

Productivity, Quality and Export Behavior*

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July 2011

Abstract

In a representative sample of Italian manufacturing firms, we find a robust negative correlation between productivity (however measured) and sales to low-income destinations as a share of total exports. This fact seems at odds with the heterogeneous-firms literature, which predicts high-productivity firms to sell relatively more in harder-to-reach destinations. We argue that this and other empirical regularities can arise from the interplay between endogenous, cross-firm heterogeneity in product quality and cross-country heterogeneity in quality consumption. To test this conjecture, we marry Verhoogen (2008) with Eaton, Kortum and Kramarz (2011), by introducing quality into a heterogeneous-firms framework featuring firm- and market-specific shocks in entry costs and demand, and structurally estimate the model's parameters by the simulated method of moments. Our estimates imply the preference for quality to be monotonically increasing in per capita income of the foreign destinations. The model also predicts a negative correlation between firms' involvement in innovation activities and their export share to low-income destinations, a finding supported by our data. Overall, our results strongly suggest that firms producing higher-quality products tend to concentrate their sales in high-income markets.

JEL Numbers: F1. **Keywords:** Heterogeneous Firms; Productivity; Quality; Export Shares; Structural Estimation.

*The paper has benefited enormously from the comments of three anonymous referees. We also thank Francisco Alcalá, Carlo Altomonte, Elisa Borghi, Bruno Cassiman, Davide Castellani, Luca De Benedictis, Anna Falzoni, Samuel Kortum, Crt Kostevc, Marco Leonardi, Marc Muendler, Marcella Nicolini, Fabrizio Onida, Gianmarco Ottaviano, Luca Sala, Daniel Treffer, Jaume Ventura, Eric Verhoogen, Frederic Warzynski and seminar participants at many venues for comments and discussions. All errors are our own. We gratefully acknowledge financial support from Unicredit Banca, Centro Studi Luca d'Agliano, the FIRB project "International Fragmentation of Italian Firms. New Organizational Models and the Role of Information Technologies" (Italian Ministry of Education, University and Research) and the EFIGE project (European Commission FP7, N. 225551). Rosario Crinò gratefully acknowledges financial support also from the Barcelona GSE research network, the Government of Catalunya and the Spanish Ministry of Science and Innovation (Project ECO 2009-07958).

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In this paper, we study how the interplay between firm and foreign market characteristics affects key aspects of export behavior. Our contribution is motivated by some new and perhaps surprising facts in the light of the recent heterogeneous-firms literature. In particular, using a representative sample of Italian manufacturing firms, drawn from a reliable dataset used also in other studies,¹ we find a strong and robust negative correlation between firms' productivity and their share of total exports to low-income destinations. This fact seems at odds with the common wisdom, positing that only the most productive firms are profitable enough to break into harder-to-reach destinations.

In line with a recent literature pointing to the crucial role of quality in international trade, we argue that this and other empirical regularities can arise from the interplay between endogenous, cross-firm heterogeneity in product quality and cross-country heterogeneity in quality consumption. Specifically, we conjecture that more productive firms tend to concentrate their sales in high-income markets because they produce higher-quality products, for which relative demand is higher in high-income destinations. This conjecture is indeed supported by our data.

We start, in Section 2, by illustrating the main patterns in our data. We first show that it replicates the empirical regularities recently unveiled by Eaton, Kortum and Kramarz (2011, henceforth EKK) using French data. Next, we show some new facts. In particular, we provide extensive evidence on a negative cross-firm correlation between productivity (revenue-TFP or value added per unit of factor cost, as in EKK) and the export share to low-income destinations. The negative correlation holds independent of sample size (i.e., it is equally strong for the sample of all exporters and for that of exporters to both high-income and low-income destinations) and is not affected by outliers, estimation method and specification details.

In Section 3, building on Verhoogen (2008), we start by formulating a stripped-down heterogeneous-firms model that clarifies the main insight behind our interpretation of the evidence, and discuss its implications in the light of the received literature. The crucial assumptions for the results are that consumers choose quality consumption based on their income and firms product quality based on their productivity.² The baseline model can nicely explain a negative correlation between productivity and the export share to low-income destinations, but only conditional on firms entering both high-income and low-income destinations. Yet, in our data the negative correlation holds strong also unconditionally, i.e.,

¹For instance, Parisi, Schiantarelli and Sembenelli (2006), Benfratello, Schiantarelli and Sembenelli (2009) and Angelini and Generale (2008) use the same dataset to investigate, respectively, the impact of firms' innovation strategies on the growth of TFP, the relationship between financial development and innovation, and the relationship between financial constraints and firm size distribution. Moreover, using older releases of our dataset, Castellani (2002) shows evidence that exporters are generally more productive than non-exporters and that productivity increases after exporting (learning-by-exporting).

²In Verhoogen (2008), which uses a different model, these two ingredients prove crucial to explain the link between trade and skill upgrading in Mexico.

across all exporters. Moreover, in the baseline model firms enter foreign markets according to an exact hierarchy, whereas there is no strict sorting of exporters in our data. Therefore, following EKK, we extend the model to allow for firm- and market-specific heterogeneity in entry costs and demand, and estimate its deep parameters by the simulated method of moments. Consistent with our theory, estimated parameters imply the preference for quality to be monotonically increasing in per capita income of the destinations: on average, it is almost 3 times higher in high-income destinations, and in the richest destination (North America) it is roughly 20 times as high as in the poorest destination (Africa). Moreover, with the estimated set of parameters, the model matches our data well and correctly predicts a negative unconditional (as well as conditional) correlation between exporters' productivity and their export share to low-income destinations.

The model also predicts a strong negative correlation between firms' R&D intensity and their export share to low-income destinations, with or without controlling for productivity. These implications are successfully tested in Section 4. More generally, in our model high-productivity firms produce higher-quality products because they invest more in R&D and related activities. Hence the model suggests, in line with the empirical literature on quality differentiation (e.g., Sutton, 1998, and more recently Kugler and Verhoogen, 2011), that firms' innovation activities are close proxies for product quality. Exploiting a quasi-unique feature of our dataset, we therefore extract the principal component from a number of firm-level variables measuring innovation activities and treat it as a synthetic quality proxy.³ Consistent with our theory, we find this variable to be strongly negatively correlated with the export share to low-income destinations. Finally, the model predicts the correlations between the export share to an individual destination and productivity, R&D intensity or product quality to be all increasing in the destination's per capita income. We find strong support for these predictions using a panel of firms' export shares to all of the destinations for which we have data.

Our paper is related to various strands of the literature. First, it is related to the empirical literature on quality and trade. Based on industry- and product-level data, studies in this area suggest quality consumption to be strongly increasing in per capita income and cross-country heterogeneity in product quality to be crucial to explain international specialization.⁴ In this respect, our results can be interpreted as the micro-level counterpart, in the presence of heterogeneous firms, of the Linder hypothesis, positing

³We are aware of only one dataset, for a developing country, with broadly similar information on innovation activities (see Bustos, 2011). We view our approach to estimating product quality as complementary to the standard practice of using unit values as, e.g., in the recent firm-level studies by Manova and Zhang (2011) and Bastos and Silva (2010). Its main advantage is that it does not require a one-to-one relationship between quality and prices (see Hallak, 2006, and Khandelwal, 2010, on this point). For an alternative approach to estimating quality, based on producer ratings from wine guides, see Crozet, Head and Mayer (2011).

⁴As for trade and quality consumption see, in particular, Bils and Klenow (2001), Hummels and Skiba (2004), Brooks (2006), Hallak (2006, 2010) and Choi, Hummels and Xiang (2009). As for product quality and trade, see Schott (2004), Hummels and Klenow (2005) and Hallak and Schott (2011).

that richer countries tend to import more from countries producing higher-quality goods.⁵

Second, our paper is related to a number of recent contributions introducing quality into a heterogeneous-firms framework.⁶ With the notable exception of Verhoogen (2008), these studies do not posit a role for both product quality and quality consumption. Our main contribution to this growing literature is to show how these ingredients can help explain some important aspects of export behavior.

Finally, and probably more importantly, our paper is closely related to EKK, which develops and estimates a heterogeneous-firms model *à la* Melitz (2003) with firm-specific shocks and endogenous entry costs *à la* Arkolakis (2010). Their work represents the most demanding and successful attempt so far to explain export behavior across destinations, yet it cannot easily accommodate our empirical regularities. Our contribution is to show how embedding Verhoogen’s (2008) insight on product quality and quality consumption into an EKK-like framework may help understand what we view as key features of export behavior.

2 EMPIRICAL REGULARITIES

In this section, we illustrate our data and the main patterns in it.

2.1 DATA

Our data comes from the 9th survey “Indagine sulle Imprese Manifatturiere”, administered by the Italian Commercial Bank *Unicredit*. The survey is based on a questionnaire sent to a sample of 4289 manufacturing firms and contains information for the period 2001-2003. Answers to the survey questions are complemented by balance sheet data. The sample is stratified by size class, geographic area and industry to be representative of the population of Italian manufacturing firms with more than 10 employees. We drop roughly 100 firms reporting negative values for sales, capital stock or material purchases, or for which the various categories of employees (by educational level or occupation) do not sum up to the reported total employment. Out of the remaining firms, 3365 have complete information on TFP and sales to individual destinations; we use these firms in most of the empirical analysis and the simulations.

The dataset contains information on firms’ exports in the year 2003 to the following destinations: EU15, New EU Members, Other European countries, North America, Latin America, China, Other Asian countries, Africa and Oceania. To show our main empirical regularities, we aggregate them into two groups of high-income and low-income destinations. In particular, the former group includes North America,

⁵See, in particular, Hallak (2006, 2010), for empirical evidence on the Linder hypothesis using bilateral, industry-level data.

⁶See, in particular, Kugler and Verhoogen (2011), Johnson (2009), Baldwin and Harrigan (2011), Hallak and Sivadasan (2009), Alcalà (2007) and Manasse and Turrini (2001).

EU15 and Oceania (*NA*, *EU15*, *OCE*), whereas the latter includes Africa, China, Latin America and New EU Members (*AFR*, *CHN*, *LAT*, *EU10*). We exclude Other Europe and Other Asia from the two groups, because these destinations include countries that are very heterogeneous in terms of per capita income.⁷ Based on data from the World Development Indicators, average PPP per capita income in 2003 equals 27000 US\$ in the group of high-income destinations and 4500 US\$ in the group of low-income destinations.⁸

Table 1 reports statistics on firms' entry and exports across destinations. The total number of exporters for which we have complete information on TFP and sales to individual destinations is 2507, roughly 75% of the total number of firms;⁹ among them, 2428 sell to high-income destinations and 1315 to low-income destinations. As for individual destinations, EU15 is the most popular one, with 2357 exporters and an average export share of 70%. The least popular destination is instead China, with 321 exporters and an average export share of 2%.

2.2 EKK-TYPE PATTERNS

Following EKK, in Table 2 we report the number of exporters to the strings of the seven foreign destinations that obey a hierarchy in terms of popularity. If firms entered markets according to an exact hierarchy, exporters to the $(n + 1)^{st}$ most popular destination would also sell in the n^{th} most popular destination. As shown in column (1), only 54% of the exporters enter markets according to an exact hierarchy.¹⁰ In Column (2), we use marginal probabilities of entry in each destination, drawn from column (2) of Table 1, to predict how many exporters would enter each string under independence, namely, under the assumption that selling in a destination is independent of selling in any other destination. Note that only 38% of exporters would enter strings according to an exact hierarchy under independence. These patterns are broadly consistent with those reported by EKK using more detailed export destination data.¹¹ They suggest that, although firms do not enter foreign markets according to an exact hierarchy, entry does not seem to be a random process.

More generally our data replicates, on a smaller scale, all the main empirical regularities unveiled by EKK for French firms. In particular, in the Appendix we show that: a) the number of exporters

⁷Both areas include the richest and poorest countries in the world. For instance, Other Asia comprises Japan and Afghanistan, whereas Other Europe comprises Switzerland and Norway, as well as Russia and the Balkans. Our main results are however robust to including these areas among either the low-income or the high-income destinations.

⁸As for individual destinations, PPP per capita income (in US\$) equals: 29000 (*NA*), 27000 (*EU15*), 20000 (*OCE*), 13000 (*EU10*), 7000 (*LAT*), 5000 (*CHN*), 2000 (*AFR*).

⁹This figure is very close to that reported in other studies based on micro-level data collected by the Italian Statistical Office, e.g., Castellani, Serti and Tomasi (2010).

¹⁰The issue of non-hierarchical destinations becomes less relevant if we focus on two aggregate destinations (high-income and low-income), as most exporters to low-income destinations also export to high-income destinations (1236 out of 1315).

¹¹EKK find that 27% of exporters enter the seven most popular destinations according to an exact hierarchy (versus 13% under independence).

(normalized by Italy’s market share in a destination) and their sales to a destination are increasing in the destination’s market size; b) firms entering a greater number of foreign destinations, and firms entering harder-to-reach destinations, sell more in Italy; c) firms’ normalized export intensity (i.e., sales to a destination over domestic sales, both normalized by average sales in the respective market) is higher in more popular destinations.

2.3 PRODUCTIVITY AND THE EXPORT SHARE TO LOW-INCOME DESTINATIONS

Having shown that the patterns in our data are consistent with those in EKK, we now document a new fact, namely, a strong and robust negative correlation between productivity and the export share to low-income destinations (the ratio of exports to these areas over total exports, henceforth ES_l). To begin with, we split the exporters’ TFP distribution into ten bins of equal size and compute the average value of ES_l across all exporters in each bin.¹² The results are reported in Figure 1a), showing that the relationship between ES_l and TFP is strongly decreasing across bins. In panel b), we repeat the exercise for selected destinations using four TFP bins. Note that the correlation is strongly negative for Africa and Latin America (two low-income destinations) and strongly positive for EU15 and North America (two high-income destinations).

Next, we turn to parametric estimates to perform statistical inference. In particular, we run cross-sectional OLS regressions of the following form:

$$ES_{lj} = \chi_0 + \chi_1 \ln TFP_j + \chi_i + e_j, \quad (1)$$

where j indexes firms, χ_i are 3-digit industry fixed effects¹³ and e is an error term. Our coefficient of interest, χ_1 , reflects the correlation between TFP and the export share to low-income destinations. The baseline results are reported in Table 3, where each column refers to a different TFP estimate. In particular, TFP is based on: cross-sectional estimates of a Cobb-Douglas production function in columns (1)-(4) and of a translog production function in columns (5)-(8) (as in Amiti and Konings, 2007); semiparametric Cobb-Douglas panel estimates in columns (9)-(11) (i.e., Levinsohn and Petrin, 2003, Olley and Pakes, 1996, and De Loecker, 2011); cross-sectional OLS Cobb-Douglas estimates at the 2-digit industry level in column (12) (as in Bernard and Jensen, 1999, and Kugler and Verhoogen, 2009).¹⁴ Given

¹²Unless otherwise stated, the TFP measure we refer to is the augmented Olley and Pakes (1996) estimate proposed by De Loecker (2011), see footnote 14.

¹³Industries are classified according to the ATECO system, the standard industrial classification in Italy, equivalent to the NACE classification.

¹⁴All production functions are estimated using a revenue-based measure of output and four inputs (high-skill labor, low-skill labor, materials and physical capital). Log TFP is defined as $\ln Y_j - \sum_{\varrho} \xi_{\varrho} \cdot \ln \varrho_j$, where Y is output, ϱ is one of the four inputs and ξ_{ϱ} is one of the twelve estimates of its output elasticity. By using a battery of TFP estimates (whose correlation equals 0.84 on average and ranges from a minimum of 0.40 to a maximum of 0.99), we tackle the main issues involved in

that our main regressor is estimated, we report bootstrapped standard errors based on 500 replications (in square brackets), as well as, for comparison, heteroskedasticity-robust analytical standard errors (in round brackets).

In panel a), we estimate (1) for all exporters. Note that χ_1 is always negative and significantly different from zero beyond the 1% level, using either type of standard errors. Point estimates imply that a doubling of TFP is associated with a fall in the export share to low-income destinations of roughly 8 percentage points. In panel b), we estimate (1) on the subsample of exporters to both high-income and low-income destinations. Note that the negative correlation between ES_l and TFP is slightly larger and still precisely estimated across the board.¹⁵

Finally, in Table 4 we show that the TFP elasticity of export revenue is increasing in the destination's per capita income.¹⁶ In panels a)-c) we regress, respectively, log exports to low-income destinations (r_l), log exports to high-income destinations (r_h) and log total exports ($r_h + r_l$) on TFP and 3-digit industry dummies. Note that the export-TFP elasticity is positive and precisely estimated in all cases, and that in high-income destinations it is roughly twice as large as in low-income destinations. In panels d)-f), we control for sample size by rerunning the same regressions on exporters to both destinations and find very similar results.

2.4 ROBUSTNESS CHECKS

We start by checking that the negative correlation between ES_l and TFP is not driven by outliers. The results are in panel a) of Table 5. In columns (1)-(2) we winsorize and trim, respectively, the distributions of TFP and ES_l at the 5th and 95th percentiles, whereas in column (3) we estimate (1) using an outlier-robust procedure.¹⁷ In all cases, the results are similar to those reported in Table 3a). In column (4), we regress ES_l on three dummy variables for firms in the second, third and fourth quartile of the TFP

the estimation of production function parameters, namely: a) choice of appropriate specification and sectorial aggregation of the production function; b) choice of appropriate estimators to address attenuation and simultaneity biases. As we do not observe firm-level prices, our revenue-TFP estimates may also reflect price differences across firms (Foster, Haltiwanger and Syverson, 2008). A first-order source of price differences, namely, markup heterogeneity due to asymmetries in market power in a context of horizontal product differentiation (omitted price variable bias, see Klette and Griliches, 1996), is addressed by the augmented Olley and Pakes estimator proposed by De Loecker (2011), which we use in column (11). We implement this estimator by augmenting the production function with log average output ($\ln Q_i$) in the 3-digit industry of each firm, and then compute log TFP as $(1/(1 - \chi_Q)) \cdot (\ln Y_j - \sum_e \xi_e \cdot \ln \varrho_j - \chi_Q \cdot \ln Q_i)$, where χ_Q is the coefficient on $\ln Q_i$. Revenue-TFP may also capture quality heterogeneity across firms, which may lead to both upward and downward biases, with ambiguous net effects (Katayama, Lu and Tybout, 2009, Kugler and Verhoogen, 2011). Guided by our theoretical model, we control for quality heterogeneity by adding R&D intensity in most of the TFP estimates. In the next section we discuss, in the light of our structural estimates, the possible impact of measurement error in TFP on our results.

¹⁵As we showed in a previous version of the paper, Crinò and Epifani (2010), an equally strong pattern of correlations obtains when normalizing exports to low-income destinations by total sales (rather than total exports).

¹⁶From here onwards, to save space, we report bootstrapped standard errors only and focus on the augmented Olley and Pakes TFP estimate. Our main results are robust across the twelve TFP measures and are available upon request.

¹⁷As for winsorizing, we replace the observations in the tails of the distributions of ES_l and TFP with the 5th and 95th percentiles. As for the outlier-robust procedure, we use the `rreg` command in Stata.

distribution: the estimated coefficients are negative, statistically significant and increasing in absolute value, confirming that outliers play no role for our results.

In panel b), we check the robustness of our results with respect to the estimation strategy. To begin with, note that our TFP estimates build on the implicit assumption that firms share the same production function and that all heterogeneity is concentrated in the TFP term. We now allow for the possibility that exporters to low-income destinations use different technologies. To this purpose, we estimate TFP separately on exporters to low-income destinations and all other firms, and then rerun (1) using the new estimate. The results in column (5) show that the negative correlation between ES_l and TFP is now even stronger.

Next, note that so far we have relied on a two-step approach, in which TFP is estimated first, and then ES_l is regressed on it. An alternative strategy is to estimate the correlation between TFP and ES_l jointly with the production function parameters, so as to allow for the export decision in the first stage. Following Amiti and Konings (2007), we implement this one-step approach by adding ES_l as an explanatory variable in a Cobb-Douglas specification. The results are in column (6). Note that the coefficient on ES_l is negative, very precisely estimated and similar in size to those in Table 3a). In column (7), we repeat the exercise by interacting each input with 3-digit industry dummies, thereby further relaxing the assumption of equal technologies across industries. The estimated correlations are largely unchanged, confirming that one-step and two-step approaches yield similar results. In column (8), we revert to the two-step approach and allow for fully flexible (i.e., firm-specific) technologies, by using a Tornqvist index of TFP. The latter is constructed as $(\ln Y_j - \overline{\ln Y}) - 0.5 \cdot \left[\sum_{\varrho} (sh_{\varrho j} + \overline{sh_{\varrho}}) \cdot (\ln \varrho_j - \overline{\ln \varrho}) \right]$, where Y is output, sh_{ϱ} is the cost share of input ϱ (i.e., labor, capital and materials) and a bar over a variable denotes its sample mean.¹⁸ Importantly, the coefficient on the TFP index is negative, significant at the 1% level and similar in size to those obtained in Table 3a) using estimated TFP measures.¹⁹

In panel c), we finally show that our stylized fact is unlikely to be driven by omitted variables correlated with TFP and ES_l . We start, in column (9), by showing that the results are little affected when adding to the baseline regression a large battery of controls: a full set of dummies for Italian administrative regions, the share of part-time workers in total employment, a dummy variable for firms quoted on the stock market and a set of three dummy variables controlling for ownership structure. In column (10), we control instead for other forms of firm participation in foreign markets, and in particular for foreign direct investment (FDI), material and service offshoring ($IMPINT$ and $SERV$) and inshoring ($INSH$).²⁰

¹⁸See, e.g., Aw, Chen and Roberts (2001). Unlike in the other TFP estimates, here we use overall labor rather high-skill and low-skill labor, because we do not observe wages by skill group.

¹⁹Note that the TFP index nicely complements the one-step approach, because a computed measure of TFP is less likely to be affected by the bias due to abstracting from the export decision in the first step. However, the TFP index builds on stronger assumptions and cannot accommodate measurement error (see, e.g., Van Biesebroeck, 2007).

²⁰ FDI is the ratio of investment over total sales for the period 2001-2003. $IMPINT$ is the share of imported inputs in

Note that the export share is weakly positively correlated with most of these variables and that our coefficient of interest is unaffected.

In column (11), we add to our baseline specification a full set of export market dummies for firms selling in each of the seven destinations. This should help control, among other things, for price differences across markets that are constant across firms (see also De Loecker, 2007, on this point).²¹ Note that the main results are qualitatively similar. Finally, in column (12) we add a full set of interaction terms between export market dummies and 2-digit industry dummies, so as to allow for industry-specific price differences across markets. This specification now includes roughly three hundred variables, with a dramatic loss of degrees of freedom. Strikingly, however, the export share to low-income destinations remains strongly negatively correlated with TFP.

2.5 VALUE ADDED PER UNIT OF FACTOR COST

So far, we have relied on the TFP-based productivity measures most commonly used in the empirical trade literature. We now show the results obtained with an alternative productivity measure recently proposed by EKK. Specifically, we define productivity as value added per unit of factor cost (VA_{FC}), where value added equals revenue minus intermediate spending and factor cost equals total wage bill plus the cost of capital.²² Then, we reestimate the main regressions for the export share to low-income destinations using the new productivity measure instead of TFP. As shown in Table 6, the results are similar, confirming that our evidence is not crucially affected by the way productivity is defined and measured.

3 THEORY AND STRUCTURAL ESTIMATION

In this section, we first formulate a simple model illustrating the key ingredients behind our interpretation of the above empirical regularities, and discuss its implications in the light of the heterogeneous-firms literature. Then, following EKK, we develop a structural model, estimate its deep parameters by the simulated method of moments and study its implications.

total input purchases in 2003. $SERV$ is a dummy variable equal to 1 if a firm purchased services from abroad in 2003. $INSH$ is the share of sales arising from productions subcontracted by foreign firms in 2003.

²¹If, *ceteris paribus*, exporters systematically charge lower prices in low-income destinations, their revenue-TFP may be underestimated and its negative correlation with ES_t overstated (see, e.g., Demidova, Looi Kee and Krishna, 2006, and Corcos et al., 2010).

²²The cost of capital is computed as the capital stock multiplied by the real interest rate (3%) plus the depreciation rate (12%).

3.1 BASELINE MODEL

The representative consumer in destination z is characterized by the following preferences:

$$U_z = \left[\int_{v \in V} \lambda(v)^{\iota(y_z)(1-\rho)} d(v)^\rho \right]^{\frac{1}{\rho}} \quad 0 < \rho < 1, \quad (2)$$

where $v \in V$ indexes goods available for consumption in destination z , $d(v)$ is consumption and $\lambda(v) \geq 1$ is the quality of good v . Our first key assumption is that the preference for quality, reflected by the parameter $\iota(y_z) > 0$, is non-homothetic with respect to per capita income, y_z .²³ Specifically, we assume that $\iota(y_h) > \iota(y_l)$ for $y_h > y_l$. Maximization of (2) subject to a budget constraint yields the demand for good v in destination z :

$$d_z(v) = \lambda_z(v)^{\iota(y_z)} \frac{p_z(v)^{-\sigma} R_z}{P_z^{1-\sigma}}, \quad (3)$$

where R_z is total expenditure, $p_z(v)$ is the price of good v in destination z , $\sigma = (1 - \rho)^{-1} > 1$ is the constant elasticity of substitution between any two goods and P_z is the ideal price index associated to (2). Eq. (3) implies that the relative demand for high-quality products is ceteris paribus higher in high-income destinations.²⁴

Firms produce differentiated goods under monopolistic competition and are heterogeneous in terms of efficiency, φ , and product quality, λ . Home (Italian) firms are indexed by j . We assume that the marginal cost of producing good j for market z , $MC_z(j)$, is decreasing in firms j 's efficiency and increasing in product quality:²⁵

$$MC_z(j) = c_z(j) \lambda_z(j)^\delta, \quad c_z(j) = \frac{w\tau_z}{\varphi(j)}, \quad (4)$$

where w is the unit price of the bundle of inputs used to produce final output, $\tau_z > 1$ is an iceberg trade cost and $\delta \geq 0$ is the elasticity of marginal cost to product quality; $c_z(j)$ can be interpreted as a measure of the marginal cost per unit of quality.

²³Some recent contributions provide interesting microfoundations for the non-homotheticity of the demand for quality. In Fajgelbaum, Grossman and Helpman (2009), it is the outcome of discrete choices by consumers and complementarity in preferences between the quality of differentiated goods and the quantity of homogeneous goods. In Alcalà (2009), it arises instead from the fact that consumption requires time, leisure time is decreasing in per capita income and higher-quality goods provide higher satisfaction per unit of time. See also Markusen (1986), Hunter (1991) and Matsuyama (2000) on the role of non-homothetic preferences in international trade with representative firms, and Falvey and Kierzkowski (1987), Flam and Helpman (1987), Stokey (1991) and Murphy and Shleifer (1997) on product quality in international trade.

²⁴Note that, in a poor country, the elasticity of aggregate demand with respect to product quality may look like that of a rich country if income distribution is extremely unequal. The structural estimation results reported in the next section seem to suggest, however, that this is not the case in our data.

²⁵Marginal cost may be increasing in product quality if, for instance, higher-quality products require higher-quality inputs, see, e.g., Verhoogen (2008), Kugler and Verhoogen (2011) and Johnson (2009).

The profit maximizing price is a constant markup ($1/\rho$) over marginal cost.²⁶

$$p_z(j) = \frac{1}{\rho} c_z(j) \lambda_z(j)^\delta. \quad (5)$$

Using (3) and (5) yields firm j 's revenue in destination z :

$$r_z(j) = \lambda_z(j)^{\tilde{\iota}(y_z)} R_z (\rho P_z)^{\sigma-1} c_z(j)^{1-\sigma}, \quad (6)$$

where $\tilde{\iota}(y_z) = \iota(y_z) - \delta(\sigma - 1)$ is the elasticity of revenue with respect to product quality. Note, from (4) and (6), that the term $\varphi(j)^{\sigma-1}$ captures how efficiency gets translated into revenue for given quality; henceforth, we will refer to it as productivity.

Our second key assumption is that producing higher-quality products requires higher fixed costs in terms of R&D and other innovation activities.²⁷ Specifically, we assume that producing a variety of quality λ_z for destination z requires a fixed cost $RD_z = b\lambda_z^\gamma$, where $b > 0$ is a constant and $\gamma > 0$ is the elasticity of the fixed cost with respect to product quality. Note that λ is indexed by z because we assume that firms sell goods of different quality in different markets.²⁸

Firm j 's profits in market z are given by:

$$\pi_z(j) = \frac{1}{\sigma} r_z(j) - E_z - b\lambda_z(j)^\gamma, \quad (7)$$

where E_z is a destination-specific exogenous entry cost. Firm j chooses λ_z to maximize profits in z ; provided that $\tilde{\iota}(y_z) > 0$, the first-order condition for a maximum can be written as:

$$RD_z(j) = b\lambda_z(j)^\gamma = \frac{\tilde{\iota}(y_z)}{\gamma\sigma} r_z(j), \quad (8)$$

which implies that the fixed cost of quality upgrading is proportional to firm j 's revenue in destination z .²⁹ Solving for $\lambda_z(j)$ and using (6) yields optimal product quality:

$$\lambda_z(j) = \left[\frac{\tilde{\iota}(y_z) R_z (\rho P_z)^{\sigma-1} c_z(j)^{1-\sigma}}{b\gamma\sigma} \right]^{\frac{1}{\gamma - \tilde{\iota}(y_z)}}, \quad (9)$$

²⁶For an alternative approach in which quality is embedded into a framework *à la* Melitz and Ottaviano (2008) featuring variable markups see, for instance, Kneller and Yu (2008).

²⁷See, e.g., Sutton (1991, 1998), and more recent applications to a heterogeneous-firms framework by Johnson (2009), Hallak and Sivadasan (2009) and Kugler and Verhoogen (2011). For instance, in a variant of the model in the latter paper, fixed costs are complementary to input quality in producing output quality.

²⁸See Verhoogen (2008) for an interesting case study consistent with this assumption. See also Bastos and Silva (2010) for evidence on within-firm-product variation in unit values across export destinations. In the Appendix we show, however, that similar results hold under the alternative assumption that firms target their global market in choosing quality.

²⁹If $\tilde{\iota}(y_z) \leq 0$, revenue is non-increasing in product quality. In this case, firms maximize profits by setting $\lambda_z = 1$, i.e., they sell standardized products in destination z . See also the discussion in the Appendix.

where $\gamma - \tilde{\iota}(y_z) > 0$ by the second-order condition for a maximum. Note that more productive firms produce higher-quality products for all the destinations they sell to, because they can spread the higher fixed costs of quality upgrading over a greater revenue. Using (9) in (6), revenue can be written as:

$$r_z(j) = \left[\frac{\tilde{\iota}(y_z)}{b\gamma\sigma} \right]^{\frac{\tilde{\iota}(y_z)}{\gamma - \tilde{\iota}(y_z)}} [R_z(\rho P_z)^{\sigma-1} c_z(j)^{1-\sigma}]^{\frac{\gamma}{\gamma - \tilde{\iota}(y_z)}}. \quad (10)$$

Firm j enters destination z if $\pi_z(j) > 0$; using (8) in (7) yields the zero-profit revenue cutoff:

$$\bar{r}_z = \frac{\gamma\sigma E_z}{\gamma - \tilde{\iota}(y_z)}. \quad (11)$$

Equating (10) to (11) yields the zero-profit cost cutoff:

$$\bar{c}_z = \left[\frac{\gamma - \tilde{\iota}(y_z)}{\gamma\sigma E_z} \right]^{\frac{\gamma - \tilde{\iota}(y_z)}{\gamma(\sigma-1)}} \left[\frac{\tilde{\iota}(y_z)}{b\gamma\sigma} \right]^{\frac{\tilde{\iota}(y_z)}{\gamma(\sigma-1)}} R_z^{\sigma-1} \rho P_z. \quad (12)$$

Finally, using (12) in (9) and (10) we can write the expressions for product quality and revenue in destination z (conditional on entry) as functions of zero-profit cutoffs:

$$\lambda_z(j) = \left(\frac{\tilde{\iota}(y_z) E_z}{b[\gamma - \tilde{\iota}(y_z)]} \right)^{\frac{1}{\gamma}} \left(\frac{c_z(j)}{\bar{c}_z(j)} \right)^{\frac{(1-\sigma)}{\gamma - \tilde{\iota}(y_z)}}, \quad (13)$$

$$r_z(j) = \frac{\gamma\sigma E_z}{\gamma - \tilde{\iota}(y_z)} \left[\frac{c_z(j)}{\bar{c}_z} \right]^{\frac{(1-\sigma)\gamma}{\gamma - \tilde{\iota}(y_z)}} = \frac{\gamma\sigma E_z}{\gamma - \tilde{\iota}(y_z)} \left[\frac{\varphi(j)}{\bar{\varphi}_z} \right]^{\frac{(\sigma-1)\gamma}{\gamma - \tilde{\iota}(y_z)}}, \quad (14)$$

where $\bar{\varphi}_z = w\tau_z/\bar{c}_z$ is the zero-profit productivity cutoff in destination z . Note, from (14), that the elasticity of revenue with respect to productivity is increasing in per capita income of destination z .

Consider now two foreign destinations, indexed by h and l , with $y_h > y_l$. Firm j 's export share to the low-income destination is:

$$ES_l(j) = \frac{r_l(j)}{r_l(j) + r_h(j)} = \frac{r_l(j)/r_h(j)}{r_l(j)/r_h(j) + 1}. \quad (15)$$

Evidently, $ES_l(j)$ is monotonically increasing in relative exports, $r_l(j)/r_h(j)$. Using (14), taking the log of $r_l(j)/r_h(j)$ and differentiating yields:

$$\frac{d \ln r_l(j)/r_h(j)}{d \ln \varphi(j)^{\sigma-1}} = - \left[\frac{\tilde{\iota}(y_h)}{\gamma - \tilde{\iota}(y_h)} - \frac{\tilde{\iota}(y_l)}{\gamma - \tilde{\iota}(y_l)} \right] < 0. \quad (16)$$

Hence, for firms exporting to both destinations, the model naturally delivers a negative relationship between productivity and the export share to the low-income destination.³⁰

³⁰Note that $ES_l = 0$ for $\varphi < \bar{\varphi}_l$, implying an ambiguous unconditional correlation between ES_l and productivity (more on this below).

3.2 DISCUSSION

This stripped-down model captures the basic idea behind our interpretation of the evidence, namely, that the empirical correlations between productivity and exports arise from the interaction between non-homothetic preferences and firm heterogeneity in product quality. Before extending the model and estimating its deep parameters, we pause to discuss its implications in the light of the heterogeneous-firms literature with homogeneous quality.

3.2.1 *Melitz*

In the simplest case in which product quality plays no role (i.e., $\lambda_z(j) = 1$ for all j and z), we are back in the Melitz (2003) model and firm j 's revenue can be written as:

$$r_z(j) = \sigma E_z \left(\frac{\varphi(j)}{\bar{\varphi}_z} \right)^{\sigma-1},$$

where $\bar{\varphi}_z^{\sigma-1} = \sigma E_z / [R_z (\rho P_z / w \tau_z)^{\sigma-1}]$. Conditional on firms selling in both destinations, the export share to the low-income destination is therefore unrelated to productivity:

$$\frac{r_l(j)}{r_h(j)} = \frac{E_l}{E_h} \left(\frac{\bar{\varphi}_h}{\bar{\varphi}_l} \right)^{\sigma-1}.$$

Unconditionally, i.e., across all exporters, the model predicts instead a positive correlation between ES_l and productivity, as $ES_l = 0$ for $\bar{\varphi}_h < \varphi < \bar{\varphi}_l$. Hence, the simplest version of the Melitz model cannot explain our empirical regularities.³¹

3.2.2 *Export versus FDI*

Next, consider the export versus FDI decision. As argued by Helpman, Melitz and Yeaple (2004), the FDI option is relatively more profitable for more productive firms. This suggests that, by reducing exports of more productive firms, FDI may induce a negative correlation between exports and productivity. However, given that a (horizontal) FDI may be a better substitute for exports to similar-income destinations (Markusen, 1995), it may lead more productive Italian firms to export relatively less to other high-income markets, thereby inducing a positive (rather than a negative) correlation between productivity and the export share to low-income destinations. Therefore, FDI does not seem to provide an obvious alternative explanation for our key empirical regularity. Moreover, as already shown in Table 5, controlling for FDI

³¹Our empirical regularities are not implied, either, by the models in Bernard et al. (2003), Bernard, Redding and Schott (2007) and Melitz and Ottaviano (2008).

(and other variables broadly related to it) does not weaken the negative correlation between ES_l and productivity.

3.2.3 Endogenous market penetration costs

Consider now endogenous market penetration costs *à la* Arkolakis (2010). In this case, firm j 's entry costs in destination z are given by:

$$E_z(j) = E_z \frac{1 - (1 - f_z(j))^{1-\beta}}{1 - \beta}, \quad (17)$$

where $\beta > 0$ and $f_z(j)$ is the share of consumers reached by firm j in destination z . Eq. (17) reflects the assumption that entry costs (i.e., marketing costs) are increasing and convex in the degree of market penetration. According to (17), the marginal cost of market penetration equals $E_z(1 - f_z(j))^{-\beta}$; firm j 's revenue now equals instead $r_z(j) = \sigma f_z(j) E_z (\varphi(j)/\bar{\varphi}_z)^{\sigma-1}$, and profit maximization yields the following expression for optimal market penetration: $f_z(j) = 1 - [\bar{\varphi}_z/\varphi(j)]^{(\sigma-1)/\beta}$. Note that $f_z(j)$ is decreasing in $\bar{\varphi}_z$, i.e., firms reach a larger share of consumers in more popular destinations. It follows that the export share to the low-income destination is now increasing in productivity also conditional on firms entering both destinations:

$$\begin{aligned} \frac{r_l(j)}{r_h(j)} &= \frac{1 - \left(\frac{\bar{\varphi}_l}{\varphi(j)}\right)^{(\sigma-1)/\beta} E_l \left(\frac{\bar{\varphi}_h}{\bar{\varphi}_l}\right)^{\sigma-1}}{1 - \left(\frac{\bar{\varphi}_h}{\varphi(j)}\right)^{(\sigma-1)/\beta} E_h \left(\frac{\bar{\varphi}_h}{\bar{\varphi}_l}\right)^{\sigma-1}} \\ &\Rightarrow \frac{d \ln [r_l(j)/r_h(j)]}{d \ln \varphi(j)^{\sigma-1}} = \frac{1}{\beta \varphi(j)} \frac{f_h(j) - f_l(j)}{f_l(j) f_h(j)} > 0. \end{aligned} \quad (18)$$

Hence, convex entry costs *à la* Arkolakis do not seem to help explain our empirical regularities, as they lead more productive firms to sell to relatively more consumers in harder-to-reach destinations.³²

3.2.4 Firm-specific heterogeneity in entry costs and demand

Our baseline model can nicely explain a negative correlation between productivity and the export share to low-income destinations, but only conditional on firms exporting to both destinations. Yet, our evidence shows that the negative correlation holds strong also across all exporters. Moreover, in the baseline model firms enter foreign destinations according to an exact hierarchy dictated by their efficiency; yet, as shown in Section 2, there is no strict sorting of exporters in our data.

³²In Arkolakis (2010) and EKK, endogenous entry costs are useful to accommodate the presence of small exporters. In our model, a similar role is played by the endogenous, market-specific fixed costs of quality upgrading, as they lead more productive firms to bear higher overall fixed costs in each of the destinations they sell to.

To account for these facts, following EKK, in the next section we generalize our model by introducing firm- and market-specific heterogeneity in entry costs and demand. To provide context, we start by discussing how the presence of firm-specific shocks is likely to affect the unconditional correlation between ES_l and φ . Note, first, that a standard selection effect implies that low-productivity firms are less likely to export to less popular destinations. This leads to a higher frequency of zero export shares ($ES_l = 0$) among low-productivity exporters and induces, *ceteris paribus*, a positive correlation between ES_l and φ . Second, low-productivity firms hit by a positive entry shock in a low-income destination are likely to export only there. This implies a higher frequency of export shares equal to one ($ES_l = 1$) among low-productivity exporters and leads, *ceteris paribus*, to a negative correlation between ES_l and φ . Hence, the two effects push in opposite directions and are stronger among low-productivity exporters, as high-productivity firms are more likely to export to both destinations.

To have a sense of how these forces affect the relationship between ES_l and φ in EKK, we have simulated their model using our data.³³ Specifically, we have run 50 simulated regressions of $ES_l(j)$ on $\ln[\varphi(j)^{\sigma-1}]$ for 2507 artificial exporters, so as to mimic the regression results reported in Table 3. The average simulated regression coefficient (standard error) equals 0.076 (0.013) unconditionally and 0.127 (0.013) conditional on firms entering both high-income and low-income destinations, thereby suggesting that the EKK model cannot easily accommodate our key empirical regularities.

3.3 STRUCTURAL MODEL

Following the tractable and elegant approach proposed by EKK, we now add more structure to the baseline model, in order to estimate its deep parameters and test its predictions in the presence of firm- and market-specific heterogeneity in entry costs and demand.

3.3.1 Additional assumptions

We assume that entry costs to destination z equal $E_z(j) = \varepsilon_z(j)E_z$, where $\varepsilon_z(j)$ is a fixed-cost shock specific to firm j in destination z . Similarly, we denote by $\alpha_z(j)$ an exogenous demand shock specific to firm j in destination z . Finally, we assume that $\alpha_z(j)$ and $\eta_z(j) = \alpha_z(j)/\varepsilon_z(j)$ (where η can be interpreted as an entry shock) are drawn from a joint density $g(\alpha, \eta)$ that is the same across destinations and independent of $c_z(j)$.

Next, we assume that the measure of firms in country $m \in \{1, 2, \dots, \bar{m}\}$ with efficiency greater than φ equals $\mu^m(\varphi) = T^m \varphi^{-\theta}$, where $\theta > 0$ and $T^m > 0$. Using (4), the measure of firms with a unit cost of serving destination z less than c is therefore $\mu_z^m(c) = \Phi_z^m c^\theta$, where $\Phi_z^m = T^m (w^m \tau_z^m)^{-\theta}$. Under these

³³See the next section for more details on the simulation algorithm.

assumptions, the expressions for \bar{c}_z , $\lambda_z(j)$ and $r_z(j)$ in (12)-(14) generalize as follows:³⁴

$$\bar{c}_z(j) = \left[\frac{\gamma - \tilde{l}(y_z)}{\gamma \sigma E_z} \frac{\eta_z(j)}{\alpha_z(j)} \right]^{\frac{\gamma - \tilde{l}(y_z)}{\gamma(\sigma-1)}} \left[\frac{\tilde{l}(y_z)}{b \gamma \sigma} \right]^{\frac{\tilde{l}(y_z)}{\gamma(\sigma-1)}} [\alpha_z(j) R_z]^{\frac{1}{\sigma-1}} \rho P_z, \quad (19)$$

$$\lambda_z(j) = \left(\frac{\alpha_z(j)}{\eta_z(j)} \frac{\tilde{l}(y_z) E_z}{b [\gamma - \tilde{l}(y_z)]} \right)^{\frac{1}{\gamma}} \left(\frac{c_z(j)}{\bar{c}_z(j)} \right)^{\frac{(1-\sigma)}{\gamma - \tilde{l}(y_z)}}, \quad (20)$$

$$r_z(j) = \frac{\alpha_z(j)}{\eta_z(j)} \frac{\gamma \sigma E_z}{\gamma - \tilde{l}(y_z)} \left[\frac{c_z(j)}{\bar{c}_z(j)} \right]^{\frac{(1-\sigma)\gamma}{\gamma - \tilde{l}(y_z)}}. \quad (21)$$

3.3.2 Price index

The price index faced by the representative consumer in destination z is:

$$P_z = \frac{1}{\rho} \left[\iint \left(\sum_{m=1}^{\bar{m}} \int_0^{\bar{c}_z^m(\alpha, \eta)} \alpha \lambda_z^m(c) \tilde{l}(y_z) c^{1-\sigma} d\mu_z^m(c) \right) g(\alpha, \eta) d\alpha d\eta \right]^{-\frac{1}{\sigma-1}},$$

where the inner integral represents the price index in destination z of the bundle of goods imported from country m for a given realization of the shocks. Using (19) and (20), and following the same steps as in EKK, yields:

$$P_z = \frac{1}{\rho} R_z^{-\frac{\theta - (\sigma-1)}{(\sigma-1)\tilde{\theta}}} \left(\frac{q_z}{b\sigma} \right)^{-\frac{q_z}{(\sigma-1)}} (1 - q_z)^{\frac{1}{\tilde{\theta}} - \frac{1-q_z}{(\sigma-1)}} (\kappa_{1z} \psi_z)^{-\frac{1}{\tilde{\theta}}}, \quad (22)$$

where:

$$\begin{aligned} q_z &= \frac{\tilde{l}(y_z)}{\gamma} < 1 - \frac{1}{\tilde{\theta}}, \quad \tilde{\theta} = \frac{\theta}{\sigma - 1}, \\ \psi_z &= \sum_m \Phi_z^m (\sigma E_z^m)^{-(1-q_z)\tilde{\theta}+1}, \\ \kappa_{1z} &= \kappa_{0z} \iint \alpha^{q_z \tilde{\theta} + 1} \eta^{(1-q_z)\tilde{\theta} - 1} g(\alpha, \eta) d\alpha d\eta, \\ \kappa_{0z} &= \frac{(1 - q_z) \tilde{\theta}}{(1 - q_z) \tilde{\theta} - 1}. \end{aligned}$$

Note that q_z is the elasticity of revenue with respect to product quality divided by the elasticity of fixed costs with respect to product quality. We may refer to it as the normalized preference for quality. In this framework, it parsimoniously summarizes the impact of product quality and quality consumption on export behavior.³⁵

³⁴To save on notation, in the following we omit the country superscript when we refer to Home variables.

³⁵The restriction $q_z < 1 - 1/\tilde{\theta}$ follows from our assumption of a positive and finite P_z .

Substituting (22) into (19) yields the following expression for the cost cutoff $\bar{c}_z(j)$:

$$\bar{c}_z(j) = \alpha_z(j)^{\frac{q_z}{(\sigma-1)}} \eta_z(j)^{\frac{1-q_z}{(\sigma-1)}} (\sigma E_z)^{-\frac{1-q_z}{(\sigma-1)}} \left[\frac{R_z (1 - q_z)}{\kappa_{1z} \psi_z} \right]^{\frac{1}{\theta}}. \quad (23)$$

3.3.3 Entry and sales

The measure N_z of domestic firms selling in destination z is obtained by integrating the measure $\mu_z(\bar{c}_z(\alpha, \eta))$ of firms passing the entry hurdle over the joint density $g(\alpha, \eta)$:

$$N_z = \iint \Phi_z \bar{c}_z^\theta(\alpha, \eta) g(\alpha, \eta) d\alpha d\eta = \frac{\kappa_{2z} \Pi_z R_z (1 - q_z)}{\kappa_{1z} \sigma E_z}, \quad (24)$$

where:

$$\begin{aligned} \Pi_z &= \frac{\Phi_z}{\psi_z} (\sigma E_z)^{1 - \frac{1-q_z}{(\sigma-1)}}, \\ \kappa_{2z} &= \iint \alpha^{\tilde{\theta} q_z} \eta^{\tilde{\theta}(1-q_z)} g(\alpha, \eta) d\alpha d\eta. \end{aligned}$$

For a given realization of the shocks, total sales $X_z(\alpha, \eta)$ of domestic firms in destination z are obtained by substituting (23) into (21) and integrating revenue over the measure of costs $\mu_z(c)$:

$$X_z(\alpha, \eta) = \frac{\alpha_z(j) \sigma E_z}{\eta_z(j) (1 - q_z)} \int_0^{\bar{c}_z(\alpha, \eta)} \left[\frac{c}{\bar{c}_z} \right]^{\frac{1-\sigma}{1-q_z}} \theta \Phi_z c^{\theta-1} dc = \frac{\kappa_{0z}}{\kappa_{1z}} \Pi_z R_z \alpha^{\tilde{\theta} q_z + 1} \eta^{\tilde{\theta}(1-q_z) - 1}.$$

Total sales are then obtained by integrating $X_z(\alpha, \eta)$ over the joint density $g(\alpha, \eta)$:

$$X_z = \frac{\Pi_z R_z}{\kappa_{1z}} \kappa_{0z} \iint \alpha^{\tilde{\theta} q_z + 1} \eta^{\tilde{\theta}(1-q_z) - 1} g(\alpha, \eta) d\alpha d\eta = \Pi_z R_z. \quad (25)$$

Using (25) and (24) yields average sales \bar{X}_z of domestic exporters in destination z , which in turn allows us to write market entry costs in terms of \bar{X}_z :

$$\bar{X}_z = \frac{X_z}{N_z} = \frac{\kappa_{1z} \sigma E_z}{\kappa_{2z} (1 - q_z)} \Rightarrow \frac{\sigma E_z}{1 - q_z} = \frac{\kappa_{2z}}{\kappa_{1z}} \bar{X}_z. \quad (26)$$

3.3.4 Standardized unit costs

Following EKK, we define a new variable, the standardized unit cost $u(j)$, obtained as a transformation of firm j 's efficiency:

$$u(j) = T \varphi(j)^{-\theta} \Rightarrow \varphi(j) = \left(\frac{T}{u(j)} \right)^{\frac{1}{\theta}}.$$

The above transformation implies that the measure of firms with standardized unit cost below u equals the measure of firms with efficiency greater than $(T/u)^{1/\theta}$, and therefore we have: $\mu((T/u)^{1/\theta}) = T \left((T/u)^{1/\theta} \right)^{-\theta} = u$. It follows that standardized unit costs have a uniform measure that does not depend on any parameter.³⁶ Next, we write $c_z(j)$ and $\bar{c}_z(j)$ in terms of $u(j)$ and $\bar{u}_z(j)$:

$$c_z(j) = \frac{w\tau_z}{\varphi(j)} = \left(\frac{u(j)}{\Phi_z} \right)^{\frac{1}{\theta}} \Rightarrow \bar{c}_z(j) = \left(\frac{\bar{u}_z(j)}{\Phi_z} \right)^{\frac{1}{\theta}}. \quad (27)$$

Using (23) and (24) in (27) yields an expression for $\bar{u}_z(j)$ in terms of N_z :

$$\bar{u}_z(j) = \Phi_z \bar{c}_z(j)^\theta = \alpha_z(j)^{\tilde{\theta}q_z} \eta_z(j)^{\tilde{\theta}(1-q_z)} \frac{\Pi_z R_z (1-q_z)}{\sigma E_z \kappa_{1z}} = \frac{N_z}{\kappa_{2z}} \alpha_z(j)^{\tilde{\theta}q_z} \eta_z(j)^{\tilde{\theta}(1-q_z)}. \quad (28)$$

Substituting (26)-(28) into (21), firm j 's revenue can finally be written as:

$$r_z(j) = \frac{\kappa_{2z}}{\kappa_{1z}} \frac{\alpha_z(j) \bar{X}_z}{\eta_z(j)} v(j)^{-1/\tilde{\theta}(1-q_z)}, \quad (29)$$

where $v(j) = u(j)/\bar{u}_z(j)$ has a uniform distribution on the unit interval conditional on entry into market z .

3.3.5 Parametrization of the shocks

Finally, as in EKK, we assume that $\ln \alpha$ and $\ln \eta$ are normally distributed with zero mean, variance σ_α^2 and σ_η^2 and correlation $\rho_{\alpha\eta}$. Under these assumptions, κ_{1z} and κ_{2z} can be written as:

$$\begin{aligned} \kappa_{1z} &= \frac{\tilde{\theta}(1-q_z)}{\tilde{\theta}(1-q_z) - 1} \times \\ &\quad \exp \left\{ \frac{1}{2} \left[\sigma_\alpha^2 (\tilde{\theta}q_z + 1)^2 + 2\rho_{\alpha\eta} \sigma_\alpha \sigma_\eta (\tilde{\theta}q_z + 1) [\tilde{\theta}(1-q_z) - 1] + \sigma_\eta^2 [\tilde{\theta}(1-q_z) - 1]^2 \right] \right\}, \\ \kappa_{2z} &= \exp \left\{ \frac{1}{2} \left[\sigma_\alpha^2 (\tilde{\theta}q_z)^2 + 2\rho_{\alpha\eta} \sigma_\alpha \sigma_\eta \tilde{\theta}^2 q_z (1-q_z) + \sigma_\eta^2 [\tilde{\theta}(1-q_z)]^2 \right] \right\}. \end{aligned} \quad (30)$$

By comparing the expressions in (28)-(30) for entry hurdles, revenue, κ_{1z} and κ_{2z} with the equivalent expressions in EKK, note that our model boils down to theirs for $q_z = 0$ (under the assumption of exogenous entry costs). As illustrated below, we can therefore easily adapt the EKK algorithm to simulate our model's behavior.

³⁶This result proves useful in simulations, as it allows one to isolate the stochastic elements of the model from its parameters. See Eaton and Kortum (2010, Ch. 4) for an illustration.

3.4 SIMULATION, ESTIMATION AND MODEL FIT

In this section, we simulate a set of artificial Italian firms selling in at least one out of seven foreign destinations, three high-income and four low-income destinations. We use these artificial data to compute a set of artificial moments, which will then be compared with moments from the actual data to estimate the model's parameters and study its implications.

3.4.1 Simulation algorithm

We simulate a set of S artificial firms, indexed by s . This requires assigning a cost draw $u(s)$ and a value of the destination-specific shocks $\ln \alpha_z(s)$ and $\ln \eta_z(s)$ to each of them. As for the shocks, we first draw $S \times 7$ realizations of $a_z(s)$ and $h_z(s)$ independently from the standard normal distribution $N(0, 1)$ and then construct the realizations of $\ln \alpha_z(s)$ and $\ln \eta_z(s)$ as:

$$\begin{bmatrix} \ln \alpha_z(s) \\ \ln \eta_z(s) \end{bmatrix} = \begin{bmatrix} \sigma_\alpha \sqrt{1 - \rho_{\alpha\eta}^2} & \sigma_\alpha \rho_{\alpha\eta} \\ 0 & \sigma_\eta \end{bmatrix} \begin{bmatrix} a_z(s) \\ h_z(s) \end{bmatrix}. \quad (31)$$

As for the cost draws, we first draw S realizations of $v(s)$ independently from the uniform distribution $U[0, 1]$. Then, we use (28) to construct $S \times 7$ entry hurdles $\bar{u}_z(s)$. To this purpose, we use (30) to calculate κ_{1z} and κ_{2z} in each destination, and we replace N_z with the actual integer number of Italian firms selling in each destination. This allows us to construct the cost draws as $u(s) = v(s)\bar{u}^X(s)$, where $\bar{u}^X(s) = \max_z \{\bar{u}_z(s)\}$. This ensures that $u(s)$ is a realization from the uniform distribution over the interval $[0, \bar{u}^X(s)]$ and is therefore consistent with firm s selling in at least one foreign destination. Next, using (29) we calculate sales in destination z as:

$$r_z(s) = \delta_z(s) \frac{\kappa_{2z} \alpha_z(s) \bar{X}_z}{\kappa_{1z} \eta_z(s)} \left(\frac{u(s)}{\bar{u}_z(s)} \right)^{-1/\tilde{\theta}(1-q_z)}, \quad (32)$$

where $\delta_z(s)$ is an indicator variable equal to one for $u(s) \leq \bar{u}_z(s)$, namely, for firms selling in destination z . Moreover, we replace \bar{X}_z with actual average sales of Italian firms entering destination z . Finally, we use (32) to compute the export share to low-income destinations as $ES_l(s) = r_l(s)/(r_l(s) + r_h(s))$, where $r_l(s)$ are the overall sales to the four low-income destinations and $r_h(s)$ are the overall sales to the three high-income destinations.

3.4.2 Estimation

We use the above algorithm to estimate the following set of parameters: $\Theta = \sigma_\alpha, \sigma_\eta, \rho_{\alpha\eta}, \tilde{\theta}, q_z$, where z is one of the seven export destinations. To estimate Θ , we simulate 50000 artificial firms and use this data to compute a vector of moments $\hat{\phi}(\Theta)$. We choose the set of moments to exploit information on the distribution of exporters' sales across destinations. Specifically, we compute the q^{th} percentile (for $q = 5, 10, \dots, 90$) of normalized sales (i.e., divided by average sales) for each destination (r_z), for low-income and high-income destinations (r_l and r_h), and for total exports ($r_h + r_l$). This gives us a 180-element vector of artificial moments to be matched with the equivalent vector ϕ of moments from the actual data. We therefore compute $\Delta(\Theta) = \phi - \hat{\phi}(\Theta)$, the vector of deviations between actual and artificial moments, and search for a $\hat{\Theta}$ such that $\hat{\Theta} = \arg \min_{\Theta} \{\Delta(\Theta)'W\Delta(\Theta)\}$, where W is a 180×180 identity matrix. The best fit is achieved at the following parameter values (with bootstrapped standard errors in parenthesis):³⁷

σ_α	σ_η	$\rho_{\alpha\eta}$	$\tilde{\theta}$			
0.096	1.080	-0.916	2.607			
(0.004)	(0.166)	(0.040)	(0.452)			
q_{NA}	q_{EU15}	q_{OCE}	q_{EU10}	q_{LAT}	q_{CHN}	q_{AFR}
0.310	0.265	0.173	0.157	0.132	0.061	0.013
(0.020)	(0.025)	(0.017)	(0.007)	(0.006)	(0.003)	(0.001)

Although our estimates cannot be directly compared with those in EKK, who rely on more disaggregated data, it is nonetheless interesting to note that our estimate of σ_α (0.09 versus 1.69 in EKK) implies a much lower (by an order of magnitude) idiosyncratic variation in firms' sales across destinations, whereas our estimate of σ_η (1.08 versus 0.34 in EKK) implies a higher idiosyncratic variation in firms' entry costs across destinations.

More importantly our estimates imply that, consistent with our theory, the normalized preference for quality is monotonically increasing in the destination's per capita income. Cross-destination differences in q_z are also large and little affected by simulation error. For instance, the estimated preference for quality in the poorer destination, Africa, is less than one-20th that in the richest destination, North America. Such asymmetries suggest quality to play a prominent role for the direction and intensity of international trade.³⁸

³⁷Bootstrapped standard errors are based on 25 replications of the minimization procedure, implemented in MATLAB using the simplex algorithm.

³⁸For instance, they may help explain why rich countries still trade so little with African countries in manufacturing. See also Sutton (2007) on this point.

3.4.3 Model fit

To get a broad picture of the model fit, Figure 2 plots the vector ϕ of actual moments on the y -axis against the vector $\hat{\phi}$ of simulated moments on the x -axis. A regression of ϕ on $\hat{\phi}$ yields an R -squared of 0.95, suggesting that, with the estimated set of parameters, the model does a good job of matching moments of Italian data.

Next, we check whether the model is able to predict our key stylized fact. To this purpose, we run 50 simulated regressions of $ES_l(j)$ on $\ln[\varphi(j)^{\sigma-1}]$ for a set of 2507 artificial exporters.³⁹ The average simulated regression coefficient (standard error) equals -0.051 (0.012) for all exporters and -0.063 (0.011) for firms entering both high-income and low-income destinations. By comparing simulated results with actual regression results in panels a) and b) of Table 3, note that the model correctly predicts the pattern of correlations and broadly matches their size. Simulated coefficients are however smaller than actual ones in absolute value.

In comparing simulated and actual regression results, we are abstracting from measurement error in TFP. Guided by our structural estimates, which are independent of TFP estimates, we can have a sense of how mis-measurement of TFP may affect our empirical regularities. In particular, simulated regressions yield revenue-productivity elasticities equal to 1.85 (high-income destinations), 1.35 (low-income destinations) and 1.70 (total exports). The actual elasticities reported in Table 4 are therefore downward biased according to the model, consistent with measurement error in TFP. However, the estimates in panels a) and c) of Table 4 also imply an ES_l -TFP elasticity of $0.45 - 0.99 = -0.54$, versus an implied simulated elasticity of $1.35 - 1.70 = -0.35$. Hence, these back-of-the-envelope calculations suggest attenuation bias due to mis-measured TFP to be largely netted out in the regressions for the export shares, and to potentially account for all of the discrepancy between simulated and actual regressions in Table 3.

3.5 VALUE ADDED PER UNIT OF FACTOR COST

We now test whether the model is able to predict a negative correlation also between $ES_l(j)$ and value added per unit of factor cost, $VA_{FC}(j)$. To this purpose, we define firm j 's value added as $VA(j) = r(j) - I(j)$, where $r(j) = \sum_{z \in Z} r_z(j)$ is total revenue and $I(j)$ is intermediate spending, computed as:⁴⁰

$$I(j) = (1 - \beta_V) \frac{\sigma - 1}{\sigma} r(j) + (1 - \beta_E) E(j) + (1 - \beta_{RD}) RD(j),$$

³⁹In the simulations, cross-firm variation in log productivity is captured by the term $-(1/\tilde{\theta}) \ln u(s)$.

⁴⁰Note that the set of destinations Z now includes also the domestic market. This requires modifying the simulation algorithm to include non-exporters. Specifically, in $u(s) = v(s)\bar{u}^X(s)$, we replace $\bar{u}^X(s)$ with $\bar{u}(s) = \max_{z \in Z} \{\bar{u}_z(s)\}$. Moreover, it requires choosing a value of q_z for the domestic market, which we set equal to the average for high-income destinations.

where β_V , β_E and β_{RD} reflect, respectively, the share of factor cost in: variable cost, $\frac{\sigma-1}{\sigma}r(j)$, fixed entry costs, $E(j) = \sum_{z \in Z} E_z(j)$, and R&D costs, $RD(j) = \sum_{z \in Z} b\lambda_z^\gamma(j)$.

Computing intermediate spending and factor cost requires an estimate of the elasticity of substitution σ and of the share of factor cost in the three cost components. In the spirit of EKK, we calibrate these parameters to match actual data on value added per unit of factor cost. Specifically, we choose as moments the 5th to 90th percentiles of the distribution of VA_{FC} (18 moments overall), thereby obtaining the following parameter estimates: $\sigma = 1.58$, $\beta_V = 0.12$, $\beta_E = 0.37$ and $\beta_{RD} = 0.03$.

Using the above estimates, we simulate the behavior of 3365 artificial firms (with 50 draws), so as to match the actual number of firms in our dataset (i.e., including non-exporters). The model predicts, on average, 2687 exporters (versus 2507 in our data). Then, we run simulated regressions of $ES_l(j)$ on $\ln[VA_{FC}(j)]$ to replicate the results in columns 1) and 2) of Table 6. The average simulated regression coefficient (standard error) equals -0.095 (0.019) for all exporters and -0.061 (0.017) for firms entering both high-income and low-income destinations. Note that the model correctly predicts the pattern of correlations, although it overpredicts their size.

3.6 R&D INTENSITY AND EXPORT BEHAVIOR

We now use the simulated model to draw implications for the relationship between firms' R&D intensity and their export behavior. From (8), we have:

$$RD(j) = \sum_{z \in Z} b\lambda_z^\gamma(j) = \frac{1}{\sigma} \sum_{z \in Z} q_z r_z(j). \quad (33)$$

Hence, R&D spending equals a sort of weighted average of firms' revenues in the destinations they sell to, with weights proportional to per capita income of the destinations (recall that q_z is increasing in y_z). The model therefore implies that firms' R&D intensity is closely related to their sales distribution across destinations. In particular, simulated regressions imply a strong negative correlation between $ES_l(j)$ and $RDI(j) = RD(j)/r(j)$, with or without controlling for $\ln[\varphi(j)^{\sigma-1}]$, whose correlation with the export share is also significantly negative.⁴¹ Finally, simulated regression results imply that the correlation between $RDI(j)$ and the export share to individual destinations, $ES_z(j) = r_z(j)/\sum_{z \neq d} r_z(j)$, is strongly

⁴¹Specifically, simulated regressions of $ES_l(j)$ on $RDI(j)$ and $\ln[\varphi(j)^{\sigma-1}]$ yield average coefficients (standard errors) of -0.325 (0.005) and -0.013 (0.004), where the former coefficient is essentially identical also without controlling for productivity. The intuition for why productivity may affect the export share also conditional on R&D intensity (and, therefore, also conditional on quality) is that our model features more dimensions of heterogeneity, due to firm-specific shocks in entry costs and demand. This breaks the simple, deterministic relationship between productivity and other endogenous firm-level variables, which characterizes models with one dimension of heterogeneity. See also Hallak and Sivadasan (2009) on this point. They formulate a model with two dimensions of firm heterogeneity, in order to explain their robust finding that exporters' premia remain positive and statistically significant conditional on firm size.

increasing in q_z , as shown in Figure 3.⁴²

4 EVIDENCE ON INNOVATION, QUALITY AND EXPORT BEHAVIOR

In this Section, we test the above-mentioned qualitative implications. To this purpose, we exploit some unique information in our dataset on firms' innovation activities. We focus, in particular, on the following variables: R&D intensity (R&D spending over total sales, RDI), the share of sales from innovative products, and a dummy variable equal to one for firms that invested in process innovation in the previous three years. We start by testing whether these variables are inversely correlated with the export share to low-income destinations. As shown in columns (1)-(3) of Table 7, the correlation is always negative and, except for the dummy variable, very precisely estimated. In columns (5)-(7), we control for TFP. As predicted by the model, the coefficient on RDI (and related proxies) is unaffected, and the coefficient on TFP is also negative and precisely estimated. Finally, as a further robustness check, in columns (9)-(11) we also control for firm size using the log number of employees. The main results are unchanged and the coefficient on firm size is insignificantly different from zero.

Next we construct a new variable, dubbed *Quality*, obtained by extracting the principal component from the above proxies for firms' innovation activities. In the light of our model, this variable can be given two complementary interpretations. First, it can be interpreted as a synthetic proxy for the intensity of firms' innovation activities. Second, and probably more interestingly, it can be treated as a proxy for product quality. The reason is that, as suggested by (33), high-productivity firms produce higher-quality products because they invest more in R&D and related activities.⁴³ In columns (4), (8) and (12) of Table 7, we therefore use the new proxy instead of the individual proxies for innovation intensity. Note that ES_l is strongly negatively correlated with *Quality*, with or without controlling for productivity and firm size.

In Table 8, we perform additional robustness checks, using RDI in panel a) and *Quality* in panel b). Specifically, we add to the baseline specification the same controls used in Table 5: general controls in column (1), trade controls in column (2) and export market dummies in column (3). In columns (4)-(6), we add TFP to the above specifications, and in columns (7)-(9) we also control for firm size. In all cases, the export share to low-income destinations is strongly negatively correlated with both RDI and *Quality*.

Finally, we study how the correlation between ES_l and *Quality* depends on industry characteristics. It is easy to conjecture that a multi-sector extension of our model would predict industries characterized by a

⁴²The model also implies the correlation between $ES_z(j)$ and productivity to be increasing in q_z .

⁴³This interpretation is also consistent with the classic and more recent literature on quality differentiation (e.g., Sutton, 1998, and Kugler and Verhoogen, 2011), which suggests the scope for quality upgrading to be associated with the intensity of R&D and other activities aimed at producing new products or processes.

greater scope for quality differentiation to deliver a stronger negative correlation between the two variables. This is because a given heterogeneity in efficiency would translate into higher quality heterogeneity in these industries. To test this conjecture, following Kugler and Verhoogen (2011), we construct a variable, *Quality Differentiation*, equal to the median R&D intensity across all firms in each 3-digit industry. The results are reported in Table 9, with standard errors corrected for clustering within 3-digit industries. In column (1), we regress ES_i on *Quality*, *Quality Differentiation* and their interaction: as expected, the coefficients on *Quality* and its interaction with *Quality Differentiation* are negative and very precisely estimated. In column (2), we add TFP and its interaction with *Quality Differentiation*: the coefficient on the latter interaction term is insignificantly different from zero and our coefficients of interest are little affected. In column (3), we add firm size and its interaction with *Quality Differentiation*, and find that the results are unchanged. Finally, in column (4) we also interact *Quality* with a dummy for differentiated (3-digit) industries, identified using the Rauch (1999) classification. Consistent with this variable being a proxy for horizontal rather than vertical differentiation, the coefficient on the new interaction term is insignificantly different from zero and the other results are qualitatively unchanged.

4.1 PANEL EVIDENCE

Our model predicts that the correlations between productivity, R&D intensity or product quality and the export share to a destination are increasing in the destination’s per capita income. To test these predictions, we construct a panel of export shares to each of the seven destinations and estimate regressions of the form:

$$ES_{zj} = \chi_z + \chi_{zi} + \chi_1 \Omega_j + \chi_2 (\Omega_j \cdot y_z) + e_{zj}, \quad (34)$$

where ES_{zj} is firm j ’s export share to destination z , χ_z are destination fixed effects, χ_{zi} are destination-industry fixed effects, y_z is destination z ’s per capita income⁴⁴ and Ω is one of the following three variables: productivity (TFP or VAF_C), *RDI* or *Quality*. Note that the term $\Omega_j \cdot y_z$ captures the impact of foreign income on the correlation between ES_z and Ω : the expected sign of χ_2 is therefore positive. The results are reported in Table 10, with standard errors corrected for clustering at the firm level. To begin with, in columns (1) and (2) we estimate (34) with $\Omega =$ productivity. As expected, the coefficient χ_2 is always positive and statistically significant beyond the 1% level.

Next, we set $\Omega = RDI$ in columns (3)-(7) and $\Omega = Quality$ in columns (8)-(12). In particular, in columns (3) and (8) we estimate the baseline specification, in columns (4) and (9) we control for TFP and its interaction with foreign income, and in columns (5) and (10) we add firm size and its interaction with

⁴⁴We measure y_z using data on per capita GDP in PPP for the year 2003 (sourced from the World Development Indicators) and normalize it by Italy’s per capita income.

foreign income. Note that χ_2 is positive and precisely estimated across the board. Finally, in columns (6)-(7) and (11)-(12) we sequentially add distance and population of the foreign destination interacted with all the above firm characteristics, so as to check that our main results are not spuriously driven by the correlation of distance and market size with per capita income.⁴⁵ Strikingly, the coefficient χ_2 is very precisely estimated also in these very demanding specifications.⁴⁶

5 CONCLUSION

In this paper, we have documented new empirical regularities in the pattern of firms' exports across destinations. Using firm-level data for Italy we have shown, in particular, that a number of productivity measures are strongly negatively correlated with the export share to low-income destinations. We have argued that this fact cannot be easily accommodated by the existing heterogeneous-firms literature. We have therefore formulated a simple model in which, in the spirit of Verhoogen (2008), high-productivity firms endogenously choose higher-quality products and high-income countries have a stronger preference for high-quality goods. The model naturally delivered the main patterns in our data and was amenable to the structural estimation of its parameters along the lines recently suggested by Eaton, Kortum and Kramarz (2011).

With the estimated set of parameters, the model fitted our data well. The estimated parameters imply the preference for quality to be monotonically increasing in per capita income of the foreign destinations and suggest cross-destination heterogeneity in quality consumption to be large. The estimated model also delivered testable predictions concerning the relationship between R&D intensity, product quality and export behavior. Exploiting some unique information in our dataset, we tested these predictions and found that they are supported by our data. In particular, we found that a number of proxies for firms' involvement in innovation activities are strongly negatively correlated with their export share to low-income destinations.

Our results bear some potentially relevant implications. In particular, they suggest that what firms produce, and how they produce it, seems to be closely related to where they sell it. This implies, for

⁴⁵We compute distances as the number of kilometers between Rome and the capital city of Italy's main trading partner within destination z (see Corcos et al., 2010, for a discussion of alternative distance measures). We use data from CEPII and normalize individual distances by the average across all destinations. For a given destination, the main trading partner is the country with the highest share in Italy's trade, retrieved from CEPII's data on bilateral trade flows for the year 2003. In particular, the main trading partners are: Germany (*EU15*), United States (*NA*), Australia (*OCE*), Poland (*EU10*), Brazil (*LAT*), Tunisia (*AFR*) and China (*CHN*). Population figures are sourced from the WDI for the year 2003 and normalized by Italy's population.

⁴⁶Although the coefficients are imprecisely estimated, our results are broadly consistent with the correlation between export shares and quality/marginal cost being increasing in distance. They are therefore consistent with the Hummels and Skiba (2004) "good apples" story and with a by now large literature showing that export unit values are higher in more distant markets (see, in particular, Johnson, 2009, Baldwin and Harrigan, 2011, Manova and Zhang, 2011, Bastos and Silva, 2010, and Martin, 2010).

instance, that quality upgrading may be a prerequisite for effective access to richer countries' markets. Moreover, our results suggest that North-South trade liberalization may have not too disruptive effects on rich countries' industrial structure, because the trade-reducing effect of non-homothetic preferences may be exacerbated in the presence of firm heterogeneity in productivity and quality.

Although in recent years we have dramatically improved our understanding of firms' export behavior, the determinants of the popularity of foreign destinations from the standpoint of domestic exporters are not yet fully understood. We hope that, by showing how firms' exports may depend on the interplay between productivity, product quality and quality consumption, our contribution can shed light on this important issue. We still do not know, however, whether the empirical regularities documented in this paper, although strong and plausible, hold elsewhere. Testing whether our results extend beyond Italian manufacturing is therefore a promising avenue for future research.

6 APPENDIX

6.1 EKK-TYPE PATTERNS

We now show that the Italian data broadly replicates all the main patterns unveiled by EKK using French data (see Section 2 of that paper).

In Figure A1, we show how firms' entry and sales to each of the seven foreign destinations depend on market size. Panel a) plots the number of Italian exporters to each destination (normalized by Italy's market share in the destination) against the destination's total manufacturing absorption.⁴⁷ Note that the normalized number of exporters is strongly increasing in the destination's market size. Panel b) plots the 50th and 90th percentiles of exporters' sales in each destination against total manufacturing absorption. With one exception (*EU10*), sales are strongly increasing in the destination's market size.

In Figure A2, we show the relationship between firms' export participation and sales in Italy. To begin with, we group firms according to the minimum number k of foreign destinations in which they sell, with k ranging from 1 to 7 in our data. In panel a), we plot the 90th percentile sales in Italy of firms exporting to at least k destinations, with k on the horizontal axis. Note that sales in Italy are almost monotonically increasing in k . In panel b), we plot sales in Italy against the number of exporters to at least k destinations. The relationship is almost monotonically decreasing. In panel c), we plot sales in Italy against the number of exporters to each destination. With the exception of China, firms selling to more popular destinations have lower sales in Italy.

⁴⁷Italy's market share in each destination, and total manufacturing absorption of the destinations, are constructed using data from Dekle, Eaton and Kortum (2007), available for the year 2004. We use data on Italy's main trading partner within each destination. Market shares are defined as Italy's exports over total expenditure in the destinations; manufacturing absorption is defined instead as production plus imports minus exports in each destination. Data are converted from US\$ to Euros using exchange rates from the European Central Bank.

Finally, we show how the normalized export intensity varies with the number of exporters to a destination; the former variable is defined as the ratio of sales to a destination over domestic sales, both divided by average sales in the respective market. In Figure A3, we plot the mean and 95th percentile export intensity against the number of exporters to each destination. Note that the normalized export intensity is strongly increasing in the popularity of a destination.

To conclude our data nicely replicates, on a smaller scale, EKK-type patterns, and hence does not seem to be special in this respect.⁴⁸ By the same token, the new patterns shown in our paper, not studied by EKK, may perhaps hold true in their (and other) datasets as well.

6.2 GLOBAL QUALITY UPGRADING

Finally, we show that similar results hold when firms target their global market (rather than individual destinations) in choosing quality. In this case, they solve the following problem:

$$\max_{\lambda} \left\{ \varphi(j)^{\sigma-1} \sum_{z \in \{d, h, l\}} \delta_z(j) \left(M_z \lambda^{\tilde{t}(y_z)} - E_z \right) - b \lambda^{\gamma} \right\}, \quad (35)$$

where a subscript d indexes domestic variables, $M_z = R_z (\rho P_z / w \tau_z)^{\sigma-1}$ and $\delta_z(j)$ is an indicator variable equal to one if firm j sells in market z (i.e., $\delta_z(j) = 1$ for $\varphi(j) > \bar{\varphi}_z$). The first-order condition for this problem can be written as:

$$\gamma b \lambda^{\gamma} = \varphi(j)^{\sigma-1} \sum_{z \in \{d, h, l\}} \delta_z(j) \tilde{t}(y_z) M_z \lambda^{\tilde{t}(y_z)}, \quad (36)$$

where both the LHS and the RHS are increasing in λ and, by the second-order condition for a maximum, the LHS is steeper than the RHS. Note, first, that a higher value of φ shifts the RHS upwards, implying a higher equilibrium value of λ for given δ_z . Second, starting from $\delta_d = 1$ and $\delta_h = \delta_l = 0$, the RHS shifts upwards for $\delta_h = 1$ and for $\delta_h = \delta_l = 1$, implying that firms exporting to a larger number of markets choose a higher value of λ . Moreover, for $\bar{\varphi}_l > \bar{\varphi}_h > \bar{\varphi}_d$, the latter firms are more productive. Hence, as in the baseline model, high-productivity firms produce higher-quality products: they enter more destinations (extensive margin) and sell more in each of them (intensive margin), hence they can spread the higher fixed costs of quality upgrading over a greater revenue. By applying the implicit function theorem to

⁴⁸Although explaining the above empirical regularities was clearly not the focus of this paper, our model is able to replicate their qualitative pattern with the estimated set of parameters. The results are available upon request.

(36), we can write a general expression for the elasticity of product quality to productivity:

$$\epsilon \equiv \frac{d \ln \lambda(j)}{d \ln \varphi(j)^{\sigma-1}} = \frac{\sum_{z \in \{d, h, l\}} \delta_z(j) \tilde{\iota}(y_z) M_z \lambda(j)^{\tilde{\iota}(y_z)}}{\sum_{z \in \{d, h, l\}} \delta_z(j) [\gamma - \tilde{\iota}(y_z)] \tilde{\iota}(y_z) M_z \lambda(j)^{\tilde{\iota}(y_z)}} > 0,$$

where the inequality follows from the second-order condition for optimal product quality. Hence we have:

$$\frac{r_l(j)}{r_h(j)} = \lambda(j)^{\tilde{\iota}(y_l) - \tilde{\iota}(y_h)} \frac{M_l}{M_h} \Rightarrow \frac{d \ln (r_l(j)/r_h(j))}{d \ln \varphi(j)^{\sigma-1}} = \epsilon [\tilde{\iota}(y_l) - \tilde{\iota}(y_h)] < 0. \quad (37)$$

A special case is of interest because it may lead to quality differentiation across destinations (as in the baseline model) even when firms choose quality to solve (35). To see this assume, for simplicity, that $y_d = y_h$. More importantly, assume that y_l is so low that revenue is decreasing in quality in destination l , i.e., $\tilde{\iota}(y_l) = \iota(y_l) - \delta(\sigma - 1) < 0$. In this case, firms maximize profits by selling standardized products in the low-income destination (i.e., they set $\lambda_l(j) = 1$), and otherwise choose quality based only on the size of high-income countries.⁴⁹ In this case, it is straightforward to show that:

$$\frac{d \ln (r_l(j)/r_h(j))}{d \ln \varphi(j)^{\sigma-1}} = -\frac{\tilde{\iota}(y_h)}{\gamma - \tilde{\iota}(y_h)} < 0.$$

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⁴⁹Note, in passing, that the model provides a possible microfoundation for the assumption, standard in the literature on endogenous technological change (see, e.g., Gancia and Zilibotti, 2009), that firms target their innovations based on the size of high-income markets only.

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Table 1 - Firms' Entry and Exports across Destinations

	Number of Exporters	Share of Total Exporters	Export Share
	(1)	(2)	(3)
Aggregate Destinations			
High-Income	2428	0.97	0.83
Low-Income	1315	0.52	0.17
Individual Destinations			
EU15	2357	0.94	0.70
North America	1104	0.44	0.12
New EU Members	865	0.35	0.08
Africa	562	0.22	0.04
Latin America	494	0.20	0.03
Oceania	350	0.14	0.01
China	321	0.13	0.02
Total	2507		

High-income destinations include North America, EU15 and Oceania. Low-income destinations include Africa, China, Latin America and New EU Members. All variables are computed for the year 2003. Source: *Unicredit*.

Table 2 - Firms Selling to Strings of Foreign Destinations

	Number of Exporters	Under Independence
	(1)	(2)
Export Strings		
EU15	759	404
EU15 - NA	332	318
EU15 - NA - EU10	99	167
EU15 - NA - EU10 - AFR	35	48
EU15 - NA - EU10 - AFR - LAT	31	12
EU15 - NA - EU10 - AFR - LAT - OCE	38	2
EU15 - NA - EU10 - AFR - LAT - OCE - CHN	55	0
Total	1349	951
% of Total	0.54	0.38

The string "EU15" means selling in EU15 but not in the other destinations, "EU15 - NA" means selling in EU15 and North America but not in the other destinations, etc.. Column (1) shows how many exporters sell to each string in the data. Column (2) shows how many exporters would sell to each string under the assumption that selling in a destination is independent of selling in any other destination; these numbers are computed using data in column (2) of Table 1.

Table 3 - Productivity and Export Behavior: TFPDependent Variable: Export Share to Low-Income Destinations (ES_L)

	Cobb-Douglas Production Functions				Translog Production Functions				Panel Regressions			CD+Controls
	Baseline	Adding Controls	Prod/Non-Prod	2SLS	Baseline	Adding Controls	Prod/Non-Prod	2SLS	Lev./Pet.	Olley/Pakes	Olley/Pakes Augmented	(2-Digit Ind.)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
a) All Exporters												
ln TFP	-0.080*** [0.024] (0.024)	-0.080*** [0.024] (0.024)	-0.078*** [0.021] (0.022)	-0.087*** [0.024] (0.024)	-0.098*** [0.027] (0.027)	-0.098*** [0.026] (0.026)	-0.085*** [0.023] (0.024)	-0.102*** [0.027] (0.026)	-0.079*** [0.021] (0.022)	-0.079*** [0.021] (0.021)	-0.077*** [0.021] (0.021)	-0.075*** [0.024] (0.024)
Obs.	2185	2185	2507	2185	2185	2185	2507	2185	2507	2507	2507	2185
R-squared	0.11	0.11	0.10	0.12	0.12	0.12	0.10	0.12	0.10	0.10	0.10	0.11

b) Exporters to Both High-Income and Low-Income Destinations

ln TFP	-0.097** [0.038] (0.037)	-0.095** [0.038] (0.037)	-0.086*** [0.033] (0.033)	-0.110*** [0.036] (0.036)	-0.124*** [0.037] (0.037)	-0.121*** [0.038] (0.038)	-0.103*** [0.034] (0.034)	-0.135*** [0.036] (0.036)	-0.099*** [0.034] (0.033)	-0.090*** [0.033] (0.033)	-0.090*** [0.033] (0.032)	-0.096*** [0.037] (0.037)
Obs.	1077	1077	1236	1077	1077	1077	1236	1077	1236	1236	1236	1077
R-squared	0.14	0.14	0.12	0.14	0.14	0.14	0.13	0.14	0.13	0.13	0.13	0.14

OLS regressions with robust standard errors in round brackets and bootstrapped standard errors based on 500 replications in square brackets. ***, **, * = significant at 1, 5 and 10 percent level, respectively. All specifications include a full set of industry dummies, defined at the 3-digit level of the ATECO classification. Each column in the table refers to a different TFP estimate. All production functions are estimated using a revenue-based measure of output and four inputs: high-skill labor, low-skill labor, materials and physical capital. Revenue-based output is the sum of sales, capitalized costs and change in final goods inventories; material inputs are the difference between purchases and change in inventories of intermediate goods; capital stock is the book value of capital. Skills are proxied by occupations (production vs. non-production workers) in columns (3), (7) and (9)-(11); otherwise, they are proxied by educational attainment (workers with at least a high school degree vs. other workers). The production functions are estimated on the cross-section of firms for the year 2003 in columns (1)-(8) and (12) and on the three-year panel for 2001-2003 in columns (9)-(11). Estimation is performed by: OLS in columns (1)-(3), (5)-(7) and (12); Two-Stage Least Squares (using inputs in 2001 and 2002 as instruments for their level in 2003) in columns (4) and (8); semiparametric methods (respectively, Levinsohn and Petrin, 2003, Olley and Pakes, 1996, and De Loecker, 2011) in columns (9)-(11). In columns (2)-(4) and (6)-(12), the production functions include the following controls: R&D intensity, the share of part-time workers in total employment, a dummy for firms quoted on the stock market, three dummies for ownership structure and full sets of dummies for Italian administrative regions and 3-digit industries. In columns (9)-(11), they also include time dummies.

Table 4 - TFP Elasticity of Foreign Sales

Dependent Variables Indicated in Panels' Headings

	a) Log Exports to Low-Income Destinations (r_l)	b) Log Exports to High-Income Destinations (r_h)	c) Log Total Exports ($r_h + r_l$)
ln TFP	0.447* [0.246]	1.087*** [0.183]	0.991*** [0.164]
Obs.	1315	2428	2507
R-squared	0.12	0.11	0.12
	d) Log Exports to Low-Income Destinations (r_l)	e) Log Exports to High-Income Destinations (r_h)	f) Log Total Exports ($r_h + r_l$)
ln TFP	0.526* [0.278]	1.091*** [0.296]	0.936*** [0.270]
Obs.	1236	1236	1236
R-squared	0.12	0.16	0.15

TFP is based on the augmented Olley and Pakes estimate. All specifications include a full set of 3-digit industry dummies and standard errors are bootstrapped (500 replications). See also notes to previous tables.

Table 5 - TFP and Export Behavior: Robustness ChecksDependent Variables: Export Share to Low-Income Destinations (ES_i) and Log Output (Y , columns (6) and (7))

	a) Outliers				b) Estimation Method				c) Specification			
	Winsorizing	Trimming	Robust Estimation	TFP Bins	Sample Split	One-Step Approach	One-Step Approach	Tornqvist Index of TFP	General Controls	Trade Controls	Exp. MKT Dummies	Exp. MKT * Ind. Dummies
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ln TFP	-0.083***	-0.101***	-0.077***		-0.269***			-0.069***	-0.066***	-0.079***	-0.029**	-0.035***
	[0.023]	[0.035]	[0.022]		[0.024]			[0.026]	[0.022]	[0.021]	[0.013]	[0.013]
ES_i						-0.071***	-0.062***					
						[0.020]	[0.022]					
ln TFP (2 nd Quartile)				-0.026*								
				[0.016]								
ln TFP (3 rd Quartile)				-0.031*								
				[0.016]								
ln TFP (4 th Quartile)				-0.053***								
				[0.015]								
FDI										0.667		
										[0.963]		
IMPINT										0.043		
										[0.040]		
SERV										0.016		
										[0.013]		
INSH										-0.008		
										[0.019]		
Obs.	2507	1116	2507	2507	2507	2185	2185	2115	2473	2463	2507	2507
R-squared	0.11	0.12	0.10	0.10	0.17	0.96	0.97	0.11	0.12	0.10	0.60	0.64

The observations in the tails of the distributions of ES_i and TFP are replaced by the 5th and 95th percentiles in column (1) and excluded in column (2). The results in column (3) are obtained using the `meq` command in Stata. In column (4), the explanatory variables are dummies taking a value of 1 for firms in the second, third and fourth quartile of the TFP distribution; the reference group is given by firms in the first TFP quartile. In column (5), TFP is estimated separately on exporters to low-income destinations and all other firms. In columns (6) and (7), the Cobb-Douglas production function is augmented by ES_i : inputs enter linearly in the former column and interacted with 3-digit industry dummies in the latter. In column (8), TFP is computed rather than estimated, using the formula for the Tornqvist index illustrated in the text. In column (9), *general controls* are: the share of part-time workers in total employment, a dummy for firms quoted on the stock market, three dummies for ownership structure and a full set of dummies for Italian administrative regions. In column (10), *FDI* is the ratio of outward FDI to sales over the period 2001-2003, *IMPINT* is the share of imported inputs in total input purchases, *SERV* is a dummy variable equal to 1 for importers of services, and *INSH* is the share of sales subcontracted from abroad. In column (11), *export market dummies* are seven dummies each taking a value of 1 for firms exporting to a given destination. Column (12) also includes interactions between export market dummies and 2-digit industry dummies. All specifications include a full set of 3-digit industry dummies. See also notes to previous tables.

Table 6 - Productivity and Export Behavior: Value Added per Unit of Factor CostDependent Variable: Export Share to Low-Income Destinations (ES_i)

	a) Main Specifications		b) Robustness Checks		
	All Exporters	Exporters to Both High-Income and Low-Income Destinations	Winsorizing	General Controls	Trade Controls
	(1)	(2)	(3)	(4)	(5)
ln VA_{FC}	-0.036***	-0.029**	-0.035***	-0.031***	-0.036***
	[0.011]	[0.015]	[0.012]	[0.011]	[0.011]
Obs.	2494	1227	2494	2460	2450
R-squared	0.11	0.12	0.11	0.12	0.11

VA_{FC} is value added per unit of factor cost. Value added equals revenue minus intermediate spending and factor cost equals total wage bill plus the cost of capital. The cost of capital is computed as the capital stock multiplied by the real interest rate (3%) plus the depreciation rate (12%). All specifications include a full set of 3-digit industry dummies and standard errors are robust to heteroskedasticity. See also notes to previous tables.

Table 7 - Innovation, Quality and Export BehaviorDependent Variable: Export Share to Low-Income Destinations (ES_{it})

	Baseline				Controlling for TFP				Controlling for Firm Size			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
R&D Intensity (RDI)	-0.020***				-0.019***				-0.019***			
	[0.007]				[0.007]				[0.007]			
Share of Sales from Innovative Products		-0.051***				-0.050***				-0.050***		
		[0.014]				[0.015]				[0.015]		
Dummy for Process Innovation			-0.172				-0.144				-0.145	
			[0.123]				[0.137]				[0.136]	
Quality				-0.041***				-0.041***				-0.041***
				[0.014]				[0.014]				[0.014]
ln TFP					-0.078***	-0.089***	-0.084***	-0.081***	-0.079***	-0.089***	-0.084***	-0.082***
					[0.024]	[0.026]	[0.023]	[0.027]	[0.024]	[0.026]	[0.023]	[0.027]
ln Employment									0.012	0.015	0.003	0.017
									[0.023]	[0.023]	[0.022]	[0.025]
Obs.	2415	2515	2754	2186	2341	2272	2486	2115	2341	2272	2486	2115
R-squared	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11

Quality is the principal component of the first three variables, extracted through factor analysis. All specifications include a full set of 3-digit industry dummies and standard errors are robust to heteroskedasticity. See also notes to previous tables.

Table 8 - Innovation, Quality and Export Behavior: Robustness ChecksDependent Variable: Export Share to Low-Income Destinations (ES_{it})

	Control Variables: General			General	Trade			General	Trade			General	Exp. MKT		
	Controls				Controls				Controls				Dummies		
	(1)	(2)	(3)		(4)	(5)	(6)		(7)	(8)	(9)				
a) Using R&D Intensity															
RDI	-0.020***	-0.022***	-0.015**	-0.018***	-0.020***	-0.014**	-0.019***	-0.020***	-0.013**						
	[0.007]	[0.008]	[0.006]	[0.007]	[0.008]	[0.006]	[0.007]	[0.007]	[0.006]						
ln TFP				-0.067***	-0.080***	-0.029*	-0.068***	-0.080***	-0.027*						
				[0.025]	[0.025]	[0.016]	[0.025]	[0.025]	[0.016]						
ln Employment							0.010	0.000	-0.061***						
							[0.028]	[0.025]	[0.017]						
Obs.	2380	2334	2415	2309	2305	2341	2309	2305	2341						
R-squared	0.12	0.10	0.60	0.12	0.11	0.60	0.12	0.11	0.60						
b) Using Quality															
Quality	-0.039***	-0.047***	-0.019*	-0.041***	-0.045***	-0.019*	-0.041***	-0.045***	-0.019*						
	[0.014]	[0.014]	[0.011]	[0.014]	[0.014]	[0.011]	[0.014]	[0.014]	[0.011]						
ln TFP				-0.071**	-0.082***	-0.031*	-0.071**	-0.082***	-0.029*						
				[0.028]	[0.027]	[0.018]	[0.028]	[0.028]	[0.018]						
ln Employment							0.013	0.006	-0.059***						
							[0.029]	[0.026]	[0.018]						
Obs.	2155	2114	2186	2087	2086	2115	2087	2086	2115						
R-squared	0.13	0.11	0.60	0.13	0.11	0.59	0.13	0.11	0.60						

General controls in columns (1), (4) and (7) are the share of part-time workers in total employment, a dummy for firms quoted on the stock market, three dummies for ownership structure and a full set of dummies for Italian administrative regions. *Trade controls* in columns (2), (5) and (8) are the ratio of outward FDI to sales over the period 2001-2003, the share of imported inputs in total input purchases, a dummy variable equal to 1 for importers of services and the share of sales subcontracted from abroad. *Export market dummies* in columns (3), (6) and (9) are seven dummies each taking a value of 1 for firms exporting to a given destination. All specifications include a full set of 3-digit industry dummies and standard errors are robust to heteroskedasticity. See also notes to previous tables.

Table 9 - Industry Characteristics, Quality and Export BehaviorDependent Variable: Export Share to Low-Income Destinations (ES_L)

	Baseline	Controlling for TFP	Controlling for Firm Size	Controlling for Horizontal Differentiation
	(1)	(2)	(3)	(4)
Quality	-0.044*** [0.012]	-0.045*** [0.012]	-0.045*** [0.012]	-0.031 [0.027]
Quality * Quality Differentiation	-0.049*** [0.017]	-0.045** [0.018]	-0.045** [0.018]	-0.044** [0.018]
ln TFP		-0.100*** [0.029]	-0.100*** [0.030]	-0.100*** [0.030]
ln TFP * Quality Differentiation		-0.005 [0.034]	-0.005 [0.034]	-0.005 [0.034]
ln Employment			0.003 [0.021]	0.004 [0.022]
ln Employment * Quality Differentiation			0.001 [0.035]	0.001 [0.035]
Quality * Horizontal Differentiation				-0.019 [0.033]
Quality Differentiation	0.150*** [0.047]	0.138*** [0.048]	0.137*** [0.052]	0.137*** [0.052]
Obs.	2186	2115	2115	2115
R-squared	0.01	0.02	0.02	0.02

Quality differentiation is the median R&D intensity across all firms in each 3-digit industry. *Horizontal differentiation* is a dummy for differentiated (3-digit) industries, identified using the Rauch (1999) classification. Standard errors are corrected for clustering within 3-digit industries. See also notes to previous tables.

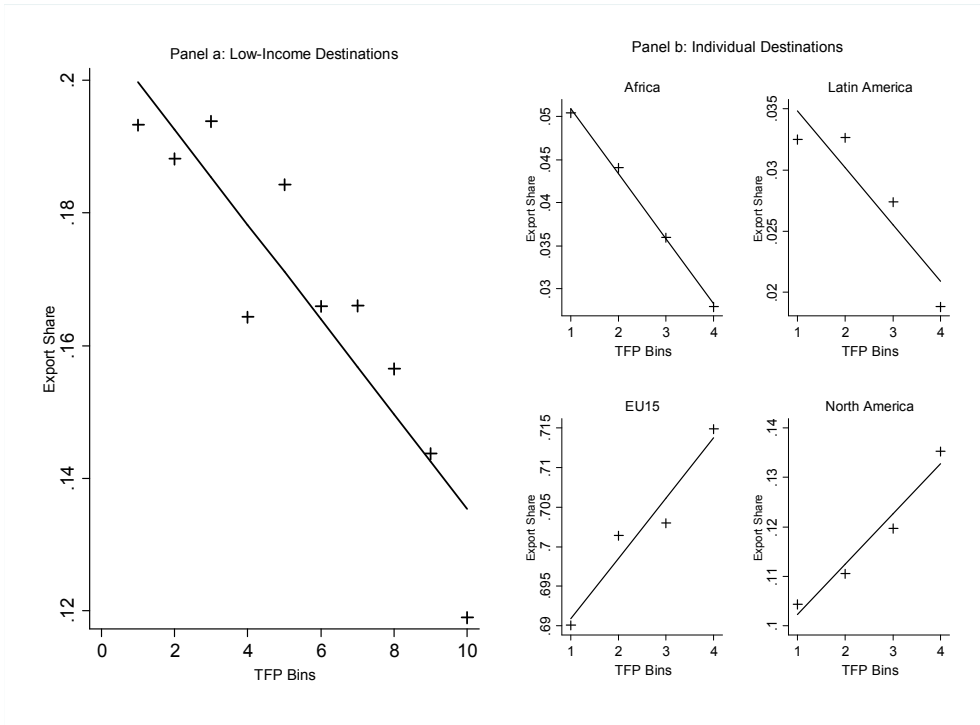
Table 10 - Productivity, Quality and Export Behavior: Panel Regressions

Dependent Variable: Export Share to Destination $\xi_i(ES_{it})$

	$\Omega = \text{Productivity}$		$\Omega = \text{RDI}$					$\Omega = \text{Quality}$					
	TFP	VA_{FC}	Baseline	Adding	Adding	Adding	Adding	Baseline	Adding	Adding	Adding	Adding	
	(1)	(2)	(3)	TFP	Firm Size	Distance	Population	(8)	TFP	Firm Size	Distance	Population	
In Productivity	-0.032***	-0.014***		-0.028***	-0.029***	-0.028***	-0.053***		-0.030***	-0.030***	-0.026***	-0.048**	
	[0.008]	[0.004]		[0.008]	[0.008]	[0.008]	[0.020]		[0.009]	[0.009]	[0.009]	[0.022]	
In Productivity * Income	0.058***	0.025***		0.051***	0.051***	0.051***	0.070***		0.053***	0.053***	0.055***	0.070***	
	[0.015]	[0.008]		[0.015]	[0.015]	[0.015]	[0.021]		[0.017]	[0.017]	[0.017]	[0.024]	
RDI			-0.007***	-0.007**	-0.007**	-0.007*	-0.019**						
			[0.003]	[0.003]	[0.003]	[0.004]	[0.010]						
RDI * Income			0.013***	0.012**	0.012**	0.012**	0.020***						
			[0.005]	[0.005]	[0.005]	[0.005]	[0.008]						
Quality								-0.014***	-0.014***	-0.014***	-0.017***	-0.041***	
								[0.005]	[0.005]	[0.005]	[0.006]	[0.013]	
Quality * Income								0.025***	0.025***	0.025***	0.024**	0.041***	
								[0.009]	[0.009]	[0.009]	[0.009]	[0.013]	
In Employment					0.003	-0.011	-0.018				0.005	-0.010	-0.014
					[0.008]	[0.008]	[0.017]				[0.009]	[0.008]	[0.018]
In Employment * Income					-0.006	-0.011	-0.006				-0.008	-0.014	-0.010
					[0.015]	[0.016]	[0.020]				[0.016]	[0.017]	[0.022]
In Productivity * Distance						-0.001	-0.000					-0.005	-0.003
						[0.005]	[0.005]					[0.005]	[0.005]
RDI * Distance						0.001	0.001						
						[0.003]	[0.003]						
Quality * Distance												0.003	0.005
												[0.004]	[0.004]
In Employment * Distance						0.017***	0.017***					0.016***	0.017***
						[0.005]	[0.005]					[0.005]	[0.005]
In Productivity * Population							0.002*						0.001
							[0.001]						[0.001]
RDI * Population							0.001**						
							[0.000]						
Quality * Population													0.002***
													[0.001]
In Employment * Population							0.000						0.000
							[0.001]						[0.001]
Obs.	17549	17458	16905	16387	16387	16387	16387	15302	14805	14805	14805	14805	14805
R-squared	0.67	0.68	0.67	0.67	0.67	0.67	0.67	0.68	0.68	0.68	0.68	0.68	0.68

The panel is obtained by pooling data on firms' export shares to the following destinations: EU15, New EU Members, North America, China, Latin America, Africa and Oceania. *Income* is the average PPP per capita GDP of each destination, relative to Italy's. *Distance* is the number of kilometers between Rome and the capital city of the main trading partner within each destination, relative to the average distance across all destinations. *Population* is the size of each destination's population relative to Italy's. All regressions control for destination and destination-industry fixed effects. Standard errors are corrected for clustering at the firm level. See also notes to previous tables.

Figure 1 - Productivity and Export Shares: Non-Parametric Evidence



To construct each graph, the exporters' TFP distribution is split into bins of equal size and the average export share is computed across all exporters in each bin. Results are based on the augmented Olley and Pakes TFP estimate (see Table 3).

Figure 2 - Model Fit

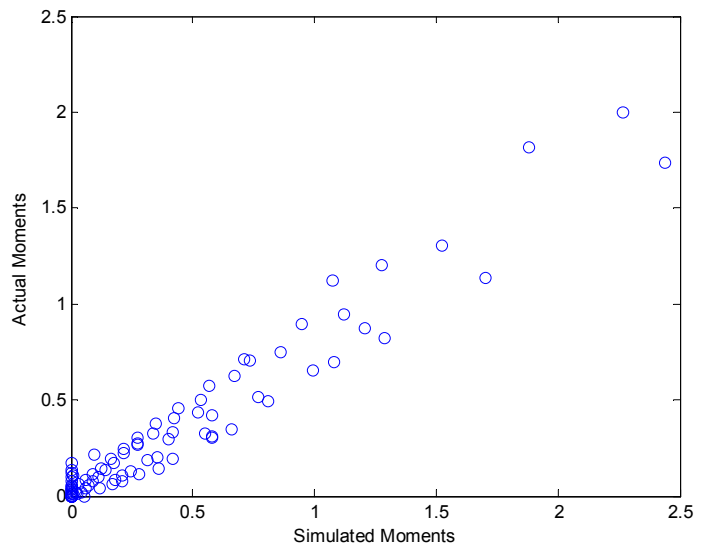


Figure 3 - R&D Intensity and Export Shares across Destinations

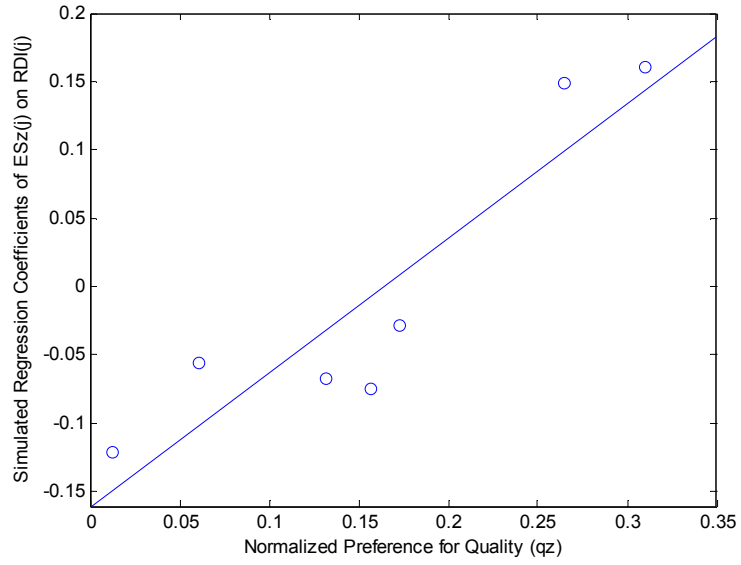
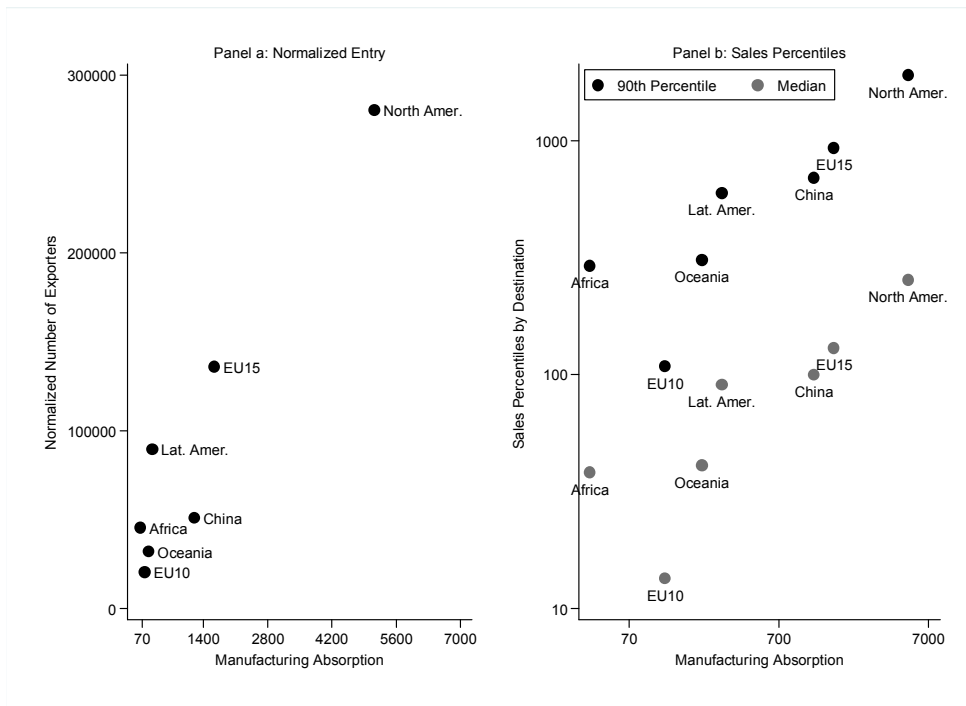
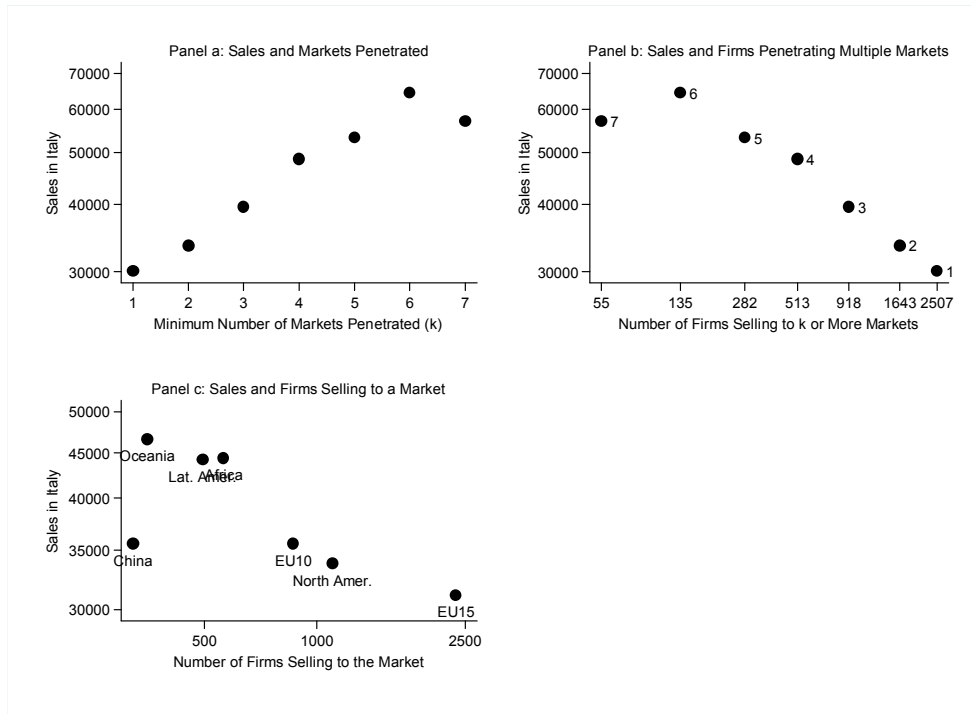


Figure A1 - Entry and Sales by Market Size



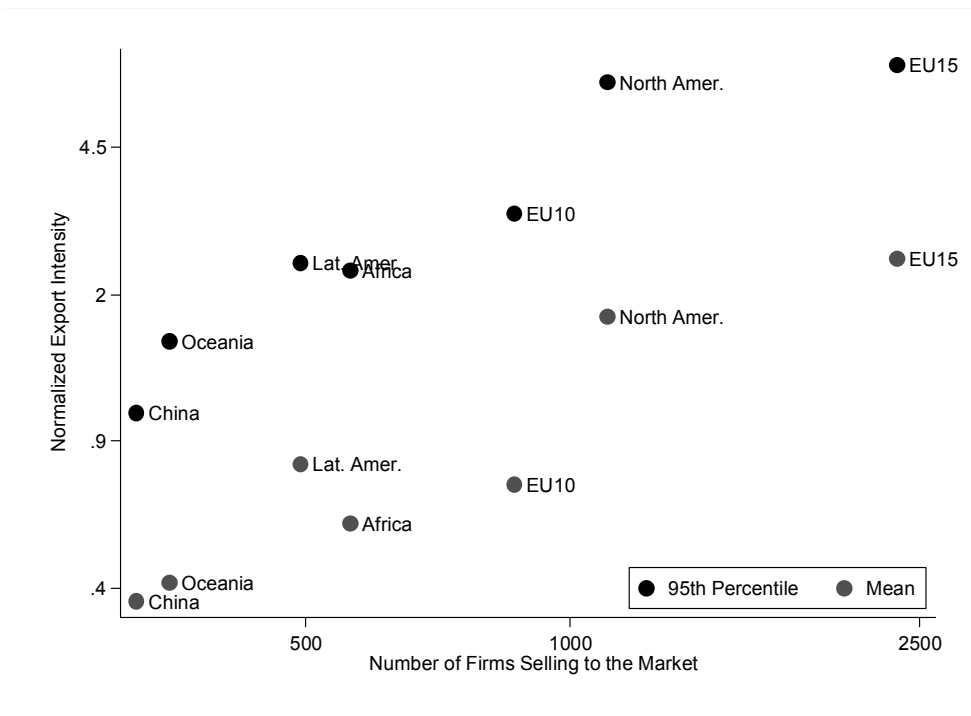
Manufacturing absorption is defined as production plus imports minus exports and is expressed in billions of Euros.

Figure A2 - Domestic Sales and Export Participation



The vertical axis of each graph reports the 90th percentile of sales in Italy (in thousands of Euros) for the corresponding group of exporting firms.

Figure A3 - Export Intensity by Destination



Normalized export intensity is defined as the ratio of sales to a destination over domestic sales, both divided by average sales in the respective market.