The role of the gravity forces on firms' trade

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Abstract

This paper offers both a theoretical framework and empirical evidence on the role that the two gravity forces, namely market size and geographical distance, have indirectly through imports, on firms' exports patterns. The model shows that sourcing from bigger and closer markets implies higher productivity gains which, in turn, increase firms' ability to enter export market, as well as their export value. Exploiting data on product and destination-level transactions of a large panel of Italian firms, the paper shows that, on average, the indirect effects of the gravity forces are about one third of their direct effects.

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1. Introduction

The gravity equation in international trade has been largely used as a workhorse for analyzing the determinants of bilateral trade and the geographical patterns of economic activity. The equation shows that trade between two countries is proportional to their respective sizes and inversely proportional to the geographic distance between them. The recent heterogeneous-firms trade models have reckoned that the gravity forces shape export performance also at the firm level: larger size or lower distance increase the probability that a firm exports to a particular destination (the extensive margin), as well as its export value to that market (the intensive margin) (Chaney, 2008; Helpman et al., 2008; Eaton et al., 2011).[1] The same literature has shown that there exist a strong complementarity between firms' import and export activities: the majority of exporters are also importers and vice versa. The connection between the two sides of trade could have important consequences for the elasticity of exports with respect to the gravity forces (Bernard et al., 2016).

Following the studies that have taken into account firms' import and export linkages, this paper improves upon the existing literature by considering the role that the gravity forces have on firms' export patterns through the imports of intermediate inputs. Our research provides empirical evidence that market size and geographical distance have an indirect effect, through imports, on a firm' s probability of exporting to a specific destination and its export value to that destination. As in previous papers, in our setting sourcing intermediate inputs from abroad has a positive impact on firms' exports because of productivity enhancing effect due to variety, quality and technological mechanisms.[2] This work contributes to the existing literature by showing that the economic geography of imports is crucial in influencing firms' productivity and exports: productivity gains from imports depend indeed on the size and the distance of the source countries. As a consequence, the elasticity of exports with respect to gravity forces is magnified.

To guide our empirical analysis we introduce in the theoretical framework of Chaney (2008), which derives the export gravity equation for final goods in a model of trade with firm heterogeneity, an intermediate input sector and the possibility for final producers to use a continuum of intermediate inputs sourced from multiple locations differing in terms of size, labour costs, trade and institutional barriers. The technology is similar to early endogenous growth models (Romer, 1990; Rivera-Batiz and Romer, 1991), which use a Cobb Douglas specification in which there is love of variety in intermediate inputs. The model predicts that the positive effect of importing on a firm's productivity is heterogeneous across source countries and it depends on both the mass of imported intermediate inputs available, as well as the price of each intermediate. Bigger markets provide a larger variety of inputs, while closer countries charge lower prices because of lower transportation costs. Therefore, variation in the gravity forces determine heterogeneous productivity gains across import-source countries: importing from larger and closer markets has a stronger positive effect on firms' productivity. The efficiency gains, in turn, rise a firm's probability of exporting, as well as its export value. It follows that, in addition to the standard direct effect on firms' export patterns, market size and distance exert an effect on

[1] In a recent book van Bergeijk and Brakman (2014) review the methodological and theoretical advances regarding the gravity model.Head and Mayer (2014) propose a review of the estimation and interpretation of gravity equations for bilateral trade.

[2] For a theoretical background of the productivity gains induced by intermediate inputs see Markusen (1989); Grossman and Helpman (1991); Acharya and Keller (2009); Eaton et al. (2011), among others. Micro-level empirical evidence on the positive effect of imports on firms' productivity include Halpern et al. (2011) for Hungary, Paul and Yasar (2009) for Turkey, Conti et al. (2014) for Italy, Gorg et al. (2008) for Ireland, Vogel and Wagner (2010) for Germany. Other relevant papers that investigate the effect of input trade liberalization on firms' productivity are Fernandes (2007); Pavcnik (2002); Amiti and Konings (2007); Kasahara and Rodrigue (2008), among others. Alternatively, the link between importing and exporting could be due to the existence of sunk costs complementarities between the two activities as in Kasahara and Lapham (2013) (see section 4.2.1 for a discussion on this channel).

exports indirectly through heterogeneous efficiency gains induced by imports of intermediate inputs. A decline in transportation costs (i.e., distance), and therefore a reduction in the cost of imported inputs, increases a firm's productivity allowing it to offer its exports at lower prices and to increase its revenues in the exporting markets.[3] Following a similar reasoning, the bigger the foreign country, the larger the mass of imported inputs and the lower the marginal cost of production: a rise in the size of the foreign market determines larger efficiency gains and thereby increases a firm's export performance.

The theoretical set-up helps us in driving our empirical analysis. We exploit an original Italian database obtained by merging a firm-level dataset, including standard balance sheet information, with a transaction-level dataset, recording custom information on exports and imports for each product and destination. Firm-level trade data are complemented by country characteristics including proxies for market size, distance, variable and fixed trade costs. We estimate a production function taking into account the role of imports of intermediate inputs and we derive the contribution of imports to a firm's total factor productivity. Our results point at the importance of foreign intermediates in explaining productivity differences across firms within sectors. On average our estimates indicate that a firm that increases its ratio of total intermediate inputs (foreign plus domestic) over domestic intermediate inputs by 10% can improve its TFP by 3.5%.

We then test for the indirect effect that the two gravity forces, through the import-related component of TFP, have on a firm's export participation and export sales in a destination market. We adopt an instrumental variable (IV) strategy to control for possible endogeneity bias of our key variable due to omitted variables or reverse causality. The empirical analysis provides evidence that the firms' productivity component due to imports, which is heterogeneous across import-source countries, has a positive impact on both firm-country export margins. We also confirm previous results regarding the direct channel of the two gravity forces according to which the probability of exporting to a specific market as well as the amount of exports increase with market size but decrease with distance. Finally, we quantify the indirect effects of the two gravity forces on a firm's export patterns. We estimate that on average the indirect effects of the gravity forces are about one third of the direct effects obtained in the gravity equations.

Our paper directly relates to the literature on the gravity equation. Applied for the first time by Tinbergen (1962), the equation shows that trade between two countries is proportional to their respective sizes, measured by their GDP, and inversely proportional to the geographic distance between them. The heterogeneous-firm model brings to the gravity model a need to consider the effects of trade barriers both on the value of exports by current exporters and on the entry of exporters. In his model Chaney (2008) extends the work of Melitz (2003) to show that there is both an intensive and an extensive margin of adjustment of trade flows to trade barriers. In a similar manner, Helpman et al. (2008) derive a gravity equation and develop an estimation procedure to obtain the effects of trade barriers and policies on the two margins. Micro-level empirical analyses confirm several of the theoretical implications predicted by these models. Eaton et al. (2011, 2004) for France and Bernard et al. (2007) for the US find that the number of exporting firms is sharply decreasing in the distance to the destination country and increasing in importers' income. Using firm-level Frech data, Crozet and Koenig (2010) estimate the effect of trade barriers on different export margins. Other empirical studies offer evidence that market-specific trade costs affect individual export decision and export sales to a particular destination (Lawless and Whelan, 2014; Creusen et al., 2011; Serti and Tomasi, 2014). By considering the import side, Loof and Andersson (2010) and Conti et al. (2014) estimate the causal impact of importing from different sources on the firm level productivity. None of the cited studies, however, consider how the economic geography of import activities

[3]The result that intermediates magnify the elasticity of trade flows to trade barriers is also provided by Yi (2003); Caliendo and Parro (2015); Aichele et al. (2014). Our theoretical framework emphasizes the role of firm heterogeneity and of self-selection across both export and import activities.

impacts exports trough its heterogeneous effect on firms' productivity. While it has been already established that market size and distance are crucial in shaping exports patterns, it is an open question whether and how the two gravity variables play a role indirectly through imports.

Within the vast empirical literature on firm heterogeneity in international trade, this article directly relates to the emerging literature on the interdependence between importing and exporting activities. A leading recent theory is provided by Kasahara and Lapham (2013) who develop a symmetric country model on the import-productivity-export nexus. The positive link between imports and exports is confirmed empirically by Bernard et al. (2007) for the US, Bas and Strauss-Kahn (2014) for French, Feng et al. (2016) for China, Muuls and Pisu (2009) for Belgium, LoTurco and Maggioni (2015) for Turkey, Aristei et al. (2013) for a group of Eastern European and Central Asian countries, Altomonte and Bekes (2009) for Hungary, Kasahara and Lapham (2013) for Chile. Evidence for Italy has been provided by Castellani et al. (2010) and LoTurco and Maggioni (2013). Other papers look at the connection between the two trade activities by investigating the effect of input-trade liberalization on firm export outcomes (Bas, 2012; Bas and Strauss-Kahn, 2015; Fan et al., 2016; Chevassus-Lozza et al., 2013). Unlike these papers, we explore the link between imports and exports in a multi-country environment focusing on the role played by the economic geography on such a nexus.

The remained of the paper is organized as follows. Section 2 presents a trade model with heterogeneous firms, featuring imports in intermediate inputs to derive the export gravity equation, both at firm and industry-level. Section 3 describes the data for the empirical study. Section 4 presents the estimation results and Section 5 concludes.

2. The model

We develop a simple model that extend Melitz (2003) and Chaney (2008) to incorporate trade in intermediates in an asymmetric countries environment. Our aim is to derive the firm-country equations for export participation and values and to include cross country determinants of export and import activities, which is the focus of the paper.

2.1. The firm-level export gravity equation

We consider a model with N potential asymmetric countries, indexed by n, each of them populated by a continuum of individuals of measure L_n. Individuals derive utility from the consumption of the $H+1$ final goods existing in the economy, with Q_{hn} representing consumption of final good h in the generic country n and μ_h is the optimal share of expenditure devoted to good h. Sector 0 produces an homogeneous good while each of the rest H different sectors produces a continuum of varieties ω in the set Ω_h. Preferences across different varieties of the same final good are described by standard CES utility function with $q_{hn}(\omega)$ denoting the quantity consumed of variety ω of good h in country n and the parameter σ_h controls for the elasticity of substitution across varieties within the sector h.

The homogeneous good is produced under perfect competition using a linear technology. To produce one unit of the homogeneous good in country n, a firm needs to employ $(1/\varepsilon_n)$ units of labour. As standard in this literature, if we consider this good as the numeraire, perfect competition implies that this sector pins down the wages in each country (i.e. $w_n = \varepsilon_n$).

In the other final good sectors, each firm produces a unique differentiated variety. To produce, each firm f in sector h needs to incur in a per period fixed cost of operation F_h (in units of the numeraire). We assume that firms use intermediate inputs and labor to produce using the following Cobb-Douglas technology

$$q_{hn}^{f} = \varphi_h^{f} \left(l_{hn}^{f}\right)^{1-\alpha_h} \left(m_{hn}^{f}\right)^{\alpha_h} \tag{1}$$

where l_{hn}^{f} denotes labor dedicated to production, $m_{hn}^{f} = \left(\int\limits_{\nu\epsilon\Lambda} \left(m_{hn}^{f}(\nu)\right)^{\frac{\phi_h - 1}{\phi_h}} \right)^{\frac{\phi_h}{\phi_h - 1}}$ is the intermediate composite input used in sector h where $m_{hn}^{f}(\nu)$ is a firm f's demand of the intermediate input variety ν produced in country n, and φ_{h}^{f} denotes a firm's innate productivity described below. The parameter $\phi_h > 1$ controls for the degree of substitutability across intermediate inputs within a sector. The parameter α_h measures the importance of intermediate inputs in the production of each final good. Both are assumed to be identical across countries. Common to Romer (1990) and Rivera-Batiz and Romer (1991), we assume that there are decreasing returns to scale associated with each intermediate input variety (i.e., $\frac{\phi_h - 1}{\phi_h} < 1$) while a firms' production increases with the mass of varieties of intermediates used.

Firms in the H final good sectors differ in their innate productivity φ_{h}^{f}. Following Chaney (2008), we assume that each firm, at the moment of entry, obtains its innate ability from a common Pareto distribution with cumulative distribution function given by

$$\Pr(\varphi_{h}^{f} \leq \varphi) = 1 - \varphi^{-\gamma_h}$$

with γ_h controlling for the productivity dispersion within sectors.[4]

In the intermediate input sector, each firm within each country is producing a unique variety using one unit of labor to produce one unit of output. As in Chaney (2008), we assume that the mass of entrants is proportional to the income of the economy (i.e. $w_n L_n$) and we denote with $0 < \beta_{sn} < 1, s = h, m$, respectively the proportion of firms in each final good sector h and in the intermediate input sector m in country n.

Firms can trade in both final goods and intermediate inputs. Moreover, both activities bear fixed and variable costs. A firm in the final good sector h and country k which wants to export to country j must pay a fixed cost of F_{hxkj} units of the homogeneous good while a firm in the same sector and country which wants to import needs to pay a fixed cost of F_{hik} units. In order to keep tractability in the model, we assume that once a firm pays F_{hik}, it has access to all the intermediate inputs varieties available in the world. In section 2.2, we show that the effects of importing intermediates on exporting at the firm-level can be summarized with one statistic independently of the latter assumption. The inclusion of fixed costs in both activities implies that not all firms are going to find profitable either to export final goods or to import intermediates. Therefore, the model predicts self-selection in both exporting and importing activities based on productivity levels. In addition, both type of exporters, final good and intermediate producers bear variable trade costs of the iceberg type $\tau_{hlkj},\ l = x, m$. We follow Anderson and van Wincoop (2004) in assuming that the amount of units an exporter must ship for selling one unit of its product at destination, τ_{hlkj}, is a log-linear function of D_{kj}, the distance between countries, and Δ_{hlkj} which represents other variable costs (i.e. tariffs). More precisely,

$$\tau_{hlkj} = \Delta_{hlkj} \left(D_{kj}\right)^{\delta_h}, l = x, m \tag{2}$$

where $\Delta_{hlkj} > 1$ if $k \neq j$ and δ_h is the elasticity of trade costs to distance.

In this model entry is exogenous and firms earn positive profits. To complete the definition of the model, as it is common in the literature, we assume that all existing firms in the world belong to a mutual fund and each individual in each country owns w_n shares of this mutual fund.

Given the general set-up, we can now derive the two firm-level export gravity equations, for the extensive and the intensive margin respectively, which are the focus of the current work. In order to obtain these two expressions one needs to derive first firms' productivity threshold required to survive in the market (φ_{hk}), to export (φ_{hxkj}) to a country, and to import (φ_{hik}). Indeed, the export productivity point, φ_{hxkj}, depends on the aggregate price index which is an endogenous variable that in turn depends on both the import and the survival productivity thresholds. Using these productivity cutoffs and solving for the aggregate price index allows to

[4]Following the broad literature on trade and firm heterogeneity we assume $\gamma_h > \sigma_h - 1$ and $\gamma_h > 2$.

obtain the export gravity equations. The details of the derivation for the firm-level extensive and the intensive margin of exports are provided in the Online Appendix of the paper.

Since the model is deterministic, depending on the parameters configuration we can have different types of equilibria. Here our focus is on equilibria where the firms engaged in international trade are either both exporters of final goods and importers of intermediate products or just only importers. The sufficient and necessary condition for the existence of this type of equilibria is reported in the Online Appendix.

The firm-level gravity equation for the extensive margin of export, that is the probability that a firm in country k exports to country j, is given by

$$\Pr(\varphi \geq \varphi^*_{hxkj}) = (\lambda'_{4h})^{-\gamma_h} \underbrace{\left(\frac{Y_j}{Y}\right)\left(\frac{w_k \tau_{hxkj}}{\theta'_{hj}}\right)^{-\gamma_h} (f_{hxkj})^{\frac{-\gamma_h}{\sigma_h - 1}}}_{Chaney's} \underbrace{(\tilde{\chi}_{hk})^{\gamma_h}}_{intermediate\ contribution} \tag{3}$$

where λ'_{4h} is a constant, θ'_{hj} is the multilateral resistance term and $\tilde{\chi}_{hk} = \chi_{hk} \left(\frac{\beta_{mk} Y_k}{Y}\right)^{\frac{\alpha_h}{\phi_h - 1}}$.

This expression relates the standard elements found in a gravity equation to the probability that a firm in k exports to country j (and therefore the mass of firms in k exporting to country j). The last element of equation (3) captures the contribution of intermediate inputs to a firm's Total Factor Productivity (TFP). This element is crucial to our analysis since it captures the response to changes in trade costs or market size of a firm's trade partners in the firm's export status via importing. In the next section we will show and develop this last point in greater detail.

The firm-level gravity equation for the intensive margin of exports, that is the firm's export volume to country j, is given by

$$X^f_{hxkj}(\varphi^f) = (\lambda'_{3h}) \underbrace{\left(\frac{Y_j}{Y}\right)^{\frac{\sigma_h - 1}{\gamma_h}} \left(\frac{\theta'_{hj}}{w_k \tau_{hxkj}}\right)^{\sigma_h - 1}}_{Chaney's} \underbrace{(\tilde{\chi}_{hk})^{\sigma_h - 1}}_{intermediate\ contribution} (\varphi^f)^{\sigma_h - 1} \tag{4}$$

where λ'_{3h} is a constant.[5] As for the extensive margin, a firm's exports of country k to j depends on the use and the amount of intermediates, as expressed by the last element of equation 4.

2.2. Imports, total factor productivity and country characteristics

Given expressions 3 and 4, we derive a set of predictions that can be tested empirically.

Proposition 1. *Importing intermediate inputs has a positive effect on a firm's productivity. This effect depends on the characteristics of the country of origin of imports.*

Since a firms' technology presents decreasing returns to scale associated with each intermediate input, importing intermediates allows the firm to escape from these decreasing returns by splitting its intermediate input requirements across more varieties. The ability of a firm to do so depends on the mass of imported intermediate inputs available, as well as on the price of each intermediate input. Indeed, it is possible to derive a firm's total factor productivity

$$\frac{q^f_{hk}}{\left(l^f_{hk}\right)^{1-\alpha_h}\left(M^f_{tot}\right)^{\alpha_h}} = \varphi^f_h \underbrace{\underbrace{\left[\sum_{j=1}^{N}\left(\left(\frac{w_j}{w_k}\right)\tau_{mjk}\right)^{1-\phi_h}\left(\frac{\beta_{mj}}{\beta_{mk}}\right)\frac{Y_j}{Y_k}\right]^{\frac{\alpha_h}{\phi_h - 1}}}_{\chi_{hk}} \left(\frac{\beta_{mk} Y_k}{Y}\right)^{\frac{\alpha_h}{\phi_h - 1}}}_{\tilde{\chi}_{hk}} \left(\frac{(1+\pi)}{Y}\right)^{\frac{\alpha_h}{1-\phi_h}}. \tag{5}$$

[5] Following Chaney (2008) notation $\lambda'_{3h} = \sigma\,(\lambda'_{4h})^{1-\sigma}$.

where the left-hand side is the expression for the TFP of a firm f belonging to sector h, that we will bring directly to the data in section 4.1. In the right-hand side of the equation, the first term represents a firm's innate productivity, the second term ($\tilde{\chi}_{hk}$) captures the contribution of intermediate inputs to a firm's TFP and the third term is just a constant common to all firms. The term $\tilde{\chi}_{hk}$ is a weighted sum of the varieties sourced from each country where the weights take into account the fact that varieties coming from different countries have different prices.[6] This term can be conveniently decomposed in an element, χ_{hk}, that reflects the gains from importing intermediates and a component that accounts for the effect of the number of domestic varieties. The gains from importing depend: *(i)* on the transportation costs, which determine the price of the different varieties of intermediate inputs, and *(ii)* on the mass of varieties sourced from each location. The term χ_{hk}, capturing the effect of importing intermediates on a firm's TFP, can be rewritten as $\left(\frac{M^f_{tot}}{M^f_k}\right)^{\frac{\alpha_h}{\phi_h-1}}$, where M^f_k is the total volume of domestic intermediate inputs used by a firm.[7]

Note that the result concerning the gains from importing is robust to an alternative richer environment in which a firm bears fixed costs of importing per market, which are source-country specific. When the fixed costs of importing are heterogeneous across countries, a firm's choice regarding the number of source markets will depend on the characteristics of these markets and on its innate productivity. This will influence the number of countries included in χ_{hk}. However, the statistic $\left(\frac{M^f_{tot}}{M^f_k}\right)^{\frac{\alpha_h}{\phi_h-1}}$ would still capture the positive contribution of importing on a firm's TFP. Therefore, Proposition 1 of the model holds both in the simplified setting of a unique fixed cost of importing and in the more general case in which there are multiple fixed costs of importing and these are heterogeneous across countries.

Proposition 2. *The effect of distance on a firm's probability of exporting and its export value is magnified by the presence of trade in intermediate inputs.*

To the extent that export and import variable costs have common determinants, as assumed in the model, a decrease in transportation costs has a comparatively larger impact on exports than in the absence of intermediate imports. This is the consequence of the fact that a reduction in distance affects a firm's export patterns through a direct effect, standard in the literature, and an indirect effect, via importing. Taking logs and derivatives in equation (3) we obtain the effect that a decrease in D_{kj} has on a firm's export status

$$\frac{d\ln(\Pr(\varphi \geq \varphi^*_{hxkj}))}{d\ln(D_{kj})} = -\delta_h\gamma_h + \gamma_h\frac{d\ln\chi_{hk}}{d\ln D_{kj}} \tag{6}$$

and a similar expression is obtained for a firm's export value

$$\frac{d\ln X^f_{hxkj}(\varphi^f)}{d\ln D_{kj}} = -\delta_h(\sigma_h-1) + (\sigma_h-1)\frac{d\ln\chi_{hk}}{d\ln D_{kj}}. \tag{7}$$

The direct effect corresponds to the first element on the right hand side of equations (6) and (7). That is, a reduction in the transportation costs between the country of origin k and the country of destination j allows a firm to charge lower prices, increasing both the probability that a firm becomes an exporter to that destination and its export sales to that country. The indirect effect is inherent to this framework and it is captured by the second element of both equations. The reduction in transportation costs between k and j decreases the cost of importing intermediates from country j. This allows a firm to better reallocate its intermediate

[6] Indeed, if there were no transportation costs and wages were equal across countries this term will be reduced to $\sum_{j=1}^{N}\frac{\beta_{mj}Y_j}{Y}$.

[7] See section 2.2 in the Online Appendix for a formal proof.

input requirements across existing varieties and, as a consequence, to become more efficient, as indicated in equation (5). The increase in a firm's TFP allows to charge lower prices, increasing its probability of exporting and its export sales not only to country j but to all destinations.[8]

Proposition 3. *The effect of market size on a firm's probability of exporting and on its export value is magnified by the presence of trade in intermediate inputs.*

Taking logs and derivatives in equation (3) we obtain the effect that a decrease in Y_j has on a firm's export status

$$\frac{d\ln(\Pr(\varphi \geq \varphi^*_{hxkj}))}{d\ln Y_j} = 1 + \gamma_h \frac{d\ln \chi_{hk}}{d\ln Y_j}. \tag{8}$$

and a similar expression is obtained for a firm's export value

$$\frac{d\ln X^f_{hxkj}(\varphi^f)}{d\ln Y_j} = \left(\frac{\sigma_h - 1}{\gamma_h}\right) + \left(\frac{\sigma_h - 1}{\gamma_h}\right)\frac{d\ln \chi_{hk}}{d\ln Y_j}. \tag{9}$$

An increase in foreign market size has a positive effect on exports due to both a direct and an indirect effect. First, the larger the income level of country j, the larger the expenditure on final goods and the market potential for exporters. This reduces the productivity level necessary to cover the fixed costs of exporting to that destination and it increases a firm's export sales to that country. Second, the positive effect of the country size is magnified by the fact that the foreign market could be also a source of intermediate inputs. The larger the source country, the larger the mass of imported intermediate inputs. The access to a larger set of intermediate input varieties coming from that country has a positive effect on a firm's TFP and it allows a firm to charge lower prices. A firm's probability of becoming an exporter and its export value to country j as well as to all other destinations ($s \neq j$), consequently, increases.[9]

The simple theoretical model presented in the paper explores the potential effect of changes in trade costs or market sizes on a firm's export patterns in a tractable manner. The main predictions of the model holds in a more complex but richer environment in which we allow for technological differences in the production of intermediates across countries and differences in quality across intermediate inputs. The Online Appendix discusses the robustness of our results under these alternative assumptions.

3. Data

This section describes the firm-level data and the country-level variables employed in the regressions. The empirical analysis combines two sources of data collected by the Italian Statistical Office (ISTAT): the Italian Foreign Trade Statistics (COE), and a firm-level accounting dataset (Micro.3).[10] The data are available for the period 2000-2006.

[8]Indeed, the decrease in the cost of importing from country j has an impact also on a firm's export behavior to destination country s, with $s \neq j$, that is $\frac{d\ln(\Pr(\varphi\geq\varphi^*_{hxks}))}{d\ln(D_{kj})} = \gamma_h \frac{d\ln\chi_{hk}}{d\ln D_{kj}}$ and $\frac{d\ln X^f_{hxks}(\varphi^f)}{d\ln D_{kj}} = (\sigma_h - 1)\frac{d\ln\chi_{hk}}{d\ln D_{kj}}$.

[9]In this framework the domestic market size also affects a firm's export behaviour. More populated and more productive economies provide a greater number of varieties of intermediate inputs which increases a firm's TFP (this is reflected in equation 5). The increase in a firm's TFP decreases the marginal cost of production which allows a firm to charge lower prices. The latter gives a competitive advantage to domestic firms in foreign markets. Unfortunately, we are not able to test this prediction since we have information only for one domestic market, that is Italy.

[10]The database has been made available for work after careful screening to avoid disclosure of individual information. The data were accessed at the ISTAT facilities in Rome. The database has been built as a result of collaboration between ISTAT and a group of LEM researchers from the Scuola Superiore Sant'Anna, Pisa. See Grazzi et al. (2013) for further details.

The COE dataset is the official source for the trade flows of Italy and it reports all cross-border transactions performed by Italian firms.[11] For all trade flows, we observe annual values, expressed in euros, disaggregated by countries of destination for exports and markets of origin for imports. The available information on product categories, classified according to the 6-digit Harmonized System allows us to single out firms' imports in intermediate inputs defined as those falling into the intermediate input category according to the Broad Economic Categories (BEC) classication of HS6 products. The BEC classification has been widely used in the literature of international trade to identify intermediate inputs (Amiti et al., 2014; Brandt et al., 2012).

Data on firm-level characteristics are obtained from Micro.3, which includes census data on Italian firms with more than 20 employees from all sectors of the economy for the period 1989-2006. The database contains information on a number of variables appearing in a firm's balance sheet. For the purpose of this paper we use: number of employees, turnover, value added, capital, labour cost, intermediate inputs costs and capital assets. Capital is proxied by tangible fixed assets at book value (net of depreciation). Nominal variables are in million euros and are deflated using 2-digit industry-level production prices indices provided by ISTAT. After merging these two databases, we work with an unbalanced panel of about 48,179 manufacturing firms over the sample period.

In addition to firm-level data, we complement the analysis with information on country characteristics. We consider the two standard gravity-type variables, GDP_{jt} and $Distance_j$ to proxy for market size (Y_{jt}) and transportation costs (D_j), respectively. Data on GDP are taken from the World Bank's World Development Indicators database. Information on geographical distances are taken from CEPII and calculated following the great circle formula (De Sousa et al., 2012).

We augment the gravity model by including additional variables that might be expected to affect the costs of trading internationally. As predicted by equation (3) of our model, the probability of exporting depends on variable trade costs not related to distance (Δ_j), market specific fixed costs (F_j) and a multilateral resistance term (θ_{jt}). At the same time equation (4) suggests that a firm's export sales to a specific destination can be modelled in a parallel fashion to the model for export participation, though in this case market-specific fixed costs are not included.

For additional trade costs (Δ_j), we use a measure of average country-level import tariffs taken from the Fraser Institute ($Trade\ Opening_{jt}$)(Gwartney et al., 2014). This variable is a simple average of three sub-components: revenue from trade taxes, the mean tariff rate and the standard deviation of tariffs. Each sub-component is a standardized measure ranging from 0 to 10 which is increasing in the freedom to trade internationally. As a robustness check, available upon request, we get the most-favored-nation tariffs (MFN tariffs) from the World Integrated Trade Solution (WITS) dataset.

The market specific fixed costs (F_j) can be related to the establishment of a foreign distribution network, difficulties in enforcing contractual agreements, or the uncertainty of dealing with foreign bureaucracies. Following Bernard et al. (2015), to generate a proxy for these costs we use information from three measures from the World Bank Doing Business dataset: number of documents for importing, cost of importing and time to import (Djankov et al., 2010). Given the high level of correlation between these variables, we use the primary factor ($Market\ Costs_j$) derived from principal component analysis as that factor accounts for most of the variance contained in the original indicators.

Finally, to proxy the multilateral resistance terms (θ_{jt}) we employ the variable $Remoteness_{jt}$ which captures the extent to which a country is separated from other potential trade partners. The idea is that a remote country has high shipping costs, high import prices, and thus a high aggregate price index. As in Manova and Zhang (2012) the variable remoteness is computed for

[11] ISTAT collects data on trade based on transactions. A detailed description of requirements for data collection on trade is provided in the Online Appendix.

Table 1: Production function estimates

	$\ln l$ (1)	$\ln k$ (2)	$\ln \frac{M_{tot}}{M_k}$ (3)	N.Obs (4)
Food, Beverages and Tobacco	0.78***	0.16***	0.72***	9,875
Textiles and Apparel	0.91***	0.08***	0.39***	16,579
Hide and Leather	0.91***	0.08***	0.58***	6,517
Wood and Cork	0.97***	0.11***	0.25***	3,753
Pulp and Paper	0.90***	0.12***	0.27***	3,351
Printing and Publishing	0.92***	0.09***	0.33***	4,848
Coke and Chemical products	0.99***	0.06***	0.25***	6,334
Rubber and Plastics	0.91***	0.09***	0.41***	9,258
Processing of non-metallic minerals	0.88***	0.17***	0.31***	8,382
Basic Metals	0.90***	0.10***	0.29***	4,268
Fabricated Metal Products	0.86***	0.11***	0.37***	23,748
Machinery and Equipment	0.96***	0.05***	0.28***	21,647
Electrical and Optical Equipment	0.94***	0.07***	0.26***	12,296
Motor Vehicles and Trailers	0.82***	0.11***	0.16***	2,857
Other Transport Equipment	0.91***	0.12***	0.38***	1,726
Other manufacturing industries	0.90***	0.09***	0.23***	9,876

Note: The table reports regressions using data on 2000-2006. Column (1) reports the coefficient of labour (l), column (2) the coefficients of capital (k) and column (3) the coefficients of the ratio of intermediate inputs on domestic inputs (M_{tot}/M_k) of a production function estimation run sector by sector. All the regressions include a constant term. Bootstrapped standard errors (500 replications) are reported in parenthesis below the coefficients. Asterisks denote significance levels (***:p<1%; **: p<5%; *: p<10%).

each country as the distance weighted sum of the market sizes of all trading partners. Precisely, $Remoteness_j = \sum_{n=1}^{N} GDP_n * distance_{nj}$, where GDP_n is the GDP of the origin country and $distance_{nj}$ is the distance between n and j, and the summation is over all countries in the world n. Our results are robust to the use of an alternative measure of remoteness used in Baldwin and Harrigan (2011) given by $Remoteness_j = \sum_{n=1}^{N} (GDP_n/distance_{nj})^{-1}$.

4. Results

This section presents the results of our empirical analysis testing the main predictions of our theoretical model derived in section 2. We follow three steps. First, we provide evidence that importing has a positive effect on a firm's TFP.[12] Second, we estimate the equation for a firm's export participation and for its export sales and show the influence that the component of TFP related to importing has on both the extensive and the intensive margin of exports. Third, we estimate the indirect impact that the two gravity forces have on a firm's exports due to the presence of imports in intermediates.

4.1. Imported intermediate inputs and firm productivity

Proposition 1 suggests that importing intermediate inputs increases a firm's productivity. Equation (5) derives an expression for a firm's TFP which depends on its initial productivity draw, (φ^f), the ratio of total intermediates over domestic inputs used, $\left(\frac{M_{tot}^f}{M_k^f}\right)$ and a set of variables which are constant at the firm-level.

[12] As done by Bas and Strauss-Kahn (2014); Goldberg et al. (2010); Kasahara and Lapham (2013) we could also show that productivity is increasing in the number of varieties imported by firms. This question is left for future research as our focus here is on the indirect effect on a firm's exports of the two gravity forces due to an increase in a firm's efficiency.

As a first step of our empirical investigation, we estimate total factor productivity taking into account the ability of a firm to import intermediates. We obtain estimates of the production function by relying on the semi-parametric strategy proposed by Levinsohn and Petrin (2003) and refined by De Loecker (2013). The aim of this methodology is to solve the problem of simultaneity between the inputs choice and the productivity shocks, the latter being unobserved by the econometrician. This is done by proxying the productivity shocks with a function of materials and by retrieving the innovation in productivity (the component of productivity at time t which is not predictable by the firm at time $t-1$) based on a first order Markov process for productivity. The works of De Loecker (2013) point to the importance of allowing the demand of intermediate inputs and the productivity dynamics to depend on internationalization choices of the firm.[13]

For each sector h, we consider the production function used in our theoretical model augmented with physical capital

$$\ln y_t^f = \beta_0 + \beta_l \ln l_t^f + \beta_k \ln k_t^f + \frac{\alpha}{\phi - 1} \ln \frac{M_{tot,t}^f}{M_{kt}^f} + \ln \varphi_t^f + \epsilon_t^f \qquad (10)$$

where y_t^f is the value added of firm f at time t, l_t^f is labor, k_t^f stands for the capital stock and $\frac{M_{tot,t}^f}{M_{kt}^f}$ corresponds to the ratio of total over domestic intermediate inputs. The error can be decomposed into a productivity shock φ_t^f, observable to firms but not to the econometrician, and an i.i.d. component ϵ_t^f. The constant, β_0, subsumes common industry-level factors such as Y_k in equation (5).

Table 1 presents the results of the production function estimates. The estimated coefficients for the ratio of total over domestic intermediate inputs in equation (10) are always positive and statistically significant across different sectors, pointing to the importance of foreign intermediates in explaining productivity differences across firms within sectors. At one extreme, for the Food, Beverage and Tobacco sector, we find that a 10% rise in the ratio of intermediate inputs on domestic inputs would increase productivity by 7.2%. At the bottom of the sectoral distribution, this effect amounts to 1.6% for the Motor Vehicles and Trailers sector.

4.2. The extensive and intensive margins of exports

Equations (3) and (4) describe how a firm's decision to export and its export value to a country are related to gravity forces both through a direct effect and an indirect effect due to the TFP contribution of trade in intermediates. These two equations form the underpinning of our estimations. Therefore, a model for a firm's decision to export to a specific country can be specified as follows

$$ExportStatus_{jt}^f = b_0 + b_1 \ln \widehat{\varphi}_t^f + b_2 \ln \widehat{\chi}_t^f + b_3 \ln D_j + b_4 \ln Y_{jt} + b_5 \Delta_{jt} + b_6 F_j + b_7 \ln \theta_{jt} + d^f + d_i + \epsilon_{jt}^f \qquad (11)$$

where the dependent variable, $ExportStatus_{jt}^f$, is a dummy variable that takes value one if a firm f exports to country j at time t and zero otherwise. The empirical specification includes our estimates for a firm's innate productivity, $\widehat{\varphi}_t^f$, and for the TFP-enhancing effect of imported intermediate inputs $\ln \widehat{\chi}_t^f = \widehat{\frac{\alpha}{\phi-1}} \ln \frac{M_{tot}^f}{M_k^f}$. In accordance with our model we expect both b_1 and b_2 to be positive. In addition, the equation includes all the country-level variables that appear in equation (3) (Y_{jt}, θ_{jt}, D_j, Δ_{jt}, F_j). The model predicts that the probability of serving the foreign market j should increase with the size of the country ($b_4 > 0$) and the level of remoteness ($b_7 > 0$) and decrease with the level of variable costs ($b_3 < 0$; $b_5 < 0$) and fixed costs ($b_6 < 0$).

Following Bernard and Jensen (2004) to estimate our binary choice framework with unobserved heterogeneity, we employ a linear probability model so that firm fixed effects are

[13] In the Online Appendix we describe in detail the TFP estimation.

accounted for in the regressions. Although this estimation strategy suffers from the problem of predicted probabilities outside the 0-1 range, it allows us to control for any unobserved time constant firm characteristic that influences the decisions regarding entry into foreign markets. We report standard errors clustered at the firm-level but the results are robust to alternative treatments of the error terms, such as clustering by country or firm and country. By exploiting the three-dimensional nature (firms, destinations, time) of our dataset we include firm fixed effects, d^f, to account for time-invariant firm-level unobserved heterogeneity. Moreover, we introduce year-geographical areas dummies (d_i) to account for all the time-variant shocks common to countries belonging to the same area. We group countries in 20 different areas as done in Serti and Tomasi (2014).

We next explore whether firm and country differences are relevant for determining how much a firm sells across different markets, that is the intensive margin of exports. The econometric model, which can be thought of as a micro-gravity equation, takes the following form

$$\ln Exports^f_{jt} = c_0 + c_1 \ln \widehat{\varphi}^f_t + c_2 \ln \widehat{\chi}^f_t + c_3 \ln D_j + c_4 \ln Y_{jt} + c_5 \Delta_{jt} + c_6 \ln \theta_{jt} + d^f + d_i + \epsilon^f_{jt} \tag{12}$$

where the dependent variable is the (log) total exports of firm f to country j at time t. As in the previous equation, we include a firm's innate productivity, the TFP component related to the use of imported inputs, country determinants, firm dummies and year (or year-area) dummies. Following equation (4), we exclude the trade fixed costs variable. As for the export decision equation, we run the regression controlling for firm and year-area fixed effects.

To take into account firms' unobserved heterogeneity, we estimate equation 12 also using the level of exports as dependent variable by employing a conditional (firm) fixed-effects Poisson model (Silva and Tenreyro, 2006), which is appropriate for nonlinear models such as the gravity equation. The main advantage of the Poisson estimator is that it naturally includes observations for which the observed trade value is zero, that is it takes into account the extensive and the intensive margins at the same time. Such observations are dropped from the OLS model because the logarithm of zero is undefined. However, especially at the firm level, zero trade flows are very common, since not all firms are trading with all partners.

One of the main problems in estimating equations (11) and (12) concerns the potential endogeneity of our key covariate, that is the estimated TFP-enhancing effect of imported intermediate inputs ($\widehat{\chi}^f_t$), which is a positive function of the share of imported intermediate inputs. The introduction of firm fixed effects ensures that our results are not driven by time constant unobserved heterogeneity which is correlated with the imported inputs decisions. However, endogeneity can arise because of time variant omitted variables, simultaneity problems, or measurement error.

First, in estimating the evolution of $\widehat{\varphi}^f_t$ we incorporate possible learning by importing effects and we rely on lagged inputs sourcing strategies in the moment conditions.[14] This should reduce the likelihood that the error term contains unobserved productivity shocks that affect both our key variable and a firm's sales (abroad and at home). However, we cannot rule out that a firm changes its share of imported intermediate inputs as a reaction to cost and/or demand shocks which are not picked up by $\widehat{\varphi}^f_t$.[15] A positive correlation between these productivity shocks and the relative use of imported intermediates would induce an upward bias in the estimates of the $\widehat{\chi}^f_t$ coefficient.

Second, our model suggests that causality runs from importing to exporting. However, in the presence of learning-by-exporting causality may run also in the other direction: by expanding their exports firms become more efficient and, as a consequence, increase their use of imported intermediate inputs. This would make the estimates of $\widehat{\chi}^f_t$ coefficient be downward biased.

[14] This is shown in equations (5) and (6) of the Online Appendix.

[15] Since we are using a value added-generating production function, $\widehat{\varphi}^f_t$ contains both efficiency and demand factors.

Third, our main dependent variable is likely to be measured with error because we cannot observe the prices of intermediate inputs and we are using aggregate sectoral prices to deflate their observed values. If expansions in the deflated value of domestic (imported) intermediate inputs understates (overstates) the actual increase in the use of domestic (imported) intermediate inputs, the coefficient for $\widehat{\chi}_t^f$ would be downward biased.

To identify the causal effect of the TFP related to imported inputs on firms' export activities we apply an instrumental variable approach and consider different sets of instruments.

As a first strategy, following previous work by Mion and Zhu (2013), we construct firm-level instruments based on three macroeconomic variables: real exchange rate (RER), input tariffs (TARIFF) and gross domestic product (GDP).[16] While the first two variables capture exogenous changes in the relative costs, the last proxies variations in the number of available varieties of foreign intermediate inputs. Starting from these three variables, we compute firm-level instruments by taking a weighted average where the weights reflect the relative importance of the different source countries in a firm's total imported inputs. Specifically, we construct, for each firm, the weighted average of $\ln RER$, denoted as IV_{RER_f}, and of $\ln GDP$, denoted as IV_{GDP_f}, using as weights a firm's import share of each country. As far as tariffs are concerned, we exploit the disaggregated nature of our dataset by constructing a firm-level input tariff IV (IV_{TAR_f}) using as weights each firm's import shares at the product-country level. In order to address issues related to changes, across products or countries, in the firm imported input mix due to variations in the macro variables, we rely on constant weights computed as the import shares of the initial year. As a robustness check we adtop alternative weighting strategies, e.g., one year lagged import shares or the import shares of the first year in which the firm is observed importing. By employing these instruments we aim at exploiting the exogenous variation of source weighted macro variables as predictors of changes in the usage of imported intermediate inputs at the firm level.

Estimation results are shown in columns 1-3 of Table 2 for the extensive margin, the intensive margin and the Poisson specification, respectively.[17] At the bottom of the Table we report the under-identification (Kleibergen-Paap LM), weak identification (Kleibergen-Paap Wald F), and over-identifying restriction (Hansen J) statistics and p-values. The statistics of the first two tests indicate that our instruments have predictive power and the Hansen test suggests that our instruments are valid.

The results provide a clear picture. Column 1 shows that a firm's probability of exporting to a destination is positively affected by both the innate productivity ($\widehat{\varphi}_t^f$) and the TFP-enhancing effect of imported intermediate inputs ($\widehat{\chi}_t^f$). A 10 percent increase in the innate productivity is associated with an increase of about 1.4 percentage points in the probability of exporting to a destination. The magnitude of this effect is sizable if compared with the probability of exporting to a country observed in our sample, which is about 8 percent. This means that a firm's probability of exporting to a country rises of approximately 18 percent, following a 10 percent increase in $\widehat{\varphi}_t^f$. The coefficient for the contribution of imported intermediate inputs to TFP is positive and statistically significant. The coefficient is higher in magnitude to that observed for the innate productivity: a 10 percent increase in $\widehat{\chi}_t^f$ is associated with an increase of about 7.5 percentage points in the probability of exporting to a destination. The result provides evidence for the relevance of the TFP-enhancing effect of imported intermediates: a rise of 10 percent of $\widehat{\chi}_t^f$ increases the probability of exporting by more than 90 percent.

As for the two gravity variables, we find that the probability of exporting to a specific market

[16]The information on RER comes from the International Financial Statistics (IFS) of the IMF, those on GDP comes from the World Bank database, and for tariff we use the Most Favorite Nation (MFN) applied tariff at the HS6 level collected by the WITS (World Bank) database for the 2000-2006 period.

[17]For both the linear and Poisson specifications we use a GMM estimator. For the former we use the moment conditions described in Blundell et al. (2002) and Agrawal et al. (2014): $E\left[\left(y_{it} - \mu_{it}\frac{\overline{y_i}}{\overline{\mu_i}}\right) z_{it}\right] = 0$, where $\mu_{it} = \exp(x_{it}\beta)$ and $(\overline{y_i}, \overline{\mu_i})$ are means of the outcome and the predicted outcomes at the firm level.

Table 2: Firms' exports extensive and intensive margin by country: instrumental variables

Dep. Var.	$ExportStatus^f_{jt}$	$\ln Export^f_{jt}$	$Export^f_{jt}$	$ExportStatus^f_{jt}$	$\ln Export^f_{jt}$	$Export^f_{jt}$	$ExportStatus^f_{jt}$	$\ln Export^f_{jt}$	$Export^f_{jt}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$IV_{RER_f}IV_{GDP_f},IV_{TAR_f}$			$IV^P_{OECDM_f}IV^P_{EUM_f}$			$IV^C_{OECDM_f}IV^C_{EUM_f}$		
$\ln \widehat{\varphi}^f_t$	0.138***	1.170***	1.451***	0.116***	1.480***	1.427***	0.117***	1.417***	1.366***
	(0.016)	(0.136)	(0.329)	(0.016)	(0.182)	(0.329)	(0.014)	(0.160)	(0.274)
$\ln \widehat{\chi}^f_t$	0.751***	5.332***	12.678***	0.598***	7.529***	11.310***	0.605***	7.007***	10.487***
	(0.084)	(1.028)	(3.395)	(0.087)	(1.380)	(4.372)	(0.074)	(1.192)	(3.276)
$\ln GDP_{jt}$	0.062***	0.507***	0.837***	0.058***	0.491***	0.833***	0.057***	0.491***	0.836***
	(0.000)	(0.004)	(0.019)	(0.000)	(0.004)	(0.018)	(0.000)	(0.004)	(0.025)
$\ln Distance_j$	-0.089***	-0.521***	-0.925***	-0.084***	-0.505***	-0.939***	-0.084***	-0.505***	-0.967***
	(0.001)	(0.009)	(0.061)	(0.001)	(0.008)	(0.058)	(0.001)	(0.008)	(0.059)
$Trade\ Opening_{jt}$	0.011***	0.052***	0.038**	0.010***	0.048***	0.043**	0.010***	0.049***	0.050***
	(0.000)	(0.003)	(0.018)	(0.000)	(0.003)	(0.017)	(0.000)	(0.003)	(0.018)
$\ln Remoteness_{jt}$	0.089***	0.448***	0.990***	0.085***	0.424***	1.030***	0.085***	0.422***	1.029***
	(0.002)	(0.034)	(0.225)	(0.002)	(0.032)	(0.202)	(0.002)	(0.032)	(0.205)
$Market\ Costs_j$	-0.016***		-0.310***	-0.014***		-0.299***	-0.014***		-0.268***
	(0.000)		(0.063)	(0.000)		(0.060)	(0.000)		(0.053)
Year*Area FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	6,881,017	1,265,926	6,881,017	8,474,705	1,437,138	8,474,705	8,504,862	1,439,078	8,504,862
adj. R^2	0.359	0.339		0.349	0.331		0.349	0.332	
Underidentification stat.	203.542	180.981		169.497	111.183		241.706	157.994	
(p-value)	0.000	0.000		0.000	0.000		0.000	0.000	
Weak identification stat.	69.863	61.604		88.192	56.857		126.809	80.709	
Hansen J stat.	0.842	0.583	2.911	0.004	0.203	0.021	0.320	0.035	1.593
(p-value)	0.656	0.747	0.233	0.950	0.652	0.884	0.572	0.851	0.207

Note: The table reports regressions using data on 2000-2006. In Columns 1-3 the instrumental variables $IV_{RER_f}IV_{GDP_f},IV_{TAR_f}$ are built by weithing ln RER, ln GDP and TARIFF by a firm's import share of each country in the initial year. In Columns 4-6 the instrumental variables $IV^P_{OECDM_f}$ and $IV^P_{EUM_f}$ are built by weighting the total imports of non-European OECD and of European countries by the relative importance of a product in a firm's total imports in the initial year. In columns 7-9 the instrumental variables $IV^C_{OECDM_f}$ and $IV^C_{EUM_f}$ are built by weighting the total imports from China of non-European OECD countries and of European countries by the relative importance of a product in a firm's total imports in the initial year. All the regressions include a constant term. Robust standard errors clustered at the firm-level are reported in parenthesis below the coefficients. Asterisks denote significance levels (***:p<1%; **: p<5%; *: p<10%).

increases with market size but decreases with distance. A 10 percent rise in the destination country's GDP is associated with an increase of 0.6 percentage points in the probability of exporting to that country. A 10 percent increase in distance decreases the likelihood of a positive export decision by approximately 0.9 percentage points. As above, to gauge the economic significance of these variables we compare the estimated effects with the observed probability of exporting. The coefficient for market size suggests that, holding all other independent variables constant, a 10 percent increase in the GDP of a country raises the probability of exporting to that market by about 8 percent. The *ceteris paribus* effect of a 10 percent increase in distance is a decrease in the probability of exporting of around 11 percent.

Concerning the other country properties, as expected the probability of exporting decreases with market costs. The negative and significant coefficient of $Market\ Costs$ suggests the existence of country-specific fixed export costs: the lower these costs are, the higher the probability of reaching a market. Easy and accessible markets are likely to be served by a large number of firms, whereas less accessible countries with higher fixed export costs are more difficult to export to. The coefficients for $Remoteness$ and $Trade\ Opening$ have both the expected positive sign. Since remoteness makes a destination market less competitive, *ceteris paribus*, it is relatively easier for a firm to serve a trade partner that is geographically isolated from most other nations. The probability of exporting to a country should indeed increase with both the remoteness of the destination and its level of freedom to trade.

Column 2 and 3 of Table 2 report the result for the intensive margin. The estimated parameters display the expected signs. We confirm that both the innate productivity and the TFP-enhancing effect of imported intermediate inputs positively affect a firm's exports to a country. More productive firms export more to each country: a 10 percent increase in a firm's innate productivity increases its exports by approximately 12 percent. Even stronger is the effect of productivity due to imported intermediate inputs: exports increase by more than 50 percent following a rise of 10 percentage of $\widehat{\chi}_t^f$. The estimated elasticities of exports to GDP and $Distance$ are 0.51 and -0.52, respectively. Finally, the estimated effects of $Remoteness$ and $Trade\ Opening$ show the expected positive signs and are statistically significant. Column 3 considers the estimation of Equation (12) in its multiplicative form with a pseudo-maximum-likelihood technique. Looking at the results we can conclude that the main message with respect to the previous specifications does not change. The estimated elasticity of exports with respect to both the innate productivity and the TFP component related to importing is economically and statistically significant. The interpretation of the coefficients from the Poisson model is straightforward, and follows exactly the same pattern as under OLS, that is the coefficients of any independent variables entered in logarithms can be interpreted as simple elasticities.

As a second strategy, similarly to Hummels et al. (2014), we build two other instruments based on the total imports of non-European OECD countries and of European countries, excluding imports from Italy. The total OECD and European countries imports are obtained from the COMTRADE dataset at the level of HS6 products. We create two firm-level indexes using as weights the relative importance of a product in a firm's total imports during the initial year. We denote these two instruments as $IV^P_{OECDM_f}$ and $IV^P_{EUM_f}$. This IV strategy exploits the variation of aggregate imports at the product level for other developed countries as predictor of changes in the TFP enhancing effect of firm-level imports. The exclusion restriction is based on the hypothesis that aggregate import dynamics at the product level for other developed countries are mainly determined by supply-side cost and technology factors which are sufficiently exogenous to a firm's export performance. However, it is possible that the increase in imports of a particular intermediate input is determined by an increase in the international demand of the corresponding final products. Our results are robust to controlling for this by using the total exports of non-European OECD countries and of European countries (excluding Italy), weighted by the relative importance of a product in a firm's total exports in the initial year. These two variables will reflect international demand shocks for a firm's exported products. Results, reported in column 4-6 of Table 2, are robust to the use of these IVs.

Table 3: Firms' exports extensive margin by country: IV. Robustness Checks

Dep. Var.	$ExportStatus^f_{jt}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Learning by exporting		Excluding	Excluding Importers	Firm-Destination and Year-Destination FE		
		ln RER	Only-Exporters	of No-Intermediates		No Imports Dest.	No Imports Dest Learning by Exporting
$\ln\widehat{\varphi}^f_t$	0.134***	0.105***	0.131***	0.167***	0.151***	0.125***	0.122***
	(0.016)	(0.013)	(0.015)	(0.023)	(0.017)	(0.015)	(0.015)
$\ln\widehat{\chi}^f_t$	0.753***	0.565***	0.803***	0.858***	0.818***	0.661***	0.662***
	(0.084)	(0.073)	(0.089)	(0.111)	(0.089)	(0.081)	(0.081)
$\ln GDP_{jt}$	0.062***	0.057***	0.063***	0.068***			
	(0.000)	(0.000)	(0.000)	(0.000)			
$\ln Distance_j$	-0.089***	-0.084***	-0.089***	-0.093***			
	(0.001)	(0.001)	(0.001)	(0.001)			
$Trade\ Opening_{jt}$	0.011***	0.009***	0.011***	0.011***			
	(0.000)	(0.000)	(0.000)	(0.000)			
$\ln Remoteness_{jt}$	0.089***	0.083***	0.089***	0.092***			
	(0.002)	(0.002)	(0.002)	(0.002)			
$Market\ Costs_j$	-0.016***	-0.012***	-0.016***	-0.017***			
	(0.000)	(0.000)	(0.000)	(0.000)			
$\ln RER_{jt}$		-0.003***					
		(0.000)					
Year*Area FE	Yes	Yes	Yes	Yes	-	-	-
Firm FE	Yes	Yes	Yes	Yes	-	-	-
Firm-Destination FE	-	-	-	-	Yes	Yes	Yes
Year-Destination FE	-	-	-	-	Yes	Yes	Yes
N	6,874,184	6,098,845	6,851,795	5,503,763	6,595,861	6,101,267	6,094,859
adj. R^2	0.359	0.309	0.359	0.370	0.791	0.764	0.764
Underidentification stat.	205.816	205.769	201.276	139.243	205.080	205.931	208.411
(p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Weak identification stat.	70.939	70.944	69.190	48.032	70.235	70.720	71.884
Hansen J stat.	0.880	3.156	0.822	3.286	1.368	1.338	1.377
(p-value)	0.644	0.206	0.663	0.193	0.505	0.512	0.502

Note: The table reports regressions for the extensive margin using data on 2000-2006 and using as instrumental variables $IV_{RER_f} IV_{GDP_f}, IV_{TAR_f}$ built by weithing ln RER, ln GDP and TARIFF by a firm's import share of each country in the initial year. In columns 1, 2 and 7 we re-estimate the two TFP components by allowing the law of motion of φ^f_t to endogenously depend on the export share. In column 3 we exclude the only-exporters from the analysis. In column 4 we consider only those firms importing intermediate inputs. In columns 5-7 we control for firm-destination and year-destination fixed effects. In column 6 we exclude from the sample the export destinations from which the firm is importing. Asterisks denote significance levels (***:p<1%; **: p<5%; *: p<10%).

As a third strategy, we use instruments based on the total imports from China of non-European OECD countries and of European countries, excluding Italy. As before, we weight these trade flows by using the relative importance of a product in a firm's total imports during the initial year. We denote the resulting indexes as $IV^C_{OECDM_f}$ and $IV^C_{EUM_f}$. The main insight of these IVs is to exploit the increase in Chinese exports to other developed countries as an exogenous supply shock. Indeed, during our sample period there has been an impressive increase of imports from China, mainly due to its growth in competitiveness and its accession to the WTO. A similar identification strategy is used by Autor et al. (2013); Donoso et al. (2015); Dauth et al. (2018). Our findings are consistent using this alternative IVs. Also the magnitude of the coefficients does not change with respect to the previous estimates.

4.2.1. Robustness checks

In this section, we consider a set of exercises aimed at testing the robustness of our results to alternative estimates of a firm's TFP, to changes in the sample composition, to the inclusion of additional controls in the baseline specification, and to the adoption of alternative fixed effects.

The existence of learning by exporting effects could create reverse causality problems which we tried to address by using IVs. However, there is also the possibility that the variable $\hat{\chi}^f_t$ mechanically contains learning by exporting effects because the import share of a firm is positively correlated to its export share. Therefore, we have re-estimated the two TFP components by allowing the law of motion of φ^f_t to endogenously depend on the export share.

Table 4: Firms' exports intensive margin by country: IV. Robustness Checks

Dep. Var.	$\ln Exports^f_{jt}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Learning by exporting	ln RER	Excluding Only-Exporters	Excluding Importers of No-Intermediates	Firm-Destination and Year-Destination FE	No Imports Dest.	No Imports Dest Learning by Exporting
$\ln \widehat{\varphi}^f_t$	1.156***	1.109***	1.123***	1.265***	1.841***	1.472***	1.441***
	(0.132)	(0.142)	(0.127)	(0.177)	(0.182)	(0.177)	(0.171)
$\ln \widehat{\chi}^f_t$	5.352***	5.311***	5.658***	5.611***	10.548***	7.899***	7.918***
	(1.033)	(1.157)	(1.108)	(1.213)	(1.259)	(1.365)	(1.367)
$\ln GDP_{jt}$	0.507***	0.462***	0.507***	0.520***			
	(0.004)	(0.004)	(0.004)	(0.004)			
$\ln Distance_j$	-0.521***	-0.457***	-0.522***	-0.537***			
	(0.009)	(0.009)	(0.009)	(0.010)			
$Trade\ Opening_{jt}$	0.052***	0.031***	0.052***	0.053***			
	(0.003)	(0.003)	(0.003)	(0.003)			
$\ln Remoteness_{jt}$	0.449***	0.317***	0.449***	0.480***			
	(0.034)	(0.037)	(0.034)	(0.036)			
$\ln RER_{jt}$		-0.018***					
		(0.002)					
Year*Area FE	Yes	Yes	Yes	Yes	-	-	-
Firm FE	Yes	Yes	Yes	Yes	-	-	-
Firm-Destination FE	-	-	-	-	Yes	Yes	Yes
Year-Destination FE	-	-	-	-	Yes	Yes	Yes
N	1,264,966	917,691	1,262,797	1,111,953	1,139,449	809,188	808,584
adj. R^2	0.339	0.295	0.339	0.342	0.822	0.791	0.791
Underidentification stat.	180.480	176.866	181.798	131.450	175.874	165.782	164.150
(p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Weak identification stat.	61.758	60.598	61.984	45.044	59.513	56.398	56.278
Hansen J stat.	0.616	0.390	0.503	0.058	0.908	2.020	2.154
(p-value)	0.735	0.823	0.778	0.971	0.635	0.364	0.341

Note:The table reports regressions for the extensive margin using data on 2000-2006 and using as instrumental variables $IV_{RER_f} IV_{GDP_f}, IV_{TAR_f}$ built by weithing ln RER, ln GDP and TARIFF by a firm's import share of each country in the initial year. In columns 1, 2 and 7 we re-estimate the two TFP components by allowing the law of motion of φ^f_t to endogenously depend on the export share. In column 3 we exclude the only-exporters from the analysis. In column 4 we consider only those firms importing intermediate inputs. In columns 5-7 we control for firm-destination and year-destination fixed effects. In column 6 we exclude from the sample the export destinations from which the firm is importing. Asterisks denote significance levels (***:p<1%; **: p<5%; *: p<10%).

Results obtained by using this alternative TFP estimation strategy are reported in columns 1 and 2 of Tables 3 for the extensive margin and Table 4 for the intensive margin. The robustness checks for the Poisson specification are shown in Table 5. In column 1 we employ the baseline IV specification, using as instruments IV_{RER_f}, IV_{GDP_f}, and IV_{TAR_f}. In column 2 we augment the model by adding as control the logarithm of the real exchange rate of the destination country ($\ln RER_{jt}$). Indeed, failure of the exclusion restriction may stem from a potential correlation between the instrument IV_{RER_f} and the component of the error term related to variation in the exchange rate of the destination country, given that the latter could impact firms' exports. The results are not affected by taking directly into account possible learning by exporting mechanisms in the TFP estimation and by the inclusion of the additional control: the $\hat{\chi}^f_t$ is still positive and statistically significant, and the point estimate is statistically equal (within 1 standard error band) to the baseline estimates.

Next, we re-estimate the baseline specification on different sub-samples to verify that our main results do not crucially depend on the peculiar behavior of specific groups of firms. First, we exclude from the analysis those firms that are only exporters. This paper focus on equilibria where the firms engaged in international trade are either two-way traders or just-only importers. Our data confirms that the majority of firms are involved in both trade activities while only a small fraction exports without importing. Column 3 of Tables 3 and 4 presents the results by dropping the only exporters. Second, in column 4 of Tables 3 and 4, we exclude from

Table 5: Firms' exports by country (Poisson): instrumental variables. Robustness Checks

Dep. Var.	$Exports^f_{jt}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Learning by exporting	ln RER	Excluding Only-Exporters	Excluding Importers of No-Intermediates		Firm-Destination FE No Imports Dest.	No Imports Dest Learning by Exporting
$\ln \widehat{\varphi}^f_t$	1.382***	1.200***	1.361***	1.530***	1.474***	2.085***	1.989***
	(0.308)	(0.319)	(0.301)	(0.389)	(0.332)	(0.373)	(0.349)
$\ln \widehat{\chi}^f_t$	13.119***	11.047***	12.834***	12.042***	12.727***	15.407***	16.319***
	(3.445)	(3.608)	(3.488)	(3.942)	(3.412)	(4.949)	(5.255)
$\ln GDP_{jt}$	0.836***	0.809***	0.838***	0.838***			
	(0.019)	(0.026)	(0.019)	(0.020)			
$\ln Distance_j$	-0.918***	-0.873***	-0.926***	-0.919***			
	(0.061)	(0.092)	(0.061)	(0.064)			
$Trade\ Opening_{jt}$	0.036**	0.018	0.038**	0.036*			
	(0.018)	(0.021)	(0.018)	(0.018)			
$\ln Remoteness_{jt}$	0.972***	0.897***	0.995***	0.986***			
	(0.225)	(0.232)	(0.225)	(0.235)			
$Market\ Costs_j$	-0.317***	-0.313***	-0.309***	-0.310***			
	(0.063)	(0.063)	(0.062)	(0.065)			
$\ln RER_{jt}$		-0.046***					
		(0.014)					
Year*Area FE	Yes	Yes	Yes	Yes	-	-	-
Firm FE	Yes	Yes	Yes	Yes	-	-	-
Firm-Destination FE	-	-	-	-	Yes	Yes	Yes
Year FE	-	-	-	-	Yes	Yes	Yes
N	6,874,184	6,098,845	6,851,795	5,503,763	6,595,861	6,101,267	6,094,859
Hansen J stat.	3.177	4.174	2.917	3.353	2.440	2.081	1.887
(p-value)	0.204	0.124	0.233	0.187	0.295	0.353	0.389

Note: The table reports regressions for the extensive margin using data on 2000-2006 and using as instrumental variables IV_{RER_f} IV_{GDP_f},IV_{TAR_f} built by weithing ln RER, ln GDP and TARIFF by a firm's import share of each country in the initial year. In columns 1, 2 and 7 we re-estimate the two TFP components by allowing the law of motion of φ^f_t to endogenously depend on the export share. In column 3 we exclude the only-exporters from the analysis. In column 4 we consider only those firms importing intermediate inputs. In columns 5-7 we control for firm-destination and year-destination fixed effects. In column 6 we exclude from the sample the export destinations from which the firm is importing. Asterisks denote significance levels (***:p<1%; **: p<5%; *: p<10%).

the analysis those firms that source from abroad both capital and intermediate goods and consider only those firms importing intermediate inputs. In the paper we consider as importers those firms that source from abroad intermediates inputs, defined as those falling into the intermediate input category according to BEC classification system. However, there are firms importing both intermediate inputs and capital goods. To properly account for the effect of imports of intermediates, we exclude those sourcing from abroad also capital goods. The findings are robust to these changes in the sample coverage, which affect neither the sign of the coefficients nor their significance.

As an alternative specification, in columns 5-7 of Tables 3 and 4 we estimate the equations including firm-destination and year-destination fixed effects. In this case, identification of our key variable, $\hat{\chi}^f_t$, relies only on variations over time of a firm's exports to the same destination, controlling for time variant and time invariant country characteristics. In our theoretical framework the effect of importing intermediate inputs comes only through $\hat{\chi}^f_t$. However, besides the TFP mechanism, there could be additional channels through which importing intermediate inputs influences exporting. In particular, one could imagine that importing from country j reduces the fixed or variable cost of exporting to country j. By controlling for firm-destination and year-destination fixed effects we can reduce this issue to the extent it is connected to time-constant unobserved heterogeneity at the firm-country level or to unobserved country level determinants of trade flows which are common at the import and at the export side. In addition, in column 6 we exclude from the sample the export destinations from which the firm is

Table 6: Import ratio elasticities

Dep. Var.	Import ratio M^f_{jt}/M^f_{kt} (1)	(2)
$\ln GDP_{jt}$	0.167***	0.822***
	(0.009)	(0.027)
$\ln Distance$	-0.186***	-0.796***
	(0.015)	(0.089)
$Market\ Costs_j$		-0.046
		(0.058)
Year*Area FE	Yes	Yes
Firm FE	Yes	Yes
N	493,288	17,988,803
adj. R^2	0.326	

Note: The table reports the results of the OLS (column 1) and of the Poisson Pseudo Maximum Likelihood (column 2) estimators using data on 2000-2006. The dependent variable is the import ratio (M^f_{jt}/M^f_{kt}) in logarithm (column 1) and in value (column 2). All the regressions include a constant term. Robust standard errors clustered at the firm-level are reported in parenthesis below the coefficients. Asterisks denote significance levels (***:p<1%; **: p<5%; *: p<10%).

importing. In this way possible market specific cost externalities from importing to exporting are shut down. If these factors were driving our results we would expect a decrease in the estimated effect of $\hat{\chi}^f_t$. Finally, in column 7 we use the TFP variables calculated including exporting in the TFP estimation (as in columns 1 and 2). The estimation results displayed in columns 5-7 confirm our main findings.

4.3. The indirect effect of gravity forces

The aim of this section is to quantify the indirect impact of gravity forces on a firm's export behaviour through importing. As indicated by equations (6)-(9), to do that we first need to compute the elasticity of χ_k with respect to the two gravity forces. Then, we have to multiply the elasticity of χ_k with respect to either distance or market size by the elasticity of exports to χ_k, obtained through the export gravity equations. In this way we obtain the elasticity of exports to distance and market size through importing.

Let's start with the computation of the elasticity of χ_h with respect to distance from country j, $\rho^f_{D_j}$, which can be written as

$$\rho^f_{D_j} = \frac{d\ln\chi_k}{d\ln D_{kj}} = \frac{\alpha}{\phi-1} * \frac{M^f_j}{\sum_{n=1}^N M^f_n} * \frac{d\ln\left(\frac{M^f_j}{M^f_k}\right)}{d\ln D_{kj}}. \tag{13}$$

Similarly, the elasticity of χ_k with respect to market size of country j, $\rho^f_{Y_j}$, is given by

$$\rho^f_{Y_j} = \frac{d\ln\chi_k}{d\ln Y_j} = \frac{\alpha}{\phi-1} * \frac{M^f_j}{\sum_{n=1}^N M^f_n} * \frac{d\ln\left(\frac{M^f_j}{M^f_k}\right)}{d\ln Y_j}. \tag{14}$$

The first term in both equations is the TFP elasticity to imports and can be retrieved from the estimates of the production function, column 3 of Table 1. The second element, which is directly observable in our data, is the fraction of imports of firm f from country j over the total intermediate inputs used by the firm. The third term can be obtained by estimating the elasticity of the ratio of imports from j over domestic intermediates with respect to distance and

Table 7: Average indirect effects of gravity forces on export margins: by origin of imports

Import-Source Country	Extensive Margin		Intensive Margin		Both Margins	
	Ψ_{Y_j} (1)	Ψ_{D_j} (2)	Ψ_{Y_j} (3)	Ψ_{D_j} (4)	Ψ_{Y_j} (5)	Ψ_{D_j} (6)
Germany	0.005	-0.005	0.033	-0.032	0.079	-0.077
France	0.002	-0.002	0.016	-0.016	0.039	-0.038
Belgium	0.001	-0.001	0.008	-0.008	0.019	-0.019
Spain	0.001	-0.001	0.008	-0.008	0.019	-0.018
China	0.001	-0.001	0.008	-0.007	0.018	-0.018
Austria	0.001	-0.001	0.007	-0.007	0.017	-0.017
UK	0.001	-0.001	0.006	-0.006	0.015	-0.015
Netherlands	0.001	-0.001	0.006	-0.006	0.015	-0.015
Switzerland	0.001	-0.001	0.006	-0.006	0.014	-0.013
USA	0.001	-0.001	0.005	-0.005	0.012	-0.011

Note: The table reports the estimated average indirect effects of distance and market size for the import-source country j on firms' exports to any destination (Ψ_{D_j} and Ψ_{Y_j}, respectively). These elasticities are computed at the firm-country level by multiplying the elasticity of χ_k with respect to either Y ($\rho^f_{Y_j}$) or D ($\rho^f_{D_j}$) by the elasticity of exports to χ_k obtained as the estimated coefficients on $\ln \widehat{\chi}^f_t$ reported in columns 1-3 of Table 2 for the extensive, intensive and both margins, respectively. All the estimated indirect effects are statistically significant at 1%. Standard errors, which are not reported, have been obtained by bootstrapping (500 replications).

GDP. According to our theoretical setting, the ratio of imports of intermediates from country j to domestic intermediates can be expressed by

$$\frac{M^f_j}{M^f_k} = \frac{\beta_{mj} Y_j}{\beta_{mk} Y_k} \left(\left(\frac{w_j}{w_k} \right) \tau_{mjk} \right)^{1-\phi} \quad .$$

Given that the above expression is log-linear in distance and market size, we first estimate by OLS the following equation

$$\ln \frac{M^f_{jt}}{M^f_{kt}} = a_0 + a_1 \ln Y_{jt} + a_2 \ln D_j + d^f + d_i + \epsilon^f_{jt}. \tag{15}$$

where, in addition to the two gravity forces Y_{jt} and D_j, we add a set of dummies to control for firm fixed-effects, d^f, and for year-geographical areas fixed-effects, d_i. Then, to take into account the large proportion of zeros observed in the data, we estimate the elasticity of the ratio with respect to gravity forces by using a conditional (firm) fixed-effects Poisson regression. The estimates of the log-linear specification are reported in column 1 of Table 6. In column 2 we show the results of the Poisson regression, and we include as an additional control the proxy for fixed costs *Market Costs*. We observe that the elasticity of the import ratio is slightly lower than unity for both GDP and distance. Therefore, it is confirmed that firms' sourcing behaviour is influenced by the same standard gravity forces which are also active on the export side.

With the three terms of equations (13) and (14), we can now compute the indirect effect on a firm's export behaviour of the two gravity forces at the firm-origin level.

In Table 7 we report the estimated average indirect effects of distance and market size for the origin country j. These indirect effects are labeled Ψ_{D_j} and Ψ_{Y_j}, respectively. The table reports the results for the ten countries with the highest estimated effects. The results for market size and distance are quantitatively very similar, mainly due to the fact that the estimated elasticities of the import ratio with respect to the two gravity forces are almost identical (see Table 6). If we concentrate on the last two columns where we consider together both margins, the results indicate that, for firms importing from Germany, a rise in German

Table 8: Average indirect effects of gravity forces on export margins: by sector

Sector	Extensive Margin Ψ_{Y_h} (1)	Extensive Margin Ψ_{D_h} (2)	Intensive Margin Ψ_{Y_h} (3)	Intensive Margin Ψ_{D_h} (4)	Both Margins Ψ_{Y_h} (5)	Both Margins Ψ_{D_h} (6)
Food, Beverages and Tobacco	0.018	-0.017	0.126	-0.122	0.299	-0.290
Textiles and Apparel	0.026	-0.025	0.186	-0.180	0.442	-0.428
Hide and Leather	0.028	-0.027	0.200	-0.193	0.475	-0.460
Wood and Cork	0.032	-0.031	0.226	-0.219	0.538	-0.521
Pulp and Paper	0.033	-0.032	0.234	-0.226	0.556	-0.539
Printing and Publishing	0.022	-0.021	0.154	-0.149	0.366	-0.354
Coke and Chemical products	0.032	-0.031	0.227	-0.219	0.539	-0.522
Rubber and Plastics	0.036	-0.035	0.256	-0.248	0.608	-0.589
Processing of non-metallic minerals	0.018	-0.017	0.127	-0.123	0.301	-0.291
Basic Metals	0.037	-0.035	0.260	-0.252	0.618	-0.599
Fabricated Metal Products	0.024	-0.023	0.168	-0.163	0.400	-0.387
Machinery and Equipment	0.010	-0.010	0.072	-0.070	0.171	-0.166
Electrical and Optical Equipment	0.017	-0.017	0.122	-0.118	0.291	-0.282
Motor Vehicles and Trailers	0.013	-0.013	0.094	-0.091	0.224	-0.217
Other Transport Equipment	0.031	-0.030	0.222	-0.215	0.528	-0.511
Other manufacturing industries	0.009	-0.009	0.067	-0.065	0.159	-0.154
All Manufacturing	0.022	-0.021	0.156	-0.151	0.370	-0.359

Note: The table reports the estimated average indirect effects for sector h of distance and market size on firms' exports to any destinationfor (Ψ_{D_h} and Ψ_{Y_h}, respectively). These elasticities are computed at the firm level by multiplying the elasticity of χ_k with respect to either Y (ρ^f_Y) or D (ρ^f_D) by the elasticity of exports to χ_k obtained as the estimated coefficients on $\ln \widehat{\chi}^f_t$ reported in columns 1-3 of Table 2 for the extensive, intensive and both margins, respectively. All the estimated indirect effects are statistically significant at 1%. Standard errors, which are not reported, have been obtained by bootstrapping (500 replications).

market size of 10 percent would imply an increase of 0.8 percent in exports to each destination country.[18] A similar effect is detected for a decrease in transportation costs.

Together with the indirect effect of the two gravity forces for each import-source country j, it is possible to assess the indirect effect of a change in transportation costs or market size common across all countries. In this case, the elasticity of χ_k with respect to market size (or distance) is given by

$$\rho^f_Y = \sum_{j \neq Italy} \rho^f_{Y_j} \quad \text{or} \quad \rho^f_D = \sum_{j \neq Italy} \rho^f_{D_j}$$

obtained by substituting the second element of equations (13) and (14) with the fraction of a firm's imports from all countries over its total intermediate inputs. The results in Table 8 show the average indirect effects of this generalized change for firms belonging to sector h. Some heterogeneity is observed, with the Rubber and Plastic industry having the largest indirect impacts.

For the average manufacturing firm, the size of the estimated indirect effects of the gravity forces is about one third of the estimated direct effects obtained in the gravity equations (compare the last row of Table 8 with the estimated coefficients of GDP and distance reported in Table 2). Therefore, the magnitude of these indirect effects suggests that the TFP channel through which gravity forces affects exports is not just a theoretical possibility, but also an economically relevant mechanism. Our results confirm the predictions of the model according to which variations in trade costs and in the economic size of trade partners may have substantial

[18] As indicated in section 2.2, a change in transportation costs or market size of importing country j has an indirect impact on a firm's export behavior not only to country j but also to each export destination s, with $s \neq j$.

indirect consequences on exporters' performance.

5. Conclusions

The recent heterogeneous-firm models have brought to the gravity model a need to consider the effects that the two gravity forces, namely market size and distance, have on firms' export patterns. This paper unveils a new channel through which these two forces affects firms international trade activities through their indirect effects on imports. Our theoretical framework introduces intermediate inputs into a standard Melitz (2003)/Chaney (2008) model of trade with firm heterogeneity and asymmetric countries. The model shows that, in addition to the standard direct effect, market size and distance exert an additional effect on exports through the heterogeneous efficiency gains induced by imports of intermediate inputs. Indeed, importing has a positive effect on a firm's productivity which depends on both the mass of imported intermediate inputs available, as well as on the price of each intermediate. An increase in foreign market size has a positive effect on exports directly but also indirectly through an efficiency increase induced by the imports of intermediate inputs. Similarly, a decline in transportation costs, and therefore a reduction in the cost of imported inputs, has an indirect effect on a firm's exports pattern due to the increase in its productivity which allows to offer its exports at lower prices and to increase its revenues in the exporting markets.

The propositions of the model are tested using a large and unique panel data set of Italian manufacturing firms over the 2000-2006 period. First, we structurally estimate the contribution of importing to TFP. Second, we estimate how this improvement in efficiency affects firm-country margins of exports, controlling for the potential endogeneity of our key covariate. Third, we show that firms' import behaviour is affected by market size and distance and we quantify the indirect effect, via importing, of these two gravity forces on a firm's exports. We find that the elasticity of exports to market size and distance is magnified when imports of intermediates are accounted for: the size of the estimated indirect effects of the gravity forces is about one third of the estimated direct effects.

Overall, our findings suggest that the productivity gains from importing are heterogeneous depending on the import-source countries. The firms' productivity component due to imports has in turn a positive impact on firms' ability to sell their products internationally. Important policy implications follow from our results. Given that firms' sourcing strategies shape their export behavior, policies directly aimed at restricting imports by increasing trade costs or negative shocks occurring in import-source countries, can indirectly harm the export performance of domestic firms. Moreover, such events would impact more the most productive domestic firms, which make intensive use of imported inputs.

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