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Claire Giordano, Paloma Lopez-Garcia Firm heterogeneity and
trade in EU countries:
a cross-country analysis

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Abstract

Firms are heterogeneous, even within narrowly defined sectors. This paper surveys the relevant theoretical and empirical literature on firm heterogeneity and external trade. By innovatively exploiting rich cross-country micro-aggregated data sourced from the ECB Competitiveness Research Network (CompNet), this study then investigates the main implications of firm heterogeneity for trade of EU countries, showing a set of stylised facts. On the one hand, exporting firms are larger, more productive and pay higher wages than non-exporting firms. Only these firms are able to bear export costs, related to various factors, such as tariff and non-tariff trade barriers, the quality of the legal system or access to finance. Hence, only few enterprises actually export, and the intensity of aggregate export concentration within few large firms varies across countries and sectors. On the other hand, opening to trade boosts individual firms' productivity growth, via a number of channels, and also enhances allocative efficiency across firms, in turn increasing aggregate productivity growth. One of the main standard determinants of export growth, namely changes in the real effective exchange rate, impacts aggregate performance differently across countries and sectors, depending on sectoral composition and on firm characteristics within a given sector.

Keywords: Trade, firm heterogeneity, productivity, real effective exchange rates

JEL codes: F14, L25

Non-technical summary

This paper illustrates and provides evidence on several stylised facts, put forward by the recent theoretical and empirical trade literature based on firm heterogeneity. It employs the CompNet database, and in particular the so-called “Productivity” and “Trade” modules, for 14 EU countries over the period 2002-13. To our knowledge, this is the first study that tackles the links between firm heterogeneity and external trade, using such a vast, comparable cross-country and micro-founded dataset.

In the first part of the paper, the two-way relationship between external trade and productivity is assessed. On the one hand, exporting firms are found to be larger, more productive and pay higher wages than the non-exporting enterprises in the same sector. Only these firms can indeed bear the costs linked to accessing export markets which, in turn, depend upon tariff and non-tariff barriers, credit availability and the quality of domestic institutions, amongst various factors. A country’s aggregate exports are therefore concentrated in few firms; the degree of export concentration varies across countries and sectors. On the other hand, opening to trade boosts a firm’s productivity, via learning-by-doing and skill upgrading mechanisms, as well as by using cheaper and/or higher quality intermediate inputs. Trade liberalisation also leads to a reallocation of production factors toward more productive firms in a given sector, thereby boosting aggregate productivity growth also via this channel.

The second part of the paper analyses the relationship between export growth and one of its main determinants, changes in the real effective exchange rate (REER). The export elasticity to REERs varies across sectors and countries. A REER depreciation entails an increase in the intensive margin of exports (i.e. of the value of exports of each incumbent exporter), which is, however, smaller the larger the size of the firm, the higher the concentration in the sector (and therefore the market power of the firm) and the more intense the participation in global value chains. The extensive margin of exports (i.e. the number of exporting firms) also increases when the REER depreciates; the elasticity is higher the larger the mass of firms near the “productivity threshold” above which exporting becomes feasible. Therefore, the elasticity of a country’s aggregate exports to its REER depends on the sectoral composition of its foreign sales, firm characteristics (such as size, market power and participation in global value chains) and on the relative importance of the intensive vs. extensive margins.

1 Introduction¹

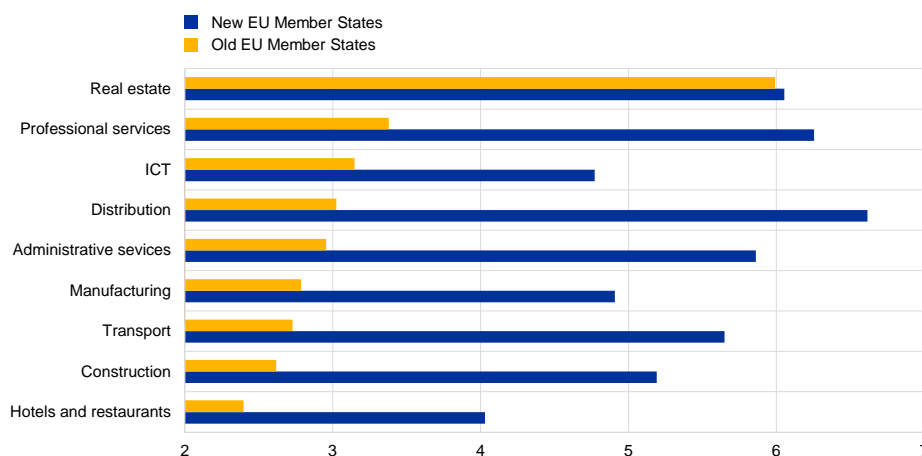
Owing to the increased availability of firm-level data, various empirical studies have documented the existence of large heterogeneity in performance across firms. In particular, firms are very different in terms, for example, of size, cost structure, profits and productivity, even within finely disaggregated sectors (Bartelsman and Dhrymes 1998; Bartelsman and Doms 2000; Restuccia and Rogerson 2008; Syverson 2011).

This is also the case for EU countries, a set of which is shown in Chart 1. Amongst the old Member States (i.e. countries that joined the EU by 1995 at the latest) considered, the top 10% most productive firms are on average between two to three times more productive than firms located at the bottom 10% of the labour productivity distribution in the same sector, defined at the 2-digit level. This dispersion is even higher for new EU Member States.²

Chart 1

Within-sector dispersion in firm labour productivity in selected EU countries

(ratio of the labour productivity level of the top and bottom deciles of firms in each 2-digit sector, 2001-13)



Sources: Authors' calculations based on CompNet data.

Notes: The old EU Member States are: Belgium, Denmark, Finland, France, Italy and Spain. The new EU Member States are: Croatia, Estonia, Hungary, Lithuania, Poland, Romania, Slovakia and Slovenia. The ratios in each 2-digit sector are aggregated to the macro-sector level using value-added shares; unweighted averages are taken across countries and years. 2013 data are not available for Lithuania, Hungary, Romania and Slovenia.

Moreover, the labour productivity distribution of firms is asymmetric as it displays notable skewness (Chart 2). In particular, productivity is more concentrated in the left-hand tail of the distribution where the low-productivity firms stand, although to a different extent across countries.

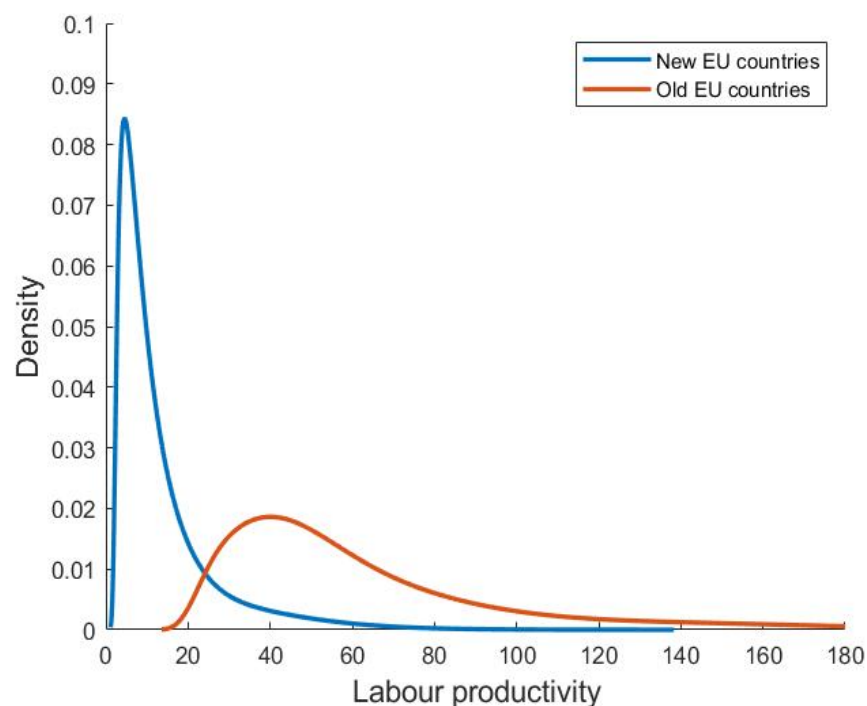
¹ A first version of this paper was published as ECB (2017), co-authored also with Elisa Gamberoni.

² The levels of within-sector dispersion in Chart 1 are similar to those reported in Berlingieri, Blanchenay and Criscuolo (2017). Bartelsman, Haltiwanger and Scarpetta (2013) explain the differences in within-sector dispersion in productivity between Central and Eastern European countries and Western Europe with the fact that, during the initial years of the transition to market economies, which our period captures, low-productivity firms survived and coexisted with new, far more productive firms created in the private sector.

Chart 2

The labour productivity density function in manufacturing

(2002-13)



Sources: Authors' calculations based on CompNet data.

Notes: The definition of old and new EU Member States is that in Chart 1. Unweighted averages are taken across countries and years. The chart refers to the average over the period 2002-13 in order to obtain a balanced sample of countries. Labour productivity is measured as real value added per employee and expressed in thousands of euros. The chart refers to firms with at least 20 employees in manufacturing.

The acknowledgement of firm heterogeneity and its inclusion in economic models is changing the way economic analysis is conducted in a number of fields, ranging from the understanding of productivity drivers and wage inequality to international trade, to mention but a few topics. This paper focuses on the implications of firm heterogeneity for external trade, based on the recent developments of the trade literature, and summarised in eight stylised facts. The analysis is based on a rich, comparable cross-country and micro-founded database covering 14 EU countries – including both the early and the late joiners – to our knowledge for the first time for such an ambitious purpose.

The discussion is structured around two large topics. The first is the two-way link between firm productivity and trade. Exporters are the most productive firms in the economy in that only few firms are able to pay the fixed and variable costs of exporting (Melitz 2003). In turn, trade can boost both exporting firms' productivity and aggregate productivity. The channels are manifold, and include learning-by-exporting (for example, De Loecker 2013; Bloom, Draca and Van Reenen 2016) and learning and upgrading by sourcing better-quality imports (for instance, Amiti and Konings 2007; Bas and Strauss-Kahn 2015), as well as a better reallocation of production factors across firms (amongst others, Bernard and Jensen 2004; Berthou et al. 2017).

The second trade-related implication of firm heterogeneity concerns the estimation of the relationship between exports and the real effective exchange rate (REER). In particular, the literature has found that there is strong heterogeneity across sectors and firms in elasticities of exports to movements in the REER. In particular, estimated elasticities depend on the underlying distribution of firm productivity and size. The reasons behind these findings are twofold: (i) large, more productive, firms respond to exchange rate fluctuations less strongly than smaller enterprises and this affects the intensive margin (i.e. the amount of goods exported by existing exporters) of export growth (for example, Amiti, Itskhoki and Konings 2014; Berthou and Dhyne 2018); and (ii) countries where a large mass of firms are close to the “productivity threshold”, above which they start selling abroad, require smaller movements in the REER to achieve aggregate export gains because of the larger role of the extensive margin (i.e. the entry of new exporting firms into the market; for instance, see di Mauro and Pappadà 2014).

The analysis in this paper relies on the information compiled by the “Trade” and “Productivity” modules of the micro-aggregated database constructed in the context of the ECB Competitiveness Research Network (CompNet), which results from the merge at the firm level between information from balance sheets and on export activity. The database compiles several moments of the distribution of relevant indicators in a given country-sector-year in order to preserve the confidentiality of the data. This paper generally covers 14 EU countries (Belgium, Denmark, Finland, France, Italy, Estonia, Czech Republic, Lithuania, Poland, Hungary, Romania, Slovakia, Slovenia and Spain) and 23 manufacturing sectors over the period 2002-13 (2012 for some countries), as shown in Table A.1 in Annex 1.³

The structure of the article is the following. Section 2 discusses the literature on the two-way link between productivity and trade, and provides related empirical evidence for the EU. Section 3 assesses the relationship between exports and REERs in EU countries, by focusing both on the intensive and the extensive margin of exports. Section 4 concludes.

³ The “Productivity” module is available for the period 2001-13, although it is unbalanced given delayed entry of some countries and availability of information until 2012 for countries obtained from the 4th vintage of CompNet data. This explains the different time coverage of different tables and charts, according to the indicators considered. More information on the construction and coverage of the various modules and overall dataset is provided in Annex 1, as well as in Lopez-Garcia and di Mauro (2015) and in Berthou et al. (2015).

2 Productivity and trade: a two-way link

2.1 The role of firm productivity for trade

Until the 1990s, the standard trade theory assumed that firms were homogeneous within each economy.⁴ In the neoclassical trade models, welfare gains from trade arise from the increase in world production and consumption following the specialisation of countries in the industries where they have a comparative advantage (Ricardo 1817; Heckscher 1919; Ohlin 1933; Samuelson 1948). Specifically, countries export those products for which they have lower opportunity costs of production relative to other industries and to other countries.⁵ Later “new trade” models incorporated the empirical feature that countries exchange similar goods, implying that trade across countries also occurs within the same industry, by assuming increasing returns to scale, monopolistic competition, and consumers’ preference for a variety of products. In these models, under a “representative firm” setting, the gains from trade arise because trade liberalisation leads to an increase in market size, which allows firms to reduce production costs and widens the availability of cheaper varieties of goods (Krugman 1980; Helpman and Krugman 1985). All these models assume that countries rather than firms compete in global markets.

Pioneering plant-level studies pointed, however, to firm heterogeneity in performance, especially between exporting and non-exporting firms. In particular, by employing firm-level US manufacturing data, Bernard and Jensen (1995; 1997; 1999) documented large, significant gaps between exporters and non-exporters, in terms of size, productivity, capital and technological intensity and wages paid to their employees. Based on this empirical evidence, the so-called “new-new trade” theory acknowledges the presence of firm heterogeneity. Building on earlier theoretical models of firm size and dynamics,⁶ Melitz (2003) offers a tractable framework on the link between trade and productivity, which has become the new cornerstone of trade theory.⁷ In this model atomistic firms need to pay a fixed cost for producing domestically, which is thereafter sunk. When they start operating, they produce horizontally differentiated varieties within the industry under conditions of monopolistic competition. Participation in export activities then requires the payment of an additional fixed cost, as well as a variable “iceberg” cost.⁸ This implies that firms will

⁴ See Helpman (1999) for a review of the trade literature until the 1990s.

⁵ In particular, Ricardo’s (1817) theory, assuming that only labour is needed to produce output, predicted that a country exports products where its labour productivity is high relative to its labour productivity in other products. In addition to trade in products, according to Samuelson’s (1948) two-factor (labour and capital), two-sector (export and import-competing) version of the Heckscher-Ohlin theory, a country should export the good that is relatively intensive in using the production factor with which the country is relatively well endowed, thereby emphasising the role of trade in factor contents.

⁶ Older theoretical models in this strand of the literature include, for example, Jovanovic (1982) and Hopenhayn (1992).

⁷ See also Bernard, Redding and Schott (2007), Melitz and Ottaviano (2008) and Melitz and Redding (2014).

⁸ According to the iceberg model (Samuelson 1954), an exporter has to produce and ship $\tau > 1$ units for one unit to arrive on the export market. The excess $\tau - 1 > 0$ units shipped “disappear” during transit and thus constitutes a trade cost. Hence more valuable goods are more expensive to trade internationally as trade costs increase proportionally with the (exporter) value of the good.

enter the market and produce, and eventually export, only if they find it profitable. Since profitability depends on the productivity level of each firm, only a fraction of firms, i.e. those above an endogenously determined “productivity threshold”, will be able to enter the domestic market and produce, and only a fraction of these firms will in turn be able to overcome the even higher entry barrier to export.⁹ In order to obtain “selection into export status”, the fixed export cost is assumed to be larger than the fixed production cost, so that in equilibrium a country’s marginal exporters are more productive than its marginal producers.¹⁰

The observed productivity premium for exporters raised the issue of whether the most productive firms “self-select” into trading activities *ex ante* or whether it is the participation in trading activities that increases their productivity after entry (for example, due to learning-by-exporting). Widespread empirical evidence on the existence of sunk entry costs to export and of persistence in export activities supports the former hypothesis,¹¹ suggesting that only the most productive firms within sectors find it profitable to incur these entry costs; the second hypothesis will be tackled further on.

Stylised fact #1: Firms that have just started to export are larger, more productive and pay higher wages than non-exporting firms in a given sector.

To test whether this is the case in the EU, we estimate country-specific exporter premia, defined as the *ceteris paribus* percentage difference of a given performance-related variable between exporters and non-exporters, as is standard in the trade literature (e.g. Bernard and Jensen 1995; Bernard et al. 2007; ISGEP 2008). In particular, for each country we regress several *performance* indicators such as average labour productivity, size (in terms of employment) and wages of each type of firm on a dummy variable (*D_newexporter*) taking value one for new exporters and zero for non-exporters, after controlling for firm-specific characteristics (*controls*) and

⁹ Melitz’s (2003) model focuses solely on exporting; its framework was then extended to incorporate foreign direct investment (FDI) as an alternative way to service foreign markets by Helpman, Melitz and Yeaple (2004). The current paper does not, however, touch upon FDI.

¹⁰ In addition to the assumption on the nature of trade costs, Melitz’s (2003) model also requires a constant elasticity of substitution demand system and assumes that productivity follows a Pareto distribution. However, a study based on CompNet data for 16 EU countries in the years 2001-2012 (Barba Navaretti et al. 2016) has shown how exporter competitiveness (measured as the residual of an export regression, once all possible destination markets’ characteristics, trade costs and geographical, cultural and historical features are netted out) is positively correlated not only with average firm productivity, a “sufficient” statistic in a Pareto distribution, but also with other moments of the productivity distribution, namely with its dispersion and its asymmetry. Using US transaction-level data, Bonfiglioli, Crinò and Gancia (2018) also showed that the distribution of firm-level characteristics, and not only their mean, affect aggregate trade outcomes. Furthermore, Bernard et al. (2018) develop a model which includes a much wider range of firm decision margins than those predicted by Melitz (2003): each firm can choose its production locations, export markets for each plant, the products to export from each plant to each market, the exports of each product from each plant to each market, the countries from which to source intermediate inputs for each plant and the imports of each intermediate input from each source country by each plant. These “global” firms are unlikely to be atomistic and therefore their pricing and product introduction decisions affect market aggregates; strategic market power is thus considered in this more comprehensive model. Finally, a very recent strand of the literature has shown that fixed costs are more relevant at the product than at the firm level (Steingrass 2018), but clearly this type of analysis requires highly granular, product-based data, which the CompNet database does not cover.

¹¹ See amongst others, Roberts and Tybout (1997) for Colombia, Eaton, Kortum and Kramartz (2011) for France, Bernard and Wagner (2001) and Arnold and Hussinger (2005) for Germany, Castellani and Zanfei (2007) for Italy, Clerides, Lach and Tybout (1998) for Mexico and for Morocco, Damijan, Polanec and Prasnikar (2004) for Slovenia, Farinas and Martin-Marcos (2007) for Spain, Girma, Greenaway and Kneller (2004) for the U.K. and Bernard and Jensen (2004) for the US.

fixed effects. Hence, we only consider new exporting firms, defined in the CompNet database as those firms that export at time t and $t+1$, but did not sell abroad at time $t-1$, relative to non-exporting firms in the same sector.¹² The coefficient attached to this dummy variable is then interpreted as the performance premia of firms that just entered international markets versus non-exporting firms in the same sector. The choice of focusing solely on new exporters reduces the risk that results are affected by possible *ex post* increases in productivity of exporting firms, and therefore provides evidence on whether the best-performing firms self-select into export markets. The regression is as follows:

$$\ln(\text{performance})_{s,t} = \beta D_{\text{newexporter}}_{s,t} + \gamma D_{\text{controls}}_{s,t} + \mu_s + \tau_t + \varepsilon_{s,t} \quad (1)$$

where *controls* include the size of the firm, measured as number of employees, in the labour productivity and wage regression, and labour productivity in the size regression, μ_s are sectoral fixed effects, τ_t are time fixed effects, s indicates 2-digit sectors and t indicates years. Ordinary least squares (OLS) regressions with robust standard errors are conducted over the period 2002-13 country by country. All β coefficients are statistically significant at conventional confidence intervals.¹³ The performance premia (in percentage values) for each country are plotted in Chart 3 and confirm the existence of large differences in terms of average productivity – up to 50% higher –, size and wages between new exporting firms and non-exporting firms operating in the same 2-digit industry.¹⁴ As regards labour productivity specifically, figures in Chart 3 are significantly more contained than those reported in Chart 1. Amongst various reasons, in Chart 3 it is noteworthy that productivity premia are estimated conditionally to a set of control variables, namely the size of firms and various fixed effects, whereas in Chart 1 computations provided do not take into account observed and unobserved heterogeneity.¹⁵ In conclusion, the finding that new exporting firms already display an advantage in productivity compared to non-exporters supports the hypothesis of self-selection into export markets within the EU. This evidence, however, does not exclude participation in trading activities also raising firm productivity at a later stage as a result, as will be discussed more thoroughly later in the paper.

¹² Note that, according to the definition employed in the CompNet database, a firm may be classified several times as a “new” exporter, as long as it stays out of the international markets for two consecutive years.

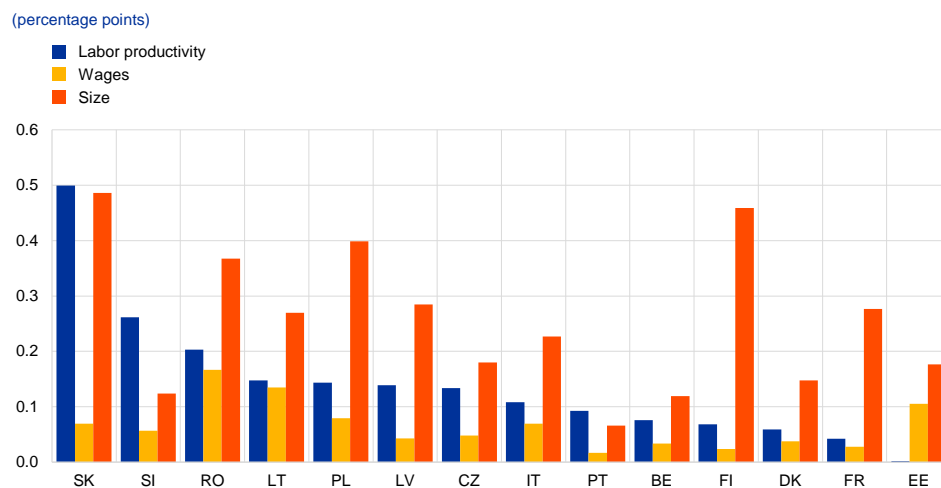
¹³ The only exceptions are Estonia for the labour productivity premium, Slovenia and Portugal regarding the size premium and Portugal, Latvia and Finland for the wage premium. Note, however, that the premia of all countries would be significant at the 1% level if no other firm characteristic were controlled for. For instance, Estonia’s labour productivity premium of new exporters becomes not significant when size is controlled for, because in this country only very large firms are productive enough to become new exporters.

¹⁴ The existence of a premium across all these dimensions is found also when comparing the whole set of exporting (i.e. also incumbent exporters) with non-exporting firms.

¹⁵ This reduction in exporter premia after controlling for heterogeneity is standard in the literature (see, for example, Bernard et al. 2007; ISGEP 2008).

Chart 3

Performance premia of new manufacturing exporting *vis-à-vis* non-exporting firms in the same 2-digit sector in selected EU countries



Sources: Authors' calculations based on CompNet data.

Notes: See the main text for the details on the computation of the estimated premia.

Stylised fact #2: Fixed costs of exporting depend, among other things, upon factors such as the quality of the legal system, access to finance and tariff and non-tariff trade barriers.

Participation in export activities and the size of export volumes depend on whether firms find it profitable to pay the trade costs and expand into foreign markets. Consistently with the gravity literature, in addition to standard time-invariant trade costs, such as geographical distance and language differences, examples of barriers to trade are infrastructure and logistic costs, distribution and marketing costs, availability of staff with skills to manage foreign networks, tariffs and non-tariff barriers, availability of credit, and the cost of obtaining information about foreign markets.¹⁶

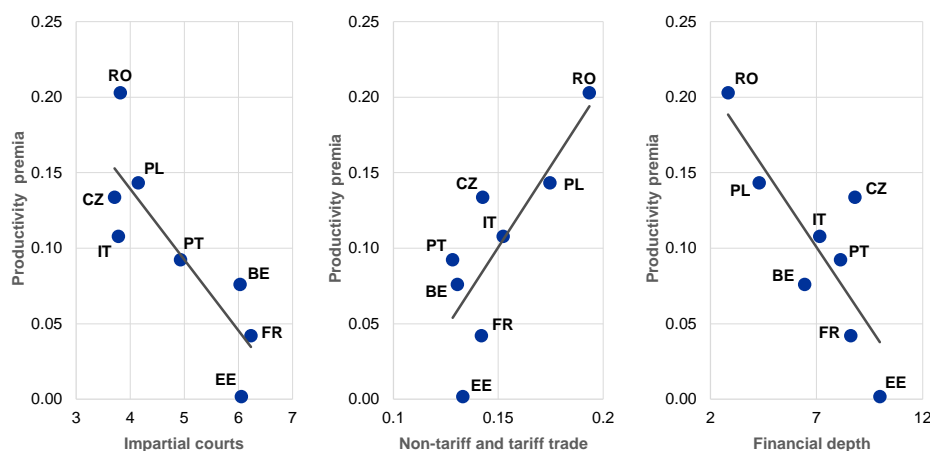
To explore the possible determinants of the fixed costs of trade in the EU, we start from the claim that in countries with high fixed trade costs new exporters need to be relatively more productive to enter international markets. Hence in the following exercise fixed trade costs will be approximated by the productivity premium of new exporters.

First, in Chart 4 we examine the unconditional relationships between the labour productivity premia estimated as in equation (1) and several institutional country features related to the legal, trade and financial environment sourced from the Fraser Institute (more detail on these variables may be found in Annex 2).

¹⁶ Amongst many studies, see, for example, Minetti and Chun Zhu (2011) on the role of credit rationing and Fontagné et al. (2015) on the impact of tariffs and stringent non-tariff barriers in foreign markets on export performance.

Chart 4

The link between country-level characteristics and a proxy of fixed costs of trade



Sources: Authors' estimates based on CompNet data and Fraser Institute Indicators.
 Notes: Labour productivity premia are estimated according to equation (1). The average over the period 2004-15 is taken for the indicators of the Fraser Institute.

Next, to test the statistical significance of these relationships in a more structured regression analysis, we use a variant of equation (1), where premia are time-invariant. In particular, we estimate new exporters' productivity premia for each country-year by interacting the dummy $D_newexporter$ in equation (1) with a complete set of year dummies. The reason is that there might be time variation in the fixed cost of trade, particularly amongst those countries in our sample which joined the EU in 2004. We then assess their correlation with potential determinants of fixed trade costs by running the following cross-country regressions using OLS with clustered standard errors, where c indicates the country and t indicates the year:

$$premium_{c,t} = \gamma X_{c,t} + \tau_t + C_{c,t} + \varepsilon_{c,t} \quad (2)$$

$X_{c,t}$ is one of the following country-specific variables (again, see Annex 2 for a detailed definition and sources): soundness of the legal system, tariff and non-tariff trade barriers¹⁷ and access to finance, which, by their nature, should affect firm-level fixed rather than variable costs of trade;¹⁸ τ_t are year dummies to capture common shocks; $C_{c,t}$ are controls and include year-on-year changes in the employment rate, capturing country-specific business cycles which may affect exporting and non-exporting firms differently, and the log of manufacturing value added, which captures the economic

¹⁷ Although we focus solely on EU countries, our proxies of trade and non-trade barriers, described in detail in Annex 2, present some variability across economies. In particular, they point to higher barriers in Central and Eastern European countries, especially at the beginning of the 2002-13 period under analysis. Moreover, despite belonging to the EU, member countries may still impose non-tariff measures, as discussed, for example, in Kirpichev and Moral-Benito (2018).

¹⁸ See also Helpman, Melitz and Rubinstein (2008) on this point.

size of each country.¹⁹ Table 1 shows the standardised – thereby comparable – coefficients of running the regression (2) on one variable $X_{c,t}$ at a time.²⁰

In line with the existing literature it is found that fixed trade costs are decreasing with the soundness of the legal system and easiness of access to finance in the origin country, whereas they are increasing in tariff and non-tariff barriers.²¹ These results are also consistent with studies showing that countries with lower GDP per capita – which generally is associated with lower-quality institutions – feature higher exporters' productivity premia because they have less integrated markets which allow non-exporters with low levels of productivity to survive (Hallward-Driemeier, Iarossi and Sokoloff 2002). Hence in those economies, firms that are able to afford the costs associated with exporting tend to be much more productive than the average firm.

Table 1
The link between country-level characteristics and a proxy of fixed costs of trade

Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Legal system							
Judicial independence	-0.356***						
Protection of property rights		-0.319**					
Impartial Courts			-0.307**				
Tariff and non-tariff trade barriers							
Tariff and non-tariff barriers				0.388***			
Mean tariff rate					0.301**		
Access to finance							
Financial regulation						-0.199+	
Financial depth							-0.250***
Observations	77	77	77	77	77	77	145
R-squared	0.257	0.207	0.158	0.220	0.160	0.184	0.123

Sources: Authors' estimates based on CompNet data and Fraser Institute Indicators.

Notes: OLS regressions, as in equation (2), with clustered standard errors. Beta coefficients are standardised. All regressions control for year fixed effects, manufacturing value added and aggregate employment growth.*** p<0.01, ** p<0.05, * p<0.10, + p<0.15.

Stylised fact #3: Exports are concentrated in few firms, albeit to a different extent across countries and sectors.

The fact that firms have to pay both a variable and fixed cost for exporting implies that only the most productive firms in a given country or sector can afford to sell in international markets. Moreover, according to Chart 2 the productivity distribution is

¹⁹ The latter variable is an attempt at introducing a gravity control. We also tried to include country dummies in order to account for country-specific firm characteristics that affect the productivity distribution; these fixed effects, however, wipe out the statistical significance of the determinants of trade costs, which vary little over time, and are therefore not included in our baseline specification. Indicators of labour and product market regulation have also been included in the baseline specification, but are found to be statistically insignificant.

²⁰ Amongst the controls, value added is statistically significant and positive, implying that exporter premia are higher the larger the size of the manufacturing sector it operates in. Country-specific business cycle conditions, on the other hand, do not appear to be significant. Due to the fact that all variables in Table 1 are highly collinear, in a standard horse-race exercise, only one of them – compliance costs for exporting and importing- marginally retains its statistical significance when all regressors are included together in one regression (results available upon request).

²¹ Clearly, it would be interesting to also test for the significance of the legal system and other institutional features in the destination country, in addition to the source country. Unfortunately, CompNet data do not include bilateral trade information and, therefore, the destination country cannot be identified.

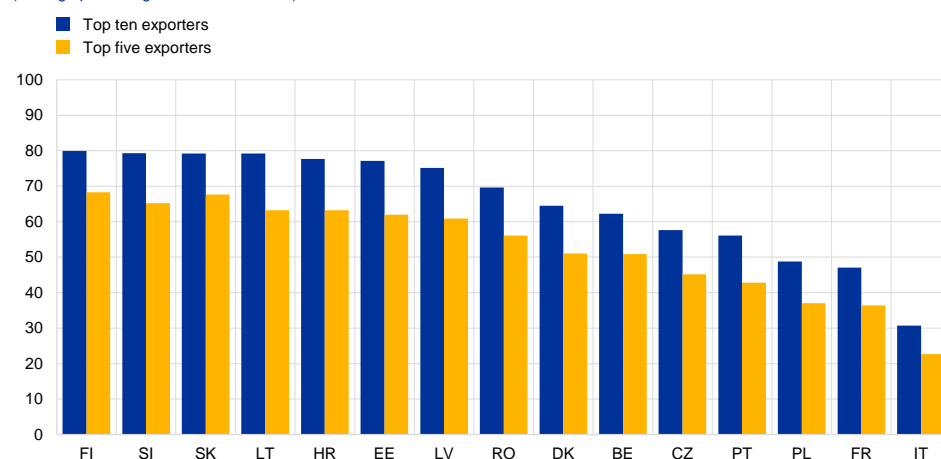
skewed in all countries, that is, it features a large mass of low productive firms and few productive firms. Hence, the international performance of a given country will depend on the behaviour of a small number of exporting firms at the top of the distribution (the so-called “happy few” stylised fact advocated by Mayer and Ottaviano, 2011).²²

In the EU it is found that, on average, the top exporters in a country (top-10 firms in terms of exporting value) account for about 50 to 80% of aggregate exports, with the notable exception of Italy, where the concentration of exports in top exporters is lower (Chart 5). Even in large countries, such as France, the top exporters sell at least half of total exports, so the large concentration is not only explained by country size. There may be more subtle explanations, which we explore next.

Chart 5

Share of manufacturing exports sold by top exporting firms, broken down by country

(average percentage shares in 2002-13)



Sources: Authors' calculations based on CompNet data.

Notes: Top exporting firms are the top 5 or top 10 firms in each sector in terms of exporting value. Weighted averages are taken across sectors, where the weights are value-added shares in total manufacturing value added.

One possible reason of this cross-country variation in export concentration is the relative size of exporting firms in each country. The case of Italy is paradigmatic. Chart 6 shows that exporting firms in Italy are smaller than the average in the rest of the EU countries considered, after controlling for the sector of activity. This is particularly the case for the large exporting firms in Italy (those in the top 10% of the size distribution of exporting firms), which are only half the size of the large exporting firms in the same sector in other countries.²³

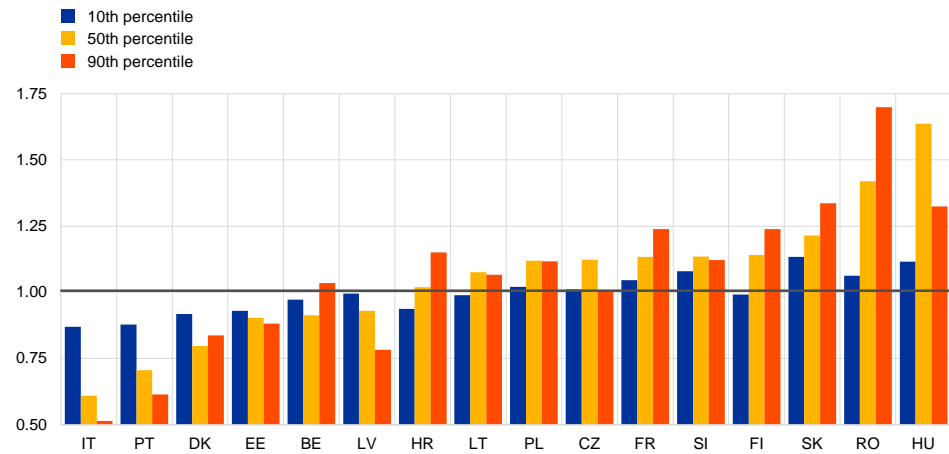
²² Other studies pointing to the fact that few, large firms shape country export patterns are Bernard, Jensen and Schott (2009), Freund and Pierola (2015) and Berthou et al. (2015). The more general conclusion that several macroeconomic questions can be clarified by looking at the behaviour of large firms can be found in Gabaix (2011) and in di Giovanni, Levchenko and Méjean (2014). Moreover, Autor et al. (2017) argue that if globalisation or technological changes benefit the most productive firms in each sector, product market concentration will rise as sectors become increasingly dominated by “superstar” firms with high profits; therefore, aggregate outcomes (amongst which the evolution of the country’s labour share on which the study focuses) will more intensely reflect the attributes of a handful of firms. However, more recently, and specifically referring to trade, Bonfiglioli, Crinò and Gancia (2018) find that heterogeneity, defined as a variation in characteristics across a large number of firms, explains variation in exports across countries and sectors to a higher extent than granularity, defined as exceptional performance in a small number of firms.

²³ On the specific Italian case, see Bugamelli et al. (2018).

Chart 6

Size of manufacturing exporting firms in each country relative to the EU average in the same sector

(ratio to the average size of exporting firms in the same sector in other countries, 2002-13 averages)



Sources: Authors' calculations based on CompNet data.

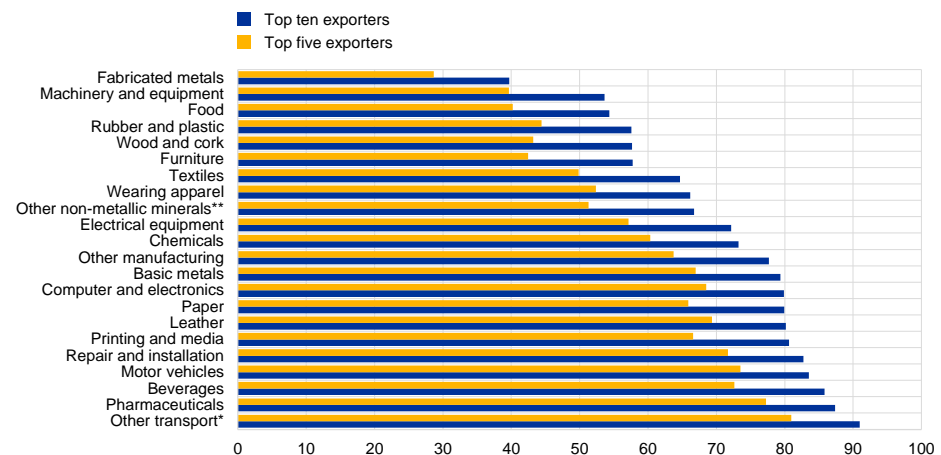
Notes: Ratio of the size in terms of employees of firms in a given 2-digit manufacturing sector in a given size decile to the EU average, normalised to 1. p_10, p_50 and p_90, refer to a firm in the 10th, 50th and 90th decile of the size distribution, respectively.

Another possible reason behind the wide disparity in export concentration is country-specific sector specialisation. The reason is that export concentration varies significantly across manufacturing sectors depending on the optimal scale of operation of firms, which in turn depends on sector-specific technological characteristics. Chart 7 shows that concentration is highest in sectors such as transport equipment and pharmaceuticals and lowest in, for example, the machinery and equipment and fabricated metals sectors. Chart 8 shows a positive correlation between the cross-country average export concentration and the median size of firms in each sector, which is a proxy of the required scale of operations in the sector.

Chart 7

Share of manufacturing exports sold by top exporting firms, broken down by sector

(average percentage shares in 2002-13)



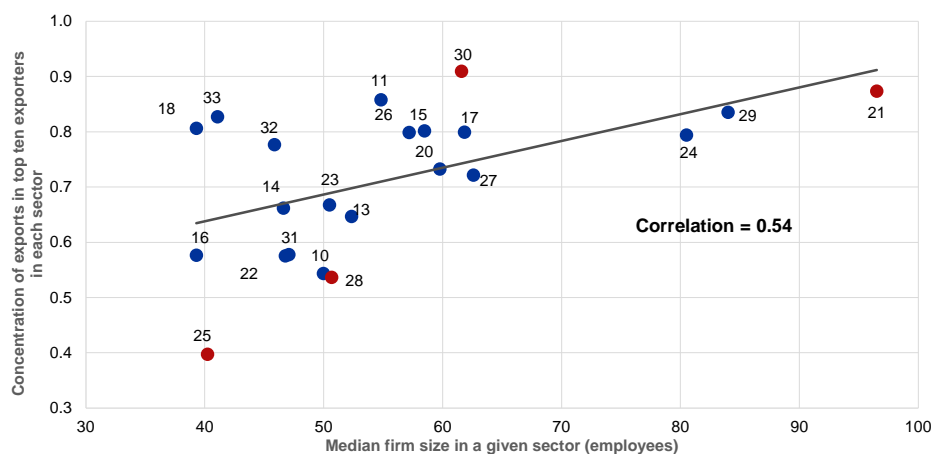
Sources: Authors' calculations on CompNet data.

Notes: Unweighted averages are taken across countries. *Manufacture of transport equipment net of motor vehicles. **Manufacture of non-metallic mineral products, such as glass, plastic, cement, etc.

Chart 8

Share of manufacturing exports sold by top exporting firms and median firm size in the sector

(average percentage shares in 2002-13)



Sources: Authors' calculations on CompNet data.

Notes: Export shares of the top ten exporting firms in each manufacturing sector and median number of employees per company in a given sector. Unweighted averages are taken across countries. Sectors: 10. Food products; 11. Beverages; 13. Textiles; 14. Wearing apparel; 15. Leather and related products; 16. Wood and cork; 17. Paper products; 18. Printing and media; 20. Chemicals; 21. Pharmaceuticals; 22. Rubber and plastic products; 23. Other non-metallic mineral products; 24. Basic metals; 25. Fabricated metal products; 26. Computer and electronics; 27. Electrical equipment; 28. Machinery and equipment; 29. Motor vehicles; 30. Other transports; 31. Furniture; 32. Other manufacturing; 33. Repair and installation of machinery. Sectors marked in red are sectors with the two highest (sectors 30 and 21) and lowest (sectors 25 and 28) average percentage shares of manufacturing exports sold by top exporting firms; see Chart 6).

2.2 The effects of trade on productivity

External trade can in turn affect the two components of aggregate productivity growth: (i) firms' own productivity growth; and (ii) the reallocation of production factors across firms.²⁴

Stylised fact #4: Opening to trade increases within-firm productivity growth, thereby enhancing aggregate productivity growth.

Trade can increase within-firm productivity growth via several channels. First, exporting is associated with skills upgrading, particularly for domestic frontier firms. For example, Bustos (2011) finds an increased demand for skills after the creation of MERCOSUR. Furthermore, as firms become larger and start exporting, they expand their organisational capital, inducing a greater need for more complex management structures, which in turn generally brings more skills (Bloom, Draca and Van Reenen 2016). Exporting also generates opportunities for learning-by-exporting for firms and their workers (De Loecker 2013). Demand factors also play an important role in inducing positive knowledge spillovers from exporting, given that they enable firms to learn about more sophisticated consumers and competitive markets. Accordingly, one

²⁴ In addition to firms' productivity, trade can also have beneficial effects on, for example, consumer spending and welfare. It can lead to lower prices of consumer goods, which especially favours low- and middle-income groups who spend a larger share of their disposable income on standardised consumer items (see, for example, Broda and Weinstein 2006; Carluccio, Gautier and Guilloux-Nefussi 2018; Jaravel and Sager 2018), and more generally leads to a greater variety of goods and services for all consumers. The analysis of these effects, however, goes beyond the scope of this paper.

explanation of the success of China in international markets is that Chinese firms invested in capability building to improve their product appeal and demand (Sutton 2007; Schott 2008; Brandt, Van Biesebroeck and Zhang 2012). Furthermore, Brambilla, Lederman and Porto (2012) show that firms exporting predominantly to high-income countries, which, according to Linder's (1961) hypothesis, demand higher-quality goods, use relatively higher levels of skills and pay higher wages than domestic firms or exporters to middle- or low-income countries.

Second, trade liberalisation might alter the decisions related to technology adoption and innovation. For example, if adopting a new technology requires the payment of a fixed cost, the most productive firms, which enjoy higher revenues, will be those adopting the most advanced technologies. Trade liberalisation, by increasing potential export revenues, allows more firms to access the export market and to upgrade their technology, given their productivity level. As a result, during a period of trade liberalisation, both incumbent and new exporters upgrade their technology faster than non-exporters. More specifically, Bonfiglioli, Crinò and Gancia (2016) develop a theoretical model that shows how export opportunities, by increasing the payoffs in the tail of the productivity distribution, induce firms to invest in bigger projects with more spread-out outcomes. Hence, export opportunities increase firm productivity by fostering innovation. Empirical evidence documents that both knowledge flows from international buyers and competitors and enhanced competition boost post-entry performance of new exporters, since exporters are more likely to innovate and to shift resources toward their most profitable products (Mayer, Melitz and Ottaviano 2014). In particular, using French firm-level data, Mayer, Melitz and Ottaviano (2016) find that in response to positive demand shocks in export markets, multi-product firms skew their export sales towards their best performing products whilst dropping the least-performing products. The increased competition from demand shocks and the induced product mix reallocations are shown to significantly boost productivity growth within the firm.

As a result of trade, the productivity gap relative to new exporters or non-exporting firms thus tends to increase after entry into foreign markets. Chart 9 shows the relative advantage in terms of productivity, size and wage growth of exporting firms which have been operating in international markets for at least three years (i.e. "incumbent exporters" in the CompNet database) relative to new exporting firms operating in the same country, year and 2-digit industry, after controlling for country, sector and year fixed effects. Separate regressions have been run for old and new EU members. In all cases differences between continuous and new exporters are significant and range from 0.07 percentage point additional annual TFP growth in old EU members (0.16 points in new EU members) to 0.16 points of additional labour productivity growth (0.10 points in new EU members).

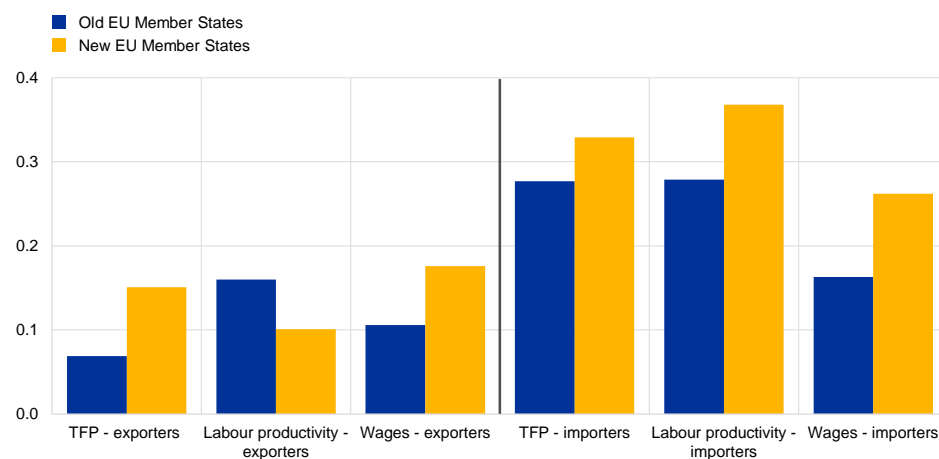
Another channel via which trade boosts firm productivity growth is the import of a wider range of cheaper and/or higher quality intermediate inputs, in turn due to imperfect substitution between domestic and foreign goods, which can lead to higher domestic value added growth, higher productivity growth and higher quality final goods (Markusen 1989; Grossman and Helpman 1991). Recent firm-level evidence confirms the quantitative importance of this input channel for a number of countries, both

emerging and advanced, in particular for Chile (Kasahara and Rodrigue 2008), China (Bas and Strauss-Kahn 2015), France (Bas and Strauss-Kahn 2014), Hungary (Halpern, Koren and Szeidl 2015), India (Topolova and Khandelwal 2011) and Indonesia (Amiti and Konings 2007).²⁵ Moreover, based on cross-country cross-sector time series, Ahn et al. (2016) find that the impact of the input variety and quality channels that underpin input tariff liberalisation on productivity is much stronger than the pro-competition effect of output tariff liberalisation, suggesting that trade liberalisation in upstream sectors matters more for sector-level productivity than liberalisation in the sector itself, especially when FDI barriers are reduced simultaneously. Chart 9 confirms that importing firms grow, in terms of productivity, up to 0.4 percentage points more per year than firms sourcing from domestic providers. This is more than double the growth advantage of continuing exporters versus new exporters shown in the same chart, hence confirming the relative importance of the import channel for technology diffusion.

Chart 9

Growth of manufacturing incumbent exporters/importers relative to new exporters/importers in the same sector in the EU

(growth premia of incumbents relative to new firms; 2002-13 average)



Sources: Authors' calculations based on CompNet data.

Notes: Unweighted averages across countries; weighted averages across 2-digit sectors, where the weights are value-added shares; average in the period 2002-13.

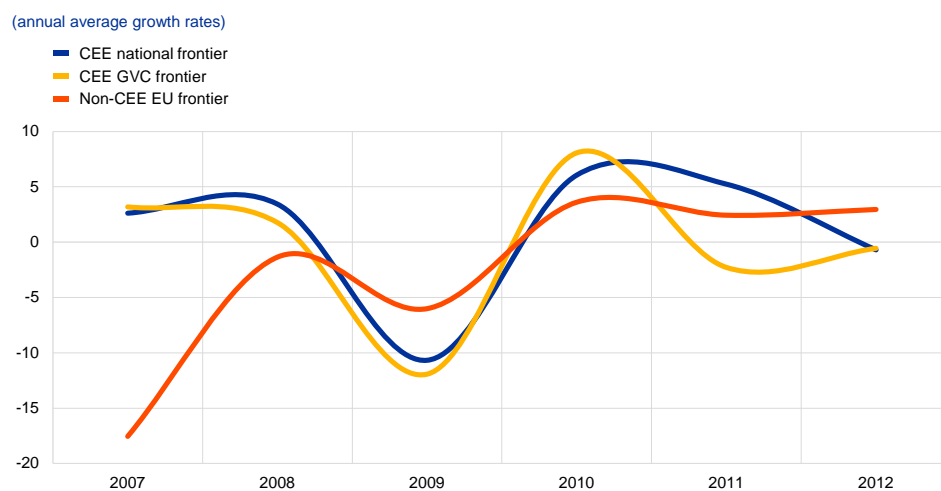
The relatively higher wage growth in both importing and continuous exporters also confirms the findings in Koren and Csillag (2011) and MacGarvie (2006), which show that sophisticated machinery and capital goods require highly trained technicians, once they have been imported by a firm. In particular, using data from Hungary for the period 1994-2004, Koren and Csillag (2011) construct a measure of exposure to imported machines combining data on workers' occupations with information on imported products. The study finds that, all other things being equal, the wage of workers increases by about 3% after a firm purchases the imported machinery.

²⁵ Istat (2017) finds that Italian "two-way traders", i.e. firms that both import and export, are larger and have a higher labour productivity than firms that simply export. This is unsurprising given that exporting and importing decisions are interdependent in that incurring the fixed exporting cost increases firm revenue, which makes it more likely that the firm will find it profitable to incur the fixed cost of sourcing inputs from any given country. This study does not, however, investigate whether these premia are a result, or a pre-requisite, of this type of internationalisation setup.

Furthermore, technology tends to flow faster and more easily as a result of the interconnections established in global value chains (GVCs). These production arrangements link together multiple firms, usually located in different countries, in similar ways to intra-group investment and trade. Following Andrews, Criscuolo and Gal (2016), Chiacchio, Gradeva and Lopez-Garcia (2018) use CompNet data for nine Central and Eastern European (CEE) countries merged with information from WIOD input-output tables to examine the role of GVCs as a driver for the diffusion of technology created at the frontier. The study differentiates between two groups of firms in CEE countries: the most productive firms in the sector, i.e. the national frontier firms, directly participating in GVCs, and their local suppliers, indirectly benefitting from technology diffusion through domestic networks. The main results confirm the importance of GVCs for the technology upgrade of firms in EU catching-up economies and establishes that the most important channel for technology diffusion are the backward linkages of host countries, that is, the incorporation of foreign value added to the host country's exports. Drawing on the results of Chiacchio, Gradeva and Lopez-Garcia (2018), Chart 10 shows the close co-movement between TFP growth of the CEE national frontier firms and the so-called "CEE GVC frontier" which includes the most productive firms in country-sectors in Western Europe with tight GVC links with CEE host economies.²⁶

Chart 10

TFP growth of the most productive ("frontier") firms and their global value chain (GVC) partners in selected central and eastern European (CEE) EU countries and other EU countries



Sources: Chiacchio, Gradeva and Lopez-Garcia (2018) based on CompNet and WIOD (2016) data.

Notes: The TFP frontier refers to the unweighted average annual TFP growth of the top 20% of productive firms in each two-digit sector. The GVC frontier is the weighted average of total TFP of the most productive firms in non-CEE EU countries, with weights based on the share of imported intermediates of each CEE country-sector pair from each non-CEE EU country. The CEE EU countries are Bulgaria, the Czech Republic, Estonia, Croatia, Latvia, Lithuania, Hungary, Poland, Romania, Slovenia and Slovakia; the non-CEE EU countries are Belgium, Denmark, Germany, Spain, France, Italy, Austria, Portugal and Finland.

²⁶ Chart 10 is a variation of the corresponding chart in ECB (2017). The latter reported TFP growth of frontier firms computed as the unweighted average TFP growth of firms at the 80th and 90th percentile of the TFP distribution. Chart 10 herein instead computes the weighted average TFP growth of firms at the 80th and 90th percentile, using the respective employment shares as weights. Both weighted and unweighted measures anyhow lead to the same qualitative results. Moreover, the data used to compute the country-sector weights in Chart 10 are sourced from the latest WIOD release (late 2016), whereas in ECB (2017) data from the OECD's International Trade by Commodities Statistics (ITCS1) and the UNSD's Comtrade2 were used.

Stylised fact #5: Opening to trade also fosters a more efficient allocation of resources across firms, in turn again increasing aggregate productivity growth.

Trade can also improve the allocation of production factors across firms, which in turn contributes significantly to aggregate productivity growth. Productivity gains from opening to trade may indeed accrue disproportionately to larger and more productive firms, enabling them to gain market share and enhancing aggregate productivity. In particular, as predicted by Melitz (2003), trade liberalisation leads to an increase in export market sales of high-productivity exporting firms, by lowering trade costs. Moreover, the most productive non-exporting firms find it profitable to engage in export activities and to expand to take advantage of the larger foreign market, whereas the least efficient, non-exporting producers tend to exit the market as increased import competition contracts their revenues. Production inputs are, therefore, reallocated towards more productive firms, which leads to an increase in aggregate productivity through a change in industry composition.

The empirical literature has found robust evidence that the reallocation effect across producers stemming from exposure to international trade significantly boosts aggregate productivity. Based on US census data for 1983-92, around 40% of aggregate TFP growth was found to result from increasing output shares of the more productive, exporting firms (Bernard and Jensen 2004). Half of this effect came about because of within-sector reallocation of resources and the other half stemmed from cross-sector reallocation. Similarly, according to CompNet data referring to 14 EU countries in 1998-2011, an increase in export demand was associated with a rise in total manufacturing productivity, of which about one third accrued from within-sector labour reallocation (Berthou et al. 2017).²⁷

Table 2 confirms these findings for EU countries by generally showing a statistically significant and positive correlation between sector allocative efficiency and openness to trade, after controlling for country, sector, time and country-year fixed effects. In particular, allocative efficiency is measured in three different ways, depending on the productivity indicator and market share used in each case. The TFP OP gap (first put forward by Olley and Pakes 1996) refers to the sector covariance between a firm's TFP and its value added share in the sector; the higher this covariance, the larger the size of the most productive firms and, in turn, the greater the sector's allocative efficiency. The labour productivity OP gap instead measures the sector covariance between firm's labour productivity and its employment sector share. Finally, the capital OP gap is the sector covariance between a firm's capital productivity and its share in sector tangible capital. Sector openness to trade is measured by the share of exporting firms in the sector (which accounts for the extensive margin of trade, which we will discuss more thoroughly in Section 3) and by the share of the sector's exporting value in the total of the country. Each openness measure is also turned into

²⁷ The importance of the reallocation effect in boosting aggregate productivity is not only limited to advanced economies. For example, in the aftermath of trade liberalisations in Chile, roughly two-thirds of the observed rise in aggregate productivity was found to be the result of reallocation from the least to the most efficient producers (Pavcnik 2002). Based on evidence for Taiwan, Edmond, Midrigan and Xu (2015) find that opening up to trade strongly increases competition and reduces resource misallocation, measured by the dispersion in mark-ups across firms, up to one-half, thereby significantly boosting aggregate productivity.

a dummy taking the value one if the sector is more exposed to international competition than the median in a given country-year.

Table 2
Trade and sectoral allocative efficiency

Explanatory variables	Dependent variable											
	TFP OPGAP				Labour productivity OPGAP				Capital productivity OPGAP			
Dummy=1 if share of exporting firms>median	0.049** (0.0249)				0.008 (0.0124)				0.049* -0.025			
Share of exporting firms	0.082 (0.123)				0.045 (0.051)				0.303*** (0.105)			
Dummy=1 if share of export value>median	0.136*** (0.034)				0.060*** (0.015)				-0.033 (0.030)			
Share of export value	1.083*** (0.350)				0.610*** (0.144)				0.015 (0.278)			
Constant	0.541*** (0.066)	0.498*** (0.103)	0.428*** (0.078)	0.458*** (0.077)	0.135*** (0.026)	0.112*** (0.039)	0.084*** (0.028)	0.086*** (0.030)	-0.313*** (0.060)	-0.466*** (0.0882)	-0.288*** (0.072)	-0.316*** (0.0687)
Country / sector / year /country-year fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	1,572	1,572	1,572	1,572	2,190	2,190	2,190	2,190	2,178	2,178	2,178	2,178
R-squared	0.432	0.428	0.455	0.459	0.337	0.337	0.363	0.382	0.472	0.477	0.469	0.467

Sources: Authors' calculations based on CompNet data.

Notes: All regressions control for country, sector, year and country-year fixed effects. Countries included are the Czech Republic, Estonia, Latvia, Poland, Slovakia, Slovenia, Belgium, France and Italy. The definitions of the dependent and explanatory variables are provided in the main text. *** p<0.01, ** p<0.05, * p<0.10, + p<0.15.

An alternative measure of allocative inefficiency, or production factor misallocation, first put forward by Hsieh and Klenow (2009), points to similar evidence. This indicator measures the dispersion in the marginal revenue productivity of capital and labour – MRPK(L) – across firms.²⁸ The underlying rationale is that, in a given sector, if firms face the same marginal costs, labour and capital should flow across firms until the marginal return of employing an extra unit of factor input is equalised across firms. However, the presence of different constraints that affect production factor allocation (e.g. heterogeneous access to financial resources, different degrees of exposure to product market and labour regulation, firm-specific corruption etc.) could prevent this reallocation of inputs and, therefore, induce firms to employ sub-optimal amounts of production factors compared to their productivity level. The result would be that marginal revenue productivities of inputs are not equalised across firms within a sector, leading to a non-zero dispersion in MRPK(L). The higher this dispersion, generally measured by the standard deviation of firms' MRPK(L) within a given sector, the higher is the within-sector misallocation of the corresponding production factor.

²⁸ In more detail, in the presence of output distortions, Hsieh and Klenow (2009) show that: $MRPL_{si} = w_s \frac{1}{1-\tau_{Ysi}}$ i.e. firm i 's MRPL is not equal to the average wage of the sector s in which it operates (and therefore not equal to that of all other firms in the sector), but rather it is larger than the average wage, a proxy of the marginal wage. In particular, it is higher the larger the firm's output distortion. Similarly, $MRPK_{si} = r_s \frac{1+\tau_{Ksi}}{1-\tau_{Ysi}}$ i.e. the MRPK is equal to the average sector interest rate, adjusted by both the firm's capital and output distortions. This implies that MRPK is also not equalised across firms in the sector.

Based on CompNet data, Gamberoni, Giordano and Lopez-Garcia (2016), Giordano and Lopez-Garcia (2018) and Bañbura et al. (2018) report a general increase in total-economy capital misallocation since the early 2000s within the EU, as opposed to flatter labour inefficiency dynamics, as shown in Charts 11 and 12.²⁹ Interestingly for the purpose of this paper, when analysing dynamics broken down by 1-digit sectors as in Chart 13, it is evident that the documented upward trend in capital misallocation has mainly been driven by private non-financial services, as opposed to industrial sectors.³⁰ Interestingly, it is the least tradable service sectors (namely professional, scientific and technical activities) that marked the largest rise, again suggesting a positive correlation between sector tradability and allocative efficiency (i.e. the inverse of misallocation).

A couple of caveats to this analysis of the Hsieh and Klenow (2009) indicator are, however, warranted.³¹ First, one could argue that the “20E sample” employed herein (as reported in Annex 1) does not capture any productivity-enhancing reallocation process concerning micro firms, which may have been significant, especially in the recent crisis years, in countries with highly fragmented production, such as Italy (Linarello and Petrella 2017; Istat 2017). This would suggest that the latter sample, used in this paper, may be slightly over-estimating capital misallocation dynamics, especially in those countries with many micro firms. Second, one could argue that higher misallocation in services may be due to the larger measurement error in output, and therefore of productivity, of services than of industry (for an overview of this issue see, for example, Griliches 1992). However, in Chart 11 and Chart 12 we only consider the dynamics, not the levels, of input misallocation and this potential bias would affect our results only if the accuracy of measurement of productivity in services has changed significantly over the period here considered. Moreover, based on a 3-digit NACE sector classification, Dias, Robalo Marques and Richmond (2016) confirm that the bulk of service sectors in Portugal has systematically recorded higher input misallocation than the bulk of the manufacturing branches, regardless of the different degree of difficulty of output measurement across such narrowly defined and heterogeneous service sectors. It is thus hard to believe that this stark regularity across service sectors *vis-à-vis* manufacturing industries is entirely explained by measurement issues.³²

²⁹ Slovakia is the only country for which capital misallocation has declined over the period considered. Although results for single countries would deserve a much more thorough investigation, ideally based on actual firm-level data which are not available in the CompNet database, it is noteworthy that the IMF (2002) found evidence of vast credit misallocation in Slovakia in the Nineties, which was then significantly reduced after 1999 by the restructuring of the banking sector. This finding is consistent with the declining trend in capital misallocation we observe for this country in the subsequent decade in Chart 11.

³⁰ Accurately measured dispersions in MRPK(L) are only available for 1-digit sectors, thereby impeding the duplication of Table 2 with the Hsieh and Klenow (2009) indicator. See Lopez-Garcia and di Mauro (2016) and Bañbura et al. (2018) for further details on the estimation of the latter measure in the CompNet database, as well as for some sensitivity analysis.

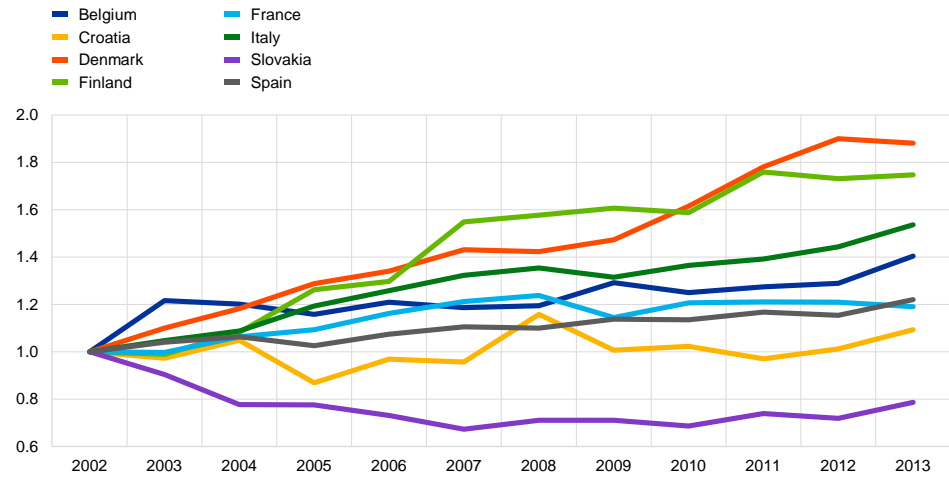
³¹ See Bañbura et al. (2018) for a more thorough discussion of the limitations of both this proxy of production factor misallocation and of the afore-mentioned OP gap.

³² Indeed, Dias, Robalo Marques and Richmond (2016) find evidence that higher misallocation in services in Portugal is due to higher output-price rigidity, greater labour adjustment costs and more informality than in manufacturing.

Chart 11

Capital misallocation in selected EU economies by country

(2002=1; dispersion in marginal productivity of capital)



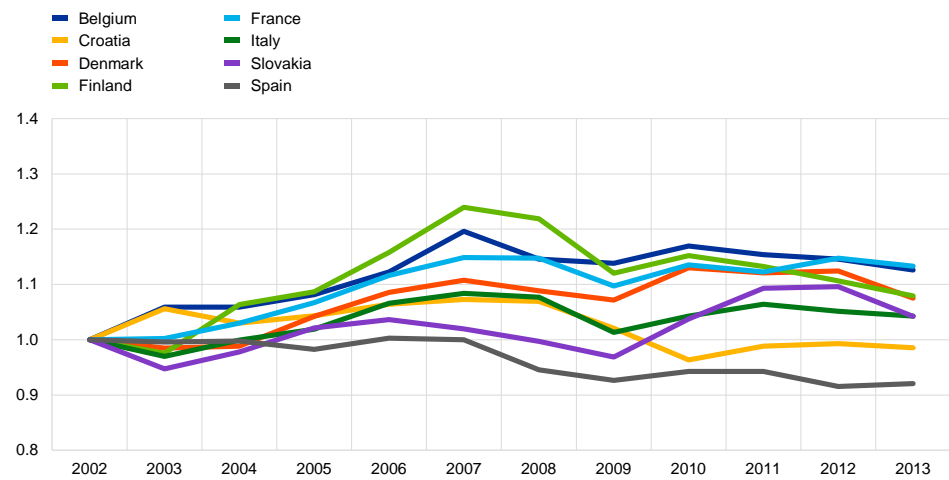
Sources: Barıburat al. (2018) based on CompNet data.

Notes: Weighted averages of 1-digit sector-level indicators, where the weights are sectoral shares in real value added, and the sectors are those reported in Chart 13.

Chart 12

Labour misallocation in selected EU economies by country

(2002=1; dispersion in marginal productivity of labour)



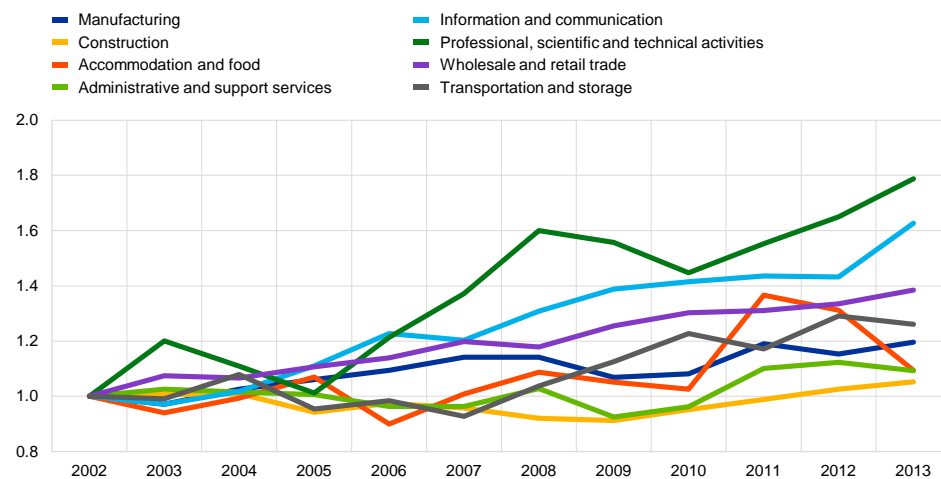
Sources: Barıburat al. (2018) based on CompNet data.

Notes: Weighted averages of 1-digit sector-level indicators, where the weights are sectoral shares in real value added, and the sectors are those reported in Chart 13.

Chart 13

Capital misallocation in selected EU economies by sector

(2002=1; dispersion in marginal productivity of capital)



Sources: Bañbura et al. (2018) based on CompNet data.

Notes: Simple averages of 1-digit sector-level indicators across the countries included in Charts 11 and 12.

3 Firm heterogeneity and the elasticity of exports to real effective exchange rates

Aggregate export dynamics depend on a number of factors, one of which is the change in a country's price competitiveness, in turn commonly measured by the real effective exchange rate (REER): an improvement in price competitiveness, measured by a REER depreciation, generally leads to higher export growth.

Stylised fact #6: The elasticity of exports to changes in the REER varies across sectors and across firms.

Analyses based on macroeconomic data have pointed to a relatively low reactivity of exports to REERs, or to Harmonised Competitiveness Indicators (HCIs) for euro area countries, suggesting an incomplete pass-through or “exchange rate disconnect”, as well as vast country heterogeneity.³³ The sensitivity of exports to REERs appears, however, to be higher when it is estimated on more granular data. Indeed, export elasticities estimated using sector- or firm-level data and then aggregated at the country level are significantly larger in absolute value than macro-elasticities (see Table 3 and references therein), as are sector-aggregated import elasticities (see, for example, Imbs and Méjean 2008; Feletigh and Federico 2010; Corbo and Osbat 2013).³⁴

³³ The elasticity of exports of euro area countries to HCIs in macroeconomic analyses is generally smaller than one (Goldstein and Khan 1985; Christodouloupoulou and Tkačevs 2014; Giordano and Zollino 2016 and 2017; Bugamelli et al. 2018).

³⁴ Referring to Table 3, Corbo and Osbat (2013) estimate Armington elasticities of substitution for 106 manufacturing industries, based on monthly Eurostat product-level COMEXT data for the period 1995-2009 and then aggregate them to a country estimate using country-specific weights. Import and export elasticities are then retrieved as (1- the Armington elasticity). Christodouloupoulou and Tkačevs (2014) estimate standard export and import long-run elasticities using quarterly national account Eurostat data from 1995 to 2013 and a wide range of HCIs, based on different price and cost indices. In principle, trade elasticities computed using aggregated data should reflect the weighted average of the sectorial elasticities, as long as residuals are well-behaved. However, work by Imbs and Méjean (2015) among others shows that this is not the case and results in aggregation bias. More concretely, the estimation of elasticities based on aggregate data presumes: i) the same reaction of trade volume across goods, regardless of the degree of substitution between domestic and foreign goods (in reality, a homogenous good will react more strongly to exchange-rate movements); and ii) that each good accounts for the same import share in a country's basket. As in the real world this is not the case because of heterogeneity, residuals will be correlated with the regressors, thus biasing the coefficients, and therefore the estimated elasticities, downwards.

Table 3

REER/HCI elasticity estimates by country based on macro and sectoral data

	Macro elasticity of exports of goods to HCIs	Sector aggregated export elasticity of goods to relative unit value of exports and imports
AT	-0.85	-3.0
CY	-0.03	-5.4
EE	-0.78*	-6.9
FI	-2.41*	-2.5
FR	-0.79*	-3.4
DE	-0.50*	-4.3
GR	0.55	-3.6
IE	-0.45	-2.3
IT	-0.33*	-2.4
MT	-2.66*	-4.0
NL	-0.39*	-2.7
PT	-1.12*	-3.1
SK	-0.43	-3.3
SI	0.00	-3.4
ES	-0.55*	-2.5

Sources: Christodouloupoulou and Tkačevs (2014) for macro elasticities and Corbo and Osbat (2013) for sector-aggregated elasticities. Notes: * denotes significance at least at a 10% confidence level. See footnote 34 for details on how these elasticities are computed.

We contribute to this existing set of findings by employing CompNet data and by estimating, in particular, the following regression, country by country:

$$\Delta \text{totexports}_{s,t} = \alpha + \beta_1 \Delta \text{fdemand}_{s,t} + \beta_2 \Delta \text{reer}_{s,t} + FE + \varepsilon_{s,t,t} \quad (3)$$

where the dependent variable is the year-on-year log change in the total export value of all exporters in sector s and time t of a given country. Variables are respectively the log change in foreign demand and that in the REER/HCI of the same country-sector in the same time period; in particular, the latter are taken with a one-year lag, consistently with the literature that finds a delayed effect of REER movements on exports (e.g. Christodouloupoulou and Tkačevs 2014; Giordano and Zollino 2016 and 2017; Bugamelli et al. 2018). Exports are sourced from CompNet. The foreign demand variable is taken from Berthou et al. (2017), which provides an exogenous indicator of foreign demand addressed to each country-sector-year.³⁵ The sectorial REER/HCI variable, deflated with the producer price index, is sourced from Dozovic (2017). Estimation is obtained by applying Pesaran and Smith's (1995) Mean Group (MG) estimator. For a given country, this procedure estimates regression (3) for each sector, allowing therefore for heterogeneous elasticities across sectors, and then averages the estimated elasticities across sectors.

³⁵ In particular, this is similar to a Bartik instrument, constructed on WIOD data, which exploits information about the initial export structure of each country-sector and foreign partners' total imports in these sectors, following a similar methodology developed in Berman, Berthou and Héricourt (2015). We are grateful to Antoine Berthou for sharing these data with us.

Standard results of an increase in foreign demand and/or a depreciation in the REER/HCI boosting exports are reported in Table 4.³⁶ Although not strictly comparable due to the fact that CompNet export data are in value terms whereas the elasticities reported in the second column of Table 3 are based on volumes and those in the third column on unit values, it is clear that our estimates generally lie in between the macro and the genuinely micro results. Given the micro-aggregated underlying nature of the CompNet dataset, they are, however, still biased to the downside.

Table 4
REER/HCI elasticity estimates by country based on CompNet micro-aggregated data

Explanatory variables	Dependent variable: Δ total export value of all exporters							
	Belgium	Italy	France	Lithuania	Finland	Poland	Hungary	Romania
Δ foreign demand (t/t-1)	0.7323*** (0.0468)	0.9918*** (0.0300)	0.8285*** (0.0290)	1.4655*** (0.1058)	1.1944*** (0.0416)	1.1819*** (0.0794)	1.1430*** (0.0487)	1.0199*** (0.0661)
Δ REER (t-1/t-2)	0.2709*** (0.0920)	-0.7916*** (0.0789)	-0.9272*** (0.0763)	-1.3932*** (0.1461)	-0.9679*** (0.2244)	0.2265*** (0.0746)	0.2223+ (0.1597)	-0.1480** (0.0734)
Constant	-0.0296*** (0.0035)	-0.0186*** (0.0028)	-0.0450*** (0.0028)	0.0425*** (0.0130)	-0.0257*** (0.0045)	0.0301*** (0.0051)	0.0289*** (0.0048)	0.0417*** (0.0081)
Sector / year fixed effects	YES	YES	YES	YES	YES	YES	YES	YES
Observations	976	1456	1438	922	965	500	803	957
Root mean-squared error	0.317	0.131	0.060	0.130	0.074	0.156	0.056	0.138

Notes. Country-specific mean-group estimation results of equation (3). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10, + p<0.15.

In addition, estimated trade elasticities are very heterogeneous across sectors.³⁷ The sectoral composition of a country's exports therefore significantly affects the role of the REER in explaining aggregate export performance. For example, Auer and Sauré (2011) show that Swiss exports are heavily concentrated in price-insensitive sectors, explaining the low reactivity of aggregate Swiss exports to changes in the REER.

Table 5 reports estimation results of regression (3) on the dataset described above, now estimated sector by sector; MG estimation is again employed, this time to allow for country slope heterogeneity. On average in the panel of EU countries reported in Table 4 sectoral REER elasticities are generally statistically significant and negative, albeit with different magnitudes across sectors.³⁸ In other terms, there is large sectoral heterogeneity in the REER elasticity within countries, even inside the EU.

³⁶ The few exceptions are Belgium, Poland and, possibly, Hungary, for which the REER elasticity is actually positive, yet small in absolute terms. This could be due to the fact that these countries import a significant amount of intermediate inputs, also to produce their exports, which could explain the sign of the REER elasticity. According to WIOD data, these three countries' manufacturing share of imported intermediate goods out of total intermediate goods was over 40% on average in the 2002-13 period, against, for example, approximately 25% in Italy. Note that the fit of the specification (inversely proxied by the root mean-squared error) is poorest in the cases of Belgium and Poland, potentially suggesting an omitted variable bias, where the omitted variable could be participation in global and/or regional value chains. Table 6, pooling all countries, shows that higher participation in GVCs could turn the sign of the REER coefficient positive.

³⁷ For example, the standard deviation of import elasticities across 4-digit manufacturing industries in Germany has been found to be nearly 4 (Corbo and Osbat 2013).

³⁸ The positive sign and/or statistical insignificance that comes up in some sectors could either be due to the lower number of observations (e.g. beverages) and/or to the fact that some sectors may be on average more dependent on imported intermediate goods, such as wearing apparel and fabricated metals, a fact which can flip the expected negative sign of the REER elasticity.

Table 5

REER/HCI elasticity estimates by sector based on CompNet micro-aggregated data

Explanatory variables	Dependent variable: Δ total export value of all exporters									
	Food products	Beverages	Textiles	Wearing apparel	Leather	Wood	Paper	Printing	Chemicals	Pharmaceuticals
Δ foreign demand ($t/t-1$)	0.7279*** (0.0404)	0.9520*** (0.1150)	1.1704*** (0.0539)	1.1905*** (0.0786)	1.4506*** (0.1530)	1.0508*** (0.0312)	1.1428*** (0.1332)	1.0948*** (0.1483)	1.5033*** (0.0634)	0.0172 (0.0709)
Δ REER ($t-1/t-2$)	-0.5467*** (0.0900)	0.1013 (0.3212)	-0.4792*** (0.1814)	0.3142+ (0.2360)	-1.7139*** (0.2599)	-1.1329*** (0.2567)	-0.9307*** (0.3155)	-0.1120 (0.2640)	-0.3232** (0.1353)	-0.7268*** (0.1338)
Constant	0.0060** (0.0027)	-0.0034 (0.0169)	-0.0553*** (0.0063)	-0.0973*** (0.0063)	0.0124*** (0.0043)	0.0144* (0.0083)	-0.0005 (0.0058)	0.0096 (0.0144)	-0.0297*** (0.0060)	0.0546*** (0.0115)
Country / year fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	559	368	491	522	430	527	479	415	458	333
Root mean-squared error	0.077	0.135	0.169	0.115	0.124	0.080	0.109	0.151	0.100	0.178

Explanatory variables	Dependent variable: Δ total export value of all exporters									
	Rubber	Other non-metallic minerals	Basic metals	Fabricated metals	Computer equipment	Electrical equipment	Machinery and equipment	Motor vehicles	Furniture	Other manufacturing
Δ foreign demand ($t/t-1$)	1.0500*** (0.0220)	1.0023*** (0.0706)	1.1230*** (0.0435)	0.7246*** (0.0254)	0.3514*** (0.1023)	1.0077*** (0.0972)	0.9611*** (0.0159)	1.4207*** (0.0216)	0.7869*** (0.0830)	0.7457*** (0.1737)
Δ REER ($t-1/t-2$)	0.0334 (0.0540)	-0.7146*** (0.1371)	-0.3035*** (0.0903)	-0.0021 (0.1214)	-0.5509*** (0.0675)	-0.4174*** (0.1090)	0.1620 (0.2182)	0.1034 (0.5158)	-1.1597*** (0.2718)	0.9933*** (0.2561)
Constant	0.0139+ (0.0085)	-0.0127+ (0.0084)	-0.0124** (0.0053)	0.0298*** (0.0063)	-0.0446*** (0.0064)	-0.0102+ (0.0073)	0.0214*** (0.0062)	0.0019 (0.0080)	-0.0004 (0.0073)	0.0060 (0.0095)
Country / year fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	531	511	425	586	479	484	562	479	503	445
Root mean-squared error	0.073	0.189	0.087	0.110	0.210	0.109	0.092	0.089	0.123	0.464

Notes. Sector-specific mean-group estimation results of equation (3). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10, + p<0.15.

Stylised fact #7: The intensive margin of exports is found to react less to REER fluctuations the larger the market power in a given sector and the more import-intensive the exports.

REERs may also affect the two margins of aggregate export performance to a different extent, which can also explain the large cross-sector heterogeneity in REER elasticities. Medium-run export dynamics can be decomposed into the “intensive margin” of exporters (the changes in foreign sales of existing exporting firms) and the “extensive margin” (the entry of new exporters). Hence REER depreciation, to the extent that it lowers the sunk cost of exports, can both boost sales abroad of existing exporters and facilitate the entry of new exporters. The underlying micro-economic structure of each sector matters in determining the reaction of export volumes to changes in exchange rates via these two channels.

Starting with the intensive margin, Berthou and Dhyne (2018) find that large and more productive exporting firms exhibit up to three times lower elasticities to CPI-deflated

REER movements and up to eight times lower elasticities to unit labour cost-deflated elasticities than the smaller, less productive exporting firms. This result is based on the estimation of export elasticities to REERs by firm-level productivity quartile on CompNet data for 11 EU countries in the period 2001-11. Comparable results are also found in Demian and di Mauro (2015).

Hence, the overall reactivity of exports to REER fluctuations is lower the larger the concentration of exports in fewer, larger, highly productive firms. One possible explanation of the different reactivity of firms to exchange rate shocks is that firms have heterogeneous pricing-to-market strategies: in particular, the larger, more productive enterprises tend to absorb exchange rate changes by varying their mark-up, which leads to a weaker reaction of their export volumes.³⁹ Multi-product firms are also less sensitive to REER movements: in response to negative exchange rate shocks, firms pull out their least productive products from the export markets and concentrate on their more productive goods (Dekle, Jeong and Kiyotaki 2015; Mayer, Melitz and Ottaviano 2016). More import-intensive exporters, which are usually the largest and most productive firms even amongst exporters, adjust their export prices less to changes in exchange rates, since they face offsetting exchange rate effects on their marginal costs of production; this low reactivity to REER developments is further reinforced by the fact that these exporters also have high export market shares and hence large mark-ups (Amiti, Itskhoki and Konings 2014).⁴⁰ Based on Belgian firm-level data, this study found that if small exporters barely adjust their producer prices and fully pass on the exchange rate movements to foreign consumers, larger exporters offset nearly half of changes in exchange rates by adjusting their prices. These results have important implications for aggregate pass-through, since large exporters account for a huge share of exports, as seen already in Chart 4. Finally, large firms may be able to resort to exchange rate hedging via financial instruments which may not be available or are too costly for small firms. Moreover, using data on Japanese firms, Dekle and Ryoo (2007) find that firms hedge less in industries in which exchange rate depreciation is correlated with loosening financing constraints. In industries in which currency depreciation is correlated with tightening financing constraints, firms hedge more to insulate their cash flows from exchange rate shocks.

With respect to the intensive margin, we estimate the following dynamic export regressions on CompNet data for 12 EU countries in the years 2001-12:

$$\begin{aligned} \Delta \text{avg exports}_{s,i,t} = & \alpha + \beta_1 \Delta \text{demand}_{s,i,t} + \beta_2 \Delta^- \text{reer}_{s,i,t} + \beta_3 y_{s,i,t} \\ & + \beta_4 \Delta^- \text{reer}_{s,i,t} * y_{s,i,t} + FE + \varepsilon_{s,i,t} \end{aligned} \quad (4)$$

where the dependent variable is the year-on-year log change in the average export value of incumbent exporters only in sector s , country i and time t . The first two explanatory variables are respectively the log change in foreign demand and the negative log change in the REER/HCI of the same country-sector in the same time

³⁹ There is strong evidence of heterogeneous pricing-to-market strategies, for example, in France (Berman, Martin and Mayer 2012).

⁴⁰ In other terms, a firm's import intensity and destination-specific export market share are a sufficient statistic for its exchange rate pass-through, with the former proxying for marginal cost sensitivity to exchange rates and the latter proxying for mark-up elasticity.

period and y is either a measure of concentration in a given sector (denoted $C10$ below) or an indicator of GVC participation. Similarly to exports, the concentration measures are taken from CompNet. Foreign demand and sectorial REER/HCIs are the same as those employed to estimate equation (3). We here include negative changes in the REER/HCI in order to single out the effect of real depreciations, given the often documented asymmetric response of exports to REER movements. Finally, the GVC participation indicator is taken from the OECD TiVA database as an average of the backward participation indicator (i.e. foreign value added embodied in exports, as a percentage of total gross exports of the exporting country) and of the forward participation indicator (i.e. domestic value added embodied in foreign exports, as a percentage of total gross exports of the source country).

The results in Table 6, obtained by OLS with sector, country and time fixed effects, point to a real depreciation in a country-sector being linked to an increase in average exports of an already exporting firm in that sector (column 1).⁴¹ Moreover, higher growth in sectorial foreign demand is associated with a larger rise in the average exports of a firm in that sector. These are standard results. Real depreciations are then found to boost average firm exports less the more concentrated the sector (so indirectly, both the larger the size of firms and the higher their mark-ups; column 2). Furthermore, elasticities are lower (in absolute value) the more integrated the firms in the sector are in GVCs (column 3), and actually could turn positive, more generally confirming the results in Amiti, Itskhoki and Konings (2014).⁴²

⁴¹ The correlation is statistically weak in this regression, but becomes more robust when sectoral characteristics are taken into account. Interestingly, this effect is contemporaneous. A similar analysis on the extensive margin, which we discuss further on, finds a significant negative correlation between this other margin and REER depreciation, albeit with a one-year lag; it is presumably easier and quicker for an already exporting firm to increase its foreign sales than for a non-exporting firm to start exporting, in the face of REER depreciation.

⁴² When both concentration and GVC measures are included together, they lose statistical significance, plausibly due to multicollinearity.

Table 6

The link between real depreciations and the intensive margin of trade

Explanatory variables	(1)	(2)	(3)
	Dependent variable: Δ average export value of continuing exporters		
Δ foreign demand (t/t-1)	0.56*** (0.169)	0.52*** (0.186)	0.53*** (0.168)
Δ - REER (t/t-1)	-0.51+ (0.345)	-0.98*** (0.290)	-1.91** (0.769)
C10 (t)		0.02 (0.126)	
Δ - REER (t/t-1) * C10 (t/t-1)		0.58** (0.282)	
GVC participation (t-1)			0.28* (0.143)
Δ - REER * GVC participation (t/t-1)			3.60* (2.122)
Constant	-0.14 (0.120)	-0.14+ (0.105)	-0.06 (0.053)
Country / sector / year fixed effects	YES	YES	YES
Observations	1,207	1,087	1,206
R-squared	0.2013	0.1931	0.2045

Notes: Panel fixed-effects estimation results of equation (4). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10, + p<0.15.

Stylised fact #8: The larger the mass of firms that are close to the “productivity threshold”, the higher the reactivity of the extensive margin of exports to changes in the REER.

Turning to the extensive margin, a depreciation of the REER in a given country will trigger higher demand for its tradable goods, thus leading to a decrease in the “productivity threshold” of exporting firms, i.e. the threshold above which it becomes feasible for firms to enter export markets. The larger the mass of firms close to this threshold in a given country, the higher the probability that new firms will be able to enter foreign markets when price competitiveness improves. Using CompNet data, di Mauro and Pappadà (2014) show that the thickness of the right tail of the productivity distribution affects the extent to which the extensive margin of trade contributes to the increase in aggregate exports. This result is, however, valid only in static terms. Indeed, given that the “productivity threshold” cannot be measured, it is not that straightforward which summary statistic of the productivity distribution is the most relevant to proxy the mass of firms that could start exporting in the face of a REER shock.

For this exercise we have decided to approximate the productivity threshold to start exporting with the average TFP of new exporters, in a given country-sector-year. We next argue that the closer to this threshold is the average productivity of non-exporters in that same country-sector-year, the more firms will find it profitable to start exporting after REER depreciation.

In order to test this hypothesis, we construct the ratio of TFP of non-exporters to new exporters for each country-sector year sourced from CompNet and estimate the following regression:

$$\begin{aligned}
 \text{Number of new exporters}_{s,i,t} &= \alpha + \beta_1 \Delta \text{demand}_{s,i,t} + \beta_2 \Delta^- \text{reer}_{s,i,t-1} \\
 &+ \beta_3 rTFPno_new_{s,i,t-1} + \beta_4 \Delta^- \text{reer}_{s,i,t-1} \times rTFPno_new_{s,i,t-1} \\
 &+ FE + \varepsilon_{s,i,t}
 \end{aligned} \tag{5}$$

where the dependent variable is the number of new exporting firms in sector s , country i and time t , the first two explanatory variables are respectively the change in foreign demand and the negative change in the REER of the same country-sector in the previous period and $rTFPno_new$ is a the ratio of average TFP of non-exporters to new exporters in the same country, sector and year. The larger the ratio, the closer is the productivity of non-exporters to the required exporting threshold. Panel OLS with country, sector and time fixed effects are employed. Results in the first column of Table 7 confirm the standard findings that depreciation in the REER is correlated with a rise in the number of exporting firms, albeit with a two-year delay. The second column includes the interaction of the depreciation in the REER with the relative TFP of non-exporters, which is statistically significant and negative, suggesting that the higher the mass of firms “available” to enter the export market, the larger the positive impact of a REER depreciation on the number of exporters.

Table 7
The link between real depreciations and the extensive margin of trade

Explanatory variables	(1)	(2)
	Dependent variable: Number of new exporters	
Δ foreign demand (t/t-1)	0.38 (0.325)	0.52 (0.414)
Δ^- REER (t-2/t-3)	-2.33*** (0.669)	5.56 (5.023)
Δ^- REER (t-1/t-2) * ratio TFP no_new (t-1)		-11.01* (5.844)
ratio TFP no_new (t-1)		-0.11 (0.165)
Constant	2.24*** (0.146)	2.26*** (0.177)
Country / sector / year fixed effects	YES	YES
Observations	598	388
R-squared	0.682	0.759

Notes: Panel fixed-effects estimation results of equation (4). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10, + p<0.15.

Ultimately, the overall sensitivity of aggregate exports to changes in the REER will depend on the relative importance of the intensive versus the extensive margins of exports. The existing empirical literature is inconclusive with respect to the relative importance of these two channels, since it varies across sectors, the considered

time-span and the granularity of the employed data (see, for example, Helpman, Melitz and Rubenstein 2008; Crozet and Koenig 2008; Fernandes et al. 2018). However, the intensive margin is generally found to matter more than the extensive margin in advanced economies (Campa, 2004; Besedeš and Prusa 2011; Bugamelli, Linarello and Serafini 2018).

4 Concluding remarks

This paper reviews some implications of firm heterogeneity for external trade. The availability of firm-level data has unveiled the vast heterogeneity of performance across firms even within narrowly defined sectors and has led to the development of theoretical models which accommodate this heterogeneity. By using the comparable cross-country micro-aggregated CompNet database available for 14 EU economies, this paper uncovers and confirms eight stylised facts underlying the recent trade literature, for the first time to our knowledge for such a wide country sample.

New exporting firms are larger, more productive and pay higher wages than non-exporting firms (*Fact #1*). There is evidence of significant premia in terms of size, wages and labour productivity of new exporting firms relative to non-exporting firms operating in the same sector in selected EU countries. This suggests that only the most productive and largest firms can actually afford to bear trade costs, and thus self-select into exports. Fixed costs of exporting depend, among other factors, on the quality of the domestic legal system, access to finance and tariff and non-tariff trade barriers (*Fact #2*). Improvements in firm productivity, as well as reductions in exogenous trade costs, can have substantial positive effects on firms' sales and therefore on aggregate exports. For example, by improving institutional quality and by eliminating trade barriers, a higher number of firms could bear the cost of exporting.

Overall exports are concentrated in few firms, albeit to a different extent across countries and sectors (*Fact #3*). Therefore, the behaviour of a handful of enterprises can have a significant impact on a country's aggregate (external) performance; focusing on average, "representative" firms misses out on this granularity.

Opening to trade increases within-firm productivity growth (*Fact #4*), and therefore aggregate productivity, via several channels (learning-by-doing; increase in innovation; rise in the quality of inputs). Trade liberalisation also increases aggregate productivity by fostering a more efficient allocation of production factors across firms (*Fact #5*).

An important determinant of export growth is the change in the real effective exchange rate (REER). The reactivity of exports to changes in the REER is affected by firm heterogeneity, which is only picked up by granular data. In the literature trade elasticities are found to vary across sectors and across firms (*Fact #6*). The microstructure of the economy also affects the way REER movements impact on the two components of aggregate export performance, namely the "intensive" and the "extensive margin" of exports. In particular, the intensive margin of exports, i.e. the average exports of existing exporters, is found to react less to REER fluctuations the larger their market power in a given sector and the more import-intensive their exports (*Fact #7*). Moreover, the smaller the mass of firms close to the "productivity threshold" above which they start to export, the lower the reactivity of the extensive margin of exports, i.e. the entry of new exporters, to changes in the REER (*Fact #8*). The overall effect of changes in the REER on aggregate external performance thus depends on several factors, such as firm characteristics, the productivity distribution within sectors

and the composition of sectors within the total economy, as well as on the relative importance of the intensive and extensive margins.

Annex 1 CompNet data and country/year coverage

The Competitiveness Research Network (CompNet) was founded by the EU System of Central Banks in 2012 to bring together the work and expertise of economists working on competitiveness-related issues. The purpose was to improve the analysis of competitiveness, understood in a broad sense, by exploiting macro, micro and global value chain information. The main output of the Network has been, and still is, to produce comparable cross-country firm-based information that underlies the analyses conducted by the participating institutions, as well as the research community.

Since 2012 CompNet has evolved and been enlarged, increasing the number of stakeholders which now include, besides the European Central Bank and a number of National Central Banks of the ESCB, the European Commission, the European Investment Bank and the European Bank for Reconstruction and Development. The Halle Institute for Economic Research and the Tinbergen Institute, two European research institutes renowned for their expertise in productivity analysis, also actively participate in the project, with the Halle Institute also cooperating in a number of important tasks like the preparation of the statistical code, the collection of data and the provision of other services. Another important development has been the involvement as data providers of a number of National Statistical Institutes and other national research centres with access to firm-level data.

The CompNet dataset is based mainly on administrative data from firm registries and provides harmonised cross-country information on the main moments of the sector distribution (e.g. mean, median, standard deviation, deciles of the distribution, etc.) for a number of variables related to firm performance and competitiveness. From the beginning CompNet adopted the so-called “distributed micro-data approach” as developed by Bartelsman, Haltiwanger and Scarpetta (2004). In this approach, a common protocol is used to extract relevant information, aggregated in such a way as to preserve confidentiality, from existing firm-level datasets available within each National Central Bank (NCB) or National Statistical Institute (NSI) but keeping much of the richness of the underlying firm-level information. The common methodology harmonises industry coverage, variable definitions, estimation methodologies and sampling procedures, as much as the underlying raw data allows it. Details are documented in Lopez-Garcia and di Mauro (2015), Berthou et al. (2015), Aglio et al. (2018) and Lopez-Garcia (2018), to which we refer.

This paper uses information from the 4th and 5th vintages of the dataset, the most recent vintages available at the time of writing. In February 2019 CompNet released the 6th vintage, including information for a similar number of countries until 2015.⁴³ The new vintage incorporates several improvements relative to the previous rounds, in

⁴³ For details on the content of the 6th vintage, the reader can refer to the most recent user guide (Aglio et al. 2018), available on the CompNet webpage: www.comp-net.org.

terms of both the content and the procedure of data collection. However, the number of indicators collected in Trade module, heavily employed in this paper, was reduced. In particular, the value of exports was not measured and this makes it currently impossible to reproduce the analysis in this paper with the more updated data. The next vintage of the CompNet dataset, which should be available in early 2020, will again include all the main trade indicators.

Table A.1 shows the share of firms and employment covered by the merged 4th and 5th vintages of CompNet in each country.

The two first columns refer to the coverage of the population of similar firms, i.e. non-financial corporations with employees operating in the business economy, whereas columns 3 and 4 refer to the coverage of the corresponding national accounts aggregates.

The coverage of this specific paper, in terms of countries and years, is instead illustrated in Table A.2. Cross-country comparable trade data are not available for Spain, which is therefore dropped from all trade-related charts and regressions. Moreover, 54 2-digit sectors in the non-financial business economy according to the NACE rev.2 system are considered. For presentation purposes in the paper, results are often aggregated to nine 1-digit sectors (macro-sectors), by using value-added shares.

Finally, CompNet collects all competitiveness-related indicators for two distinct samples of firms: (1) non-financial corporations with at least one employee (full sample); and (2) non-financial corporations with at least 20 employees (“20E sample”). The reason is that some countries do not sample small firms (these are the cases of France, Poland and Slovakia). To be able to compare those countries with the rest of CompNet participants, all information is collected considering only firms with at least 20 employees in all countries. Furthermore, that sample is population weighted so that the distribution of firms in the sample resembles the distribution of firms in the population by macro-sector and size class.⁴⁴ For comparability reasons we only use the 20E sample in the analysis of this paper, unless otherwise indicated.

⁴⁴ CompNet considers 5 size-classes, following Eurostat: firms with 1-9 employees; 10-19; 20-49; 50-249; and 250 or more.

Table A.1

CompNet dataset's firm and employment coverage

Country	Coverage vs. similar population of firms (OECD) ¹		Coverage vs. National Accounts (Eurostat) ³	
	Average No of firms per year	Total employment	Value added	Total employment
Belgium	23%	79%	33%	40%
Czech Republic	6%	70%	17%	39%
Denmark	69%	64%	56%	28%
Estonia	67%	90%	7%	28%
Finland	44%	83%	42%	48%
France ²	86%	89%	46%	63%
Hungary	44%	88%	20%	50%
Italy	11%	65%	20%	34%
Lithuania	27%	43%	20%	46%
Poland ²	76%	91%	24%	58%
Romania	70%	47%	29%	37%
Slovakia ²	91%	95%	NA	29%
Slovenia	31%	85%	NA	46%
Spain	18%	47%	51%	30%

Notes: (1) Coverage is computed over the period 2004-2007, with the exception of Portugal (2006-2007). Data of the population of firms with at least 1 employee come from the OECD Structural Business Statistics repository; (2) France, Poland and Slovakia provide information only for firms with 20 employees or more. The coverage is computed over the population of firms with 20 employees or more; (3) Coverage of the whole economy (not only private firm sector) is computed for 2005, with the exception of Portugal, for which 2006 is used instead. Eurostat data comes from National Accounts: series nama_gdp_c and nama_aux_pem, respectively.

Table A.2

CompNet country/year coverage for this paper

Productivity module	BE (2002-2013), DK (2002-2013), EE (2002-2013), ES (2002-2013), FI (2002-2013), FR (2002-2013)**, HR (2002-2013), HU (2003-2012)*, IT (2002-2013), LT (2002-2011)*, PL (2005-2013)**, RO (2003-2012)*, SI (2002-2012)*, SK (2002-2013)**
Trade module	BE (2002-2013), DK (2002-2013), EE (2002-2013), FI (2002-2013), FR (2002-2013)**, HR (2002-2013), IT (2002-2013), LT (2002-2011)*, PL (2005-2013)**, RO (2003-2012)*, SI (2002-2012)*, SK (2002-2013)**

Notes: (*) indicates countries for which only the 4th vintage of the CompNet dataset is available, with data until 2012. For the rest of the countries the 5th vintage is available with data up until 2013. (**) is available only for firms with 20 or more employees. Differences in the country/year coverage may arise for specific indicators within each module.

Annex 2 Variable definitions

Variables*	Definition	Source
Legal System		
Judicial independence	This component is taken from the Global Competitiveness Report question: "Is the judiciary in your country independent from political influences of members of government, citizens, or firms?"	World Economic Forum, Global Competitiveness Report
Protection of property rights	This component is taken from the Global Competitiveness Report question: "Property rights, including over financial assets, are poorly defined and not protected by law or are clearly defined and well protected by law."	World Economic Forum, Global Competitiveness Report
Impartial courts	This component is from the Global Competitiveness Report question: "Is the judiciary in your country independent from political influences of members of government, citizens or firms?"	Global Competitiveness Report
Summary measure: Integrity of the legal system	Based on the International Country Risk Guide, it is composed of two components. One assesses the strength and impartiality of the legal system and the other the popular observance of the law.	PRS Group, International Country Risk Guide
Tariff and non-tariff barriers to trade		
Tariff and non-tariff barriers	This sub-component is based on the Global Competitiveness Report survey question: "In your country, tariff and non-tariff barriers significantly reduce the ability of imported goods to compete in the domestic market?"	World Economic Forum, Global Competitiveness Report
Mean tariff rate	Unweighted mean of tariff rates	World Trade Organization
Access to finance		
Financial regulation	Data on credit-market controls and regulations were used to construct rating intervals. Countries with interest rates determined by the market, stable monetary policy, and reasonable real-deposit and lending-rate spreads received higher ratings.	World Bank, World Development Indicators; International Monetary Fund, International Financial Statistics.
Financial depth	This is given by the financial resources provided to the private sector by domestic money banks and other financial institutions as a share of GDP	International Financial Statistics (IFS), International Monetary Fund (IMF)

* All indicators were rescaled so that a positive increase reflects an increase in the actual underlying measure (e.g. the higher the financial regulation indicator the more intense is regulation in that specific country).

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Competitiveness Research Network

This paper presents research conducted within the Competitiveness Research Network (CompNet). CompNet is a research network founded in 2012 to foster the debate on competitiveness and productivity issues among partner institutions and researchers. It aims at providing a robust theoretical and empirical link between drivers of competitiveness and macroeconomic performance for research and policy analysis purposes. Originally founded by the European System of Central Banks (ESCB), CompNet now includes as partner institutions the European Central Bank (ECB), the European Commission (EC), the Leibniz Institute for Economic Research of Halle (IWH), the European Bank of Reconstruction and Development (EBRD), the European Investment Bank (EIB), the Tinbergen Institute and several national central banks. CompNet-related research is conducted in two main work streams: 1) Productivity growth drivers and efficiency of resource allocation; 2) International trade, euro area rebalancing and global value chains. The views expressed in this paper are those of the author(s) and do not necessarily reflect those of the ECB, Banca d'Italia, the ESCB and any of the other organisations associated with the Network.

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