Productivity, Quality, and Export Intensities

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Abstract

We study how firm and foreign market characteristics affect the geographic distribution of exporters' sales. To this purpose, we use export intensities (the ratio of exports to sales) across destinations as our key measures of firms' relative involvement in heterogeneous foreign markets. In a representative sample of Italian manufacturing firms, we find a robust negative correlation between revenue-TFP and export intensity to low-income destinations and, more generally, that the correlations between export intensities and TFP are increasing in per capita income of the foreign destinations. We argue that these (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 propose a new strategy to proxy for product quality that allows to exploit some unique features of our dataset. Our results strongly suggest that firms producing higher-quality products tend to concentrate their sales in the domestic and other high-income markets.

JEL Numbers: F1.

Keywords: Heterogeneous Firms; Export Intensities; Quality; Technical Efficiency; Total Factor Productivity (TFP).

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1 Introduction

In this paper, we study how firm and foreign market characteristics affect the geographic distribution of exporters' sales. To this purpose, we use export intensities (the ratio of exports to sales) across destinations as our key measures of firms' relative involvement in heterogeneous foreign markets and show how they are correlated with other firm characteristics. We argue that this approach allows to gain new insight on the determinants of export behavior in a world of heterogenous firms and destinations.

The paper is motivated by some new and perhaps surprising facts in the light of the recent heterogeneous-firms literature.[1] Using a representative sample of Italian manufacturing firms, drawn from a reliable dataset used also in other studies,[2] we find a strong and robust negative correlation between export intensity to low-income destinations and revenue-TFP and, more generally, that the correlation between TFP and export intensity across foreign destinations is strongly increasing in foreign income.[3] These facts are seemingly at odds with the conventional wisdom, according to which, due to fixed and variable costs of exporting, only the most productive firms are profitable enough to break into small, distant or low-income destinations.[4] Although our findings are not inconsistent with the received literature, they qualify it in an important respect. In particular, they show that within the pool of exporters to any low-income destination, high-TFP firms export relatively less, as they tend to concentrate their sales into the domestic and other high-income markets.

We argue, both theoretically and empirically, that these facts can arise from the interplay between endogenous, cross-firm heterogeneity in product quality and cross-country heterogeneity in quality consumption, and propose a new strategy to proxy for firms' product quality that allows to test this conjecture. Our findings suggest that more productive firms produce higher-quality

[1] This literature has extensively analyzed firms' export behavior (but has left the pattern and determinants of export intensities largely unexplored), unveiling a number of new and interesting stylized facts. See, in particular, Bernard and Jensen (1995, 1999). See also Bernard et al. (2007), and Mayer and Ottaviano (2007) for comprehensive surveys of the empirical literature. These findings have pushed toward a new paradigm, initiated by Melitz (2003), that puts heterogeneous firms at center stage in the analysis of international trade and suggests productivity to be the key determinant of their export status.

[2] For 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' innovative 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 (see also Castellani and Zanfei, 2007, on this point), and that productivity increases after exporting (learning-by-exporting).

[3] In Melitz's (2003) model, export intensity is unrelated to productivity, conditional on exporting, because more productive firms sell proportionately more in both the domestic and foreign market. Our facts are not implied, either, by the models in Bernard et al. (2003), Bernard, Redding and Schott (2007) and Melitz and Ottaviano (2008).

[4] See, in particular, the influential papers by Eaton, Kortum and Kramarz (2004, 2008).

products, and that relative demand for these goods is higher in high-income destinations. They are therefore in line with a recent empirical literature pointing to the growing role of quality in international trade using industry-level data. In particular, this literature suggests quality consumption to be strongly increasing in per capita income and product quality to be crucial to explain international specialization.[5] The main contribution of this paper is therefore to help fill the gap between firm-level studies on the determinants of export behavior, which do not generally posit a role for product quality and quality consumption, and industry-level studies on the role of quality in international trade.[6] In particular, we view our findings as complementary to those of recent studies providing support for the Linder hypothesis that richer countries tend to import more from countries producing higher-quality goods using bilateral, industry-level data.[7]

In Section 2, we start by showing our main facts on export intensities and TFP. To take account of possible biases contaminating TFP estimates, following a recent literature, and in particular De Loecker (2007, 2008) and Amiti and Konings (2007), we allow for different specifications (and sectorial aggregation) of the underlying production function, for different estimators of its parameters, for different proxies of some inputs, and for a rich set of controls. Moreover, we allow technology to differ depending on export status, use computed rather than estimated TFP measures, and estimate the correlation between export intensities and TFP using a direct approach in which the production function is augmented by export intensities. Since we do not observe firm-level prices, and therefore rely on revenue-based measures of output, all our TFP measures are likely to reflect a combination of technical efficiency, product quality and markups. To be more confident that our results are mainly driven by firm heterogeneity in productivity and product quality, we propose various strategies to control for markup heterogeneity arising from asymmetries in market power (De Loecker, 2008) and market-specific demand shocks (Demidova, Looi Kee and Krishna, 2006).

We find that the TFP elasticity of export intensity to low-income destinations is invariably negative, large and very precisely estimated: conditional on exporting, a doubling of TFP is associated with about a 60% fall in the export intensity. A similar pattern characterizes other measures of export intensity to low-income destinations, i.e., the ratio of exports to domestic sales, whereas measures of export intensity to high-income destinations are positively correlated with TFP. Fi-

[5] As for trade and quality consumption see, in particular, Bils and Klenow (2001), Hummels and Skiba (2004), Brooks (2006), Hallak (2006, 2008), and Choi, Hummels and Xiang (2009). As for product quality and trade, see Schott (2004), Hummels and Klenow (2005), Hallak and Schott (2008).

[6] Although the issue of how productivity, product quality and quality consumption influence firms' export behavior across heterogeneous destinations, which is the main focus of our paper, is largely unexplored in the heterogeneous-firms literature, a number of works study product quality at the firm level. See, in particular, interesting recent works by Verhoogen (2008), Baldwin and Harrigan (2007), Alcalà (2007), Hallak and Sivadasan (2008), Johnson (2009), Kugler and Verhoogen (2008) and Manova and Zhang (2009), most of which will be cited in context.

[7] See, in particular, Hallak (2006, 2008).

nally, we find that the TFP elasticity of firms' revenue across destinations is higher the higher is per capita income of the destination.

In Section 3, building on Verhoogen (2008) and Johnson (2009), we illustrate a stripped-down heterogenous-firms model consistent with these facts. The crucial assumptions for the results are that consumers choose quality consumption based on their per capita income and firms product quality based on their productivity.[8] The model suggests the interaction of productivity, product quality and quality consumption to crucially affect firms' relative sales across heterogeneous destinations. In particular, it yields the general prediction that the correlation between export intensity and TFP is increasing in per capita income of the foreign destinations and is mediated by firm heterogeneity in product quality.

Next, we discuss how several other first-order determinants of export behavior affect the relationship between export intensity and TFP. In particular, we allow for multiproduct firms (Bernard, Redding and Schott, 2006), for country-specific (Eaton, Kortum and Kramarz, 2004) or endogenous (Arkolakis, 2008) fixed costs of entry, for the endogeneity of the export versus FDI choice (Helpman, Melitz and Yeaple, 2004), and for per unit trade costs (Hummels and Skiba, 2004). We learn that some of these new ingredients can generate a negative relationship between export intensity and TFP that grows stronger with distance. None can however provide an alternative explanation for a different pattern of correlations across high-income and low-income destinations.

In Section 4, we propose a new strategy to proxy for firms' product quality that allows to test our mechanism, according to which the correlations between export intensities and TFP are driven by firm heterogeneity in product quality. Although measuring product quality is no easier than measuring TFP, the empirical literature (e.g., Sutton, 1998, and more recently Kugler and Verhoogen, 2008) suggests that the scope for quality differentiation is generally associated with the intensity of R&D and other activities aimed at producing new products or processes, with marketing activities, with the managerial capability of a firm, and more generally with the intensity of investment activities. In this respect, a quasi-unique feature of our dataset is that it contains a large number of firm-level variables to proxy for these characteristics, e.g., R&D and marketing expenditures per employee, sales of innovative products per employee, proxies for firms' propensity to make process innovations, share of managers in total employment, etc..[9]

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

[9] We are aware of only one dataset, for a developing country, with broadly similar information (see Bustos, 2010). We view our approach to estimating product quality as complementary to the standard practice of using unit values. Its main advantage is that it does not require a one-to-one relationship between quality and prices. See also Hallak (2006) on this point.

We find that, as expected, TFP is positively correlated with all these variables. Then, we construct a synthetic proxy for product quality by extracting their principal component through factor analysis and find that, strikingly, its negative correlation with export intensity to low-income destinations is even stronger, whereas the coefficient of TFP is no longer robust across specifications after controlling for quality. We also find that the results are much stronger in the sub-sample of industries producing differentiated products, where the scope for quality differentiation is arguably greater. For robustness, we also expand the set of variables from which we extract the principal component by including other variables frequently used in the empirical literature to proxy for quality, i.e., average firm wages and firm size (Kugler and Verhoogen, 2008), and find very similar results.

Next, to test the general prediction that the elasticity of export intensity to TFP/quality is increasing in foreign per capita income, we construct a panel of firms' export intensities to all of the destinations for which we have data. Consistent with the proposed explanation, we find an interaction term between TFP/quality and per capita income of the foreign destinations to be strongly positively correlated with export intensity. In line with some complementary explanations discussed in the theoretical section, we also find evidence that the TFP elasticity of export intensity is decreasing in the distance of the foreign destinations.

Finally, we compute the TFP elasticities of export intensity across individual destinations and compare them with those predicted based on our panel estimates. We find that variation in foreign income alone provides a surprisingly accurate account of the sign and size of these elasticities across low-income destinations. Other complementary explanations, such as those related to distance, are instead required to account for the TFP elasticities of export intensity across destinations with an income similar to Italy's, which is consistent with our mechanism being weaker the smaller the cross-country asymmetries in per capita income. We conclude that our results highlight a crucial role for product quality and quality consumption in international trade.

2 Stylized Facts

In this section, we illustrate the dataset and our strategy for TFP estimation. Then, we show our key stylized fact, a strong negative correlation between TFP and export intensity to low-income destinations, and other empirical regularities related to it.

2.1 Data Description

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 4,289 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.

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 stylized facts, we start by reaggregating them into two groups of high-income and low-income destinations. In particular, the former group includes EU15, North America, and Oceania, whereas the latter includes Africa, China, Latin America and New EU Members. We exclude Other Europe and Other Asia from the two groups, because they include countries that are very heterogeneous in terms of per capita income.[10] Based on data from the World Development Indicators, average PPP per capita income in 2003 equals 27,000 US$ in the group of high-income destinations, 4,500 US$ in the group of low-income destinations, and 26,000 US$ in Italy.

With regard to input and output data, we use a revenue-based measure of output, defined as the sum of sales, capitalized costs and change in final goods inventories (see, e.g., Parisi, Schiantarelli and Sembenelli, 2006), and four inputs: materials, physical capital, high-skill and low-skill labor. Material inputs are computed as the difference between purchases and change in inventories of intermediate goods. Capital stock is the book value reported in the balance sheets. Finally, as for the labor inputs, we use two standard proxies for skill, one based on the educational attainment of the workforce (available for the year 2003) and the other on occupational data (available for the whole period).[11]

Table 1 reports descriptive statistics for the year 2003. The median firm in the sample produces about 1 million Euros worth of output and employes 50 workers, 30% of which are non-production

[10] Both 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.

[11] In particular, high-skill workers are proxied for by workers with at least a high-school degree, or by non-production workers (the sum of entrepreneurs, managers, technical and administrative employees). By implication, low-skill workers are proxied for by workers without a high-school degree, or by manual workers.

workers (37% are high-school or college graduates), and whose productivity (value added per worker) equals 90 thousand Euros. As for export behavior, three-fourths of the firms in our sample sell abroad.[12] Moreover, borrowing terminology from Eaton, Kortum and Kramarz (2008), high-income countries are more popular destinations than low-income countries for Italian exporters: almost all of them (91%) sell to the former and only a subset (49%) to the latter. Similarly, the export intensity to high-income destinations is higher than that to low-income destinations (30% versus 10% on average).[13]

2.2 TFP Estimation

As is the case with most other micro datasets, we do not observe firm-level prices and therefore rely on revenue-based measures of TFP (henceforth, TFP for brevity). These measures reflect technical efficiency and product quality, but may also capture markups.[14] To be more confident that our results are mainly driven by firm heterogeneity in productivity and product quality, we address two key sources of markup heterogeneity: a) asymmetries in market power in a context of horizontal product differentiation (following Klette and Griliches, 1996, and De Loecker, 2008) and b) market-specific demand shocks (following Demidova, Looi Kee and Krishna, 2006).

Price issue aside, obtaining reliable measures of TFP is a hard task because several challenges are involved in the estimation of production function parameters.[15] These range from the choice of appropriate specification and sectorial aggregation of the production function, to that of appropriate estimators to address attenuation and simultaneity biases. Given that there is no simple and unique solution to these issues, we estimate different TFP measures and then study their correlation with export intensities (i.e., using a two-step approach).[16] In particular, as for the choice of functional form, we use both a Cobb-Douglas and a translog specification (as in Hellerstein, Neumark and Troske, 1999, and Amiti and Konings, 2007). With regard to the choice of estimation method, we start by estimating the two production functions by OLS using cross-sectional variation in the year 2003. Then, to address measurement error (attenuation bias) and potential correlation between inputs and unobserved productivity (simultaneity bias), we follow three complementary approaches.

[12] This 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).

[13] When computed for the whole sample (i.e., considering also non-exporting firms), average export intensity equals 26%, a value close to the manufacturing-wide figure reported by the Italian Statistical Office (30%).

[14] For a discussion on this point, see, among others, Klette and Griliches (1996), Amiti and Konings (2007), De Loeker (2008), Foster, Haltiwanger and Syverson (2008), and Katayama, Lu and Tybout (2009).

[15] See Ackerberg et al. (2007) for a recent survey of the literature on TFP estimation.

[16] For robustness, however, we also use a one-step approach in which the production function is augmented by export intensities, and an approach based on computed rather than estimated TFP measures.

First, we estimate the two production functions with (and without) a large set of controls, and using two different proxies for skill. Second, we estimate them by Two-Stage Least Squares, using inputs in the years 2001 and 2002 as instruments for their levels in 2003 (as in Hellerstein, Neumark and Troske, 1999). Third, following De Loecker (2007), we estimate the Cobb-Douglas specification using the semiparametric estimators proposed by Olley and Pakes (OP, 1996) and Levinsohn and Petrin (LP, 2003), which fully exploit the panel dimension of our three-year dataset. Importantly, we also use an OP estimator augmented by average industry output which, as mentioned earlier, addresses the *omitted price variable bias* arising from asymmetries in market power. Finally, as for the choice of sectorial aggregation, we also estimate cross-sectional OLS Cobb-Douglas production functions at the (2-digit) industry level (as in Bernard and Jensen, 1999, and Kugler and Verhoogen, 2009).

Overall, our strategy yields twelve different estimates of the output elasticity of each production factor. Methodological details and estimation results are illustrated in the Appendix. We use these estimates to compute twelve baseline TFP measures, in which (the log of) TFP is defined as $\ln Y_j - \sum_r \xi_r \cdot \ln r_j$, where j indexes firms, Y is output, r is one of the four inputs used in our analysis, and ξ_r is one of the twelve estimates of the output elasticity of factor r. The simple correlation among these TFP estimates is reassuringly high, as it equals 0.84 on average and ranges from a minimum of 0.40 to a maximum of 0.99, which suggests that TFP estimates are unlikely to be crucially driven by methodological choice and specification details in our data.

2.3 TFP and Export Intensity to Low-Income Destinations

Armed with a battery of TFP estimates, we now show evidence of a strong and robust negative correlation between TFP and export intensity to low-income destinations (the ratio of exports to these areas over total sales, henceforth EXP_l). To begin with, we run non-parametric cross-sectional regressions of $\ln EXP_l$ on (the log of) each of our TFP estimates. The results are reported in Figure 1, where each graph corresponds to a different TFP measure (see below) and all variables are expressed in deviations from 3-digit industry averages.[17] Note that all graphs convey the same main message: conditional on exporting to low-income destinations, TFP and export intensity are negatively correlated and their relationship is roughly linear.

Next, we turn to parametric estimates to perform statistical inference. We run cross-sectional

[17] Industries are classified according to the ATECO system, the standard industrial classification in Italy, equivalent to NACE. Note that taking the log of EXP_l conditions the analysis on exporting to low-income destinations. Moreover, deviating the variables from industry averages wipes out industry-specific characteristics and implies that the regression curves will pass through the origin in all of the graphs shown below.

OLS regressions of the following form:

$$\ln EXP_{l_j} = \alpha_0 + \alpha_1 \ln TFP_j + \eta_i + u_j, \qquad (1)$$

where j indexes firms, EXP_l is export intensity to low-income destinations, TFP is one of our twelve TFP measures, η_i are 3-digit industry fixed-effects, and u is an error term. Our coefficient of interest is α_1, the TFP elasticity of export intensity to low-income destinations. The baseline results are reported in Table 2, where each column refers to a different TFP estimate. In particular, as detailed in the Appendix, columns (1)-(4) refer to cross-sectional Cobb-Douglas estimates, columns (5)-(8) to cross-sectional translog estimates, columns (9)-(11) to semiparametric Cobb-Douglas panel estimates, and column (12) to cross-sectional OLS Cobb-Douglas estimates at the 2-digit industry level. Given that our main regressor is estimated, we report bootstrapped standard errors based on 100 replications (in square brackets) as well as, for comparison, heteroskedasticity-robust analytical standard errors (in round brackets). Note that α_1 is always negative and significantly different from zero beyond the 1% level, using either type of standard errors. The estimated elasticity is also large in absolute value, implying that a doubling of TFP is associated with about a 60% fall in the export intensity to low-income destinations.

In the Appendix, we show that this result is strikingly robust to outliers, estimation method, sample size, and specification. In particular, to account for outliers, we reestimate equation (1) by quantile regressions, by winsorizing or trimming the distributions of TFP and EXP_l, by using an outlier-robust procedure, and by replacing TFP with dummies for firms with intermediate and high levels of TFP. As for estimation: a) we allow exporters to low-income destinations to use radically different technologies by re-estimating all the TFP measures for these firms only and then rerunning equation (1) using the new estimates; b) we use a one-step approach in which the production function is augmented by EXP_l to allow for the export decision in the first stage (see, in particular, Amiti and Konings, 2007); c) we use a computed measure of TFP based on a Tornqvist index to allow for firm-specific technologies (see, in particular, Van Biesebroeck, 2007). As for sample size, we reestimate equation (1) on exporters to high-income *and* low-income destinations, on all exporters, and on all firms (i.e., including also non exporters). We find the negative correlation between EXP_l and TFP to hold independent of sample size and to be weaker when including non exporters, which is consistent with the latter firms being less productive.[18] Finally, as for specification, we include a

[18] Note however that, as is the case with most other micro-level datasets, our sample is left-censored (as it excludes firms with less than 10 employees, among which non-exporters are likely to be concentrated) and is therefore not very well-suited to study conditional (on exporting) versus unconditional correlations. Moreover, the theoretical predictions shown in the next section are sharper and more interesting for conditional correlations, on which we will therefore

large set of controls, and in particular variables potentially correlated with TFP and EXP_l, such as the export intensity to high-income destinations and proxies for foreign direct investment, material and service offshoring, and inshoring. More importantly, we account for price differences stemming from heterogeneity in demand shocks or pricing behavior across markets (Demidova, Looi Kee and Krishna, 2006) by adding to equation (1) full sets of export market dummies and their interactions with 3-digit industry dummies (see, in particular, De Loecker, 2007).

2.4 Other Stylized Facts

Finally, in Table 3, we show some other empirical regularities closely related to the previous fact. From here onwards, to save space, we report bootstrapped standard errors only and focus on three key TFP estimates, namely, those corresponding to columns (6), (10) and (12) in Table 2.[19] In panels a)-c), we regress the log of, respectively, exports to low-income destinations (r_l), domestic sales (r_d) and exports to high-income destinations (r_h) on TFP and 3-digit industry dummies. Note that, consistent with the stylized fact shown in the previous section, the TFP elasticity of revenue is positive, precisely estimated, and increasing in per capita income of the destination market. As a check, in panels d)-f) we rerun the same regressions on the sample of firms with positive export intensity to low-income destinations (i.e., the sample used in the previous section). Consistently, the elasticities for the domestic and other high-income markets are roughly twice as large as that for low-income destinations.

In panels g)-i), the dependent variables are the log of, respectively, r_l/r_d, r_h/r_d and r_h/r_l: TFP is strongly negatively correlated with r_l/r_d, weakly positively correlated with r_h/r_d, and strongly positively correlated with r_h/r_l. Finally, in panels j)-l) the dependent variables are, respectively, the log of export intensity to high-income destinations (EXP_h), the share of total exports from high-income destinations (ES_h), and the log of overall export intensity (EXP). Note that TFP is weakly positively correlated with EXP_h, strongly positively correlated with ES_h, and uncorrelated with EXP.

To conclude, our data shows that TFP is negatively correlated with measures of export intensity to low-income destinations and positively correlated with measures of export intensity to high-income destinations. This different pattern of correlations is associated with a higher TFP elasticity of firm revenue from sales to higher-income destinations. In the next section, we incorporate these

focus in the rest of the paper.

[19] Our main results are robust across the twelve TFP measures. Most of them are reported in previous versions of the paper and are available upon request.

key features of our data in a simple model.

3 A Simple Model

In this section, we formulate the simplest model needed to account for the above stylized facts. In particular, we show that under plausible assumptions the export intensity to lower-income destinations is inversely related to product quality and productivity, the main determinants of revenue-TFP, and that the relationship between export intensity and productivity/quality is increasing in per capita income of the foreign destination.

We consider a partial-equilibrium model of a one-sector economy open to international trade and admitting a representative consumer characterized by the following preferences:

$$U = \left[\int_{v \in V} q(v)^{1-\rho} c(v)^{\rho} dv \right]^{\frac{1}{\rho}}, \quad 0 < \rho < 1, \tag{2}$$

where V is a continuous set of varieties available for consumption, indexed by v, $c(v)$ is consumption and $q(v)$ is quality of variety v, as perceived by the representative consumer.[20] Maximization of (2) subject to a budget constraint yields the following demand for variety v:

$$c(v) = q(v) \frac{p(v)^{-\sigma} R}{P^{1-\sigma}}, \tag{3}$$

where R is total income, $p(v)$ is the price of variety v, $\sigma = (1-\rho)^{-1} > 1$ is the constant elasticity of substitution between any two varieties, and P is the ideal price index associated to (2).[21]

Our first key assumption is that the preference for quality by the representative consumer is non-homothetic with respect to per capita income, y.[22] In particular, we assume that $q(v) = \lambda(v)^{\alpha(y)}$,

[20] Each variety is therefore a Cobb-Douglas bundle of physical quantity and perceived quality. See, e.g., Manasse and Turrini (2001).

[21] The expression for the ideal price index of (2) is: $P = \left[\int_{v \in V} q(v) p(v)^{1-\sigma} dv \right]^{\frac{1}{1-\sigma}}$. Although P is endogenous to the industry, firms treat it as exogenous, because their size is negligible relative to the size of the industry. See Helpman (2006) for an illustration of the heterogeneous-firms model in partial equilibrium.

[22] Some recent contributions provide interesting microfoundations for the non-homotheticity of demand for quality. In particular, 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.

where $\lambda(v) \geq 1$ denotes "true" product quality[23] and $\alpha(y) > 0$ captures the elasticity of demand with respect to product quality. We assume that $\alpha(y') > \alpha(y'')$ for $y' > y''$, which implies that the relative demand for higher-quality products is higher in high-income countries.[24]

Let subscripts d and f denote variables pertaining to the domestic and foreign markets, respectively. Firms produce differentiated products under monopolistic competition and are heterogeneous in productivity and product quality. We start by assuming that product quality is exogenous. This assumption will be relaxed shortly. Producing a particular variety requires a marginal cost of $1/\theta$, where θ is a measure of firm productivity.[25] The price that maximizes domestic firms' profits in market $z \in \{d, f\}$ is $p_z = \frac{\tau_z}{\rho\theta}$, where $\frac{1}{\rho} = \frac{\sigma}{\sigma-1}$ is a constant price-marginal cost markup, and $\tau_z > 1$ is an iceberg trade cost.[26] Using (3) and the expressions for q_z and p_z yields revenue in market z for a (λ, θ)-firm:

$$r_z(\lambda, \theta) = \theta^{\sigma-1} R_z \left(\frac{\rho P_z}{\tau_z}\right)^{\sigma-1} \lambda^{\alpha(y_z)}, \qquad z \in \{d, f\}, \tag{4}$$

which implies that the elasticity of firm revenue to product quality is increasing in per capita income of destination z. Finally, using (4) we obtain the ratio of exports to destination f over domestic sales:

$$\frac{r_f}{r_d} = \frac{R_f \left(P_f/\tau_f\right)^{\sigma-1}}{R_d \left(P_d/\tau_d\right)^{\sigma-1}} \lambda^{\alpha(y_f)-\alpha(y_d)} \Rightarrow \frac{d\ln(r_f/r_d)}{d\ln\lambda} = \alpha(y_f) - \alpha(y_d). \tag{5}$$

Note that r_f/r_d is increasing (decreasing) in product quality for $y_f > y_d$ ($y_f < y_d$) and unrelated to product quality for $y_f = y_d$. More generally, the elasticity of r_f/r_d to product quality is increasing in per capita income of the foreign destination.

Consider now two foreign destinations, indexed by $f \in \{l, h\}$, with $y_l < y_d < y_h$. The export intensity to the lower-income destination is: $EXP_l \equiv \frac{r_l}{r_d+r_l+r_h} = \frac{r_l/r_d}{1+r_l/r_d+r_h/r_d}$.[27] Equation (5)

[23] We assume that λ is defined over the range $[1, \infty)$ or otherwise a rise in the intensity of preference for quality, $\alpha(y)$, would have ambiguous effects on the demand for quality.

[24] Note that the elasticity of aggregate demand to product quality of a poor country may look like that of a rich country if income distribution is very unequal. However, if α is sufficiently concave with respect to per capita income, income distribution effects are unlikely to overturn the ranking of elasticities across countries based on per capita income. In our empirical analysis, we use data on exports to broad destinations including more than one country, and therefore the possible presence of some poor (and presumably small) countries with a high α is unlikely to affect the main results.

[25] A more general and realistic expression for the marginal cost (see Johnson, 2009) is $MC = \frac{\lambda^\delta}{\theta}$, $\delta > 0$, which allows the marginal cost to be increasing in product quality. In general, our main results are unaffected, as the above formulation can be shown to be formally equivalent to a rescaling of the elasticity of demand with respect to product quality (from $\alpha(y)$ to $\alpha(y) - (\sigma - 1)\delta$). However, as discussed in Section 3.2 and shown in the Appendix, the relationship between marginal cost and product quality crucially affects the results when variable trade costs include a per unit component.

[26] τ_z is the number of units to be produced in order for one unit to reach consumers in market z.

[27] The ratio of exports to total sales, which we use in most of our empirical analysis, is the standard definition of export intensity in the empirical literature. It is less vulnerable to outliers and measurement errors than the ratio of exports to domestic sales, as the latter gives an overwhelming weight to firms selling a tiny share of their output in the domestic market and, at the same time, implies that firms selling all of their output abroad are dropped from the

implies that a rise in product quality reduces r_l/r_d and increases r_h/r_d, thereby reducing EXP_l through both channels. In particular, using (5) into the expression for EXP_l, taking logs and differentiating yields:

$$\frac{d\ln EXP_l}{d\ln\lambda} = -\left[\alpha(y_d)-\alpha(y_l)\right](1-EXP_l) - \left[\alpha(y_h)-\alpha(y_d)\right]EXP_h < 0. \tag{6}$$

Similarly, the export intensity to the higher-income destination is: $EXP_h \equiv \frac{r_h}{r_d+r_l+r_h} = \frac{r_h/r_d}{1+r_l/r_d+r_h/r_d}$, which implies a positive elasticity of EXP_h with respect to λ:[28]

$$\frac{d\ln EXP_h}{d\ln\lambda} = \left[\alpha(y_h)-\alpha(y_d)\right](1-EXP_h) + \left[\alpha(y_d)-\alpha(y_l)\right]EXP_l > 0. \tag{7}$$

Finally, the model generally implies a positive correlation between product quality and the export share to the high-income destination ($ES_h \equiv \frac{r_h}{r_l+r_h}$)[29] and an ambiguous correlation between product quality and the overall export intensity ($EXP \equiv \frac{r_l+r_h}{r_d+r_l+r_h}$).[30]

This stripped-down model captures the basic idea behind our interpretation of the evidence, namely, that the empirical correlations between TFP and export intensities arise from the interaction between non-homothetic preferences and firm heterogeneity in product quality. Naturally, revenue-TFP does not only capture product quality but also (or mainly) technical efficiency. Moreover, in the presence of fixed costs of exporting, the above correlations hold only conditional on exporting to a given destination. Next, we address these issues.

3.1 Endogenous Product Quality

We now endogenize product quality in order to study its relationship with technical efficiency. Our second key assumption is that higher-quality products require higher fixed costs. This captures the idea that quality upgrading involves more intensive R&D and marketing activities, which are

sample.

[28]Equation (7) also implies, however, that the positive correlation between EXP_h and λ is weak across a high-income country's firms exporting mainly to other high-income countries (as is the case with Italy), as in this case both terms on the RHS of (7) are small.

[29]Using (5), we have:

$$\frac{d\ln ES_h}{d\ln\lambda} = \left[\alpha(y_h)-\alpha(y_l)\right](1-ES_h),$$

which is greater than zero (unless no firm exports to the low-income destination).

[30]The elasticity of EXP to λ can be written as:

$$\frac{d\ln EXP}{d\ln\lambda} = \frac{d\ln EXP_l}{d\ln\lambda}EXP_l + \frac{d\ln EXP_h}{d\ln\lambda}(1-EXP_l),$$

i.e., it is a weighted average of the elasticities to high-income and low-income destinations. Its sign is therefore, in general, ambiguous.

mainly fixed costs in nature.[31] In particular, we assume that producing a variety of quality λ requires a fixed cost equal to $\frac{1}{\eta}\lambda^{\eta}$, where $\eta > 0$ is the elasticity of the fixed cost to product quality. Moreover, we assume that firms choose product quality based on the characteristics of each market, and hence that they sell goods with different characteristics to different destinations.[32] The main advantage of this formulation is that it delivers a simple, closed-form solution for the elasticity of product quality to productivity.[33] In the Appendix we show, however, that the qualitative results are unchanged under the equally plausible assumption that firms choose a uniform product quality across the destinations they sell to.

Firms choose λ_z to maximize profits in market z, equal to $\pi_z = M_z \theta^{\sigma-1} \lambda_z^{\alpha(y_z)} - \frac{1}{\eta}\lambda^{\eta} - \phi_z$, where $M_z = \frac{1}{\sigma} R_z \left(\frac{P_z}{\tau_z}\rho\right)^{\sigma-1}$ is a measure of market size and ϕ_z is a fixed cost of entry into destination z (e.g., the cost of setting up a shop). Solving this problem yields optimal product quality, λ_z^*:

$$\lambda_z^* = \arg\max_{\lambda_z} \left\{ M_z \theta^{\sigma-1} \lambda_z^{\alpha(y_z)} - \frac{1}{\eta}\lambda^{\eta} - \phi_z \right\} = \left[\alpha(y_z) M_z \theta^{\sigma-1}\right]^{\frac{1}{\eta-\alpha(y_z)}}, \ z \in \{d, h, l\}, \tag{8}$$

where $\eta - \alpha(y_z) > 0$ by the second-order condition for a maximum. Hence, more productive firms produce higher-quality products in all the destinations they sell to, because they can spread the higher fixed costs of quality upgrading over a greater revenue. Using (8) into $r_z = \sigma M_z \theta^{\sigma-1} \lambda_z^{*\alpha(y_z)}$ yields the ratio of exports to domestic sales:

$$\frac{r_f}{r_d} = \frac{M_f \lambda_f^{*\alpha(y_f)}}{M_d \lambda_d^{*\alpha(y_d)}} = \frac{M_f}{M_d} \frac{\left[\alpha(y_f) M_f \theta^{\sigma-1}\right]^{\frac{\alpha(y_f)}{\eta-\alpha(y_f)}}}{\left[\alpha(y_d) M_d \theta^{\sigma-1}\right]^{\frac{\alpha(y_d)}{\eta-\alpha(y_d)}}}, \ f \in \{h, l\}, \tag{9}$$

Finally, taking the log of (9) and differentiating yields:

$$\frac{d\ln(r_f/r_d)}{d\ln\theta} = (\sigma - 1)\left(\frac{\alpha(y_f)}{\eta - \alpha(y_f)} - \frac{\alpha(y_d)}{\eta - \alpha(y_d)}\right). \tag{10}$$

Note first that, due to fixed costs of exporting, equations (9)-(10) hold only conditional on exporting to destination f, namely, for $\theta > \theta_f$, where θ_f is the productivity cutoff for exporters to destination f.[34] Second, equation (10) implies: $\frac{d\ln EXP_l}{d\ln\theta} < 0$, $\frac{d\ln EXP_h}{d\ln\theta} > 0$, $\frac{d\ln ES_h}{d\ln\theta} > 0$, $\frac{d\ln EXP}{d\ln\theta} \gtreqless 0$ and, more generally, that the elasticity of export intensity to productivity is increasing in y_f. Hence,

[31] See, e.g., Sutton (1991, 1998), and more recent applications to a heterogeneous-firms framework by Johnson (2009) and Hallak and Sivadasan (2008).

[32] See Verhoogen (2008) for an interesting case study consistent with this assumption.

[33] As shown in the Appendix, this allows us to easily extend the basic model to incorporate other first-order determinants of export behavior.

[34] Substituting λ_z^* from (8) into $\pi_z = M_z \theta^{\sigma-1} \lambda_z^{*\alpha(y_z)} - \frac{1}{\eta}\lambda_z^{*\eta} - \phi_z = 0$ and solving for θ yields the productivity

productivity and product quality share the same pattern of relations with export intensities.

Note, finally, that although revenue-TFP is closely related to product quality and productivity, it may also capture variation across firms in price-marginal cost markups, which in this model are instead constant. Although markups may reflect pure demand shocks and pricing power (an issue addressed empirically in the previous section), they are likely to be positively correlated with productivity and product quality, which may indeed strengthen the positive correlation of revenue-TFP with λ and θ.[35]

3.2 Discussion

We now discuss, in the light of the recent literature, how other firm characteristics and first-order determinants of export behavior may affect the relationship between export intensities and productivity. Here we focus on the main results, the details and derivations being reported in the Appendix. Consider first multiproduct firms. As shown, e.g., by Bernard, Redding and Schott (2006), these firms play a prominent role in international trade.[36] The presence of multiproduct firms introduces an *extensive margin of products* that may strengthen the negative correlation between productivity and export intensity to low-income destinations and, more generally, the positive dependence of this correlation on per capita income of the foreign destinations. This is because more productive firms, by producing higher-quality products, can profitably sell a relatively larger number of products to high-income destinations.

Consider now fixed costs of exporting. As shown by Eaton, Kortum and Kramarz (2004, 2008), these are mainly country-specific, thereby preventing most exporters from selling to many foreign countries. In our data, we only observe exports to broad destinations generally including more than one country. The presence of multicountry export destinations introduces an *extensive margin of countries* which tends to reduce the negative correlation between productivity and export inten-

cutoff, θ_z, for sellers to destination z:

$$\theta_z^{\sigma-1} = \frac{1}{\alpha(y_z)M_z}\left(\frac{\phi_z}{\frac{1}{\alpha(y_z)}-\frac{1}{\eta}}\right)^{\frac{\eta-\alpha(y_z)}{\eta}}, \quad z\in\{d,h,l\}, \tag{11}$$

implying that productivity cutoffs are increasing in the ratio of fixed costs of entry to market size, ϕ_z/M_z, and decreasing in per capita income of the destination, y_z.

[35] It is easy to construct examples in which this is indeed the case. For instance, following Dinopoulous and Unel (2009), we may assume that when a new variety is invented, a competitive fringe of potential imitators is able to copy the product at a marginal cost that is increasing in the quality of the new variety, e.g., equal to λ. This forces firms to charge a limit price equal to λ to deter entry (provided that the monopoly price is greater than the limit price, i.e., that $\frac{1}{\rho\theta}>\lambda$). In this case, unlike in the standard monopolistic competition framework, the price-marginal cost markup equals $\lambda\theta$, and is therefore increasing in product quality and productivity. By implication, in this case the export intensity to the low-income destination is inversely related also to markups.

[36] For instance, they report that more than one half of U.S. exporting firms export more than one product.

sity to low-income destinations, because more productive firms can break into a larger number of countries within any destination. This suggests that our results may provide a lower bound for the negative correlation between TFP and export intensity to low-income destinations that would arise using country-level data.

In the baseline model, we have treated the fixed costs of entry as exogenous and uniform across firms. As argued by Arkolakis (2008), this assumption has the counterfactual implication that no firm could profitably export small volumes of output.[37] Following Arkolakis, we have therefore endogenized the fixed costs of entry by assuming that reaching an additional consumer in each market involves an increasing marginal cost. This assumption introduces an *extensive margin of consumers*, whereby more productive firms reach a larger share of the population in each market, as they enjoy higher sales per consumer and can therefore afford higher market penetration costs. This tends to strengthen our results because, when market penetration costs are endogenous, high-productivity, high-quality firms have a stronger incentive to concentrate marketing efforts, and therefore sales, in higher-income destinations, where sales per consumer of higher-quality products are relatively higher.

Next, consider the *export versus FDI* decision. As shown 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 export intensity and productivity. The export-FDI tradeoff may therefore partly explain our main stylized fact, but is unlikely to be the whole story, for two main reasons. First, as shown in the Appendix, controlling for FDI (and other variables broadly related to it) does not weaken the negative correlation between TFP and export intensity to low-income destinations. Second, given that (a horizontal) FDI is an even better substitute for exports to similar-income destinations, we should also observe a strong negative correlation between TFP and export intensity to high-income destinations. The latter is instead weakly positive in our data. Interestingly, however, the effect of FDI may indirectly work through trade costs, as the export-FDI tradeoff switches in favor of FDI when trade costs are higher. This suggests that a negative correlation between export intensity and productivity may be more likely in trade with distant countries. In the next section, we provide evidence consistent with this implication.

Finally, we discuss how our results depend on the nature of variable trade costs. In the baseline model, we have assumed that variable trade costs are of the iceberg type, in this following a vast

[37] As shown by Eaton Kortum and Kramarz (2008), the smallest 25% of French exporters in a particular market sell less than 10,000 US$ in that market. See Arkolakis (2008) for more details on this point.

theoretical literature. However, as shown by Hummels and Skiba (2004), transport costs more closely resemble per unit costs rather than per value costs. *Per unit trade costs* may provide an alternative explanation for a negative correlation between export intensity and productivity, because they represent a higher share of marginal cost for high-productivity firms, and therefore have a stronger negative impact on their relative sales abroad. Moreover, as shown by Hummels and Skiba, the relative importance of per unit trade costs tends to increase with distance, which provides an additional reason for why the elasticity of export intensity to productivity may be decreasing in distance.[38]

To conclude, although we can find alternative explanations for a negative correlation between export intensity and productivity, none can account for a different pattern of correlations between high-income and low-income destinations. More generally, our discussion points to two specific implications of our theory that can hardly be replicated by alternative explanations: first, that the correlation between export intensity and productivity is increasing in per capita income of the foreign destinations and, second, that it is mediated by firm heterogeneity in product quality. In the next section, we will test these implications.

4 Testing the Model's Implications

To begin with, we propose an empirical strategy to proxy for product quality at the firm level. Then we show that, consistent with the model, our proxies are positively correlated with TFP and, more importantly, are strongly negatively correlated with export intensity to low-income destinations, especially so in the sub-sample of industries characterized by a greater scope for quality differentiation. Next, we construct a panel of firms' export intensities to all of the destinations for which we have data to test the prediction that the elasticity of export intensity to TFP and product quality is increasing in foreign income against alternative predictions. Finally, we compute the TFP elasticity of export intensity across individual destinations to test whether variation in foreign income can help predict their sign and size.

[38] In the Appendix we also show, however, that the above implications crucially rely on the assumption that higher-quality products sell at a lower price. Under the alternative assumption that marginal cost is increasing in product quality and productivity, the implications of per unit trade costs are reversed, as in this case the elasticity of export intensity to productivity is ceteris paribus positive and increasing in distance.

4.1 Evidence on Product Quality

As mentioned in the Introduction, a quasi-unique feature of our dataset is that it reports information on many firm-level variables that are highly likely to be correlated with product quality according to both the classic and the more recent empirical literature on quality differentiation (see, e.g., Sutton, 1998, and Kugler and Verhoogen, 2008). We focus, in particular, on the following variables: R&D and marketing expenditures per employee, sales of innovative products per employee, a dummy equal to one for firms that invested in process innovation in the previous three years, its interaction with sales of innovative products per employee, the share of managers in total employment, and the level of investment per employee.

We start by regressing each of these variables on TFP and 3-digit industry dummies. We expect a positive correlation, first, because a revenue-based measure of TFP also captures product quality and, second, because productivity and product quality are positively correlated according to the model. As shown in Table 4, all these variables are indeed positively correlated with TFP and their coefficients are also quite precisely estimated. Given, however, that none of them is a perfect proxy for product quality, following a standard practice in the empirical literature we extract their principal component by factor analysis. The basic idea is that the principal component may capture the common link of these variables with product quality. As shown in the table, the principal component, denoted by Q_1, is strongly positively correlated with TFP.

The model also implies that product quality is positively correlated with firm size. We therefore construct a second proxy, Q_2, by adding the number of employees to the set of variables from which we extract the principal component. Table 4 shows that, consistent with a large empirical literature, firm size is strongly positively correlated with TFP, and that the correlation between Q_2 and TFP is strong and positive as well. Finally, in the spirit of Kugler and Verhoogen (2008), in which input quality and output quality are closely related, we also add average firm wages to the factor analysis to proxy for input quality, and denote by Q_3 the resulting principal component. As shown in the table, both average wages and Q_3 are positively correlated with TFP.

Having shown that product quality is likely to be correlated with TFP, we now perform a crucial test. We rerun the main specifications used in Section 2 and in the Appendix to illustrate our stylized facts by replacing TFP with our proxies for product quality, $Q_1 - Q_3$.[39] If, as suggested by the model, the negative correlation between TFP and export intensity to low-income destinations

[39] The only difference in these specifications is that $Q_1 - Q_3$ enter in levels rather than in logs, because they are standardized variables with mean zero and standard deviation one. By implication, the coefficients cannot be interpreted as elasticities. For comparability, we also standardize the other variables used in Table 5.

is mainly driven by firm heterogeneity in product quality, we should *a fortiori* observe a negative correlation when regressing export intensity on proxies for product quality. As shown in panel a) of Table 5, this is indeed what we find: strikingly, in all specifications $Q_1 - Q_3$ are strongly negatively correlated with EXP_l. In panel b), we add TFP to the regressors: the main results are unchanged and the coefficient of TFP is no longer robust across specifications.

In Table 6, we rerun the baseline regressions after splitting our sample in two subgroups of industries producing homogeneous and differentiated products according to Rauch's (1999) classification. In particular, in panel a) we regress EXP_l on $Q_1 - Q_3$ and 3-digit industry dummies, and in panel b) we also add TFP. Interestingly, the export intensity to low-income destinations is strongly negatively correlated with product quality (and TFP) only in the differentiated-product industries. This suggests that, consistent with the model, our stylized fact is more relevant in industries characterized by a greater scope for quality differentiation.

Finally, we show evidence that firms selling to a larger number of destinations produce higher-quality products, as they can spread the higher fixed costs of quality upgrading over a larger output.[40] In columns (1)-(3) of Table 7a, we regress $Q_1 - Q_3$ on 3-digit industry dummies and two mutually exclusive categorical variables, D_{DH} and D_{DHL}, taking a value of 1, respectively, for firms selling only to the domestic and high-income foreign markets and for those selling *also* to low-income destinations. In columns (4)-(6), we add TFP among the controls. Note that the (standardized) coefficients of D_{DH} and D_{DHL} are always positive and precisely estimated, and that the latter coefficient is much larger than the former. In panel b), as a robustness check, we replace D_{DH} and D_{DHL} with M, the number of destinations a firm sells to (including the domestic market), whose coefficient is always positive and highly significant.

4.2 Panel Evidence

A robust implication of the model is that the elasticity of export intensity to product quality and productivity is increasing in per capita income of the foreign destinations. In Section 2, we have already documented a different pattern of correlations between high-income and low-income areas. We now exploit all the information in our dataset to test for a systematic relationship between the elasticity of export intensity with respect to productivity/quality and per capita income of the foreign destinations. To this purpose, we construct a panel of export intensities to each of the seven

[40] Although in the baseline model illustrated in the main text optimal product quality is market-specific, in an extension in the Appendix we show that, when firms sell the same product across destinations, optimal product quality is increasing in the number of markets a firm sells to.

destinations for which we have data and estimate the following regression:

$$\ln EXP_{fj} = \eta_f + \eta_{fi} + \beta_1 \ln X_j + \beta_2 (\ln X_j \times y_f) + u_{fj}, \tag{12}$$

where i indexes 3-digit industries, EXP_{fj} denotes firm j 's export intensity to destination f, η_f are destination fixed-effects, η_{fi} are destination-industry fixed effects, X is TFP or product quality, and y_f is relative per capita income of destination f.[41] Note that the term $\ln X_j \times y_f$ captures the impact of foreign income on the TFP (quality) elasticity of export intensity: the expected sign of β_2 is therefore positive. The results are reported in Table 8, using TFP measures in panel a) and product quality measures in panel b); standard errors are corrected for clustering at the firm level.

As for TFP measures, in columns (1)-(3) we estimate equation (12) without controls. As expected, the coefficient β_2 is always positive, large, and significant beyond the 1% level.[42] In columns (4)-(6), we add the interaction between firm j's TFP and the distance of destination f from Italy to proxy for trade costs.[43] As argued in the previous section, this term indirectly controls for the possible impact of FDI and per unit trade costs on the TFP elasticity of export intensity. Note that its coefficient is negative and precisely estimated, which is broadly consistent with the export-FDI tradeoff switching in favor of FDI in trade with distant countries, and/or with relevant per unit trade costs combined with a marginal cost à la Melitz (2003). More importantly, adding this term does not affect the sign and significance of the coefficient β_2, and therefore the impact of foreign income on the estimated elasticity.

Finally, in columns (7)-(9) we add the interaction between TFP and the number of countries within each destination.[44] This term controls for the fact that, as argued in the previous section, the elasticity of export intensity to productivity may be increasing in the number of countries within any destination when fixed costs of exporting are country-specific. The coefficient of this interaction term is however imprecisely estimated and the other results are unaffected.

In panel b), we report the results using our proxies for product quality. Provided that the

[41] We measure y_f using data on per capita GDP in PPP for the year 2003 from the World Development Indicators, and normalize it by Italy's per capita income.

[42] Note, also, that the coefficients β_1 and β_2 have roughly the same size and opposite sign, consistent with export intensity and TFP being essentially unrelated for $y_f = 1$, i.e., in trade with similar-income destinations.

[43] Distances are computed as the number of kilometers between Rome and the capital city of Italy's main trading partner within destination f. We use data from CEPII and normalize 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 (North America), Australia (Oceania), Poland (New EU Members), Brazil (Latin America), Tunisia (Africa), and China.

[44] This variable is constructed using information from the World Bank and normalized by the average number of countries across all destinations.

positive impact of foreign income on the estimated elasticities is mainly driven by firm heterogeneity in product quality, we expect, *a fortiori*, a positive sign of β_2 when using $Q_1 - Q_3$ instead of TFP. Crucially, the coefficient β_2 is positive and precisely estimated in all specifications.

4.3 Evidence on Individual Destinations

As a final step, in Table 9 we report the elasticities of export intensity with respect to TFP (to maximize degrees of freedom) obtained by estimating equation (1) for each of the seven destinations separately.[45] As for low-income destinations (Africa, China, Latin America and New EU Members), the elasticities are always negative, large, and quite precisely estimated despite the small samples. As for high-income destinations, the estimated elasticity is weakly positive for EU15, weakly negative for North America, and strongly negative for Oceania, the most distant destination from Italy.[46]

Next, we confront the elasticities estimated in Table 9 with those implied by the panel estimates in Table 8a to check whether differences in per capita income can help explain their pattern. In particular, for any destination f, the TFP elasticity of export intensity predicted on the basis of its relative income is equal to $\beta_1 + \beta_2 y_f$. The results are in column (2) of Table 10, whereas column (1) reports the elasticities estimated in Table 9 to help comparison. Results in both columns are based on the augmented Olley-Pakes TFP estimates. As for low-income destinations, predicted elasticities always match the sign of the estimated elasticities and account for 97% of their size on average. Predicted elasticities do instead a poor job of matching the sign and size of those estimated for high-income destinations (they account for only 21% of their size on average). Finally, in column (3) we report the elasticities predicted on the basis of foreign income and distance. Note that predicted elasticities now always match the sign of the estimated elasticities. More importantly, for low-income destinations the average match with estimated elasticities is virtually unaffected (predicted elasticities now account for 102% of their size on average), whereas the match improves substantially for high-income destinations, as predicted elasticities now account for 98% of estimated elasticities on average.

These results suggest that foreign income crucially affects the relationship between TFP and export intensity when it is substantially different from domestic income, and that other complemen-

[45] Note that these elasticities can be equivalently obtained as the coefficients β_{fTFP} from the following panel regression: $\ln EXP_{fj} = \eta_f + \eta_{fi} + \sum_f \beta_{fTFP}(\ln TFP_j \times DEST_f) + u_{fj}$, where the terms $\ln TFP_j \times DEST_f$ are interactions between firm j's TFP and the seven destination dummies ($DEST$).

[46] By comparing the elasticities estimated in Table 9 for individual destinations with those in Tables 2 and 3 for the aggregate of low-income and high-income destinations, note that the latter are substantially higher. As discussed in the theoretical section, this result is consistent with the extensive margin of countries increasing the correlation between export intensity and productivity when using more aggregated export data.

tary explanations, such as those related to trade costs, are instead required to account for firms' exports to similar destinations. These results are consistent with the proposed explanation, whereby the interplay between product quality and quality consumption crucially affects relative sales only across heterogenous markets.

5 Conclusion

In this paper, we have documented some new empirical regularities on firms' export behavior across heterogeneous destinations. In particular, using firm-level data for Italy, we have shown that revenue-TFP is negatively correlated with export intensity to low-income destinations, and that the correlation between export intensities and TFP is increasing in per capita income of the foreign destinations.

We have argued that these facts may arise from the interplay between firm heterogeneity in product quality and non-homothetic preferences with respect to quality. As in Johnson (2009), heterogeneity in product quality may endogenously arise from heterogeneity in productivity and fixed costs of quality upgrading, which jointly imply that high-productivity firms produce higher-quality goods. Non-homothetic preferences may lead, instead, to a higher relative demand for higher-quality products in high-income countries.

The proposed explanation nicely fits our stylized facts, and implies that the latter are mainly driven by a positive correlation between TFP and product quality. To test this implication, we have proposed a new strategy to proxy for product quality building on the received idea (e.g., Sutton, 1998) that quality differentiation is generally associated with the intensity of R&D and marketing activities and the managerial capability of a firm. We have therefore constructed several proxies for these variables and extracted their principal components through factor analysis, which we have then used as proxies for product quality.

We have shown that our proxies are strongly positively correlated with revenue-TFP, consistent with our TFP measures capturing product quality and with high-productivity firms producing higher-quality products. More importantly, we have shown that product quality is strongly negatively correlated with export intensity to low-income destinations and that the correlation between export intensities and product quality is strongly increasing in per capita income of the foreign destinations. Finally, we have shown that the relationship between TFP and export intensity is crucially affected by foreign income only when the latter is substantially different from the domestic income, whereas other variables, such as distance, are important to account for firms' relative sales across destinations with a similar income.

Our results bear some potentially relevant implications. In particular, they suggest that quality upgrading may be a prerequisite for effective access to richer countries' markets. Moreover, they 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 fixed costs of exporting and firm heterogeneity in product quality.

Although in recent years we have dramatically improved our understanding of firms' export behavior, there are still some unresolved issues. In particular, the determinants of the "popularity" of foreign destinations from the standpoint of domestic exporters are not yet fully understood (Eaton, Kortum and Kramarz, 2008). We hope that, by showing how export intensities 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 in general. Testing whether our results extend beyond Italian manufacturing is therefore a promising avenue for future research.

6 Appendix

6.1 TFP Estimation

In this section, we detail our strategy for estimating the TFP and illustrate the main results. The production function of firm j is:

$$Y_j = f(R_j) \cdot \omega_j, \tag{13}$$

where Y is revenue-based output, $R \in \{S, U, K, M\}$ is the vector of inputs (respectively, high-skill labor, low-skill labor, physical capital and materials), and ω is TFP. The stochastic Cobb-Douglas specification of equation (13) is:

$$\ln Y_j = \beta_0 + \beta_S \ln S_j + \beta_U \ln U_j + \beta_K \ln K_j + \beta_M \ln M_j + \ln \omega_j + \varepsilon_j, \tag{14}$$

where β_r ($r \in R$) is the elasticity of output with respect to input r and ε_j is a white-noise disturbance. The Cobb-Douglas specification is appealing due to its simple log-linear form, but imposes strong restrictions on the substitutability among inputs. Hence, we also estimate the following translog specification:

$$\ln Y_j = \beta_0 + \sum_{r \in R} \beta_r \cdot \ln r_j + 0.5 \cdot \sum_{r \in R} \sum_{z \in R} \beta_{rz} \cdot \ln r_j \cdot \ln z_j + \ln \omega_j + \varepsilon_j, \tag{15}$$

where the elasticity of output with respect to input r, λ_r, now equals:

$$\lambda_{rj} \equiv \frac{\partial \ln Y_j}{\partial \ln r_j} = \beta_r + \sum_{z \in R} \beta_{rz} \cdot \ln z_j. \tag{16}$$

The translog specification is more general than the Cobb-Douglas, but is also more demanding in terms of identifying variance and may exacerbate bias due to measurement error. The (log of) TFP is computed as $\ln Y_j - \sum_r \xi_r \cdot \ln r_j$, where ξ_r equals β_r for the Cobb-Douglas and λ_r for the translog.

As mentioned in the main text, we start by estimating (14) and (15) by OLS, using only cross-sectional variation in the year 2003. Then, we use different strategies to address attenuation and simultaneity biases.[47] In particular, we estimate (14) and (15) with and without a large set of controls, by using two different proxies for skill, and by using the Two-Stage Least Squares (2SLS) estimator.[48,49] Finally, we estimate equation (14) by using the semiparametric estimators proposed by Olley and Pakes (OP, 1996) and Levinsohn and Petrin (LP, 2003), which deal with the simultaneity bias in a more structural way than does the 2SLS estimator and perform reasonably well in the presence of measurement error (Van Biesebroeck, 2007).

The semiparametric estimators assume that TFP is a state variable in the dynamic optimization problem of the firm and that it follows a first-order Markow process. Profit maximization yields an investment demand function (in OP) and a materials demand function (in LP) that depend on TFP and the other state variable, capital. Under certain conditions, these functions are monotonically increasing in TFP, and can thus be inverted non-parametrically to express TFP in terms of observables.[50] Then, OLS yields unbiased estimates of the variable input elasticities (β_S and β_U in LP; β_S, β_U and β_M in OP). The remaining coefficients are estimated in a second stage by non-linear least squares. Standard errors are computed by bootstrap, using 100 replications in our case.[51]

[47] The two biases may point in opposite directions. See De Loecker (2008) and Van Biesebroeck (2007) on the practical relevance of this point in TFP estimation.

[48] Note that, in the presence of heteroskedasticity of unknown form in the error term, 2SLS estimates are consistent but inefficient. Therefore, we have also estimated (14) and (15) by Generalized Method of Moments (GMM). GMM estimates are efficient, but the efficiency gain may be offset by poorer performance in small samples. In practice, however, our GMM estimates (unreported to save space) are very similar to 2SLS estimates.

[49] We have also estimated (15) by combining it with the expression for the output share of labor, and by applying Iterated Three-Stage Least Squares on the resulting system of equations. System estimation is more efficient than single-equation estimation but, if the system is miss-specified, parameters may be biased and inference incorrect. Our system estimation results, reported in a previous version of this paper, are very similar to the single-equation 2SLS results.

[50] The `levpet` routine in Stata 10 (Petrin, Poi and Levinsohn, 2004), which we use to implement the LP estimator, employs a third-order polynomial in materials and capital as the non-parametric approximation. As for the OP estimator, we have programmed our own routine using a fourth-order polynomial in investment and capital (as in Amiti and Konings, 2007).

[51] The OP estimator can also correct for bias due to firm exit. Note, however, that all firms in our sample are observed over the entire sample period.

Despite the many similarities, the two estimators have some important differences that may affect their relative performance.[52] We thus use both approaches for robustness.

Lacking information on output prices at the firm level, we implement the semiparametric estimators by deflating output with producer price indexes for each 3-digit industry.[53] As noted by Klette and Griliches (1996), if firms have pricing power because they produce horizontally differentiated products, their prices deviate from the industry average and these deviations may be correlated with input choices (omitted price variable bias). Following Klette and Griliches (1996), we therefore augment the production function with the log of average output in the 3-digit industry to which a firm belongs (Q). For industry i, this variable is computed as the weighted sum of deflated revenues, with weights equal to firms' market shares.[54] As in De Loecker (2008), we implement the correction within the OP framework, because very restrictive assumptions are required in the LP case to preserve the invertibility of the materials demand function. The coefficient of average industry output, β_q, is identified in the first estimation stage and then used to compute the log of TFP as $(1/(1-\beta_q)) \cdot (\ln Y_j - \sum_r \beta_r \cdot \ln r_j - \beta_q \cdot \ln Q_i)$.

Results Table A1 reports cross-sectional Cobb-Douglas estimates in columns (1)-(4), cross-sectional translog estimates in columns (5)-(8), and semiparametric Cobb-Douglas panel estimates in columns (9)-(11). The table shows estimates of β_r in columns (1)-(4) and (9)-(10), of λ_r in columns (5)-(8), and of $\beta_r/(1-\beta_q)$ in column (11). Estimates of λ_r are evaluated at the sample mean with standard errors computed by the delta method.

In column (1), we estimate the Cobb-Douglas production function without controls. In columns (2)-(4), we add a large set of controls: a full set of dummies for Italian administrative regions and for 3-digit industries, the share of part-time workers in total employment, a dummy variable equal to 1 if a firm is quoted on the stock market, and a set of three dummy variables that control for ownership structure. In column (3), we use occupations instead of educational attainment to proxy for skill. In column (4), we report 2SLS estimates using inputs in the years 2001 and 2002 to instrument for their levels in 2003. In column (5), we estimate the translog production function without controls. In columns (6)-(8) we add controls, in column (7) use occupations instead of educational attainment to proxy for skill, and in column (8) use 2SLS. Finally, in columns (9)-

[52] In particular, the OP estimator requires discarding observations with zero investment flows (about 25% in our dataset), and this may bias parameter estimates and imply an efficiency loss relative to the LP estimator. The latter is however subject to more serious collinearity problems, which implies that identification of the labor coefficients is sensitive to the assumptions concerning the data generating process (Ackerberg, Caves and Frazer, 2006).

[53] Similarly, we deflate capital with a common price index for investment goods and materials with a common price deflator for intermediate inputs. All deflators are drawn from the Italian Statistical Office.

[54] This is motivated by the fact that the price index is a market share-weighted average of firms' prices.

(11) we report semiparametric estimates, using the same controls as before plus a full set of time dummies. Overall, the table seems to suggest that methodological choice and specification details have a relatively modest impact on most estimated elasticities.

Next, we relax the assumption of a common production function across manufacturing industries. We therefore estimate equation (14) separately for 2-digit industries by cross-sectional OLS, using the same specification as in column (2) of Table A1.[55] The results are in Table A2. Note that most elasticities are precisely estimated also at the 2-digit industry-level and that the point estimates are generally close to those reported in Table A1.

6.2 Robustness Checks on the Stylized Facts

In this section, we check the robustness of the negative correlation between export intensity to low-income destinations and TFP with respect to outliers, estimation method, sample size and specification.

6.2.1 Outliers

In Figure A1, we estimate equation (1) by quantile regressions. We report coefficients for the percentiles between the 5$^{\text{th}}$ and the 95$^{\text{th}}$ of the conditional distribution of EXP_l (dashed line), together with 90% confidence intervals (shaded area); for comparison, we also report OLS estimates (straight solid line). Note that the quantile regression coefficients are always negative, statistically significant (except for a few cases corresponding to low percentiles), and remarkably similar to OLS estimates, suggesting that the negative correlation between TFP and export intensity to low-income destinations holds across the entire conditional distribution of EXP_l, not just on average.

While quantile regressions are less sensitive than OLS to influential observations, in Table A3 we further account for outliers. In panels a) and b), we winsorize and trim, respectively, the distributions of both TFP and EXP_l at the 5$^{\text{th}}$ and 95$^{\text{th}}$ percentiles, and in panel c) we estimate equation (1) with an outlier-robust procedure.[56] In all cases, the results are similar to those reported in Table 2. Finally, in panel d) we regress EXP_l on two dummies for firms with intermediate and high levels of TFP.[57] Note that the estimated coefficients are always negative, statistically significant, and increasing in absolute value, confirming that EXP_l and TFP are inversely correlated in our

[55] Due to data constraints, we aggregate the smallest contiguous industries.

[56] As for winsorizing, we follow Angrist and Krueger (1999). As for the outlier-robust procedure, we use the `rreg` command in Stata with biweight tuning coefficient of 7.

[57] These dummies are constructed by splitting the TFP distribution in three bins of equal size. The reference group is given by firms with low TFP levels.

data.

6.2.2 Estimation Method

The results in the main text are based on the assumption that all 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 radically different technologies. To this purpose, we reestimate the TFP measures for these firms only, and then rerun equation (1) using the new estimates. The results are in panel a) of Table A4. Note that export intensity to low-income destinations is still strongly negatively correlated with TFP, and that the coefficients are precisely estimated and very similar in magnitude to those reported in Table 2.

So far, we have relied on a two-step approach, in which we first estimated TFP and then regressed EXP_l on it. An alternative strategy is to estimate the correlation between TFP and EXP_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 EXP_l as an explanatory variable in a regression for log output using a Cobb-Douglas specification. The results are in panel b), column (4). Note that the coefficient of EXP_l is negative and very precisely estimated, and the point estimate is essentially identical to the one obtained by regressing TFP on EXP_l and 3-digit industry dummies (unreported to save space). In column (5), we repeat the exercise by interacting each input with 3-digit industry dummies, thereby further relaxing the assumption of equal technologies across industries. The results are virtually unchanged, suggesting that one-step and two-step approaches yield very similar results. Hence, in panel c) we revert to the two-step approach and allow for fully flexible (i.e., firm-specific) technologies by using a Tornqvist index of TFP constructed as $(\ln Y_j - \overline{\ln Y}) - 0.5 * \left[\sum_{r\in\{L,M,K\}}(sh_{rj} + \overline{sh_r}) * (\ln r_j - \overline{\ln r})\right]$, where Y denotes output, sh_r is the cost share of input r (i.e., labor, L, materials, M, and capital, K), and a bar over a variable denotes its sample average (Aw, Chen and Roberts, 2001).[58] Importantly, the coefficient of the TFP index is negative, significant at the 1% level, and very similar to the coefficients obtained in Table 2 using estimated TFP measures.[59]

[58] We use overall labor because we do not observe separate wages for high- and low-skill workers.

[59] Note 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 cannot accomodate measurement error and builds on strong assumptions, in particular, that markets are perfectly competitive.

6.2.3 Sample Size

We now show how our stylized fact depends on sample size. The results are in Table A5, with EXP_l in levels rather than in logs. In panel a), we use the benchmark sample including all exporters to low-income destinations (i.e., the sample used so far); in panel b), we include only firms exporting to both high-income and low-income destinations;[60] in panel c) we include all exporters and, finally, in panel d) we include all firms (i.e., also non-exporters). Strikingly, the negative correlation between EXP_l and TFP holds independent of sample size. However, it is weaker when including non-exporters, which is consistent with these firms being less productive.

6.2.4 Specification

We now show that our stylized fact is unlikely to be driven by omitted variables correlated with TFP and export intensity to low-income destinations. The results are in Table A6. We start, in panel a), by adding to the baseline regression the same battery of controls used in Tables A1-A2 to estimate the production function parameters and find that the results are now even stronger. In panel b), we control for (the log of) export intensity to high-income destinations (EXP_h), which does not affect the main results. In panel c), we include proxies 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 ($INSH$).[61] Note that EXP_l is (weakly) negatively correlated with FDI, suggesting that exports and foreign investment are substitutes in our data. Moreover, EXP_l is negatively correlated with material offshoring and positively correlated with inshoring and service offshoring. Our coefficient of interest is however unaffected.

As mentioned in the text, revenue-based measures of TFP may also capture price differences stemming from heterogeneity in demand shocks or pricing behavior across markets (Demidova, Looi Kee and Krishna, 2006). For instance, if ceteris paribus exporters systematically charge lower prices in low-income destinations, their TFP may be underestimated and its negative correlation with export intensity may be overstated. To address this issue, in panel d) we add to our baseline specification a full set of export market dummies, each taking a value of 1 for firms exporting to a given destination.[62] These dummies should help control for price differences across markets that are constant across firms (see also De Loecker, 2007, on this point). While these dummies

[60] This is equivalent to excluding roughly 100 firms exporting to low-income destinations only.

[61] FDI is the ratio of investment over total sales between 2001-2003. $IMPINT$ is the share of imported inputs in total input purchases in 2003. $SERV$ is a dummy equal to 1 if a firm purchased services from abroad in the year 2003. $INSH$ is the share of sales arising from productions subcontracted by foreign firms in 2003.

[62] Recall that we observe exports to four low-income and three high-income destinations.

are jointly significant, the main results are unchanged. In panel e), we add a full set of interaction terms between the export market dummies and 3-digit industry dummies to allow for the possibility that price differences across markets are industry-specific. This specification now includes roughly seven hundreds variables, with a dramatic loss of degrees of freedom. Strikingly, however, export intensity to low-income destinations is still strongly negatively correlated with TFP (all coefficients are negative and significant at the 5% level).[63]

6.3 Extending the Baseline Model

In this Appendix, we extend the basic setup to allow for: a) multiproduct firms and the extensive margin of products (Bernard, Redding and Schott, 2006); b) country-specific fixed costs of exporting and the extensive margin of countries (Eaton, Kortum and Kramarz, 2004); c) endogenous fixed costs of entry and the extensive margin of consumers (Arkolakis, 2008); d) endogenous export versus FDI decisions (Helpman, Melitz and Yeaple, 2004); e) per unit trade costs (Hummels and Skiba, 2004).

6.3.1 Multiproduct Firms

Consider a continuum of product lines, indexed by $i \in [0, 1]$. Product lines are symmetric, hence we can write $M_{zi} = \frac{1}{\sigma} R_{zi} \left(\frac{P_{zi}}{\tau_{zi}} \rho \right)^{\sigma - 1} = M_z$, implying that optimal product quality equals $\lambda^*_{zi} = \lambda^*_z = \left[\alpha(y_z) M_z \theta^{\sigma-1} \right]^{\frac{1}{\eta - \alpha(y_z)}}$. The only source of heterogeneity across products is in the exogenous fixed cost of entry, which we assume to equal ϕ_z / i. This captures in a parsimonious way the assumption that profitability varies across product lines.

The borderline product sold by a θ-firm in market z, i_z, is pinned down by the equality between operating profits generated by product i and the fixed cost ϕ_z / i:

$$M_z \theta^{\sigma-1} \left[\alpha(y_z) M_z \theta^{\sigma-1} \right]^{\frac{\alpha(y_z)}{\eta - \alpha(y_z)}} - \frac{1}{\eta} \left[\alpha(y_z) M_z \theta^{\sigma-1} \right]^{\frac{\eta}{\eta - \alpha(y_z)}} = \phi_z / i,$$

which yields: $i_z = \phi_z \left(M_z \theta^{\sigma-1} \right)^{-\frac{\eta}{\eta - \alpha(y_z)}} \left(\left[\alpha(y_z) \right]^{\frac{\alpha(y_z)}{\eta - \alpha(y_z)}} - \frac{1}{\eta} \alpha(y_z)^{\frac{\eta}{\eta - \alpha(y_z)}} \right)^{-1}$. The range of products sold in a market z, $(1 - i_z)$, is therefore increasing in productivity. Its elasticity with respect to θ,

[63] Demidova, Looi Kee and Krishna (2006) suggests to account for market-specific demand shocks by augmenting the polynomial (non-parametric) approximation for TFP in the OP estimator with export shares to different destinations. Because we observe exports only in one year, implementing this approach would require assuming that export shares remained constant over the sample period, which would not guarantee the invertibility of the policy functions in the OP estimator (see Van Biesebroeck, 2005, for a discussion of the invertibility conditions in a similar setting). Yet, we have experimented with this approach under such an assumption and found no change in the results.

which captures the extensive margin of products, is:

$$\frac{d\ln(1-i_z)}{d\ln\theta} = (\sigma-1)\left(\frac{\alpha(y_z)}{\eta-\alpha(y_z)}\right). \tag{17}$$

The ratio of exports to domestic sales is:

$$\frac{r_f}{r_d} = \frac{\int_{i_f}^{1} M_{f,i}\lambda_{fi}^{*}di}{\int_{i_d}^{1} M_{d,i}\lambda_{di}^{*}di} = \frac{(1-i_f)M_f}{(1-i_d)M_d}\frac{\left[\alpha(y_f)M_f\theta^{\sigma-1}\right]^{\frac{\alpha(y_f)}{\eta-\alpha(y_f)}}di}{\left[\alpha(y_d)M_d\theta^{\sigma-1}\right]^{\frac{\alpha(y_d)}{\eta-\alpha(y_d)}}di}. \tag{18}$$

Taking the log of (18), differentiating and using (17) yields:

$$\frac{d\ln(r_f/r_d)}{d\ln\theta} = 2(\sigma-1)\left(\frac{\alpha(y_f)}{\eta-\alpha(y_f)} - \frac{\alpha(y_d)}{\eta-\alpha(y_d)}\right). \tag{19}$$

By comparing (19) and (10), note that, as mentioned in the main text, the extensive margin of products strengthens the negative relationship between productivity and export intensity to low-income destinations and, more generally, increases the sensitivity of this elasticity to per capita income differences across destinations.

6.3.2 *Country-Specific Fixed Costs of Exporting*

Consider a foreign destination f consisting of a continuum of countries, indexed by $s \in [0,1]$, homogeneous in terms of per capita income y_f but heterogeneous in terms of size. Assume that exporting to each of these countries involves a fixed cost ϕ_f. Denoting by M_B the market size of the biggest of these countries, the size of country s can be written as $M_s = sM_B$, where s also denotes its relative size.

We still assume, as in the baseline model, that optimal product quality is destination-specific (rather than country-specific within any destination). In this case, conditional on exporting to destination f, the exporting cutoff to country s is:

$$\theta_s^{\sigma-1} = \frac{\phi_f}{\lambda_f^{*\alpha(y_f)}sM_B} = \frac{\theta_B^{\sigma-1}}{s}, \tag{20}$$

where θ_B is the exporting cutoff to the biggest country within destination f. Note that θ_s is inversely related to s, and that all firms with productivity $\theta > \theta_B$ can break into a positive measure of countries. For instance, a firm with productivity θ_s can export to those countries whose relative size is in the range $[s,1]$. Aggregating across countries within destination f, the overall export revenue of a θ_s-firm is:

$$r_f(\theta_s) = \sigma M_B \theta_s^{\sigma-1} \lambda_f^{*\alpha(y_f)} \int_s^1 S g(S) dS, \tag{21}$$

where $g(\cdot)$ is the pdf of relative country size within destination f. Assuming, for simplicity, that g is uniform in $[0,1]$, we have:

$$\int_s^1 S g(S) dS = \frac{1}{2}\left(1 - s^2\right) = \frac{1}{2}\left[1 - \left(\frac{\theta_B}{\theta_s}\right)^{2(\sigma-1)}\right], \tag{22}$$

where the latter equality follows from equation (20). Equation (22) gives the proportion of total market size of destination f reached by a θ_s-firm. This term captures the extensive margin of countries: it is increasing (and concave) in θ_s, because more productive firms can break into a larger measure of countries.[64]

Using (22) into (21), the ratio of total exports to destination f over domestic sales for a θ_s-firm can be written as:

$$\frac{r_f}{r_d} = \frac{1}{2}\frac{M_B}{M_d}\left[1 - \left(\frac{\theta_B}{\theta_s}\right)^{2(\sigma-1)}\right]\frac{\lambda_f^{*\alpha(y_f)}}{\lambda_d^{*\alpha(y_d)}}, \tag{23}$$

where λ_f^* and λ_d^* are given by:

$$\begin{aligned} \lambda_f^* &= \left[\alpha(y_f) M_B \theta_s^{\sigma-1} \frac{1}{2}\left(1 - \left(\frac{\theta_B}{\theta_s}\right)^{2(\sigma-1)}\right)\right]^{\frac{1}{\eta-\alpha(y_f)}}, \\ \lambda_d^* &= \left[\alpha(y_d) M_d \theta^{\sigma-1}\right]^{\frac{1}{\eta-\alpha(y_d)}}. \end{aligned} \tag{24}$$

Using (24) into (23), taking logs and differentiating yields:

$$\frac{d\ln(r_f/r_d)}{d\ln\theta_s} = (\sigma-1)\left[\overbrace{\underbrace{\frac{2\left(\frac{\theta_B}{\theta_s}\right)^{2(\sigma-1)}}{1-\left(\frac{\theta_B}{\theta_s}\right)^{2(\sigma-1)}}}_{\text{direct impact}}}^{\text{country extensive margin}} + \overbrace{\frac{\alpha(y_f)}{\eta-\alpha(y_f)}\left(1 + \underbrace{\frac{2\left(\frac{\theta_B}{\theta_s}\right)^{2(\sigma-1)}}{1-\left(\frac{\theta_B}{\theta_s}\right)^{2(\sigma-1)}}}_{\text{indirect impact}}\right) - \frac{\alpha(y_d)}{\eta-\alpha(y_d)}}^{\text{intensive margin}}\right]. \tag{25}$$

By comparing (25) and (10), note that the extensive margin of countries has both a direct and an

[64] The term is concave in θ_s because, although more productive firms can sell to more countries, these additional countries are smaller and hence add less and less to export revenue.

indirect positive impact on the elasticity of r_f/r_d to θ_s. The intuition is that more productive firms can break into a larger number of countries within a particular destination, which directly increases their export intensity. Moreover, a larger market incentivates quality upgrading, which further increases export intensity. Hence, as mentioned in Section 3.2, the extensive margin of countries weakens the negative correlation between productivity and export intensity to low-income destinations, but does not change the general conclusion that the correlation between export intensity and productivity is increasing in per capita income of the foreign destinations.

6.3.3 Endogenous Fixed Costs of Entry

We now show how the results are affected in the presence of endogenous fixed costs of entry (so far assumed equal to ϕ_z and uniform across firms). In particular, following Arkolakis (2008), we assume that the marginal cost of reaching an additional consumer in market z is $\frac{\phi_z}{(1-n_z)^\beta}$, where $\beta > 0$ and n_z is the share of the total population, L_z, reached by a firm. Total sales in market z now equal $n_z L_z$ times sales per consumer:

$$r_z = n_z L_z y_z \left(\frac{\rho P_z}{\tau_z} \right)^{\sigma-1} \lambda_z^{*\alpha(y_z)} = n_z \theta^{\sigma-1} \sigma M_z \lambda^{*\alpha(y_z)}, \tag{26}$$

which implies that optimal product quality for market z, λ_z^*, is now increasing in n_z:

$$\lambda_z^* = \left[\alpha(y_z) n_z M_z \theta^{\sigma-1} \right]^{\frac{1}{\eta-\alpha(y_z)}}. \tag{27}$$

The optimal n_z is determined by equating the marginal cost of market penetration to operating profits per consumer:

$$\frac{\phi_z}{(1-n_z)^\beta} = n_z \theta^{\sigma-1} \frac{M_z}{L_z} \lambda^{*\alpha(y_z)}, \tag{28}$$

where both are increasing in n_z. The second-order condition for a maximum requires that $\frac{\beta}{(1-n_z)} > \frac{\alpha(y_z)}{\eta-\alpha(y_z)}$, a sufficient condition being $\beta > \frac{\alpha(y_z)}{\eta-\alpha(y_z)}$ for $z \in \{d, f\}$. Using (27) into (28) and applying the implicit function theorem yields:

$$\frac{d \ln n_z}{d \ln \theta} = (\sigma - 1) \frac{\frac{\eta}{\eta-\alpha(y_z)}}{\frac{\beta}{(1-n_z)} - \frac{\alpha(y_z)}{\eta-\alpha(y_z)}} > 0. \tag{29}$$

Optimal market penetration is therefore increasing in θ. This captures Arkolakis' (2008) extensive margin of consumers, whereby more productive firms enjoy higher sales per consumer and can therefore afford higher market penetration costs, thereby reaching a larger number of consumers in each destination. From (26), the ratio of exports to domestic sales is: $\frac{r_f}{r_d} = \frac{n_f}{n_d}\frac{M_f \lambda^{*\alpha(y_f)}}{M_d \lambda^{*\alpha(y_d)}}$. Taking logs, differentiating and using (27) and (29) finally yields:

$$\frac{d\ln(r_f/r_d)}{d\ln\theta} = (\sigma-1)\left(\frac{\alpha(y_f)}{\eta-\alpha(y_f)} - \frac{\alpha(y_d)}{\eta-\alpha(y_d)}\right) + \underbrace{\left(\frac{\eta}{\eta-\alpha(y_f)}\right)\frac{d\ln(n_f)}{d\ln\theta} - \left(\frac{\eta}{\eta-\alpha(y_d)}\right)\frac{d\ln(n_d)}{d\ln\theta}}_{\text{extensive margin of consumers}}. \tag{30}$$

Note, from (30) and (29), that for $\beta/(1-n_z) \simeq \beta$ (a reasonable approximation when, as in our data, firms are small relative to the size of the markets they sell to), the extensive margin of consumers strengthens the negative correlation between productivity and export intensity to lower-income destinations and, more generally, the positive dependence of this correlation on foreign per capita income.[65]

6.3.4 Export Versus FDI

Assume that domestic firms can serve the foreign destination f through either exports or a horizontal FDI. The latter involves a fixed cost $\phi_{fI} > \phi_f$, but no variable trade costs ($\tau_{fI} = 1 < \tau_f$). Denoting by π_f and π_{fI}, respectively, profits from exporting versus going multinational, we can write:[66]

$$\pi_f = \theta^{\sigma-1} M_f \lambda_f^{*\alpha(y_f)} - \frac{1}{\eta}\lambda_f^{*\eta} - \phi_f, \quad \pi_{fI} = \theta^{\sigma-1} M_f \tau_f^{\sigma-1} \lambda_{fI}^{*\alpha(y_f)} - \frac{1}{\eta}\lambda_{fI}^{*\eta} - \phi_{fI},$$

where $\lambda_f^* = \left[\alpha(y_f) M_f \theta^{\sigma-1}\right]^{\frac{1}{\eta-\alpha(y_f)}}$, as before, and $\lambda_{fI}^* = \left[\alpha(y_f) M_f \tau_f^{\sigma-1}\theta^{\sigma-1}\right]^{\frac{1}{\eta-\alpha(y_f)}} = \lambda_f^* \tau_f^{\frac{\sigma-1}{\eta-\alpha(y_f)}}$ is the optimal product quality chosen by a multinational firm. An FDI is more profitable than exports if $\pi_{fI} > \pi_f$, which implies the following productivity cutoff, θ_{fI}, for multinational firms:

$$\theta_{fI}^{\sigma-1} = \frac{1}{\alpha(y_f) M_f}\left[\frac{(\phi_{fI} - \phi_f)}{\frac{1}{\alpha(y_f)}\left(\tau_f^{\frac{\alpha(y_f)(\sigma-1)}{\eta-\alpha(y_f)}} - 1\right) - \frac{1}{\eta}\left(\tau_f^{\frac{(\sigma-1)\eta}{\eta-\alpha(y_f)}} - 1\right)}\right]^{\frac{\eta-\alpha(y_f)}{\eta}}. \tag{31}$$

[65] For n_z large, the impact of the extensive margin of consumers is instead ambiguous. The reason is that in this case, although more productive firms enjoy relatively higher sales per consumers in high-income countries, they may also bear disproportionately higher marginal market penetration costs once they reach a substantial share of the population. As mentioned earlier, this latter case is unlikely to be most relevant in our data.

[66] Recall that $M_f = \frac{1}{\sigma} R_f \left(\frac{P_f}{\tau_f}\rho\right)^{\sigma-1}$, which implies that the effective size of the foreign market in the case of an FDI is $M_f\ \tau_f^{\sigma-1}$.

Hence, the FDI option is more likely the lower is $\phi_{fI} - \phi_f$ and the higher is τ_f (recall that $\alpha(y_f) < \eta$). How does this affect the relationship between r_f/r_d and θ? When exports and FDI are perfect substitutes, so that r_f/r_d drops to zero for $\theta > \theta_{fI}$, the relationship is unaffected, conditional on exporting. More generally, when FDI and exports are imperfect substitutes (i.e., FDI reduces but does not drive exports to zero), FDI may induce a negative correlation, also conditional on exporting, between productivity and export intensity, as it reduces the export intensity of more productive firms. This effect may be stronger in trade with distant countries, as the FDI option is more likely for higher trade costs.

6.3.5 Per Unit Trade Costs

Following Hummels and Skiba (2004), we now assume that exporting involves a per unit component $t_f > 0$ in addition to a per value component $\tau_f > 1$. Moreover, we relax the assumption that marginal cost is independent of product quality. In particular, following Johnson (2009), we assume that marginal cost equals $\frac{\lambda_z^{*\delta}}{\theta}$, where $\delta > 0$ is the elasticity of marginal cost to product quality.[67] Finally, to isolate the effect of per unit trade costs, we assume that the foreign country is identical to the domestic country and, for simplicity, we ignore the indirect impact of per unit trade costs through optimal product quality.[68]

Under these assumptions, the profit maximizing price charged by a θ-firm to destination f is $p_f = \frac{1}{\rho}\left(\tau_f \frac{\lambda_f^{*\delta}}{\theta} + t_f\right)$, and export revenue is $r_f = \left(\tau_f \lambda_f^{*\delta} + \theta t_f\right)^{1-\sigma} \theta^{\sigma-1} M_f \lambda_f^{*\alpha(y_f)}$. Moreover, it is straightforward to show that $\lambda_f^* = \lambda_d^* = \left[\left(\alpha(y_f) - \delta(\sigma-1)\right) M_f \theta^{\sigma-1}\right]^{\frac{1}{\eta - \alpha(y_f) + \delta(\sigma-1)}}$, where $\eta - \alpha(y_f) + \delta(\sigma - 1) > 0$ by the second-order condition for optimum product quality. Using λ_f^* into r_f, computing the log of r_f/r_d and differentiating yields:

$$\frac{d \ln r_f/r_d}{d \ln \theta} = (\xi - 1)\,\frac{(\sigma-1)\theta t_f}{\tau_f \lambda_f^{*\delta} + \theta t_f},$$

where $\xi = \frac{\delta(\sigma-1)}{\eta - \alpha(y_f) + \delta(\sigma-1)} > 0$ is the elasticity of marginal cost to productivity and its size crucially affect the relationship between export intensity and productivity. In particular, for $\xi < 1$, marginal cost is decreasing in productivity (as assumed so far) and r_f/r_d is inversely related to θ also in trade

[67] Marginal cost may be increasing in product quality if, for instance, higher-quality products require higher-quality inputs, see, e.g., Verhoogen (2008) and Kugler and Verhoogen (2008). This formulation implies that, due to the positive relationship between product quality and productivity, the relationship between marginal cost and θ is now ambiguous.

[68] We ignore the impact of per unit trade costs on optimal product quality as this would prevent us from obtaining a closed-form solution for λ_f^*. However, this indirect effect of per unit trade costs points in the same direction as the direct effect, and would therefore strengthen the results shown below.

with similar countries. The reason is that in this case per unit trade costs represent a higher share of marginal cost for high-productivity firms, and hence have a stronger negative impact on their export intensity. Moreover, export intensity is decreasing in per unit trade costs, which are strongly increasing in distance, according to Hummels and Skiba (2004). For $\xi > 1$, however, marginal cost is increasing in productivity and the above implications are reversed. In this case, the elasticity of export intensity to productivity is ceteris paribus positive and increasing in distance, as per unit trade costs now represent a lower share of marginal cost for high-productivity firms.

6.4 Uniform Product Quality Across Markets

Finally, we show how our results are affected when firms choose a uniform product quality across the destinations they sell to. In this case, they choose product quality as to maximize overall profits, and therefore solve the following problem:

$$\max_{\lambda} \left\{ \sum_{z \in \{d,h,l\}} \left[I_z M_z \theta^{\sigma-1} \lambda^{\alpha(y_z)} - \phi_z \right] - \frac{1}{\eta} \lambda^{\eta} \right\}, \tag{32}$$

where I_z is an indicator variable equal to one if a firm is present in market z (i.e., $I_z = 1$ for $\theta > \theta_z$). In our data (as in most other data) not all firms export, and virtually all firms exporting to low-income destinations also export to high-income destinations, suggesting that $\theta_l > \theta_h > \theta_d$. The first-order condition for this problem can be written as:

$$\theta^{\sigma-1} \sum_{z \in \{d,h,l\}} I_z M_z \alpha(y_z) \lambda^{\alpha(y_z)} = \lambda^{\eta}, \tag{33}$$

where both the LHS and the RHS are increasing in λ and, by the second-order condition for a maximum, the RHS is steeper than the LHS.[69] Note, first, that a higher value of θ shifts the LHS upwards, implying a higher equilibrium value of λ for given I_z. Second, starting from $I_d = 1$,

[69] By differentiating the first-order condition with respect to λ we obtain:

$$\begin{aligned} & \frac{\partial}{\partial \lambda} \left[\theta^{\sigma-1} \sum_{z \in \{d,h,l\}} I_z M_z \alpha(y_z) \lambda^{\alpha(y_z)} - \lambda^{\eta} \right] \\ = \; & \frac{1}{\lambda} \left[\theta^{\sigma-1} \sum_{z \in \{d,h,l\}} \left[I_z M_z \alpha(y_z)(\alpha(y_z)-1) \lambda^{\alpha(y_z)} \right] - (\eta - 1)\, \lambda^{\eta} \right] \\ = \; & \frac{1}{\lambda} \left[\theta^{\sigma-1} \sum_{z \in \{d,h,l\}} I_z M_z \left[\alpha(y_z) - \eta \right] \alpha(y_z) \lambda^{\alpha(y_z)} \right], \end{aligned}$$

where the latter equality follows from the first-order condition. By inspection, a sufficient condition for this expression to be negative is $\eta > \max_z \alpha(y_z)$.

$I_h = I_l = 0$, the LHS shifts upwards for $I_h = 1$ and for $I_h = I_l = 1$, implying that firms exporting to a larger number of markets choose a higher value of λ. Moreover, for $\theta_l > \theta_h > \theta_d$, the latter firms are more productive. We therefore conclude that, as in the baseline model in the main text, high-θ firms produce higher-quality products. In particular, they sell more in each destination (intensive margin) and can break into a larger number of markets (extensive margin), hence they can spread the higher fixed costs of quality upgrading over a greater revenue. By applying the implicit function theorem to equation (33), we can write a general expression for the elasticity of product quality to productivity:

$$\frac{d\ln\lambda}{d\ln\theta} = \epsilon = \frac{(\sigma-1)\sum\limits_{z\in\{d,h,l\}} I_z M_z \alpha(y_z)\lambda^{\alpha(y_z)}}{\sum\limits_{z\in\{d,h,l\}} I_z M_z \alpha(y_z)\left[\eta-\alpha(y_z)\right]\lambda^{\alpha(y_z)}} > 0,$$

where the latter inequality follows directly from the second-order condition for optimal product quality.[70] Finally, using (5) we have:

$$\frac{d\ln(r_f/r_d)}{d\ln\theta} = \frac{d\ln(r_f/r_d)}{d\ln\lambda}\frac{d\ln\lambda}{d\ln\theta} = \epsilon\left[\alpha(y_f)-\alpha(y_d)\right]. \tag{34}$$

By comparing (34) and (10), note that the qualitative results are unchanged.

References

[1] Ackerberg, D., C. L. Benkard, S. Berry and A. Pakes, 2007, "Econometric Tools for Analyzing Market Outcomes," in J. J. Heckman and E. E. Leamer, eds., *Handbook of Econometrics*, 6(1), pp. 4171-4276

[2] Ackerberg, D., K. Caves and G. Frazer, 2006, “Structural Identification of Production Functions," *Mimeo*, University of California Los Angeles

[3] Alcalà, F., 2007, "Product Quality and Trade," *Mimeo*, University of Murcia

[4] Alcalà, F., 2009, "Time, Quality and Growth," *Working Paper* 07, Departamento de Fundamentos del Análisis Económico, University of Murcia

[5] Amiti, M. and J. Konings, 2007, "Trade Liberalization, Intermediate Inputs, and Productivity: Evidence from Indonesia," *The American Economic Review*, 97(5), pp. 1611-1638

[70] Note that $\epsilon = \frac{\sigma-1}{\eta-\alpha(y_d)}$ for non-exporting firms and for firms exporting only to high-income destinations when $y_d = y_h$. For firms exporting also to low-income destinations, $\epsilon \to \frac{\sigma-1}{\eta-\alpha(y_d)}$ from below for $\lambda \to \infty$ and $y_d = y_h$. More generally, for $y_h > y_d$, ϵ is increasing in the relative size and per capita income of the high-income destination, with $\epsilon \to \frac{\sigma-1}{\eta-\alpha(y_h)}$ for $\frac{M_h}{M_d+M_h+M_l} \to 1$.

[6] Angelini, P. and A. Generale, 2008, "On the Evolution of Firm Size Distributions," *The American Economic Review*, 98(1), pp. 426-438

[7] Angrist, J. D. and B. Krueger, 1999, "Empirical Strategies in Labor Economics," in O. C. Ashenfelter and D. Card (eds.), *Handbook of Labor Economics*, pp 1277-1366, Elsevier Science

[8] Arkolakis, K., 2008, "Market Penetration Costs and the New Consumers Margin in International Trade," *NBER Working Paper* 14214

[9] Aw, B. Y., X. Chen and M. J. Roberts, 2001, "Firm-Level Evidence on Productivity Differentials and Turnover in Taiwanese Manufacturing," *Journal of Development Economics*, 66(1), pp. 51-86

[10] Baldwin, R. E. and J. Harrigan, 2007, "Zeros, Quality and Space: Trade Theory and Trade Evidence," *NBER Working Paper* 13214

[11] Benfratello, L., F. Schiantarelli and A. Sembenelli, 2009, "Banks and Innovation: Microeconometric Evidence on Italian Firms," *Journal of Financial Economics*, 90(2), pp. 197-217

[12] Bernard, A. B., J. Eaton, J. B. Jensen and S. Kortum, 2003, "Plants and Productivity in International Trade," *The American Economic Review*, 93(4), pp. 1268–1290

[13] Bernard, A. B. and J. B. Jensen, 1995, "Exporters, Jobs, and Wages in U.S. Manufacturing: 1976–1987," *Brookings Papers on Economic Activity: Microeconomics*, pp. 67–119

[14] Bernard, A. B. and J. B. Jensen, 1999, "Exceptional Exporter Performance: Cause, Effect or Both?," *Journal of International Economics*, 47(1), pp. 1-25

[15] Bernard, A. B., J. B. Jensen, S. J. Redding and P. Schott, 2007, "Firms in International Trade," *The Journal of Economic Perspectives*, 21(3), pp. 105-130

[16] Bernard, A. B., S. J. Redding and P. Schott, 2006, "Multi-Product Firms and Trade Liberalization," *NBER Working Paper* 12782

[17] Bernard, A. B., S. J. Redding and P. Schott, 2007, "Comparative Advantage and Heterogeneous Firms," *The Review of Economic Studies*, 74(1), pp. 31-66

[18] Bils, M. and P. Klenow, 2001, "Quantifying Quality Growth," *The American Economic Review*, 91(4), pp. 1006-1030.

[19] Brooks, E. L., 2006, "Why Don't Firms Export More? Product Quality and Colombian Plants," *Journal of Development Economics*, 80(1), pp. 160-178

[20] Bustos, P., 2010, "Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinean Firms," *The American Economic Review*, forthcoming

[21] Castellani, D., 2002, "Export Behavior and Productivity Growth: Evidence from Italian Manufacturing Firms," *Weltwirtschaftliches Archiv/Review of World Economics*, 138(4), pp. 605–628

[22] Castellani, D., F. Serti and C. Tomasi, 2010, "Firms in International Trade: Importers' and Exporters' Heterogeneity in the Italian Manufacturing Industry," *The World Economy*, 33(3), pp. 424-457

[23] Castellani, D. and A. Zanfei, 2007, "Internationalisation, Innovation and Productivity: How Do Firms Differ in Italy?," *The World Economy*, 30(1), pp. 156-176

[24] Choi, Y. C., D. Hummels and C. Xiang, 2009, "Explaining Import Quality: The Role of the Income Distribution," *Journal of International Economics*, 77(2), pp. 265-275

[25] De Loecker, J., 2007, "Do Exports Generate Higher Productivity? Evidence from Slovenia," *Journal of International Economics*, 73(1), pp. 69-98

[26] De Loecker, J., 2008, "Product Differentiation, Multi-Product Firms and Estimating the Impact of Trade Liberalization on Productivity," *Mimeo*, Princeton University

[27] Demidova, S., H. Looi Kee and K. Krishna, 2006, "Do Trade Policy Differences Induce Sorting? Theory and Evidence from Bangladeshi Apparel Exporters," *NBER Working Paper* 12725

[28] Dinopoulos, E. and B. Unel, 2009, "Quality Heterogeneity and Global Economic Growth," *Mimeo*, University of Florida

[29] Eaton, J., S. Kortum and F. Kramarz, 2004, "Dissecting Trade: Firms, Industries, and Export Destinations," *The American Economic Review: Papers and Proceedings*, 94(2), pp. 150-154

[30] Eaton, J., S. Kortum and F. Kramarz, 2008, "An Anatomy of International Trade: Evidence from French Firms," *NBER Working Paper* 14610

[31] Fajgelbaum, P., G. Grossman, and E. Helpman, 2009, "Income Distribution, Product Quality, and International Trade," *NBER Working Paper* 15329

[32] Falvey, R. and H. Kierzkowski, 1987, "Product Quality, Intra-Industry Trade and (Im)perfect Competition," in H. Kierzkowski, ed., *Protection and Competition in International Trade*, Basil Blackwell, Oxford

[33] Flam, H. and E. Helpman, 1987, "Vertical Product Differentiation and North–South Trade," *The American Economic Review*, 77(5), pp. 810–822

[34] Foster, L., J. Haltiwanger and C. Syverson, 2008, "Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability?," *The American Economic Review*, 98(1), pp. 394-425

[35] Hallak, J. C., 2006, "Product Quality and the Direction of Trade," *Journal of International Economics*, 68(1), pp. 238–265

[36] Hallak, J. C., 2008, "A Product-Quality View of the Linder Hypothesis," *The Review of Economics and Statistics*, forthcoming

[37] Hallak, J. C. and P. K. Schott, 2008, "Estimating Cross-Country Differences in Product Quality," *NBER Working Paper* 13807

[38] Hallak, J. C. and J. Sivadasan, 2008, "Productivity, Quality and Exporting Behavior under Minimum Quality Requirements," *Mimeo*, Universidad de San Andrés

[39] Hellerstein, J. K., D. Neumark and K. R. Troske, 1999, "Wages, Productivity, and Worker Characteristics: Evidence from Plant-Level Production Functions and Wage Equations," *Journal of Labor Economics*, 17(3), pp. 409-446

[40] Helpman, E., 2006, "Trade, FDI, and the Organization of Firms," *Journal of Economic Literature*, 44(4), pp. 580-630

[41] Helpman, E., M. J. Melitz and S. R. Yeaple, 2004, "Export Versus FDI with Heterogeneous Firms," *The American Economic Review*, 94(1), pp. 300-316

[42] Hummels, D. and P. Klenow, 2005, "The Variety and Quality of a Nation's Exports," *The American Economic Review*, 95(3), pp. 704-723

[43] Hummels, D. and A. Skiba, 2004, "Shipping the Good Apples Out? An Empirical Confirmation of the Alchian-Allen Conjecture,"*Journal of Political Economy*, 112(6), pp. 1384-1402

[44] Hunter, L., 1991, "The Contribution of Non-Homothetic Preferences to Trade," *Journal of International Economics*, 30(3-4), pp. 345–358

[45] Johnson, R. C., 2009, "Trade and Prices with Heterogeneous Firms," *Mimeo*, Dartmouth College

[46] Katayama, H., S. Lu and J. Tybout, 2009, "Firm-Level Productivity Studies: Illusions and a Solution," *International Journal of Industrial Organization*, 27(3), pp. 403-413

[47] Klette, T. J. and Z. Griliches, 1996, "The Inconsistency of Common Scale Estimators when Output Prices are Unobserved and Endogenous," *Journal of Applied Econometrics*, 11(4), pp. 343-361

[48] Kugler, M. and E. Verhoogen, 2008, "The Quality-Complementarity Hypothesis: Theory and Evidence from Colombia," *NBER Working Paper* 14418

[49] Kugler, M. and E. Verhoogen, 2009, "Plants and Imported Inputs: New Facts and an Interpretation," *The American Economic Review: Papers and Proceedings*, 99(2), pp. 501-507

[50] Levinsohn, J. and A. Petrin, 2003, "Estimating Production Functions Using Inputs to Control for Unobservables," *The Review of Economic Studies*, 70(2), pp. 317-342

[51] Manasse, P. and A. Turrini, 2001, "Trade, Wages and Superstars," *Journal of International Economics*, 54(1), pp. 97–117

[52] Manova, K. and Z. Zhang, 2009, "Quality Heterogeneity across Firms and Export Destinations," *NBER Working Paper* 15342

[53] Markusen, J., 1986, "Explaining the Volume of Trade: An Eclectic Approach," *The American Economic Review*, 76(5), pp. 1002–1011

[54] Matsuyama, K., 2000, "A Ricardian Model with a Continuum of Goods under Non-Homothetic Preferences: Demand Complementarities, Income Distribution, and North–South Trade," *Journal of Political Economy*, 108(6), pp. 1093–1120

[55] Mayer, T. and G. Ottaviano, 2007, "The Happy Few: The Internationalisation of European Firms," *Bruegel Blueprint Series*, November 2007

[56] Melitz, M. J., 2003, "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, 71(6), pp. 1695-1725

[57] Melitz, M. J. and G. Ottaviano, 2008, "Market Size, Trade, and Productivity," *The Review of Economic Studies*, 75(1), pp. 295-316

[58] Murphy, K. M. and A. Shleifer, 1997, "Quality and Trade," *Journal of Development Economics*, 53(1), pp. 1–15

[59] Olley, G. S. and A. Pakes, 1996, "The Dynamics of Productivity in the Telecommunications Equipment Industry", *Econometrica*, 64(6), pp. 1263-1297

[60] Parisi, M. L., F. Schiantarelli and A. Sembenelli, 2006, "Productivity, Innovation and R&D: Micro Evidence for Italy," *European Economic Review*, 50(8), pp. 2037-2061

[61] Petrin, A., B. P. Poi and J. Levinsohn, 2004, "Production Function Estimation in Stata Using Inputs to Control for Unobservables," *The Stata Journal*, 4(2), pp. 113-123

[62] Rauch, J. E., 1999, "Networks versus Markets in International Trade," *Journal of International Economics*, 48(1), pp. 7-35

[63] Schott, P. K., 2004, "Across-Product versus Within-Product Specialization in International Trade," *The Quarterly Journal of Economics*, 119(2), pp. 647-678

[64] Stokey, N., 1991, "The Volume and Composition of Trade between Rich and Poor Countries," *The Review of Economic Studies*, 58(1), pp. 63–80

[65] Sutton, J., 1991, *Sunk Costs and Market Structure: Price Competition, Advertising, and the Evolution of Concentration*, MIT Press: Cambridge, Massachusetts

[66] Sutton, J., 1998, *Technology and Market Structure: Theory and History*, MIT Press: Cambridge, Massachusetts

[67] Van Biesebroeck, J., 2005, "Exporting Raises Productivity in Sub-Saharan African Manufacturing Firms," *Journal of International Economics*, 67(2), pp. 373-391

[68] Van Biesebroeck, J., 2007, "Robustness of Productivity Estimates," *Journal of Industrial Economics*, 3(55), pp. 529-569

[69] Verhoogen, E., 2008, "Trade, Quality Upgrading and Wage Inequality in the Mexican Manufacturing Sector," *The Quarterly Journal of Economics*, 123(2), pp. 489-530

Table 1 - Descriptive Statistics

	Technology			
	Mean	Median	Std. Dev.	Observations
Output (€, '000)	36205	9942	154463	3804
Labor Productivity (€, '000)	109	90	81	3748
Capital Stock per Worker (€, '000)	51	32	70	3798
Materials per Worker (€, '000)	140	87	215	3749
Number of Employees	144	49	414	4123
College + High-School Graduates (%)	44.1	36.7	26.7	3652
Non-Production Workers (%)	33.4	29.4	18.5	4084
	Export Intensity (%)			**Exporters**
	Mean	Median	Std. Dev.	Number (%) of Firms
All Destinations	40.2	36.0	28.4	3058 (75.6)
High-Income Destinations	30.1	25.0	24.0	2788 (68.9)
Low-Income Destinations	10.5	6.3	11.4	1484 (36.7)

Output equals sales plus capitalized costs and change in final goods inventories. *Labor productivity* is value added per worker. *Capital stock* is the book value of capital. *Materials* are the difference between purchases and change in inventories of intermediate goods. *Non-production workers* include entrepreneurs, managers, technical and administrative employees. *Export intensity* is the ratio of exports to total sales. *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: *Capitalia.*

Table 2 - Export Intensity to Low-Income Destinations and TFP

Dependent Variable: Log of Export Intensity to Low-Income Destinations (EXP_l)

	Cobb-Douglas Production Functions				Translog Production Functions				Panel Regressions			CD+Controls (2-Digit Ind.)
	Baseline	Adding Controls	Prod/Non-Prod	2SLS	Baseline	Adding Controls	Prod/Non-Prod	2SLS	Lev./Pet.	Olley/Pakes	Olley/Pakes Augmented	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ln TFP	-0.650***	-0.650***	-0.598***	-0.672***	-0.671***	-0.690***	-0.570***	-0.684***	-0.590***	-0.575***	-0.565***	-0.645***
	[0.164]	[0.166]	[0.168]	[0.157]	[0.170]	[0.169]	[0.168]	[0.163]	[0.167]	[0.167]	[0.164]	[0.174]
	(0.172)	(0.173)	(0.165)	(0.165)	(0.183)	(0.185)	(0.180)	(0.173)	(0.164)	(0.164)	(0.161)	(0.179)
Obs.	1173	1173	1348	1173	1173	1173	1348	1173	1348	1348	1348	1173
R-squared	0.17	0.17	0.16	0.17	0.17	0.17	0.16	0.17	0.16	0.16	0.16	0.17

OLS regressions with robust standard errors in round brackets and bootstrapped standard errors based on 100 replications in square brackets. ***,** ,* = significant at 1, 5 and 10 percent level, respectively. Each column in the table refers to a different TFP estimate (see Tables A1-A2 for details). All specifications include a full set of industry dummies, defined at the 3-digit level of the ATECO classification.

Table 3 - Other Stylized Facts

Dependent Variables Indicated in Panels' Headings

	a) Log of Exports to Low-Income Destinations (r_l)			b) Log of Domestic Sales (r_d)			c) Log of Exports to High-Income Destinations (r_h)		
	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. +
ln TFP	0.569**	0.447*	0.643**	0.785***	0.822***	0.779***	1.110***	1.087***	1.051***
	[0.280]	[0.258]	[0.286]	[0.107]	[0.101]	[0.099]	[0.186]	[0.152]	[0.176]
Obs.	1146	1315	1146	2971	3493	2971	2116	2428	2116
R-squared	0.13	0.12	0.13	0.16	0.17	0.16	0.12	0.11	0.11

	d) Log of Exports to Low-Income Destinations (r_l) - Only Exporters to Low-Income Destinations			e) Log of Domestic Sales (r_d) - Only Exporters to Low-Income Destinations			f) Log of Exports to High-Income Destinations (r_h) - Only Exporters to Low-Income Destinations		
	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. +
ln TFP	0.569**	0.447*	0.643**	1.143***	0.962***	1.223***	1.250***	1.091***	1.350***
	[0.280]	[0.258]	[0.286]	[0.198]	[0.221]	[0.200]	[0.243]	[0.339]	[0.254]
Obs.	1146	1315	1146	1139	1308	1139	1077	1236	1077
R-squared	0.13	0.12	0.13	0.22	0.21	0.22	0.16	0.16	0.16

	g) Log of Exports to Low-Income Destinations over Domestic Sales (r_l/r_d)			h) Log of Exports to High-Income Destinations over Domestic Sales (r_h/r_d)			i) Log of Exports to High-Income Destinations over Exports to Low-Income Destinations (r_h/r_l)		
	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. +
ln TFP	-0.628**	-0.556**	-0.642**	0.150	0.286*	0.038	0.606**	0.564**	0.603**
	[0.266]	[0.219]	[0.291]	[0.158]	[0.157]	[0.162]	[0.242]	[0.231]	[0.239]
Obs.	1139	1308	1139	2099	2408	2099	1077	1236	1077
R-squared	0.19	0.18	0.19	0.16	0.14	0.16	0.14	0.13	0.14

	j) Log of Export Intensity to High-Income Destinations (EXP_h)			k) Export Share of High-Income Destinations (ES_h)			l) Log of Overall Export Intensity (EXP)		
	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. +
ln TFP	0.061	0.148	0.017	0.147***	0.151***	0.162***	-0.029	0.086	-0.106
	[0.115]	[0.100]	[0.100]	[0.043]	[0.037]	[0.041]	[0.108]	[0.096]	[0.111]
Obs.	2189	2515	2189	2292	2636	2292	2313	2732	2313
R-squared	0.13	0.12	0.13	0.08	0.08	0.08	0.18	0.17	0.18

The estimates in panel k) are obtained by Tobit controlling for censoring at 0 and 1. All specifications include a full set of 3-digit industry dummies. See also notes to previous tables.

Table 4 - Product Quality and TFP

Dependent Variables Indicated in Panels' Headings

	a) R&D and MKTG Expenditure per Worker			b) Sales of Innovative Products per Worker			c) Dummy for Process Innovation		
	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.
ln TFP	0.070**	0.058***	0.210**	0.021***	0.025***	0.113***	0.044**	0.030*	0.135*
	[0.031]	[0.022]	[0.103]	[0.006]	[0.007]	[0.028]	[0.022]	[0.018]	[0.072]
Obs.	2240	2509	2240	2742	3130	2742	3089	3570	3089
R-squared	0.06	0.07	0.06	0.12	0.10	0.13	0.05	0.05	0.05
	d) Dummy for Process Innov. x Sales of Innov. Prod.			e) Employment Share of Managers			f) Investment per Worker		
	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.
ln TFP	0.063*	0.047*	0.211*	0.088***	0.046**	0.368***	0.064***	0.054**	0.156**
	[0.037]	[0.027]	[0.120]	[0.023]	[0.021]	[0.093]	[0.020]	[0.022]	[0.070]
Obs.	2723	3107	2723	3104	3664	3104	2503	2958	2503
R-squared	0.05	0.04	0.05	0.06	0.06	0.07	0.13	0.06	0.12
	g) Number of Employees			h) Average Wages					
	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.			
ln TFP	0.022**	0.048***	0.070**	0.360***	0.331***	1.254***			
	[0.010]	[0.014]	[0.034]	[0.035]	[0.033]	[0.127]			
Obs.	3112	3664	3112	3108	3659	3108			
R-squared	0.10	0.09	0.10	0.29	0.25	0.27			
	i) Q_1			j) Q_2			k) Q_3		
	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.
ln TFP	0.108***	0.082***	0.335**	0.108***	0.082***	0.337**	0.129***	0.103***	0.420***
	[0.038]	[0.028]	[0.135]	[0.038]	[0.028]	[0.135]	[0.037]	[0.027]	[0.131]
Obs.	1692	1905	1692	1692	1905	1692	1691	1903	1691
R-squared	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09

All variables are standardized with mean 0 and variance 1. Q_1-Q_3 are obtained through factor analysis, by extracting the principal components of the variables in panels a)-f), a)-g) and a)-h), respectively. All specifications include a full set of 3-digit industry dummies. See also notes to previous tables.

Table 5 - Export Intensity to Low-Income Destinations and Product Quality

Dependent Variable: Log of Export Intensity to Low-Income Destinations (EXP_l)

	a) Main Specifications						b) Adding TFP					
	Baseline	General Controls	ln EXP_h	Trade Controls	Exp. MKT. Dummies	Exp. MKT. x Ind. Dummies	Baseline	General Controls	ln EXP_h	Trade Controls	Exp. MKT. Dummies	Exp. MKT. x Ind. Dummies
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Q_1	-0.068***	-0.066***	-0.070***	-0.070***	-0.062***	-0.038**	-0.062***	-0.059***	-0.064***	-0.063***	-0.052***	-0.037**
	[0.013]	[0.013]	[0.012]	[0.015]	[0.013]	[0.016]	[0.012]	[0.013]	[0.012]	[0.013]	[0.012]	[0.017]
ln TFP							-0.143***	-0.147***	-0.124**	-0.131**	-0.159***	-0.106
							[0.054]	[0.055]	[0.052]	[0.052]	[0.051]	[0.094]
Obs.	854	846	811	778	854	854	787	779	747	774	787	787
R-squared	0.21	0.25	0.24	0.26	0.33	0.64	0.21	0.25	0.24	0.26	0.33	0.66
Q_2	-0.068***	-0.066***	-0.070***	-0.070***	-0.062***	-0.038**	-0.062***	-0.059***	-0.064***	-0.063***	-0.053***	-0.037**
	[0.013]	[0.013]	[0.012]	[0.015]	[0.013]	[0.016]	[0.012]	[0.013]	[0.012]	[0.013]	[0.012]	[0.017]
ln TFP							-0.143***	-0.147***	-0.124**	-0.131**	-0.159***	-0.106
							[0.054]	[0.055]	[0.052]	[0.052]	[0.051]	[0.094]
Obs.	854	846	811	778	854	854	787	779	747	774	787	787
R-squared	0.21	0.25	0.24	0.26	0.33	0.64	0.21	0.25	0.24	0.26	0.33	0.66
Q_3	-0.071***	-0.068***	-0.074***	-0.075***	-0.063***	-0.039**	-0.063***	-0.059***	-0.066***	-0.066***	-0.053***	-0.039**
	[0.014]	[0.015]	[0.014]	[0.016]	[0.014]	[0.017]	[0.013]	[0.014]	[0.013]	[0.014]	[0.013]	[0.019]
ln TFP							-0.142***	-0.145***	-0.121**	-0.129**	-0.158***	-0.105
							[0.054]	[0.055]	[0.052]	[0.052]	[0.051]	[0.094]
Obs.	800	792	759	777	800	800	786	778	746	773	786	786
R-squared	0.21	0.25	0.24	0.26	0.33	0.66	0.21	0.25	0.24	0.26	0.33	0.66

General controls in columns (2) and (8) 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. EXP_h in columns (3) and (9) is export intensity to high-income destinations. *Trade controls* in columns (4) and (10) 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 (5) and (11) are seven dummies each taking a value of 1 for firms exporting to a given destination. Finally, in columns (6) and (12) export market dummies are interacted with 3-digit industry dummies (roughly 700 dummies overall). (See also Table A6.) TFP is based on the augmented Olley-Pakes estimates. All variables are standardized with mean 0 and variance 1. All specifications include a full set of 3-digit industry dummies. See also notes to previous tables.

Table 6 - Export Intensity to Low-Income Destinations and Product Quality (Homogeneous and Differentiated Industries)

Dependent Variable: Log of Export Intensity to Low-Income Destinations (EXP_l)

	a) Baseline		b) Adding TFP	
	Homogeneous Industries	Differentiated Industries	Homogeneous Industries	Differentiated Industries
	(1)	(2)	(3)	(4)
Q_1	-0.043	-0.070***	-0.044	-0.060***
	[0.077]	[0.013]	[0.077]	[0.012]
ln TFP			-0.030	-0.235***
			[0.086]	[0.067]
Obs.	369	485	351	436
R-squared	0.24	0.19	0.24	0.20
Q_2	-0.041	-0.070***	-0.041	-0.060***
	[0.077]	[0.013]	[0.077]	[0.012]
ln TFP			-0.030	-0.235***
			[0.086]	[0.067]
Obs.	369	485	351	436
R-squared	0.24	0.19	0.24	0.20
Q_3	-0.053	-0.073***	-0.044	-0.061***
	[0.067]	[0.014]	[0.068]	[0.013]
ln TFP			-0.028	-0.234***
			[0.086]	[0.067]
Obs.	354	446	350	436
R-squared	0.24	0.18	0.24	0.20

Homogeneous and differentiated industries are defined according to Rauch's (1999) classification. TFP is based on the augmented Olley-Pakes estimates. All variables are standardized with mean 0 and variance 1. All specifications include a full set of 3-digit industry dummies. See also notes to previous tables.

Table 7 - Product Quality and Destination Markets

Dependent Variables: Proxies for Product Quality (Q_1 -Q_3)

	a) Exporters to High-Income Destinations Only and Exporters to Both Destinations					
	Baseline			Controlling for TFP		
	Q_1	Q_2	Q_3	Q_1	Q_2	Q_3
	(1)	(2)	(3)	(4)	(5)	(6)
D_{DH}	0.056***	0.057***	0.067***	0.057***	0.058***	0.066***
	[0.015]	[0.015]	[0.016]	[0.017]	[0.017]	[0.017]
D_{DHL}	0.121***	0.123***	0.133***	0.120***	0.123***	0.131***
	[0.030]	[0.030]	[0.032]	[0.034]	[0.034]	[0.033]
ln TFP				0.086***	0.086***	0.107***
				[0.029]	[0.029]	[0.028]
Obs.	2036	2036	1897	1849	1849	1847
R-squared	0.07	0.07	0.09	0.09	0.09	0.10
	b) Number of Destination Markets					
	Baseline			Controlling for TFP		
	Q_1	Q_2	Q_3	Q_1	Q_2	Q_3
	(1)	(2)	(3)	(4)	(5)	(6)
M	0.095***	0.098***	0.104***	0.083***	0.087***	0.093***
	[0.021]	[0.021]	[0.021]	[0.019]	[0.019]	[0.019]
ln TFP				0.083***	0.084***	0.104***
				[0.028]	[0.028]	[0.027]
Obs.	2036	2036	1897	1849	1849	1847
R-squared	0.07	0.07	0.09	0.09	0.09	0.10

In panel a), D_{DH} is a dummy equal to 1 for firms selling to the domestic and high-income markets only. D_{DHL} is a dummy equal to 1 for firms selling also to low-income destinations. Firms selling only to the domestic market are the reference group. In panel b), M is the number of markets (from 1 to 8) each firm sells to. TFP is based on the augmented Olley-Pakes estimates. All variables are standardized with mean 0 and variance 1. All specifications include a full set of 3-digit industry dummies. See also notes to previous tables.

Table 8 - Export Intensity, TFP and Product Quality (Panel Regressions)

Dependent Variable: Log of Export Intensity to Destination *f* (EXP_{fi})

	a) Using TFP								
	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ln TFP	-1.267***	-1.006***	-1.207***	-1.075***	-0.826***	-0.961***	-1.070***	-0.868**	-0.867**
	[0.257]	[0.227]	[0.247]	[0.264]	[0.231]	[0.251]	[0.403]	[0.357]	[0.392]
ln TFP * Income	1.105***	0.988***	0.979***	1.090***	0.972***	0.942***	1.088***	0.997***	0.886***
	[0.272]	[0.233]	[0.263]	[0.273]	[0.233]	[0.263]	[0.329]	[0.286]	[0.318]
ln TFP * Distance				-0.295**	-0.273**	-0.359***	-0.296**	-0.264**	-0.378***
				[0.132]	[0.114]	[0.127]	[0.149]	[0.130]	[0.144]
ln TFP * Countries							0.000	0.001	-0.003
							[0.009]	[0.007]	[0.008]
Obs.	5406	6217	5406	5406	6217	5406	5406	6217	5406
R-squared	0.39	0.38	0.39	0.39	0.38	0.39	0.39	0.38	0.39

	b) Using Proxies for Product Quality								
	Q_1	Q_2	Q_3	Q_1	Q_2	Q_3	Q_1	Q_2	Q_3
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Proxy for Product Quality	-0.119***	-0.122***	-0.134***	-0.112***	-0.115***	-0.126***	-0.150***	-0.150***	-0.166***
	[0.041]	[0.041]	[0.044]	[0.039]	[0.039]	[0.041]	[0.037]	[0.038]	[0.040]
Proxy for Product Quality * Income	0.096**	0.100**	0.118**	0.115***	0.120***	0.135***	0.131***	0.135***	0.151***
	[0.042]	[0.043]	[0.050]	[0.043]	[0.044]	[0.047]	[0.037]	[0.037]	[0.042]
Proxy for Product Quality * Distance				-0.038	-0.041	-0.036	-0.028	-0.032	-0.025
				[0.030]	[0.030]	[0.031]	[0.032]	[0.033]	[0.033]
Proxy for Product Quality * Countries							0.002	0.002	0.002
							[0.002]	[0.002]	[0.002]
Obs.	3930	3930	3694	3930	3930	3694	3930	3930	3694
R-squared	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42

The panel is obtained by pooling data on export intensities 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 in each destination, relative to the average distance across all destinations. *Countries* is the number of countries within each destination, relative to the average number of countries across all destinations. 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.

Table 9 - Export Intensity and TFP (Cross-Sectional Regressions for Individual Destinations)

Dependent Variables: Log of Export Intensity to Each Destination

	a) New EU Members			b) Latin America			c) China			d) Africa		
	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.
ln TFP	-0.845***	-0.555***	-0.772***	-0.890**	-1.089***	-1.137***	-0.870*	-0.732*	-0.766*	-1.151***	-0.711**	-1.056***
	[0.246]	[0.194]	[0.239]	[0.378]	[0.339]	[0.378]	[0.471]	[0.410]	[0.424]	[0.337]	[0.296]	[0.299]
Obs.	771	884	771	436	498	436	287	330	287	499	579	499
R-squared	0.17	0.13	0.17	0.25	0.24	0.26	0.43	0.43	0.43	0.23	0.20	0.23

	e) EU15			f) North America			g) Oceania		
	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.
ln TFP	0.045	0.128	0.026	-0.320	-0.103	-0.466*	-1.243***	-0.837**	-1.314***
	[0.141]	[0.117]	[0.120]	[0.224]	[0.180]	[0.242]	[0.448]	[0.354]	[0.405]
Obs.	2130	2441	2130	976	1127	976	307	358	307
R-squared	0.12	0.10	0.12	0.14	0.13	0.14	0.36	0.33	0.37

All specifications include a full set of 3-digit industry dummies. See also notes to previous tables.

Table 10 - TFP Elasticities of Export Intensity: Predicted vs. Estimated

	Estimated	Predicted (based on *Income*)	Predicted (based on *Income* and *Distance*)
	(1)	(2)	(3)
Elasticities			
New EU Members	-0.555	-0.514	-0.402
Latin America	-1.089	-0.753	-0.981
China	-0.732	-0.817	-1.008
Africa	-0.711	-0.925	-0.773
EU15	0.128	-0.006	0.104
North America	-0.103	0.073	-0.092
Oceania	-0.837	-0.237	-0.805
Comparisons (Predicted/Estimated, %)			
Mean Low-Income		97.5	102.5
Mean High-Income		20.9	97.7

Column (1) reproduces the elasticities estimated in Table 9. Columns (2) and (3) report the predicted elasticities based on the panel estimates in Table 8a. All elasticities refer to the augmented Olley-Pakes TFP estimates.

Table A1 - Production Function Estimates

Dependent Variable: Log of Real Output (Y)

	Cobb-Douglas Production Functions				Translog Production Functions				Panel Regressions		
	Baseline	Adding Controls	Prod/Non-Prod	2SLS	Baseline	Adding Controls	Prod/Non-Prod	2SLS	Lev./Pet.	Olley/Pakes	Olley/Pakes Augmented
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Output Elasticity											
High-Skill Labor	0.187***	0.162***	0.188***	0.250***	0.165***	0.147***	0.161***	0.219***	0.172***	0.187***	0.191***
	[0.011]	[0.015]	[0.016]	[0.017]	[0.008]	[0.009]	[0.012]	[0.019]	[0.008]	[0.007]	[0.008]
Low-Skill Labor	0.127***	0.126***	0.122***	0.093***	0.149***	0.146***	0.135***	0.091***	0.103***	0.094***	0.096***
	[0.008]	[0.011]	[0.012]	[0.015]	[0.007]	[0.008]	[0.010]	[0.013]	[0.007]	[0.006]	[0.007]
Physical Capital	0.055***	0.064***	0.061***	0.039***	0.047***	0.053***	0.065***	0.055***	0.076	0.088***	0.088***
	[0.007]	[0.009]	[0.009]	[0.007]	[0.006]	[0.007]	[0.007]	[0.008]	[0.063]	[0.029]	[0.024]
Materials	0.603***	0.617***	0.612***	0.597***	0.628***	0.648***	0.637***	0.631***	0.615***	0.607***	0.619***
	[0.014]	[0.019]	[0.018]	[0.013]	[0.006]	[0.008]	[0.009]	[0.010]	[0.119]	[0.009]	[0.012]
Obs.	3132	2812	3219	2460	3132	2812	3219	2460	9759	7267	7267
R-squared	0.94	0.95	0.96	0.93	0.95	0.96	0.97	0.94	-	-	-
Returns to Scale	0.97	0.97	0.98	0.98	0.99	0.99	1.00	1.00	0.97	0.98	0.99
P-value Hansen J-stat.				0.35				0.17			
F-Stat. of exclud. instr. (min/max)				735/1689				233/1526			

Columns (2)-(4) and (6)-(11) include the following controls: 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; columns (9)-(11) also include time dummies. Skills are proxied by occupations in columns (3), (7), and (9)-(11), and by educational attainment otherwise. In 2SLS estimates, all inputs are instrumented with their first and second lags. Translog output elasticities are evaluated at the sample mean and standard errors are computed by the delta method. In columns (9)-(11), standard errors are based on 100 bootstrap replications. The output elasticities in column (11) are corrected using the estimated coefficient of average industry output as explained in the Appendix. See also notes to previous tables.

Table A2 - Production Function Estimates at the 2-Digit Industry Level

Dependent Variable: Log of Real Output (*Y*)

		High-Skill Labor	Low-Skill Labor	Physical Capital	Materials	Obs.	R-squared
15	Food products and beverages	0.119***	0.064*	0.143***	0.650***	323	0.94
		[0.041]	[0.036]	[0.038]	[0.073]		
17	Textiles	0.282***	0.146***	0.042	0.483***	213	0.92
		[0.080]	[0.029]	[0.030]	[0.077]		
18	Wearing apparel, dressing and dyeing of fur	0.220***	0.109***	0.072	0.542***	81	0.95
		[0.050]	[0.040]	[0.044]	[0.073]		
19	Leather, luggage, handbags, saddlery, harness and footwear	0.094***	0.169***	0.048**	0.697***	130	0.97
		[0.021]	[0.049]	[0.020]	[0.054]		
20	Wood and products of wood and cork, except furniture	0.108***	0.149***	0.062**	0.662***	88	0.98
		[0.031]	[0.039]	[0.024]	[0.048]		
21	Pulp, paper and paper products	0.102***	0.175***	0.041*	0.684***	83	0.99
		[0.031]	[0.052]	[0.025]	[0.037]		
22	Publishing, printing and reproduction of recorded media	0.337***	0.203**	0.073	0.399***	65	0.94
		[0.095]	[0.092]	[0.049]	[0.114]		
23 - 24	Coke, refined petroleum products and nuclear fuel - Chemicals	0.180***	0.097***	0.018	0.708***	172	0.98
		[0.028]	[0.021]	[0.016]	[0.028]		
25	Rubber and plastic products	0.137***	0.155***	0.067***	0.646***	144	0.99
		[0.027]	[0.033]	[0.019]	[0.024]		
26	Other non-metallic mineral products	0.170***	0.176***	0.058**	0.611***	186	0.97
		[0.030]	[0.026]	[0.023]	[0.031]		
27	Basic metals	0.153***	0.209***	0.014	0.620***	99	0.99
		[0.029]	[0.037]	[0.028]	[0.042]		
28	Fabricated metal products, except machinery and equipment	0.155***	0.182***	0.102**	0.551***	387	0.93
		[0.044]	[0.045]	[0.045]	[0.060]		
29	Machinery and equipment n.e.c.	0.182***	0.114***	0.040***	0.613***	382	0.97
		[0.018]	[0.017]	[0.011]	[0.021]		
30 - 31	Office machinery and computers - Electrical machinery and apparatus n.e.c.	0.125***	0.101***	0.030*	0.686***	104	0.98
		[0.035]	[0.035]	[0.017]	[0.041]		
32 - 33	Radio, television and communication equipment and apparatus - Medical, precision and optical instruments, watches and clocks	0.141**	0.086**	0.017	0.688***	99	0.98
		[0.058]	[0.036]	[0.030]	[0.054]		
34 - 35	Transport equipment	0.158	0.054	0.046	0.693***	65	0.99
		[0.097]	[0.109]	[0.055]	[0.122]		
36	Manufacture of furniture; manufacturing n.e.c.	0.090***	0.134***	0.061**	0.673***	191	0.97
		[0.030]	[0.025]	[0.026]	[0.053]		

OLS regressions with robust standard errors in square brackets. All regressions include the same controls as in column (2) of Table A1. See also notes to previous tables.

Table A3 - Export Intensity to Low-Income Destinations and TFP (Outliers)

Dependent Variable: Log of Export Intensity to Low-Income Destinations (EXP_l)

	a) Winsorizing (5%)			b) Trimming (5%)			c) Outlier-Robust Estimation			d) TFP Bins		
	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ln TFP	-0.727***	-0.636***	-0.573***	-0.467*	-0.463***	-0.408**	-0.641***	-0.544***	-0.587***			
	[0.181]	[0.173]	[0.171]	[0.240]	[0.171]	[0.191]	[0.192]	[0.162]	[0.183]			
ln TFP > 33%										-0.160*	-0.188**	-0.204**
										[0.090]	[0.082]	[0.087]
ln TFP > 66%										-0.265***	-0.299***	-0.309***
										[0.095]	[0.088]	[0.095]
Obs.	1173	1348	1173	978	1127	991	1173	1348	1173	1173	1348	1173
R-squared	0.17	0.16	0.16	0.14	0.13	0.13	0.18	0.17	0.18	0.17	0.16	0.17

The observations in the tails of the distribution of EXP_l and TFP are replaced by the 5^{th} and 95^{th} percentiles in panel a) and excluded in panel b). The results in panel c) are obtained with the *rreg* command in Stata and biweight tuning coefficient of 7. In panel d), the explanatory variables are dummies taking a value of 1 for firms with intermediate and high levels of TFP and are obtained by splitting the TFP distribution in three bis of equal size; the reference group is firms with low TFP. All specifications include a full set of 3-digit industry dummies. See also notes to previous tables.

Table A4 - Export Intensity to Low-Income Destinations and TFP (Estimation Method)

Dependent Variables: Log of Export Intensity to Low-Income Destinations (EXP_l, Panels a) and c)) and Log of Output (Y, Panel b))

	a) Sample Split			b) One-Step Approach		c) Tornqvist Index of TFP
	TL + Controls	OP Augmen.	CD 2-D. + Contr.	Common Input Elasticities	Industry-Specific Input Elasticities	
	(1)	(2)	(3)	(4)	(5)	(6)
ln TFP	-0.709***	-0.628***	-0.549***			-0.570***
	[0.172]	[0.167]	[0.165]			[0.182]
ln EXP_l				-0.021***	-0.021***	
				[0.005]	[0.006]	
Obs.	1173	1348	1173	1173	1173	1155
R-squared	0.17	0.16	0.17	0.97	0.98	0.18

In panel a), TFP is estimated on the subsample of exporters to low-income destinations. In panel b), the Cobb-Douglas production function is augmented by *ln* EXP_l: inputs enter linearly in column (4) and interacted with 3-digit industry dummies in column (5). In panel c), TFP is computed rather than estimated, using the formula for the Tornqvist index illustrated in the Appendix. All specifications include a full set of 3-digit industry dummies. See also notes to previous tables.

Table A5 - Export Intensity to Low-Income Destinations and TFP (Sample Size)

Dependent Variable: Export Intensity to Low-Income Destinations (*EXP$_l$*) in Levels

	a) Exporters to Low-Income Destinations			b) Exporters to High-Income and Low-Income Destinations			c) All Exporters			d) All Firms		
	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ln TFP	-0.062***	-0.050***	-0.056***	-0.048***	-0.036**	-0.041**	-0.039***	-0.032***	-0.032***	-0.027***	-0.025***	-0.024***
	[0.017]	[0.015]	[0.016]	[0.018]	[0.014]	[0.017]	[0.009]	[0.008]	[0.008]	[0.006]	[0.005]	[0.005]
Obs.	1173	1348	1173	1102	1267	1102	2292	2636	2292	3043	3501	3043
R-squared	0.18	0.18	0.18	0.15	0.15	0.15	0.14	0.13	0.14	0.14	0.13	0.14

The estimation sample consists of firms exporting to low-income destinations in panel a), firms exporting to both low-income and high-income destinations in panel b), firms exporting to any destination in panel c), exporting and non-exporting firms in panel d). All specifications include a full set of 3-digit industry dummies. See also notes to previous tables.

Table A6 - Export Intensity to Low-Income Destinations and TFP (Specification)

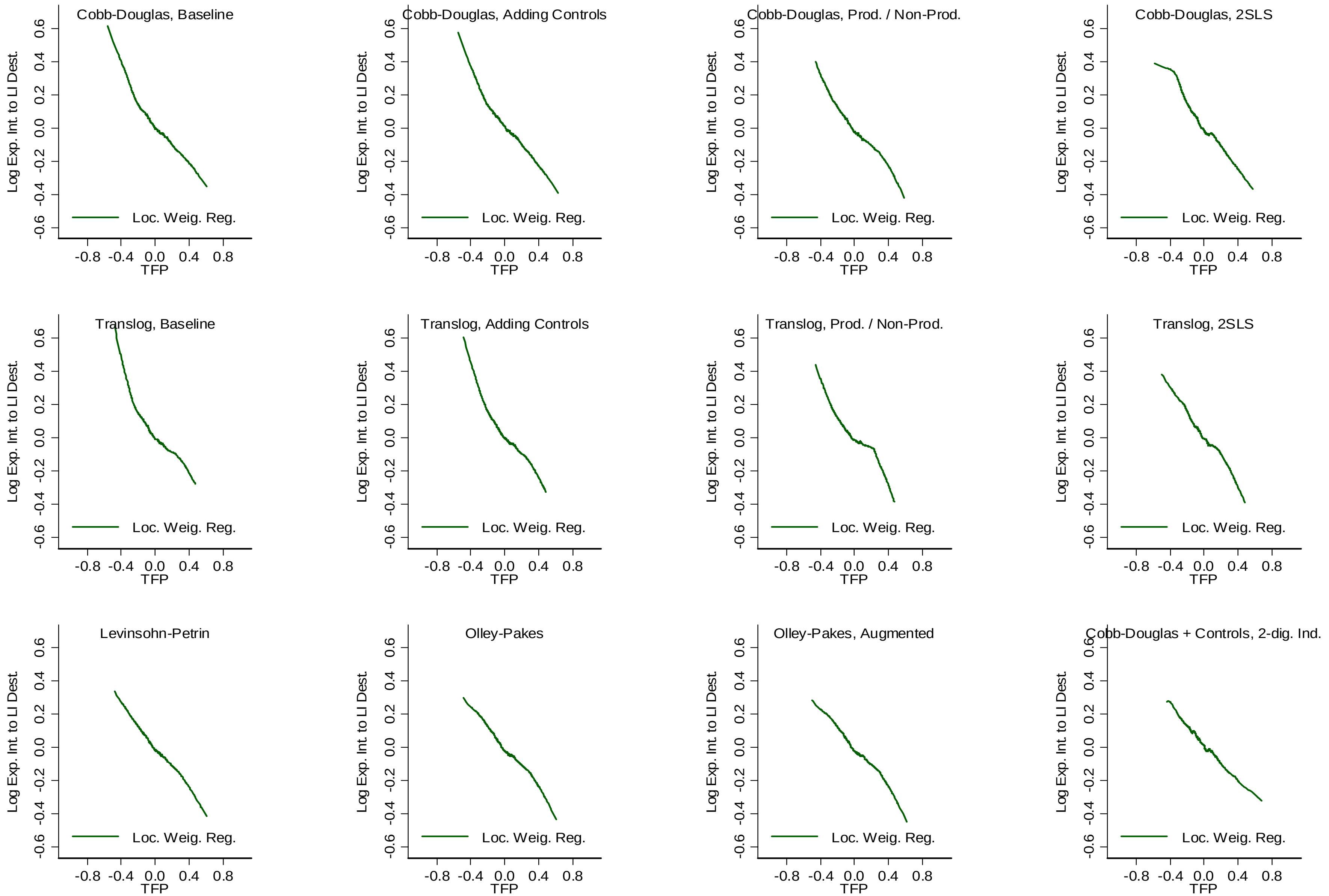
Dependent Variable: Log of Export Intensity to Low-Income Destinations (*EXP$_l$*)

	a) Adding General Controls			b) Adding Export Intensity to High-Income Destinations			c) Adding Trade Controls			d) Adding Export Market Dummies			e) Adding Export Market Dummies Interacted with 3-digit Industry Dummies		
	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.	TL + Controls	OP Augmen.	CD 2-D. + Contr.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
ln TFP	-0.736***	-0.615***	-0.734***	-0.672***	-0.490***	-0.600***	-0.621***	-0.559***	-0.653***	-0.693***	-0.542***	-0.676***	-0.685**	-0.491**	-0.598**
	[0.190]	[0.158]	[0.196]	[0.213]	[0.151]	[0.181]	[0.177]	[0.163]	[0.173]	[0.155]	[0.150]	[0.165]	[0.266]	[0.212]	[0.252]
ln EXP_h				0.197***	0.222***	0.196***									
				[0.038]	[0.035]	[0.038]									
FDI							-1.650	-0.471	-1.550						
							[5.296]	[3.685]	[5.321]						
IMPINT							-0.045	-0.053	-0.029						
							[0.256]	[0.269]	[0.258]						
SERV							0.051	0.071	0.063						
							[0.083]	[0.079]	[0.083]						
INSH							1.062***	0.970***	1.074***						
							[0.125]	[0.119]	[0.125]						
Obs.	1057	1204	1057	1102	1267	1102	1124	1288	1124	1173	1348	1173	1173	1348	1173
R-squared	0.21	0.21	0.21	0.21	0.20	0.21	0.24	0.22	0.24	0.28	0.26	0.28	0.57	0.53	0.57

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. *EXP$_h$* is export intensity to high-income destinations. *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. *INSH* is the share of sales subcontracted from abroad. *Export market dummies* are seven dummies each taking a value of 1 for firms exporting to a given destination. The general controls, the export market dummies and their interactions with industry dummies are always jointly significant. All specifications include a full set of 3-digit industry dummies. See also notes to previous tables.

Figure 1 - Export Intensity to Low-Income Destinations and TFP (Non-Parametric Regressions)

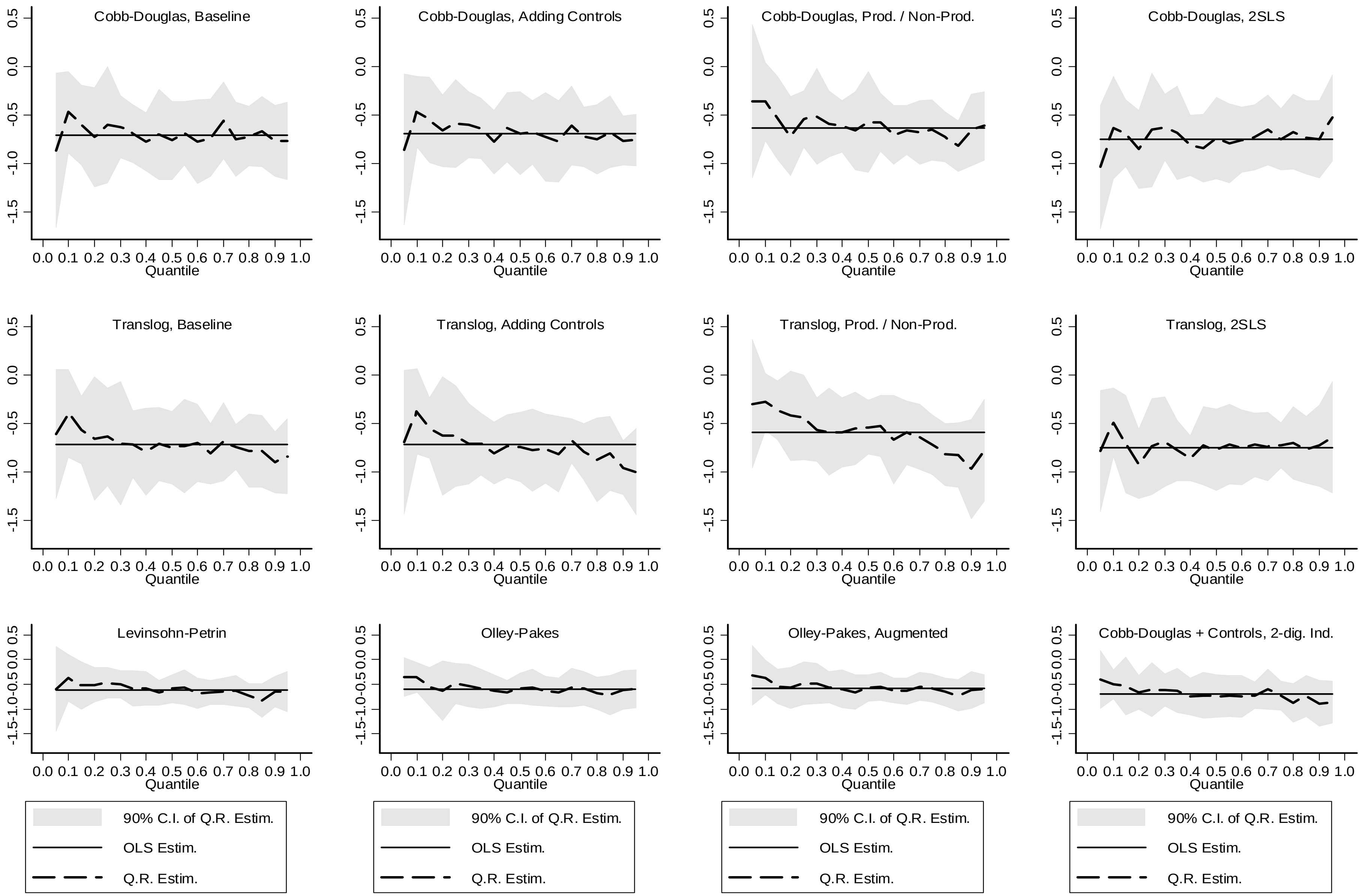
Dependent Variable: Log of Export Intensity to Low-Income Destinations (EXP_l)



Locally weighted least-squares regressions with bandwidth equal to 0.8. Each graph refers to the log of a different TFP measure, as indicated in the heading. All variables are deviated from 3-digit industry averages.

Figure A1 - Export Intensity to Low-Income Destinations and TFP (Quantile Regressions)

Dependent Variable: Log of Export Intensity to Low-Income Destinations (EXP_l)



Each graph shows the quantile regressions coefficients of *ln TFP* (as indicated in the heading of each panel) for the 5th-95th percentiles of the conditional distribution of *ln* EXP_l, along with 90% confidence intervals based on 100 bootstrap replications and OLS estimates from the same regression. All specifications include industry dummies.