It takes (more than) a moment: Revisiting the link between firm productivity and aggregate exports*

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Abstract

This paper examines empirically which features of an exporting country's firm-level productivity distribution are related to its aggregate exports. It implicitly tests if the data support the prediction of the standard trade model with heterogeneous firms la Melitz (2003) that, within a general gravity framework, only the first moment (i.e., the mean) of the firm-level productivity distribution affect aggregate exports. The empirical analysis, which is based on a panel of 17 European countries and 22 manufacturing industries, provides robust support to the alternative view that also higher moments of the productivity distribution matter. In particular, we find that the exporter's multilateral resistance term is positively related not only to the average productivity but also to indicators of rightward asymmetry and, to a lesser extent, dispersion. As export-promoting policies are concerned, these results point to the importance of measures aimed at strengthening the competitiveness of medium-high productive firms and the mechanisms governing allocative efficiency.

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1 Introduction

Translating the micro predictions of the trade theory with heterogeneous firms into their macro-aggregate outcomes and, consequently, into policy prescriptions is far from obvious. The standard trade model la Melitz (2003) generates a gravity equation whereby aggregate export outcomes are determined by the average firm productivity in the exporting country (Head and Mayer, 2014). In other words, under the standard triplet of assumptions of Melitz (2003) — that is, CES demand systems, iceberg export costs and Pareto productivity distributions —, the exporter fixed effect, which is broadly a measure of inherent competitiveness of the exporting country defined in the gravity literature as the multilateral resistance term, depends only on the first moment of the underlying firm productivity distribution. This is at least at odds with the well-known evidence that the dominant share of a country's aggregate exports is mostly due to a small set of very large firms, the so called Happy Few (Ottaviano and Mayer, 2011). Given that the happy few are very likely concentrated in the top percentiles of firm productivity distributions, it is reasonable to expect that average productivity is not a sufficient statistics for trade outcomes and that instead other features of the distribution are relevant. In particular, productivity distributions with the same mean but different higher-order moments related to the shape of the right tail could entail different export performances.

In this paper we exploit a new and unique dataset, called CompNet, that provides a panel of cross-country, cross-sector data for 17 European countries and 22 manufacturing industries. Developed within the European System of Central Banks, CompNet has been generated by running identical codes on firm-level harmonized datasets made available by National Central Banks or Statistical Institutes to produce a large set of information on firm-level productivity distribution at the industry-country-year level. CompNet is therefore the ideal dataset to study connections between micro-features and macro-outcomes. We then match CompNet with Eurostat's ComExt trade data by origin country, destination market, sector and year.

We take these data within a general gravity estimation. Using a general, model-free and non-naive gravity specification we first derive an exporter country's multilateral resistance term that varies also across industries and time, while controlling for importing country fixed effects and the standard dyadic variables. Then, in a second step, to test whether the interpretation of the standard trade model is supported by the data we regress the estimated multilateral resistance terms on different moments of the firm productivity distributions, while controlling for various fixed effects.

We find strong and robust evidence against the null hypothesis that only average productivity matters for aggregate exports. Exporters fixed effects are indeed positively correlated to the mean, but also to measures of dispersion and asymmetry of the underlying firm productivity distributions. Asymmetry, measured with both parametric and non-parametric indicators, is especially important and explains a considerable share of the cross-industry and cross-country variance of the exporting country's multilateral resistance term.

Our results have at least two important implications. From an analytical point of view, they call for more general or different functional forms than those used in the standard trade model to explain aggregate bilateral exports. The recent revisit of the theoretical foundations of gravity models and particularly the inclusion of the heterogeneous firms approach has highlighted that it is not possible to estimate structural gravity models and compute exporters and importers multilateral resistance terms without assuming Pareto distributions (Chaney, 2008; Head and Mayer, 2014; Helpman et al., 2008). Moreover, a growing number of contributions on the theory and measurement of welfare gains from trade, triggered by the initial work of Arkolakis et al. (2012), has recently shown that in order to correctly compute variable bilateral elasticities to trade costs it is necessary to deviate from the Pareto distribution assumption (Bas et al., 2015; Melitz and Redding, 2015). We add to this micro-to-macro literature and show the Pareto distribution assumption fails even when linking exporters' efficiency with its aggregate exports. We stop short of providing an alternative theoretical framework. The second implication is for the policy perspective. Our results imply that, for any given average productivity level, policies enhancing the rightward asymmetry of the productivity distributions strengthens aggregate exports. Of course, this happens also when average productivity is raised, but we show that the magnitude of the impact of asymmetry is roughly as large as that of the mean in all batteries of estimations we carry out. The CompNet database (CompNet Task Force, 2014) shows that there is a huge variance in productivity distributions across the CompNet sample countries, both in terms of mean and higher moments. Particularly for countries with a relatively low mean, for example the Central and Eastern European economies, it might be much more effective to strengthen the best performers (frequently, foreign investors) than trying to lift up the whole population of firms. Equally, policies aimed at fostering allocative efficiency, i.e., moving market shares from less to more productive firms, could be more effective in boosting aggregate exports than those supporting small medium enterprises, independently of their growth performance.

The next section develops theoretically a general aggregate demand function model with heterogeneous producers, which is a streamlined version of Melitz (2003) based on the three key assumptions of CES demand systems, variable iceberg export cost and fixed export cost and Pareto productivity distributions. We derive a gravity equation that connects bilateral exports to the exporting countries' capability to export to all destinations, the characteristics of the destination markets and bilateral trade costs. The model defines the null hypothesis to be taken to the data, that aggregate exports depends only on average productivity but not on higher-order moments. After describing the two datasets in Section 3, we outline our empirical strategy which is developed in two steps (Section 4)): first a gravity equation is run to estimate the exporter country's fixed effects (by sector and year), then such a set of fixed effects are regressed on different moments of the productivity distributions. Section 5 presents all the results, while the last one concludes.

2 Theoretical Framework

Our aim is to investigate which features of the productivity distribution of a country's producers explain its aggregate exports. Specifically, we want to check whether the implications of the "standard model" with heterogeneous firms à la Melitz (2003) are supported by the data. As the model is well known, here we only provide a streamlined presentation. Further details can be found in the original paper and in recent surveys such as those by Costinot and Rodriguez-Clare (2014) and Head and Mayer (2014).

Consider an economy consisting of M countries indexed $m = 1, ..M$. The focus will be on the bilateral exports from an 'origin' country o to a 'destination' country d. In each country m there are a large number of monopolistically competitive producers N_m, each supplying a unique variety of a horizontally differentiated good with marginal cost c distributed according to a continuous cumulative density function $G_m(c)$ with support $[0, c_{mm}]$.

The associated productivity is $1/c$ and, therefore, the upper bound of the support c_{mm} identifies the marginal cost level of the lowest efficiency producers in m. With costly trade exporters from m to d are those producers in m that are at least as efficient as the lowest efficiency producers in d after taking trade cost into account. The lowest efficiency exporters from m to d have thus marginal cost $c_{md} < c_{dd}$, where the gap is due to the presence of trade costs. Accordingly the fraction of producers in m exporting to d is $G_m(c_{md})$, and their number is

$$N_{md}^x = N_m G_m(c_{md}). \tag{1}$$

This is the 'extensive margin' of trade from m to d. Using $x_{md}(c)$ to denote the value of exports from m to d for a producer with marginal cost c, the average value of exports per exporter from m to d can be written as

$$\overline{x}_{md} = \left[\int_0^{c_{md}} x_{md}(c) dG_m(c)\right] / G_m(c_{md}). \tag{2}$$

This is the 'intensive margin' of trade from m to d. Then, by definition, aggregate exports X_{md} are such that

$$X_{md} = N_{md}^x \overline{x}_{md} = N_m \left[\int_0^{c_{md}} x_{md}(c) dG_m(c)\right]. \tag{3}$$

While expressions (1), (2) and (3) have broad validity, Melitz (2003) makes two additional restrictive assumptions with a bearing on the functional form of $x_{md}(c)$ and the gap between c_{dd} and c_{md}. Most subsequent applications of Melitz's model also make the third restrictive assumption that productivity $1/c$ follows a specific distribution. When all three assumptions hold, we have what we call the the "standard model" of international trade with heterogeneous firms.

To understand what the three additional assumptions imply, it is useful to consider the general additive separable demand system studied by Zhelobodko et al. (2012). Specifically, let a mass L_d of identical consumers in country d share the following utility function

$$U_d = \int_0^{N_d^s} u(q_d(n)) dn \tag{4}$$

which they maximize subject to the budget constraint

$$\int_0^{N_d^s} p_d(n) q_d(n) dn = y_d$$

where y_d is individual income, N_d^s is the number of sellers in d (including both local producers N_d and exporters from elsewhere N_{md}^x), $q_d(n)$ is consumption of the variety supplied by seller n, and $p_d(n)$ is its price. Utility maximization generates individual inverse demand

$$p_d(n) = \frac{u'(q_d(n))}{\int_0^{N_d^s} u'(q_d(n))q_d(n)dn} y_d$$

with associated individual expenditure

$$r_d(n) = p_d(n)q_d(n) = \frac{u'(q_d(n))q_d(n)}{\int_0^{N_d^s} u'(q_d(n))q_d(n)dn} y_d.$$

The value of exports from origin country o to destination country d for an exporter with marginal cost c can thus be stated as

$$x_{od}(c) = p_{od}(c)q_{od}(c)L_d = \frac{u'(q_{od}(c))q_{od}(c)}{\sum_{m=1}^{M} N_m \left[\int_0^{c_{md}} u'(q_{md}(c))q_{md}(c)dG_m(c)\right]} y_d L_d \tag{5}$$

with a corresponding value of aggregate exports equal to

$$X_{od} = \frac{N_o \int_0^{c_{od}} u'(q_{od}(c))q_{od}(c)dG_o(c)}{\sum_{m=1}^{M} N_m \left[\int_0^{c_{md}} u'(q_{md}(c))q_{md}(c)dG_m(c)\right]} y_d L_d \tag{6}$$

In line with Melitz (2003), the "standard model" assumes $u(q_d(n)) = (q_d(n))^{1-1/\sigma}$ so that (4) implies a CES demand system. It also assumes that there are two types of trade costs: an iceberg variable export cost $\tau_{md} > 1$ and a fixed export cost $f_{md} > 0$. Local sales incur a fixed production cost $f_{mm} > 0$ instead of the fixed export cost but no variable trade cost ($\tau_{dd} = 1$). The value of aggregate exports (6) then becomes

$$X'_{od} = \frac{[N_o G_o(c_{od})] (\bar{c}_{od})^{1-\sigma} (\tau_{od})^{1-\sigma}}{\left[\sum_{m=1}^{M} N_m G_m(c_{md})\right] (\bar{c}_d^s)^{1-\sigma}} y_d L_d \tag{7}$$

where $\bar{c}_{md}$ is the average (delivered) marginal cost of exporters from m to country d defined as

$$\bar{c}_{md} = \left[\int_0^{c_{md}} c^{1-\sigma} dG_m(c)/G_m(c_{md})\right]^{\frac{1}{1-\sigma}},$$

$\bar{c}_d^s$ is the average (delivered) marginal cost of all sellers to d defined as

$$\bar{c}_d^s = \left[\sum_{m=1}^{M} \frac{N_m}{N_d^s} (\bar{c}_{md})^{1-\sigma} (\tau_{md})^{1-\sigma}\right]^{\frac{1}{1-\sigma}},$$

and $\sum_{m=1}^{M} N_m G_m(c_{md})$ is the total number of sellers N_d^s. Collecting country indices, (7) can be rewritten as

$$X'_{od} = N_o \; G_o \left(\frac{c_{dd}}{\tau_{od}} \left(\frac{f_{dd}}{f_{od}} \right)^{\frac{1}{\sigma-1}} \right) (\bar{c}_{od})^{1-\sigma} \, (\tau_{od})^{1-\sigma} \;\; \frac{y_d L_d}{N_d^s \left(\bar{c}_d^s\right)^{1-\sigma}} \tag{8}$$

given that we have

$$c_{od} = \frac{c_{dd}}{\tau_{od}} \left(\frac{f_{dd}}{f_{od}} \right)^{\frac{1}{\sigma-1}}$$

Lastly, the "standard model" assumes that productivity follows a Pareto distribution implying the cumulative density function of marginal cost $G_m(c) = (c/c_{mm})^k$ with $c \in [0, c_{mm}]$. Higher values of $k > 1$ increase the asymmetry of the distribution by shifting density towards the upper bound of the support c_{mm}. Under this third assumption, (8) can be further specified as

$$X''_{od} = N_o \, (\bar{c}_{oo})^{-k} \;\; (f_{od})^{1-\frac{k}{\sigma-1}} \, (\tau_{od})^{-k} \;\; \frac{y_d L_d \, (\bar{c}_{dd})^{1-\sigma+k} \, (f_{dd})^{\frac{k}{\sigma-1}-1}}{N_d^s \left(\bar{c}_d^s\right)^{1-\sigma}} \tag{9}$$

This is a gravity equation that explains aggregate bilateral exports from origin country o to destination country d in terms of the 'capabilities' of country o as a supplier to all destinations $N_o \, (\bar{c}_{oo})^{-k}$, the characteristics of destination country d that promote imports from all origins

$$y_d L_d \, (\bar{c}_{dd})^{1-\sigma+k} \, (f_{dd})^{\frac{k}{\sigma-1}-1} \, / N_d^s \, (\bar{c}_d^s)^{1-\sigma} \, ,$$

and bilateral trade costs due to crossing the border f_{od} and covering distance τ_{od} (Head and Mayer, 2014). For conciseness, we introduce the term "competitiveness" of origin country o to refer to its 'capabilities' as a supplier to all destinations. Then (9) has the strong implication that the country's competitiveness $N_o \, (\bar{c}_{oo})^{-k}$ and thereby its aggregate exports to d depend only on the first moment $\bar{c}_{oo}$ of the productivity distribution of its producers but not on higher order moments.

In the next section we will bring this implication of the "standard model" to data in two steps. First, we will run gravity regressions based on (9) to estimate origin country fixed effects for a sample of Eurozone countries. These fixed effects will measure the "competitiveness" of the sampled countries as suppliers, netting out importer-specific and country-pair-specific characteristics. Second, we will check whether the variation in the estimated origin country fixed effects is related to various moments of the distribution of firm productivity. Given (9), the null hypothesis of the "standard model" is that only the first moment of the productivity distribution should matter for competitiveness. The alternative hypothesis based on (6) is that higher moments should matter too. Rejection of the null hypothesis in favor of the alternative should, therefore, be interpreted as confutation of the CES-iceberg-Pareto restrictions imposed by the "standard model".[1]

3 Data

For the empirical analysis, we use three main sources of data: European System of Central Banks' Competitiveness Network dataset (CompNet), Eurostat's ComExt trade database and CEPII database.

Under the coordination of the European Central Bank, 17 (Austria, Belgium, Croatia, Estonia, Finland, France, Germany, Hungary, Italy, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, and Spain) national central banks have produced a set of harmonized and comparable sector - and year-level production function indicators based on national firm-level samples (see CompNet Task Force, 2014).[2] The indicators available are the amount of inputs and output, labor productivity, total factor productivity (TFP) and measures of allocative efficiency such as the Olley and Pakes covariance (Olley and Pakes, 1996). What is special in CompNet is that the firm-level data have been used to compute not only averages (by country, sector and year) but also other moments of each variable's distribution. Thus for a country-sector-year triple and for each indicator, the dataset reports information on the mean, the median, the standard deviation, the skewness, and the values of various percentiles.

CompNet comprises two different samples. The *"full sample"* is produced from countries' samples based on firms with at least one employee and covers the period 1996-2012, while the *"20E sample"* is restricted to firms with at least 20 employees and starts from 2001.[3] As explained in CompNet Task Force (2014), the *"20E sample"* ensures a relatively higher degree of representativeness because the full firm-level datasets in few cases do not cover smaller firms (those with less than 10 employees in Poland, less than 20 employees in Slovakia, less than 750,000 euros of turnover in France), while in most of the other cases tend to be biased towards medium and large firms (such a bias is severe for Austria and Germany). To improve representativeness and homogeneity across countries, the *"20E sample"* has been enriched by a weighting scheme based on the total number of firms by country-year-sector-size

[1] These restrictions underpin the finding by Arkolakis et al. (2012) that several trade models share the same welfare properties.

[2] The unit of analysis is the firm. Self-employed (physical persons with economic activity) are generally not included.

[3] Both samples are slightly unbalanced: for example, Portugal data begin in 2006, while Belgian ones end in 2011)

class taken from Eurostat Structural Business Statistics (SBS).

The *"20E sample"* has some drawbacks, too. First, it obviously does not provide a full and correct representation of a country's productive system that in many European economies is populated by a large majority of very small firms. To some extent, this is going to be a minor issue in our case since we aim at explaining export performance and exporting is well-known to be an activity for more productive and relatively larger firms. Second, due to the ways some of the firm-level datasets are built there are potential sample biases towards more productive firms so that aggregate values (by country or sector) record sometimes non-negligible differences with respect to Eurostat official figures. We address these concerns by including in our econometric analysis country and sector fixed effects that may capture systematic differences across countries or sectors and by replicating all the baseline results derived from *"20E sample"* also on the *"full sample"*.

After excluding country-sector-year cells comprising less than 10 firms, we end up with an unbalanced panel of 3,484 observations for 17 European countries, two-digit manufacturing sectors (with the exclusion of Coke and Petroleum) over the period 2001-2012. The number of observations is slightly smaller when using TFP-based indicators due to the lack of data on input factors for some country-sector-year cells.

As already explained, the focus of this paper is on higher moments of the productivity distribution. At the country-sector-year level we therefore we compute 3 indicators of dispersion and 2 indicators of asymmetry. As to dispersion, we consider: i) the standard coefficient of variation (CV) given by the ratio between the standard deviation and the mean, where the normalization by the mean allows for a better comparability across countries and sectors; (ii) the ratio of the 80th to the 20th percentile of the productivity distribution ($P80/P20$), and (iii) the ratio of the 90th to 10th percentile of the productivity distribution ($P90/P10$). Unlike the coefficient of variation, the latter two ratios have the advantage of being independent of the type of the underlying distribution. A ratio $P90/P10$ equal to 2 means that the firm at the 90th percentile is twice more productive than a firm in the 10th percentile. Then, an increase of the ratio indicates that the tails of the distribution are more distant from each other in terms of productivity levels, or in other terms that the most productive firms (right part of the distribution) are relatively more productive than the least productive ones (left part of the distribution).

Asymmetry is captured by two indicators: i) the standard parametric skewness index (third central moment) (*Skew*); ii) the non-parametric Pearson's second skewness coefficient (*Pears*) computed as follows:

$$Pears = 3 * \frac{Mean - Median}{st.dev.} \tag{10}$$

This latter index is of easy interpretation. When *Pears* assumes positive (negative) values, i.e., when mean>median (mean<median), the productivity distribution is right-skewed (left-skewed). A higher index is therefore signaling a fatter and longer right tail of the distribution. The normalization of the Pearson coefficient by the standard deviation (*st.dev.*) allows a better comparability across countries and sectors. Again, *Pears* is a distribution-free indicator while *Skew* works better in the case of normality.

Table 1 reports the descriptive statistics of the productivity distribution indicators by country, that is taking averages over sectors and years. labor productivity measures are in upper panel, TFP ones in the lower panel. Focusing only on labor productivity for simplicity, we see that average values range from the lowest figures of Romania, Hungary and Lithuania to the highest ones of Germany and Austria. With some exceptions somehow related to the sample biases previously described, there appears to be a positive correlation between country size and average productivity. The dispersion and asymmetry indicators display the opposite pattern, being larger in smaller and less advanced countries.

[Table 1 about here.]

Differences in labor productivity across countries can be better appreciated in Figure 1 which shows the box plot of the productivity distribution by country. With countries ranked by average labor productivity levels, it is quite evident that large countries are more productive than small ones and that there is a great dispersion in the data both within and between countries.

[Figure 1 about here.]

Since our goal is to relate the moments of the productivity distribution to countries' trade performance, we retrieve from Eurostat's ComExt database the values of exports (in euros) for each EU country available in CompNet to 165 destination markets and for 20 manufacturing sectors (CPA 2008 2 digit) over the period 1996-2011.[4] Descriptive statistics (in log) of these data are reported in Table 1.

[4]Notice that the first two digits of CPA 2008 coincide with the first two digits of NACE rev.2.

[Table 2 about here.]

Finally, we download from the CEPII database (Mayer and Zignago, 2011) the standard dyadic variables to be used in the gravity model. In particular, for any exporting-importing country pair we derive information on the geographical distance, on the existence of a common border and a common language, and on the former colony status of the importer with respect to the exporter. As geographical distance is concerned, we use the geodesic distances calculated with the great circle formula, which is based on latitudes and longitudes of the most important cities/agglomerations (in terms of population).

4 The empirical specification

In this section, we describe our empirical strategy to test the validity of the assumptions behind the standard trade model presented in Section 2. We follow a two-step approach.

In the first step, we estimate a general gravity equation with fixed effects for the importing and exporting country corresponding to Equation 9, that is:

$$Log(X)_{odst} = \alpha_{ost} + \beta_{dst} + \gamma_{od} + \epsilon_{odst}, \tag{11}$$

where aggregate bilateral exports (X_{odst}) from origin country o to destination market d in sector s and year t are regressed on: (i) exporting country-sector-year fixed effects (α_{ost}) which proxy for the the capabilities of country o to supply all destination markets in sector d and year t and correspond to the term $N_o(\bar{c}_{oo})^{-k}$ in Equation 9; (ii) importing country-sector-year fixed effects (β_{dst}) which absorbs all the characteristics (e.g., demand) of destination market d in sector s and year t; (iii) the standard bilateral (origin-destination) time- and sector-invariant trade cost (γ_{od}). Standard errors are always robust to heteroschedasticity and clustered at the origin country-year level.

As explained by (Head and Mayer, 2014), this specification has important advantages: it *"is now common practice and recommended by major empirical trade economists"*, and it *"does not involve strong structural assumptions on the underlying model"*. Moreover, in this setting we can retrieve the exporter-sector-year fixed effects that in the gravity literature language coincide with the exporter's multilateral resistance term once all possible destination markets' characteristics (again by sector and year) and the standard dyadic (geographical-cultural-historical) features are netted out.[5] From now on, we rename the exporter's multilateral resistance term as the competitiveness indicator $Comp.Ind._{ost}$.

We then take $Comp.Ind._{ost}$ to the second step and use it as the dependent variable in the following equation:

$$Comp.Ind._{ost} = a_0 + a_1 Mean_{ost-1} + a_2 Asim_{ost-1} + a_3 Disp_{ost-1} + C_o + S_s + Y_t + e_{ost} \tag{12}$$

where we directly test whether $N_o(\overline{c}_{oo})^{-k}$ depends only on exporting country-sector-year average productivity ($Mean_{ost-1}$) as predicted by the standard Melitz model with heterogeneous firms or rather also on higher moments measuring the dispersion ($Disp_{ost-1}$) or the asymmetry ($Asim_{ost-1}$) of the productivity distribution. All the regressors are one-period lagged to minimize endogeneity (due to simultaneity or reverse causality) concerns. Country fixed effects (C_o) are included to control for time-invariant characteristics, like country size, of the exporting economy that could affect its competitiveness. Sector fixed effects (S_s) capture different degrees of tradeability across products that could easily bias the estimates given that exporting countries have different sectoral specialization. Finally, year fixed effects (Y_t) control for common international cycles. We estimate Equation 12 by OLS with standard errors that are robust to heteroschedasticity and clustered at the sector*year level to account for autocorrelation due, for example, to sectoral shocks (such as as technology shocks or sectoral trade policies).

This two-step approach is commonly used to evaluate the effect of country-sector level characteristics (such as exchange rate or wages) on trade flows (Eaton and Kortum, 2002) and foreign direct investment (Head and Ries, 2008). Importantly, the mean and the higher moments of the productivity distribution would not be identified in a one-step estimation with the high dimensional dummies that are typically included in the gravity model (Head and Mayer, 2014).

5 Results

Table 3 reports the results from the fixed effects estimation of the gravity model. We estimate it over three different sample, so as to show that the exporter's multilateral resistance terms do not vary

[5]Other estimation methods, such as tetrads transformation, even if less computationally intense in term of dummies, would not allow us to retrieve the estimates of the exporter's fixed effects of interest.

significantly when estimated over a different set of exporting countries or a different sample period.

The first sample considers as exporters all the European countries participating to the CompNet network from 1996 to 2012 (column 1)[6]; the second sample focus on the same countries but restricts the sample period to 2001-12 (column 2); the third sample is based on the smaller set of 17 countries for which we have productivity indicators in the sample *20E*, again from 2001 to 2012. All the coefficients have the expected sign and do not vary in a relevant way across estimation samples. Exports decrease with distance, while they are higher in case the exporting and importing countries share a common language and have colonial ties. Compared to the previous literature, the coefficient of distance is relatively large (above the average of 93 in Head and Mayer (2014) but still in the range of existing findings. However, it must be considered that typically trade elasticities with respect to distance tend to be higher when the estimates are mostly driven by trade flows within the same region, as is in our case (Disdier and Head (2008)).

[Table 3 about here.]

Since the $\hat{\alpha}$ estimated with the three different samples are highly pairwise-correlated (the coefficients of correlation are always around 0.98), in Table 4 we show only the coefficients from column 3, i.e., from the restricted sample of CompNet countries for which we have productivity indicators. The highest values $\hat{\alpha}$ belong to the most advanced and larger European economies, namely Germany, Italy, France, and Spain, while the lowest ones to Estonia and the East European countries (Romania, Hungary, Slovakia, Slovenia).

Even if the estimated $\hat{\alpha}_{ost}$ are positively affected by the size of the exporting country, we deem they are also good indicators of its competitiveness regardless of size. In Figure 2, we provide a scatter plot of $\hat{\alpha}_{ost}$ against the trade balance (the ratio of exports minus imports to exports plus imports) and the correspondent linear fit line. These two variables are quite clearly positively related, to say that $\hat{\alpha}_{ost}$ are indeed capturing an exporting country's overall competitiveness on the international markets of manufacturing goods.

[Table 4 about here.]

[Figure 2 about here.]

[6] These countries are: Austria, Belgium, Croatia, Czech Republic, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.

As already mentioned, the exporter's fixed effects identify the multilateral resistance term[7] and take into account anything that can affect exporters propensity to export to all destinations. Therefore, *Comp.Ind.* can be used to analyze trade determinants that cannot be identified within a gravity equation. In this vein, we test if a country's competitiveness in the international markets is affected by its average firm productivity or also by more general features of its productivty distribution.

Our baseline estimates are based on the *"20E sample"* and refer to both labor productivity (LProd) and total factor productivity (TFP).

Table 5 presents the baseline results, in the top panel (Panel A) for labor productivity, while in the bottom panel (Panel B) for TFP. The coefficient of average labor productivity is, as expected, positive and statistically significant in all the specifications: in the spirit of Melitz-type models, higher average productivity is beneficial to a country's exporting capacity. But this is not the full story. When in columns 2-6 we add the higher moments of the productivity distribution one at a time, we find that the right-skewness and, though to a smaller extent, the dispersion of the productivity distribution are also positively related to competitiveness. In the case of asymmetry the coefficients of both *Pears.* (column 5) and *Skew.* (column 6) are positive and highly significant. As to dispersion, we find a positive and significant coefficient when using the $P80/P20$ ratio (column 3) and the coefficient of variation ($LProd(C.V.)$; column 4) but no significant effect with the $P90/P10$ ratio. In the last three columns of the Table we run a horserace between mean, dispersion and asymmetry indexes and confirm that average and asymmetry are both simultaneously and robustly relevant for a country's international competitiveness. Again, the link between the dispersion of productivity and competitiveness appears to be weaker and less stable.

Quantitatively, the estimates of column 5 suggest that an increase of one standard deviation in the *Pears.* index (corresponding to a 47% increase with respect to its mean) is associated to a competitiveness index 5.7 per cent higher; as a basis of comparison, the effect of an increase of one standard deviation in average labor productivity amounts to an increase of about 6.4 per cent in *Comp.Ind.*.

The results for TFP (Panel B) are qualitatively analogous. In quantitative terms (using again the estimates of column 5), an increase of one standard deviation in the *Pears.* index is associated to a competitiveness index 6.3 per cent higher, while the effect of an increase of one standard deviation in

[7] Anderson and Yotov (2012) show that structural multilateral terms explain almost all of the variation in the estimated fixed effects generated from gravity regressions.

average TFP accounts for about a 9 per cent increase in competitiveness.

[Table 5 about here.]

5.1 Robustness

Our analysis has so far shown that average firm productivity is not a sufficient statistics of a country's competitiveness and that other moments of the productivity distributions convey novel and relevant information. Even if we are not aiming at providing any causal relationship between asymmetry or dispersion on one side and export performance on the other, we can strengthen our results by showing they are robust to different empirical specifications. To this aim, we perform three robustness exercises. In all cases, we start from the specifications of columns 7, 8, and 9 of Table 5.

The first test addresses potential omitted variable biases. In particular, we enrich Equation 12 with country*year and sector*year fixed effects, thus controlling for developments in the exporting country's effective exchange rate or for sectoral or technology shocks. For the case with country*year fixed effects, to which we add sector fixed effects, the results are reported in columns 1-3 of Table 6. Quite evidently, the strong results on the average productivity, the Pearson Index, the skewness and the coefficient of variation remain unchanged for both labor productivity and TFP. The same occurs when we include sector*year fixed effects along with country fixed effects in column 4-6.

[Table 6 about here.]

Table 7 reports a second set of robustness checks. Starting again from the specification of columns 7, 8, and 9 of Table 5, we add among the explanatory variables the (log of) number of firms to control for the role of industry size on export competitiveness.[8] Indeed, equation 9 shows that a country's export capabilities ($N_o(\bar{c}_{oo})^{-k}$) are a function not only of the average productivity ($\bar{c}_{oo})^{-k}$) but also of the number of firms in the domestic market (N_o). Columns 1,2 and 3 of Table 7 show that both mean and asymmetry ($Pears.$ and $Skew$) are statistically significant while skewness is slightly significant only in Panel B. As expected, a higher number of firms ($Log(N.Firms)$) has a positive and statistically significant effect on competitiveness.

Given that CompNet indicators are obtained by aggregating micro level data, in columns 4, 5, and 6 of Table 7, we estimate the baseline model using weighted least square (WLS). Similarly to

[8] The number of firms is retrieved from the CompNet sample 20E and therefore varies at the sector-country-year level.

Angrist (1998), we weight the observations with the number of firms within each country-sector-year cell that have been used to compute the CompNet indicators.[9] Given the definition of weights at country-sector-year level, the WLS estimator implies lower squared residuals (and consequently lower standard errors) for the observations generated with a large number of firms (i.e., large weights). Thus, the statistical significance relies more on the observations calculated on cells with a relatively larger number of firms. The WLS estimator conveys the same results: both the average and the Pearson index of the productivity distribution affect positively a country's export capabilities.

In the last three columns of Table 7, we cluster the (robust) standard errors by country*year, instead of sector*year, to control for the serial correlation of the error term due to country-specific business cycle shocks. Again, $LProd(Mean)$, $LProd(Pears.)$, and $LProd(Skew)$ are positive and statically significant.

[Table 7 about here.]

We then test the robustness of our findings to sample composition. We re-estimate our preferred specification (column 5 in Table 5) eliminating one country at a time from the *"20E sample"*. Table 8 shows the estimated coefficients for the various moments computed on labor productivity (Panel A) and TFP (Panel B). Each row reports the result obtained when excluding the country indicated in the first column of the Table. The Pearson index is always positive and significant: it ranges from 0.14 (excluding Hungary) to 0.23 (excluding Austria) in Panel A, and from 0.13 (excluding France) to 0.26 (excluding Estonia) in Panel B. A similar result applies to $LProd(Mean)$ even if it looses statistical significance in very few cases (with the exclusion of France and Slovakia in Panel A and Belgium in Panel B).

[Table 8 about here.]

Finally, we replicate the estimates on the *"full sample"* and on the same time span 2001-2012: all the results above hold through with the only exception of a less robust positive coefficient of average TFP.

[Table 9 about here.]

[9] Angrist (1998) shows that the weighted regression with grouped data (both dependent and main explanatory) produces coefficients equal to those generated when using the underlying micro-data sample.

6 Concluding remarks

This paper provides a new contribution to the study of how the micro characteristics of productivity distributions affect aggregate trade. It shows that the standard trade model with heterogeneous firms based on the three key assumptions of CES demand functions, iceberg trade costs and Pareto distributions does not provide empirically valid predictions on the supply side factors that are relevant for aggregate exports. In particular, we showed that the (country-sector-year) average productivity is not a sufficient statistics for the exporter's multilateral resistance term, which we take as a proxy of its competitiveness, once dyadic and importer's characteristics are controlled for. Instead, a country's export competitiveness is significantly and robustly correlated with the dispersion and the asymmetry of the productivity distribution.

While calling for new theories generating testable predictions fitting our evidence, our work has also important implications for the design of policies. According to our results, and from the point of view of expanding aggregate exports, policy makers should avoid targeting the whole distribution of firms and rather focus: i) on the top percentiles of the distributions, i.e., on those firms that are more likely to contribute to aggregate exports; ii) on favouring a healthy process of allocative efficiency stretching productivity distributions rightwards through a rapid growth of middle-high productivity firms towards the highest percentiles.

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A Evidence

In the micro-based trade model, the CES-Pareto-iceberg assumption implies that aggregate export are higher in country/sector showing higher average productivity. However, averages do not fully describe the characteristics of the underlying firms' population. For example, two countries with the same average productivity can not be identical: on the one side, a country may have both extremely productive and sluggish firms, and on the other side a country is characterized by homogenous firms. While averages are similar, the distributions of firms' productivity differ. To illustrate it, we report in Figure 3 kernel density for simulated data (10,000 observations). For each of the four plots, we draw the kernel density of two populations generated by different distributions but with the same mean.

Panel *(a)* reports two gamma distributions with the same mean but different shape and scale parameters. The continuous line depicts a skewed population with a thick tail (longer and fatter) , while the dotted lines is more symmetric (around the mean). Both populations show the same averages but different characteristics in term of standard deviation, skewness and non-parametric skewness (i.e., $Pears.= (mean - median)/st.dev.$).

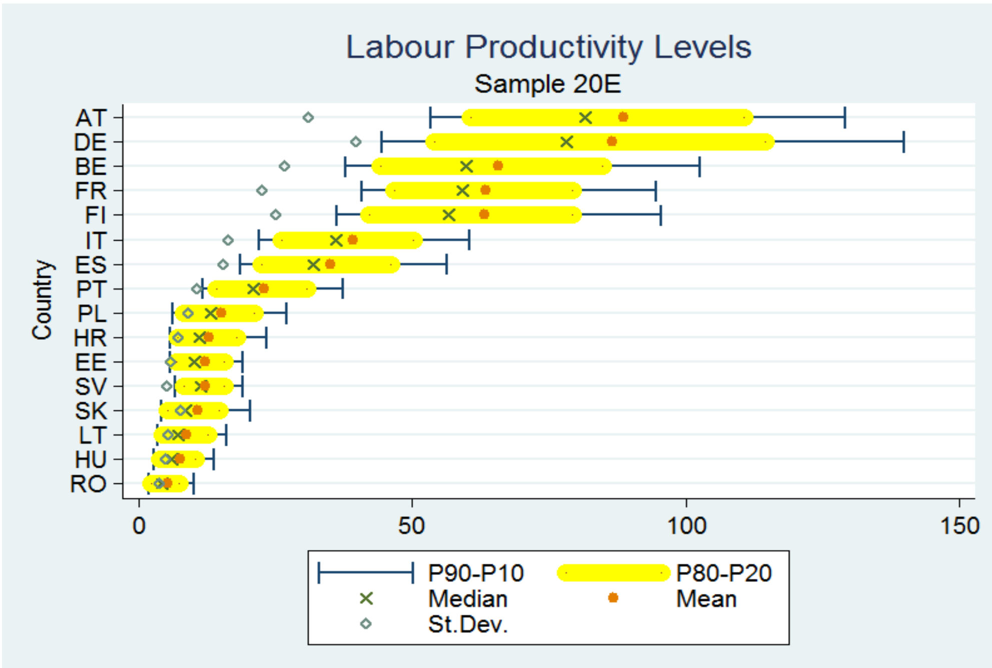
Also populations with same mean and standard deviation can be different. Panel (b) reports a gamma (continuous line) and a normal distribution (dotted line) with the same mean and standard deviation. While gamma population is right skewed, the normal distribution is symmetric around the mean (by definition). The former has a longer right tail, while the latter a longer left tail. Finally, panel *(c)* and *(d)* depict Lognormal and Pareto distributions, respectively. Again, in both cases the mean is not informative of the characteristics of the underlying population. So any analysis, involving countries' comparison, risk to be not accurate whether it relies on the populations' mean. It is of particular interest in the international trade as long as the assumption of Pareto distribution (with CES preferences and iceberg trade cost) implies that aggregate export depends on the average productivity.

[Figure 3 about here.]

[Figure 4 about here.]

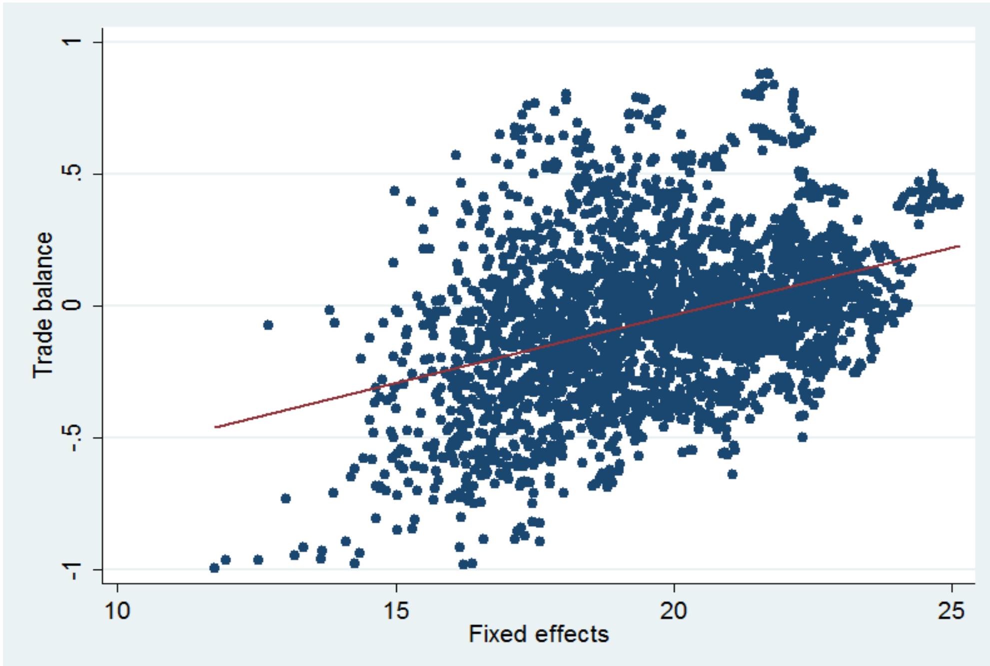
Figures

Figure 1: Labor productivity levels by country



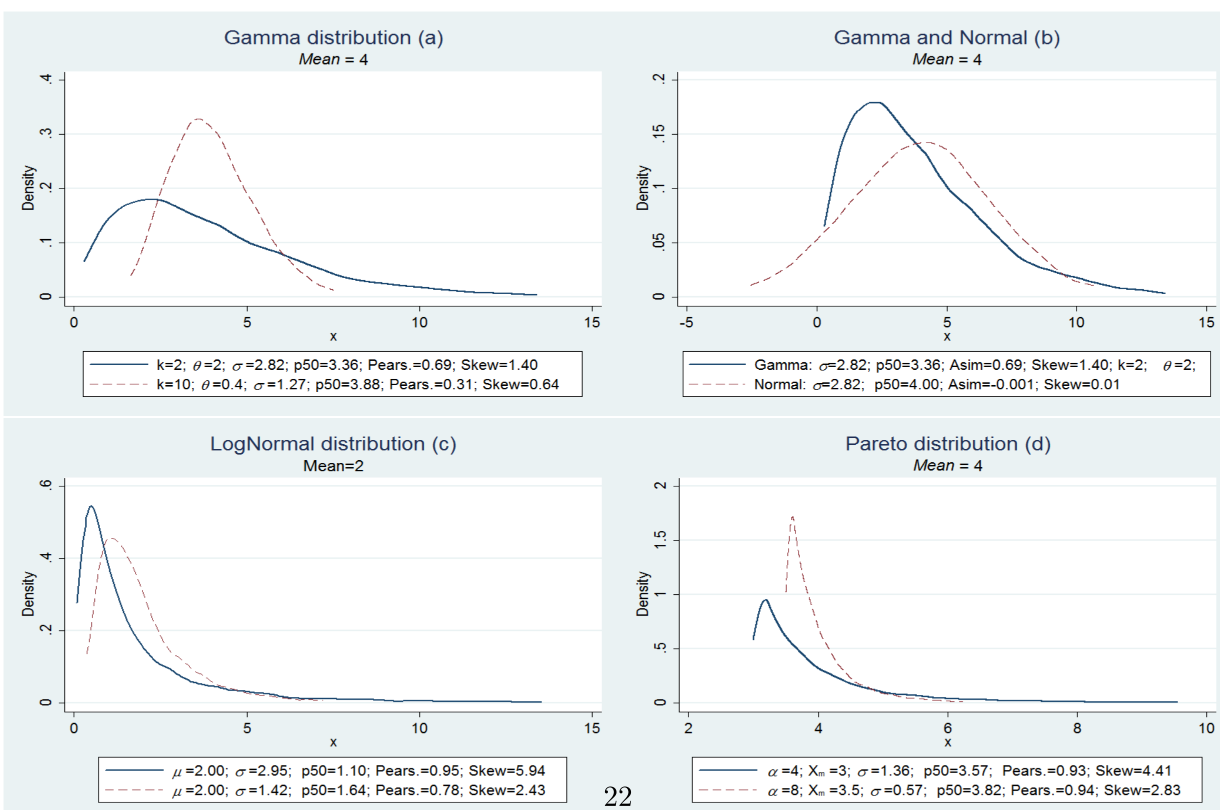
Source: authors elaborations on CompNet data (sample 20E from 2001). Countries are ranked by average productivity as computed in CompNet in decreasing order. Statistics are defined as country unweighted averages (across sector-years) of CompNet micro-based indicators. The red dot is the mean of average labor productivity. The cross represents the average median, while the diamond the average standard deviation. The blue line is the average difference between the 90th (right end) and the 10th percentile (left end) of labor productivity. The yellow bar measures the average difference between the 80th (right end) and the 20th percentile (left end) of labor productivity.

Figure 2: Trade balance and exporter's fixed effects



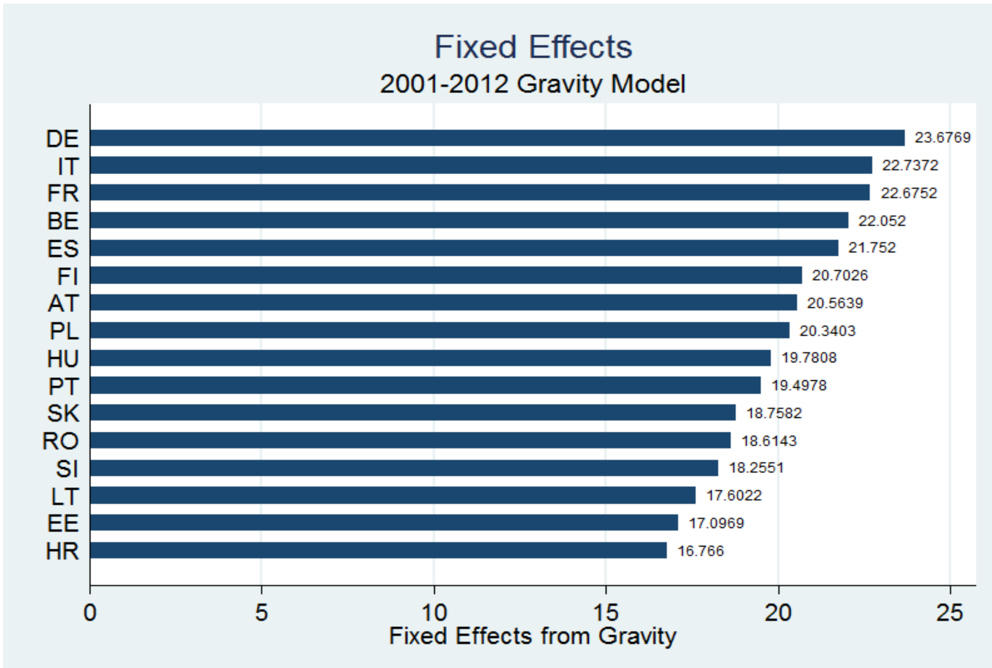
Source: authors elaborations on Eurostat ComExt data. Each dot is defined at country-sector-year level. The Y-axis reports the trade balance defined as $\frac{export-import}{export+import}$. The X-axis reports the fixed effect computed from Eq. 11 (see Table 3, Col.3.). The red line represents the linear interpolation.

Figure 3: Example of distributions



Source: simulated data on 10000 observations. Gamma distribution: k is the shape parameter and θ is the scale parameter. Asim. is the Pearson's Second Skewness Coefficient defined as $(mean - median)/(std.dev.)$

Figure 4: Exporting country's fixed effects (averaged by sector and year)



Source: authors elaborations on Eurostats ComExt data. The bars report for each country the average fixed effects computed from Eq. 11 (see Table 3, Col.3.) across sectors and years.

Tables

Table 1: Statistics on Productivity ‡

			Labour Productivity			
Country	LProd(Mean)	LProd(Pears.)	LProd(C.V.)	LProd(Skew.)	LProd(P90/P10)	LProd(P80/P20)
Austria	88.544	0.517	0.359	0.865	2.523	1.847
Belgium	60.997	0.639	0.401	1.244	2.687	1.878
Croatia	12.851	0.753	0.555	1.263	4.230	2.540
Estonia	12.287	0.643	0.507	0.950	3.826	2.431
Finland	63.509	0.657	0.375	1.231	2.453	1.749
France	65.768	0.654	0.404	1.223	2.711	1.909
Germany	86.527	0.640	0.461	1.218	3.205	2.129
Hungary	7.512	0.791	0.678	1.595	5.862	2.922
Italy	39.201	0.615	0.428	1.302	2.834	1.948
Lithuania	8.746	0.776	0.636	1.285	5.378	3.109
Poland	15.303	0.764	0.662	1.702	4.939	2.785
Portugal	22.957	0.613	0.463	1.132	3.293	2.166
Romania	5.153	0.903	0.753	1.854	5.883	3.185
Slovakia	10.693	0.816	0.736	1.912	5.551	2.924
Slovenia	12.239	0.547	0.427	1.049	2.985	1.970
Spain	35.059	0.619	0.440	1.129	3.035	2.046
Total	36.877	0.679	0.510	1.304	3.756	2.311
			Total Factor Productivity			
Country	TFP(Mean)	TFP(Pears.)	TFP(C.V.)	TFP(Skew.)	TFP(P90/P10)	TFP(P80/P20)
Austria	0.760	0.583	0.379	1.656	2.355	1.778
Belgium	27.799	0.745	0.486	1.704	3.039	2.041
Croatia	0.730	0.738	0.536	1.256	3.863	2.442
Estonia	1.719	0.566	0.478	0.816	3.604	2.345
Finland	13.342	0.641	0.430	1.412	2.640	1.847
France	0.729	0.601	0.408	1.431	2.652	1.871
Germany	2.336	0.688	0.567	1.864	3.759	2.375
Hungary	2.313	0.825	0.701	1.843	5.581	2.904
Italy	0.978	0.696	0.476	1.675	3.012	2.030
Lithuania	4.379	0.747	0.603	1.261	5.098	2.933
Poland	3.354	0.690	0.632	1.822	4.646	2.663
Portugal	16.821	0.699	0.571	1.904	3.654	2.329
Romania	1.421	0.864	0.746	2.082	5.778	3.158
Slovakia	1.546	0.724	0.685	1.841	4.879	2.700
Slovenia	2.169	0.640	0.456	1.169	3.269	2.125
Spain	1.275	0.788	0.542	1.978	3.502	2.237
Total	5.330	0.707	0.546	1.601	3.849	2.362

‡ Source: authors elaborations on CompNet data (sample 20E from 2001). Each cell reports for both labor productivity and TFP, the country's averages (across sector-year) of efficiency, and the indicators of dispersion and asymmetry (see Section 3) Mean: micro-based average productivity (unweighted). Pears: Pearson's second skewness coefficient. C.V.: coefficient of variation. Skew: parametric skewness from CompNet. $P90/P10$: ratio of the 90th percentile of labor productivity to the 10th percentile. $P80/P20$: ratio of the 80th percentile of labor productivity to the 20th percentile.

Table 2: Exports by country (averaged by sector and year) - log values ‡

Country	Mean	St.Dev	IQR	Obs	Min	Max
Austria	6.496	3.429	5.248	34470	0	15.680
Belgium	7.235	3.163	4.437	37727	0	16.529
Croatia	4.808	3.016	4.855	15693	0	12.997
Estonia	4.677	3.104	5.034	16033	0	13.688
Finland	6.011	3.319	5.181	28154	0	14.542
France	8.031	3.147	4.521	39571	0	16.600
Germany	8.348	3.427	5.046	41009	0	17.023
Hungary	5.798	3.463	5.382	25388	0	15.606
Italy	8.055	3.146	4.729	39256	0	15.760
Lithuania	4.855	3.140	5.059	18882	0	13.478
Poland	6.186	3.495	5.424	31281	0	15.620
Portugal	5.551	3.053	4.352	30134	0	14.457
Romania	5.513	3.250	5.049	22986	0	14.650
Slovakia	5.686	3.303	4.963	21887	0	15.316
Slovenia	5.542	3.157	4.803	22484	0	13.827
Spain	7.384	2.973	4.209	36072	0	16.363
Total	6.582	3.441	5.104	461027	0	17.023

‡ Source: authors elaborations on Eurostat ComExt data. IQR: inter quantile range.

Table 3: Gravity Model ‡

	(1) All	(2) From 2001	(3) From 2001 (Country in sample 20E)
Log(Distance)	-1.643***	-1.67***	-1.625***
	(.1175)	(.1206)	(.1407)
Common Border	.0801	.1508	.0345
	(.2084)	(.2093)	(.2023)
Common Language	.9666***	.9733***	.9728***
	(.1111)	(.1179)	(.1542)
Former Colony	1.068***	1.005***	1.104***
	(.245)	(.2439)	(.2381)
Obs.	775764	578965	472321
R^2	.8025	.7967	.8055
Fixed Effects 1	Origin*Sector*Year	Origin*Sector*Year	Origin*Sector*Year
Fixed Effects 2	Destination*Sector*Year	Destination*Sector*Year	Destination*Sector*Year

‡ Linear regression model with two high dimensional fixed effects (Guimarães and Portugal, 2010). Robust standard errors are clustered at origin*year level and reported in the parenthesis. Significance level: * 0.10>p-value, ** 0.05>p-value, *** 0.01>p-value Col.1: the estimation sample includes as origin all the countries in the CompNet network from 1995. Col.2: the estimation sample includes as origin all the countries in the CompNet network from 2001. Col.3: the estimation sample includes as origin all the countries in the CompNet -*sample 20E* database (from 2001).

Table 4: Competitiveness Index [‡]

Country	Mean	St.Dev	IQR	Obs	Min	Max
Austria	19.618	1.563	1.404	264	11.738	22.360
Belgium	20.666	1.689	2.231	264	14.760	23.414
Croatia	16.167	1.168	1.790	242	12.738	18.431
Estonia	16.191	1.491	1.794	264	9.972	18.744
Finland	18.675	2.062	2.173	264	12.774	22.449
France	21.525	1.708	1.865	264	15.824	23.747
Germany	22.316	1.504	2.096	264	18.168	25.127
Hungary	17.927	1.739	2.121	262	12.589	21.933
Italy	21.752	1.705	1.015	264	15.931	24.666
Lithuania	16.794	1.371	1.358	264	11.547	19.640
Poland	19.188	1.476	1.575	264	14.278	22.152
Portugal	18.877	1.212	1.348	264	13.886	20.597
Romania	17.626	1.528	1.910	264	12.293	20.250
Slovakia	17.364	1.698	1.625	263	9.773	21.138
Slovenia	17.332	1.692	1.883	264	11.565	19.944
Spain	20.800	1.549	1.401	264	15.384	22.937
Total	18.941	2.508	3.706	4199	9.773	25.127

[‡] Source: authors elaborations on Eurostats Comext data. The competitiveness index coincides with the exporters multilateral resistance terms that has been estimated by the general gravity equation with fixed effects reported in Col.3 of Table 3. Here we report the countrys average across sectors (17 NACE manufacturing) and year (2001-12).

Table 5: Baseline model - Productivity distribution and competitiveness index (sample20E)‡

Panel A	**Labour Productivity**								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
LProd(Mean)$_{ist-1}$	.0014*	.0014*	.0014*	.0018**	.0018**	.003***	.0018**	.0018**	.0029***
	(8.1e-04)	(8.1e-04)	(8.1e-04)	(8.1e-04)	(8.2e-04)	(8.3e-04)	(8.2e-04)	(8.2e-04)	(8.3e-04)
LProd(P90/P10)$_{ist-1}$		-.0017					-.011		
		(.0091)					(.0094)		
LProd(P80/P20)$_{ist-1}$			.0645**					.0336	
			(.0259)					(.0266)	
LProd(C.V.)$_{ist-1}$				.8851***					.293**
				(.123)					(.1392)
LProd(Pears.)$_{ist-1}$					.1872***		.1977***	.1709***	
					(.0495)		(.052)	(.052)	
LProd(Skew.)$_{ist-1}$						.2213***			.1844***
						(.0244)			(.0289)
Const.	20.24***	20.24***	20.11***	19.79***	20.08***	19.8***	20.1***	20.02***	19.72***
	(.0941)	(.1035)	(.1119)	(.1144)	(.1025)	(.1043)	(.1059)	(.1134)	(.113)
Country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Sector fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Clustering	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year
Obs.	3013	3013	3013	3013	3013	3013	3013	3013	3013
R^2	.9149	.9149	.915	.9162	.9153	.917	.9153	.9153	.9171

Panel B	**Total Factor Productivity**								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TFP(Mean)$_{ist-1}$	.0012***	.0013***	.0013***	.002***	.0017***	.0023***	.0017***	.0017***	.0024***
	(2.9e-04)	(2.8e-04)	(2.8e-04)	(2.5e-04)	(2.7e-04)	(2.2e-04)	(2.6e-04)	(2.6e-04)	(2.2e-04)
TFP(P90/P10)$_{ist-1}$		.0229**					.0139		
		(.0109)					(.0109)		
TFP(P80/P20)$_{ist-1}$			.0695**					.0433	
			(.0289)					(.0296)	
TFP(C.V.)$_{ist-1}$				1.06***					.2875*
				(.1174)					(.1515)
TFP(Pears.)$_{ist-1}$					.2027***		.1868***	.1831***	
					(.0511)		(.0537)	(.0541)	
TFP(Skew.)$_{ist-1}$						.2224***			.1849***
						(.0191)			(.0266)
Const.	20.53***	20.51***	20.38***	19.99***	20.45***	20.17***	20.41***	20.37***	20.1***
	(.0495)	(.0635)	(.0805)	(.0819)	(.0614)	(.0881)	(.0655)	(.0788)	(.0928)
Country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Sector fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Clustering	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year
Obs.	2611	2611	2611	2611	2611	2611	2611	2611	2611
R^2	.9191	.9193	.9193	.9224	.9196	.9238	.9197	.9197	.9239

‡ OLS model. Dependent variable: competitiveness index from Eq. 11 (see Col.3, Tab. 3). Country, Sector, and Year dummies are included in all the specifications. Time span: 2001-2012. Clustered robust standard errors are reported in parentheses. Significance level: * 0.10>p-value, ** 0.05>p-value, *** 0.01>p-value.

Table 6: Robustness I - Productivity distribution and competitiveness index (sample20E)‡

Panel A	Labor Productivity					
	(1)	(2)	(3)	(4)	(5)	(6)
$LProd(Mean)_{ist-1}$	.0021**	.002**	.0032***	.0018**	.0017**	.0028***
	(8.5e-04)	(8.5e-04)	(8.8e-04)	(8.8e-04)	(8.8e-04)	(8.9e-04)
$LProd(P90/P10)_{ist-1}$	-.008			-.0137		
	(.0097)			(.0104)		
$LProd(P80/P20)_{ist-1}$		.0326			.0282	
		(.0279)			(.0293)	
$LProd(C.V.)_{ist-1}$			.4245***			.2666*
			(.1505)			(.1496)
$LProd(Pears.)_{ist-1}$	.2093***	.1858***		.175***	.148**	
	(.0546)	(.0546)		(.0577)	(.058)	
$LProd(Skew.)_{ist-1}$			.195***			.1851***
			(.0299)			(.0308)
Const.	17.54***	17.43***	17.15***	20.01***	19.9***	19.69***
	(.2027)	(.2041)	(.1889)	(.1139)	(.1244)	(.1165)
Country*year fixed effects	yes	yes	yes	no	no	no
Sector*year fixed effects	no	no	no	yes	yes	yes
Country fixed effects	no	no	no	yes	yes	yes
Sector fixed effects	yes	yes	yes	no	no	no
Clustering	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year
Obs.	3013	3013	3013	3013	3013	3013
R^2	.9171	.9171	.9193	.9175	.9175	.9192

Panel B	Total Factor Productivity					
	(1)	(2)	(3)	(4)	(5)	(6)
$TFP(Mean)_{ist-1}$	.0017***	.0017***	.0024***	.0017***	.0017***	.0023***
	(2.7e-04)	(2.7e-04)	(2.3e-04)	(2.8e-04)	(2.8e-04)	(2.3e-04)
$TFP(P90/P10)_{ist-1}$	.0157			.0135		
	(.0115)			(.0117)		
$TFP(P80/P20)_{ist-1}$		.042			.0447	
		(.0306)			(.0318)	
$TFP(C.V.)_{ist-1}$			.3228**			.2738*
			(.1573)			(.1611)
$TFP(Pears.)_{ist-1}$	.1758***	.175***		.1921***	.1875***	
	(.0564)	(.0564)		(.0606)	(.0611)	
$TFP(Skew.)_{ist-1}$			.1845***			.1861***
			(.0277)			(.0284)
Const.	20.44***	20.41***	20.75***	20.7***	20.57***	20.34***
	(.0557)	(.071)	(.0795)	(.0719)	(.0929)	(.1084)
Country*year fixed effects	yes	yes	yes	no	no	no
Sector*year fixed effects	no	no	no	yes	yes	yes
Country fixed effects	no	no	no	yes	yes	yes
Sector fixed effects	yes	yes	yes	no	no	no
Clustering	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year
Obs.	2611	2611	2611	2611	2611	2611
R^2	.9213	.9213	.9256	.9219	.9219	.9258

‡ OLS model. Dependent variable: competitiveness index from Eq. 11 (see Col.3, Tab. 3). Time span: 2001-2012. Clustered robust standard errors are reported in parentheses. Significance level: *0.10>p-value, ** 0.05>p-value, *** 0.01>p-value.

Table 7: Robustness II - Productivity distribution and competitiveness index (sample20E)‡

Panel A	Labor Productivity								
	Num. of firms			WLS			Alternative clustering		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
LProd(Mean)$_{ist-1}$	.002**	.0019**	.0016**	.0036***	.0036***	.0049***	.0018***	.0018***	.0029***
	(7.8e-04)	(7.8e-04)	(7.4e-04)	(9.9e-04)	(1.0e-03)	(9.8e-04)	(5.9e-04)	(5.9e-04)	(6.1e-04)
LProd(P90/P10)$_{ist-1}$	.0026			-.022			-.011		
	(.0113)			(.0158)			(.0099)		
LProd(P80/P20)$_{ist-1}$		.0933***			-.0288			.0336	
		(.035)			(.0423)			(.0307)	
LProd(C.V.)$_{ist-1}$			.894***			-.0948			.293*
			(.1773)			(.241)			(.1695)
LProd(Pears.)$_{ist-1}$	.195***	.1522***		.3373***	.3253***		.1977***	.1709***	
	(.0485)	(.0476)		(.0764)	(.0795)		(.0546)	(.0538)	
LProd(Skew.)$_{ist-1}$			-.0407			.2293***			.1844***
			(.0304)			(.0382)			(.0336)
Log(N.Firms)$_{ist-1}$	.7911***	.7975***	.7928***						
	(.0437)	(.0427)	(.0417)						
Const.	16.19***	16.02***	15.98***	20.02***	20.02***	19.82***	20.1***	20.02***	19.72***
	(.2345)	(.2398)	(.2235)	(.1182)	(.1236)	(.1296)	(.0995)	(.1098)	(.0948)
Country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Sector fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Clustering	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year	country-year	country-year	country-year
Obs	3013	3013	3013	3013	3013	3013	3013	3013	3013
R^2	.9354	.9357	.936	.9363	.9362	.9371	.9153	.9153	.9171

Panel B	Total Factor Productivity								
	Num. of firms			WLS			Alternative clustering		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TFP(Mean)$_{ist-1}$	7.0e-04***	7.0e-04***	.001***	.0021***	.0021***	.0023***	.0017***	.0017***	.0024***
	(2.4e-04)	(2.4e-04)	(2.4e-04)	(2.5e-04)	(2.5e-04)	(2.1e-04)	(2.3e-04)	(2.3e-04)	(1.9e-04)
TFP(P90/P10)$_{ist-1}$	.0244*			-.034**			.0139		
	(.0129)			(.0142)			(.01)		
TFP(P80/P20)$_{ist-1}$		.09**			-.0743**			.0433	
		(.0364)			(.037)			(.029)	
TFP(C.V.)$_{ist-1}$			.7367***			-.3266			.2875*
			(.1818)			(.2)			(.1559)
TFP(Pears.)$_{ist-1}$	.187***	.1742***		.4519***	.444***		.1868***	.1831***	
	(.0506)	(.0512)		(.072)	(.0731)		(.0592)	(.0589)	
TFP(Skew.)$_{ist-1}$			.0509*			.2484***			.1849***
			(.0269)			(.0306)			(.0292)
Log(N.Firms)$_{ist-1}$	.8541***	.8576***	.8235***						
	(.0509)	(.0502)	(.05)						
Const.	16.34***	16.22***	16.23***	20.38***	20.43***	20.29***	20.41***	20.37***	20.1***
	(.261)	(.2621)	(.2525)	(.0882)	(.1027)	(.119)	(.0956)	(.1055)	(.1198)
Country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Sector fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Clustering	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year	country-year	country-year	country-year
Obs	2611	2611	2611	2611	2611	2611	2611	2611	2611
R^2	.9398	.9399	.9418	.9377	.9376	.9404	.9197	.9197	.9239

‡ OLS model. Dependent variable: competitiveness index from Eq. 11 (see Col.3, Tab. 3). WLS: weighted least square. Country, Sector, and Year dummies are included in all the specifications. Time span: 2001-2012. Clustered robust standard errors are reported in parentheses. Significance level: * 0.10>p-value, ** 0.05>p-value, *** 0.01>p-value.

Table 8: Robustness III - Productivity distribution and competitiveness index (sample20E)‡

Panel A		**Labor productivity**			
Excluded country	$LProd(Mean)_{ist-1}$	$LProd(P90/P10)_{ist-1}$	$LProd(Pears.)_{ist-1}$	Obs.	R^2
AUT	.0025**	-.0066	.2348***	2819	.917
BEL	.0022***	-.0106	.2158***	2813	.9185
CRO	.0017**	-.015	.178***	2933	.9145
EST	.0019**	-.0245***	.2296***	2846	.9136
FIN	.0025***	-.0106	.1842***	2798	.9258
FRA	.0011	-.0092	.1595***	2782	.913
GER	.0021**	-.0106	.2041***	2782	.9042
HUN	.0018**	.0017	.1435***	2825	.9175
ITA	.0015*	-.0214**	.1742***	2782	.9108
LIT	.0018**	-.0089	.2138***	2834	.9143
POL	.0015*	-.0086	.2032***	2866	.9165
PRT	.0023***	-.0093	.2145***	2887	.9187
ROM	.0018**	.0012	.2148***	2826	.9204
SVK	.0014	-.0154	.1817***	2810	.9144
SLO	.0018**	-.0163*	.2255***	2810	.9123
SPA	.0017**	-.0087	.185***	2782	.9138

Panel B		**Total factor productivity**			
Excluded country	$LProd(Mean)_{ist-1}$	$LProd(P90/P10)_{ist-1}$	$LProd(Pears.)_{ist-1}$	Obs.	R^2
AUT	.0017***	.0139	.1869***	2600	.9196
BEL	-.002	.0178	.1416**	2411	.922
CRO	.0017***	.007	.2107***	2537	.9192
EST	.0017***	-.0017	.2599***	2458	.9191
FIN	.002***	.0089	.1444***	2403	.9319
FRA	.0017***	.0243**	.1298**	2381	.9172
GER	.0017***	.0148	.1729***	2391	.9079
HUN	.0018***	.0326**	.1847***	2443	.9221
ITA	.0015***	.0063	.156***	2431	.9155
LIT	.0016***	.0116	.147**	2449	.9186
POL	.0018***	.0137	.195***	2487	.9214
PRT	.0016***	.0167	.2123***	2509	.923
ROM	.0018***	.0161	.2152***	2454	.924
SVK	.0018***	.0129	.1973***	2412	.9187
SLO	.0017***	.0186*	.2192***	2408	.9168
SPA	.0017***	.0143	.1631***	2391	.9185

‡ OLS model. Each row reports the estimates of Eq. 12 on a reduced sample(excluding one country). Dependent variable: competitiveness index from Eq. 11 (see Col.3, Tab. 3). Country, Sector, and Year dummies are included in all the specifications. Time span: 2001-2012. Robust standard error are clustered at sector*year level and are reported in parentheses. Significance level: * 0.10>p-value, ** 0.05>p-value, *** 0.01>p-value.

Table 9: Baseline model - Productivity distribution and competitiveness index (sample ALL)[‡]

Panel A	Labor Productivity								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
LProd(Mean)$_{ist-1}$	.0016*	.0016*	.0016*	.0024***	.0024***	.0031***	.0024***	.0024***	.0031***
	(8.3e-04)	(8.3e-04)	(8.3e-04)	(8.8e-04)	(8.7e-04)	(9.0e-04)	(8.7e-04)	(8.7e-04)	(8.8e-04)
LProd(P90/P10)$_{ist-1}$		-.0032					-.0125		
		(.0088)					(.0091)		
LProd(P80/P20)$_{ist-1}$			-.0299					-.0666**	
			(.0281)					(.0292)	
LProd(C.V.)$_{ist-1}$				.6755***					.2292
				(.1771)					(.2259)
LProd(Pears.)$_{ist-1}$					.3546***		.3772***	.3968***	
					(.0657)		(.0689)	(.07)	
LProd(Skew.)$_{ist-1}$						.1331***			.1051***
						(.0263)			(.0331)
Const.	20.3***	20.31***	20.36***	19.93***	20.01***	19.98***	20.03***	20.1***	19.93***
	(.0911)	(.0983)	(.1116)	(.14)	(.1092)	(.1106)	(.1109)	(.1189)	(.1378)
Country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Sector fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Clustering	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year
Obs.	2920	2920	2920	2920	2920	2920	2920	2920	2920
R^2	.9172	.9172	.9172	.9178	.9179	.918	.918	.9181	.918

Panel B	Total Factor Productivity								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TFP(Mean)$_{ist-1}$	.0017	8.2e-04	-3.5e-04	.0346***	.0125	.039***	.0118	.0084	.0393***
	(.0096)	(.0096)	(.0098)	(.0104)	(.0105)	(.0101)	(.0104)	(.0108)	(.0103)
TFP(P90/P10)$_{ist-1}$		.0092					.0031		
		(.0104)					(.0104)		
TFP(P80/P20)$_{ist-1}$			.0834***					.0672**	
			(.03)					(.0306)	
TFP(C.V.)$_{ist-1}$				1.274***					1.16***
				(.1958)					(.264)
TFP(Pears.)$_{ist-1}$					.1815***		.176***	.1405**	
					(.0539)		(.0541)	(.0551)	
TFP(Skew.)$_{ist-1}$						.1516***			.0309
						(.0227)			(.0329)
Const.	20.41***	20.39***	20.27***	19.88***	20.29***	20.2***	20.29***	20.21***	19.89***
	(.0667)	(.0732)	(.0835)	(.0974)	(.0779)	(.0643)	(.0804)	(.0889)	(.1)
Country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Sector fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Clustering	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year	sector-year
Obs.	2769	2769	2769	2769	2769	2769	2769	2769	2769
R^2	.9181	.9181	.9184	.9198	.9183	.919	.9183	.9185	.9199

[‡] OLS model. Dependent variable: competitiveness index from Eq. 11 (see Col.3, Tab. 3). Country, Sector, and Year dummies are included in all the specifications. Time span: 2001-2012. Clustered robust standard errors are reported in parentheses. Significance level: * 0.10>p-value, ** 0.05>p-value, *** 0.01>p-value.