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Distant but within sight. Firm-level evidence about productivity gaps between Germany and France

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The study investigates differences in firm productivity levels between France and Germany within the manufacturing sector. In addition, it analyzes the possible asymmetric effect that the Great Recession had on firm productivity in both countries. Our results reveal a systematic productivity advantage of Germany over France in the manufacturing industry over the period 2003-2013. This is explained by a lead of Germany over France in almost every sector considered. At the same the productivity gaps have significantly narrowed down over time. This result is explained both by a better performance of French firms in every sector and by a deterioration of German firms in some sectors, especially after the Great Recession.

Keywords: International productivity gaps, productivity distribution, firm level comparisons.
JEL classification: F10, D24

1 Introduction

This work investigates firm level productivity differences between France and Germany. Drawing on a unique census database of French and German firms, we build comparable productivity measures and we investigate statistically significant differences in the productivity levels in manufacturing sectors, and their evolution over time. In particular, we analyze productivity gaps before and after the financial and economic crisis of 2008, and we discuss how it affected the evolution of productivity in France and Germany. Finally, we do not only focus on average productivity gaps, but we consider the whole distribution of productivity.

Discussions about differences in competitiveness across countries are a privileged subject not only of academic but also public and political discussions in Europe. Germany and France are two very good example in this respect. On the one hand, Germany has displayed and exceptional economic performance of in the last decade (see Dustmann et al., 2014) together with an abundant current account surplus. Moreover, it also shown a strong resilience during the last crisis, particularly in terms of employment rate. On the other hand, France has recently been qualified as an example of economic decline, because of a much lower growth and employment performance than Germany, and because of the chronic deficit in the current account balance (see Le Moigne and Ragot, 2015).

The debates about competitiveness gaps have often focused on productivity, as a fundamental determinant both of labor costs and more, in general, as a determinant of the ability to export (see e.g. Wagner, 2007; Dhyne et al., 2014). At the same time, they have usually been based on country or industry aggregates. Although aggregate productivity is a useful concept that allows one setting some order of magnitude, it may be far too simplistic. A good deal of empirical contributions (see e.g. Bartelsman and Doms, 2000; Dosi et al., 2012; Yu et al., 2015; Dhyne et al., 2014, among few recent examples of a much larger literature) has indeed pointed to the enormous heterogeneity existing in productivity levels both within as well across sectors at any level of aggregation. In addition, such heterogeneity often results in highly skewed distributions, i.e. distributions whose behavior cannot just be summarized by mean and variance. It follows that comparison focusing only on aggregate statistics can often lead to misleading conclusions about true productivity gaps existing among countries. Finally, one should mention the fact that, even when micro-data about productivity levels is available, comparison across countries are made difficult (if not impossibile) by the different definition of variables and/or by the different methods to measure them (Bellone et al., 2014).

On these grounds, the aim of this paper is to perform an analysis of productivity differentials across countries by tracking the entire distributions of productivity levels, and by using comparable productivity metrics across France and Germany. In that, our contribution improves upon existing studies on the subject (e.g. Dhyne et al., 2014) in three dimensions. First, we do not simply track the moments of the different distributions, but we quantitatively evaluate productivity differences by performing statistical tests on those distributions. More precisely, besides the standard Student's t-test on differences in means, we also perform Kolmogorov-Smirnov's tests of first-order stochastic dominance. This allows us to detect statistically significant productivity gaps beyond the ones related to differences in the first moments of the distributions (or not captured by them). Second, given the time-span of our data, we are able to analyze the asymmetric effect that the 2008 crisis had in both countries in terms of productivity. Hence, we perform an overall assessment of productivity gaps over 2003-2013 and then we break down these differences into two different periods: 2003-2007 and the years 2009-2013. Finally, we perform an analysis of the sources of productivity gaps, not only by studying the relevance of within-firm vs. allocative efficiency drivers (Olley and Pakes, 1996), but also by analyzing the time evolution of different percentiles in the productivity distribution.

Our results show that Germany outperforms France over the whole sample period of our analysis, with an average total factor productivity (TFP) advantage of 3% in the whole manufacturing industry and an average lead of 13% in terms of apparent labor productivity (ALP). This productivity gap is the result of an almost omnipresent German advantage in most of the 15 manufacturing sectors included in our sample. At the same time, we observe a systematic and significant narrowing down of productivity gaps between France and Germany, with France taking over in the second period in some sectors. This productivity convergence is mainly due to an improvement of productivity of French firms, which largely stems from gains in within-firm productivity and only minimally from a positive reallocation of market shares. In addition, the convergence is also the result of a deterioration of productivity levels of German firms in many sectors, especially in the post-crisis period.

Finally, our analysis of productivity percentiles reveals that the convergence trend has involved all firms in a sector, irrespectively of their position in the productivity distribution, although they are much more marked for firms in the bottom of the distribution.

Our results have also implications for the literature. In particular, the narrowing productivity gaps between Germany and France observed almost in any sector indicate the source of the widening differences in current accounts between the two countries is probably not related to differences in efficiency of the production process, but must instead be found in other determinants of cost competitiveness (Le Moigne and Ragot, 2015), or in other non-cost related factors (see e.g. Dosi et al., 2015). Furthermore, our results have also implications for the debate about the possible "cleansing effects" of recessions (Caballero and Hammour, 1994; Foster et al., 2016). In particular, we find little evidence for such a cleansing effect. On the one hand, the market reallocation has played only a tiny role in explaining productivity convergence between France and Germany. Second, the crisis has favored such a convergence by negatively impacting on the productivity of German firms rather than by accelerating the productivity of French ones.

The rest of the paper is structured as follows. In section 2 we present our database including the harmonization required to make reliable comparisons. Section 3 describes the productivity measures and the methodology we employ in our analysis. Section 4 performs a analysis of productivity gaps for the manufacturing sector as a whole. Section 5 considers instead each manufacturing sector in detail. Finally, Section 6 concludes.

2 Data

In this section we briefly present our dataset and discuss the strategies that we follow in order to ensure data comparability. Further details about data sources and accessibility are presented in the Appendix.

Our data come mainly from 4 sources: (i) administrative fiscal files (FICUS and FARE) provided by the French statistical office (Insee-DGFiP), containing comprehensive balance-sheet information for all firms operating in France; (ii) the cost structure survey (CSS), which is a module of the AFiD (Amtliche Frimendaten für Deutscheland) of the German Statistical Office (Destatis), containing production and financial information for manufacturing firms over 20 employees; (iii) Groningen EU KLEMS database, which provides country-sector specific deflators; (iv) GGDC Productivity Level Database, from where we get purchasing power parities (PPP). Additionally, we use yearly French corporate tax rates and average hours worked by sector from INSEE, German corporate tax rates from Eurostat and average hours worked by sector from Destatis, and Eurostat data for yearly long-term interest rates for both countries.

Confidentiality restrictions imposed by the two national statistical offices preclude merging firm-level data, which is required for the comparisons that we intend to carry out. We thus apply the methodology proposed by Bellone et al. (2014) (see also the next section) to circumvent this issue. For this, we build a database containing productivity indicators and export behavior of both countries at the percentile level within each of the 2-digits NACE (Statistical Classification of Economic Activities in the European Community) sectors. It covers manufacturing firms with 20 employees or more. The full list of sectors is provided in Table 6. [1] The relevant set of comparable variables that we use in our analysis are reported in Table 1. The Harmonization process is described below and the raw data, together with their correspondence in each data country source are presented in Table 5 in the Appendix.

Table 1: Variables and Definitions

VARIABLE	HARMONIZED DEFINITION
Real Value Added$_i$	Total sales minus trading goods minus raw materials minus other costs. Deflated using Value added deflator from EU KLEMS.
Employees (L)$_i$	Average number of employees in full-time equivalents.
Real wage bill (WB)$_i$	Gross wages plus social contribution by employer. Deflated using output EU KLEMS deflator.
Average hours worked (H)$_i$	Firm level average hours worked defined as the product of firm level employees and sector level average yearly hours worked per employee (country-year specific). Sector averages come from each national statistical office.

[1] We drop some sectors because of confidentiality issues. Further details are found in Table 6.

Real capital stocks (K)$_i$	Firm level capital stocks are estimated as the product of sector level average life expectancy of capital and firm level depreciation amount, following (Wagner, 2010) Life Expentancy Method. Deflated uisng EU KLEMS capital deflator.
Depreciation $(\delta)_s$	Defined as the ratio of average consumption of capital and average capital stocks.
Life Expectancy $(LE)_s$	Life expectancy of capital is computed as the inverse of $(\delta)_s$.
Real intermediate inputs (M)$_i$	Expenses in goods + expenses in raw materials + other expenses and external charges. Deflated using intermediate inputs output deflator from EU KLEMS.
Real production (Y)$_i$	Total sales deflated using output deflator from EU KLEMS.
Exporter status (Xer)$_i$	Dummy variable indicating whether a firm exported products during the year or not.
Real value of exports (X)$_i$	Deflated using output deflator from EU KLEMS. total value of exports over the year measured in EUR.

Notes: variables at the firm (i) and sector (s) level.

French data provides information about the whole economy beyond manufacturing industry, sector-level deflators, and firm capital. In contrast, German data doesn't. We therefore adopt different harmonization strategies to ensure maximum comparability. In particular, we adapt French variables – even if they are readily available – to comply with the way German variables are calculated. This strategy minimizes the risk that cross-country differences are the result of differences in measurement or in methodologies adopted.

Sectoral comparisons are easily carried out given the existing activity harmonized classifications within Europe. In this sense, the manufacturing industry is defined as the category C of the first level of the Statistical Classification of Economic Activities in the European Community (NACE rev. 2, 2008) and the 10-33 2-digits of the second level of the NACE. These two levels are common to the International Standard Industrial Classification of All Economic Activities (ISIC), as well as to the French and German classifications: Nomenclature d'Activité Française, rev 2 (NAF rev. 2, 2008) and Klassifikation der Wirtschaftszweige, Ausgabe 2008 (WZ 2008), respectively.

Information on firm capital stock (required to compute TFP) is not available in German databases. We were thus forced to reconstruct these data by using the perpetual inventory method (PIM).[2] In particular we adopt the modified PIM approach proposed in (Mueller, 2008; Wagner, 2010). Mueller (2008), according to which the initial capital stock is calculated from annual depreciation and from the average life expectancy of a unit of capital stock. The starting point is given by following relation between life expectancy and capital stock:

$$\overline{LE_s} = 1/\delta_s = \frac{(\text{average amount of } \delta)_s}{K_s} \tag{1}$$

From equation (1) we calculate the proxy for firm-level capital stock as $K_i = \delta_i \times \overline{LE_s}$. The data on capital assets and depreciation come from the German statistical Office (Destatis). To compute the average life expectancy, we use the total capital stock (repurchasing value) at the 2-digit level and we divide it by the respective depreciation (current prices). Next, the amount of firm-level depreciation is multiplied by the average life expectancy. The underlying assumption is that firms within a 2-digit sector have the same capital structure and apply the same depreciation routines. For consistency reasons, we apply the same methodology on French data with the exception that $\overline{LE_s}$ is constructed using firm data and generating average at the level of each sector-year; it is computed as the ratio of the amount of depreciation and capital stocks (tangible fixed assets in the balance-sheet).

All nominal values (value added, capital, inputs, output) are divided by the corresponding country-time-sector specific price deflators.For consistency reasons, we used the deflators from the Groning EU KLEMS as also deflators are not available from the German statistical office.[3].

Finally, to ensure comparisons between common units, we accounted for the fact that one euro of wage or investment acquires different amounts of goods and capital in two different countries. Hence, all measures were adjusted for PPP measures at the country and

[2] Mueller (2008) discusses the pros and cons of the standard perpetual inventory method. For short time series this method has the disadvantage of losing observations when performing the actual analyses. However, also, other procedures like using investment as a proxy for capital – by assuming that investment expenditure is proportional to capital – can provide poor approximation in some cases.

[3] See Jäger (2016) for details about these deflators.

sector level. We used PPP data from GGDC Productivity Level Database, where PPP series are expressed relative to the United States.[4] To obtain a French-German sector-specific PPP we proceeded as follows,

$$X_s^{DE,FR} = \frac{X_s^{FR}/PPP^s_{FR\to US}}{PPP^s_{US\to DE}}$$

where $X_s^{DE,FR}$ is a sector-s French variable X (any input, output or productivity measure) expressed in German PPP euro; X_s^{FR} is the sector-s French nominal value expressed in French euro; $PPP^s_{FR\to US}$ is the French PPP sector-s series relative to US sector-s dollars and $PPP^s_{US\to DE}$ the sector-s German PPP series relative to US sector-s dollars. Note that this procedure implies that only French data need to be transformed in order to make it comparable with German ones.[5]

3 Productivity measures and methodology employed

We use two traditional productivity measures calculated at the firm level. The simplest one is the standard apparent labor productivity (ALP), which reflects output per hour worked. In addition, we use total factor productivity (TFP), which adjusts for the contributions of capital and materials.

Apparent labor productivity (ALP), is calculated as the ratio of real value added and average number of hours worked. Additionally, sector fixed effects are taken away in order to capture solely the productivity evolution and not structural differences among sectors. For total factor productivity (TFP), instead, we follow the methodology proposed by (Bellone et al., 2014). It consists in a non-parametric estimation performed by using the so-called *Multilateral Productivity Index* developed by Caves et al. (1982) and extended by Good et al. (1997). This method is based on a index number approach returning a comparable productivity index, computed as the deviation with respect to a common reference firm and it does not require a direct estimation of the underlying production functions. More formally, we compute the TFP index as follows:

[4]GGDC Productivity Level Database - 1997 benchmark. See Inklaar et al. (2009) for details.

[5]Notice that that PPP sector-specific measures are only available for 1997.We thus assume that relative sector-country prices were constant over the period of our analysis.

$$\ln \text{TFP}_{it} = \ln Y_{it} - \overline{\ln Y_t} + \sum_{\tau=2}^{t} \left(\overline{\ln Y_\tau} - \overline{\ln Y_{\tau-1}} \right) \tag{2}$$

$$- \sum_{n=1}^{N} \frac{1}{2} \left(S_{nit} + \overline{S_{nt}} \right) \left(\ln X_{nit} - \overline{\ln X_{nt}} \right) \tag{3}$$

$$- \sum_{\tau=2}^{t} \sum_{n=1}^{N} \frac{1}{2} \left(\overline{S_{n\tau}} + \overline{S_{n\tau-1}} \right) \left(\overline{\ln X_{n\tau}} - \overline{\ln X_{n\tau}} \right) \tag{4}$$

where Y_{it} is real gross output of firm i at time t, using the set of inputs X unit (labour, capital and materials). S unit is the cost share of input X nit in the total cost. The symbols with an upper bar are the corresponding measures for the reference point (the hypothetical firm). They are computed as the arithmetic mean of the corresponding firm level variables over all firms in year t. Subscripts τ and n are indices for time and inputs, respectively. This methodology is particularly suited to comparisons within firm-level panel data sets as it guarantees the transitivity of any comparison between two firm-year observations by expressing each firm's input and output as deviations from a single reference point for each year.

As we mentioned in the previous section, confidentiality restrictions prevent us from merging the firm level databases. We thus implemented a methodology allowing us to circumvent this restricion and to perform reliable comparisons. This requires aggregating and summarizing firm data by percentiles (within any given sector and period) in order to approximate the cumulative distribution function for each country (within any given sector and period).

We perform several analyses on the above mentioned distributions. First, we track (only at the country level) the evolution of average productivity, both unweighted and weighted by value added shares. Weighted productivity corresponds to the traditional measure of aggregate productivity. Moreover, these two averages can be related to the relative importance of idiosyncratic firm learning vs. allocative efficiency drivers of productivity. In particular Olley and Pakes (1996) decompose aggregate productivity as sum of the unweighted average productivity, capturing firm learning, and a covariance term, measuring the ability of market forces in reallocating market shares across firms with heterogeneous productivity levels. More precisely, Olley and Pakes (1996) show that the productivity level (of a country or of a specific sector within a country), denoted by Π, can be decomposed as follows:

$$\Pi = \sum_{i=1}^{N} \theta_i \pi_i = \bar{\pi} + \sum_{i=1}^{N} (\theta_i - \bar{\theta})(\pi_i - \bar{\pi}) \tag{5}$$

where N is the number of firms (in a country or in a specific sector), θ_i is the firm share in total value added, π_i is the productivity level of the firm, and $\bar{\pi}$ and $\sum_{i=1}^{N} \theta_i \pi_i$ are, respectively, the unweighted and weighted average producitivity levels. From Eq. (5) it also follows that the difference between these two averages measures the "allocative efficiency" term.

Furthermore, we run three types of statistical tests to detect significant differences in productivity levels between Germany and France, both at the aggregate and sectoral levels. The first of them is the standard t-test for equality of means, which assumes the normality of the two distributions involved and unequal variances of productivity levels. In addition, given that the normality assumption is rarely met, we also employ two-sided and one-sided Kolmogorov-Smirnov (KS) tests. More specifically, let $G(z)$ and $F(z)$ denote the cumulative distribution functions (CDFs) of the productivity levels of German and French firms, respectively. The hypothesis to be tested is whether both distributions are identical. This is done with the help of the two-sided KS test:

$H_0 : G(z) - F(z) = 0 \;\; \forall\, z \in \mathbb{R}$ versus the alternative hypothesis,

$H_0 : G(z) - F(z) \neq 0$ for some $z \in \mathbb{R}$

In contrast, the one-sided KS test allows testing whether $G(z)$ stochastically dominates $F(z)$, which is formulated as follows:

$H_0 : G(z) - F(z) \leq 0 \;\; \forall\, z \in \mathbb{R}$ versus the alternative hypothesis,

$H_0 : G(z) - F(z) > 0$ for some $z \in \mathbb{R}$

In this sense, if the two-sided test is rejected while the one-sided test isn't, one can conclude that the productivity distribution of German firms lies to the right of the productivity distribution of French firms, thereby implying a first-order stochastic dominance of Germany over France in terms of productivity levels.

We first apply all the above tests on the whole sample period (2003-2013). We then repeat the exercise after splitting the sample in two sub-periods, namely Period 1: 2003-2007 and Period 2: 2009-2013. The two periods capture the phase of the economy respectively before and after the crisis of 2008. Investigating statistical differences within each period thus delivers information about whether the crisis also represented a structural break or not in the dynamics of productivity differences between Germany and France.

Finally, we complement the analysis of distributional differences by studying the time-evolution of percentiles of the distributions in the two countries considered. Such an analysis is useful as it provides hints about whether the the observed cross-country differences (or the absence of them) are the result of productivity shifts of all firms or they can rather be related to the productivity dynamics of a specific group of firms (e.g. the most productive ones).

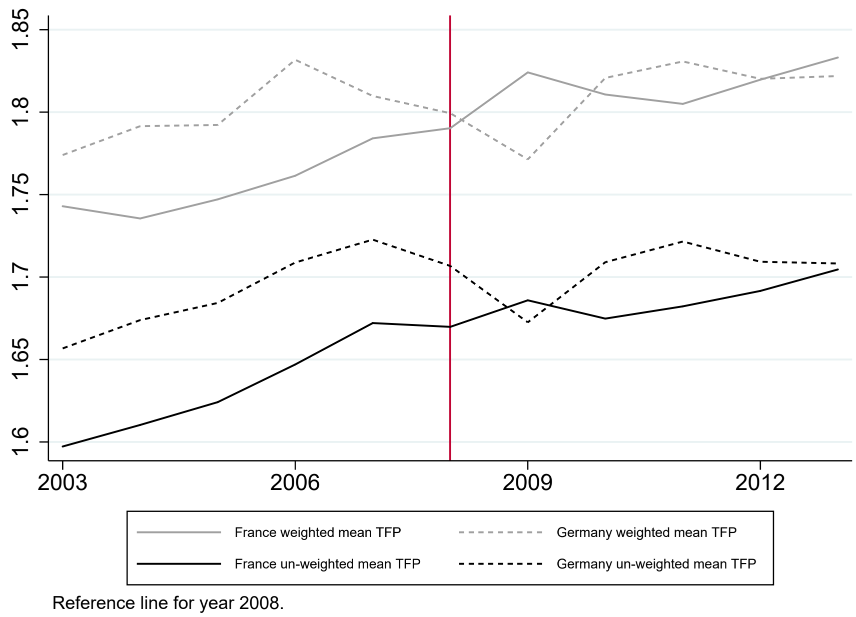
4 On the evolution of productivity distributions in manufacturing

Let us start our analysis by investigating the evolution of aggregate productivity differences between Germany and France. the evolution of average firm level TFP (in logs) for the two countries in Figure 1 over the whole sample period. We plot both a simple un-weighted average TFP (black) and a (value-added) weighted TFP (in grey). As we discussed in previous section, the weighted mean gives a better idea of aggregate productivity dynamics, whereas the unweighted mean captures the impact on productivity of within-firm learning. In addition, we show in Figure 2 the difference between the two means, capturing the allocative efficiency contribution to productivity dynamics (cf. the previous section).

The first fact emerging from Figure 1 is a clear TFP convergence over time between France and Germany, regardless of the average considered. The initial strong difference in TFP in 2003 becomes barely visible in 2013. This is explained by a more sustained productivity evolution in France (solid lines) than in Germany (dashed lines). Additionally, the 2009 crisis seems to have strongly affected German productivity while a very small effect on French TFP is observed, resulting in a temporary higher average TFP in France than in Germany.

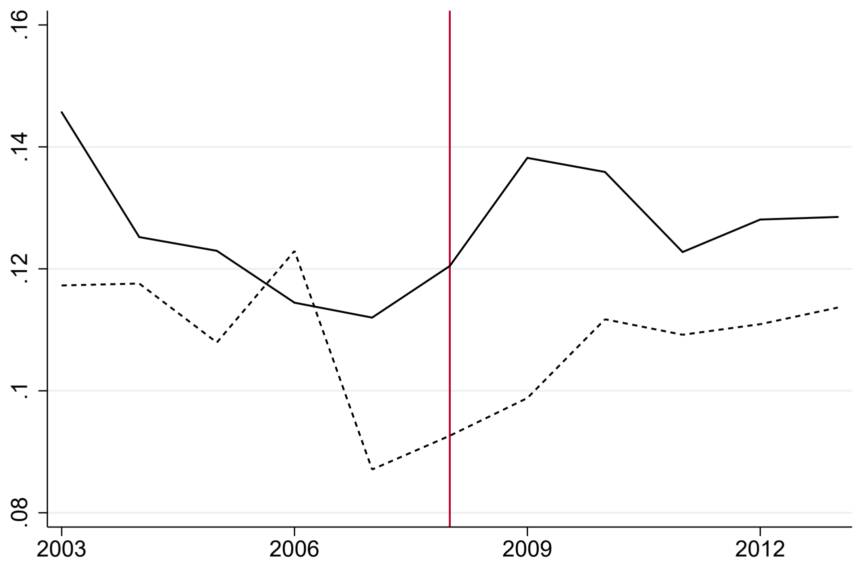
What is role played by idiosyncratic learning vs. allocative efficiency in the above convergence process? First, the steady pace of the evolution of the unweighted productivity in mean in France viz. the German one points to the positive role played by firm learning in promoting convergence. Furthermore, the comparison of Figures 1 and 2 reveals, that the largest contribution to productivity levels indeed comes from within-firm learning. (a result in line with most studies on firm-level productivity dynamics, see e.g. Bartelsman and Doms, 2000; Bartelsman et al., 2013; Dhyne et al., 2014). In constrast, allocative efficiency accounts only for a very small part of overal productivity levels, i.e. of an order of magnitude which is at least ten times smaller than the one stemming from within-firm learning, both in France and in Germany. At the same time, the allocative efficiency term is always positive in both countries, suggesting the presence of a market reallocation process favoring more productive firms.[6]. Such a reallocation process has had a positive role in explaining the observed productivity convergence between the two countries. Figure 2 indeed reveals that allocative efficiency has always been higher in France than in Germany during the whole sample period considered (with a small break in 2006), thus reinforcing the positive trend stemming from within-firm drivers.

Figure 1: Evolution of average ln TFP manufacturing sectors



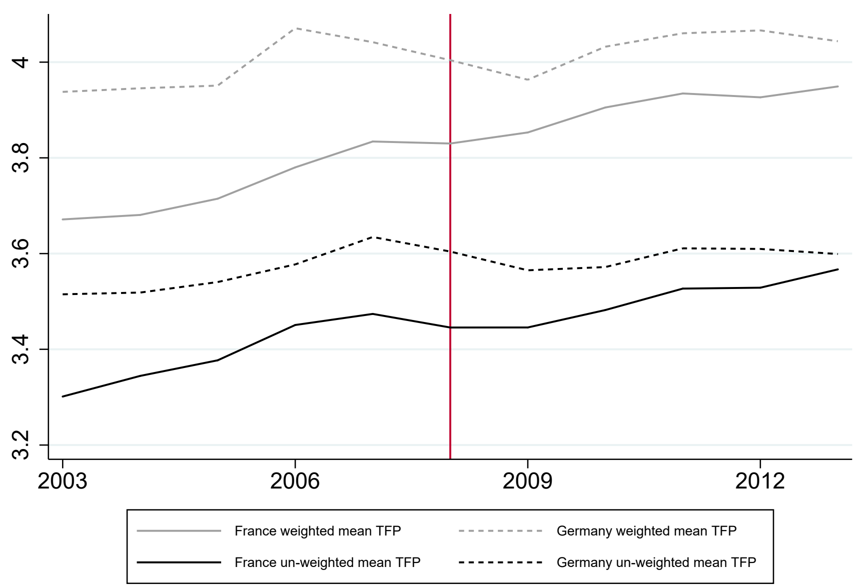
[6]Notice also that allocative efficiency has decreased in both countries until the 2008 crisis (especially in Germany), then returning to 2003 levels since then

Figure 2: ln TFP: Allocative efficiency manufacturing sectors



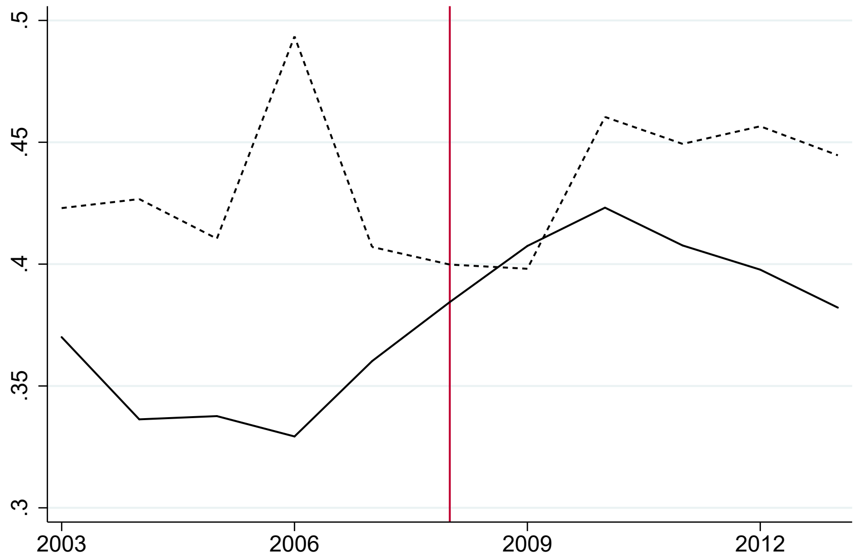
Dashed line is Germany and solid line is France. Reference line for year 2008. Allocative efficiency is the difference between the weighted-mean productivity and the simple average productivity.

Figure 3: Evolution of average ln ALP manufacturing sectors



Reference line for year 2008.

Figure 4: ln ALP: Allocative efficiency manufacturing sectors

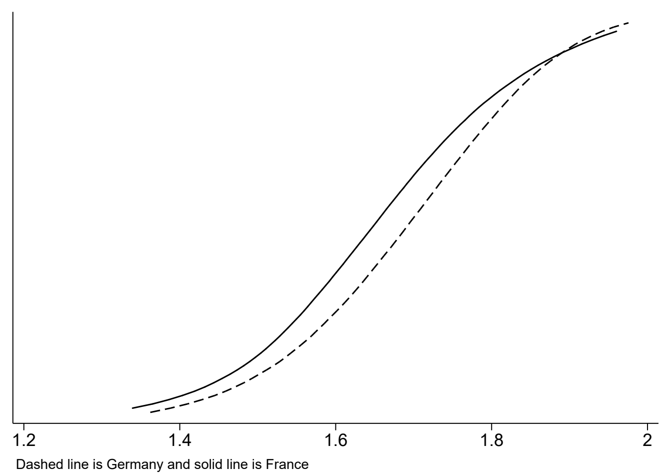


Dashed line is Germany and solid line is France. Reference line for year 2008. Allocative efficiency is the difference between the weighted-mean productivity and the simple average productivity.

The analysis of productivity gaps using the ALP measure confirms most conclusions reached with TFP. Indeed, Figure 3, which depicts the evolution of average ALP for both countries, indicates a clear convergence between French and German firms during the period of our analysis. Nonetheless, the convergence is less pronounced than what observed for TFP, especially when the weighted average is considered. In addition the ALP patterns were not affected by the crisis in both countries (contrary to what observed with TFP, cf. the German case). Finally, and interestingly, Figure 4 reveals that the ALP-based allocative efficiency contribution was lower in France than in Germany during the period considered, although it has significantly recovered since 2006. This may reflect the importance of capital in total production in France, which is taken into account by TFP but not by ALP.

Let us now turn to analyze whether the convergence that we have just described has affected distributional differences in firm productivity between Germany and France. We begin by considering differences over the whole sample period. Figure 5 shows the cumulative distribution function (CDF) of (the logartihm of) TFP of all manufacturing sectors.[7] Figure 6 show instead the CDF of the logarithm of ALP. Both figures show that Germany (dashed line) outperforms France (solid line) over the whole period considered in the manufacturing sectors in our sample. The same result is found when productivity is measured by ALP in Figure 6. In addition, the productivity advantage of Germany over France is more important when one considers ALP than TFP.

Figure 5: CDF ln TFP all manufacturing sectors

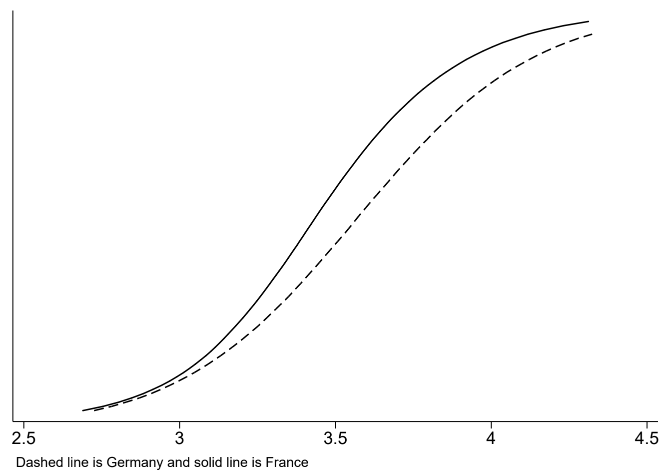


The German advantage over France is confirmed by the tests displayed in the last row of Table 2. Results for TFP are shown in the first block, where one can see that the mean overall difference between the German and French productivity is positive and statistically significant at the 1% level, as inferred from the t-statistic in column 4. This means that Germany's average TFP advantage over France over the whole sample period is of 3%. Additionally, as it was suggested by the visual inspection of the CDFs, the productivity advantage of Germany with respect to France becomes much larger when considering ALP, with a 13% (third column of ALP block) mean difference, statistically significant at the highest levels.

As we mentioned in the Section 3, the t-test assumes a normal distribution, an hypothesis

[7] It is worth recalling at this point that some sectors had to be dropped, given the lack of sufficient data for Germany after complying with the confidentiality restrictions. Hence, when we talk about "all manufacturing" we refer to the total of the remaining sectors, which are the following: 10, 13, 17, 20, 22, 23, 24, 25, 26, 27, 28, 29, 31, 32 and 33.

Figure 6: CDF ln ALP all manufacturing sectors



which is hardly verified in practice as many previous studies indicate (Bellone et al., 2014; Dosi et al., 2012; Yu et al., 2015). Therefore, we also carry out the KS test for first-order stochastic dominance. The advantage of the latter is also that it is distribution free and that it compares the entire distribution of both countries' productivity, going beyond the comparison of simple average productivity differences.

The KS test results, the maximum distance among the two distributions and the KS statistic, are displayed in the last two columns of each productivity measure block. A negative distance in the table means that the German distribution lies to right of the French distribution and this maps into a first-order stochastic dominance of the German firms' productivity with respect to the French firms' one.The KS tests confirm the result obtained with t-tests, as well as the fact that the productivity gap is larger when one considers ALP than when one considers the TFP measure.

The above tests thus indicate the presence of a statistically significant productivity advantage of German firms over French ones. Such a productivity advantage is not just limited to differences in simple averages, but it spans over the entire distribution, as confirmes by the KS tests. At the same time, it is also worth considering whether the aforementioned productivity gaps have significantly shrank or not over time, as the analysis of the evolution of averages at the beginning of the section seems to suggests. For this reason we plot in Figures 7 and 8 the CDFs of, respectively, TFP and ALP measures, after breaking down the sample in two sub-periods: 2003-2007 and 2009-2013.

The analysis of the two figures shows that Germany dominated France over the first period in terms of TFP. In contrast, the distance between the two distributions is much narrower in the second period, and they eveven overlap, especially in the higher percentiles. We can reach similar conclusions for the analysis of ALP distributions by period, although the distance between the two distributions is much more visible than with TFP, in line with the previous results discussed in this section.

These graphical findings are confirmed by statistical tests on distributions. These are separately shown in the last row of Table 3 (for the t-test) and in Table 4 (for the KS test). From the TFP measure, we find that the mean advantage of Germany over France has decreased by 4% (the difference between the two periods mean differences). This result is mostly explained by a 5% improvement in the French average productivity, while the German average TFP modestly gained 1% from one period to another. If we consider the ALP measure, the average difference moved from 16% in the first period to 8% in the second period. The reduction of the initial productivity gap by half is again, mostly due to a significant improvement in the average productivity of French firms, which increased by 12% between the two periods, while German firms only gained 4% on average. Concerning the KS test results, it is also the case that Germany keeps its advantage with a first-order stochastic dominance over France in both periods. However, the maximum distance between the French and German TFP distributions is reduced by more than 3 times in the second period. Moreover, although the change is much smaller for ALP, this German dominance over France also decreased after 2008 (passing from a maximum distance of 18 to 12).

Figure 7: CDF ln TFP by periods manufacturing sectors

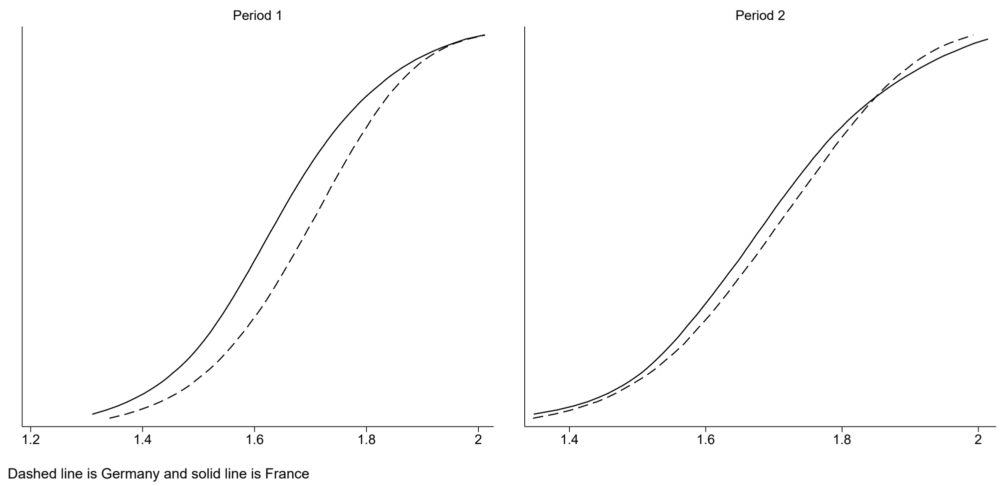
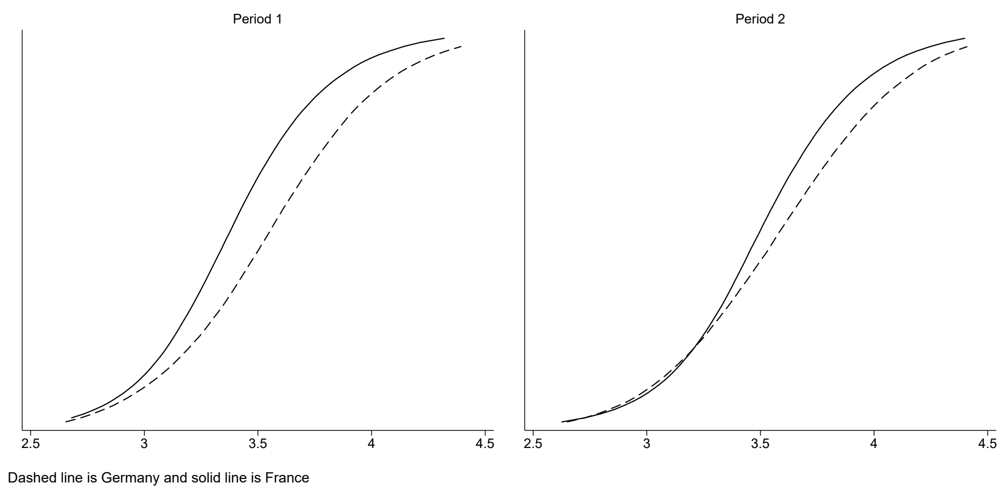
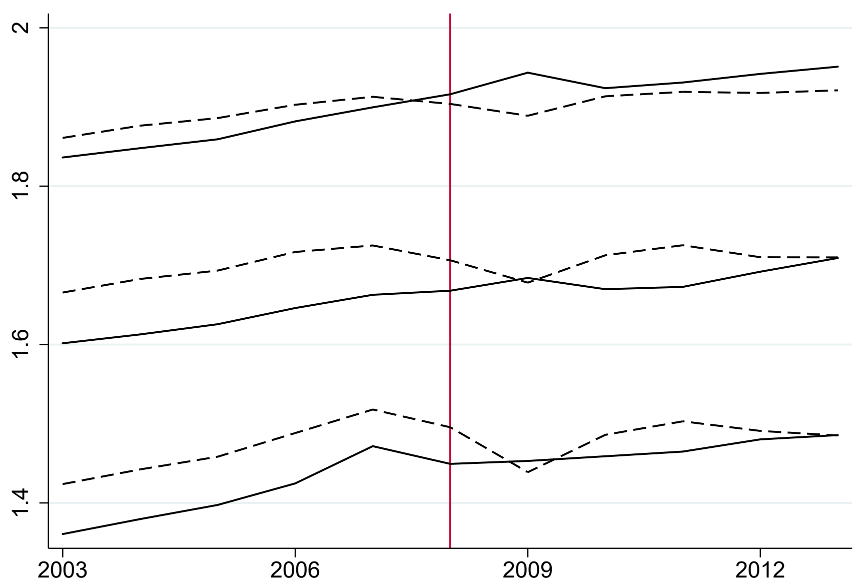


Figure 8: CDF ln ALP by periods manufacturing sectors



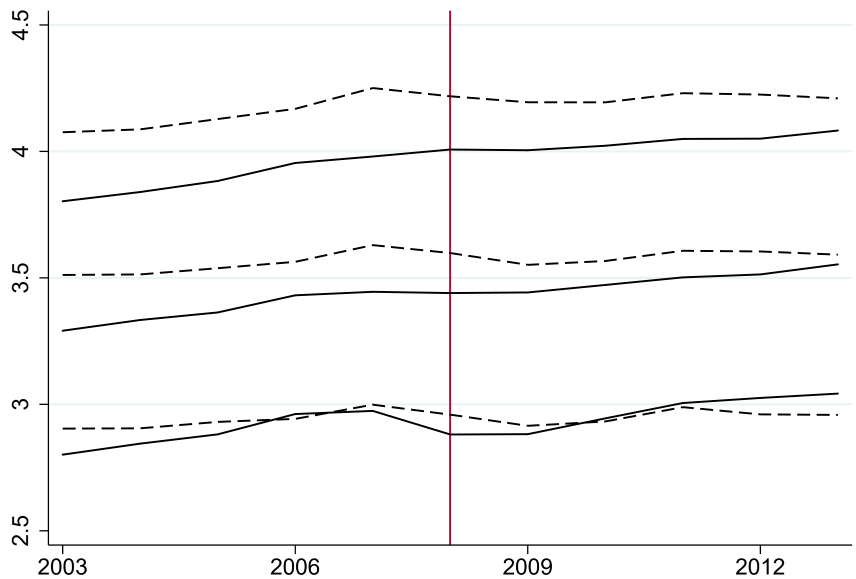
Finally, the plots in Figures 9 and 8 show the evolution of the 10th, 50th and 90th percentiles of the productivity distributions of respectively, TFP and ALP. In that, these figures help to shed light on whether some specific group of firms in the producitivity distributions have been mainly responsible for the convergence discussed so far. The comparison of the two plots reveals, first, that regardless of their position in the productivity distribution, all French firms have significantly increased their productivity over time and converged to levels comparable to the ones of German firms. This is especially the case when TFP in considered. Indeed the the TFP productivity level of French percentiles at the end of the period is either the same as the one of German firms or higher. This is not the case for ALP levels where some gaps remain (especially in the upper part of the distribution). In particular, the most productive firms (i.e. those in 90th percentile of the distribution) are probably responsible for the stronger catching-up observed when analyzing TFP. These firms have indeed leapfrogged German ones over-time, especially in the post-crisis phase. In line with other results exposed in this section, the crisis has had a negative effect on the productivity of German firms but not French ones, which have instead performed a steady increase in productivity over the period analyzed.

Figure 9: Ln TFP evolution by percentiles: 10th, 50th and 90th



Dashed line is Germany and solid line is France. Reference line for year 2008.

Figure 10: Ln ALP evolution by percentiles: 10th, 50th and 90th



Dashed line is Germany and solid line is France. Reference line for year 2008.

To sum up, all the results discussed in this section robustly point in one clear direction: German manufacturing firms lead French ones in terms of productivity levels, but the gap between the two has significantly shrunk over the years, and in some cases (the TFP of most productive firms) has turned in favor of French firms. Within-firm drivers are mostly responsible for the convergence. Their effect has however been reinforced played by the reallocation of market shares towards more productive firms, which has been stronger in France than in Germany. Finally, and interestingly, the crisis has had an asymmetric effect in the two countries. The crisis has indeed led to a temporary decrease in the productivity of German firms, whereas this has not been the case for French ones. In the next section we turn to analyze whether the above regularities are confirmed or not when one considers specific sectors of manufacturing activity.

Table 2: Productivity differences Germany and France 2003-2013

	ln TFP						ln ALP					
	Mean		Mean diff.				Mean		Mean diff.			
Sector	**DE**	**FR**	**DE -FR**	**t-stat**	**Max. D**	**KS stat**	**DE**	**FR**	**DE -FR**	**t-stat**	**Max. D**	**KS stat**
Food products	1.67	1.53	0.14	97.07	-0.40	-40.03	3.45	3.00	0.45	69.59	-0.33	-33.63
Textiles	1.79	1.76	0.03	8.21	-0.06	-2.95	3.38	3.25	0.13	11.71	-0.11	-5.51
Paper	1.83	1.67	0.16	49.13	-0.53	-26.16	3.59	3.16	0.44	44.93	-0.39	-19.43
Chemicals	1.79	1.80	-0.01	-2.50	0.06	3.73	3.97	3.97	-0.00	-0.04	-0.03	-1.88
Rubber & plastic	1.78	1.92	-0.14	-79.93	0.46	33.02	3.54	3.83	-0.29	-40.99	0.30	21.74
Non-metallic mineral	1.71	1.61	0.10	36.67	-0.27	-16.39	3.59	3.33	0.26	29.29	-0.20	-12.25
Basic metals	1.80	1.71	0.09	27.33	-0.31	-14.75	3.77	3.53	0.24	20.64	-0.27	-12.97
Metal products	1.70	1.66	0.03	26.18	-0.11	-11.69	3.60	3.47	0.13	32.61	-0.17	-18.34
Computer & electr. & optical	1.68	1.58	0.11	23.27	-0.16	-9.12	3.65	3.42	0.24	21.00	-0.17	-9.79
Electrical equipment	1.76	1.73	0.04	10.18	-0.07	-4.00	3.56	3.48	0.08	8.33	-0.06	-3.46
Machinery & equipment	1.63	1.64	-0.00	-1.09	0.05	4.71	3.81	3.82	-0.01	-2.54	0.07	6.64
Motor vehicles & trailers	1.74	1.68	0.06	16.19	-0.19	-9.98	3.63	3.50	0.13	12.50	-0.17	-9.02
Furniture	1.77	1.55	0.21	66.24	-0.57	-25.91	3.48	2.91	0.57	53.54	-0.54	-25.02
Other manufacturing	1.66	1.54	0.13	34.52	-0.26	-12.69	3.56	3.17	0.39	34.24	-0.33	-16.25
Repair & instal. machinery	1.64	1.64	-0.01	-3.25	0.11	6.70	3.67	3.72	-0.05	-5.40	0.15	9.34
All sectors	1.69	1.66	0.03	60.33	-0.11	-27.52	3.56	3.44	0.13	85.41	-0.15	-37.86

Notes: Max. D is the maximum distance among German and French cumulative distributions.
KS test critical values: 10% at 1.63 ; 5% at 1.73 ; 1% at 1.95.
T test critical values: 10% at 1.65 ; 5% at 1.96 ; 1% at 2.58.

Table 3: Mean differences and t-test of productivity by periods

		Mean ln TFP					Mean ln ALP				
Sector	**Period**	**DE**	**FR**	**Diff. DE-FR**	**t-stat**	**△ Diff.**	**DE**	**FR**	**Diff. DE -FR**	**t- stat**	**△ Diff.**
Food products	**1**	1.68	1.53	0.15	91.71	-0.04	3.53	2.97	0.57	68.4	-0.27
	2	1.65	1.53	0.11	46.16		3.33	3.03	0.3	28.74	
Textiles	**1**	1.79	1.74	0.05	11.53	-0.04	3.39	3.23	0.16	12.55	-0.15
	2	1.8	1.79	0.01	1.03		3.38	3.36	0.01	0.71	
Paper	**1**	1.81	1.64	0.17	51.49	-0.02	3.52	3.06	0.46	33.08	-0.13
	2	1.86	1.72	0.15	22.33		3.65	3.33	0.33	21.64	
Chemicals	**1**	1.8	1.79	0.01	1.29	-0.03	4.01	3.92	0.09	6.39	-0.18
	2	1.79	1.81	-0.02	-5.61		3.93	4.02	-0.09	-5.22	
Rubber & plastic	**1**	1.77	1.88	-0.11	-46.51	-0.05	3.52	3.73	-0.21	-21.17	-0.19
	2	1.79	1.96	-0.16	-58.98		3.52	3.92	-0.4	-38.27	
Non-metallic minerals	**1**	1.69	1.59	0.11	32.08	-0.01	3.56	3.27	0.29	25.55	-0.04
	2	1.74	1.64	0.1	22.28		3.63	3.38	0.25	16.53	
Basic metals	**1**	1.81	1.69	0.12	28.86	-0.06	3.8	3.53	0.27	16.84	-0.1
	2	1.8	1.73	0.06	10.64		3.71	3.54	0.17	9.24	
Metal products	**1**	1.71	1.64	0.07	48.81	-0.07	3.64	3.44	0.2	38.21	-0.14
	2	1.68	1.69	0	-1.83		3.56	3.5	0.06	8.96	
Computer & electr. & optical	**1**	1.65	1.49	0.16	24.93	-0.13	3.61	3.22	0.4	24.6	-0.33
	2	1.72	1.69	0.03	4.69		3.73	3.67	0.07	4.06	
Electrical equipment	**1**	1.73	1.64	0.09	17.22	-0.1	3.48	3.27	0.21	15.39	-0.26
	2	1.81	1.82	-0.01	-0.98		3.65	3.7	-0.05	-3.9	
Machinery & equipment	**1**	1.66	1.61	0.05	22.49	-0.13	3.9	3.78	0.11	17.75	-0.29
	2	1.59	1.67	-0.08	-29.3		3.68	3.86	-0.18	-21.92	
Motor vehicles & trailers	**1**	1.73	1.66	0.07	13.5	-0.01	3.63	3.49	0.14	9.38	-0.04
	2	1.75	1.69	0.06	10.14		3.62	3.52	0.1	6.22	
Furniture	**1**	1.77	1.53	0.25	62.07	-0.08	3.53	2.89	0.64	46.6	-0.17
	2	1.75	1.57	0.17	29.64		3.38	2.91	0.47	26.25	
Other manufacturing	**1**	1.68	1.51	0.17	30.39	-0.09	3.6	3.11	0.49	29.39	-0.22
	2	1.64	1.56	0.08	16.38		3.49	3.22	0.27	14.67	
Repair & instal. machinery	**1**	1.64	1.6	0.04	11.83	-0.11	3.7	3.66	0.03	2.89	-0.19
	2	1.63	1.69	-0.07	-16.77		3.61	3.77	-0.16	-10.39	
All sectors	**1**	1.69	1.63	0.05	68.77	-0.04	3.54	3.38	0.16	78.67	-0.08
	2	1.7	1.69	0.01	12.86		3.58	3.5	0.08	35.55	

Notes: Period 1 is 2003-2007 and Period 2 is 2009-2013.
Gap DE-FR is the mean difference of productivity between Germany and France.
T test critical values: 10% at 1.65 ; 5% at 1.96 ; 1% at 2.58.
△ diff. is the difference between the Gap in P2 and the Gap in P1.

Table 4: Maximum distance CDF and KS test of productivity stochastic dominance by periods

		ln TFP			ln ALP		
Sector	**Period**	**Max. D**	**KS stat**	**Critical Prob.**	**Max. D**	**KS stat**	**Critical Prob.**
Food products	**1**	-0.44	-31.73	0.00	-0.41	-30.15	0.00
	2	-0.33	-20.69	0.00	-0.24	-15.28	0.00
Textiles	**1**	-0.12	-4.62	0.00	-0.16	-6.27	0.00
	2	0.09	2.44	0.00	-0.04	-1.10	0.18
Paper	**1**	-0.57	-20.79	0.00	-0.47	-17.30	0.00
	2	-0.54	-16.32	0.00	-0.33	-10.07	0.00
Chemicals	**1**	-0.04	-1.78	0.00	-0.10	-4.49	0.00
	2	0.11	4.32	0.00	0.10	3.96	0.00
Rubber & plastic	**1**	0.37	19.26	0.00	0.23	12.08	0.00
	2	0.57	25.10	0.00	0.40	17.77	0.00
Non-metallic	**1**	-0.28	-12.51	0.00	-0.25	-11.27	0.00
minerals	**2**	-0.29	-10.54	0.00	-0.19	-6.97	0.00
Basic metals	**1**	-0.39	-12.98	0.00	-0.32	-10.75	0.00
	2	-0.23	-7.06	0.00	-0.21	-6.50	0.00
Metal products	**1**	-0.21	-16.20	0.00	-0.25	-19.59	0.00
	2	0.07	4.61	0.00	-0.09	-6.00	0.00
Computer & electr.	**1**	-0.26	-10.78	0.00	-0.26	-10.88	0.00
& optical	**2**	-0.08	-2.85	0.00	-0.07	-2.51	0.00
Electrical	**1**	-0.17	-6.88	0.00	-0.15	-6.12	0.00
equipment	**2**	0.05	1.82	0.00	0.06	2.21	0.00
Machinery	**1**	-0.10	-6.88	0.00	-0.12	-8.32	0.00
& equipment	**2**	0.22	12.77	0.00	0.18	10.51	0.00
Motor vehicles	**1**	-0.22	-8.07	0.00	-0.19	-7.03	0.00
& trailers	**2**	-0.18	-6.01	0.00	-0.16	-5.39	0.00
Furniture	**1**	-0.62	-21.34	0.00	-0.58	-20.32	0.00
	2	-0.52	-13.68	0.00	-0.50	-13.43	0.00
Other	**1**	-0.32	-11.14	0.00	-0.38	-13.36	0.00
manufacturing	**2**	-0.19	-5.78	0.00	-0.26	-7.97	0.00
Repair & instal.	**1**	-0.08	-3.73	0.00	0.09	4.28	0.00
machinery	**2**	0.25	8.94	0.00	0.26	9.49	0.00
All	**1**	-0.16	-27.97	0.00	-0.18	-31.79	0.00
sectors	**2**	-0.05	-8.13	0.00	-0.12	-19.67	0.00

Notes: Max. D is the maximum distance among German and French cumulative distributions.
KS test critical values: 10% at 1.63 ; 5% at 1.73 ; 1% at 1.95.
Period 1 is 2003-2007 and Period 2 is 2009-2013.

5 Sectoral Analysis

The aggregate analysis reported in previous section has identified the presence of significant productivity gaps between Germany and France, which are nevertheless shrinking as a result of a convergence processing due both to a catching up by French firms, and to flattening of productivity growth of German firms, especially in the years after the crisis. Let us now explore productivity profiles in each sector at a time. whether the foregoing two features are replicated also at the sectoral level and, relatedly, whether they are general features of all sectors of manufacturing activity or are rather compositional effects due to the productivity dynamics of some specific sectors.

The results about statistical test on productivity differences across sectors shown in Table 2 for both productivity measures. Table 6 reports the NACE code for each sector as well as the category to which the sector belongs to in the OECD taxonomy based on R&D intensity (see Galindo-Rueda and Verger, 2016). Figures from 11 to 13 in the appendix compare instead the CDFs of specific sectors, for TFP. Figures from 14 to 16 do the same for ALP. The main message arising from examining each sector is that Germany outperforms France in almost all manufacturing sectors over the whole period of analysis. Again, this holds for both productivity measures considered. France only performs better in two medium-technology sectors like 22 *rubber and plastic products* (NACE code 22) and *repair and installation of machinery and equipment* (NACE code 33), with a TFP mean difference of 14% for the former and a mean difference of 1% for the latter. This difference appears stronger for the ALP measure, where France outperforms Germany by 29% in the first sector mentioned, and by 5% in the second one. These patterns are also confirmed by the KS results, where France dominates Germany in both productivity measures.

Furthermore, if one focuses only the TFP measure, it appears that France also (slightly) outperforms Germany in a medium-high technology sector like *chemicals and chemical products* (NACE code 20) with an average advantage of 1%, which is also confirmed by a (modest) stochastic dominance of the French distribution over the German one. This advantage vanishes however vanished when one considers ALP. In addition, if we examine TFP, French firms have comparable productivity levels as German ones in another medium-technology industry (*machinery and equipment*, NACE code 33). When considering ALP, though, France has a statistically significant advantage over Germany.

Apart from these 4 sectors, Germany displays a systematic productivity advantage over France (in 11 out of 15 sectors). This advantage is confirmed by both tests and by both measures, without exceptions. In addition, average productivity gaps are systematically more pronounced with ALP than with TFP. On the contrary, when analyzing the whole distribution of firms with the KS test, where the German stochastic dominance over France is more pronounced with TFP than with ALP in some sectors, particularly those where Germany has a strong advantage over France (namely, sectors 10, 17 and 31).

At the same time, some heterogeneity across sectors is found, particularly with very large productivity gaps in sectors like *Food products* (NACE code 10), *Paper and paper products* (NACE code 10) and *furniture* (NACE code 31) and much less pronounced differences within sectors such as *Textiles* (NACE code 13), *Metal products* (NACE code 25), *Computer, electronic and optical products* (26) and *Electrical equipment* (NACE code 27). The largest gap is found in the *Furniture* sector, with a mean difference of 21% with TFP and of 57% with ALP in the same sector. This sector also displays the largest stochastic dominance of German firms with respect to French ones.

A more robust assessment of these productivity gaps should nonetheless take into account their evolution over time and also whether the 2008 crisis had any effect on these. We thus replicate the analysis of firm productivity gaps by splitting the sample in two different periods: before and after 2008 (see Tables 3 4 and figures in the appendix) . When looking at the results sector by sector, the first striking fact is that the productivity gap is closing in all sectors included in our sample. Such decreasing gaps are due not only to systematic improvements in the manufacturing sector in France – in both measures – but also to a slowdown of productivity in various sectors in Germany. For instance, the average mean gap in TFP, Germany is losing ground in 8 sectors out of 15 in the second period. Besides, out of the 15 sectors in which Germany starts with an initial advantage in the first period, there are 3 where the advantage turns in favor of France in the second period, and for both productivity measures considered.[8] These sectors are *Chemicals and chemical*

[8]While this is also true for ALP in sector 27 (*electrical equipment)*, the German advantage in TFP for this sector vanishes but doesn't turn into an advantage for France. In the same vein, there are 2 additional sectors in which the average productivity difference between both countries is not statistically significant in the second period, namely sector 13 (*textiles)* – with both measures – and sector 25 (*fabricated metal products)*, when periodicity is measured by TFP. Nonetheless, German still displays and advantage over France in the second period in this sector with the ALP measure.

products), *Machinery and equipment)*, *Repair and installation of machinery and equipment)*. Notice that these are sectors are also where productivity gaps where either absent or in favor of France in the analysis performed over the whole sample period. It follows that the French firms performed a significant catching up in productivity in the period after the crisis. In the *rubber and plastic products)*, instead, French firms had a productivity advantage also before 2008. This advantage further increased in the second period, mainly because of significant decrease in the productivity of German firms in this sector.

Furthermore, if productivity is measured by ALP, we find that Germany performs worse in 10 out of 15 sectors in the second period. The sector where Germany loses the most over time is sector 28 (*Machinery and equipment)*, with a 22% decrease in productivity. Indeed, the same sector experienced one of the strongest productivity gap reductions, narrowing by 13% in terms TFP and by 29% in terms of ALP. In both cases, Germany has an advantage over France in the first period (5% and 11%, respectively), while the opposite is true after 2008, with France displaying a mean productivity advantage over Germany (of 8% and 18%, respectively).

The sector where the productivity gap narrows the most, however, is *Computer, electronic and optical products)* (NACE code 26) , with a 13% decrease in the initial TFP gap and a 33% decrease in the initial ALP gap. Despite such a big reduction, in both cases, Germany still has a mean productivity advantage over France in the second period (of 3 and 7%, respectively). *Computer, electronic and optical products)* is also the sector where France gained the most in terms of productivity passing from one period to another, experiencing a 20% average TFP improvement and a 45% increase in average ALP. Another sector displaying a strong gap reduction is *Electrical equipment)* with an initial 9% TFP gap, in favor of Germany, turning into a non statistically significant difference in the second period. This result is stronger for ALP, where the German advantage over France of 21% before 2008, turns into a mean French advantage of 5% in the second period.

Another result which is worth mentioning is the divergent conclusion arising from the two productivity measures for some sectors. Particularly, in sector 10 (*food products)* we find a modest drop of 4% in the TFP mean productivity gap between France and Germany, while the average ALP gap closed by 27% (being one of the sectors experiencing a strong reduction in the average ALP differences (passing form 57% in the first period to 3% in the second). This large decline in the ALP gap between France and Germany is mainly due to an important drop of 20% in the average ALP in Germany in the second period (while average TFP only dropped by 3% from one period to another).

In conclusions, the above sectoral analysis mostly confirm the hints from the results obtained by considering the manufacturing sector as a whole. At the end of 2013 German firms have a systematic productivity advantage over French ones in most manufacturing sector. Nevertheless, such an advantage is disappearing almost everywhere, especially because of the good performance of French firms in the years between 2009 and 2013. In some cases the advantage has already turned in favor of French firms. A pertinent question that arises is whether the convergence observed at the sectoral level is due to the productivity performance of specific group of firms. Figures from 17 to 20 in the appendix plot the evolution of TFP at the median and the 10th and 90th percentiles. Figures from 21 to 24 plot instead the evolution of ALP for the same percentiles.

Although sectors are very heterogeneous, some common patterns can be identified. More specifically, when one considers the TFP measure, the gap reduction over time (or in the increase in the French lead for the sectors where France starts with an advantage) involves all the percentiles of the distribution. However, it is often more pronounced at the 10th percentile. This is particularly the case for sectors like *Food products*, *Paper and paper products*, *Electrical Equipment*, and *Repair and installation of machinery and equipment)*, and much less often at the 90th percentile (only in *Basic metals* sector). Additionally, as it was the case for the whole manufacturing, France seems to have been less hit by the crisis in most sectors -with a stronger general resilience in the 10th percentile. This is the case for 8 out of 15 sectors. In contrast, German firms show a more severe slowdown between 2008 and 2009, particularly visible in 7 out of 15 sectors. This slowdown is again more severe for firms in the 10th percentile, which display the deepest troughs in most sectors. The results from the ALP analysis mostly confirm the above patterns. In particular, the French catch-up is again more visible at the 10th percentile than in the rest of the distribution. However, contrary to the TFP measure, it is now French firms in some sectors that show a higher sensibility to the crisis than German firms. In the same way as before, firms in the 10th percentile seem to have been affected the most by the crisis.

6 Conclusions

In this paper we have analyzed differences in productivity levels between France and Germany, based on firm-level large-scale data bases covering most of the manufacturing industry. Following the methodology proposed by Bellone et al. (2014), we were able construct comparable productivity measures and to track the whole distribution of productivity levels in the two countries. Furthermore, we quantitatively evaluated productivity differentials by performing statistical tests of differences in means as well as statistical tests of first-order stochastic dominance. In addition, we investigated the impact of the Great Recession on productivity differentials between the two countries, and we tracked the evolution of percentiles of the productivity distribution in order to detect specific group of firms driving productivity differences.

Our results reveal an overall advantage of Germany over France in the manufacturing industry over the period 2003-2013. Nonetheless, breaking down our sample into two periods, uncovers a very interesting convergence in firm-level productivity between the two countries, especially after the Great Recession. This result is explained both by a better performance of French firms in every sector and a deterioration of German firms in some sectors. The results of our analysis indicate that the increasing gap between the two countries in international market shares is not related to differences in productivity. In addition, they point to a rather negative effect (rather than a positive one) of the last economic crisis on the productivity level of firms.

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Appendix

German data and access terms

The German AFiD (Amtliche Frimdaten fûr Deutschland) database of the German Statistical Office (Destatis) consists of 6 surveys over the period 2003-2013, each with a different coverage. Three of these provide information at the firm level and the remaining three are collected at the level of plant. Due to confidentiality constraints, a threshold of 20 or more employees applies for both firm and plant surveys. Below this threshold no data is observed. This means that a multi-plant firm owning only plants with less than 20 employees each appears in the plant-level surveys, while the firm (as a whole) does not appear in the firm-level surveys, if the sum of employees in all its plants is equal or greater to 20.

Among these surveys, our main source is the cost structure survey (CSS). The CSS is a one-step stratified random sample of German firms with at least 20 employees. It provides representative firm information on a yearly basis and covers about 40% of firms in the manufacturing sector. The focus is on the manufacturing sector because, despite figures for other sectors are available, the quality of German data on these is less reliable. The metadata can be retrieved from http://www.forschungsdatenzentrum.de/bestand/kse_panel/kse_panel_metadatenreport_1995-2014.pdf

The number of employees in the CSS is measured in full time equivalents: number of owners working in the firm plus number of employees minus number of part-time employees plus full-time equivalents of part-time employees. Even if we observe data stating on 2001, we start our analysis in 2003 due to the change in measurement methodology in 2002 causing a break in the series of the number hours worked in Germany. Finally, capital stocks are not available from any of these surveys.

It is worth mentioning that despite the fact that the "annual report survey" is a firm-level census and covers around 95% of firms above 20 employees, we can't rely on it as a main source because it lacks many variables needed for our productivity computations. Particularly, labor in full time equivalents, this being particularly relevant given that German labor market reforms made part-time contracts much more common in Germany [9]

The manufacturing industry is defined as category C of the first level of the Klassifikation der Wirtschaftszweige, Ausgabe 2008 (WZ 2008) and the 10-33 2-digits of the second level of the WZ, 2008. Both levels are common to the Statistical Classification of Economic Activities in the European Community (NACE) and the International Standard Industrial Classification of All Economic Activities (ISIC).

French data and access terms

Our data sources for French firms come from the FICUS and FARE bases and are made available by the DGFiP- INSEE. These bases are drawn from fiscal files and no firm size threshold determining the inclusion/exclusion is applied. Hence, there is full coverage of French firms given that every firm is subject to compulsory reporting with fiscal authorities. The FICUS-FARE base contains balance sheet information on employment, capital, depreciation, investment, the wage bill, materials, four-digit sector the firm belongs to, etc. that are important in estimating productivity. In addition, a unique firm identifier is associated to each firm (siren number). Mergers and acquisitions and changes in intra-group organization can break the firm identifier series given that the siren changes over time. Therefore, new sirens do not necessary reflect to new firms in the market.

Given that, on the one hand the French bases provide full coverage of firms and contain all information needed for computing productivity measures, while on the other hand German data is subject to much more constraints, we don't use all French variables directly from the raw data (e.g. capital stocks and deflators), but instead we adapt the construction of French variables in order to harmonize measurement methodology. Particularly we keep only firms with 20 employees or more within the manufacturing sector.

The manufacturing industry is defined as category C of the first level of the Nomencla-

[9]"The fragile comparability of working time in France and Germany" by Thomas Körner (Destatis), Loup Wolff (Insee, CEE).

ture d'Activité Française, rev 2 (NAF rev. 2, 2008) and the 10-33 2-digits of the second level of the NAF. Both levels are common to the Statistical Classification of Economic Activities in the European Community (NACE) and the International Standard Industrial Classification of All Economic Activities (ISIC).

Table 5: Firm level variables correspondence

	TRANSLATION	VAR CODE FR	VAR CODE DE	VAR NAME FR	VAR NAME DE
Sales					
+	sales trading goods	VENTMAR	[kse_ef37]	Vente de marchandises	Umsatz: aus Handelsware
+	sales own products	PRODVEN	[kse_ef35]	Production vendue de biens et services	Umsatz: aus eigenen Erzeugnissen
+	commission fees from commercial mediation		[kse_ef38]		Umsatz: aus eigenen Erzeugnissen
+	other sales		[kse_ef39]		Umsatz: aus Handelsware
=	total sales	CATOTAL	[kse_ef40]	Chiffre d'affaires total	Umsatz insgesamt (Summe aus kse_ef35 bis kese_ef39)
Stocks					
-	stock intermediate/finished products at t0		[kse_ef41]		Bestände an unfertigen/ fertigen Erzeugnissen aus eigener Produktion Anfangsbestand
+	stock intermediate/finished products at t1		[kse_ef42]		Bestände an unfertigen/ fertigen Erzeugnissen aus eigener Produktion Endbestand
=	change in inventories of intermediated/finished products	PRODSTO		Production stockée	
+	self-produced capitalized assets	PRODIMM	[kse_ef44]	Production immobilisée	Wert der im Geschäftsjahr aktivierten selbsterstellten Anlagen
Raw materials					
+	stock raw material at t0		[kse_ef50]		Bestände an Roh- Hilfs- und Betriebsstoffen zu Beginn des Geschäftsja
-	stock raw material at t1		[kse_ef51]		Bestände an Roh- Hilfs- und Betriebsstoffen am Ende des Geschäftsjahr
=	change in inventories raw material	VARSTMP		Variation de stocks de matières premières et approvisionnements	Bestandsveränderung R/H/B-Stoffe
-	purchases raw material	ACHAMPR	[kse_ef52]	Achats de matières premières yc droits de douane	Eingänge (Einkäufe) von Roh- Hilfs- und Betriebsstoffen während des G
Trading goods					
+	stock trading goods at t0		[kse_ef56]		Bestand an Handeslwaren zu Beginn des Geschäftsjahres
-	stock trading goods at t1		[kse_ef57]		Bestand an Handeslwaren am Ende des Geschäftsjahres
=	change in inventories trading goods	VARSTMA		Variation de stocks de marchandises	Bestandsveränderung Handelwaren
-	purchases trading goods	ACHAMAR	[kse_ef58]	Achats de marchandises	Eingänge (Einkäufe) an Handeslwaren während des Geschäftsjahres
Other cost					
-	cost of hired workers		[kse_ef63]		Kosten für Leiharbeiter

Table 5 – *Continued on next page*

AUTACHA Autres achats et charges externes

-	cost of wagework by other firms		[kse_ef64]		Kosten für durch andere Unternehmen durchgeführte Lohnarbeiten
-	cost of repair work		[kse_ef65]		Kosten für Reparaturen, Instandhaltungen, Installation, Montagen u.ä
-	rent, leasing		[kse_ef66]		Kosten für Mieten, Pachten und Leasing
-	other cost		[kse_ef68]		sonstige Kosten
= Value Added		VAHT		Valeur ajoutée hors taxes	

Employees					
+	Owners working in the firm	EFFSALM	[kse_ef21]	Effectif salarié moyen (equiv. temps plein)	Anzahl der tätigen Inhaber
+	Total employees		[kse_ef22]		Anzahl der Arbeitnehmer insgesamt
-	Part-time employees		[kse_ef24]		Anzahl der Arbeitnehmer: darunter Teilzeitbeschäftigte.
+	Full-time equivalents of part-time employees		[kse_ef25]		Anzahl der Arbeitnehmer: darunter Teilzeitbeschäftigte, umgerechnet in Vollzeitäquivalente
Wage bill					
+	Gross compensation	SALTRAI	[kse_ef60]	Salaires et traitements	geleistete Bruttoentgelte (ohne Arbeitgeberanteile)
+	Social contribution by employer	CHARSOC	[kse_ef61] + [kse_ef62]	Charges sociales	geleistete Bruttoentgelte + sonstige Sozialkosten (Arbeitgeberanteile)
Depreciation					
	Amount of depreciation	DOTAMOR	[kse_ef74]	Immobilisations: dotations aux ammortissements	Steuerliche Abschreibungen auf Sachanlagen
Exports					
	Total exports	CAEXPOR	[mb_26]	Chiffre d'affaires à l'export	Auslandsumsatz insgesamt in €

Sources: FICUS-FARE from INSEE-DGFip for France and CCS module of AFDiD from Destatis for Germany.

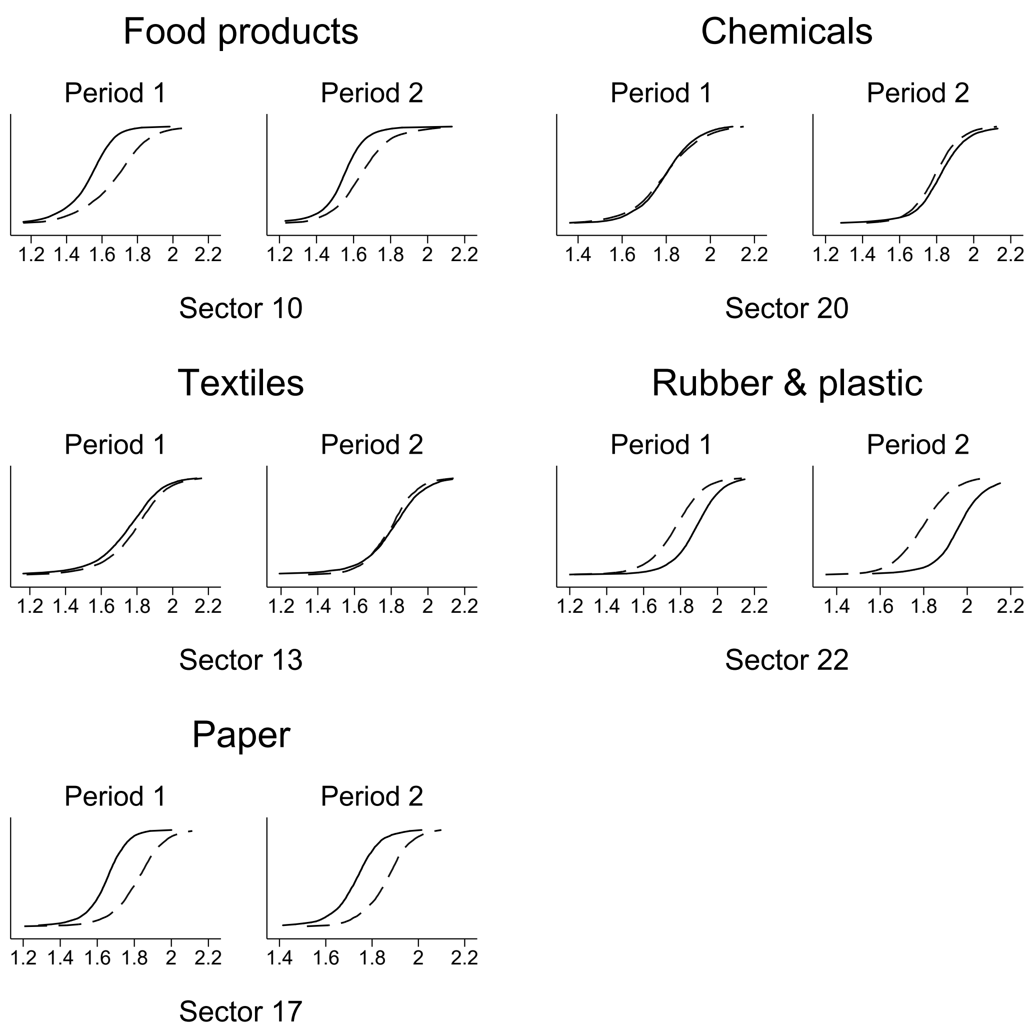
Additional figures and tables

Table 6: Manufacturing 2-digits NACE Sectors

NACE code	NACE names	OECD taxonomy	Inclusion
10	Food products	MLT	YES
11	Beverages	MLT	NO
12	Tobacco products	MLT	NO
13	Textiles	MLT	YES
14	Wearing apparel	MLT	NO
15	Leather and related products	MLT	NO
16	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	MLT	NO
17	Paper and paper products	MLT	YES
18	Printing and reproduction of recorded media	MLT	NO
19	Coke and refined petroleum products	MLT	NO
20	Chemicals and chemical products	MHT	YES
21	Basic pharmaceutical products and pharmaceutical preparations	HT	NO
22	Rubber and plastic products	MT	YES
23	Other non-metallic mineral products	MT	YES
24	Basic metals	MT	YES
25	Fabricated metal products, except machinery and equipment	MLT	YES
26	Computer, electronic and optical products	HT	YES
27	Electrical equipment	MHT	YES
28	Machinery and equipment n.e.c.	MHT	YES
29	Motor vehicles, trailers and semi-trailers	MHT	YES
30	Other transport equipment	MHT	NO
31	Furniture	MLT	YES
32	Other manufacturing	MT	YES
33	Repair and installation of machinery and equipment	MT	YES

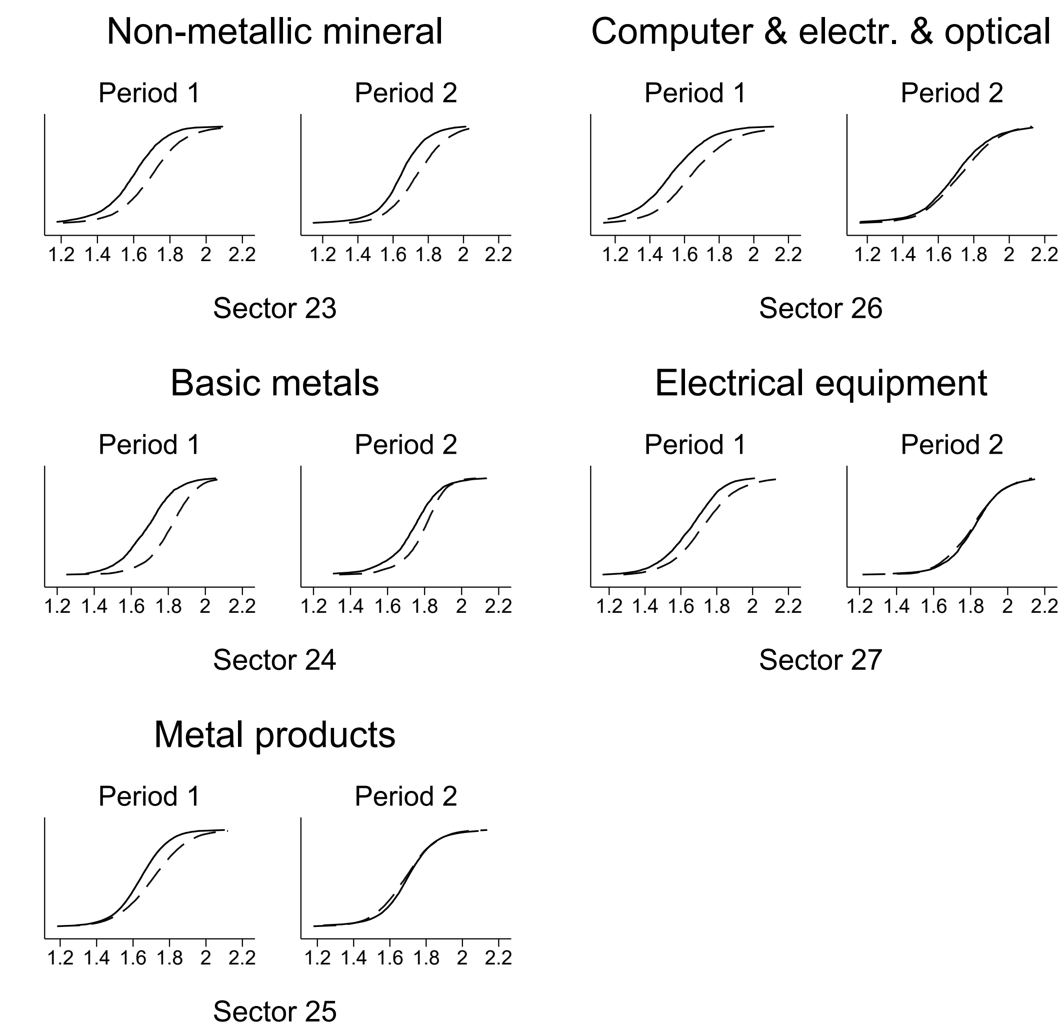
Sector exclusion is based on data availability after complying with confidentiality restrictions. OECD taxonomy indicates R&D intensity, where: ”HT” is High, ”MHT” is Medium-high, ”MT” is Medium and ”MLT” is Medium-low.

Figure 11: CDF ln TFP manufacturing sectors by periods



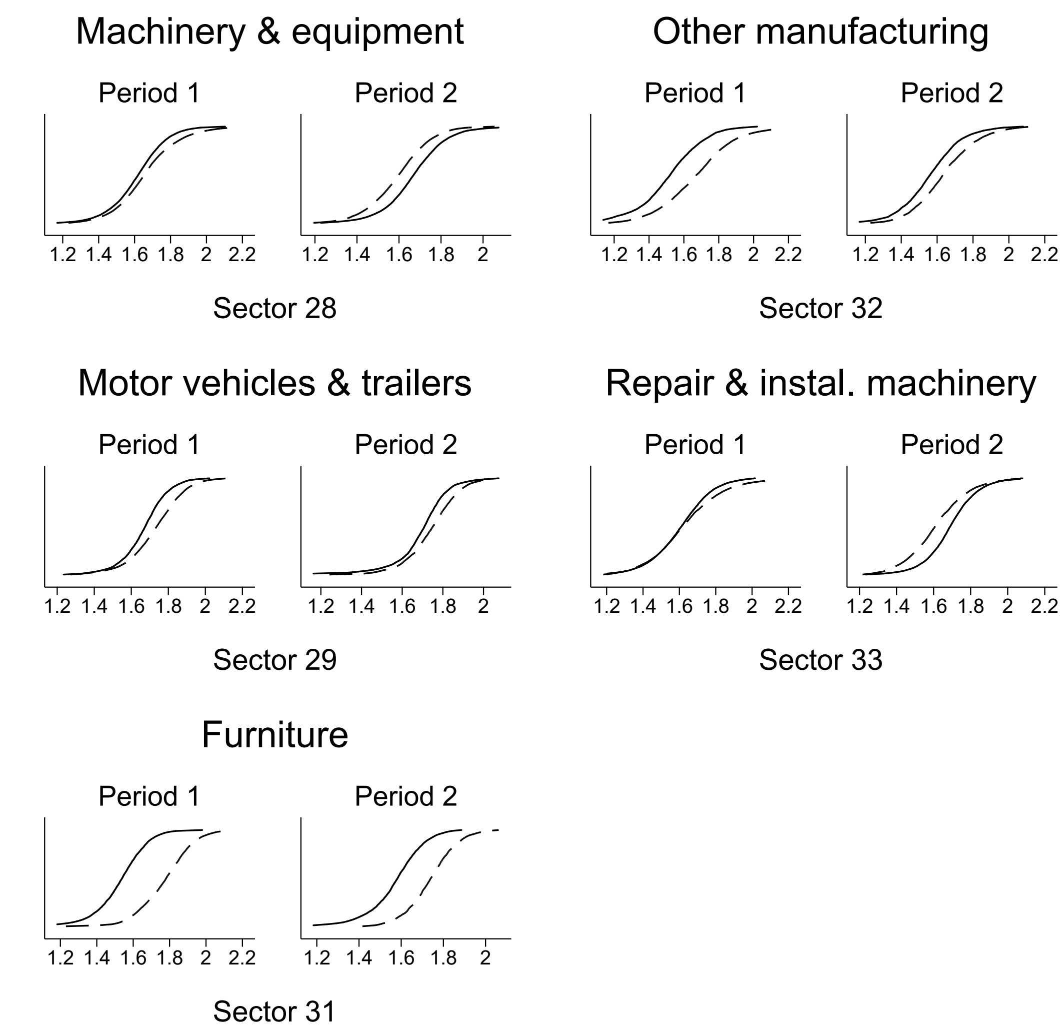
Dashed line is Germany and solid line is France. Period 1: 2003-2007 and Period 2: 2009-2013.

Figure 12: CDF ln TFP manufacturing sectors by periods



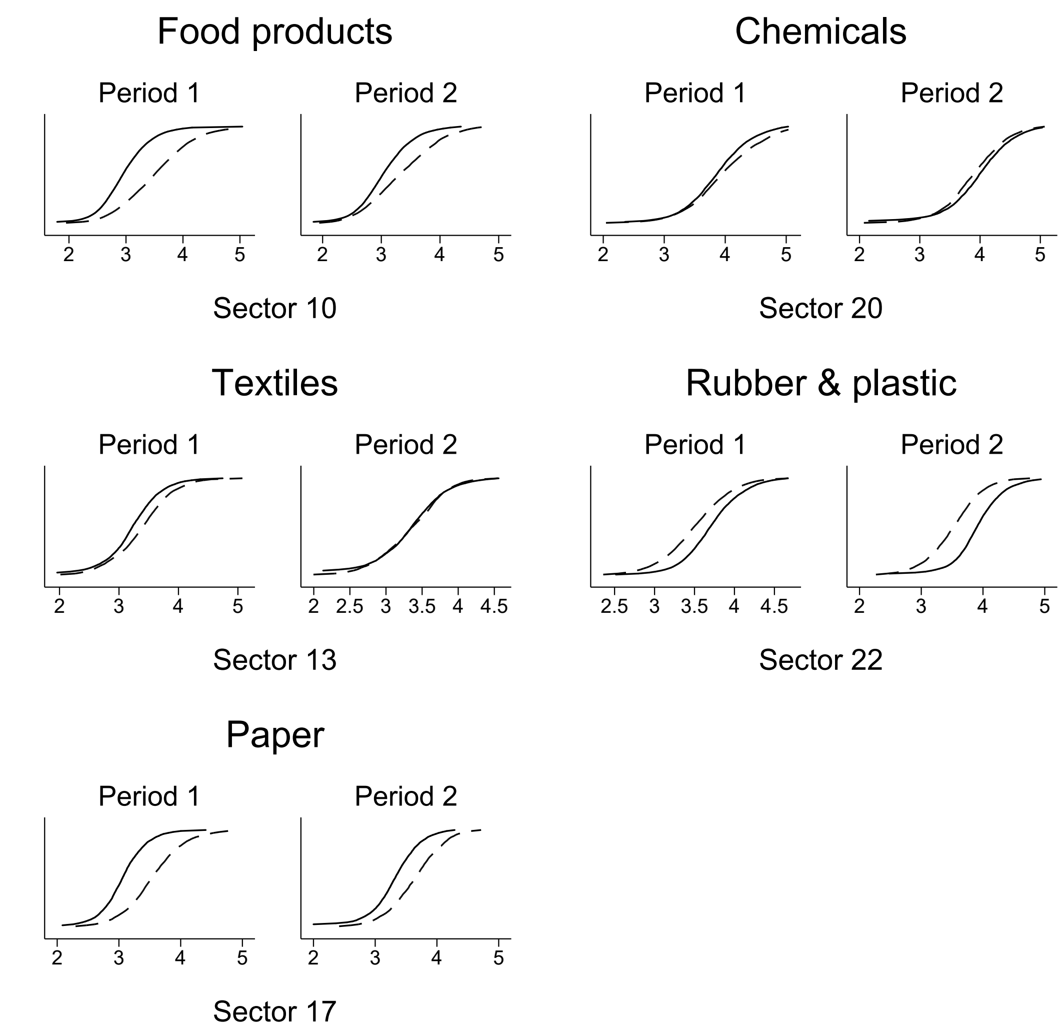
Dashed line is Germany and solid line is France. Period 1: 2003-2007 and Period 2: 2009-2013.

Figure 13: CDF ln TFP manufacturing sectors by periods



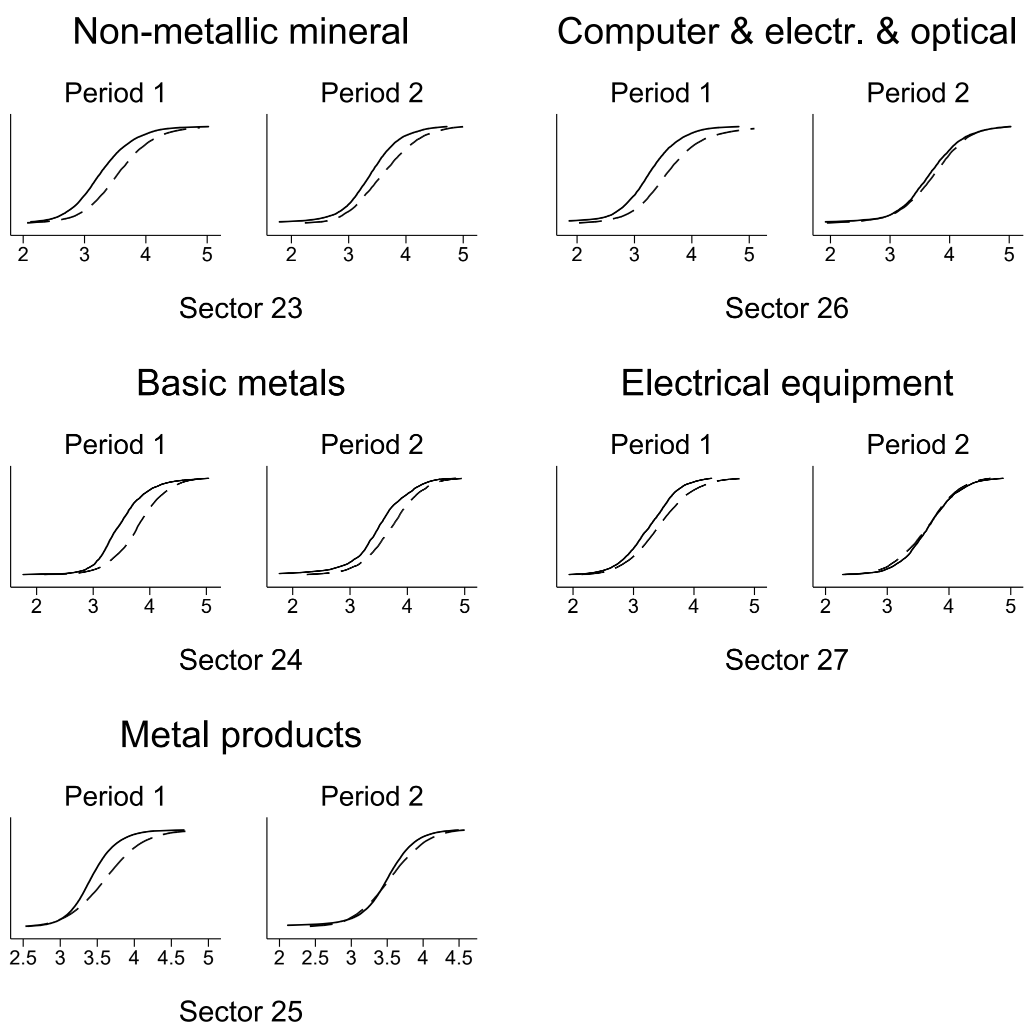
Dashed line is Germany and solid line is France. Period 1: 2003-2007 and Period 2: 2009-2013.

Figure 14: CDF ln ALP manufacturing sectors by periods



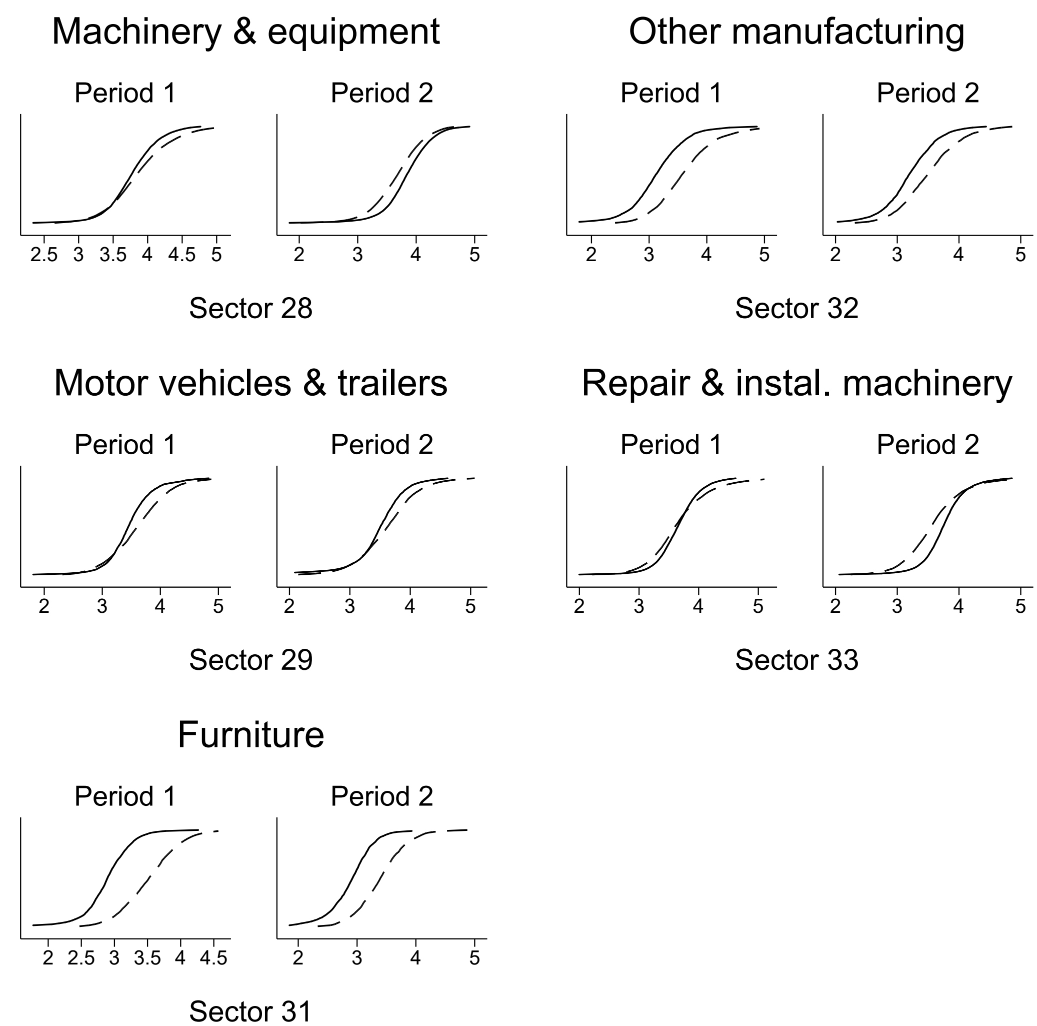
Dashed line is Germany and solid line is France. Period 1: 2003-2007 and Period 2: 2009-2013.

Figure 15: CDF ln ALP manufacturing sectors by periods



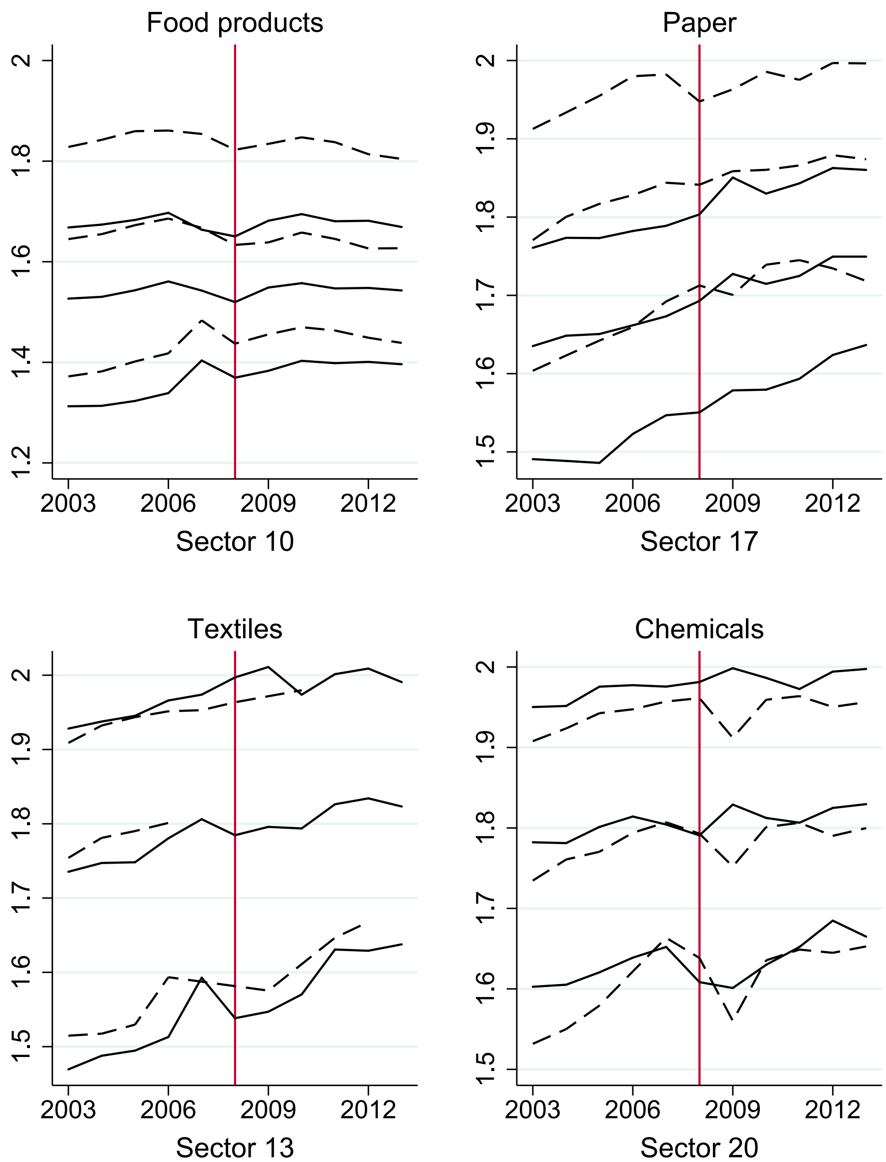
Dashed line is Germany and solid line is France. Period 1: 2003-2007 and Period 2: 2009-2013.

Figure 16: CDF ln ALP manufacturing sectors by periods



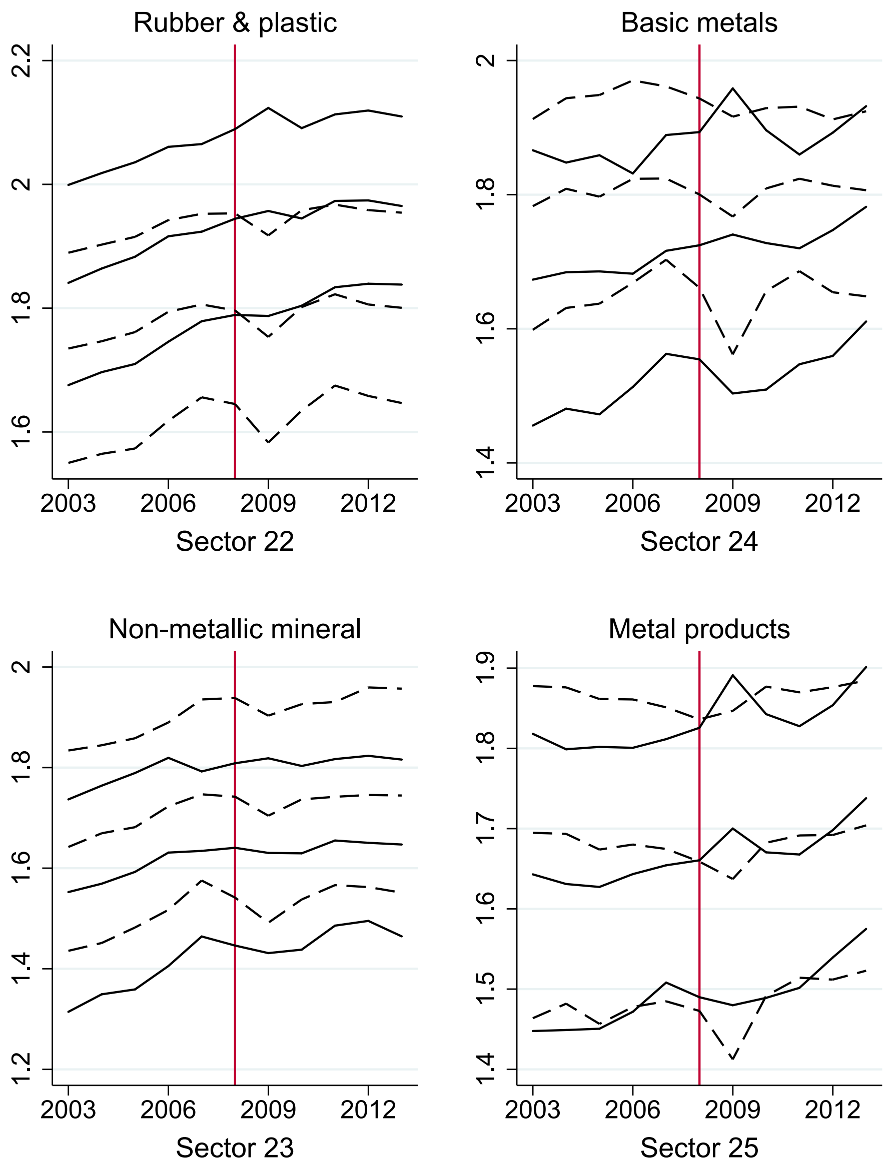
Dashed line is Germany and solid line is France. Period 1: 2003-2007 and Period 2: 2009-2013.

Figure 17: ln TFP evolution by percentiles: 10th, 50th and 90th



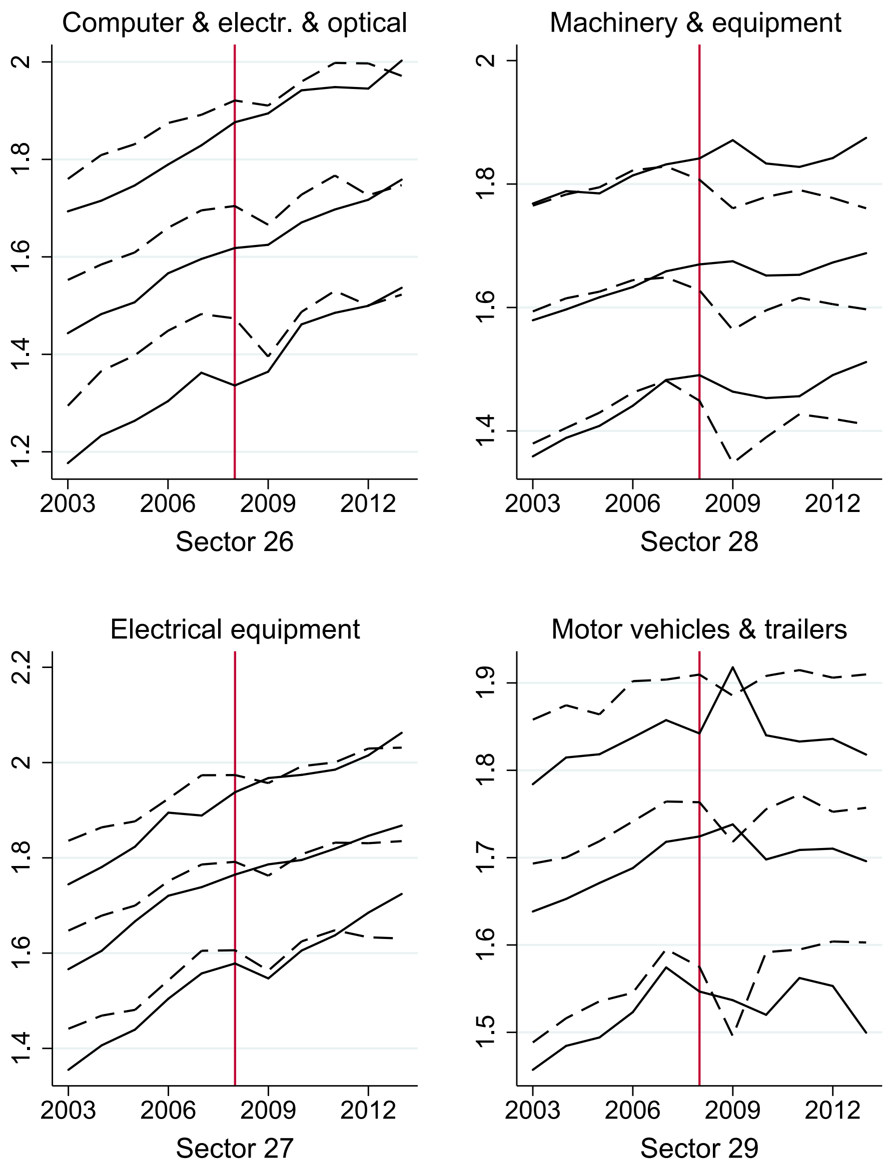
Dashed line is Germany and solid line is France. Reference line for year 2008.

Figure 18: ln TFP evolution by percentiles: 10th, 50th and 90th



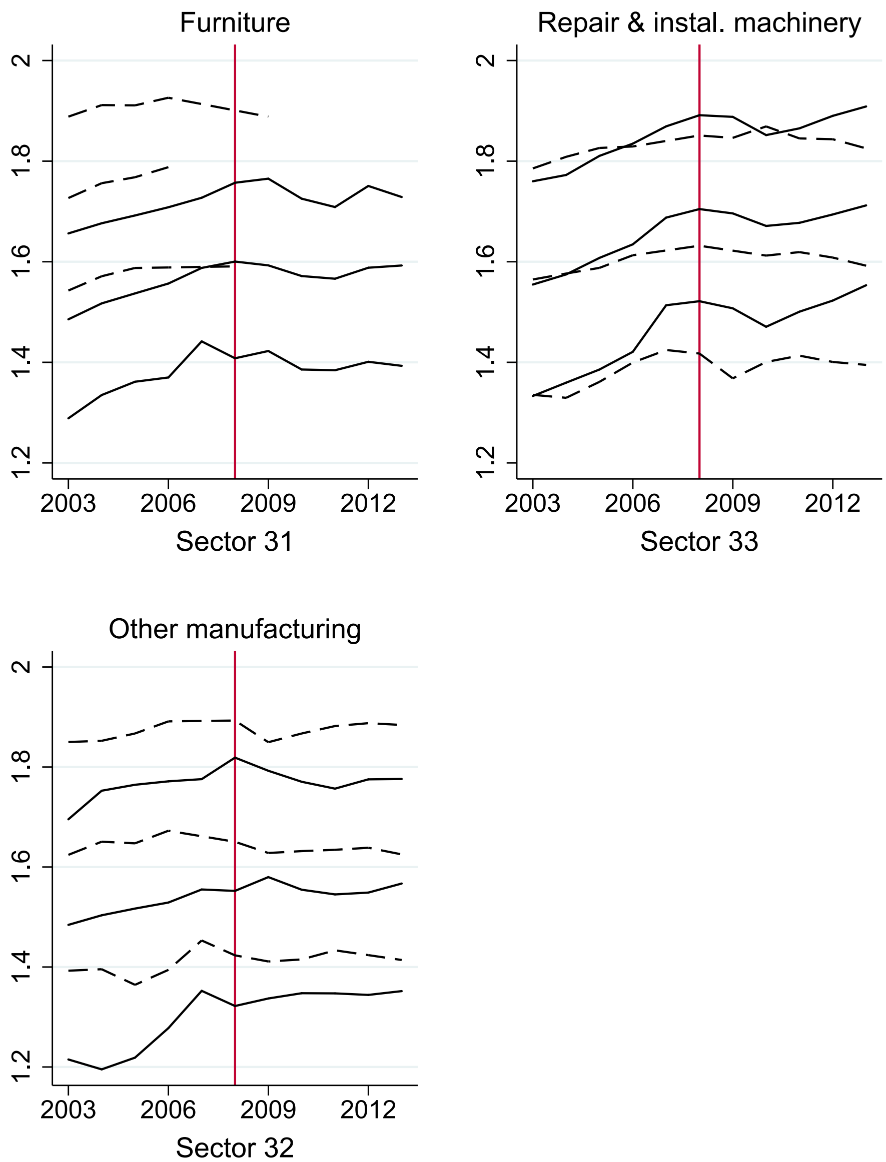
Dashed line is Germany and solid line is France. Reference line for year 2008.

Figure 19: ln TFP evolution by percentiles: 10th, 50th and 90th



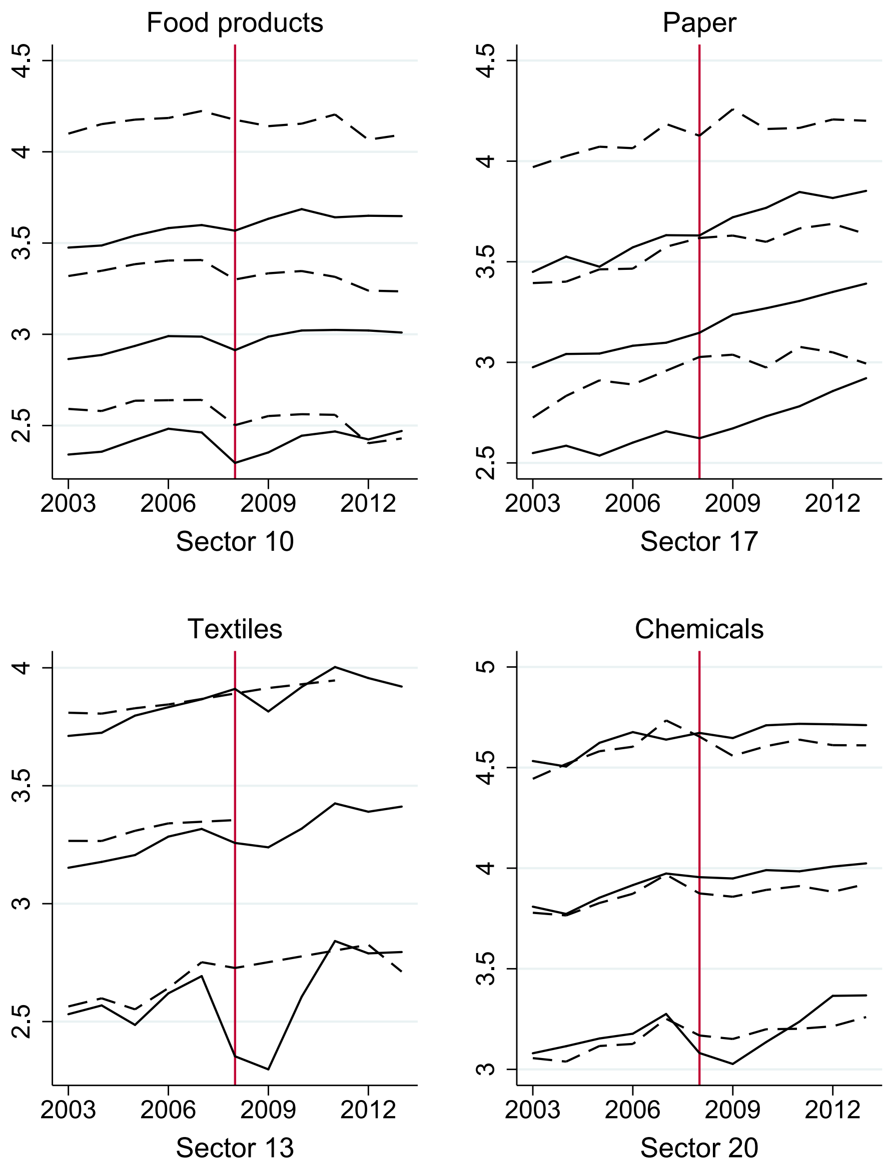
Dashed line is Germany and solid line is France. Reference line for year 2008.

Figure 20: ln TFP evolution by percentiles: 10th, 50th and 90th



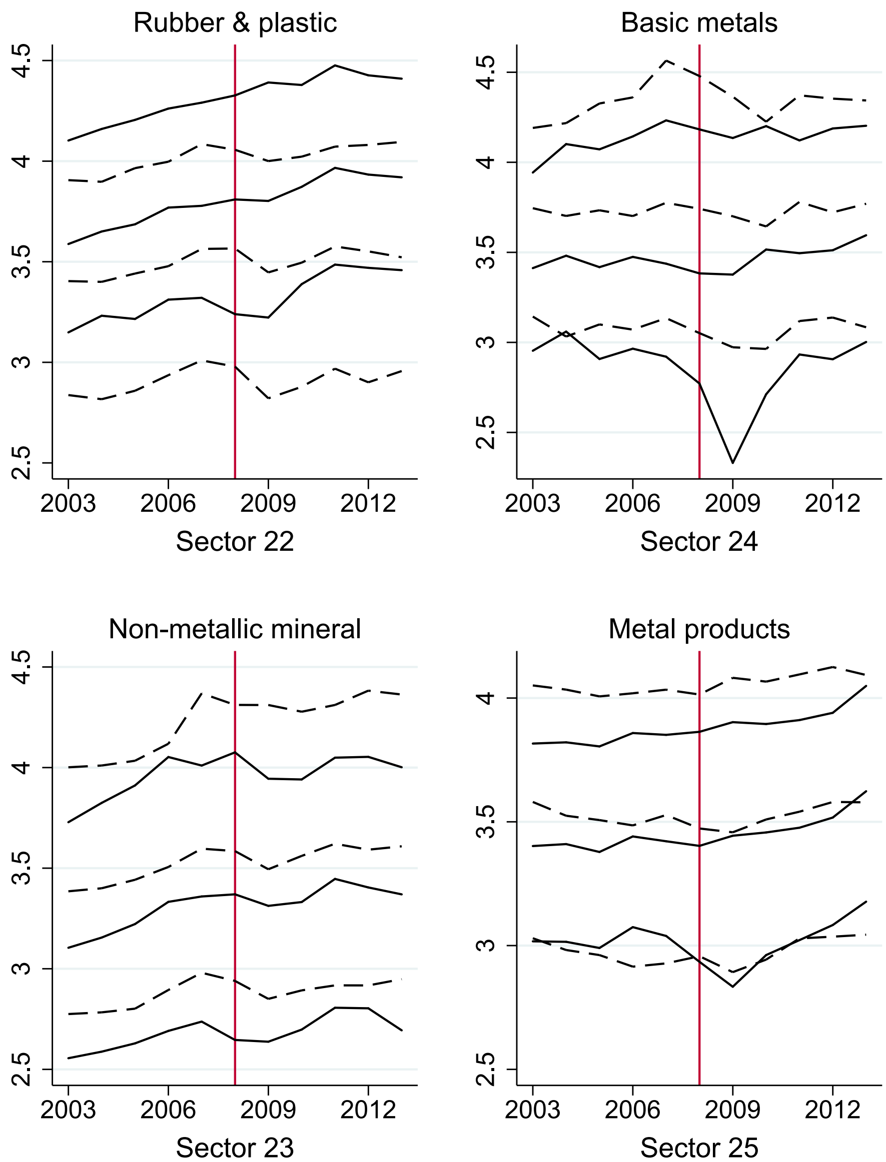
Dashed line is Germany and solid line is France. Reference line for year 2008.

Figure 21: ln ALP evolution by percentiles: 10th, 50th and 90th



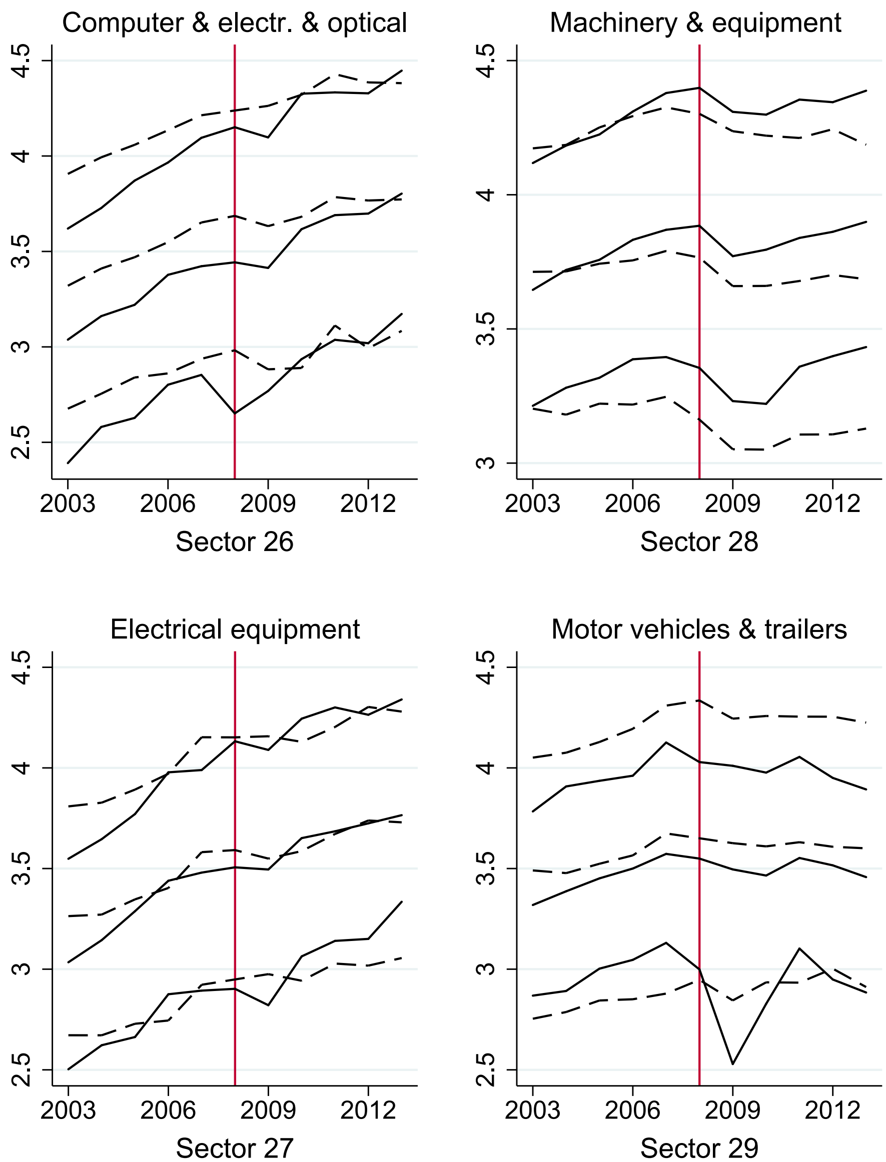
Dashed line is Germany and solid line is France. Reference line for year 2008.

Figure 22: ln ALP evolution by percentiles: 10th, 50th and 90th



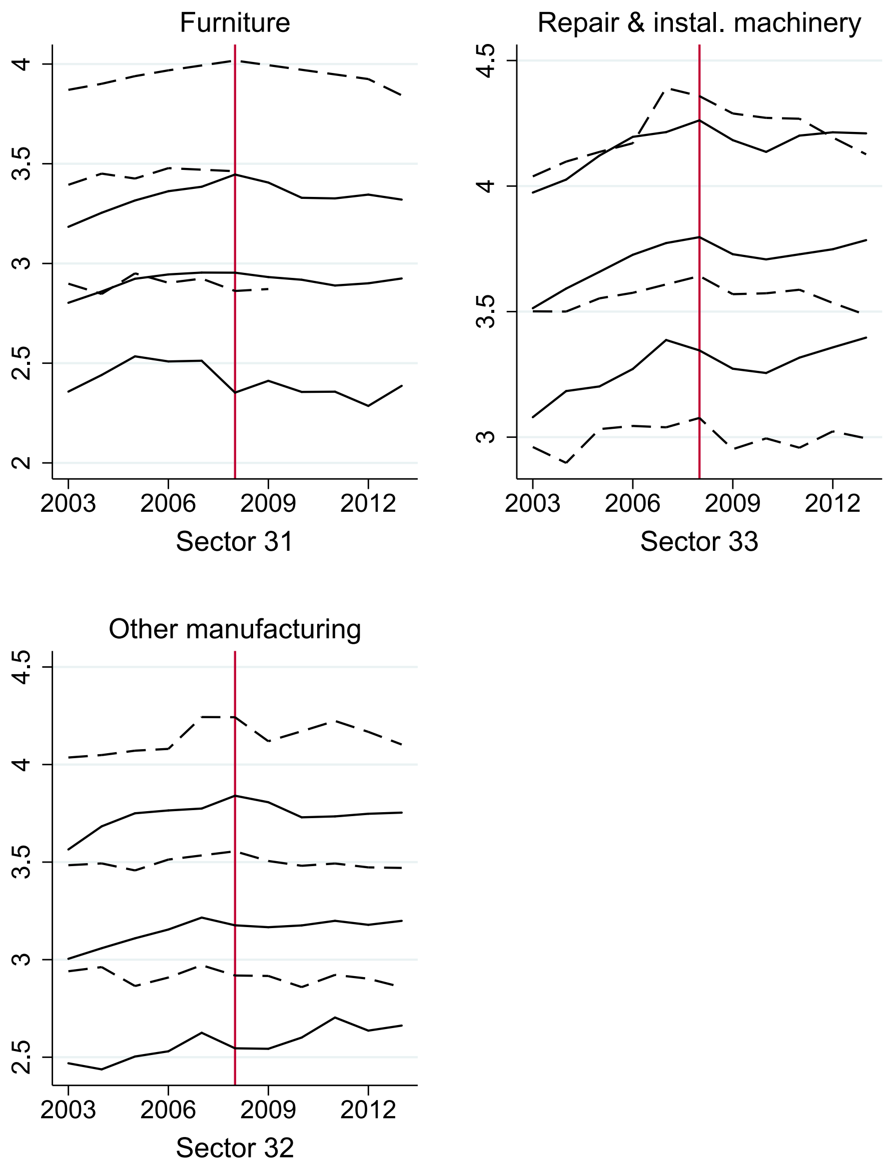
Dashed line is Germany and solid line is France. Reference line for year 2008.

Figure 23: ln ALP evolution by percentiles: 10th, 50th and 90th



Dashed line is Germany and solid line is France. Reference line for year 2008.

Figure 24: ln ALP evolution by percentiles: 10th, 50th and 90th



Dashed line is Germany and solid line is France. Reference line for year 2008.