumelt, 1982) and the "active learning" models (Ericson and Pakes, 1995).

A recently developed strand of empirical literature has tried to assess the impact of institutions on economic performance (see, for instance, Nicoletti and Scarpetta 2003, 2005). This view emphasizes the fact that the "creative destruction" process, that is the combined processes of learning/selection, may not act *per se*. Rather, the pace of reallocation that takes place in a given sector/country can be seriously distorted in some manner by existing institutional set-ups.

Our paper relates with this literature and provides some cross-country evidence for Europe on both firm productivity heterogeneity and persistence and the impact of learning and selection processes on productivity growth in the manufacturing sector.

3. Data and measurement issues

3.1 Data

This paper uses annual account data of manufacturing firms from Belgium, France, Germany, Italy and Spain over the period 1993-2003 from *Amadeus* dataset.[9] Other countries were also considered, but not included finally as reliable information was available only for a too short period. The database gathers information on firms that satisfy some country-specific size thresholds.[10] The data do not allow distinguishing between new firms and firms that simply enter the sample at a given period but were already operating previously. Similarly, we cannot separate firms' closures from firms that exit the sample because, for instance, they fall below the specified size threshold or are acquired by, or merged with, other companies. We therefore restrict the analysis to continuing firms only. Although this may seem an important limitation, the existing literature shows that the role of entry and exit of firms in explaining productivity growth in European countries is marginal compared with the US (see Bartelsman et. al., 2004). Due to the different structure of balance sheet records across countries, international comparability is made possible through a reclassification procedure.[11] Firms are classified according to their industrial main activity following to the first two letters of NACE classification.[12]

Table 1 shows the composition of the final sample adopted in the empirical analysis, and the coverage in terms of employment and value added obtained comparing our sample with aggregate estimates from Groningen Growth and Development Centre (GGDC) *60 Industries* database. In order to avoid severe problems of missing data, the sample period is shortened to 1994-2003 for Germany and Spain. The firms included in the analysis are only those not presenting missing values in employment and value added. Our final sample is fairly representative of the overall economies in the selected countries, with the average employment and value added coverage being around 16%.

The data have been carefully checked and the main problems related with missing values, unit of measure mistakes and outlier observations have been addressed. We tried to solve the latter by applying a two-step cleaning procedure. First, in order to capture inconsistencies between employment and production or wages, we dropped all observations for which the absolute value of

[9] We leave out from the study two sub-sectors, i.e. Office machinery and computers and Radio, television and communication equipment and apparatus, due to the problems detected in the developments of their deflators.

[10] German, French and Italian firms must have operating revenues larger than 1.5 million €, or total assets larger than 3 million €, or more than 20 employees in order to be included in the sample. For firms from all other countries a lower threshold of 1million € operating revenues, 2 million € total assets, 15 employees apply.

[11] For detailed information on the reclassification procedure, refer to the Amadeus information documentation.

[12] We adopt a disaggregation up to the 2 letters NACE in order to have a sufficient number of incumbent firms per industry in the sample period.

the growth rate in the compensation per employee was larger than 50%.[13] Further, we drop large companies whenever an uncommon and economically meaningless pattern in the financial dynamics appears.

Table 2 compares the employment distribution of our final sample broken down by industry technological intensity with the distribution obtained from GGDC data. Our technology classification mimics the one adopted by OECD (2005) but groups OECD *High* and *Medium-High classes* into "High Tech" industries. It turns out that high tech sectors tend to be under-represented in all countries, with the exception of Germany. The existence of heterogeneous size distributions of firms across countries may explain the uneven distribution of our samples in terms of industry technological class.

Moreover, Table 3 summarizes the employment distribution of our final sample broken down by firm size class and compares it with aggregate statistics from Eurostat. As expected, our sample tends to under-represent smaller firms, although the distribution of employment and value added in broad size classes fairly reproduces the distribution of the population represented in the Eurostat figures.

Finally, we compare the aggregate productivity growth derived from our micro database with that derived from aggregate sources, in particular the GGDC data. The sample appears to mirror quite well productivity developments at the macro level (see Table 4).

The results of our micro database are in line with the well documented downward movement in EU labour productivity trends, with EU15 and Euro area annual average labour productivity per hour growth rates falling from over 2% over the 1981-1995 period to 1.5% in 1996-2000 and to 1% in 2001-2004 – see Koszerek et al. (2007) on the EU-KLEMS database. These trends contrast with those experienced in the US that recorded a marked increase in its productivity performance over the same periods, moving from an average growth of 1.2% in 1981-1995 to 2.5% in 2001-2004. This contrast has been widespread at the industry level, i.e. both for the manufacturing and private services sectors.

[13] Compensation per employee is calculated as the ratio between total cost of employment and number of employees. The ratio is expected to be stable and annual changes exceeding 50% must be due to misreported data or other sources of measurement error. A similar indirect approach was followed in Gómez-Salvador et al. (2004). Large firms are subject to an extra cleaning since these observations are potentially influential for the results of most of the analyses.

3.2 Measurement of output, inputs and productivity

In line with a rich literature spurred by the work of Baily et al. (1992), we consider aggregate sectoral productivity growth as a weighted average of firm-level productivity growth. Although the use of plant instead of firm level data is to be preferred, so as to avoid spurious input and output flows measurement or longitudinal linkage problems (i.e. mergers, acquisitions, etc), we are constrained to use firm data due to the fact that financial statements are filled at the firm level.

Denoting P_{it} and p_{ft}, respectively, the logarithm of industry i and firm f productivity, the growth of productivity in any industrial sector can be expressed as follows:

$$\Delta P_{it} = \sum_{f \in i} s_{ft} \Delta p_{ft} \tag{1}$$

where s_f is the share of firm f in its industry of activity.

Two different measures of firm efficiency may be adopted: labour and total factor productivity, or TFP. Foster et al. (2001) summarise the findings of a large set of empirical studies and compare the pros and cons of both concepts. In the present study we adopt both measures. Log labour productivity is calculated as $\log Q_{ft} - \log L_{ft}$, where Q_{ft} is firm output and L_{ft} is the number of employees.[14] Firm output is obtained by deflating firm sales by the appropriate industry output deflator, obtained from the 60 Industries database developed by the GGDC. Obtaining estimates of TFP at the firm level deserves giving some details. The basic expression is:

$$\log TFP_{ft} = \log Q_{ft} - \alpha_K \log K_{ft} - \alpha_L \log L_{ft} - \alpha_M \log M_{ft} \tag{2}$$

where K_{ft} is a measure of the capital of the firm proxied by the book value of the material fixed assets. As there is no information on capital deflators by industry for the euro area, in order to deflate material fixed assets we use the deflators derived from the *Net Stock of Private Fixed Assets by Industry* released by the Bureau of Economic Analysis for the US. M_{ft} is a measure of the material costs of the firm. We take its book value and use as a deflator the index derived by the developments in the different components of the Producer Price Indices, weighted by the shares

[14] Although worked hours would be the most appropriate measure of firms' employment, we must adopt the number of employees due to the unavailability of data on hours at the firm level.

obtained in the input-output tables (year 2000) by sector and country. Finally, the parameters $\alpha_{K,}$ α_L and α_M are defined respectively as the share of operating surplus, i.e. profits that are a proxy of the remuneration of capital, compensation of employees and total intermediate consumption over output. These are obtained from the input-output tables of the year 2000 for each industry and country, and remain constant over time.

A final measurement issue concerns the weighting approach to be adopted in order to calculate aggregate productivity as in equation (1). Either input or output shares of firms have been adopted in the literature. Using employment weights has the advantage of relying on a variable. i.e. employment, which is less subject to measurement errors in the database. However, employment shares can be affected not only by firms' growing decisions but also by restructuring and changes in factor intensities. Adopting output weights overcomes this problem. In this case, s_{ft} denotes the market share of firm *f* in its industry at time *t*. As emphasized by Foster et al. (2001), using both input and output shares may help identify possible productivity-enhancing changes in factor intensities. We will follow this suggestion and calculate industry productivity growth adopting, alternatively, firm employment and output shares in some of the analysis presented.

4. Productivity growth: an overview

4.1 Productivity distribution

In this Section we present an overview of the distribution of labour productivity and total factor productivity in our panel of countries. Figure 1 and Figure 2 show, respectively, the nonparametric estimates of the density function of (log) labour productivity and total factor productivity (TFP) for the first and last year.[15] Summary statistics on labour productivity and TFP are reported in Table 5. TFP is not available for Germany due to the lack of information on fixed-assets and compensation of employees.

The estimated densities of labour productivity do not show a high degree of heterogeneity among countries. A common characteristic is the high heterogeneity of firm level labour productivity, as shown by the width of the distribution support. The comparison between the estimated density of labour productivity at the beginning and end of the sample period highlights that overall growth takes place in all countries but Germany, where the densities of different years superimpose to each

[15] Empirical densities are estimated adopting Epanechnikov kernel with band width $h = 0.9(\min\{\hat{\sigma}, IQR/1.34\} N^{-1/5}$, as suggested by Silverman (1986).

other, and Italy, where labour productivity seems to decline. It is interesting to notice that the distribution of TFP is different in shape from that of labour productivity, showing, with few exceptions, some clustering around peak values. This clustering results from aggregating markedly heterogeneous sectoral TFP distributions, being this heterogeneity due to the considerable technological distance among sectors.[16] As shown in Table 5, the mean value of TFP falls well below the average labour productivity in all countries.

4.2 Input and output reallocation

4.2.1 The extent of input and output reallocation

Table 6 presents estimates of the gross expansion and contraction rates of employment and output over the sample period. According to Davis and Haltiwanger (1999), expansion rate (ER) and contraction rate (CR) are calculated as follows:

$$ER = \sum_{f \in S^+} g_{ft} \frac{x_{ft}}{X_{St}}$$
$$CR = \sum_{f \in S^-} \left| g_{ft} \right| \frac{x_{ft}}{X_{St}} \qquad (3)$$

where $g_{ft} = \Delta x_{ft} / x_{ft}$, is the growth rate of $x = \{employment, output\}$ in firm f and time t and $x_{ft} = 0.5(x_{ft} + x_{ft-k})$. The sets S^+ and S^- are defined, respectively, as the set of expanding and contracting firms in sector S. Cross-country averages are calculated for each industry. Average expansion rate in total manufacturing equals 29% for employment and about 46% for output. The contraction rate is higher for employment (11%) than for output (7%). Considerable heterogeneity characterises both expansion and contraction rates at the industry level. Table 6 also shows the share of excess reallocation within each sector. Excess reallocation, calculated as the sum of gross expansion and contraction rates less the absolute value of the net growth for the industry, summarises the fraction of reallocation of input and output in excess of what would be required to accommodate the overall net change. Excess reallocation rates indicate that in almost all sectors the fraction of reshuffling of input and output exceeding the net industry change is of considerable magnitude, ranging from 14% to 32% in the case of employment and 7% to 24% for output. The simultaneous presence of high rates of reallocation of both input and output at the sectoral level

[16] This is confirmed by the absence of clear peak values in the TFP distributions at the sectoral level. A simple analysis of variance of LP and TFP confirms that the distance among average TFP across industries is larger that in the case of LP. This motivates the significantly different shapes of the two distributions at the aggregate manufacturing level.

implies that the pattern of input, output and productivity evolution entails considerable heterogeneity at the firm-level.

4.2.2 The impact of reallocation on aggregate productivity growth

We begin our empirical analysis by applying a decomposition of industry labour productivity growth into different components. Several studies have proposed alternative ways of isolating the contributions to aggregate productivity growth due to the processes of firm expansion on the one side and within-firm improvements in efficiency on the other (see, among others, Griliches and Regev, 1995; Haltiwanger, 1997; Baldwin and Gu, 2003; Foster et al., 2006). Indeed, industry (and country) productivity changes are the result of distinct processes that take place at the micro level of firm activity. Focusing on incumbent firms only, i.e. firms that are in activity for the whole period considered, it is possible to logically distinguish among different phenomena responsible for aggregate productivity dynamics. An increase in efficiency by a firm, other things being equal, translates into an improvement in more aggregate (industry or country) productivity levels. Similarly, if the most productive firms in an industry expand in terms of market shares, the overall productivity level will improve. Finally, if the two forces work together, that is if firms improving their productivity are also gaining market shares, an overall increase in productivity will result at both the industry and country levels. The decomposition methods suggested by the empirical literature try to separate these processes and isolate the amount of aggregate productivity changes imputable to each of them.

Many recent studies attempted to appraise and quantify the contribution of within-plant growth (or *learning effect*) and reallocation (or *selection effect*) on aggregate productivity growth. Although similar in their aim, these studies differ remarkably as for measurement and computational approaches. Foster et al. (2001) provide a useful reader-guide on the topic.[17]

The decomposition procedure adopted in this study is the one proposed by Foster et al. (2001), adapted to a balanced panel. We follow the notation introduced in (1) and we decompose, for any industry *i*, the productivity growth between time t-k and t according to the following formula:

$$\Delta P_{it} = \overbrace{\sum_{f \in i} s_{ft-k} \Delta p_{ft}}^{\text{within component}} + \overbrace{\sum_{f \in i} (p_{ft-k} - P_{it-k}) \Delta s_{ft}}^{\text{between component}} + \overbrace{\sum_{f \in i} \Delta p_{ft} \Delta s_{ft}}^{\text{cross term}} \tag{4}$$

[17] Most of the empirical studies on this issue analyse an open panel of firms and assess the role of entry/exit processes on total productivity growth by including an additional term in the decomposition procedure. Due to data unavailability on entry and exit processes, we focus our decomposition exercise on incumbent firms.

The first term, which most of the literature calls *within* component, measures the amount of aggregate productivity growth due to changes in productivity at the firm level (holding shares fixed). With reference to the concepts proposed by the theoretical literature reviewed in Section 2, the so called within component represents the outcome of within-firm learning, that is the process through which firms adopt new technologies or solutions and approach the efficiency frontier. Another way to interpret the within component is to look at it as the part of aggregate growth that would be observed in the absence of market share reallocation among incumbent firms. The second term, so called *between* component, results instead from changes in the market share of firms occurred between time t-k and t, weighted by the relative efficiency of firms at the beginning of the period.[18] The between component captures the movements in aggregate productivity due to differential growth, that is to the change in the market shares of firms characterized by different productivity levels at the beginning. This contribution represents the impact of the reallocation of input or output spurred by the competition selection forces. Finally, the *cross* term accounts for the simultaneous change in productivity and firm share, and summarises the combined effect of within-firm learning and between-firms selection mechanisms.

Table 7 presents the results of the aggregate productivity decomposition for all countries in the sample, obtained using alternatively employment and output weights. Although the decomposition has been computed for each industry separately, we show the results for the average industry in order to ease the presentation and the discussion of the main findings.[19]

We start by looking at the labour productivity growth decomposition using employment weights. We find that in all countries with the exception of Italy the learning component obtained using employment weights is positive and very large, often exceeding overall productivity growth. In the same countries, the effect of differential growth (the between component) is positive and small, ranging from 6% to 11% of overall productivity growth. The cross-term is generally negative and of considerable magnitude, meaning that productivity growth is not concentrated in firms that are gaining weight. In sum, in all countries but Italy, the productivity gains are mainly the result of firm learning. As regards Italy we find, in contrast to all other countries, that productivity declined, and

[18] Firm relative efficiency is calculated as the difference between firm productivity and the industry average productivity.
[19] Nominal output weights from GGDC are used to calculate the average industry figures. Results at the industry level are available upon request to the authors.

that both the learning and the cross components appear to explain this decline, while the between component is the only one contributing positively.

For comparative purposes, Bartelsman et al. (2004) adopt the same procedure to decompose productivity growth in an unbalanced panel of firms, but include also the effect of entry and exit. Although the comparability of the analyses is limited, as the observation period is almost non-overlapping, the findings of Bartelsman et al. (2004) confirm that in West Germany and France the within effect is positive and large, the contribution of the between component is positive but small and the cross-term is negative (although smaller than what we find).[20]

It is interesting to point out some differences in the results obtained using employment and output weights. When looking at the results obtained using output weights, the within component is still large, accounting for most of the overall growth, in all countries with the exception of Italy, but are generally smaller than those obtained using employment weights. The between terms are mostly negative and small, meaning that firms that were more efficient than average at the beginning, while increasing their employment share, tended to shrink in terms of output share. The cross-term is positive and accounts for a significant fraction of growth. The difference in outcomes delivered from the two decompositions deserves some attention. In order to interpret these discrepancies, it is useful to look at the correlation among firm labour productivity, output, employment and capital intensity growth rates. As shown in Table 8, the growth in labour productivity is accompanied by an increase in output and a decrease in employment in all countries. This may explain the negative sign on the cross-term component in the decomposition when using input shares. Analogously, the positive correlation between output and labour productivity growth rates may be the reason of the positive cross term when using output weights.

These results suggest that changes in factor intensity are one of the sources of the observed labour productivity growth. The positive correlation between productivity growth and capital intensity growth, along with the negative correlation of the latter with employment growth found in most countries, also suggest that the increase in productivity is led by the substitution of labour with other inputs.

Moving to the TFP decomposition, the results on the impact of the within component are rather similar to those on labour productivity . The improvement in efficiency by incumbent firms, holding their shares constant, is the largest source of TFP gains in the period. The between component is

[20] A clear reason why these results partly differ from ours lie in the inclusion in Bartelsman et al. (2004) of entry/exit effects.

larger than in labour productivity growth decomposition in France and Belgium, indicating that the selection mechanism seems to be more effective in promoting TFP than labour productivity growth. As in the case of labour productivity, TFP gains are mainly the result of firms learning, i.e. improving their efficiency, while the contribution from gains/losses in the share of the firms is less significant.

4.3. Persistence of efficiency levels and its impact on overall productivity growth

The evidence on productivity evolution opens the question of the role played by firm turnover in the productivity distribution: are firms at the bottom of the distribution in the base year moving towards the efficiency frontier? Are firms in the top part of the distribution losing competitiveness? How persistent is the productivity distribution?

Following Baily et al. (1992), we address the issue of the persistence of firms' relative efficiency by means of transition matrices. In order to calculate relative efficiency of a firm ($\tilde{p}_{ft}$), we remove from the firm labour productivity the industry average, calculated as an average of firm efficiency level weighted by their output share:

$$\tilde{p}_{ft} = p_{ft} - \sum_{f \in i} s_{ft} p_{ft} \qquad (5)$$

Table 9 and table 10 show, respectively, the cross-country average transition matrices among quintiles of labour productivity and TFP distributions over the whole sample period. Transition matrices for each country are reported in Appendix 2.

The matrices are built so that firms have been divided in quintiles, from 1 that indicates a low productivity level to 5 that indicates a high productivity level, for both the starting or base year and the end year. Each cell in the matrices shows the number (and percent) of firms pertaining to that quintile at the start and end year. For instance, 58.6% of firms (430 firms) that belong to the fist quintile of labour productivity distribution in the starting year are still in the first quintile at the end year, whereas 56.3% (377 firms) of firms that are in the first quintile of the TFP distribution at the beginning and remain in the same quintile at the end of the sample period.

The degree of persistence of relative labour productivity and TFP are rather similar. Around 44% of firms remain in the same rank of efficiency across the sample period independently of the measure adopted. The share of firms moving to higher (lower) quintiles is particularly low among firms that were in the first (fifth) quintile in the base year (about 40%) whereas it is above 60% for firms in the middle quintiles. This result is driven by the fact that since the distribution of labour productivity and TFP are roughly bell shaped.[21] Therefore it is easier for firms in the middle part of the distribution to move across quintiles.

We then break down incumbent firms into groups based upon whether the firms moved up by at least two quintiles (UP), moved down by at least two quintiles (DOWN), remained in the two top or bottom quintiles (respectively, TOP and BOTTOM), or remained roughly stable in the efficiency ranking, staying in the middle and moving by at most one quintile (MIDDLE) between the initial and ending year of the sample period. We show the fraction of firms following in each of these groups by country in Table 11 panel A, while the full transition matrices are presented in Appendix 2.

The share of firms that moved by at least two quintiles are less than 20% of the sample in all countries, whatever measure of efficiency is considered. In other words, the degree of persistence of firms' relative efficiency is rather high. Around 25% of firms in all countries remained in the middle of the distribution, while more than half of the sample persistently remains at the top and bottom part of the distribution. The high persistence of relative productivity levels suggests that firm efficiency levels are structurally different across firms. In fact, if deviations of firms' efficiency from the industry average were the product of simple transitory shocks to firm activity and firms operating in the same industry were very similar to each other, no such persistence of the productivity ranking would be expected over the observed decade.

A natural extension of the discussion about persistency in firms' efficiency is the assessment of the relative contribution to the overall productivity growth of firms that either gain (or lose) efficiency with respect to their competitors, or do not move in the efficiency ranking. We do so by applying the following simple decomposition of the overall productivity growth of incumbent firms:

$$\begin{aligned}\Delta \log P_t = & \textstyle\sum_{f\in UP}(s_{ft}\log p_{ft} - s_{ft-k}\log p_{ft-k}) \\ & + \textstyle\sum_{f\in DOWN}(s_{ft}\log p_{ft} - s_{ft-k}\log p_{ft-k}) \\ & + \textstyle\sum_{f\in TOP}(s_{ft}\log p_{ft} - s_{ft-k}\log p_{ft-k}) \\ & + \textstyle\sum_{f\in BOTTOM}(s_{ft}\log p_{ft} - s_{ft-k}\log p_{ft-k}) \\ & + \textstyle\sum_{f\in MIDDLE}(s_{ft}\log p_{ft} - s_{ft-k}\log p_{ft-k})\end{aligned} \tag{6}$$

[21] The relative labour productivity distribution is positively skewed, as the skewness coefficients are positive for all countries, but the mass of the distribution lies in the middle values of the support.

Where $\Delta \log P_t$ is the overall growth of manufacturing firms between time t-k and t, and shares s_{ft} are defined using the output share of firm *f* at time *t* in its industry, multiplied by the output share of the industry according with aggregate statistics (GGDC 60 Industries database):

$$s_{ft} = \overbrace{\frac{output_{ft}}{output_{it}}}^{\text{sample}} \times \overbrace{\frac{output_{it}}{output_{t}}}^{\text{GGDC}} \qquad (7)$$

Firm weights built in this way allow mitigating the problems of imperfect industry coverage and over-representation of some sectors in the sample. The overall productivity growth calculated through (4) equals the one shown in Table 7, obtained by summing the within, between and cross component of decomposition (2). Panel B in Table 11 shows the decomposition results by reporting the contribution in percent to manufacturing productivity growth by firms in different ranking groups. Not surprisingly, firms moving *up* in the productivity rankings contributed positively to the overall productivity dynamics, while firms moving *down* contributed negatively. The only exception being TFP in Italy, which is estimated to have declined. Moreover, in absolute terms, the contribution from those moving *up* is higher than that from those moving *down*, with the only exception of labour productivity in Italy. Firms that remain in the *top* part of the distribution over the period tend to contribute positively to the overall productivity growth, with the exception of Spain for TFP. Finally, the sign of the contribution of the *middle* and *bottom* groups varies depending on the country and concept of productivity used. The former is positive for France and Germany and changes sign in Spain and Belgium depending on whether we look at TFP (+) or labour productivity (-), and the latter is positive in Spain and France, negative in Germany and changes sign in Belgium (labour productivity negative and TFP positive).

5. The impact of firm characteristics on productivity growth

This section presents a regression analysis of firm-level productivity growth on a number of firm and sectoral characteristics. We restrict the analysis to labour productivity for various reasons: (i) it is directly observable at the firm-level and therefore better linked to firm level characteristics; (ii) it is subject to fewer caveats in terms of the number of assumptions made; and (iii) it mirrors better aggregate developments, both in terms of overall productivity growth and the pattern of decline over the 1990s. The theoretical framework from the Solow growth model leads to the following expression of labour productivity growth:[22]

$$\Delta Y(t)/ Y(t) - \Delta L(t)/ L(t) = \alpha_k(t) * [\Delta K(t)/ K(t) - \Delta L(t)/ L(t)] + R(t) \qquad (8)$$

[22] See for instance Romer (1996).

where the growth of output per worker (Y/L) is decomposed into the growth of capital per worker (K/L) and the Solow residual (R), which is usually interpreted as a measure of the contribution of technological progress. From this framework we derive the equation we are going to estimate:

$$\text{LP growth}_{i} = \alpha_0 * \text{Capital intensity}_{i} + \alpha_i * X_i + \alpha_{i+1} * S_i + \alpha_{i+2} * \text{cycle} \qquad (9)$$

where labour productivity (LP) growth at firm i is explained by three types of variables. First, firm level information on capital intensity at the start of the period. We use capital intensity instead of the capital per worker, as suggested by the model, because it helps to avoid the problem of having to deflate capital. Second, dummy variables that control for the size and age of the firm, and for whether the firm is in a process of reducing the level of employment (downsizing). The latter is constructed by giving value 1 to the firms that have reduced the level of employment over the period considered, and 0 otherwise. And third, sectoral dummies, that should help to capture technological progress, and developments in value-added at the sectoral level to take into account the cyclical position of the sector. Summary statistics of the variables are presented in Table 12.

The analysis is carried out for the growth rate over the whole period of study, i.e. 1993-2003 and for two sub-periods that are characterised by high and low labour productivity growth, 1993-97 and 1998-2003 respectively. All the countries used in the discussions of the previous sections are included, except Germany due to the lack of information regarding capital intensity. The estimates are presented using ordinary least squares (OLS). Estimates are based on clustering techniques to compute standard errors in order to control for within country correlation. In addition to sectoral dummies, we have included country dummies.

Table 13 presents the results for the period 1993-2003. Labour productivity growth estimates indicate that the level of capital intensity at the firm level at the beginning of the period has a strong influence on subsequent labour productivity developments. As regards firm characteristics, size is positively correlated with productivity growth, while age is not found to be significant. Only the age group between 11-20 years, for which productivity growth tends to be lower, is found to be significant in some regressions. Column 2, which includes activity developments at the sectoral level, seems to confirm the pro-cyclicality of labour productivity growth. Moreover, gains in productivity at the firm level are highly correlated with processes of downsizing (see column 3). Finally, when dummies on the degree of technology level are introduced instead of pure sectoral dummies, the results indicate that firms with a low technological level tend to record lower productivity growth (see column 4). The results obtained running regressions by country broadly confirm the overall picture, especially as regards capital intensity, the cycle and downsizing, while there are some small differences regarding age and, to a lesser extent, size (see the results in Appendix 2).

Table 14 exploits the fact that two sub-periods, of high and low labour productivity growth, can be differentiated in our sample, in line with the deceleration of labour productivity observed at the aggregate level. The question is whether the variables we are considering have had a different impact in each sub-period. The level of capital intensity is significant in both periods, for high and low productivity growth, although the coefficient is a bit higher in the latter. Size is significant and positive in times of high labour productivity growth only, while age is found to be relevant for the older ones in the productivity expansion and for those between 6 and 10 years old in the productivity slowdown. The cycle appears to have played a similar role in both periods, while the dummy of downsizing shows a higher coefficient in the low productivity growth period. This may be suggesting that labour market flexibility may have more positive impact on labour productivity growth in downturns. As regards the technological level, the negative impact on the firms with a low degree of technology is more significant in the low productivity growth period than in the high. Finally, when lagged productivity growth is included in the second period (the only one for which it is available), it turns to be positive and significant, indicating that there is some persistence in labour productivity growth at the firm level.

6. Conclusions

This paper presents an analysis of productivity, both labour productivity and total factor productivity (TFP), at the micro level using a balanced panel of continuing firms in the manufacturing sector for five euro area countries since the mid-90s, which appears to be representative of the developments recorded at a macro level.

Our analysis confirms a high degree of heterogeneity of productivity at the firm level. The reallocation of employment and output across firms is considerably high, although its impact on the dynamics of aggregate productivity is not strong. Indeed, we find that productivity growth, as measured by both labour and total factor productivity of continuing firms, is led by the learning process at the firm level, rather than by the gains/losses in the market share of firms spurred by the competititive selection forces. The relation between the input and output reallocation and productivity dynamics is interesting as it broadly suggests that firms' efficiency gains are generally accompanied by a decrease in the employment share of firms and an expansion in their output share. In short, our results are consistent with the hypothesis that efficiency improvements are achieved by firms in our sample through substitution between labour and capital. This hypothesis encourages deeper and more targeted empirical validation on the issue.

The analysis has also shown that firm relative efficiency is rather persistent over time, thus suggesting that structural differences across firms, rather than transitory shocks to firms' activity, drive the evolution of productivity at the firm level. Nevertheless, firms that move up in the efficiency ranking contribute considerably to the gains in aggregate productivity growth.

The regression analysis confirms the fundamental role that capital intensity plays in explaining productivity developments. Another firm characteristic that appears to matter is firm size, which favours mainly large (250-999 employees) and very large (more than 1,000 employees) firms, especially in the period of high productivity growth. Results concerning firm age are less robust, but suggest that productivity tends to grow more rapidly in the oldest firms (above 20 years) in the high productivity growth period. Other controls that are found to be relevant for productivity developments include whether the firm is in a process of downsizing, which seems more relevant in downturns, and activity developments at a sectoral level, which can be seen as an indication of a pro-cyclical behaviour. As regards the technological level, firms in low tech industries see a poor performance, especially in the low productivity growth period. Finally, the results indicate that there is some persistence in labour productivity growth at the firm level.

The investigation of aspects that can help to understand the persistent differences of productivity at the firm level, such as managerial practices or technological and innovation activity, are in our agenda for future work.

References

Ahn, S. (2000) Firm Dynamics and Productivity Growth: A Review of Micro Evidence from OECD Countries", OECD Economic Department WP 297.

Baily, C. Hulten, D. Campbell, T. Bresnahan and R.E. Caves (1992) Productivity dynamics in manufacturing plants, Brooking *Papers on Economic activity*. *Microeconomics*, 1992, 187-249.

Baldwin, J. and W. Gu (2006) Plant turnover and productivity growth in Canadian manufacturing, *Industrial and Corporate Change*, 15, 417-465

Bartelsman, E. and P. Dhrymes (1998) Productivity Dynamics: U.S. Manufacturing Plants 1972-1986, *Journal of Productivity Analysis*, 9, 1, 5-34.

Bartelsman, E. J. and M. Doms (2000) Understanding Productivity: Lessons from Longitudinal Microdata. *Journal of Economic Literature*, 38, 3, 569-594.

Bartelsman, E., S. Scarpetta and and F. Schivardi (2005) Comparative Analysis of firm Demographics and Survival: Micro-Level Evidence for the OECD countries, Industrial and Corporate Change, Vol. 14, 365-391.

Bartelsman, E., Haltiwanger J. C. and S. Scarpetta (2004) Microeconomic Evidence of Creative Destruction in Industrial and Developing Countries, Policy Research Working Paper Series 3464, The World Bank.

Caballero R.J. and M.L. Hammour (1994). The Cleansing Effect of Creative Destruction, *American Economic Review*, 84:5, 1350-68.

Campbell, J. (1998). "Entry, Exit, Embodied Technology, and Business Cycles." *Review of Economic Dynamics* 1:2 (April), 371-408.

Davis, S. J. and J. Haltiwanger (1999) Gross Job Flows, in O. Ashenfelter and D. Card (eds.), *Handbook of Labour Economics*, Elsevier Science.

Ericson, R. And A. Pakes (1995) Markov perfect industry dynamics: a framework for empirical work, *Review of Economic Studies*, 62 (1), 53-82.

Foster, L., Haltiwanger, J. and C.J. Krizan (2001) Aggregate Productivity Growth: Lessons from Microeconomic Evidence, in Edward Dean, Michael Harper and Charles Hulten (eds.) *New Developments in Productivity Analysis*, Chicago: University of Chicago Press.

Foster, L., Haltiwanger, J. and C.J. Krizan (2002) The Link Between Aggregate and Micro Productivity Growth: Evidence from Retail Trade, NBER Working Paper.

Foster, L., Haltiwanger, J. and C.J. Krizan (2006) Market selection, reallocation, and restructuring in the US retail trade sector in the 1990s, *Review of Economics and Statistics*, 88 (4), 748-758.

Gomez-Salvador, R., A. Musso, M. Stocker and J. Turunen (2006), Labour productivity developments in the euro area, ECB Occasional Paper Series, No. 53, Frankfurt am Main.

Gomez-Salvador, R., J. Messina and G. Vallanti (2004), Gross job flows and institutions in Europe, *Labour Economics*, 11, 469-485.

Griliches, Z. and H. Regev (1995) Firm Productivity in Israeli Industry: 1979-1988, *Journal of Econometrics*, 65, 1 (January), pp.175-203.

Haltiwanger, J. (1997) Measuring and Analyzing Aggregate Fluctuations: The Importance of Building from Microeconomic Evidence, Review of the Federal reserve Bank of St. Louis, May/June, p. 55-77.

Jovanovic, B. (1982) Selection and evolution of industry, *Econometrica*, 50 (3), 25-43.

Koszerek, D., K. Havik, K. Mc Morrow, W, Röger and F. Schönborn (2007) An Overview of the EU-KLEMS Growth and Productivity Accounts, European Economy Economic Papers, Number 290, October.

Lippman, S. A. and R. P. Rumelt (1982) Uncertain Imitability: An Analysis of Interfirm Differences in Efficiency under Competition, *Bell Journal of Economics*, 13 (2), 418-438.

Mortensen, D. and C. Pissarides (1994). "Job creation and destruction in the theory of unemployment." *Review of Economic Studies* 61, pp. 397-416.

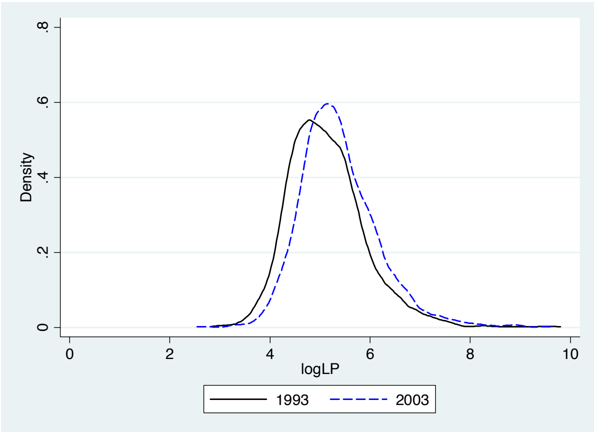
Nelson, R. R. (1981), Research on producti vity growth and productivity differences:dead ends and new departures, Journal of Economic Literature, 19 (3), 1029-1064.

Nicoletti, G. and S. Scarpetta (2003) Regulation, productivity and growth: OECD evidence, *Economic Policy* 18 (36), 9–72
Nicoletti, G. And S. Scarpetta (2005) Regulation and economic performance: product market reforms and productivity in the OECD, OECD Economic Department WP 460, Paris.
OECD (2005) Science, Technology and Industry Scoreboard, OECD publications, Paris.
Romer, D. (1996) Advanced Macroeconomics, McGraw-Hill.
Schumpeter, J. A. (1942) Capitalism, Socialism, and Democracy, New York: Harper and Brothers.
Silverman, B. W. (1986) Density Estimation for Statistics and Data Analysis, London: Chapman and Hall.

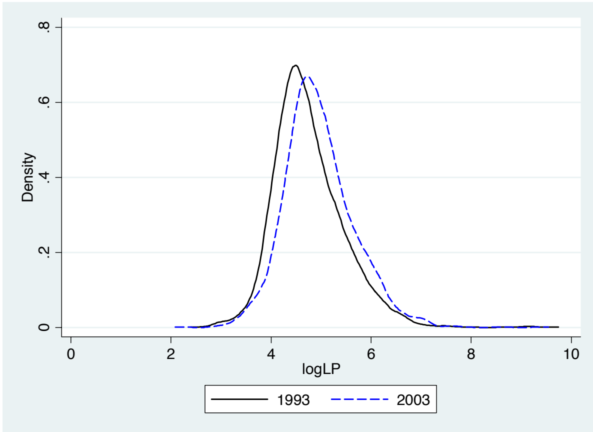
FIGURES AND TABLES

Figure 1. Nonparametric density estimation of log labour productivity levels[23]

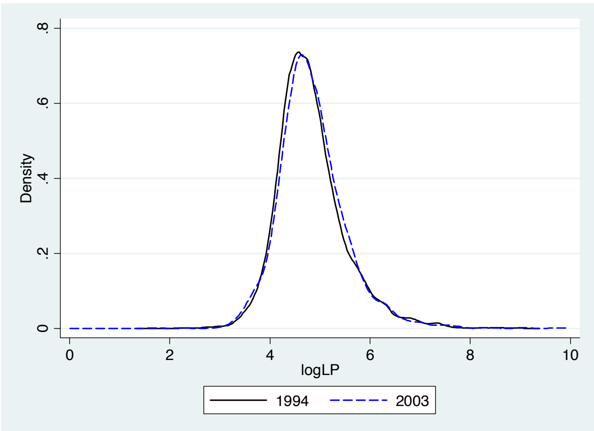
(a) Belgium



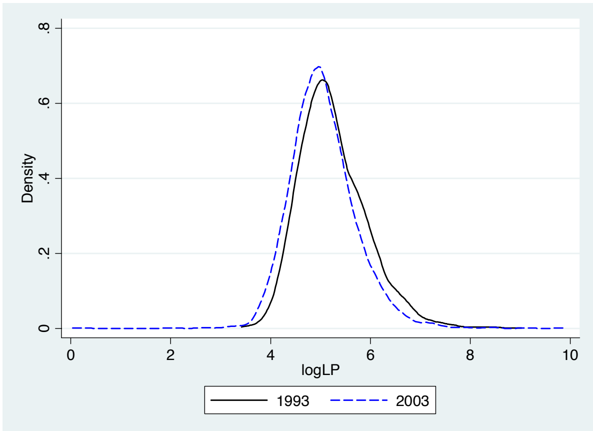
(b) France



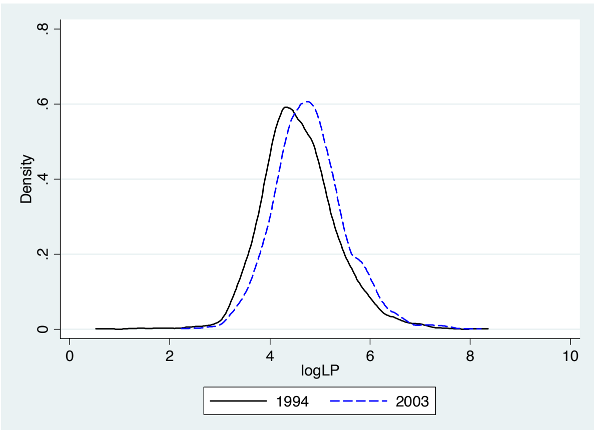
(c) Germany



(d) Italy

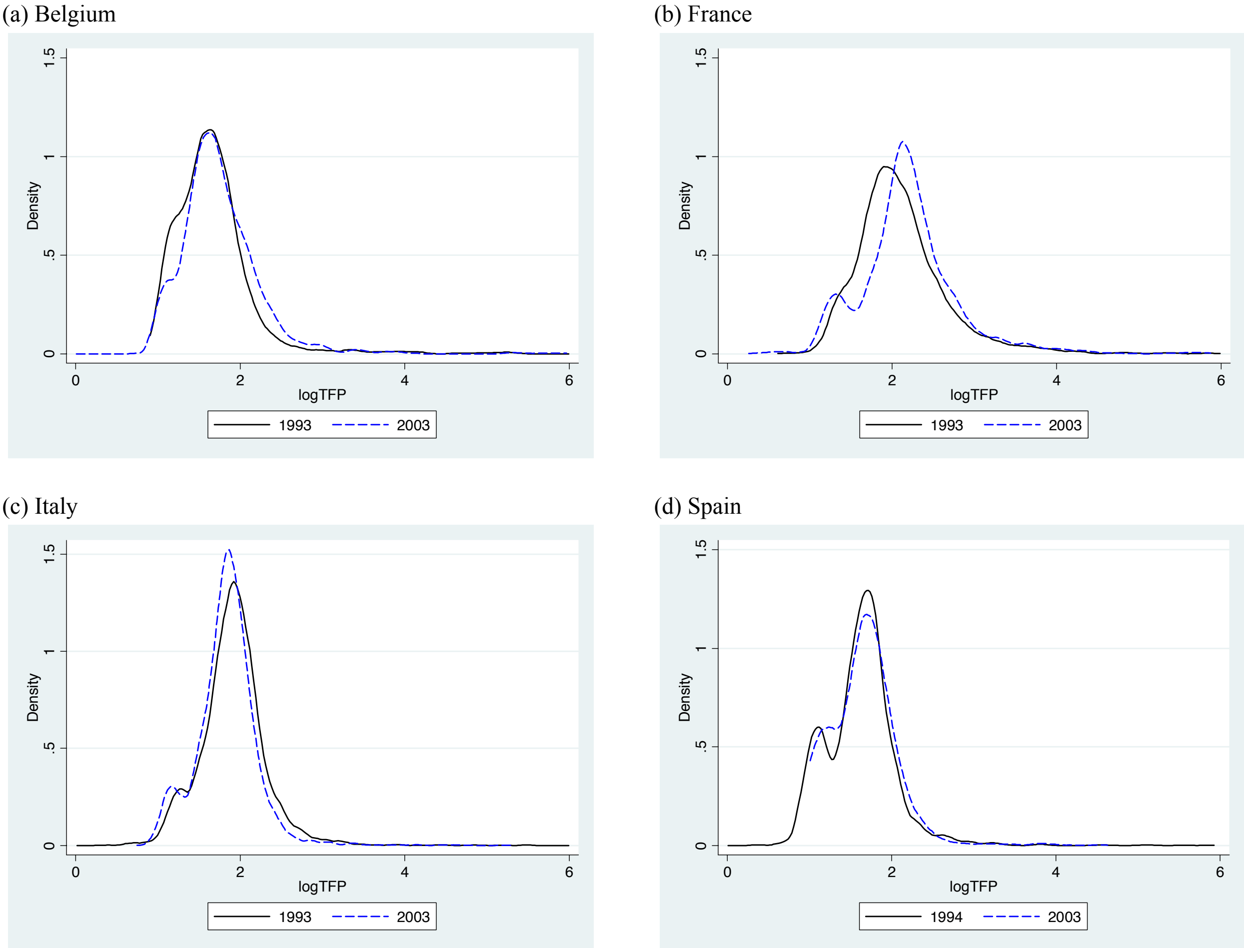


(e) Spain



[23] In order to help cross-country comparison of labour productivity distribution, we keep the support constant across countries and remove a few outliers in the distribution of log labour productivity, by constraining the range of the estimated density between 0 and 10. The number of observations for which log labour productivity falls outside the specified range is negligible.

Figure 2. Nonparametric density estimation of log TFP levels[24]



[24] In order to help cross-country comparison of TFP distribution, we keep the support constant across countries and remove a few outliers in the distribution of log TFP, by constraining the range of the estimated density between 0 and 6. The number of observations for which log TFP falls outside the specified range is negligible.

Table 1: Final sample composition

	Sample period	Number of firms per year	Employment coverage	Value added coverage
Belgium	1993-2003	1846	40.6%	45.3%
France	1993-2003	3463	11.9%	12.1%
Germany	1994-2003	4732	11.2%	-
Italy	1993-2003	5160	10.5%	13.2%
Spain	1994-2003	3160	8.5%	8.5%

Note: Employment and value added coverage are calculated using the Groeningen Growth and Development Center (GGDC) 60 Industries database. Value added is not available for German firms.

Table 2: Distribution of employment and value added per sector

		Sector (by technological intensity)		
	Data source	Low Tech	Medium Tech	High Tech
Belgium	Amadeus	0.372	0.431	0.197
	GGDC	0.261	0.354	0.386
France	Amadeus	0.345	0.459	0.196
	GGDC	0.251	0.364	0.385
Germany	Amadeus	0.268	0.418	0.314
	GGDC	0.233	0.475	0.292
Italy	Amadeus	0.313	0.401	0.286
	GGDC	0.257	0.303	0.441
Spain	Amadeus	0.412	0.434	0.153
	GGDC	0.252	0.277	0.471

Note: The figures in the table are average values over the sample period. Technological classes are adapted on the basis of OECD Science, Technology and Industry Scoreboard 2005 (Low Tech group includes NACE 15-22, 36, 37; Medium Tech includes NACE 23, 25-28; High Tech includes NACE 24, 29-35).

Table 3: Distribution of employment by firm size class

		Firm size (number of employees)		
	Data source	1 - 49	50 - 249	Over 250
Belgium	Amadeus	9.4%	31.6%	59.0%
	Eurostat	24.1%	22.1%	53.8%
France	Amadeus	12.5%	24.6%	62.8%
	Eurostat	27.4%	20.4%	52.2%
Germany	Amadeus	7.4%	24.1%	68.5%
	Eurostat	19.1%	21.5%	59.4%
Italy	Amadeus	12.9%	49.6%	37.5%
	Eurostat	42.9%	21.8%	35.3%
Spain	Amadeus	25.0%	33.0%	41.9%
	Eurostat	23.9%	39.4%	36.7%

Note: The figures in the table are average values over the sample period.

Table 4: Labour productivity developments, Amadeus versus GGDC

		Annual growth (%)		
	Data source	1993-2003	1993-97	1998-2003
Belgium	Amadeus	3.5%	5.9%	2.0%
	GGDC	3.7%	6.2%	2.1%
France	Amadeus	2.6%	3.7%	1.9%
	GGDC	2.7%	3.8%	1.8%
Germany	Amadeus	1.7%	3.4%	0.8%
	GGDC	1.7%	2.6%	1.2%
Italy	Amadeus	-0.3%	1.0%	-1.1%
	GGDC	1.4%	3.5%	0.0%
Spain	Amadeus	2.8%	3.8%	2.1%
	GGDC	0.9%	0.8%	1.0%

Note: Amadeus' results are based on input weights. The figures in the table are average values over the sample periods.

Table 5: Descriptive statistics of (log) labour productivity (LP) and TFP

	Belgium		France		Germany		Italy		Spain	
Start year	LP	TFP	LP	TFP	LP	TFP	LP	TFP	LP	TFP
mean	5.131	1.657	4.753	2.115	4.814	-	5.247	1.908	4.579	1.617
sd	0.768	0.496	0.692	0.582	0.673	-	0.684	0.415	0.733	0.429
min	2.970	0.381	2.503	0.687	0.307	-	2.812	-0.442	0.641	-0.641
max	9.662	6.392	9.636	7.407	10.015	-	8.916	6.746	8.237	5.868
End Year										
mean	5.375	1.749	4.958	2.198	4.841	-	5.049	1.833	4.797	1.641
sd	0.776	0.539	0.688	0.610	0.675	-	0.658	0.381	0.711	0.412
min	2.680	-0.610	2.195	0.333	-1.293	-	-1.134	0.398	2.343	0.641
max	9.524	6.439	9.430	7.360	10.790	-	9.821	5.893	8.096	4.562

Note: TFP cannot be computed for Germany due to the lack of information on fixed-assets and compensation of employees.

Table 6: Gross reallocation of employment, output and capital (equipment and structures) between base and end year. Cross-country averages.

Industry	Employment				Output			
	Exp. rate	Contr. rate	Net growth	Excess reall.	Exp. rate	Contr. rate	Net growth	Excess reall.
DA. Food & tobacco	0.297	0.121	0.175	0.231	0.336	0.095	0.241	0.182
DB. & DC. Textiles& Leather	0.240	0.203	0.038	0.322	0.399	0.130	0.268	0.242
DD. Wood	0.306	0.073	0.232	0.147	0.462	0.053	0.408	0.107
DE. Pulp, paper& Publishing	0.270	0.117	0.153	0.233	0.317	0.094	0.223	0.188
DF & DG. Coke, petroleum, nuclear fuels & Chemicals	0.320	0.097	0.223	0.182	0.634	0.041	0.593	0.082
DH. Rubber, plastic products	0.345	0.098	0.247	0.197	0.525	0.042	0.483	0.084
DI. Other non-metallic mineral products	0.222	0.155	0.067	0.180	0.353	0.066	0.287	0.133
DJ. Basic & Fabricated metals	0.312	0.093	0.219	0.171	0.495	0.037	0.458	0.074
DK. Machinery, equipment	0.276	0.088	0.188	0.168	0.515	0.069	0.446	0.138
DL. Electrical, electronic & Optical machinery	0.289	0.115	0.174	0.230	0.589	0.043	0.547	0.085
DM. Motor vehicles & Other transport	0.330	0.070	0.261	0.140	0.581	0.094	0.488	0.187
DN. Furniture; other	0.276	0.114	0.162	0.221	0.356	0.114	0.242	0.194
TOTAL	0.290	0.112	0.178	0.202	0.464	0.073	0.390	0.141

Table 7: Aggregate productivity decomposition

		Employment weights				Output weights			
		Total growth	Within (learning)	Between (selection)	Cross	Total growth	Within (learning)	Between (selection)	Cross
Belgium	LP	0.355	0.355	0.032	-0.033	0.425	0.284	-0.050	0.190
			100.2%	*9.1%*	*-9.3%*		*66.9%*	*-11.7%*	*44.8%*
	TFP	0.127	0.127	0.021	-0.022	0.163	0.127	0.047	-0.012
			100.7%	*16.3%*	*-17.0%*		*78.3%*	*29.1%*	*-7.4%*
France	LP	0.259	0.285	0.029	-0.056	0.311	0.242	-0.026	0.096
			110.4%	*11.4%*	*-21.8%*		*77.5%*	*-8.5%*	*30.9%*
	TFP	0.107	0.100	0.023	-0.016	0.138	0.106	0.004	0.027
			93.9%	*21.3%*	*-15.2%*		*77.2%*	*3.0%*	*19.8%*
Germany	LP	0.149	0.177	0.017	-0.045	0.211	0.122	-0.034	0.124
			118.6%	*11.5%*	*-30.1%*		*57.6%*	*-16.1%*	*58.5%*
Italy	LP	-0.026	-0.050	0.106	-0.082	0.142	-0.139	0.135	0.145
			194.4%	*-412.1%*	*317.6%*		*-97.7%*	*95.4%*	*102.3%*
	TFP	-0.065	-0.061	0.022	-0.026	-0.079	-0.062	-0.047	0.029
			95.1%	*-34.6%*	*39.5%*		*78.4%*	*58.6%*	*-37.0%*
Spain	LP	0.258	0.322	0.019	-0.064	0.301	0.248	-0.064	0.117
			116.4%	*6.9%*	*-23.3%*		*82.2%*	*-21.1%*	*39.0%*
	TFP	0.034	0.039	0.002	-0.008	0.050	0.035	0.004	0.011
			116.9%	*6.6%*	*-23.4%*		*69.7%*	*8.9%*	*21.3%*

Notes: Numbers in italics are the fraction of overall growth accounted by the component in column.

Table 8: Correlation matrix of growth rates in labour productivity (LP), output, employment and capital intensity

	ρ(LP, output)	ρ(LP, empl.)	ρ(LP, K-intens.)	ρ(empl., output)	ρ(output, K-intens)	ρ(empl, K-intens)
Belgium	0.531	-0.330	0.021	0.625	0.110	0.103
France	0.523	-0.231	0.089	0.708	0.057	-0.009
Germany	0.614	-0.421	0.376	0.457	0.012	-0.410
Italy	0.459	-0.332	0.082	0.686	-0.042	-0.112
Spain	0.570	-0.310	0.048	0.605	0.030	-0.012

Table 9: Transition matrix of relative labour productivity over the sample period

	1st Quintile in end year	2nd Quintile in end year	3rd Quintile in end year	4th Quintile in end year	5th Quintile in end year	Total in end year
1st Quintile in base year	430.2 *58.6*	182.2 *24.9*	73.2 *10.0*	30.6 *4.0*	18.8 *2.5*	735 *100.0*
2nd Quintile in base year	175.2 *24.1*	248.2 *34.0*	179.2 *24.3*	94 *12.5*	37.6 *5.0*	734.2 *100.0*
3rd Quintile in base year	73.8 *9.9*	179.4 *24.5*	244.8 *33.2*	164 *22.1*	72.4 *10.3*	734.4 *100.0*
4th Quintile in base year	35 *4.6*	89 *11.6*	162.6 *22.2*	275.8 *38.2*	172.2 *23.4*	734.6 *100.0*
5th Quintile in base year	20.6 *2.8*	35.6 *5.0*	74.6 *10.3*	170 *23.2*	433.2 *58.8*	734 *100.0*
Total in base year	734.8 *20.0*	734.4 *20.0*	734.4 *20.0*	734.4 *20.0*	734.2 *20.0*	3,672 *100.0*

Note: The 1st (5th) quintile includes firms with the lowest (highest) relative productivity levels. Each cell in the matrices shows the number and percent (in italics) of firms pertaining to that quintile at the starting and end year.

Table 10: Transition matrix of relative TFP over the sample period

	1st Quintile in end year	2nd Quintile in end year	3rd Quintile in end year	4th Quintile in end year	5th Quintile in end year	Total in end year
1st Quintile in base year	377 *56.3*	177.75 *27.7*	66.25 *10.0*	29.25 *4.4*	10.25 *1.6*	660.5 *100.0*
2nd Quintile in base year	161.5 *24.3*	228.25 *34.1*	166.25 *25.6*	81 *12.4*	22.75 *3.6*	659.75 *100.0*
3rd Quintile in base year	82.25 *12.9*	155.25 *23.6*	204.25 *30.7*	159.5 *24.0*	59 *8.8*	660.25 *100.0*
4th Quintile in base year	29.25 *4.7*	77.25 *11.4*	157.25 *23.7*	229.5 *35.0*	166.5 *25.2*	659.75 *100.0*
5th Quintile in base year	10.5 *1.9*	21.25 *3.2*	66.25 *10.0*	160.5 *24.2*	401.25 *60.8*	659.75 *100.0*
Total in base year	660.5 *20.0*	659.75 *20.0*	660.25 *20.0*	659.75 *20.0*	659.75 *20.0*	3,300 *100.0*

Note: The 1st (5th) quintile includes firms with the lowest (highest) relative productivity levels. Each cell in the matrices shows the number and percent (in italics) of firms pertaining to that quintile at the starting and end year.

Table 11: Position in productivity distribution: transition between 1996 and 2003 and contribution to overall manufacturing productivity growth by group.

	Belgium		France		Germany		Italy		Spain	
(A) Share of incumbent firms by group:										
	LP	TFP	LP	TFP	LP	TFP	LP	TFP	LP	TFP
UP	9.8%	8.0%	7.0%	7.9%	9.2%	-	9.8%	7.9%	8.6%	8.9%
DOWN	9.0%	8.8%	7.2%	9.1%	9.0%	-	10.4%	7.9%	8.6%	9.4%
BOTTOM	28.4%	28.0%	29.8%	28.7%	27.8%	-	27.2%	29.1%	28.5%	28.2%
TOP	28.4%	29.3%	29.8%	29.4%	28.7%	-	27.4%	29.2%	29.1%	28.2%
MIDDLE	24.3%	25.9%	26.2%	25.0%	25.3%	-	25.2%	26.0%	25.3%	25.2%
(B) Share of productivity growth accounted by each group:										
	Belgium		France		Germany		Italy		Spain	
	LP	TFP	LP	TFP	LP	TFP	LP	TFP	LP	TFP
UP	46.1%	26.4%	65.7%	53.4%	69.4%	-	127.9%	-37.6%	98.8%	81.8%
DOWN	-27.6%	-2.6%	-20.1%	18.6%	-53.0%	-	-134.4%	75.7%	-24.9%	-46.7%
BOTTOM	-15.2%	10.4%	3.6%	21.5%	-18.3%	-	-102.4%	-26.4%	6.4%	62.0%
TOP	108.5%	34.9%	28.3%	5.4%	84.2%	-	322.3%	29.1%	40.9%	-6.7%
MIDDLE	-11.7%	30.9%	22.4%	1.2%	17.7%	-	-113.4%	59.2%	-21.1%	9.6%

Note: The UP (DOWN) groups include firms that moved up (down) by at least two quintiles during the sample period, TOP (BOTTOM) groups include firms that remained in the two top (bottom) quintiles, while firms that remained roughly stable in the efficiency ranking, staying in the middle and moving by at most one quintile are included in the MIDDLE group. Panel A shows the percent of firms following in each of these groups by country, while Panel B shows the contribution of each group to aggregate productivity change.

Table 12: Summary statistics of the variables used in the regression analysis

	Mean	Std
Productivity growth	0.0707	0.4937
Capital intensity	0.2069	0.3674
Sectoral growth (%)	1.8433	1.7636
Dummies:	Incidence (%)	
Size		
Less than 25 employees	33.68	
25-49 employees	30.68	
50-249 employees	29.19	
250-999 employees	5.40	
More than 1,000 employees	1.05	
Age		
Less than 5 years old	15.06	
6-10 years old	18.32	
11-20 years old	29.33	
More than 20 years old	37.28	
Downsizing		
Yes	24.84	
No	75.16	
Technological level		
Low	44.14	
Medium	46.35	
High	2.23	

Table 13: Regressions of labour productivity growth on plant characteristics

Growth over 1993-2003

	Labour productivity growth			
	(1)	(2)	(3)	(4)
Capital intensity	0.120 *(7.96)*	0.121 *(8.17)*	0.125 *(8.15)*	0.119 *(10.64)*
Size: 25-49 employees	0.053 *(1.10)*	0.054 *(1.14)*	0.032 *(0.65)*	0.037 *(0.72)*
50-249 employees	0.097 *(1.57)*	0.097 *(1.58)*	0.069 *(1.12)*	0.075 *(1.19)*
250-999 employees	0.192 *(1.80)*	0.189 *(1.78)*	0.145 *(1.46)*	0.146 *(1.48)*
more than 1,000 employees	0.275 *(2.61)*	0.274 *(2.62)*	0.220 *(2.28)*	0.216 *(2.28)*
Age: 6-10 years old	0.002 *(0.56)*	0.004 *(0.70)*	0.002 *(0.03)*	0.005 *(0.69)*
11-20 years old	-0.008 *(1.11)*	-0.007 *(0.88)*	-0.014 *(1.91)*	-0.013 *(1.83)*
more than 20 years old	0.020 *(0.93)*	0.021 *(0.99)*	-0.006 *(0.32)*	-0.001 *(0.04)*
Sectoral growth		0.043 *(3.71)*	0.043 *(4.10)*	0.032 *(4.63)*
Downsizing			0.162 *(5.40)*	0.170 *(5.50)*
Technological level: low				-0.072 *(1.83)*
high				-0.069 *(1.19)*
Country dummies	Yes	Yes	Yes	Yes
Sectoral dummies	Yes	Yes	Yes	No
R^2	0.2125	0.2203	0.2378	0.2253
# observations	12,820	12,820	12,820	12,820

Note: t-statistics in parentheses. OLS estimates. Countries included: Belgium, France, Spain and Italy.

Table 14: Regressions of labour productivity growth on plant characteristics

High and low growth periods

	High labour productivity growth		Low labour productivity growth		
	(1)	(2)	(3)	(4)	(5)
Capital intensity	0.071 *(6.44)*	0.065 *(8.07)*	0.118 *(8.55)*	0.116 *(5.13)*	0.121 *(4.94)*
Size: 25-49 employees	0.026 *(1.35)*	0.027 *(1.31)*	0.009 *(0.33)*	0.012 *(0.43)*	0.011 *(0.40)*
50-249 employees	0.050 *(2.34)*	0.053 *(2.23)*	0.028 *(0.70)*	0.031 *(0.80)*	0.028 *(0.75)*
250-999 employees	0.080 *(2.42)*	0.080 *(2.32)*	0.084 *(1.28)*	0.085 *(1.32)*	0.081 *(1.30)*
more than 1,000 employees	0.120 *(4.90)*	0.115 *(4.46)*	0.131 *(1.59)*	0.130 *(1.63)*	0.124 *(1.58)*
Age: 6-10 years old	-0.004 *(0.56)*	-0.001 *(0.20)*	0.007 *(2.91)*	0.009 *(5.87)*	0.010 *(6.24)*
11-20 years old	0.003 *(0.70)*	0.004 *(0.74)*	-0.008 *(1.12)*	-0.009 *(1.16)*	-0.008 *(1.01)*
more than 20 years old	0.021 *(2.10)*	0.019 *(1.74)*	-0.015 *(1.03)*	-0.020 *(1.23)*	-0.020 *(1.22)*
Cycle	0.014 *(3.35)*	0.013 *(4.51)*	0.028 *(5.93)*	0.017 *(5.69)*	0.017 *(5.99)*
Downsizing	0.047 *(4.70)*	0.050 *(4.96)*	0.109 *(3.70)*	0.114 *(3.71)*	0.111 *(3.64)*
Technological level: low		-0.025 *(1.59)*		-0.046 *(2.57)*	-0.041 *(2.42)*
high		-0.040 *(1.07)*		-0.005 *(0.16)*	-0.001 *(0.05)*
Labour productivity growth lagged					0.062 *(3.79)*
Country dummies	Yes	Yes	Yes	Yes	Yes
Sectoral dummies	Yes	No	Yes	No	No
R^2	0.1308	0.1223	0.1929	0.1785	0.1810
# observations	12,114	12,114	12,507	12,507	12,507

Note: t-statistics in parentheses. OLS estimates. Countries included: Belgium, France, Spain and Italy.

Appendix 1

Table A1: Average number of observation and LP level: balanced vs. unbalanced sample.

Country	Sample	average num. of obs	LP mean	LP sd
Belgium	balanced	1846	5.25	0.77
	unbalanced	4334	5.26	0.84
France	balanced	3463	4.86	0.69
	unbalanced	18637	4.91	0.75
Germany	balanced	4732	4.83	0.67
	unbalanced	16211	5.19	0.79
Italy	balanced	5160	5.15	0.67
	unbalanced	14257	4.64	0.88
Spain	balanced	3160	4.69	0.72
	unbalanced	17817	5.15	0.81

Note: average values over the whole sample period are displayed.

Appendix 2

Table A2.1: Transition matrix of relative labour productivity over the sample period: Belgium.

BELGIUM	1st Quintile in 2003	2nd Quintile in 2003	3rd Quintile in 2003	4th Quintile in 2003	5th Quintile in 2003	Total in 2003
1st Quintile in 1993	203 *54.9*	100 *27.0*	46 *12.4*	12 *3.2*	9 *2.4*	370 *100.0*
2nd Quintile in 1993	97 *26.3*	125 *33.9*	80 *21.7*	47 *12.7*	20 *5.4*	369 *100.0*
3rd Quintile in 1993	41 *11.1*	87 *23.6*	116 *31.4*	79 *21.4*	46 *12.5*	369 *100.0*
4th Quintile in 1993	18 *4.9*	34 *9.2*	87 *23.6*	147 *39.8*	83 *22.5*	369 *100.0*
5th Quintile in 1993	11 *3.0*	23 *6.2*	40 *10.8*	84 *22.8*	211 *57.2*	369 *100.0*
Total in 1993	370 *20.0*	369 *20.0*	369 *20.0*	369 *20.0*	369 *20.0*	1,846 *100.0*

Table A2.2: Transition matrix of relative labour productivity over the sample period: France.

FRANCE	1st Quintile in 2003	2nd Quintile in 2003	3rd Quintile in 2003	4th Quintile in 2003	5th Quintile in 2003	Total in 2003
1st Quintile in 1993	447 *64.5*	162 *23.4*	52 *7.5*	20 *2.9*	12 *1.7*	693 *100.0*
2nd Quintile in 1993	162 *23.4*	260 *37.5*	175 *25.3*	64 *9.2*	32 *4.6*	693 *100.0*
3rd Quintile in 1993	58 *8.4*	169 *24.4*	241 *34.8*	162 *23.4*	62 *9.0*	692 *100.0*
4th Quintile in 1993	15 *2.2*	74 *10.7*	160 *23.1*	290 *41.9*	154 *22.2*	693 *100.0*
5th Quintile in 1993	11 *1.6*	28 *4.1*	64 *9.3*	157 *22.7*	432 *62.4*	692 *100.0*
Total in 1993	693 *20.0*	693 *20.0*	692 *20.0*	693 *20.0*	692 *20.0*	3,463 *100.0*

Table A2.3: Transition matrix of relative labour productivity over the sample period: Germany.

GERMANY	1st Quintile in 2003	2nd Quintile in 2003	3rd Quintile in 2003	4th Quintile in 2003	5th Quintile in 2003	Total in 2003
1st Quintile in 1994	585 *56.6*	252 *24.4*	114 *11.0*	52 *5.0*	30 *2.9*	1033 *100.0*
2nd Quintile in 1994	245 *23.8*	354 *34.3*	240 *23.3*	141 *13.7*	51 *5.0*	1031 *100.0*
3rd Quintile in 1994	116 *11.2*	246 *23.8*	362 *35.1*	222 *21.5*	86 *8.3*	1032 *100.0*
4th Quintile in 1994	50 *4.8*	134 *13.0*	233 *22.6*	391 *37.9*	225 *21.8*	1033 *100.0*
5th Quintile in 1994	36 *3.5*	46 *4.5*	83 *8.1*	226 *21.9*	640 *62.1*	1031 *100.0*
Total in 1994	1032 *20.0*	1032 *20.0*	1032 *20.0*	1032 *20.0*	1032 *20.0*	5,160 *100.0*

Table A2.4: Transition matrix of relative labour productivity over the sample period: Italy.

ITALY	1st Quintile in 2003	2nd Quintile in 2003	3rd Quintile in 2003	4th Quintile in 2003	5th Quintile in 2003	Total in 2003
1st Quintile in 1993	528 *55.8*	252 *26.6*	100 *10.6*	43 *4.5*	24 *2.5*	947 *100.0*
2nd Quintile in 1993	221 *23.4*	286 *30.2*	236 *25.0*	142 *15.0*	61 *6.5*	946 *100.0*
3rd Quintile in 1993	106 *11.2*	228 *24.1*	289 *30.5*	230 *24.3*	94 *9.9*	947 *100.0*
4th Quintile in 1993	66 *7.0*	129 *13.6*	210 *22.2*	300 *31.7*	241 *25.5*	946 *100.0*
5th Quintile in 1993	26 *2.8*	51 *5.4*	112 *11.8*	231 *24.4*	526 *55.6*	946 *100.0*
Total in 1993	947 *20.0*	946 *20.0*	947 *20.0*	946 *20.0*	946 *20.0*	4,732 *100.0*

Table A2.5: Transition matrix of relative labour productivity over the sample period: Spain.

SPAIN	1st Quintile in 2003	2nd Quintile in 2003	3rd Quintile in 2003	4th Quintile in 2003	5th Quintile in 2003	Total in 2003
1st Quintile in 1994	388 *61.4*	145 *22.9*	54 *8.5*	26 *4.1*	19 *3.0*	632 *100.0*
2nd Quintile in 1994	151 *23.9*	216 *34.2*	165 *26.1*	76 *12.0*	24 *3.8*	632 *100.0*
3rd Quintile in 1994	48 *7.6*	167 *26.4*	216 *34.2*	127 *20.1*	74 *11.7*	632 *100.0*
4th Quintile in 1994	26 *4.1*	74 *11.7*	123 *19.5*	251 *39.7*	158 *25.0*	632 *100.0*
5th Quintile in 1994	19 *3.0*	30 *4.8*	74 *11.7*	152 *24.1*	357 *56.5*	632 *100.0*
Total in 1994	632 *20.0*	632 *20.0*	632 *20.0*	632 *20.0*	632 *20.0*	3,160 *100.0*

Table A2.6: Transition matrix of relative TFP over the sample period: Belgium.

BELGIUM	1st Quintile in 2003	2nd Quintile in 2003	3rd Quintile in 2003	4th Quintile in 2003	5th Quintile in 2003	Total in 2003
1st Quintile in 1993	205 *55.4*	111 *30.0*	31 *8.4*	12 *3.2*	11 *3.0*	370 *100.0*
2nd Quintile in 1993	97 *26.3*	126 *34.2*	95 *25.8*	38 *10.3*	13 *3.5*	369 *100.0*
3rd Quintile in 1993	43 *11.7*	90 *24.4*	130 *35.2*	80 *21.7*	26 *7.1*	369 *100.0*
4th Quintile in 1993	13 *3.5*	28 *7.6*	94 *25.5*	162 *43.9*	72 *19.5*	369 *100.0*
5th Quintile in 1993	12 *3.3*	14 *3.8*	19 *5.2*	77 *20.9*	247 *66.9*	369 *100.0*
Total in 1993	370 *20.0*	369 *20.0*	369 *20.0*	369 *20.0*	369 *20.0*	1,846 *100.0*

Table A2.7: Transition matrix of relative TFP over the sample period: France.

FRANCE	1st Quintile in 2003	2nd Quintile in 2003	3rd Quintile in 2003	4th Quintile in 2003	5th Quintile in 2003	Total in 2003
1st Quintile in 1993	443 *63.9*	153 *22.1*	71 *10.3*	20 *2.9*	6 *0.9*	693 *100.0*
2nd Quintile in 1993	169 *24.4*	280 *40.5*	170 *24.6*	55 *8.0*	18 *2.6*	692 *100.0*
3rd Quintile in 1993	62 *9.0*	175 *25.3*	236 *34.1*	181 *26.1*	39 *5.6*	693 *100.0*
4th Quintile in 1993	13 *1.9*	66 *9.5*	182 *26.3*	278 *40.2*	153 *22.1*	692 *100.0*
5th Quintile in 1993	6 *0.9*	18 *2.6*	34 *4.9*	158 *22.8*	476 *68.8*	692 *100.0*
Total in 1993	693 *20.0*	692 *20.0*	693 *20.0*	692 *20.0*	692 *20.0*	3,462 *100.0*

Table A2.8: Transition matrix of relative TFP over the sample period: Italy.

ITALY	1st Quintile in 2003	2nd Quintile in 2003	3rd Quintile in 2003	4th Quintile in 2003	5th Quintile in 2003	Total in 2003
1st Quintile in 1993	543 *57.3*	237 *25.0*	105 *11.1*	46 *4.9*	16 *1.7*	947 *100.0*
2nd Quintile in 1993	244 *25.8*	337 *35.6*	226 *23.9*	108 *11.4*	31 *3.3*	946 *100.0*
3rd Quintile in 1993	120 *12.7*	226 *23.9*	296 *31.3*	220 *23.2*	85 *9.0*	947 *100.0*
4th Quintile in 1993	26 *2.8*	112 *11.8*	235 *24.8*	342 *36.2*	231 *24.4*	946 *100.0*
5th Quintile in 1993	14 *1.5*	34 *3.6*	85 *9.0*	230 *24.3*	583 *61.6*	946 *100.0*
Total in 1993	947 *20.0*	946 *20.0*	947 *20.0*	946 *20.0*	946 *20.0*	4,732 *100.0*

Table A2.9: Transition matrix of relative TFP over the sample period: Spain.

SPAIN	1st Quintile in 2003	2nd Quintile in 2003	3rd Quintile in 2003	4th Quintile in 2003	5th Quintile in 2003	Total in 2003
1st Quintile in 1994	401 *63.5*	142 *22.5*	45 *7.1*	33 *5.2*	11 *1.7*	632 *100.0*
2nd Quintile in 1994	157 *24.8*	242 *38.3*	147 *23.3*	68 *10.8*	18 *2.9*	632 *100.0*
3rd Quintile in 1994	47 *7.4*	177 *28.0*	219 *34.7*	135 *21.4*	54 *8.5*	632 *100.0*
4th Quintile in 1994	15 *2.4*	58 *9.2*	163 *25.8*	261 *41.3*	135 *21.4*	632 *100.0*
5th Quintile in 1994	12 *1.9*	13 *2.1*	58 *9.2*	135 *21.4*	414 *65.5*	632 *100.0*
Total in 1994	632 *20.0*	632 *20.0*	632 *20.0*	632 *20.0*	632 *20.0*	3,160 *100.0*

Appendix 3

Table A3: Regressions of labour productivity growth on plant characteristics: country results

	Labour productivity			
	Belgium OLS	France OLS	Spain OLS	Italy OLS
Capital intensity	0.096 *(4.89)*	0.210 *(5.12)*	0.106 *(6.94)*	0.155 *(5.74)*
Size: 25-49 employees	-0.062 *(2.10)*	-0.030 *(1.75)*	0.006 *(0.32)*	0.147 *(8.80)*
50-249 employees	-0.010 *(0.36)*	-0.020 *(1.14)*	0.004 *(0.20)*	0.203 *(11.65)*
250-999 employees	0.020 *(0.49)*	0.021 *(0.76)*	0.070 *(1.60)*	0.413 *(11.18)*
more than 1,000 employees	0.105 *(1.34)*	0.103 *(2.15)*	0.288 *(2.19)*	0.538 *(4.87)*
Age: 6-10 years old	0.022 *(0.63)*	0.012 *(0.54)*	-0.002 *(0.06)*	0.001 *(0.02)*
11-20 years old	-0.039 *(1.18)*	0.017 *(0.80)*	-0.012 *(0.51)*	-0.001 *(0.04)*
more than 20 years old	0.024 *(0.83)*	0.002 *(0.08)*	0.070 *(2.72)*	-0.003 *(0.12)*
Cycle	0.051 *(3.53)*	0.078 *(11.17)*	0.051 *(6.54)*	-0.003 *(0.22)*
Downsizing	0.183 *(8.29)*	0.103 *(6.96)*	0.142 *(6.99)*	0.243 *(12.77)*
Sectoral dummies	Yes	Yes	Yes	Yes
R^2	0.1556	0.1600	0.1005	0.1263
# observations	1,767	3,382	3,053	4,618

Note: t-statistics in parentheses.

European Central Bank Working Paper Series

For a complete list of Working Papers published by the ECB, please visit the ECB's website (http://www.ecb.europa.eu).

877 "What are the effects of fiscal policy shocks? A VAR-based comparative analysis" by D. Caldara and C. Kamps, March 2008.

878 "Nominal and real interest rates during an optimal disinflation in New Keynesian models" by M. Hagedorn, March 2008.

879 "Government risk premiums in the bond market: EMU and Canada" by L. Schuknecht, J. von Hagen and G. Wolswijk, March 2008.

880 "On policy interactions among nations: when do cooperation and commitment matter?" by H. Kempf and L. von Thadden, March 2008.

881 "Imperfect predictability and mutual fund dynamics: how managers use predictors in changing systematic risk" by G. Amisano and R. Savona, March 2008.

882 "Forecasting world trade: direct versus "bottom-up" approaches" by M. Burgert and S. Dées, March 2008.

883 "Assessing the benefits of international portfolio diversification in bonds and stocks" by R. A. De Santis and L. Sarno, March 2008.

884 "A quantitative perspective on optimal monetary policy cooperation between the US and the euro area" by S. Adjemian, M. Darracq Pariès and F. Smets, March 2008.

885 "Impact of bank competition on the interest rate pass-through in the euro area" by M. van Leuvensteijn, C. Kok Sørensen, J. A. Bikker and A. A. R. J. M. van Rixtel, March 2008.

886 "International evidence on sticky consumption growth" by C. D. Carroll, J. Slacalek and M. Sommer, March 2008.

887 "Labor supply after transition: evidence from the Czech Republic" by A. Bičáková, J. Slacalek and M. Slavík, March 2008.

888 "House prices, money, credit and the macroeconomy" by C. Goodhart and B. Hofmann, April 2008.

889 "Credit and the natural rate of interest" by F. De Fiore and O. Tristani, April 2008.

890 "Globalisation, domestic inflation and global output gaps: evidence from the euro area" by A. Calza, April 2008.

891 "House prices and the stance of monetary policy" by M. Jarociński and F. Smets, April 2008.

892 "Identification of New Keynesian Phillips Curves from a global perspective" by S. Dées, M. H. Pesaran, L. V. Smith and R. P. Smith, April 2008.

893 "Sticky wages: evidence from quarterly microeconomic data" by T. Heckel, H. Le Bihan and M. Montornès, May 2008.

894 "The role of country-specific trade and survey data in forecasting euro area manufacturing production: perspective from large panel factor models" by M. Darracq Pariès and L. Maurin, May 2008.

895 "On the empirical evidence of the intertemporal current account model for the euro area countries" by M. Ca'Zorzi and M. Rubaszek, May 2008.

896 "The Maastricht convergence criteria and optimal monetary policy for the EMU accession countries" by A. Lipińska, May 2008.

897 "DSGE-modelling when agents are imperfectly informed" by P. De Grauwe, May 2008.

898 "Central bank communication and monetary policy: a survey of theory and evidence" by A. S. Blinder, M. Ehrmann, M. Fratzscher, J. De Haan and D.-J. Jansen, May 2008.

899 "Robust monetary rules under unstructured and structured model uncertainty" by P. Levine and J. Pearlman, May 2008.

900 "Forecasting inflation and tracking monetary policy in the euro area: does national information help?" by R. Cristadoro, F. Venditti and G. Saporito, May 2008.

901 "The usefulness of infra-annual government cash budgetary data for fiscal forecasting in the euro area" by L. Onorante, D. J. Pedregal, J. J. Pérez and S. Signorini, May 2008.

902 "Fiscal consolidation in the euro area: long-run benefits and short-run costs" by G. Coenen, M. Mohr and R. Straub, May 2008.

903 "A robust criterion for determining the number of static factors in approximate factor models" by L. Alessi, M. Barigozzi and M. Capasso, May 2008.

904 "Does money matter in the IS curve? The case of the UK" by B. E. Jones and L. Stracca, June 2008.

905 "A persistence-weighted measure of core inflation in the euro area" by L. Bilke and L. Stracca, June 2008.

906 "The impact of the euro on equity markets: a country and sector decomposition" by L. Cappiello, A. Kadareja and S. Manganelli, June 2008.

907 "Globalisation and the euro area: simulation based analysis using the New Area Wide Model" by P. Jacquinot and R. Straub, June 2008.

908 "3-step analysis of public finances sustainability: the case of the European Union" by A. Afonso and C. Rault, June 2008.

909 "Repo markets, counterparty risk and the 2007/2008 liquidity crisis" by C. Ewerhart and J. Tapking, June 2008.

910 "How has CDO market pricing changed during the turmoil? Evidence from CDS index tranches" by M. Scheicher, June 2008.

911 "Global liquidity glut or global savings glut? A structural VAR approach" by T. Bracke and M. Fidora, June 2008.

912 "Labour cost and employment across euro area countries and sectors" by B. Pierluigi and M. Roma, June 2008.

913 "Country and industry equity risk premia in the euro area: an intertemporal approach" by L. Cappiello, M. Lo Duca and A. Maddaloni, June 2008.

914 "Evolution and sources of manufacturing productivity growth: evidence from a panel of European countries" by S. Giannangeli and R. Gómez-Salvador, June 2008.

ISSN 1561-0810