

# **Domestic value added content of exports: a cross-country comparison for the major European economies**

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## **Abstract**

By matching data from foreign trade statistics, National Accounts and input-output tables the analysis aims to evaluate the stimulus to growth supplied by exports. It does so taking apart the impact of the international outsourcing between 2000 and 2007 for the major European economies, i.e. Germany, Italy and France. In place of the simple value of gross exports, two indicators, *direct value added content* and *domestic value added*, try to measure the domestic effects generated by exports. In the same vein, the paper proposes a proxy to measure *labour share* in the three countries' exports.

**Keywords:** Fragmentation, vertical specialisation, factor content of trade.

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## 1. Introduction

The dramatic increase in the fragmentation of production across different countries has led to a growing awareness that conventional trade statistics may be misleading when measuring a country's export performance and the contribution of exports to domestic product and income growth. Since inputs cross the borders several times, trade flow statistics - measured in gross terms - have become less reliable to evaluate the value added that exports create in a given country.

The development of global production chains has affected the European countries as well, leading to an increased level of openness of their economies since mid-nineties up to the great trade collapse of 2008. The growth in the fragmentation of production, with a large amount of intermediate inputs imported from other countries, has been particularly strong for Germany and Italy. It has implied a lower content of domestic value added generated by exports. Although efforts have been made in theoretical and empirical studies to trace value added in international trade, a few attempts addressed to quantify the effects of international fragmentation of production on the aptitude of European economies to generate domestic value added. This paper tries to fill this void by tracing the value added content of exports and the content of its main component, labour costs, in the exports of France, Germany and Italy.

The conceptual framework used in the analysis is quite standard in the literature.

Hummels, Ishii and Yi (2001) (HIY in subsequent discussion) introduced measures of the import (foreign) content of exports (defined as "vertical specialisation") based on input-output tables. The concept of "vertical specialisation" of trade is strictly related to the international fragmentation of production. The literature on "trade in value added" shares with the literature on vertical specialisation the methodology to distinguish the foreign and the domestic content in gross exports. By implicitly adopting the HIY approach, a large number of papers used input-output tables to focus on the domestic content of Chinese exports: among them, Chen, Cheng, Fung and Lau (2004), Koopman, Wang and Wei (2008), Dean, Fung and Wang (2007). This paper mainly follows the methodologies used in this strand of empirical literature.

A more recent line of research focuses explicitly on measuring the value added content of trade by requiring an international input-output framework. Daudin *et al.* (2009), Johnson and Noguera (2010) and Koopman *et al.* (2010) used the GTAP database to calculate trade flows in value added<sup>1</sup>. In the first two papers, the authors estimate domestic value added of trade by taking into account, besides the foreign content of exports (in HIY definition), the domestic value added that comes back to the country through intermediates exported and subsequently re-imported in more processed components. Koopman *et al.* (2010) provide a conceptual framework to measure the sources of value added in the global production chains. Their framework enables a complete concordance between value added trade and official gross trade statistics.

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<sup>1</sup> The GTAP database is compiled by the Global Trade Analysis Project at Purdue University. It is a multi-country datasets, based on raw data from different sources: World Bank, IMF and United Nations Statistics and input-output tables based on national statistical sources. Data from input-output tables are adjusted to be consistent with international data sources.

Moreover, they decompose domestic value added in exports (foreign value added in imports) into components that reveal each country's upstream and downstream positions in the global value chain.

This paper is also related to the recent studies proposing measures of factor content of trade, such as Trefler and Zhu (2010) and Foster, Stehrer and de Vries (2011). In particular, the latter decomposes the factor components of trade, capital and labour income, by focusing on net trade in value added rather than exports or imports of value added separately.

This paper makes threefold contributions to the existing debate on value added content of trade. First, it uses sector trade data and National Accounts information to measure direct value added content and labour share of manufacturing exports for France, Germany and Italy. Second, it combines these data with the 2000 and 2007 input-output tables of the three countries to estimate a metric of domestic value added of exports consistent with the HIY measure of vertical specialisation and a measure of the domestic labour compensation content of exports. Third, by comparing the two measures of direct and domestic value added of exports, the paper splits the domestic value added of sectors by direct and indirect value added, the latter being the value added generated in the upstream sectors including services.

The quantification of this indirect component of value added of exports constitutes a first step to verify whether the strengthening of the global production chains has increased activities in domestic production chains in the countries under analysis. A further step should consist in splitting this indirect component into the value added created in manufacturing industry and in services. The issue is particularly relevant considering that, according to a quite common view in the economic debate, the strengthening of the global production chains may lead, in the advanced industrialised economies, to an increase in skill-intensive activities often undertaken in economic units classified as "service firms". In this regard, according to OECD and WTO (2011) *"this break-up is particularly important when identifying the sources of national competitiveness, which may rest in upstream sector which are not considered as exporters by traditional statistics, or measuring the employment impact of export production"*.

## 2. Conceptual framework<sup>2</sup>

The *value added* generated in a country or in an industry can be defined as the sum of value added  $VA$  in each sector  $i$ , that is, the value of the production of that sector,  $Y_i$ , minus the value of all inputs  $INT_i$  utilised in sector  $i$ :

$$VA = \sum_i VA_i = \sum_i (Y_i - INT_i) = \sum_i Y_i \cdot \left(1 - \sum_j a_{ji}\right) = \sum_i [Y_i \cdot va_i] \quad (1)$$

with  $a_{ji} \leq 1$  representing the value coefficient of inputs (both domestically produced and imported) from sector  $j$  employed to produce one unit of output in sector  $i$  and the term  $va_i$  the value added content of one unit of product in the sector, that is, the ratio of value added content on production in sector  $i$ . It includes the ratio of the returns of the factors of production different from intermediates: compensation of employees (wages and contributions), pre-tax profit and rent ( $va_i = ce_i + \pi_i$ ).

This formula has been applied to trade statistics in order to estimate the overall direct value added of exports, defined as the sum of the value added generated by each sector's exports in its own sector<sup>3</sup>. The underlying assumption is that in each sector the value added embodied in a good produced for export is equal to the value added of the same good produced for domestic consumption<sup>4</sup>. The expression to measure the direct *value added content of exports* for a country can be written as:

$$VAX = \sum_i X_i \left(1 - \sum_j a_{ji}\right) = \sum_i [X_i \cdot va_i] \quad (2)$$

where  $X_i$  is the value of gross exports of industry  $i$ .

Under the condition that all exports and domestic sales have the same coefficient  $a_{ji}$  for each  $i$ , at sector level the ratio of direct value added content ( $va_i$ ) is the same in final demand and exports. At the aggregate level, the direct value added content of production ( $VA$ ) and the direct value added content of exports ( $VAX$ ) are instead equal respectively to the *output-weighted* sum of the sectors' value added ratio and to the *export-weighted* sum of the sectors' value added ratio. The way to empirically implement the  $VAX$  measure is relatively clear and simple. It implies the use of National Accounts data on production and value added in order to proceed to a straightforward calculation of the value added ratio for each sector and, thus, to the estimation of  $VAX$  for the manufacturing as a whole, by applying the ratios to export statistics.

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<sup>2</sup> All the definitions of this section have been reported in a matrix notation in the Appendix.

<sup>3</sup> The definition of direct value added of exports comes from Chen et al. (2001). They make a distinction between the direct effect of exports as "the direct value added and labour requirement per unit of the output exported" and the indirect effect as the same requirement "in the production of the domestic intermediate inputs necessary for the production of the output being exported".

<sup>4</sup> This assumption is violated in countries, such as China, that engage in a massive amount of processing exports. Since imported intermediate inputs used in processing exports benefit of tariff reductions or exemption, this usually leads to a significant difference between the intensity of imported inputs in the production of processing exports and in the production for domestic final sales or normal exports. Koopman, Wang and Wei (2008) develop a procedure to adjust the calculation to allow for export processing trade.

In the same vein, this approach may be also used to extrapolate from the value added content of exports its main component, the labour share. The formula to calculate the *labour content of exports* is the following:

$$CEX = \sum_i [X_i \cdot ce_i] \quad (3)$$

where  $ce_i$  is the “compensation of employees” content for one unit of product in sector  $i$ , drawn from the National Accounts data.

The direct value added content of trade, indeed, turns to be a quite unsatisfactory metric. It catches just the value added created by the exports of each manufacturing sector in its own sector. Conceptually, a correct measure of the overall value added in trade would require information on the value added content in all inputs (goods and services) used in each manufacturing exporting sector. For this reason, I introduce the definition of *domestic value added of exports* as:

$$DVAX = \sum_i X_i \left[ va_i + \sum_j va_j a_{ji}^D + \sum_j \sum_k va_k a_{kj}^D a_{ji}^D + \sum_j \sum_k \sum_s va_s a_{sk}^D a_{kj}^D a_{ji}^D + \dots \right] \quad (4)$$

where  $a_{ji}^D$  is the share of domestically produced inputs in sector  $j$  used in sector  $i$ .

This measure of domestic value added of exports considers not only the direct value added created by each sector in the production of exported goods, but also the value added contained in its domestic inputs. This latter is contained “directly” in domestic inputs (the second term in the square brackets) and “indirectly” since the value added of a domestic input can indeed be used in a industry whose output is in turn employed in another industry, and then possibly in a third industry and so on, until it is eventually included in the exported good.

The same goal of estimating the domestic value added content of trade may be obtained by estimating the contribution of imported inputs in any exported good and then, by difference, its domestic value added content. Starting from the approach in HIY, the following expression shows a different notation for the concept of *domestic value added of exports*, which removes from a country’s gross exports the value of the imported inputs used directly or indirectly to produce exported goods in each sector  $i$ <sup>5</sup>:

$$DVAX = \sum_i X_i \left[ 1 - \left( a_i^M + \sum_j a_j^M a_{ji}^D + \sum_j \sum_k a_k^M a_{kj}^D a_{ji}^D + \sum_j \sum_k \sum_s a_s^M a_{sk}^D a_{kj}^D a_{ji}^D + \dots \right) \right] \quad (5)$$

with  $a_i^M = \sum_j a_{ji}^M < 1$  the “direct content of imported inputs” of output in sector  $i$  (the value of imports from all  $j$  sectors directly utilised to produce in sector  $i$ ) and all the terms in the round brackets representing the so called “direct and indirect import share” (or “vertical specialisation” share in HIY definition) (the value of imports from all  $j$  sectors directly and indirectly utilised to produce in sector  $i$ ).

<sup>5</sup> Chen, Cheng, Fung and Lau (2004) give proof that formulas in (4) and in (5) yield identical results. So calculating domestic value added of exports by adding up the direct value added of exports and the sum of all indirect value added contained in the domestic inputs is equivalent to calculate domestic value added by subtracting from the gross value of exports the total imports directly and indirectly used to produce them. For a more clear explanation see the two expressions in matrix notation in the appendix.

This measure of domestic value added gets rid not only of the value of imports directly contained in the production, but also of the value of imported inputs indirectly used in the production of the product  $s$ , i.e. the imported inputs embodied in domestic inputs. It represents a further improvement in catching the contribution of exports to a country's value added because for each sector it accurately includes its value added and the domestic value added embodied in its domestically produced intermediate inputs<sup>6</sup>.

In the same vein, one can estimate the *domestic content of labour in exports*, by replacing the value added coefficient in expression (4), with the compensation of employees ratio:

$$DCEX = \sum_i X_i \left[ ce_i + \sum_j ce_j a_{ji}^D + \sum_j \sum_k ce_k a_{kj}^D a_{ji}^D + \sum_j \sum_k \sum_s ce_s a_{sk}^D a_{kj}^D a_{ji}^D + \dots \right] \quad (6)$$

The approach considering the import content of domestic inputs provides a quite accurate measure of the contribution of aggregate manufacturing exports to domestic value added and labour share. The *DVAX* metric identifies the backward linkages of each manufacturing exporting sector with those sectors that create more domestic value added, up to service industry. This result is particularly relevant in consideration of a quite common view in the economic debate according to which the strengthening of global production chains may lead in the more advanced industrialised economies to an increase in skill-intensive activities often undertaken in economic units classified as “service firms”. Moreover, quantifying the break up of domestic content by direct and indirect value added may be a further step to trace the amount of the value added which manufacturing creates in the economy.

### 3. Results

#### 3.1 Data

Value added, compensation of employees, intermediate inputs and production data are from the annual National Accounts broken down into 60 branches from the Nace classification published by Eurostat<sup>7</sup>. Detailed exports data for the period between 2000 and 2010 are from the Eurostat ComExt database. National Account data are used to compute the ratio of direct value added content and the ratio of labour costs to output for each sector. These ratios are then applied to trade statistics to compute the *direct value added* and the *direct labour content of exports* in each industry and in overall manufacturing.

The estimation of the two measures of *domestic value added* and *domestic labour content of exports* exploits also the annual input-output tables (domestic and import matrices) for the benchmark years 2000 and 2007 published by Eurostat and, for Italy, by Istat. Each set of tables contains information on domestically produced inputs and imported inputs, according to a 59-sector CPA classification, including goods and

<sup>6</sup> This measure does not include the share of imported inputs that originated at home, that is, the domestic value added returned from abroad in the imported intermediate inputs. Koopman *et al.* (2010) estimate that this share is about 7.4 per cent for the EU-15 countries in 2004.

<sup>7</sup> Note that the 2008 data are the latest available ones with this sectoral detail.

services. This allows to extrapolate from the total input coefficients of production of each manufacturing sector the share of their foreign content (direct or direct plus indirect) and thus, by difference, the domestic value added coefficients at sector level. By applying these coefficients to detailed data on trade, the domestic value added and the domestic labour content of exports at aggregate manufacturing level are obtained. In this exercise the imported inputs include goods and market service products, including energy products. However, since the highly volatile prices of energy products may lead to a bias in the measurements, as a robustness check, the domestic value added of exports has been calculated even by excluding energy from the share of imported inputs. Results remained confirmed.

### *3.2 Direct value added and labour content of exports*

In the first exercise, I matched National Accounts information on value added at sector level with trade data on exports to estimate the overall direct value added induced by gross exports of manufacturing goods for France, Italy and Germany. The three countries' "gross exports" have been transformed into flows of "direct exported value added", defined as the sum of the value added generated by exports of each manufacturing sector in its own industry. Although this measure represents only a sort of lower bound of the domestic value added content of exports, the ratio between the "direct exported value added" and gross exports can be considered as a first indicator of the aptitude of a country's merchandise exports to create primary income in manufacturing<sup>8</sup>. Moreover, the comparison of the patterns of this "direct value added" indicator and the more complete measure of "domestic value added content", introduced in the next section, can provide interesting insights on the characteristics and the evolution of the domestic production chains within the economies.

Figure 1 shows the pattern of manufacturing gross exports and of their direct value added for Germany, France and Italy between 2000 and 2010. Since National Accounts data at sector level are not yet fully available for the years 2009 and 2010, for this two-year period the estimates for exported value added are obtained under the hypothesis that the direct value added content of production for each sector is equal to the one in 2007, just before the global trade collapse. This assumption allows to estimate the rebound of exported value added after the crisis for the three country *as if* the characteristics of production in every single sector in terms of ability to create value added did not change because of the crisis.

In general the pattern of direct value added generated by manufacturing exports is weaker than gross exports would indicate. This is because in the period the value added content of production decreased in almost all manufacturing sectors for the three economies under analysis. The gross value of German industrial exports increased by 60.8 per cent in the 2000-2007 period, while in terms of direct value added content the growth was lower, equal to 53.5 per cent. The divergence between the growth of gross exports and of their direct value added content was slightly greater for Italy than for Germany. In

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<sup>8</sup> Using a definition of INSEE, primary income corresponds to "the income directly related to participation of households in the production process. The majority of the primary income of households consists of the remuneration of employees, which includes wages and social contributions. This income also includes the income from property resulting from the loan or rental of financial assets or land (interest, dividends, land income, etc.)".

2007 the gross aggregate of Italian exports had grown by 38.0 percentage points with respect to 2000 compared with an increase in their value added content of about 26.3 per cent. During the same period the increase in the exported direct value added for France was almost negligible, reflecting the moderate growth of gross exports. Therefore, the performance of German exports was more favourable also in terms of direct value added produced in manufacturing, than that of Italy and especially France.

Figure 2 shows the direct value added content in terms of production and exports in 2000 and 2007 for Germany, Italy and France at the aggregate level. The German industry is characterised by a higher level of direct value added content in manufacturing with respect to the other two countries both in terms of production and exports. In 2007, for every hundred euros of exported manufacturing goods, the direct content of value added was 31 euros for Germany, 26 for Italy and 24 for France. The marked difference in the value added content between Germany and the other two countries is almost entirely due to the higher level of value added content within each sector rather than to differences in the sector composition of exports.

Since the value added content varies with the sectors and the mix of products exported is different from the mix produced, in 2000 the value added content of total production is somewhat higher than the value added content of exports for all the three countries. Between 2000 and 2007 a generalised reduction of value added content for each unit of production and exports can be observed: the reduction of the value added content of production was comparable for the three countries (around 2 percentage points). For the German manufacturing the reduction of the value added content of exports was smaller than the one for production because of a change in the sector composition of the German exports towards sectors with a higher value added content whereas for Italy the change in export composition went in the opposite direction.

Although the analysis of this paper focuses on the period from the launch of monetary union to the eve of the global crises (2000-2007), the first effects of the crisis can be shortly seen since National Account data are available up to 2008<sup>9</sup>. The trend towards the generalised reduction of the value added content became even more accentuated during the last great recession: data on 2008, the latest available, confirms a further decrease especially in the direct value added content of total production for Germany and Italy.

National Accounts have also been used to estimate the main component of the value added content of exports, the “compensation of employees”. It refers to the overall amount of remuneration paid to employees including wages and social contributions. Measuring the growth of this component aims at evaluating the “gain” for the labour force working in manufacturing derived by the increase of gross manufacturing exports. Figure 3 compares the pattern of gross exports and their direct content of “compensation of employees” for France, Germany and Italy. It is striking noticing that while for Italy and France the pattern of the overall amount of labour remuneration induced by exports is similar to the pattern of gross exports, for Germany they strongly diverge since year 2003. Therefore, the strong expansion of the German industrial exports, equal to 45 per cent in the period between 2003 and 2010, induced a “gain” in terms of overall gross wage in manufacturing

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<sup>9</sup> The analysis of this paper mainly focuses on the benchmark years 2000 and 2007. This because the estimation of the indicators presented in the following paragraph is based on the annual input-output tables currently available up to 2007.



of just 16 per cent<sup>10</sup>. The pattern is completely different for Italy and France where the evolution of “compensation of employees” content of exports is closely related to that of gross exports. The extensive reform of labour market in Germany set out by the Hartz Committee, which introduced between 2002 and 2005 a more extensive use of fixed-term and temporary contract, lowered social security contributions and some innovations to collective bargaining, may explain this pattern<sup>11</sup>.

Figure 4 tries to shed light on this pattern showing the aggregate “compensation of employees” content in terms of production and exports in 2000 and 2007 for Germany, Italy and France at aggregate industry level. In 2000 the direct labour share for German industrial production was about 25 per cent, almost 10 and 8 percentage points higher than for Italy and France. In the following seven years the share of labour costs in German manufacturing decreased by about 5 percentage points. The pattern of reduction of the “compensation of employees” content for Germany was the same if considered in terms of exports. Conversely, the level of “compensation of employees” in total production for Italy and France remained stable over the 2000-2007 years showing a reduction almost negligible.

### *3.3 Domestic value added content and domestic labour share of exports*

In this section the *domestic value added of exports*, estimated according to the definition in (5), and the two complementary indicators of “imported input content” of exports (including or not the indirect component of imported inputs) for the three countries are presented. Table 1 displays these estimates allowing for a comparison with the corresponding measures of *direct value added* in the two benchmark years.

The domestic value added shares are in general more than double of the direct value added shares. This is an unsurprising result. As already written, the direct value added aggregate catches only the value added created by each manufacturing sector’s exports in its own sector. Instead, the domestic value added aggregate is aimed at estimating the value added created by manufacturing exports in all the economy, that is in all private sectors including services, by taking into account also the domestic value added contained in all the inputs used to produce exported manufacturing goods.<sup>12</sup>

In 2007 the aggregate domestic value added shares of manufacturing exports, calculated removing from the gross exports the direct and indirect imported inputs, were 61.7, 65.5 and 64.0 per cent respectively for Italy, Germany and France (table 1 and fig. 5). This result confirms that the domestic value added generated by manufacturing exports in Germany is higher than in Italy. However, when considering the extent to which manufacturing sectors create value added in the economy and not just in their own industries, this higher aptitude of Germany with respect to Italy and especially France is strongly attenuated. In 2007 the share of domestic value added of German manufacturing exports was similar to the one calculated for French exports and closer (although still

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<sup>10</sup> In the same period, the labour input in terms of hours worked in German manufacturing decreased by 2.4 per cent; for Italy they remained almost stable (+0.7 cent).

<sup>11</sup> On this topic, see Sabbatini R. and F. Zollino (2010).

<sup>12</sup> The shares of direct and indirect content of imported inputs of exports turn out to be about ten percentage point higher than the shares calculated including only the direct import content of exports. About one third of the imported content of exports comes from indirectly imported inputs that are embodied in domestic inputs. This result is consistent with the findings in Breda and Cappariello (2010) for Italy and Germany.

higher) to the share for Italian exports. This result implies a relatively greater ability for French and Italian manufacturing industries with respect to German ones to activate value added in the upstream sectors rather than in their own industries. A higher degree of fragmentation of domestic production chains in manufacturing for France and Italy may partly explain this result: in German manufacturing firms, characterised on average by a greater dimension, a higher proportion of tasks necessary to produce are undertaken in the same firms rather in economic units in the upstream domestic industries.

From a dynamic point of view, the stronger reduction of value added generated by manufacturing exports for Italy with respect to Germany and France turns out to be confirmed even when using the domestic value added indicator (table 2). However, by comparing the growth of exports between 2000 and 2007, the direct value added, and the domestic value added for the three countries, it is evident that only for Germany the growth of domestic value added is about in line with the increase of the direct value added. For France and Italy instead the increase of domestic value added is higher than that of the direct value added in manufacturing, indicating that for these two economies the lower increase of value added within each sector has been partially compensated by a stronger activation of domestic value chains.

For comparison, the results from the exercise that excludes the energy products as inputs in order to avoid the impact of the high volatility of oil prices on the estimates are also showed (table 3). In 2007 the aggregate domestic value added content in manufacturing exports (excluding exports of “coke and refined petroleum products”) was 64.6 per cent for Italy, for Germany 67.4 and France 66.4. The shares are slightly higher with a more moderate downwards trend.

By applying labour coefficients at sector level to technical coefficients for domestic inputs from the input-output tables, the *domestic labour content* in manufacturing exports has been estimated. The results, plotted in figure 6, are compared with the estimate of *direct labour content* whereas in figure 7 the complete decomposition of exports between the domestic value added, with the detail of the domestic labour share content, and the total imported inputs is reported. Despite the dramatic reduction of labour share for Germany between 2000 and 2007, in 2007 the labour compensation content of manufacturing exports for Italy is confirmed to remain the lowest (considered both in terms of gross value and of domestic value added).

As for the case of value added, the labour content of exports in the domestic economy is greater than the sum of the labour content generated by each manufacturing industry in its own industry. Even in this case the proportion in which each manufacturing sector “contains” labour employed in the upstream sectors diverges among countries. For Germany and Italy only half of the domestic “compensation of employees” content of manufacturing exports derives from the labour contained in inputs utilised (directly and indirectly) in their production; for France the contribution of the upstream sectors to the domestic labour content is markedly higher and equal to about 60 per cent.

Moreover, the result of the strong reduction of the “direct” share of labour costs in German manufacturing exports is confirmed when the “domestic” share of labour is taken. Conversely, the share of “domestic compensation of employees” in exports for Italy and France remained stable over the 2000-2007 years. Because of the pattern of this indirect component of labour content, the one generated through the use of domestic inputs, the overall domestic labour share of manufacturing exports for France appears similar to the

one for Germany (respectively 38.7 and 38.3 per cent) and, for year 2007, the gap between Germany and France in terms of direct labour share disappears.

### *3.5 Additional insights from sectors*

In order to look at heterogeneous patterns at the sector level, tables 4, 5 and 6 report in ascending order the estimated share of domestic value added in manufacturing exports in 2007, their direct value added and each sector's share in the total manufacturing exports for Italy, Germany and France.

The ranking of the major manufacturing sectors in terms of domestic value added of exports in the three countries is quite similar. With a domestic value added between 70 and 73 per cent, "machinery and equipment" represents the sector which creates more domestic value added. Among the sectors large for all the three economies. "electrical machinery" is characterised by a large share of domestic value added although, in this case, the range is wider (from 65 for France to 74 per cent for Germany). "Motor vehicles" represents instead a sector with a low level of domestic value content (from 56 per cent for France to 63 per cent for Germany). "Chemicals", a sector characterised in France and especially in Germany by a relatively high content of domestic value added (respectively 63 and 65 per cent), in Italy creates a quite low level of domestic value added (47 per cent).

It is worthwhile to notice that a traditional sector such as "food products and beverage", which is particularly important for France since it accounts for 9 per cent of its total manufacturing exports, creates a very high level of domestic value added (79 for France and 75 per cent for Italy and Germany). Regarding to the traditional sectors in which Italy still presents a high level of specialisation (textiles and wearing apparel, furniture, leather products), they generate a relatively high domestic value added, at least for Italy and France.

## **4. Conclusions**

The development of global production chains, with an increased use of imported inputs, caused a generalised reduction of the domestic value added content for each unit of manufacturing production and exports in the major euro area economies.

In this paper, the phenomenon has been assessed for France, Germany and Italy by using two metrics well known in the literature on value added content of trade. The first one, the "direct value added share", considers just the direct value added created by exports in each manufacturing sector in its own sector; the second one, the "domestic value added share", includes also the domestic value added that exports in manufacturing create in the upstream sectors, including services, i.e. the sectors providing inputs. The same methodology has been applied to estimate the domestic content of the "compensation of employees" in exports.

By providing a description of the relationship between gross trade and its main value added component updated to the eve of the global trade collapse for these countries, the analysis highlights several interesting patterns.

First, in 2007 the "domestic value added" generated by each unit of German manufacturing exports in the overall economy (including services) was higher than in Italy

and about in line with France (respectively equal to 65.5, 61.7, and 64.0 per cent). The difference between Germany and the other two countries would be more accentuated by considering the metric of the “direct value added”, that is, the total value added created by every manufacturing sector’s exports in its own sector. This result highlights a relatively higher degree of fragmentation of domestic production chains in manufacturing for France and Italy. In German manufacturing firms, characterised on average by a greater dimension, a higher proportion of tasks necessary to produce are undertaken in the same firms rather in economic units in the upstream domestic industries.

Second, the domestic value added shares have decreased from 2000 to 2007 at a different pace among the three countries’, with a stronger reduction for Italy than for Germany and France. In a period of very different performances of gross manufacturing exports (grown by 61 per cent for Germany, 38 per cent for Italy and 13 for France) the growth of domestic value added content of German exports was robust, much higher than for Italy and France.

Third, in 2007 the domestic labour income content of manufacturing exports for Italy was markedly below the level of France and Germany (respectively equal to 30.2, 38.7 e 38.2). This difference remained despite the dramatic reduction of the share of labour costs in German manufacturing that was equal to 46.7 in 2000. Even if considered in terms of domestic value added created, in 2007 the compensation of employees content of manufacturing exports for Italy is confirmed to remain the lowest among the three countries (48 per cent, 58 for Germany and 60 for France).

In a period of robust increase for the German manufacturing exports, the growth of domestic value added content of German exports outperformed the pattern of the their domestic compensation of employees content, markedly weaker since 2003, with a major shift of the domestic value added created by exports from wages to profits. This evidence provides support for the hypothesis that profits in German took advantage of the strong increase of exports. In Italy, instead, the pattern of the overall amount of labour remuneration induced by exports was similar to the pattern of gross export. Since the level of compensation of employees share of manufacturing exports for Italy in 2000 was the lowest among the three countries (even in terms of domestic value added), there was less room for a reduction of wages.

There are several areas in which the estimations in this paper can be improved. First, it would be very interesting to split the indirect component of domestic value added of manufacturing exports into the value added created in manufacturing industry and in services. It would allow to verify if the strengthening of the global production chains may have led, in the European economies, to an increase in skill-intensive activities in services. A further step should consist to expand the period under analysis starting from 1995, since it was just in the second part of nineties that a strong increase of fragmentation of production for the three European economies took place.

## Appendix: Matrix algebra

Following the notations in Xikang (2007), in this section the formulas utilised in the paper are recast in a matrix form.

For the aggregate value added, as defined in (1), the matrix notation is:

$$VA = A_v Y \quad (A1)$$

with  $A_v$  representing the  $n$ -row vector of value added ratios and  $Y$  the  $n$ -column vector of total output.

The value added of exports, as defined in (2), is then:

$$VAX = A_v X \quad (A2)$$

where  $X$  is the  $n$ -column vector of exports.

Similarly the matrix notation for the *CEX* formula, as defined in (3), is:

$$CEX = A_{ce} X \quad (A3)$$

with  $A_{ce}$  as the  $n$ -row vector of the compensation of employees ratios.

Let  $A^d = [a_{ij}^d]$  be the matrix of direct domestic inputs coefficients and  $A^m = [a_{ij}^m]$  the matrix of direct imported inputs coefficients. The *domestic value added of exports* as defined in (4), can be expressed as:

$$DVAX = [A_v (I - A^d)^{-1}] X \quad (A4)$$

Now let's take the definition of the *direct and indirect import content of exports* that is, the sum of direct imported inputs and all rounds of indirect imports:

$$DIICE = [A_M (I - A^d)^{-1}] X$$

where  $A_M = iA^m$ , with  $A_M = (A_{M1}, A_{M2}, \dots, A_{Mn})$  is a row vector of the direct imported inputs and  $i$  is a  $n$ -row vector of 1's, i.e.,  $i = (1, 1, \dots, 1)$ .

The domestic value added of exports can be also expressed by the difference between the goods value of exports and their direct and indirect import content of exports:

$$DVAX = i - DIICE = [i - A_M (I - A^d)^{-1}] X \quad (A5)$$

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Table 1

**Shares of value added and import content in manufacturing exports**  
(in percentage)

	Italy		France		Germany	
	2000	2007	2000	2007	2000	2007
Direct value added	28.0	25.6	25.1	23.6	32.9	31.4
<i>of which: labour content</i>	15.7	15.2	15.9	15.7	25.0	20.1
Domestic value added	67.4	61.7	66.4	64.0	70.1	65.5
<i>of which: Domestic labour content</i>	31.2	30.2	38.6	38.7	46.7	38.2
Direct content of imported inputs	21.3	25.4	22.0	23.9	20.7	23.7
Direct and indirect content of imported inputs	32.6	38.3	33.6	36.0	29.9	34.5

Table 2

**Growth of gross manufacturing exports and their components (2000-2007)**  
(percentage points)

	Gross exports	Direct va of exports	of which: direct labour content	Domestic value added	of which: domestic labour content
Italy	38.0	26.3	33.7	30.7	33.8
Germany	60.8	53.5	29.5	54.8	31.5
France	13.3	6.4	12.0	10.6	13.5

Table 3

**Shares of value added and import content in manufacturing non energy exports excluding energy inputs**  
(in percentage)

	Italy		France		Germany	
	2000	2007	2000	2007	2000	2007
Domestic value added	69.1	64.6	67.8	66.4	71.2	67.4
Direct content of imported inputs	21.0	24.5	21.8	23.1	20.6	23.2
Direct and indirect content of imported inputs	30.9	35.4	32.2	33.6	28.8	32.6



Table 4

**Direct and domestic value added in Italian manufacturing by sector, 2007**

	Direct value added of exports	Domestic value added of exports	Share in total manufacturing exports
Coke, refined petroleum products and nuclear fuel	11.6	22.4	3.8
Office machinery and computers	21.6	39.8	0.5
Chemicals, chemical products and man-made fibres	22.3	47.0	9.4
Basic metals	17.8	48.4	7.7
Rubber and plastic products	26.1	58.7	3.8
Motor vehicles, trailers and semi-trailers	18.4	59.5	8.5
Other transport equipment	21.6	61.0	3.2
Radio, television and communication equipment	38.6	61.9	1.9
Textiles	28.9	62.9	4.1
Medical, precision and optical instruments	35.6	63.3	2.5
Pulp, paper and paper products	23.0	63.6	1.5
Furniture; manufacturing n.e.c.	26.6	66.1	5.0
Leather and leather products	25.3	66.6	4.2
Electrical machinery and apparatus n.e.c.	30.5	67.2	4.1
Wearing apparel; dressing; dyeing of fur	29.3	67.9	4.0
Fabricated metal products, except machinery and eq.	34.1	68.9	4.8
Machinery and equipment n.e.c.	29.2	69.8	21.6
Wood and wood products	31.9	69.8	0.5
Food products and beverages	21.1	74.8	5.5
Other non-metallic mineral products	32.0	75.6	2.9
Publishing, printing and reproduction of recorded media	36.9	76.3	0.5
Tobacco products	68.8	93.8	0.0

Table 5

**Direct and domestic value added in German manufacturing by sector, 2007**

	Direct value added of exports	Domestic value added of exports	Share in total manufacturing exports
Coke, refined petroleum products and nuclear fuel	7.2	17.3	1.9
Basic metals	24.1	50.5	7.0
Office machinery and computers	29.0	53.3	2.7
Leather and leather products	27.9	56.6	0.5
Wearing apparel; dressing; dyeing of fur	29.1	57.3	1.2
Radio, television and communication equipment	31.2	59.5	4.4
Other transport equipment	28.8	61.9	3.5
Motor vehicles, trailers and semi-trailers	24.9	63.3	20.1
Textiles	33.7	64.2	1.4
Pulp, paper and paper products	29.4	64.4	2.1
Chemicals, chemical products and man-made fibres	33.6	65.5	12.5
Rubber and plastic products	35.3	66.2	3.7
Furniture; manufacturing n.e.c.	35.1	69.1	2.0
Fabricated metal products, except machinery and eq.	38.8	71.8	3.8
Machinery and equipment n.e.c.	36.7	72.8	16.0
Electrical machinery and apparatus n.e.c.	36.1	74.1	5.5
Food products and beverages	24.1	74.7	4.1
Tobacco products	42.3	76.1	0.3
Medical, precision and optical instruments	47.9	77.0	4.6
Wood and wood products	29.6	78.0	0.8
Other non-metallic mineral products	37.8	80.0	1.4
Publishing, printing and reproduction of recorded media	42.1	85.6	0.6

Table 6

**Direct and domestic value added in French manufacturing by sector, 2007**

	Direct value added of exports	Domestic value added of exports	Share in total manufacturing exports
Coke, refined petroleum products and nuclear fuel	9.6	26.8	3.4
Motor vehicles, trailers and semi-trailers	13.4	55.8	13.7
Other transport equipment	17.2	57.0	9.8
Basic metals	21.8	58.5	7.2
Rubber and plastic products	29.5	62.0	3.3
Chemicals, chemical products and man-made fibres	21.3	63.3	16.6
Electrical machinery and apparatus n.e.c.	28.0	64.8	4.8
Pulp, paper and paper products	23.7	65.8	1.8
Textiles	28.5	66.1	1.6
Radio, television and communication equipment	23.3	66.2	3.6
Wearing apparel; dressing; dyeing of fur	31.3	68.5	1.9
Leather and leather products	40.7	70.2	1.2
Office machinery and computers	31.6	70.7	1.7
Machinery and equipment n.e.c.	31.4	71.1	9.6
Fabricated metal products, except machinery and eq.	36.5	71.5	2.6
Furniture; manufacturing n.e.c.	30.5	73.0	1.9
Medical, precision and optical instruments	38.4	74.3	3.7
Other non-metallic mineral products	34.8	78.5	1.4
Food products and beverages	23.1	78.8	9.0
Wood and wood products	28.2	78.9	0.7
Printing and reproduction of recorded media	35.7	79.9	0.6
Tobacco products	68.2	91.9	0.1

Fig.1

### Gross exports and direct value added content of exports

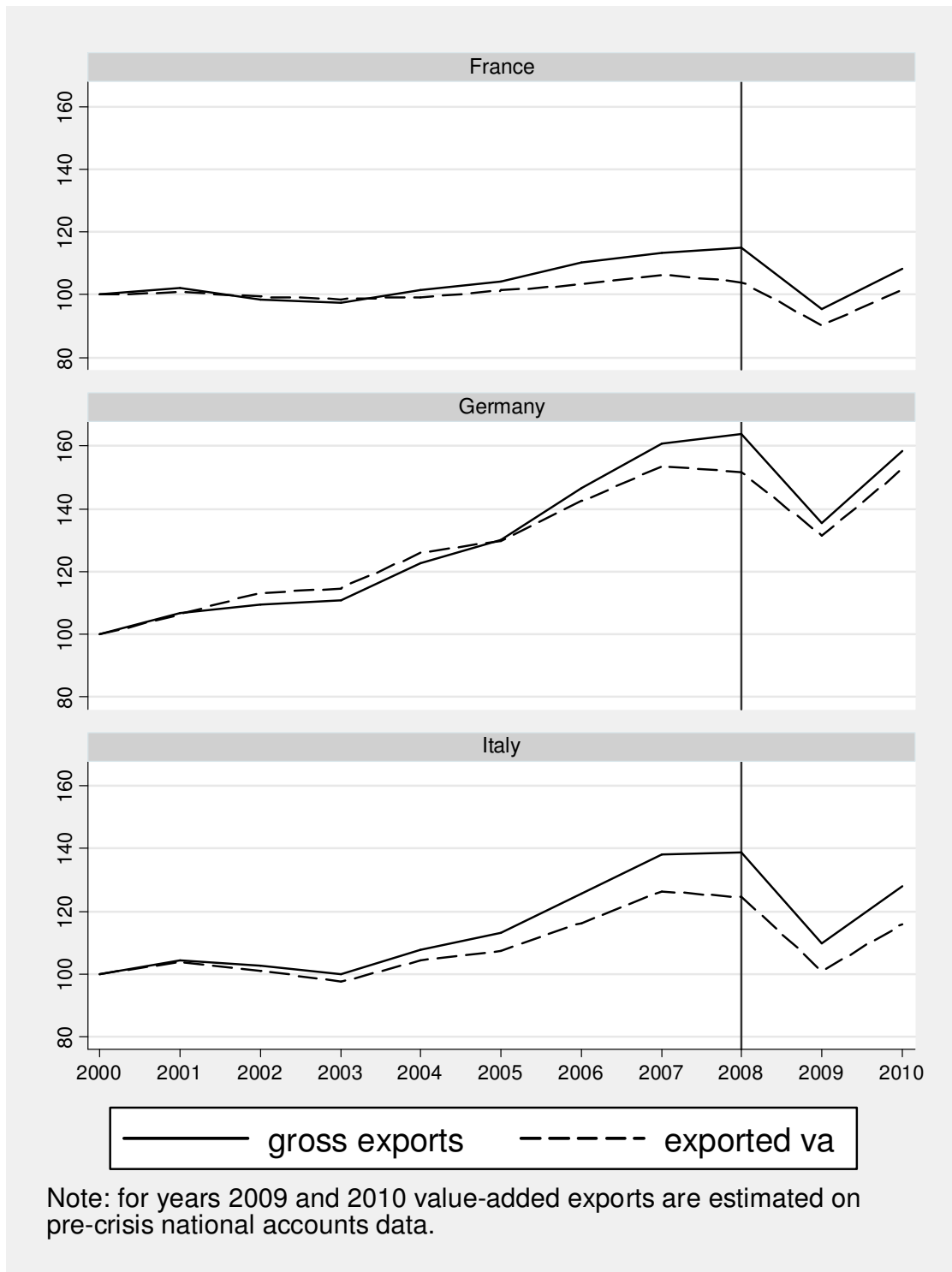


fig. 2

**Direct value added content in manufacturing production and exports**  
*(in percentage)*

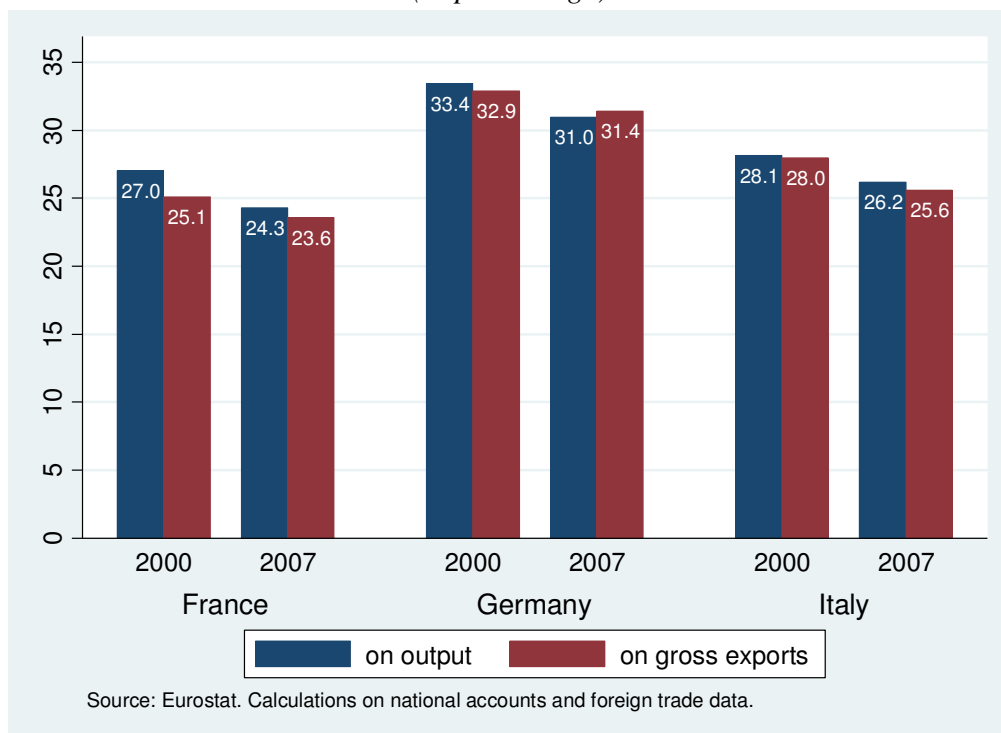


Fig.3

**Gross exports and direct compensation of employees content of exports**

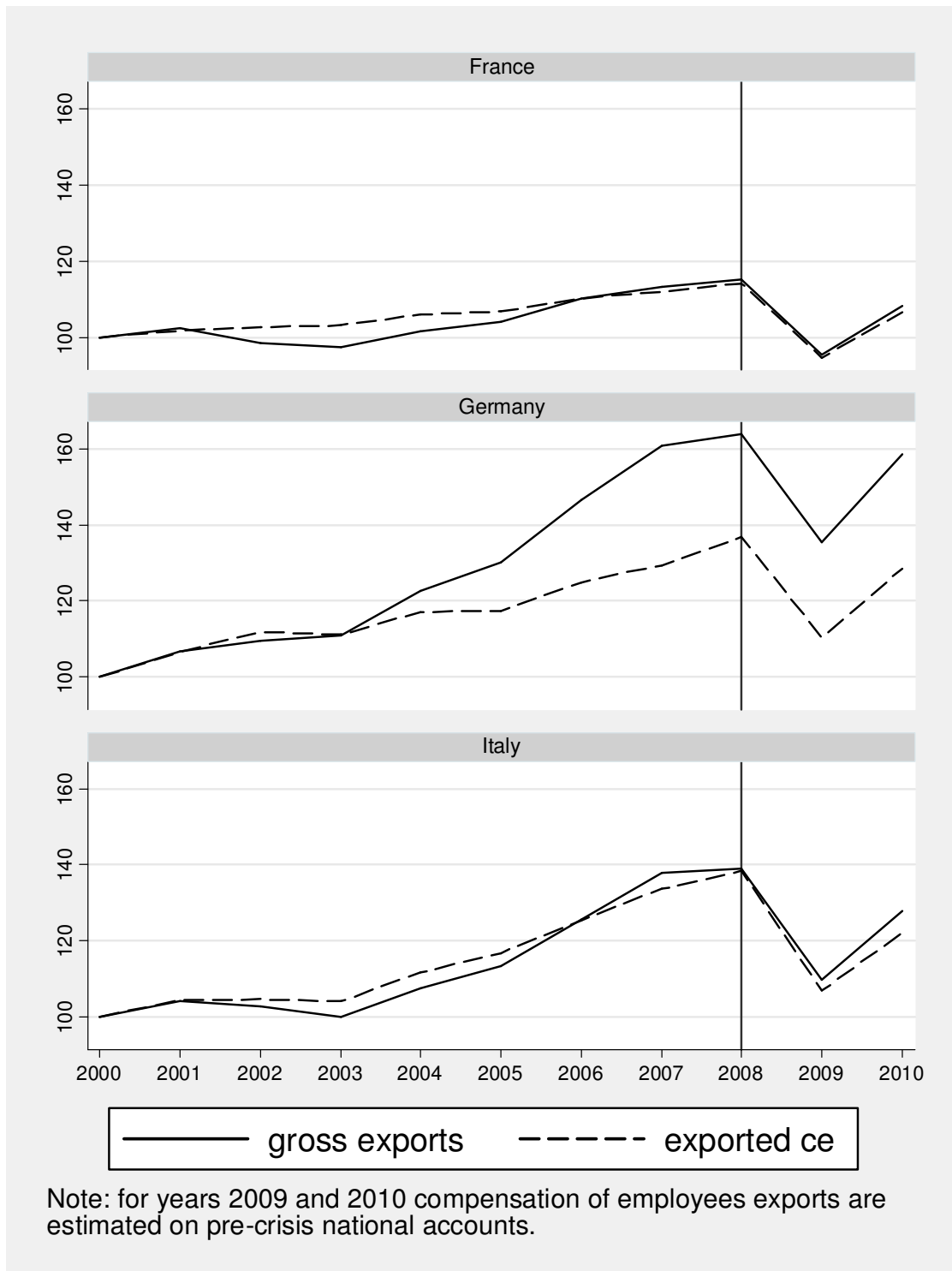


fig. 4

### Direct labour content in manufacturing production and exports (in percentage)

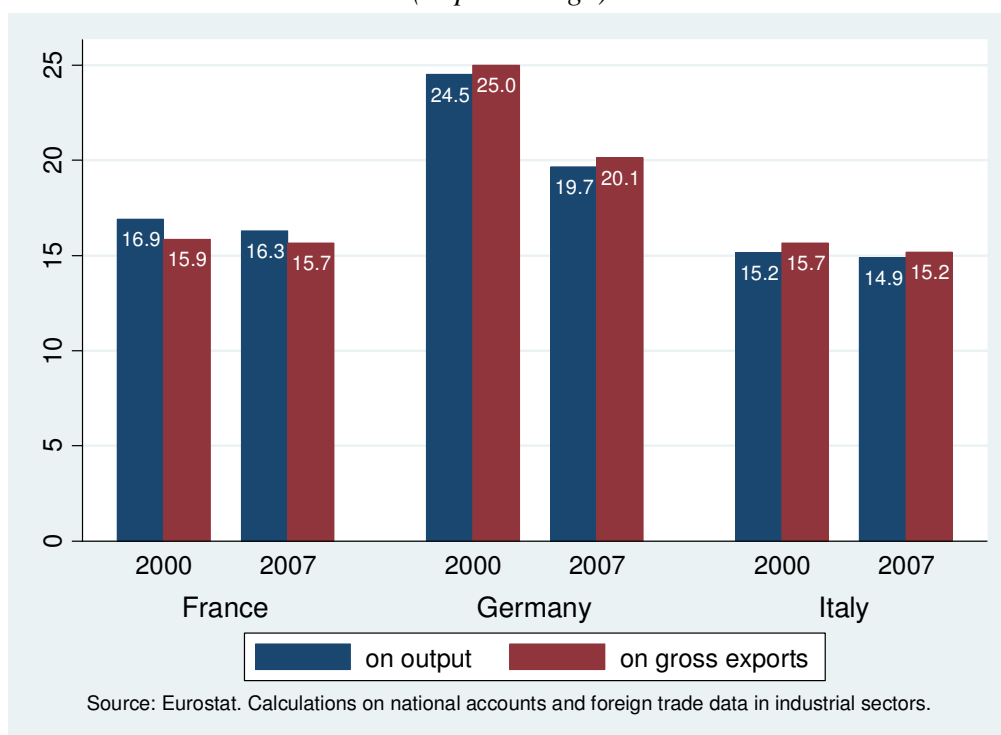


fig. 5

**Direct and domestic value added in manufacturing exports**  
(in percentage)

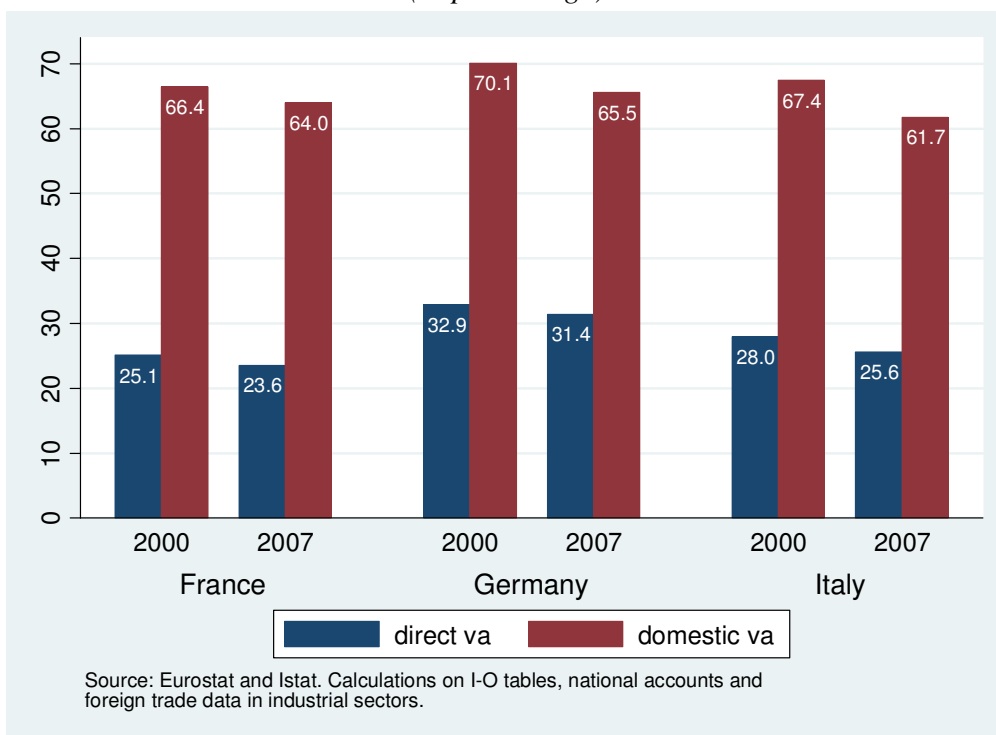


fig. 6

**Direct and domestic labour content in manufacturing exports**  
(in percentage)

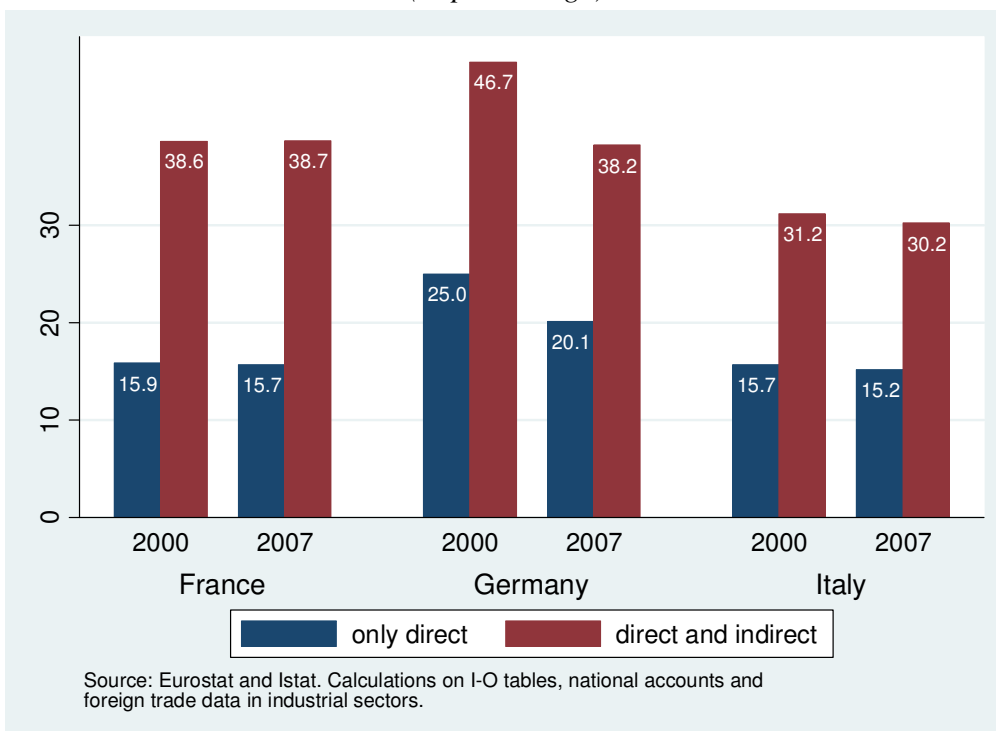




Fig. 7

**Decomposition of domestic export content**  
(in percentage)

