Exchange rate pass-through and product heterogeneity: does quality matter on the import side?

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Abstract

This paper investigates theoretically and empirically the heterogeneous response of exporters to real exchange rate fluctuations due to the quality of imported inputs and exported output. We develop a model where the production of high-quality products requires high-quality inputs sold in monopolistically competitive foreign markets. The model predicts that exporters using imported inputs have low exchange rate pass-through, but this effect is weaker for firms shipping high-quality goods. This is due to the heterogeneous price adjustments of foreign suppliers selling inputs of different quality. We test the predictions of the model using Italian firm-level trade data for the period 2000-2006. The empirical analysis shows that the imports of intermediates have a significantly weaker effect in reducing the exchange rate pass-through into the export price of high-quality varieties. By showing that the import price of high-quality inputs is less sensitive to exchange rate variations, we provide evidence supporting the theoretical hypothesis that the pricing power of input suppliers weakens the import channel.

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1. Introduction

A major puzzle in international macroeconomics is why the prices of imported goods do not fully reflect exchange rate movements. Indeed, abundant empirical evidence shows that the exchange rate elasticity of import prices is rather low. One of the possible explanations for the incomplete exchange rate pass-through (ERPT) is that exporters adopt pricing-to-market strategies, namely they adjust export prices to limit the transmission of exchange rate variations into consumer import prices (Knetter, 1993; Atkeson and Burstein, 2008). While investigation on this topic has originally been conducted on aggregate data, the recent availability of disaggregated information has revealed heterogenous pricing to market strategies across exporters depending on their productivity, market share, use of imported inputs and output quality.[3]

Our paper contributes to the existing literature on the heterogeneous pricing to market strategies of exporters by investigating, both theoretically and empirically, previously unexplored channels through which firms' characteristics might influence the transmission of exchange rate movements into consumer prices. Our research provides evidence that the imports of intermediate inputs contribute to insulate the import price of an exported final good from exchange rate variations depending on the final good quality and on the quality of the imported intermediates.[4] With respect to previous studies we propose a unified framework that jointly considers how firms' import intensities and quality levels determine ERPT heterogeneity across exporters. This new channel is key to understanding the variation in pass-through across firms.

We propose a theoretical model where the exporters of high-quality products are also importers of high-quality intermediate inputs sold in monopolistically competitive markets. The novel prediction of this model is that while the imports of intermediate inputs generally reduce an exporter's ERPT, this effect is weaker if the imported inputs have higher quality. Our framework follows the recent work of Amiti et al. (2014) which shows that the adoption of imported intermediate inputs favors an exporter's ability to insulate the consumer import price of its exported varieties from exchange rate (ER) variations. This 'intermediate imports channel' arises because changes in the ER affect with opposite sign the import prices of the imported intermediate goods and the import prices of the exported final goods. An appreciation of the currency reduces the import prices of the imported intermediate inputs, it lowers the marginal cost of production of an exporter. As a consequence, an exporter can reduce the export prices of its products to offset the effect of the appreciation on the consumer import prices.

[3]See Burstein and Gopinath (2013) for a recent survey of the literature.

[4]Throughout the paper we distinguish between the import price of an imported intermediate good (or exporter import price) and the import price of an exported final good (or consumer import price). The former is the price paid by an exporter for an imported intermediate input, the latter is the price paid by a consumer for the final good. These prices are expressed and paid in the currency of the importer. Similarly, for exports we distinguish between the export price of the final good producer and the export price of the intermediate input supplier. These prices are expressed and set in the currency of the exporter.

In the model of Amiti et al. (2014) inputs are obtained from perfectly competitive markets and foreign suppliers cannot adjust prices in response to ER variations. In our model, instead, we investigate the 'intermediate imports channel' within a more general theoretical setting where foreign suppliers of intermediate inputs have pricing power, and they can mirror the behavior of final good exporters by adjusting their export prices in response to exchange rate variations. The quality of intermediate and final goods respectively determine the ability of input suppliers and final good exporters to adjust their export prices in response to ER variations.[5] The model is able to generate a channel previously unexplored according to which the 'intermediate imports channel' has a weaker effect on the export price of high-quality final goods, as these goods require high-quality intermediate inputs provided by foreign suppliers with a greater ability to adjust their export prices.

We test the predictions of the model on a rich dataset of Italian firms reporting export and import transactions for the period 2000 to 2006. Our analysis confirms the relevance of the 'intermediate imports channel', but consistently with the model it suggests that this channel is weaker in reducing the ERPT into the consumer import price when the quality of the final goods is higher. Differences across varieties with heterogeneous quality are statistically and economically significant. According to our estimates, an exporter can reduce by 6% the ERPT into the export price of a good with 'average' quality by increasing by 50% its share of imported intermediate inputs over variable costs. However, a similar increase in the share of imported intermediates reduces the ERPT only by 2% for firms whose quality is one standard deviation above the average. This result is robust to the inclusion of different firm level characteristics which are related to firms' ability to absorb exchange rate variations in their markups. In particular, our result holds when controlling for the fact that firms with high export market shares set high markups and actively adjust them in response to ER movements. The role of suppliers' pricing strategies in determining this result is supported by further analyses on the ER sensitivity of the import prices paid by exporters for imported intermediates of different quality. Indeed, we find that the ERPT on the import prices of imported intermediates is lower for high-quality inputs.

Our empirical work overcomes one of the main limitations of previous studies on ERPT and export quality. Because the quality of exported goods is generally unobserved in trade datasets, the existing analyses focus on specific sector for which quality information is available. Chen and Juvenal (2014) restrict their investigation to the exports of Argentinian wine using rating of wine guides as a proxy of quality. Basile et al. (2012) resort to survey data to identify Italian exporters competing in foreign market through quality. Our analysis extends to a much larger set of products than the one covered by previous studies, hence producing more robust evidence supporting the hypothesis that export quality is an important determinant of ERPT heterogene-

[5] This feature of the model is consistent with previous studies showing that high-quality goods are characterized by lower ERPT (Basile et al., 2012; Chen and Juvenal, 2014).

ity across firms and products. We obtain a firm-product-destination level measure of revealed export quality from the estimation of a discrete choice model of consumer demand (Berry, 1994; Khandelwal, 2010). This estimator allows us to avoid comparability issues and measurement errors arising from the use of survey data.

Our paper relates to three strands of the international trade literature. First, our paper is mostly related to a very recent literature on exporters' heterogeneity and pricing-to-market behavior. The seminal article by Berman et al. (2012) shows that more productive exporters are more capable to reduce the ERPT into the consumer import prices. This is because larger and higher performance firms are more capable to absorb ER variations in their markups. Amiti et al. (2014), which is the paper closely related to our work, observe that import-intensive exporters have significantly lower exchange rate pass-through because of the marginal costs channels but also because they have high export market shares and hence set high markups. Chatterjee et al. (2013) study the effect of exchange rate shocks on the export behavior of multi-product firms, while Caselli et al. (2014) investigate markups adjustments across products in response to real exchange fluctuations.

The quality of exported varieties has been investigated as an additional determinant of ERPT heterogeneity. Auer and Chaney (2009) explain lower exchange rate sensitivity of higher quality goods with a model featuring assortative matching between imported goods and consumers with heterogenous preference for quality. They test their predictions by estimating the ER sensitivity of the price of US imports across goods with different quality. In the model of Basile et al. (2012) high-quality goods are characterized by lower elasticity of substitution and higher markups allowing exporters to offset exchange rate variations more actively. A similar explanation is offered by Chen and Juvenal (2014), but in their model markups are higher for high-quality exports because of the presence of distribution costs increasing in quality. While the first of these three works fails to produce empirical evidence in line with the prediction that ERPT is lower for higher quality goods, the other two confirm this hypothesis.

Second, our study relates to the well-established research program on imperfect ERPT and pricing-to-market (PTM) reviewed in Goldberg and Knetter (1997). Imperfect competition and market segmentation - through which we explain suppliers' price adjustment - play a special role in this literature (e.g., Krugman, 1986). While early empirical work documents imperfect ERPT by estimating the sensitivity of aggregate import/export price indices to exchange rate variations, more recent contributions have moved toward detailed price series at the level of very disaggregated product categories and provided more robust evidence of the substantial stickiness of consumer prices to exchange rate variations (Gopinath and Rigobon, 2008; Gopinath et al., 2010).

Third, we contribute to the literature studying the effect of imported inputs on firm performance and exports (Bas and Strauss-Kahn, 2014; Kasahara and Lapham, 2013; Navas et al., 2013). We investigate a specific channel through which the price set by the suppliers of intermediate inputs affects the export behavior of final good producers.

The rest of the paper is structured as follows. Section 2 introduces the theoretical framework and spells out the propositions that motivate our empirical investigation.

Section 3 describes the dataset and the construction of the variables that will be used in regressions. Section 4 outlines the empirical models and describes the results. Section 5 investigates how the effect of ER variations on a firm's selection of imported intermediates may affect our results. Section 6 concludes.

2. Theoretical framework

We develop a simple model in which both final good producers and intermediate input suppliers adjust their prices in response to exchange rate variations. Our model adopts a functional form similar to the one used in Kugler and Verhoogen (2012) to relate output quality to the quality of intermediate inputs and to the heterogeneous capability of final good producers. We depart from the original setting of Kugler and Verhoogen (2012) by relaxing the assumption of perfect competition in the intermediate input market, allowing for independent pricing policies among the suppliers of these inputs. In the spirit of Corsetti and Dedola (2005), we introduce local distribution costs that enter into the import price of the exported final goods. In addition, we include local adoption costs that enter into the import price of imported intermediate inputs. Both type of costs are increasing in the quality of the traded goods as in Chen and Juvenal (2014). Because the endogenous choice of imported intermediate inputs and its relationship with ERPT has been already investigated in Amiti et al. (2014), we simplify our setup by assuming that final good producers import all their intermediate inputs. This simplification focuses our attention on the heterogeneous price adjustment of intermediate suppliers as a determinant of heterogeneous ERPT among the exporters of final goods.

2.1. Output quality and input demand

Consider firm i producing one variety of an heterogeneous good that is sold in a monopolistic competitive foreign market. The quality of variety Q_i is generated by employing a continuum I of imported intermediate inputs, where m_j denotes the quantity of input j and q_j its quality. Intermediate inputs are combined according to the following CES aggregator

$$Q_i = \left[\int_{j \in I} ((q_j^{\theta} + \lambda^{\theta})^{\frac{1}{\theta}} m_j)^{\frac{\zeta-1}{\zeta}} dj \right]^{\frac{\zeta}{\zeta-1}} \tag{1}$$

where $\zeta > 1$ and it determines imperfect substitutability across inputs because higher output quality can be always achieved by adopting a more heterogeneous bundle of inputs. The extent to which the quality of an input contributes to the quality of the output depends on the exogenously given capability of the firm λ introduced in the expression $(q_j^{\theta} + \lambda^{\theta})^{\frac{1}{\theta}}$, where the condition $\theta < 0$ determines complementarity between input quality and a firm's capability. An implication of this assumption is that the marginal rate of technical substitution between input $j1$ and input $j2$ with $q_{j1} > q_{j2}$ is increasing in λ

$$\frac{\partial Q_i/\partial m_{j1}}{\partial Q_i/\partial m_{j2}} = \left(\frac{m_{j1}}{m_{j2}}\right)^{-\frac{1}{\zeta}} \left[\frac{(q_{j1}^{\theta}+\lambda^{\theta})^{\frac{1}{\theta}}}{(q_{j2}^{\theta}+\lambda^{\theta})^{\frac{1}{\theta}}}\right]^{\frac{\zeta-1}{\zeta}} \tag{2}$$

and the quantity of each input j that optimizes the quality production function in (2) is

$$m_j^* = M\left(\frac{p_j^c}{P_I}\right)^{-\zeta} \left[(q_j^{\theta}+\lambda^{\theta})^{\frac{1}{\theta}}\right]^{\zeta-1} \tag{3}$$

where M is the aggregate expenditure on intermediate inputs to produce one unit of output, and P_I is the ideal price index adjusted for the quality of intermediate inputs

$$P_I = \left[\int_{j\in I}\left(\frac{p_j^c}{(q_j^{\theta}+\lambda^{\theta})^{\frac{1}{\theta}}}\right)^{\zeta-1} dj\right]^{\frac{1}{1-\zeta}}. \tag{4}$$

The term p_j^c in equations (3) and (4) is the import price paid by the final good producer (expressed in its own currency) to acquire and introduce the intermediate input j in the productive process

$$p_j^c(q_j) \equiv \frac{p_j}{\epsilon_A} + \eta q_j \tag{5}$$

where ϵ_A is the number of units in a supplier's currency necessary to buy one unit in a final good producer's currency. The import price p_j^c is composed of the export price set by the supplier and expressed in the buyer's currency $\frac{p_j}{\epsilon_A}$, and of an adoption costs $f(q_j) = \eta q_j$ that are increasing linearly in input quality and that are expressed in the buyer's currency.[6] Equation (3) shows that the optimal quantity of each input employed by the final good producer is increasing in its quality, and that m_j^* increases faster in quality for higher values of λ because $\frac{\partial m_j}{\partial q_j \partial \lambda} > 0$.

Proposition 1: *A firm with higher capability λ generates an output of greater quality and it employs greater quantities of higher quality inputs than a firm with lower capability.*

This result is consistent with recent theoretical and empirical works showing that the production of high-quality output requires high-quality inputs (Kugler and Verhoogen, 2012; Hallak and Sivadasan, 2009).

2.2. The optimal export price of an intermediate input

Monopolistic competition in the intermediate sector and the presence of adoption costs makes it optimal for input suppliers to adjust prices in response to exchange rate

[6] The relationship between the quality of an intermediate input q_j and the export price set by the supplier p_j is defined by equation (6).

variations *vis-a-vis* the currency of the final good producers. In this section we show that under the assumption that the adoption costs are expressed in the currency of the final good producer and that they are increasing in input quality, the optimal price of the supplier offsets exchange rate variations. The price that optimizes a supplier's profit function is given by

$$p_j^*(q_j) = \frac{\zeta}{\zeta - 1}\left(MC(q_j) + \frac{\epsilon_A q_j \eta}{\zeta}\right). \tag{6}$$

We do not fix a specific functional form relating the quality of the intermediate good q_j to the marginal costs of the supplier $MC(q_j)$, but we make the standard assumption in the literature that marginal costs are monotonically increasing in quality (Verhoogen, 2008; Khandelwal, 2010; Johnson, 2012; Antoniades, 2015). Empirical support for this assumption is provided by Kugler and Verhoogen (2012) establishing a positive relationship between plant size, input and output prices using a representative sample of Colombian manufacturing firms. This evidence suggests that more capable firms produce higher quality outputs by using higher quality and more expensive intermediate inputs. The assumption that marginal costs increase in output quality is also supported by the empirical results in Brambilla et al. (2012). These authors find a positive relationship between the income level of destination countries, proxing consumers' preference for high-quality goods, and the wages of workers employed by Argentinean exporters. Hence, a positive relationship between MC and q_j arises also if suppliers of higher quality intermediates hire workers with greater skills and higher wages.

Equation (6) suggests that a supplier sets the optimal price of input j by fixing the markup over its own marginal cost of production $MC(q_j)$ and over the adoption cost paid by the final good producer divided by the parameter ζ and multiplied for the exchange rate ϵ_A. An appreciation of the final good producer's currency *vis-a-vis* the currency of the supplier (i.e., a positive variation of ϵ_A) increases the relative weight of the adaptation costs in the import price of the imported intermediate inputs (p_j^c, equation 5). This implies that the supplier of the intermediate input adjusts its markup upward because it perceives lower elasticity of demand to the export price (equation 6). The exchange rate elasticity of a supplier's optimal export price is

$$\sigma_{p_j^*,\epsilon_A} = \frac{\zeta}{\zeta - 1}\left(\frac{\epsilon_A \eta q_j/\zeta}{p_j^*}\right). \tag{7}$$

The greater is the weight of the adoption costs over the export price and the greater is the elasticity of the supplier's export price p_j^* to exchange rate variations. Hence, the elasticity in (7) is higher for higher quality intermediate inputs q_j that are characterized by higher local adoption costs. The exchange rate elasticity of the import price of the imported intermediate good is

$$\sigma_{p_j^c,\epsilon_A} = -\frac{p_j/\epsilon_A}{p_j^c} + \frac{\zeta}{\zeta - 1}\left(\frac{\eta q_j \epsilon_A}{p_j^c}\right) \tag{8}$$

the first term on the right-hand side is the negative 'exchange rate effect' that captures the reduction of the import price consequent to an appreciation of the currency of the importer. The second term instead is positive and it represents the supplier's 'export price adjustment effect' that offsets the 'exchange rate effect'. Because the second term increases in quality, we expect the p_j^c of higher quality inputs to decrease less rapidly after an appreciation of the final good producer's currency.

Proposition 2: *The price paid by the final good producer for importing a higher quality input decreases less rapidly than the price for a low quality one after an appreciation of the importer's currency* vis-a-vis *the currency of the supplier.*

2.3. ERPT into the import price of the final good

We have shown that exporters of higher quality final goods are also importers of higher quality inputs, and that the import prices of these inputs decrease less rapidly as a consequence of an appreciation of the currency of the final good exporter. We now investigate the implications of these two predictions for the 'intermediates imports channel', defined as the exchange rate elasticity of the final good producer's marginal cost. The marginal cost of producing a final good with quality Q_i is

$$M(Q_i) = \int_{j \in I} m_j(Q_i, q_j, \epsilon_A) p_j^c(q_j, \epsilon_A) dj \tag{9}$$

and its elasticity is

$$\sigma_{M,\epsilon_A}(Q_i) = \int_{j \in I} s_j(\lambda, Q_i, q_j) \sigma_{p_j^c,\epsilon_A} dj \tag{10}$$

where $s_j(\lambda, Q_i, q_j) = \frac{m_j(\lambda, Q_i, q_j) p_j^c}{M(\lambda, Q_i, q_j)}$ is the contribution of input j to marginal cost M and $\int_{j \in I} s_j dj = 1$. The integral in equation (10) is a weighted average of the import price elasticities of all the imported intermediate inputs employed to produce one unit of the final good. Because producers of higher quality final goods use more intensively higher quality inputs, and because the exchange rate elasticity of the prices of higher quality inputs is relatively less negative, producers of higher quality final goods perceive a less negative exchange rate elasticity of marginal cost. This effect is expressed by the following proposition:

Proposition 3: *The 'intermediate imports channel' is weaker for the exporters of higher quality varieties, because these exporters use more intensively imported inputs for which suppliers adjust more aggressively export prices in response to ER variations.*

We now investigate the direct effect of output quality on the pricing strategy of the final good producer in response to ER variations. The consumers of the final good optimize the following CES utility function featuring love for quality Q_i

$$U = \left[\int_{i \in \Omega} (Q_i x_i)^{\frac{\phi-1}{\phi}} di \right]^{\frac{\phi}{\phi-1}} \tag{11}$$

where Ω is a continuum of differentiated varieties i, and $\phi > 1$ determines imperfect substitution across varieties. We assume that quality increases the wedge between the export price set by the exporter of the final good and the import price paid by consumers. As shown before, for intermediate inputs this assumption relates to greater local adoption costs to employ higher quality inputs. For final goods, we assume as in Chen and Juvenal (2014) that higher quality goods have higher distribution costs. Hence the consumer import price for the final good i in the destination country is

$$p_i^c(Q_i) \equiv p_i(Q_i)\epsilon_B + \gamma Q_i \tag{12}$$

where ϵ_B is the exchange rate between the consumer's currency and the exporter's currency. The optimal export price set by the final good producer, and expressed in its own currency, is

$$p_i^*(Q_i) = \frac{\phi}{\phi-1}\left(M(Q_i) + \frac{Q_i\gamma}{\phi\epsilon_B} \right). \tag{13}$$

Hence, an exporter of an higher quality variety reacts to an appreciation of its currency by setting a lower optimal export price. The rationale behind this adjustment is that an exporter of a higher quality final good has greater scope for lowering its markup to offset the positive impact of the appreciation on the import price of its exported good.

Notice that in the case $\epsilon = \epsilon_A = \epsilon_B$ (i.e., when the final good is exported to the same country from which intermediate inputs are imported) the export price of the final good and the import price of the imported intermediate inputs will react in opposite directions in response to an appreciation of ϵ. Input suppliers will raise their input prices while exporters of final goods will reduce them. Considering the effect of the adjustment in input prices on the marginal cost of the final good producer, we obtain the exchange rate elasticity of the export price of the final good

$$\sigma_{p_i^c, \epsilon_B} = \frac{p_i \epsilon}{p_i^c} + \left[\frac{\phi}{\phi-1}\left(\sigma_{M,\epsilon_A}(Q_i) - \frac{Q_i\gamma}{p_i^c} \right) \right]. \tag{14}$$

The first term on the righ-hand side of equation (14) is the positive 'exchange rate effect' on the consumer import price, the second term in squared brackets determines imperfect exchange rate pass-through. The negative term - $\frac{Q_i\gamma}{p_i^c}$ suggests that exporters of higher quality varieties have lower ERPT because they have higher scope for offsetting ER variations through markup adjustment. This leads to our final proposition.

Proposition 4: *Output quality has a direct negative effect on ERPT by allowing exporters to offset positive exchange rate variations by reducing their markup.*

Because **Proposition 3** states that output quality weakens the 'intermediates import channel', the final effect of quality on the ERPT depends on which of the two opposite effects prevail. However, it is clear that the greater negative effect of output quality on ERPT is achieved by those companies that do not employ imported intermediates, for which $\sigma_{M,\epsilon_A}(Q_i) = 0$. For these companies, the only effect of quality on ERPT is the one described by **Proposition 4**.

3. Data and Variables

This section describes our main data sources, the variables used in the empirical analysis and the procedure we follow to obtain a revealed measure of export quality at the product-destination-firm level.

3.1. Micro level data

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).[7] The COE dataset reports all cross-border transactions performed by Italian firms during the period 2000-2006. For all export (import) flows defined at the firm-product-destination (origin) level we observe both annual values and quantities expressed respectively in euros and in kilograms.[8] Product categories are classified according to the Harmonized System classification of traded goods and they are reported at the 6-digit level (HS6). Because some product categories are assigned different HS6 product codes at different points in time, we use concordance tables provided by Eurostat to harmonize the classifications to the 2002 version.

COE data are used to obtain the unit-values uvx_{fpdt} of the exported varieties as the ratio of export values to export quantities, where the subscripts f, p, d and t respectively identify firms, HS6 product classes, destinations and years. Similarly, we construct the unit values of the imported varieties uvm_{fpct} where c denotes the country of origin. Because unit values are noisy proxies for export and import prices, we drop all observations for which year-to-year variations in unit values are above the 99th or below the 1st percentiles of the sample distribution. After this cleaning procedure we are left with around 78,000 manufacturing exporters and 50,000 importers, as reported in the first two columns of Table 1 (Panel A). The total value of the export and import flows retained in the sample is about 210 and 125 billion euros (columns 4-5, Panel A).

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,

[7]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.

[8]ISTAT collects data on trade based on transactions. The European Union sets a common framework of rules but leaves some flexibility to member states. A detailed description of requirements for data collection on trade in Italy is provided in the Appendix. Although only annual values which exceeds a threshold are reported in the dataset, this is unlikely to affect our analyses as the transactions collected cover about 98% of the total Italian trade flows (http://www.coeweb.istat.it/default.htm).

Table 1: Data coverage

Year	(1) # Exporters	(2) # Importers	(3) # Two-Way traders	(4) Exports (billion)	(5) Imports (billion)
			Panel A - COE		
2001	79,711	51,350	38,803	219.9	132.3
2003	79,375	50,175	38,153	209.0	119.1
2005	72,925	48,226	36,205	224.1	128.9
			Panel B - COE-Micro3		
2001	21,868	19,458	17,627	184.0	112.2
2003	21,134	18,380	16,683	170.4	98.1
2005	21,720	18,974	17,196	195.4	111.7
			Panel C - COE-Micro3 Non Euro destinations		
2001	21,020	16,765	15,228	80.5	56.2
2003	20,448	16,159	14,766	75.7	46.6
2005	21,082	16,802	15,307	88.5	57.3

Note. The table reports, for three different years, the number of manufacturing exporters, importers, and two-way traders, and the total value of traded goods observed in the dataset obtained by merging COE with Micro.3.

these are observed over the period 1989-2006.[9] Since 1998, census data cover the population of firms with over 99 employees, and a 'rotating sample' of firms in the employment range 20-99. In order to complete the coverage of firms in that range, from 1998 onward Micro.3 complements census data with data from the compulsory financial statement of limited liability companies.[10] The database contains information on a number of balance sheet items. For the analysis we use the following variables: number of employees, labour and material cost, value added, intermediate inputs costs and capital assets. Capital is proxied by tangible fixed assets at book value (net of depreciation). We estimate Total Factor Productivity (TFP) following the IV-GMM modified Levinsohn-Petrin procedure proposed in Wooldridge (2009), where material costs are used as a proxy for intermediate inputs. Nominal variables are in million euros and are deflated using 2-digit industry-level production prices indices provided by ISTAT.

In Table 1, columns 1 and 2 of Panel B report the number of manufacturing importers and exporters included in the dataset after merging COE with Micro 3. This is an unbalanced panel of about 21,000 exporters and 19,000 importers. These firms constitute 30% of manufacturing companies engaged in international transactions, and the generate about 85% of the total exports (column 4) and imports (column 5) of

[9]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.

[10]Limited liability companies (societa' di capitali) have to provide a copy of their financial statement to the Register of Firms at the local Chamber of Commerce.

Italy across all product categories. Even though our sample excludes many exporters, it nevertheless provides a good representation of the total international trade generated by Italian companies.

Because we are primarily concerned in the response of export and import prices to exchange rate movements, our analysis focuses on those firms exporting outside the Euro area. Panel C of Table 1 reports the number of traders active outside the Euro area and the total value of their traded goods. Exchanges with non-Euro countries account for almost 50% of the total Italian trade. Because most manufacturing exporters engage in some international transactions outside the Euro area, the exclusion of trade flows occurring within the Euro area does not reduce greatly the number of firms observed in the dataset.

Consistently with previous studies, we find that a firm's export and import activities are strongly interconnected (Bernard et al., 2007; Amiti et al., 2014). Indeed, as reported in Table 1, a large fraction of firms active in international markets are both exporters and importers. About 80% of firms with transactions outside the Euro area are both importers and exporters (Panel C of Table 1).

3.2. Measures of individual exporters' import exposure and market share

We construct a measure of a firm's import intensity from outside the Euro area (IM_{ft}) as the ratio of total imports from non-Euro countries over total variable costs, which include a firm's total wage bill and total material costs.[11] We then average this measure over the number of periods t in which the firm is observed so that to obtain a firm-level time-invariant measure of average import intensity IM_f

$$IM_f = \frac{1}{T}\sum_t \frac{\text{total non-euro imports}_{ft}}{\text{total variable costs}_{ft}}.$$

Price adjustments to exchange rate movements can be due to differences in exporters' market power across products and destinations. Indeed, large exporters are those that set high markups and that actively adjust them in response to exchange rate variations. Therefore, in the empirical analysis we include a variable aiming to control for this potential effect. As a proxy for exporters' market power we follow Amiti et al. (2014) and use the individual firm's market share, defined as the ratio between a firm's exports in product p to destination d at time t over the total exports from the same country in that same product-destination-year

$$S_{fpdt} = \frac{Exports_{fpdt}}{\sum_{f\in F_{pdt}} Exports_{fpdt}}$$

[11] To simplify the setup, our theoretical framework assumes that final good producers import all their intermediate inputs. However, in the empirical analysis we accommodate for the fact that firms import only a fraction of their inputs and we follow Amiti et al. (2014) in the definition of import intensity.

Table 2: Descriptive statistics for exporters

	Mean	Median	1st Quart.	3rd Quart.
IM_f	0.10	0.014	0.001	0.07
Employment$_{ft}$	105	44	29	85
(log) Total Factor Productivity$_{ft}$	4.4	4.4	4.1	4.8

Note. The table reports descriptive statistics (average values over the years) for the exporters in our sample (Panel C of Table1).

where $Exports_{fpdt}$ is the export value of each transaction and F_{pdt} is the set of Italian firms exporting product p to destination d at time t. Table 2 reports some summary statistics for the main firm level variables included in the model.

3.3. The estimator of export quality

We obtain a revealed measure of export quality at the product-destination-firm level by applying the methodology developed by Khandelwal (2010) to firm-level trade data. The simple intuition behind this approach is to infer the quality of each exported variety as the part of its market share within a market that is not explained by its price. Indeed, Berry (1994) shows that under the assumption that each consumer makes a discrete choice among different varieties, by considering their prices p_i^c, observed characteristics X_i, quality Q_i and her own idiosyncratic preferences, market shares result from the aggregation across consumers of their individual probability of choosing one variety over the others.[12] Therefore, the quality of each variety i can be measured as the residual from the estimation of the following demand model

$$ln(s_i) - ln(s_o) = X_i'\beta + \alpha p_i^c + \sigma_{ns} ln(s_{i/g}) + Q_i \tag{15}$$

where $ln(s_i)$ is the log market share of variety i and $ln(s_o)$ is the log market share of an 'outside variety'.[13] Consistently with the notation that we used in section 2, Q_i refers

[12]Anderson et al. (1987) show that the discrete choice model of consumer demand underlying our estimator of export quality is consistent with the CES utility function, because the CES utility function can be seen as the solution of a two-stage nested logit model where in the first stage the consumer chooses which variety to consume and in the second stage she spends all her allocated income on the chosen variety.

[13]The 'outside variety' indexed by o is a variety excluded from the estimation sample for which we observe the market share. By subtracting the log market share of the 'outside variety' s_o to the log market shares of each variety included in the estimation sample s_i we obtain normalized market shares mirroring the relative probability that a consumer in a given market chooses one unit of variety i over one unit of variety o. The utility delivered by the consumption of one unit of o is normalized to be 0. This normalization greatly simplifies the dimensionality problem in the estimation of the demand function (Berry, 1994). The 'outside variety' should be a variety whose price and quality is uncorrelated with the price and quality of the varieties whose market shares are normalized (Nevo, 2000).

to the quality of variety i. The term $ln(s_{i/g})$ is the 'nest share' of variety i, namely the market share of variety i over a more disaggregated product category than the one used to construct the market shares on the left-hand side of the model. This term allows a product market to be segmented in subclasses g of closer substitute varieties. Empirically, the unit value is used as a proxy for a variety's export price $p_i(Q_i)$. Instead, our data do not allow to construct an equivalent proxy for the consumer import price p_i^c, including distribution costs and expressed in the currency of the destination country. Substituting the equation (12) for p_i^c into (15) and rearranging we obtain

$$ln(s_i) - ln(s_o) = X_i'\beta + \alpha p_i(Q_i)\epsilon_B + \sigma_{ns} ln(s_{i/g}) + (1 + \alpha\gamma)Q_i. \tag{16}$$

A proxy for quality can be computed as a linear combination of the demand parameters $\hat{\alpha}$ and $\hat{\sigma}_{ns}$, market shares and prices as

$$\begin{aligned} Q_i^* &= [ln(s_i) - ln(s_o)] - [\hat{\alpha} p_i \epsilon_B + \hat{\sigma}_{ns} ln(s_{i/g})] \\ Q_i^* &\equiv X_i'\beta + (1 + \alpha\gamma)Q_i \end{aligned} \tag{17}$$

because we do not observe individual varieties' characteristics X_i', the estimated measure of quality Q_i^* embodies both the 'vertical' (Q_i) and the 'horizontal' component ($X_i'\beta$) of a variety's quality, where the 'vertical' component does not depend on consumers' tastes β. Since the coefficient on price α is negative and the distribution cost parameter γ is positive, then $(1 + \alpha\gamma) < 1$ and Q_i^* underestimates the vertical component Q_i of Q_i^*. This problem arises because under the assumption that quality is positively related to distribution costs, it creates a systematic wedge between the unobserved consumer import price $p_i^c(Q_i)$ and the observed export price $p_i(Q_i)$. In the theoretical model this wedge determines higher markups on higher quality varieties even in the presence of constant elasticity of substitution across goods. Under the assumption that distribution costs are linear in quality, the negative bias $\alpha\gamma Q_i$ in Q_i^* does not affect our analysis because Q_i^* can still be used to identify the relative quality of different varieties. Admittedly, Q_i^* should be given a broad definition of quality encompassing different products' aspects such as: closeness to consumers' taste, quality of the materials, design and consumers' appreciation for the brand. These are all aspects pertaining to exporters' non-price competitiveness.

The export price $p_i(Q_i)$ in equation (16) is expressed in foreign currency. By introducing destination-year fixed effects in the estimation of the demand model, we control for the common effect of exchange rate variations on the price of all varieties exported to the same country in a certain year. To obtain the empirical equivalents of the market shares we proxy for unobserved demand in each country by using the aggregate quantity imported within each 4-digit product class. We use the BACI dataset to compute the empirical counterpart of the outside variety share s_0 defined as the share on non-Italian imports over the total imports of country d in a given 4-digit product class s_{p4dt}.[14] The outside variety's share is then used to construct s_{fpdt} that is our empirical

[14]The BACI dataset reconciles trade declarations from importers and exporters as they appear in

proxy for the market share s_i

$$s_{fpdt} = \frac{ExportQuantity_{fpdt}}{MKT4_{p4dt}} = \frac{ExportQuantity_{fpdt}}{\frac{\sum_{p4dt} q_{fpdt}}{1-s_{p4dt}}}$$

where $ExportQuantity_{fpdt}$ is the quantity exported by firm f in the HS6 product class p to destination d at time t divided by our proxy of market size $MKT4_{p4dt}$, where the numerator is the total exports from Italy to country d within a 4-digit product class. The empirical counterpart of the 'nest share' $s_{i/g}$ is instead defined as

$$ns_{fpdt} = \frac{ExportQuantity_{fpdt}}{MKT6_{pdt}} = \frac{ExportQuantity_{fpdt}}{\frac{\sum_{pdt} q_{fpdt}}{1-s_{p4dt}}}$$

where $MKT6_{pdt}$ is the size of the market at the 6-digit level, where the numerator is the aggregate quantity exported by Italy to country d within the same 6-digit product class.

We estimate the following specification of the demand model

$$ln(s_{fpdt}) - ln(s_{p4dt}) = \alpha uvx_{fpdt} + \sigma_{ns} ln(ns_{fpdt}) + \delta_{dt} + \delta_{fp} + \tilde{Q}_{fpdt} \tag{18}$$

where uvx_{fpdt} is the unit-value of the exported variety, while the error $\tilde{Q}_{fpdt}$ is the empirical equivalent of the quality estimator Q_i^* in equation (17). The fixed effects δ_{dt} control for shocks in demand that are common across the varieties exported to the same destination, including variations in the exchange rate between Italy and country d. The fixed effects δ_{fp} remove the firm-product specific component from the error term, and it forces identification to exploit time and country variations in market shares and prices for a particular HS6 product exported by the same firm. Once we obtain consistent estimates of the demand parameters $\hat{\alpha}$ and $\hat{\sigma}_{ns}$, the estimator of quality is obtained as

$$\hat{Q}_{fpdt} \equiv \delta_{dt} + \delta_{fp} + \tilde{Q}_{fpdt} = [ln(s_{fpdt}) - ln(s_{p4dt})] - [\hat{\alpha} uvx_{fpdt} + \hat{\sigma}_{ns} ln(ns_{fpdt})]. \tag{19}$$

OLS estimates of α and σ_{ns} are generally upward biased because $\hat{Q}_{fpdt}$ in the error term correlates positively with the unit-value uvx_{fpdt} (Nevo, 2000). Similarly, greater quality determines higher demand within subgroups of substitute varieties, hence it correlates positively with the nest-share $\ln(ns)_{fpdt}$. To deal with endogeneity in unit-values and nest-shares we estimate equation (18) by Two Stage Least Squares (2SLS) with two instruments.

The first instrument is the average price computed across all Italian varieties of the same 6-digit product p exported to country d at time t: $z_{pdt} = N_{pdt}^{-1} \times (\sum_{pdt} uvx_{fpdt})$, where N_{pdt} is the number of Italian varieties exported to that market. Arguably, variations in the product-destination specific average price z_{pdt} over time and across

the COMTRADE database (Gaulier and Zignago, 2010).

Table 3: Quality estimation results

	Mean	Median	1st Quart.	3rd Quart	Sd.
FE price coefficient	-0.002	-0.0003	-0.001	-0.0001	0.010
FE-IV price coefficient	-0.010	-0.003	-0.007	-0.001	0.033
FE nest shares coefficient	0.887	0.902	0.859	0.941	0.071
FE-IV nest shares coefficient	0.897	0.910	0.870	0.954	0.123
Own price elasticities	-3.038	-0.639	-2.657	-0.180	6.24
$\hat{Q}_{fpdt}$	0.010	0.142	-0.637	0.828	1.266
Observations per estimation	110,931	67,717	29,556	153,624	111,514

Note. The table summarizes the results obtained from repeating the estimation of model (18) on different HS4 product categories. Own price elasticities are computed from the estimated parameters according to the formula in Berry (1994).

markets capture common demand and supply shocks affecting all Italian companies exporting a particular product. Because the dependent variable is a normalized market share, and common demand and supply shocks do not affect individual companies' market shares, this instrument is orthogonal with respect to the component of the error that is specific to individual varieties and that represent the main source of endogeneity on export prices.

Second, we instrument for the nest shares of individual firms by using the number of different 6-digit product categories exported by the same firm to d. This last instrument was used by Khandelwal (2010) under the assumption that the intensive (i.e., quantities exported) and the extensive (i.e., number of different products exported) margins of trade are correlated, but that the number of different varieties exported is uncorrelated with the quality of each individual variety.

Equation (18) is regressed separately on groups of observations belonging to different HS4 product categories. This approach allows for changes in the demand parameters across product classes. Estimation results are summarized in Table 3. In order to assess the effectiveness of our instrumental variable strategy, we compare the estimates of the coefficients α and σ_{ns} obtained from the FEIV model with those from the FE model that does not address the endogeneity problem. As expected, the distribution of the estimates of α from FEIV models has lower mean and median than the one obtained from FE models. This evidence suggests that by instrumenting unit-values and nest shares we correct the upward bias due to their correlation with the unobserved time-variant component of quality. In addition, FEIV estimates of the substitution parameter σ_{ns} fall in the plausible range $[0-1)$. Table 3 reports statistics for the price elasticity of demand obtained from the estimated parameters according to the formula detailed in Berry (1994). FEIV estimates of the demand parameters are used to obtain the measure of quality $\hat{Q}_{fpdt}$ as in equation (19).

The estimator of quality $\hat{Q}_{fpdt}$, allows us to test **Proposition 1** that relates export quality to a firm's capability and to the quality of the imported inputs. To do so we regress this estimator on export prices ($\ln uvx_{fpdt}$), a firm's productivity ($\ln TFP_{ft}$) and

Table 4: Estimated quality

	(1)	(2)	(3)	(4)	(5)
	$\ln(uvx)_{fpdt}$	$\ln TFP_{ft}$	$\ln Emp_{ft}$	$\ln Imports_{ft}$	$WAvg \ln uvm_{ft}$
$\hat{Q}_{fpdt}$	0.379***	0.084***	0.218***	0.144***	0.182***
	(0.0004)	(0.001)	(0.002)	(0.006)	(0.004)
pdt FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.618	0.136	0.163	0.184	0.416
Obs.	3,695,583	3,608,766	3,695,583	3,477,589	3,477,589

Note. The table reports results of regressions at the firm-product-destination-year level, using export and import data for the period 2000-2006. The dependent variables is reported at the top of each column. TFP is computed using the IV-GMM modified Levinsohn-Petrin procedure proposed in Wooldridge (2009). $Imports$ is a firm's total imports in year t. $WAvg \ln uvm_{ft}$ is a firm's weighted average of import unit values, using as weight the share of each transaction on a firm's total imports. Robust standard errors allowing for clustering of the residuals at the product-destination-year level are reported in parenthesis below the coefficients. All models control for product-destination-year fixed effects (pdt FE). Significance levels (***: p<1%;**: p<5%; *: p<10%).

size ($\ln Emp_{ft}$), its total imports ($\ln Imports_{ft}$) and a weighted average of the price of the imported inputs ($WAvg \ln uvm_{ft}$). All regressions include product-destination-year specific fixed effects, and parameters are identified by comparing the dependent variables across firms that in a given year export the same product to the same destination.[15] Results are reported in Table 4. The coefficient obtained in the regression on varieties' export prices (column 1) confirms that higher quality varieties are on average more expensive. Regressions on firm productivity and size (columns 2 and 3) generate evidence supporting the first prediction of our model. If size and productivity depend positively on a firm's capability (λ), then we confirm the first part of **Proposition 1** predicting a positive relationship between a firm's capability and output quality. We also find that the exporters of higher quality varieties are also more active importers (column 4) and they import more expensive varieties of intermediate goods (column 5).[16] Although the import price of the imported intermediate inputs is only an imperfect proxy for their quality, these findings support the second part of **Proposition 1** predicting that higher quality inputs are necessary to produce higher quality output.

[15] In the regressions reported in Table 4 we compute robust standard errors allowing for clustering of the residuals at the product-destination-year level. In all regressions reported in following tables we cluster the residuals at the destination-year level (or at the country-year level in regressions on import flows). All results are robust to alternative treatment of the error terms, such as clustering at the destination level.

[16] Column 4 of Table 4 reports the estimate of a regression using a firm's total imports as the dependent variable. The result does not change if we consider only imports in intermediate inputs, defined as those falling into the intermediate input category according to CEPII-BACI classification system (see Gaulier and Zignago, 2010). The coefficient in the latter case is 0.347 (0.005).

4. Empirical analysis

In this section, we first investigate whether import intensity is a determinant of Italian exporters' ERPT by replicating the analysis that Amiti et al. (2014) has conducted on Belgian firms. Second, we test the validity of our model's propositions 2 to 4 that relate export price adjustment to input and output quality. Finally, we conduct a number of robustness tests.

4.1. Imports and ERPT

Before testing the predictions of our model on the role of export quality, we first determine the average ERPT across Italian companies and whether the 'import channel' discovered by Amiti et al. (2014) is as important for Italian exporters as it is for Belgian firms.[17] Hence, we estimate the following specification

$$\Delta \ln uvx_{fpdt} = \alpha_0 + \alpha_1 \Delta RER_{dt} + \alpha_2 IM_f + \alpha_3(\Delta RER_{dt} * IM_f) + \delta + \epsilon_{fpdt} \qquad (20)$$

where the dependent variable $\Delta \ln uvx_{fpdt}$ is the log change of unit values between two consecutive years for a variety of product p exported by firm f to destination d at time t. IM_f is a firm's import intensity, δ represents different sets of fixed effects. ΔRER_{dt} measures year-to-year variations in the real exchange rate RER_{dt} between Italy and the destination country d.[18] An upward (downward) movement of RER_{dt} represents an appreciation (depreciation) of the domestic currency. In the dataset we observe the unit value uvx of each exported variety that is the empirical counterpart of the export price $p_i^*(Q_i)$ set by the exporter. In contrast, we cannot observe the import price $p_i^c(Q_i)$ paid by foreign consumers. Nevertheless, the extent to which exchange rate variations are transmitted into $p_i^c(Q_i)$ can be computed as $ERPT = 1 - \alpha_1$ where α_1 is the coefficient of ΔRER_{dt} in regressions on $\Delta \ln uvx_{fpdt}$. Accordingly, if exporters do not adjust their export prices in response to exchange rate variations then $\alpha_1 = 0$ and the ERPT is perfect. On the contrary, the closer is α_1 to -1 the greater is the offsetting adjustment of export prices to neutralize ERPT into consumer prices.

Table 5 reports the results from regressing model (20). Because we take annual differences, we end up with a smaller sample than the one used for the regressions reported in Table 4.[19] We cluster standard errors at the destination-year level in order

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[17]In the theoretical framework of Section 2 we do not address firms endogenous choice of import intensity as it is done by Amiti et al. (2014), but we still follow the empirical strategy of these authors to identify the importance of the 'intermediates import channel' by comparing ERPT across firms with different import intensity. An extension of the model is provided in Section 5.

[18]We define RER_{dt} as the product between the nominal Italian exchange rate expressed as the number of foreign currency units per home currency unit (ER_{dt}) and the ratio of the domestic consumer price level and the consumer price index abroad ($\frac{CPI_t}{CPI_{dt}}$). Using a wholesale price index to construct the real exchange rate reduces the number of countries in the sample but does not change the results. Data on nominal exchange variations and on consumer price indices are sourced from the International Financial Statistics database (IMF, 2010).

[19]About 50% of the observations are dropped when we construct the dependent variable by taking log changes of unit values between two consecutive years at a firm-product-destination level.

Table 5: Import intensity and pass-through

	$\Delta \ln uvx_{fpdt}$				
	(1)	(2)	(3)	(4)	(5)
ΔRER_{dt}	-0.027**	-0.024**			-0.025*
	(0.013)	(0.014)			(0.017)
$\Delta RER_{dt} * IM_f$		-0.153***	-0.106**	-0.103**	-0.117**
		(0.038)	(0.051)	(0.052)	(0.054)
IM_f		-0.009**	-0.007	-0.006	
		(0.004)	(0.004)	(0.004)	
$\Delta RER_{dt} * S_{fpdt}$				-0.164***	
				(0.041)	
S_{fpdt}				-0.023***	
				(0.005)	
pd FE	Yes	Yes			
t FE	Yes	Yes			Yes
pdt FE			Yes	Yes	
fpd FE					Yes
Adj. R^2	-0.015	-0.015	-0.022	-0.022	-0.042
R^2	0.053	0.053	0.219	0.219	0.432
Obs.	1,578,224	1,559,703	1,559,703	1,559,703	1,559,703

Note. The table reports the results from regressions run on firm-product-destination-year level export data for the period 2000-2006. The dependent variables and the real exchange rates are defined as annual log differences. IM_f is our proxy for import intensity; S_{fpdt} is a firm's export market share. Robust standard errors allowing for clustering of the residuals at the destination-year level are reported in parenthesis below the coefficients. Models control for different sets of fixed effects: product-destination (pd FE), year (t FE), product-destination-year (pdt FE), and firm-product destinations (fpd FE). Significance levels (***: p<1%; **: p<5%; *: p<10%).

to allow for correlation of the error terms across destination-year.[20] In column 1 we show the estimated coefficient on ΔRER_{dt} from a specification that includes only this explanatory variable together with year (δ_t) and product-destination (δ_{pd}) fixed effects that control for demand shocks affecting all firms exporting the same HS6 product to the same destination. The estimated coefficient can be interpreted as the average price adjustment to a variation in RER when we do not allow for differential response across exporters. We find that the average elasticity of export prices to RER variations is low, suggesting an almost perfect ERPT across Italian exporters. The exchange rate elasticity of Italian export prices is estimated to be of approximately -0.027, which implies an exchange rate pass-through into the import prices of about 0.97.[21]

[20] As indicated in footnote 15 the results are robust to alternative treatments of the error terms, such as clustering by destination.

[21] Using similar micro-level data for French exporters Berman et al. (2012) find an exchange rate pass-through to import prices abroad of around 0.88, while in Chatterjee et al. (2013) the producer price elasticity for Brazilian exporters is estimated to be of approximately 0.23 (77% of pass-through).

Although small at the first sight, the coefficient reported in column 1 hides a considerable amount of heterogeneity. Indeed, after including the interaction term between exchange rates and a firm's import intensity (column 2), we observe very different ERPT across firms with different import intensity IM_f. Given the inclusion of the interaction term $\Delta RER_{dt} * IM_f$, the coefficient on the un-interacted term ΔRER_{dt} captures the average adjustment of export prices among exporters that do not import intermediates ($IM_f = 0$). For this coefficient, our point estimate remains almost stable with respect to the baseline specification, around -0.024. However, the coefficient on the interaction term $\Delta RER_{dt} * IM_f$ reveals that a firm importing all its intermediate inputs from non-Euro origins (i.e., $IM_f = 1$) has an ERPT of 0.82 that is substantially lower than 0.98 for non importers. Similar findings are observed in Amiti et al. (2014) for Belgian exporters: while a firm with a zero import intensity has a pass-through of 87%, a firm with import intensity in the 95th percentile of the distribution has a pass-through of only 64%.

Columns 3 and 4 report the results from a specification including product-destination-year fixed effects (δ_{pdt}). Identification relies only on variations across firms *simultanously* exporting the same product to a given destination. We consider these specifications as the most appropriate to answer our research question as they identify the coefficient on the interaction term by comparing the price adjustment across exporters targeting the same foreign market in the same period of time. In column 4 we control for exporters' market shares S_{fpdt} within each destination by including the interaction term $\Delta RER_{dt} * S_{fpdt}$ on the right-hand side of the model. This term captures ERPT heterogeneity arising from differences in the market power of exporters within a destination country, that determine different scope for markup adjustment. As expected, firms with larger market shares have lower ERPT. Indeed, the elasticity of the exporter price to a real exchange rate change increases with a firm's market power as the interaction term between the real exchange rate and market share is negative and statistically significant.

For completeness we also estimate a specification, reported in column 5, including firm-product-destination fixed effects (δ_{fpd}). This one is the most restrictive as it also control for firm-level unobserved factors that may be correlated with the evolution of export prices. The estimated coefficient on $\Delta RER_{dt} * IM_f$ is consistently negative and significant across specifications.

4.2. Export quality, imports and ERPT

Proposition 4 predicts that the exchange rate elasticity of export prices is greater for high-quality varieties, due to a 'direct' effect of quality on a firm's ability to adjust prices. To test this prediction we estimate the following model

$$\Delta \ln uvx_{fpdt} = \alpha_0 + \alpha_1 \Delta RER_{dt} + \beta_1 \hat{Q}_{fpd} + \beta_2(\Delta RER_{dt} * \hat{Q}_{fpd}) + \delta + \epsilon_{fpdt} \qquad (21)$$

where we interact the ER variation ΔRER with a time-invariant measure of a variety's quality, $\hat{Q}_{fpd}$ measured in the first period the variety appears in the sample. We do not use a time-varying measure of quality to avoid capturing variations in quality explained by exchange rate movements.[22] Therefore, $\hat{Q}_{fpd}$ reflects differences in quality across varieties that are persistent over time. Our interest lies in the coefficient of the interaction term $\Delta RER_{dt} * \hat{Q}_{fpd}$ that identifies the differential price adjustment to exchange rate across varieties with different quality. The term δ represents different sets of fixed effects. Table 6 reports the estimation results.

Table 6: Import intensity, quality and pass-through

	$\Delta \ln uvx_{fpdt}$			
	(1)	(2)	(3)	(4)
ΔRER_{dt}	-0.024**			
	(0.012)			
$\Delta RER_{dt} * \hat{Q}_{fpd}$	-0.011**	-0.059**	-0.066***	-0.059**
	(0.005)	(0.024)	(0.025)	(0.026)
$\hat{Q}_{fpd}$	-0.011***	-0.018***	-0.019***	-0.019***
	(0.001)	(0.002)	(0.002)	(0.002)
$\Delta RER_{dt} * IM_f$			-0.129**	-0.121**
			(0.055)	(0.056)
IM_f			-0.011**	-0.011**
			(0.005)	(0.005)
$\Delta RER_{dt} * IM_f * \hat{Q}_{fpd}$			0.068**	0.068**
			(0.034)	(0.034)
$IM_f * \hat{Q}_{fpd}$			0.006**	0.006**
			(0.003)	(0.003)
$\Delta RER_{dt} * S_{fpdt}$				-0.134***
				(0.040)
S_{fpdt}				-0.012***
				(0.005)
pd FE	Yes			
t FE	Yes			
pdt FE		Yes	Yes	Yes
Adj. R^2	-0.014	-0.022	-0.022	-0.022
R^2	0.053	0.218	0.219	0.219
Obs.	1,578,224	1,578,224	1,559,703	1,559,703

Note. The table reports the results from regressions run on firm-product-destination-year level observations over the period 2000-2006. The dependent variables and the real exchange rates are defined as annual log differences. IM_f is a proxy for import intensity; S_{fpdt} is a firm's export market share; $\hat{Q}_{fpd}$ is the estimated proxy measured at the beginning of the period (time invariant). Robust standard errors allowing for clustering of the residuals at the destination-year level are reported in parenthesis below the coefficients. Models control for different sets of fixed effects: product-destination (pd FE), year (t FE), and product-destination-year (pdt FE). Significance levels (***: p<1%; **: p<5%; *: p<10%).

[22] Although, our model does not investigate a firms' endogenous quality choice with respect to exchange rate variations we cannot rule out the existence of this channel.

The negative coefficient on the interaction $\Delta RER_{dt} * \hat{Q}_{fpd}$ in column 1 is consistent with the findings of Chen and Juvenal (2014), as it suggests that export price adjustment is higher (and ERPT is lower) for higher quality varieties.[23] The coefficient on $\Delta RER_{dt} * \hat{Q}_{fpd}$ more than doubles when we adopt our preferred specification with product-destination-year fixed effects, as reported in column 2. A possible explanation for this discrepancy is that the specification in column 1 does not properly control for exporters' selection within each market over time.[24] Because product-destination-year fixed effects provide a better control for selection, they will be included in all the specifications that follow.

To test **Proposition 3**, we augment equation (21) by including on the righ-hand side the triple interaction term $\Delta RER_{dt} * IM_f * \hat{Q}_{fpd}$ capturing the extent to which export quality modifies the 'intermediates import channel' identified in the previous section. Estimation results are reported in column 3 of Table 6. The coefficient on the triple interaction term $\Delta RER_{dt} * IM_f * \hat{Q}_{fpd}$ reveals that the 'intermediates import channel' varies across exported goods with different quality.[25] Consistently with our model this coefficient is positive, suggesting that the 'intermediates import channel' is weaker for high-quality varieties.

Finally, because firms accounting for a large share of total exports have high market power, we augment the previous specification with the firm's market export share in product p, destination d at time t relative to all other (Italian) exporters. The inclusion of this variable and its interaction with the log change in exchange rate allows us to control for markups changes to exchange rate movements related to a firm's market strength in export markets. The results reported in column 4 suggest that our estimated coefficients of interest are robust when controlling for this heterogeneous pricing-to-market effects. Firms' with higher market share are those absorbing more exchange rate movements in their markups.

The relative magnitude of the coefficients of $\Delta RER_{dt} * \hat{Q}_{fpd}$ and $\Delta RER_{dt} * IM_f * \hat{Q}_{fpd}$ can be used to identify for which exporters the 'direct' positive effect of quality on ERPT prevails on the 'indirect' negative effect. From the estimated coefficients

[23] Instead, the negative coefficient on the un-interacted term $\hat{Q}_{fpd}$ suggests that high-quality varieties experience a slower increase in prices than low quality ones. A tentative interpretation of this coefficient is that higher quality goods have less scope for further quality improvements mirrored by a faster increase in prices.

[24] If quality is a relevant dimension to explain varieties' selection within each market, and if in 'tougher' times the quality of the exported varieties is higher, than it is inappropriate to compare varieties exported to the same market in different periods of time because the coefficient on the quality variable (and its interactions) will be correlated to unobserved time-varying market conditions.

[25] This specification includes also the interaction between import intensity and quality $IM_f * \hat{Q}_{fpd}$. The coefficient of this term suggests that import intensity does affect directly the price dynamic of goods with different quality.

reported in column 3 we can compute the total effect of quality on $ERPT$ as

$$\frac{\partial ERPT}{\partial \hat{Q}_{fpd}} = -0.066 + 0.068 * IM_f$$

this back-of-the-envelope calculation suggests that the negative effect of quality on ERPT is mostly relevant for exporters that do not import any intermediate good ($IM_f = 0$). According to our model this happens because domestic suppliers of intermediate inputs cannot adjust their export prices in response to exchange rate variation as foreign suppliers do. On the contrary, for a firm importing all the intermediates ($IM_f = 1$) the 'direct' and negative effect of quality on ERPT is completely neutralized by the positive 'indirect' effect. Intuitively, this happens because when the currency appreciates, the suppliers of high-quality inputs are able to raise their prices accordingly. The increase in marginal cost experienced by the final good producer reduces its ability to offset the exchange variation by reducing its markup.

Accordingly, the 'intermediates import channel' affects the ERPT as it follows

$$\frac{\partial ERPT}{\partial IM_f} = -0.129 + 0.068 * \hat{Q}_{fpd}$$

for a variety with average quality (0.010) the impact of a 50% increase in IM_f on the ERPT is -6%, for a high-quality variety with one standard deviation above the average (1.266) this effect is reduced to -2%. Hence, we conclude that the 'intermediates import channel' has a statistically and economically weaker effect on the ERPT into the price of high-quality varieties as it is predicted by **Proposition 3**.

4.3. Quality and ERPT into imported input prices

In the model, **Proposition 3** depends on the validity of **Proposition 2** stating that the import price paid by the exporters for intermediate inputs of high-quality is less sensitive to exchange rate variations. In the previous section we found empirical support for **Proposition 3**, and we now test if this result depends on the suppliers' export price adjustment as stated in **Proposition 2**. Since we do not observe the suppliers' export price, we test the validity of **Proposition 2** by looking at the import prices paid by Italian exporters for imported intermediates and by investigating whether the ERPT depends on the quality of these inputs. To do so, we estimate the following model

$$\Delta \ln uvm_{fpct} = \varphi_0 + \varphi_1 \Delta RER_{ct} + \varphi_2 HUVM_{fpct} + \varphi_3 (\Delta RER_{ct} * HUVM_{fpct}) + \delta + \epsilon_{fpct} \tag{22}$$

where $\Delta \ln uvm_{fpct}$ is the log change in the unit value of an imported input variety. The subscripts define respectively the HS6 category of the input p, the importing firm f, the country of origin c and the year the variety is imported t. Differently from the export data, when using import quantities and values from COE, the unit value we construct represents the import price of an imported variety p_j^c that approximates the price paid

Table 7: Quality and ERPT into imported input prices

	$\Delta \ln uvm_{fpct}$			
	(1)	(2)	(3)	(4)
ΔRER_{ct}	-0.201***		-0.216***	
	(0.038)		(0.051)	
$\Delta RER_{ct} * HUVM_{fpc}$	0.051**	0.054**		
	(0.026)	(0.020)		
$HUVM_{fpc}$	0.006**	0.006**		
	(0.003)	(0.003)		
$\Delta RER_{ct} * HUVM_{fpct}$			0.069**	0.054**
			(0.025)	(0.022)
$HUVM_{fpct}$			0.262***	0.275***
			(0.009)	(0.010)
pc FE	Yes		Yes	
t FE	Yes		Yes	
pct FE		Yes		Yes
Adj. R^2	0.001	0.019	0.051	0.076
Obs.	751,053	751,053	752,691	752,691

Note. The table reports the results from regressions run on firm-product-country-year level observations over the period 2000-2006. The dependent variables and the real exchange rates are defined as annual log differences. $HUVM_{fpc}$ is our proxy for high quality inputs and it is a dummy variable that takes value 1 if the unit value of input imported by the exporter f, from country c and belonging to the product category p, is above the average of import unit value of all firms importing within the same product class p, from the same country c at time t. In columns 1-2 we take the value of the dummy at the initial year thus making the variable time invariant. In columns 3-4 the dummy is time variant. Robust standard errors allowing for clustering of the residuals at the country-year level are reported in parenthesis below the coefficients. Models control for different sets of fixed effects: imported product-origin (pc FE), year (t FE), imported product-origin-year (pct FE). Significance levels (***: p<1%; **: p<5%; *: p<10%).

by the final good producer importing that variety. Therefore, a coefficient φ_1 close to -1 should now be interpreted as a sign of almost perfect ERPT. Unfortunately, we cannot estimate import quality as we did for the exports, and we resort to unit values to construct a simpler indicator of relative quality.[26] We identify high-quality inputs with the dummy variable $HUVM_{fpct}$ assuming value 1 if the unit value of any imported variety is above the average computed across all firms importing the same HS6 product p from the same country c at time t. We both construct a time varying and a time-invariant versions of this indicator.[27]

Table 7 presents the results from the estimation of model (22), which confirms the

[26] The main reason we cannot estimate imported varieties' quality is that in our dataset we do not have sufficient information to identify foreign suppliers originating individual import flows.

[27] Further details on the construction of the two versions of this indicator are provided in the note of Table 7.

predictions of our model. Indeed, we find that the ERPT on import prices is lower for high-quality inputs. Results from column 1 indicates that a 10% appreciation of the importers' currency reduces the perceived price of imported inputs on average by 1.9%, but this reduction is reduced to 1.4 % for the input varieties of higher quality. Results are robust across specifications with different combinations of fixed effects, and with time-varying or time-invariant proxies of high-quality inputs.

Table 8: Import intensity, quality and pass-through: different channels

	$\Delta \ln uvx_{fpdt}$					
	(1)	(2)	(3)	(4)	(5)	(6)
			Kugler and Verhoogen (2012)		Rauch (1999)	
	Developed	Developing	High VD	Low VD	High VD	Low VD
Δ RER$_{dt}$*$\hat{Q}_{fpd}$	-0.081***	-0.004	-0.111***	-0.009	-0.077***	0.007
	(0.024)	(0.040)	(0.031)	(0.034)	(0.025)	(0.040)
$\hat{Q}_{fpd}$	-0.019***	-0.013***	-0.014***	-0.022***	-0.024***	-0.001
	(0.003)	(0.004)	(0.003)	(0.002)	(0.002)	(0.002)
Δ RER$_{dt}$*IM$_f$	-0.151**	-0.017	-0.117**	-0.122*	-0.098*	-0.187**
	(0.070)	(0.071)	(0.050)	(0.067)	(0.050)	(0.075)
IM$_f$	-0.014**	-0.002	-0.002	-0.017***	-0.013**	-0.006
	(0.005)	(0.008)	(0.011)	(0.005)	(0.005)	(0.007)
Δ RER$_{dt}$*IM$_f$*$\hat{Q}_{fpd}$	0.082**	0.058	0.106**	0.039	0.074**	-0.001
	(0.040)	(0.060)	(0.045)	(0.053)	(0.036)	(0.055)
IM$_f$*$\hat{Q}_{fpd}$	0.004	0.009	0.017***	0.003	0.006*	0.004
	(0.003)	(0.005)	(0.003)	(0.004)	(0.003)	(0.005)
Δ RER$_{dt}$*S$_{fpdt}$	-0.159***	-0.114*	-0.140**	-0.136**	-0.126**	-0.174***
	(0.049)	(0.060)	(0.053)	(0.053)	(0.049)	(0.045)
S$_{fpdt}$	-0.005	-0.045***	-0.035***	0.011*	-0.017**	-0.007
	(0.005)	(0.009)	(0.006)	(0.006)	(0.005)	(0.006)
pdt FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	-0.019	-0.061	-0.041	0.008	-0.005	-0.055
R^2	0.195	0.309	0.196	0.227	0.210	0.263
Obs.	1,271,710	285,084	685,364	640,080	1,170,088	352,147

Note. The table reports the results from regressions run on firm-product-destination-year level observations over the period 2000-2006. The dependent variables and the real exchange rates are defined as annual differences. IM_f is our proxy for import intensity; $\hat{Q}_{fpd}$ is the estimated proxy for quality taken at the beginning of the period (time invariant). Robust standard errors allowing for clustering of the residuals at the destination-year level are reported in parenthesis below the coefficients. All specifications control for product-destination-year fixed effects (pdt FE). Significance levels (***: p<1%; **: p<5%; *: p<10%).

In order to validate the propositions of our model, we conduct two additional exercises. First, we identify inputs with different quality on the basis of their geographical origin and we replicate our main equation with the triple interaction reported in Table 6 considering imports from developed and developing countries. Intuitively, under the assumption that imported inputs from developed countries have higher quality, we would expect the effects on the triple interaction to be stronger when imports are imported from high income countries. Second, we run separate estimates of our main equation across vertically differentiated products. Similarly, under the intuition that imported inputs for highly differentiated products have higher quality, the effect should be stronger in products where vertical differentiation is more important.

Columns 1 and 2 of Table 8 present estimates from models where IM_f respectively captures import intensity from developed and developing countries only.[28] Consistently with our prior we find that the coefficient of $\Delta RER_{dt} * IM_f * \hat{Q}_{fpd}$ is positive and significant when IM_f includes only imports from developed countries (Table 8 column 1). We also find that this coefficient is larger than the one estimated when using total import intensity (Table 6 column 4).

To measure vertical differentiation of the export product categories we follow Kugler and Verhoogen (2012) and employ their classification based on the ratio of advertising plus R&D expenditures to total sales in U.S. industries.[29] The logic here is that firms invest more in R&D and advertising in sectors where it is possible to affect quality and thus there is more scope for quality differentiation. As an additional robustness check, we also employ the Rauch (1999) measure, based on whether a good is traded on a commodity exchange or it has quoted price in industry trade publications. This measures overall differentiation (i.e. both horizontal and vertical).[30]

We re-estimate our main equation, separately on different sub-samples of export transactions involving products with different degrees of vertical differentiation. Results are reported in columns 3-6 of Table 8. Columns 3-4 present estimates of the classification based on Kugler and Verhoogen (2012), while columns 5-6 show the results obtained by using the Rauch (1999) measure. Again, consistently with our expectation we find that the coefficient of $\Delta RER_{dt} * IM_f * \hat{Q}_{fpd}$ is positive and significant for relatively more differentiated products, columns 3 and 5. In both cases, we also find that this coefficient is larger than the one estimated when using the total sample (Table 6 column 4).

4.4. Robustness

In this section, we consider a set of exercises aimed at testing the robustness of our results to the inclusion of additional controls in the baseline specification, to changes in

[28]We defined as developed countries those with per capita income levels above the 50th percentile according to the World Bank. Results, available upon request, are robust if we take the 75th percentile.

[29]The original data are from the U.S. Federal Trade Commission 1975 Line of Business Survey. Kugler and Verhoogen (2012) convert FTC 4-digit industry classification into ISIC (Rev. 2) 4-digit classification using verbal industry descriptions. We convert from ISIC 4 digit level to HS6 product level using the appropriate concordance tables.

[30]As argued by Kugler and Verhoogen (2012), although the trade literature has extensively used the Rauch index as a measure of horizontal differentiation, it is indeed unclear which dimension it proxies for.

the sample composition, and to the adoption of alternative measures of import intensity and export quality.

The literature on exporters' heterogeneity and pricing-to-market behavior suggests that a firm's performance is a relevant determinant of its pricing policy in response to exchange rate variations. Indeed, Berman et al. (2012) find that larger and more productive firms tend to set higher markups in response to RER depreciations. In Table 9 we provide evidence that our empirical strategy is effective in disentangling the role of output quality from the role of other firm-level attributes that may also determine heterogenous markup adjustment. We first control for a firm's size using the log number of employees $lnEmpl_{ft}$ (column 1), we then control for the within-firm evolution of productivity ΔTFP_{ft} (column 2), and marginal costs ΔMC_{ft} (column 3).[31] In particular, the last two controls absorb markup variations explained by firm-level shocks in productivity and marginal costs. We also regress a specification with firm-product-year fixed effects δ_{fpt} that control for all the possible determinants of markup adjustment that are firm-product-year specific (column 4). The main results are robust across these specifications.

We then check whether our results are robust when considering only a firm's imports of intermediate inputs, as identified in the CEPII-BACI classification system (see Gaulier and Zignago, 2010). Therefore, we construct the import intensity measure IM_f by using only those products classified as intermediate inputs. Results with this alternative measure of import intensity, reported in column 5 of Table 9, are essentially unchanged. For multiproducts firms, the extent to which imported intermediate goods are used for production could be different across different products. To take into account this issue we provide two different exercises. As a first check, we drop marginal products, defined as those accounting for less than 1% of a firm's total exports, so to focus on firms' core products for which imports is likely to be equally important. This procedure should improve identification as products that are further away from a firm's core competencies poorly represent a firm's ability to achieve high output quality. Indeed, studies on multi-products firms find that products closer to a firm's core competencies have higher quality and they are sold for higher prices (Manova and Zhang, 2012; Eckel et al., 2011). The results in column 6 show that the positive coefficient for the triple interaction is preserved, but in this case the 'direct' effect of quality on ERPT is not completely neutralized by the positive 'indirect' effect.

[31] Note that results do not change if we include the interaction of ERPT with a firm's total factor productivity and marginal costs. The proxy for marginal costs is defined, following Amiti et al. (2014), as the log change in unit values of firm imports from all source countries weighted by the respective expenditure shares.

Table 9: Import intensity, quality and pass-through: robustness

	$\Delta \ln uvx_{fpdt}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				δ_{fpt}	Intermediates	Drop HS6 < 1%	IM_{fs}
Δ RER$_{dt}$*$\hat{Q}_{fpd}$	-0.059**	-0.063**	-0.059**	-0.009	-0.055**	-0.108**	-0.056**
	(0.026)	(0.027)	(0.026)	(0.006)	(0.026)	(0.043)	(0.027)
$\hat{Q}_{fpd}$	-0.019***	-0.018***	-0.019***	-0.003***	-0.019***	-0.040***	-0.017***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.004)	(0.002)
Δ RER$_{dt}$*IM$_f$	-0.116***	-0.115**	-0.115**	-0.116**	-0.125**	-0.169*	-0.021*
	(0.057)	(0.057)	(0.057)	(0.046)	(0.059)	(0.085)	(0.011)
IM$_f$	-0.010**	-0.011**	-0.010**		-0.010	-0.014*	-0.002*
	(0.005)	(0.005)	(0.005)		(0.007)	(0.007)	(0.001)
Δ RER$_{dt}$*IM$_f$*$\hat{Q}_{fpd}$	0.068**	0.075**	0.070**	0.043**	0.079**	0.087*	0.012*
	(0.034)	(0.034)	(0.034)	(0.020)	(0.036)	(0.046)	(0.005)
IM$_f$*$\hat{Q}_{fpd}$	0.006**	0.006**	0.006**	0.006*	0.020***	0.015***	-0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.004)	(0.002)
Δ RER$_{dt}$*S$_{fpdt}$	-0.129***	-0.128***	-0.135***	-0.024	-0.138***	-0.169*	-0.136***
	(0.040)	(0.040)	(0.040)	(0.018)	(0.035)	(0.084)	(0.039)
S$_{fpdt}$	-0.012**	-0.014***	-0.012**	-0.022***	-0.013**	-0.001	-0.012**
	(0.005)	(0.005)	(0.005)	(0.003)	(0.005)	(0.010)	(0.005)
Δ RER$_{dt}$*ln Empl$_{ft}$	-0.005	-0.006					
	(0.007)	(0.007)					
ln Empl$_{ft}$	-0.001	-0.001					
	(0.001)	(0.001)					
Δ TFP$_{ft}$		0.010***					
		(0.002)					
Δ MC$_{ft}$			0.039**				
			(0.015)				
pdt FE	Yes	Yes	Yes	No	Yes	Yes	Yes
Adj. R^2	-0.022	-0.023	-0.021	0.093	-0.021	-0.061	-0.022
R^2	0.219	0.225	0.219	0.291	0.219	0.386	0.219
Obs.	1,559,703	1,478,790	1,559,703	1,559,703	1,559,703	704,923	1,559,292

Note. The table reports the results from regressions run on firm-product-destination-year level observations over the period 2000-2006. The dependent variables and the real exchange rates are defined as annual differences. IM_f is our proxy for import intensity; S_{fpdt} is a firm's export market share; $\hat{Q}_{fpd}$ is the estimated proxy for quality taken at the beginning of the period (time invariant). TFP is computed using the IV-GMM modified Levinsohn-Petrin procedure proposed in Wooldridge (2009). Δ MC$_{ft}$ is the proxy for marginal costs defined as the log change in unit values of a firm's imports weighted by the respective expenditure shares. Robust standard errors allowing for clustering of the residuals at the destination-year level are in parenthesis . In column 4 we control for firm-product-year fixed effects and country fixed effects. All other models control for product-destination-year fixed effects (pdt FE). Significance levels (***: p<1%; **: p<5%; *: p<10%).

To address the different use of imported intermediates across the product lines of multiproduct firms, we map each HS6 product exported by a firm into a 2-digit ISIC sector, and we use input-output tables to associate a share of the imported intermediates to all exported products belonging to the same sector.[32] By obtaining a measure of import intensity IM_{fs} that varies across different exported products, we can approximate the unobserved allocation of imported intermediates across the production lines of multi-product firms. Estimates from regressions including this indicator of import intensity are reported in column 7. The estimated coefficient of all terms based on IM_{fs} are generally smaller in absolute value than those obtained using IM_f and some of them are significant at the 10% level. However, from a qualitative perspective these estimates are consistent with our baseline results.

We conclude this section, by presenting regressions of the baseline specification with alternative measures of export quality. We start by modifying slightly the instrumental variable strategy that we followed to obtain our measure of quality based on Khandelwal (2010). We first instrument the price of a firm's f variety in (18) with the average price computed across the varieties of all competitors f' operating in the same HS6 product-destination-year market: $Z_1 = (N_{pdt} - 1)^{-1} \sum_{f' \neq f, pet} uvx_{f'pdt}$.[33] We then re-estimate (18) by using the median price Z_2 computed within a market as an instrument for a variety's own price. These alternative instruments are insensitive to a variety's own-price variations, hence reducing the risk of endogeneity. When we compute these alternative instruments we also exclude from the estimation sample all markets (i.e., product-destination cells) with less than 5 competitors, to minimize the risk of strategic interactions in the price setting process.[34] Columns 1 and 2 of Table 10 respectively report regressions results when Z_1 and Z_2 are used to estimate $\hat{Q}_{fpd}$. Results are not significatively different from the ones obtained in previous regressions.

In column 3 the estimator of quality is instead computed following the methodology in Khandelwal et al. (2013). This alternative measure is closer in the spirit to the one used in the rest of the paper but it differs in two important respects: it does not depend on our strategy to estimate the parameter of the demand equation (i.e., it uses instead product-specific elasticities computed by Broda and Weinstein (2006)), and the dependent variable of the demand equation is not a market share but a variety's export quantity adjusted for its price. In column 4, instead we simply proxy for the quality of a variety with its unit value as in Auer and Chaney (2009). More specifically, we take the unit value of a variety in the first period it enters into a specific market (i.e., HS6-destination) as a time-invariant proxy for its quality in successive periods. Again, these sensitivity tests confirm that our results are robust to the use of alternative methodologies to estimate quality.

[32]We provide more details on the methodology that we use to associate imported inputs to different export sectors in the Appendix.

[33]We wish to thank an anonymous referee for suggesting Z_1.

[34]Bresnahan and Reiss (1991) show that concentrated markets with 5 or more firms approximate competitive conditions.

Table 10: Sensitivity to alternative measures of quality

	$\Delta \ln uvx_{fpdt}$			
	(1)	(2)	(3)	(4)
	Khandelwal (2010) alternative instruments		KSW (2013)	Initial unit value
	Z_1	Z_2		
$\Delta RER_{dt} * \hat{Q}_{fpd}$	-0.010**	-0.028**	0.006	-0.012
	(0.004)	(0.012)	(0.012)	(0.025)
$\hat{Q}_{fpd}$	-0.005***	-0.025***	-0.033***	-0.081***
	(0.000)	(0.002)	(0.001)	(0.003)
$\Delta RER_{dt} * IM_f$	-0.097*	-0.103*	-0.091	-0.307**
	(0.055)	(0.054)	(0.064)	(0.126)
IM_f	-0.009	-0.020***	-0.013***	-0.015
	(0.004)	(0.004)	(0.005)	(0.012)
$\Delta RER_{dt} * IM_f * \hat{Q}_{fpd}$	0.032***	0.052**	0.055*	0.076**
	(0.011)	(0.018)	(0.032)	(0.036)
$IM_f * \hat{Q}_{fpd}$	0.004***	-0.002	-0.014***	-0.006
	(0.001)	(0.002)	(0.003)	(0.004)
$\Delta RER_{dt} * S_{fpdt}$	-0.226***	-0.236***	-0.197***	-0.178***
	(0.050)	(0.051)	(0.057)	(0.040)
S_{fpdt}	-0.030***	-0.016	-0.051***	-0.039***
	(0.005)	(0.005)	(0.005)	(0.004)
pdt FE	Yes	Yes	Yes	Yes
Adj. R^2	0.002	0.006	0.023	-0.001
R^2	0.135	0.143	0.160	0.234
Obs.	1,298,431	1,190,638	1,061,214	1,559,703

Note. The table reports the results of robustness checks conducted by modifying our measure of export quality. Columns 1 to 2 report estimates obtained when the quality measure described in section 3.3 is estimated by using the alternative instruments Z_1, Z_2 for a variety's (fpd) price. Z_1 is obtained by averaging only the price of the competitors in the fpt cell with at least 5 Italian exporters, Z_2 is the median in the cell with at least 5 exporters. In column 3 the estimator of quality is obtained as in Khandelwal et al. (2013), while in column 4 we proxy quality with the unit value of a variety in the first year it appears in the dataset. Regressions are estimated on firm-product-destination-year level observations over the period 2000-2006. The dependent variables and the real exchange rates are defined as annual log differences. IM_f is a proxy for import intensity; S_{fpdt} is a firm's export market share. Robust standard errors allowing for clustering of the residuals at the destination-year level are reported in parenthesis below the coefficients. Significance levels (***: p<1%; **: p<5%; *: p<10%).

5. Endogenous import choice

The goal of this section is to investigate how exporters with different capability adjust intermediate import intensity in response to ER variations, and to verify how our predictions change when import intensity is endogeneously determined. The theoretical framework in section 2 is kept as simple as possible by assuming that a final good exporter employs exclusively imported intermediates. In this section, this assumption is relaxed by introducing in the model the import choice of the final good exporter. It is now assumed that for each intermediate input j the final good exporter can employ both a domestic and an imported version. Accordingly, the quality production function in equation (1) is modified as it follows

$$Q_i = \left[\int_{j \in I} \left((q_{jm}^{\theta} + \lambda^{\theta})^{\frac{1}{\theta}} m_j + (q_{jd}^{\theta} + \lambda^{\theta})^{\frac{1}{\theta}} d_j \right)^{\frac{\zeta-1}{\zeta}} dj \right]^{\frac{\zeta}{\zeta-1}} \tag{23}$$

where m_j and d_j are the quantities of the imported and the domestic versions of input j, while q_{jm} and q_{jd} are the qualities of the two versions. The price of the domestic version is given by

$$p_{jd}^{c}(q_{jd}) \equiv p_{jd} + \eta q_{jd} \tag{24}$$

and the price of the imported version p_{jm}^{c} is given by equation (5). While p_{jm}^{c} is affected by ER variations, p_{jd}^{c} is insulated. ER variations do not affect the nominal price of the domestic version and domestic suppliers do not adjust their markup in response to ER variations, as their marginal costs are expressed in the same currency of the adoption costs.

In the production function (23), different input varieties js are imperfect substitutes, while for each variety the domestic and the imported versions enter as perfect substitutes.[35] This implies that for each j a firm optimally chooses to use only the input version with the lower quality adjusted price $\frac{p_j^c}{(q_j^{\theta}+\lambda^{\theta})^{\frac{1}{\theta}}}$, where the denominator expresses the contribution of the input to output quality as in equation (23).[36] The imported version is chosen only if:

$$\frac{p_{jd}^{c}}{(q_{jd}^{\theta} + \lambda^{\theta})^{\frac{1}{\theta}}} > \frac{p_{jm}^{c}}{(q_{jm}^{\theta} + \lambda^{\theta})^{\frac{1}{\theta}}} \tag{25}$$

and the domestic version otherwise. Re-arranging this condition we obtain

$$\frac{p_{jm}^{c}}{p_{jd}^{c}} < \frac{(q_{jm}^{\theta} + \lambda^{\theta})^{\frac{1}{\theta}}}{(q_{jd}^{\theta} + \lambda^{\theta})^{\frac{1}{\theta}}}. \tag{26}$$

Inequality (26) implies that an exporter would still employ the relatively more expensive imported input as long as the relative price of the imported input (the term on the left-hand side) is lower than the relative contribution of this input to output quality (the term on the right hand side). When $q_{jm} > q_{jd}$, this condition is more likely to hold for firms with higher capability λ. Indeed, for firms with higher λ a quality difference

[35] Imperfect substitution between alternative versions of the same input would not affect the results. We opted for perfect substitution because this allows for a more intuitive discussion.

[36] Our treatment differs from Amiti et al. (2014), as we do not assume that a firm gains in productivity or quality by consuming a mix of domestic and foreign inputs.

in the two input versions maps into a greater difference in terms of contribution to output quality. Defining the difference in contribution to output quality as $D_{md} \equiv (q_{jd}^{\theta} + \lambda^{\theta})^{\frac{1}{\theta}} - (q_{jm}^{\theta} + \lambda^{\theta})^{\frac{1}{\theta}}$ it is easy to see that

$$\frac{\partial D_{md}}{\partial \lambda} = \lambda^{\theta-1}\left[(q_{jm}^{\theta} + \lambda^{\theta})^{\frac{1-\theta}{\theta}} - (q_{jd}^{\theta} + \lambda^{\theta})^{\frac{1-\theta}{\theta}}\right] > 0. \tag{27}$$

This effect arises because the production function (23) is supermodular in input quality and in firm capability. On the one hand, this result implies that more capable firms would care more about quality differences across versions when it comes to decide whether to employ the domestic or the foreign version of the input. As a consequence, the choice of more capable firms is less sensitive to ER variations affecting the relative price of the two versions because they are less likely to change their input composition.

Proposition 5: *The import intensity of high-capability firms is less sensitive to exchange rate variations. This happens because when there are ER depreciations (appreciations) firms with high λ substitute fewer imported (domestic) with domestic (imported) inputs.*

A depreciation of the exchange rate (i.e., fall in ϵ_A) increases the relative price of the imported variety on the left-hand side of (26). If $q_{jm} > q_{jd}$ a high-capability firm is less likely than a low-capability firm to substitute the imported version with the domestic one because for the high-capability firm the ratio on the right-hand side is greater and it would require a greater variation of the ratio on the left-hand side to induce substitution. Similarly, a high-capability firm is less likely than a low-capability one to substitute higher quality domestic versions with imported ones if the exchange rate appreciates.

We bring **Proposition 5** to the data by regressing the following equation

$$\Delta NP_{fct} = \gamma_0 + \gamma_1 \Delta RER_{ct} + \gamma_2 HUVM_{fc} + \gamma_3(\Delta RER_{ct} * HUVM_{fc}) + \delta + \epsilon_{fct} \tag{28}$$

where the dependent variable ΔNP_{fct} is the log difference between time t and $t-1$ in the number of HS6 input varieties imported by firm f from country c, and $HUVM_{fc}$ is a dummy variable assuming value one if the firm, in the first period observed importing from destination c, is on average purchasing input varieties with unit-values higher than the average computed at the product-country level. δ is either a set of country and year, or a set of country-year fixed effects.[37] The coefficient of interest is γ_3 that captures the differential reaction of importers of high-quality varieties (i.e., the high-capability exporters according to **Proposition 1**) to exchange rate variations. Table 11 reports the estimates from two specifications of equation (28) with different sets of fixed effects. The coefficient for ΔRER_{ct} confirms that for low-quality firms the number of imported

[37]For this exercise we assume that each input variety whose imports is discontinued is substituted by a domestic version, and that each newly imported input variety substitutes a domestic version.

varieties increases when the exchange rate appreciates. The estimate of γ_3 is negative and significant in both specification suggesting that importers of higher quality varieties (i.e. high-capability exporters) are less sensitive to exchange rate movements. Hence, we conclude that **Proposition 5** is supported by the empirical evidence.

Table 11: Number of imported varieties, RER variations and input quality

	Δn_{fct}	
	(1)	(2)
ΔRER_{ct}	0.028*	
	(0.017)	
$\Delta RER_{ct} * HUVM_{fc}$	-0.049**	-0.048**
	(0.002)	(0.022)
$HUVM_{fc}$	0.027***	0.027***
	(0.002)	(0.002)
c FE	Yes	No
t FE	Yes	No
ct FE	No	Yes
Adj. R^2	0.005	0.005
Obs.	447,967	447,967

Note. The table reports the results from regressions run on firm-country-year level observations over the period 2000-2006. The dependent variables Δn_{fct} is the log difference between time t and $t-1$ in the number of HS6 input varieties imported by firm f from country c. $HUVM_{fc}$ is a dummy variable assuming value one if the firm, in the first period observed importing from destination c, is on average purchasing input varieties with unit-value higher than the average at the product-country level. Robust standard errors allowing for clustering of the residuals at the country-year level are reported in parenthesis below the coefficients. Models control for different sets of fixed effects: import origin (c FE), year (t FE), import origin-year (ct FE). Significance levels (***: p<1%; **: p<5%; *: p<10%).

The 'stickier' import choice of high-capability firms described by **Proposition 5**, has implication for the 'intermediates import channel'. On the one hand, because the import intensity of high-capability firms is less elastic to ER variations, these firms are less capable to exploit an appreciation of the exchange rate as an opportunity to reduce costs by substituting some domestic input versions with foreign ones. Therefore, as in **Proposition 3** in the presence of currency appreciation the 'intermediates import channel' is weaker for the exporters of higher quality varieties, because these exporters (i.e., the high-capability firms) are less able to exploit the imports of intermediates to reduce production costs.

On the other hand, high-capability firms have less scope for substituting domestic for imported varieties when the ER depreciates. Hence, this effect in principle amplifies the positive effect of the 'intermediates import channel' on production costs when the domestic currency depreciates. However, even if high-capability producers stick to more expensive high-quality imported varieties when the domestic currency depreciates, the increase in the nominal import price of these varieties is offset by suppliers' export price adjustment, as indicated by **Proposition 3**. Therefore, in the presence of currency depreciation, the 'intermediates import channel' can still be weaker for the exporters of higher quality varieties because of the suppliers' behavior. Our empirical evidence suggests that this is indeed the case. We may conclude that the effect of the endogenous import choice does not alter our main conclusion, that is exporters using high quality imported inputs have a relatively weaker 'intermediates import channel' than firms importing lower quality inputs.

6. Conclusions

This paper puts forward a theoretical as well as an empirical analysis of exchange rate pass-through (ERPT) heterogeneity across Italian exporters. The main feature of our research is the joint study of the role of output and input quality in determining exporters' ability to insulate the import price of their goods from exchange rate variations. We propose a model where the exporters of high-quality products are also importers of high-quality inputs sold in monopolistically competitive markets. The novel prediction of this model is that while the imports of intermediate inputs generally reduce an exporter's ERPT, this effect is weaker if the imported inputs have higher quality.

We test the predictions of the model by using a very rich dataset providing information on the quantity and the value of Italian firms' import and export flows. This dataset allows us to obtain a firm-product-destination level measure of revealed export quality. Estimates of the exchange-rate sensitivity of export prices confirm that exporters using more intensively imported inputs have a greater ability to offset exchange rate variations, as in Amiti et al. (2014). However, this effect is weaker for firms exporting higher quality goods. By showing that the exporters' import price of higher quality inputs is less sensitive to exchange rate variations, we provide evidence supporting the hypothesis that the pricing power of input suppliers weakens the intermediates import channel.

Our micro results contribute to explain cross-country heterogeneity in the sensitivity of aggregate prices to exchange rate variations (Campa and Goldberg, 2005). Indeed, our findings suggest that a country's position within the quality ladder of international trade mediates the extent to which reliance on imported intermediate inputs shapes the sensitivity of aggregate export prices to exchange rate variations.

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References

Amiti, M., Itskhoki, O., Konings, J., 2014. Importers, exporters, and exchange rate disconnect. American Economic Review 104 (7), 1942–78.

Anderson, S. P., De Palma, A., Thisse, J.-F., 1987. The CES is a discrete choice model? Economics Letters 24 (2), 139–140.

Antoniades, A., 2015. Heterogeneous firms, quality, and trade. Journal of International Economics 95 (2), 263 – 273.

Atkeson, A., Burstein, A., 2008. Pricing-to-market, trade costs, and international relative prices. American Economic Review 98 (5), 1998–2031.

Auer, R., Chaney, T., 02 2009. Exchange rate pass-through in a competitive model of pricing-to-market. Journal of Money, Credit and Banking 41 (s1), 151–175.

Bas, M., Strauss-Kahn, V., 2014. Does importing more inputs raise exports? Firm level evidence from France. Review of World Economics 150 (2), 241–475.

Basile, R., de Nardis, S., Girardi, A., December 2012. Pricing to market, firm heterogeneity and the role of quality. Review of World Economics (Weltwirtschaftliches Archiv) 148 (4), 595–615.

Berman, N., Martin, P., Mayer, T., 2012. How do different exporters react to exchange rate changes? The Quarterly Journal of Economics 127 (1), 437–492.

Bernard, A. B., Jensen, J. B., Redding, S. J., Schott, P. K., Summer 2007. Firms in international trade. Journal of Economic Perspectives 21 (3), 105–130.

Berry, S. T., Summer 1994. Estimating discrete-choice models of product differentiation. RAND Journal of Economics 25 (2), 242–262.

Brambilla, I., Lederman, D., Porto, G., December 2012. Exports, Export Destinations, and Skills. American Economic Review 102 (7), 3406–38.

Bresnahan, T. F., Reiss, P. C., 1991. Entry and Competition in Concentrated Markets. Journal of Political Economy 99 (5), 977–1009.

Broda, C., Weinstein, D. E., May 2006. Globalization and the Gains from Variety. The Quarterly Journal of Economics 121 (2), 541–585.

Burstein, A., Gopinath, G., 2013. International prices and exchange rates. Working Paper 18829, National Bureau of Economic Research.

Campa, J. M., Goldberg, L. S., November 2005. Exchange rate pass-through into import prices. The Review of Economics and Statistics 87 (4), 679–690.

Caselli, M., Chatterjee, A., Woodland, A., Mar. 2014. Multi-product exporters, variable markups and exchange rate fluctuations. Discussion Papers 2014-15, School of Economics, The University of New South Wales.

Chatterjee, A., Dix-Carneiro, R., Vichyanond, J., 2013. Multi-product firms and exchange rate fluctuations. American Economic Journal: Economic Policy 5 (2), 77–110.

Chen, N., Juvenal, L., 2014. Quality, Trade, and Exchange Rate Pass-Through. Working Papers 14/42, IMF.

Corsetti, G., Dedola, L., 2005. A macroeconomic model of international price discrimination. Journal of International Economics 67 (1), 129–155.

Eckel, C., Iacovone, L., Javorcik, B., Neary, J. P., 2011. Multi-product firms at home and away: Cost- versus quality-based competence. CEPR Discussion Papers 8186.

Gaulier, G., Zignago, S., Oct. 2010. Baci: International trade database at the product-level. the 1994-2007 version. Working Papers 2010-23, CEPII research center.

Goldberg, P. K., Knetter, M. M., September 1997. Goods prices and exchange rates: What have we learned? Journal of Economic Literature 35 (3), 1243–1272.

Gopinath, G., Itskhoki, O., Rigobon, R., March 2010. Currency choice and exchange rate pass-Through. American Economic Review 100 (1), 304–36.

Gopinath, G., Rigobon, R., 05 2008. Sticky borders. The Quarterly Journal of Economics 123 (2), 531–575.

Grazzi, M., Sanzo, R., Secchi, A., Zeli, A., 2013. The building process of a new integrated system of business micro-data 1989-2004. Journal of Economic and Social Measurement (4), 291–324.

Hallak, J. C., Sivadasan, J., 2009. Firms' exporting behavior under quality constraints. Tech. Rep. 14928, National Bureau of Economic Research.

Johnson, R. C., 2012. Trade and prices with heterogeneous firms. Journal of International Economics 86 (1), 43–56.

Kasahara, H., Lapham, B., 2013. Productivity and the decision to import and export: Theory and evidence. Journal of International Economics 89 (2), 297–316.

Khandelwal, A., October 2010. The long and short (of) quality ladders. The Review of Economic Studies 77 (4), 1450–1476.

Khandelwal, A. K., Schott, P. K., Wei, S.-J., October 2013. Trade Liberalization and Embedded Institutional Reform: Evidence from Chinese Exporters. American Economic Review 103 (6), 2169–95.

Knetter, M. M., 1993. International comparisons of price-to-market behavior. American Economic Review 83 (3), 473–86.

Krugman, P., May 1986. Pricing to market when the exchange rate changes. Working Paper 1926, National Bureau of Economic Research.

Kugler, M., Verhoogen, E., 2012. Prices, plant size, and product quality. Review of Economic Studies 79 (1), 307–339.

Manova, K., Zhang, Z., 2012. Multi-product firms and product quality. Tech. Rep. 18637, National Bureau of Economic Research.

Navas, A., Serti, F., Tomasi, C., 2013. Intermediate inputs and the export gravity equation. Working Papers 2013014, The University of Sheffield, Department of Economics.

Nevo, A., December 2000. A practitioner's guide to estimation of random-coefficients logit models of demand. Journal of Economics & Management Strategy 9 (4), 513–548.

Rauch, J. E., June 1999. Networks versus markets in international trade. Journal of International Economics 48 (1), 7–35.

Verhoogen, E. A., 05 2008. Trade, Quality Upgrading, and Wage Inequality in the Mexican Manufacturing Sector. The Quarterly Journal of Economics 123 (2), 489–530.

Wooldridge, J. M., 2009. On estimating firm-level production functions using proxy variables to control for unobservables. Economics Letters 104 (3), 112 – 114.

Appendix

Customs data

In compliance with the common framework defined by the European Union (EU), there are different requirements in order for a cross-border transaction to be recorded, depending on whether the importing partner is an EU or NON-EU country, and on the value of the transaction.

As far as outside EU transactions are concerned, there is a good deal of homogeneity among member states as well as over time. In the Italian system the information is derived from the Single Administrative Document (SAD) which is compiled by operators for each individual transaction. From the introduction of the Euro, Italy has set a threshold at 620 euro (or 1000 Kg) for a transaction to be recorded. For all of these recorded extra-EU transactions, the COE data report complete about product category, destination, quantity and value.

Transactions within the EU are collected according to a different system (Intrastat). There the thresholds on the value of transactions qualifying for complete record are less homogeneous across EU member states, with direct consequences on the type of information reported in the data. In 2003 (the last year covered in the analysis), there are two cut-offs. If a firm has more than 200,000 euro of exports (based on previous year report), then she must fill the Intrastat document monthly. This implies that complete information about product types is also available. Instead, if previous year export value falls in between 40,000 and 200,000 euro, the quarterly Intrastat file has to be filled, implying that only the amount of export is recorded, while information on the product is not. Firms with previous year exports below 40,000 euro are not required to report any information on trade flows. According to ISTAT, although only one-third of the operators submitted monthly declarations, these firms cover about 98% of trade flows (http://www.coeweb.istat.it/default.htm). Thus, firms which do not appear in COE are either marginal exporters or do not export at all.

Methodology to associate imported inputs to exported products of multi-product firm

By making some assumptions over the production technology and the allocation of inputs across a firm's multiple product lines, it is possible to approximate the unobserved share of the total expenditure on each imported input that is required for the production of each exported product. The first assumption is that the expenditure on each individual input is the same across HS6 products matched to a unique sector of the input-output table. The second assumption is that the input requirements from the input-output table similarly apply across heterogeneous firms. The third assumption is that the relative importance of different product lines over a firm's total output can be measured by their relative importance over a firm's total exports. This assumption is needed because we do not observe a firm's domestic sales within individual product categories.

The OECD input-output table for Italy (relative to the early 2000s) is used to compute $n_{sk} = \frac{ValueInputs_{sk}}{ValueOutput_k}$ where $ValueInputs_{sk}$ is the gross value of the output from industry s used as an input by industry k, and $ValueOutput_k$ is the gross value of the total output of industry k. Hence, n_{sk} can be interpreted as the expenditure in intermediate inputs from industry s required to produce €1 of output in industry k. Each HS6 exported/imported product in the Italian customs data is mapped into one of the 20 industries of the input-output table. Customs data at the industry level are used to compute h_{kf} that is the value share of all HS6 products from industry k over the total exports of firm f. We then obtain the total value of imported inputs from industry s allocated to produce each exported output from industry k as:

$$Imports_{f,sk} = \left(\frac{n_{sk} h_{kf}}{\sum n_{sk} h_{kf}} \right) \times Imports_{f,s} \tag{29}$$

where $Imports_{f,s}$ is the total import value of firm f in sector s, and $Imports_{f,sk}$ is the import value of firm f in sector s required to produce outputs in sector k. The sum $\sum n_{sk} h_{kf}$ is performed over all 20 different input sectors s, but only on the output sectors k in which firm f is exporting.