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Article

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Price elasticity in import demand equations considering product quality: Estimates for the Brazilian economy (1996–2013)

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Abstract

Recent empirical studies argue that traditional trade models ignore product quality, usually leading to bias in price elasticities, which prevents the correct evaluation of trade determinants and the development of trade policies. This article quantifies the effect of quality on Brazilian imports. For that, we estimate import demand equations, including a proxy for the quality of imported goods, according to pooled data panel. Results show that price affects the demand for Brazilian imports more than quality, unlike literature results in developed countries. Introducing the quality proxy increased the price coefficient. This occurred more significantly in estimates for the manufacturing sector, supporting the hypothesis of elasticities bias when estimation does not consider product differentiation.

Keywords: Elasticity of imports; Quality; Competitiveness; Differentiation

JEL classification: F12; F14

1. Introduction

The quality of goods produced by an economy plays a key role in the development of trade relations. In a globalized world, the quality of exchanged goods becomes increasingly important in determining trade benefits. Recent empirical studies confirm the rise of trade in vertically differentiated products. Carmo and Bittencourt (2013) found that vertical intra-industry trade (VIIT) is superior to horizontal intra-industry trade (HIIT) in all bilateral relations between Brazil and OECD countries. In this regard, products exported by Brazil are of inferior quality compared to imported products with similar characteristics.

Despite the role of quality in trade flows, most empirical studies use traditional theories rather than the new theory of trade that considers the existence of differentiated products. Traditional trade theories relate to Heckscher-Ohlin,

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who explain trade from the relative endowment of production factors, and David Ricardo, who explains trade according to productivity differences in the production of homogeneous goods between countries. On the other hand, the new theory of trade, reported by Krugman (1979a, b, 1980), Lancaster (1980), and Helpman and Krugman (1985), explains trade from the economies of scale, imperfect competition, and product differentiation.

A growing literature has argued that estimates for price elasticity can lead to a bias when using traditional models, preventing correct analysis.

In this context, a common explanation for low values of price elasticities in import demand models is that they directly result from product differentiation. However, recent studies have shown that low values of demand price elasticities derived from traditional trade equations represent an underestimation bias. This underestimation relates, among other factors, to the absence of any explicit variable to measure the degree of product differentiation. In these equations, relative prices portray a double effect: a negative impact of the relative price for a given quality (pure price effect), and a positive effect of quality. The combination of these two dimensions leads to an underestimation of the price effect. Bias correction requires adding a term that represents quality, thus removing the influence of this variable on price elasticity estimates. Only then will it be possible to obtain the pure price effect.

This evidence suggests that traditional models that do not consider product quality may underestimate price elasticities and thus misevaluate economic policies in open economies. In quantitative terms, the effect of not considering product quality can be very significant in vertically integrated industries (see Falvey and Kierzkowski, 1987).

This article proposes the use of more direct measures of product quality in demand equations for Brazilian imports, following the methodology proposed by Crozet and Erkel-Rousse (2004). This will allow assessing the impact of this new variable on import demand elasticities. This study is relevant not only for understanding price elasticities in international trade and its relationship with product quality, but also for formulating adequate foreign trade policies. Price elasticities play a key role in the evaluation of these policies. Accurate knowledge of elasticities represents a very important tool for policy forecasts and studies, allowing a better understanding of the effects of changes in the tariff structure on the trade balance, and a better understanding of the country's foreign trade.

To achieve the objectives presented, in addition to this introduction, the article has four more sections. Section 2 presents a review of the relevant literature; in Section 3, we detail the model as well as the data and the econometric methodology. In Section 4, we present and analyze estimation results. Finally, Section 5 presents the main conclusions of the study.

2. Literature review

This section of the paper presents a brief review of the national and international empirical literature on elasticity estimates in international trade models.

Estimates with aggregated data predominate in the national literature, with no convergence in the results of elasticities, despite the relative abundance of studies on the subject. Trade models in Brazil initially assumed a market in perfect competition and perfectly substitutable goods, adopting the notion of a single global price. Among the various studies addressing the small country hypothesis, it is worth mentioning Cardoso and Dornbusch (1980) and Musalem (1981). However, as the manufactures trade advanced, research on foreign trade in Brazil began to consider the premise of imperfect substitutes. Thus, estimation models started to propose export quantities and prices as being determined through the interaction between demand and supply, with finite price elasticity. Among the studies that support the premise of imperfect substitution between goods, it is worth mentioning Zini (1988), Carvalho and De Negri (2000), and Skiendziel (2008).

According to the hypothesis of perfect substitutes, traded goods have the same unit value, regardless of the producing country. This hypothesis seemed correct when considering the Brazilian export basket at the time of its formulation. During that period, Brazilian exports consisted mainly of relatively homogeneous primary and semimanufactured products, and the country participated very little in the international market. Cardoso and Dornbusch (1980) estimated an equation for the supply of Brazilian manufactured exports assuming the small country hypothesis. This hypothesis proved to be adequate regarding the export price. The authors found that the price elasticity of export supply in the long run was approximately unitary. They also found evidence of export adjustment lags. Musalem (1981), in turn, quantified the level of subsidies for Brazilian manufactured exports. The authors analyzed the impact of these subsidies on export supply under the hypothesis that the country used the same manufactured prices of the international market.

Zini (1988) estimated the price and income elasticities of Brazilian foreign trade. This classic study adopted the small economy model for imports, and the imperfect substitutes model for exports. The author used quantum trading as a dependent variable, dividing exports and imports by sectoral groups. The general conclusion of Zini (1988) is that export and import functions in Brazil are moderately price elastic and strongly income elastic.

Models to estimate elasticities in the Brazilian foreign trade have been expanding, incorporating recent contributions in econometrics. Cavalcanti and Ribeiro (1998) present estimates of export equations for Brazil, carrying out tests to specify these equations. They also estimate export and import equations by examining nonstationary variables. The authors rely on the concept of cointegration using an error correction model, and analyze the exogeneity of variables.

Current Brazilian studies on elasticity estimation attempted to estimate elasticities at the sector level and according to the main trading partners,[1] as occurs when estimating the exchange rate elasticity. Within this line, Carvalho and De Negri (2000) estimated quarterly equations for the quantum of Brazilian agricultural imports and exports. The authors conclude that agricultural imports are highly dependent on the real exchange rate and on the rate of utilization of the installed domestic capacity. According to the authors, imports are dependent on the stage of the economic cycle through which a country passes. Thus, an overheated economy implies a growth in imports, while an idle economy implies a decrease in imports. The results obtained seem to confirm this.

Skiendziel (2008) estimated import and export supply and demand elasticities for Brazil, using the hypothesis of imperfect substitutes. The results were well behaved, that is, corroborated the theory both for relative price and for income. In terms of income elasticities, the author found values higher than the unit for the short and long term, with the exception of the foreign export supply, which was hypothetically assumed to be equal to the unit.

Recently, Kawamoto et al. (2013) analyzed income and price elasticities of Brazilian industrial exports and imports for the period between the years 2003 and 2010 using data disaggregated by manufacturing category. In general, the results obtained by the authors point to a more acute response to changes in income than to changes in price, both for exports and imports.

Despite the advances in estimating elasticities in the Brazilian foreign trade by using more and more recent developments in econometrics, these studies do not explicitly consider the heterogeneity of preferences in the trade model.

Regarding the international literature, Armington (1969) made the initial effort to expand the trade model. The author assumes product differentiation according to the country of origin. He also states that, for each sector, the total domestic demand is served by a good resulting from a CES (constant elasticity substitution) aggregate between domestic and imported goods. Goods previously considered homogeneous started to be treated as heterogeneous, that is, there is no perfect substitution between them, since the model assumes that consumers differentiate goods according to the producing country. The degree of substitution between domestic and imported varieties of a good, known in the literature as the Armington elasticity, has come to represent one of the main empirical instruments in the literature on international trade elasticities.

Despite considering the heterogeneity of goods, the model contemplates only horizontal differentiation and continues to assume a homogeneous market, maintaining the hypothesis of perfect competition and constant returns of scale. According to some authors, such as Orcutt (1950), Harberger (1953), Goldstein and Khan (1985), Madsen (1999), and Deyak et al. (1997), these trade equations are hard to estimate due to excessively low or unstable price elasticities, suggesting specification problems.

The study by Aiginger (1995) consists of the first empirical attempt to analyze the impacts of vertical differentiation on international trade. Applying the study to the German economy, the author determines the importance of competition via quality in a competitive environment. In this case, demand also depends on product characteristics other than price, such as reliability, design, durability, flexibility, among others. According to the author, these elements become important when the buyer is willing to spend more for a good considering these characteristics. Results show that competition via quality is more important than competition via price in determining Germany's trade flows.

Despite bringing important contributions, the study by Aiginger (1997) continues to consider a homogeneous market, which compromises the results. Trying to correct this problem, some studies have paid special attention to the effects of vertical differentiation on trade equation coefficients. The absence of this variable underestimates price elasticity, since part of the effect of the omitted variable will be captured by the price coefficient, leading to lower than expected

1 See Castilho and Luporini (2009).

values. According to the authors, the addition of a quality variable would allow removing the indirect effect of product quality from the price coefficient.

Following this line, Erkel-Rousse and Gallo (2002) and Crozet and Erkel-Rousse (2004) use a general equilibrium model with differentiated products, making explicit the consumer preference in each market and thus capturing some elements of vertical and horizontal differentiation. For that purpose, the authors use the love-of-variety model based on Spence (1976) and Dixit and Stiglitz (1977). This approach understands product differentiation as the existence of different consumers, using different varieties, where each demander chooses a certain variety. The authors show that it is thus possible to correct the bias of the price elasticity of imports and improve the statistical adjustment of the model.

The results of Crozet and Erkel-Rousse (2004) also confirm the existence of this bias. Using data for four European Union countries, the authors estimate and compare two models, one considering quality and the other excluding this new variable. Results show a higher price elasticity for the first model, evidencing that the inclusion of quality corrects the under estimation bias of elasticity.

Following the study by Crozet and Erkel-Rousse (2004), this article adds new elements to the Brazilian foreign trade model. Specifically, we address import demand using a general equilibrium analysis with differentiated products that evidences consumer preferences in each market to analyze vertical and horizontal differentiation. Thereby, we measure possible changes in import demand elasticities when considering a model with differentiated goods.

3. Methods and data source

3.1. Methodology

With a view to estimate the Brazilian demand for imports considering the variety and quality of goods, this section presents an import demand equation following Crozet and Erkel-Rousse (2004).

The formulation of a general equilibrium model with differentiated products requires highlighting the structure of consumer preferences in each market, capturing elements of this differentiation. One way of introducing the preferences for differentiated products of the agents specified in general equilibrium models is to adopt the love-of-variety approach, pioneered by Spence (1976) and Dixit and Stiglitz (1977). This approach views product differentiation considering the existence of different consumers, using different varieties, where each demander chooses a certain variety (Lemos, 2008).

The model assumes that there are $I \geq 2$ countries involved in trade, where i represents the exporting country and j refers to the importing country, which produces and trades k differentiated products; each of the k goods produced has v varieties. The country's representative consumer j maximizes the Spence–Dixit–Stiglitz sub utility function:

$$U_{kj} = \left[\sum_{i=1}^{I} \sum_{v=1}^{n_{ki}} \alpha_{kij} y_{vij}^{(\sigma-1)/\sigma} \right]^{\sigma/(\sigma-1)} \tag{1}$$

where y_{vij} represents the total demand for variety v addressed to the producer in country i, and n_{ki} the number of varieties of good k originating in country i, σ is the elasticity of substitution between domestic and imported goods from different origins. The preference parameter α_{kij} relates to the quality of the imported product, describing the consumer's preference for the differentiated variety v.

The parameters of the preference structure are the same for all varieties v of product k from the same country i. This is because preference parameters derive essentially from national differences in terms of production technology. The model also assumes that companies in a given country face the same production conditions, described below:

- There is a two-way relationship between companies and varieties;
- Companies do not consider the decisions of other companies;
- The only factor of production is labor;
- Preference for diversity is a market, rather than individual, characteristic;
- Companies pay the same wages to all workers;
- Companies show increasing returns of scale;
- Technology is the same for all varieties.

The total production of variety (v, i) is divided among j markets:

$$y_{vi} = \sum_{j=1}^{I}(1 + t_{kij})y_{vij} \tag{2}$$

Eq. (2) corresponds to the equilibrium condition, where y_{vi} represents the production share of variety (v, i) sold in market j, which is identical to the demand in market equilibrium. The combination of transport[2] and transaction costs corresponds to the destruction of a part ($t_{kij}y_{vij}$) of the production sent to market j during the transport of goods from country i to country j.

The model assumes that the conditions of production and transport are identical for each of the v varieties, which are sold in equal quantities, $y_{v_1ij} = y_{v_2ij} = \cdots = y_{v_nij}$, and at the same price, $p_{v_1ij} = p_{v_2ij} = \cdots = p_{v_nij}$, in market j. From the condition of maximizing profit, $p_{kij} = cme_{ki}$, considering a market in monopolistic competition, the following price equilibrium expression derives:

$$p_{kij} = c_{ki}(1 + t_{kij})\varepsilon_{kij}/(\varepsilon_{kij} - 1) \tag{3}$$

On the other hand, the consumer demand function, subject to consumer's budget constraint, derives from the maximization of Eq. (1):

$$y_{kij} = (p_{kij}/p_{kj})^{-\sigma}\left[\alpha_{kij}^{\sigma}/\sum_{i'=1}^{I}n_{ki'}\alpha_{ki'j}^{\sigma}\right](E_{kj}/p_{kj}) \tag{4}$$

where p_{kj} represents the average price of product k in market j, as follows:

$$p_{kj} = \left[\sum_{i=1}^{I}n_{ki}\alpha_{kij}^{\sigma}p_{kij}^{1-\sigma}/\sum_{i=1}^{I}n_{ki}\alpha_{kij}^{\sigma}\right]^{1/(1-\sigma)} \tag{5}$$

Thus, the higher the elasticity of substitution σ, the more sensitive the demand with respect to relative prices and quality. On the other hand, c_{ki} denotes the unit cost of producing variety v of product k in country i; E_{kj} is the share of country j in the national revenue allocated to the consumption of product k; and $\varepsilon_{kij} \equiv -(\partial y_{kij}/y_{kij})/(\partial p_{kij}/p_{kij})$ is the price elasticity of demand for variety v in country j, calculated from the demand function (4), which results in:

$$\varepsilon_{ij} = 1 + (\sigma - 1)\left[1 - \alpha_{kij}^{\sigma}p_{kij}^{1-\sigma}/\sum_{i=1}^{I}n_{ki'}\alpha_{ki'j}^{\sigma}p_{ki'j}^{1-\sigma}\right] \tag{6}$$

According to Dixit and Stiglitz (1977), expression (6) implies that ε_{kij} tends toward σ when the number of firms tends to infinity, considering monopolistic competition with atomized markets.

The combination between (3) and (5) shows that prices (p_{kij}) are increasing functions of quality α_{kij}, and decreasing functions of the number of varieties n_{ki}, ceteris paribus This result is a consequence of the substitution between varieties of a good, as Gaulier and Méjean (2006)[3] demonstrated from the differentiation effect, following Krugman (1980).

According to Crozet and Erkel-Rousse (2004), the equation for importing product k originating from country i to country j, considering differentiated goods, can be expressed as follows:

$$M_{kij} = n_{ki}p_{kij}y_{kij} \tag{7}$$

Substituting (4) in (7), we obtain:

$$M_{kij} = (p_{kij}/p_{kj})^{1-\sigma}\left(n_{ki}\alpha_{kij}^{\sigma}/\sum_{i'=1}^{I}n_{ki'}\alpha_{ki'j}^{\sigma}\right)E_{kj} \tag{8}$$

[2] Samuelson (1954) associates transport costs to what he calls "iceberg modeling". The author supposes that when a company sends a certain quantity of a good from one city to another, part will be lost in the way.

[3] Gaulier and Méjean (2006) study the aggregate price effect of newly imported varieties in a sample of 28 advanced and emerging market economies. The authors confirm the downward impact of variations in the imported variety on the level of import prices. Between 1994 and 2003, the emergence of new varieties led to an unrecorded 0.2 percent annual drop in import prices.

Expressing imports from country j with respect to a competitor i', we have:

$$M_{kij}/M_{ki'j} = (p_{kij}/p_{ki'j})^{1-\sigma}(n_{ki}/n_{ki'})(\alpha_{kij}/\alpha_{ki'j})^{\sigma} \tag{9}$$

By transforming Eq. (9) in terms of growth rates, we obtain:

$$\log{(mshare)_{kijI't}} = -(\alpha_p - 1)\log(price_{kijI't}) + \alpha_g \log(variety_{kijI't}) + \alpha_q(quality_{kijI't}) \tag{10}$$

where:

$$mshare_{kijI't} = \frac{M_{kijt}}{\sum_{i \in I'} M_{kI'jt}}$$

$$price_{kijI't} = \frac{p_{kijt}}{p_{kI'jt}}$$

$$variety_{ijI't} = \frac{n_{kit}}{n_{kI't}}$$

$$quality_{ijI't} = \frac{\alpha_{kijt}}{\alpha_{kI'jt}}$$

The variables $\overline{p_{kI'jt}}$, $\overline{n_{kI't}}$, and $\overline{\alpha_{kI't}}$ represent the averages of price, variety, and quality, respectively, for a group i's of competitors belonging to the set of I's partners.

$mshare_{kijI't}$ reflects the share of imports of goods from sector k originating from an exporting country i to an importing country j over period t.
$price_{kijI't}$ reflects the relative price of good k originating from country i to country j;
$variety_{ijI't}$ reflects the number of varieties of good k;
$quality_{ijI't}$ reflects the relative quality of the imported good.

This model suggests that exporters can try to acquire greater market share through two channels. One way is reducing their prices in relation to those of their competitors. The other way is making use of their relative strength through the differentiation channel, that is, they can increase the number of varieties offered or improve the quality of their products.

To arrive at the testable model, we included the variable $dist_{kijI't}$, which reflects the relative distance between trading partners i and j, representing transaction costs. According to Anderson and Marcouiller (1999) and Rauch (1999), this variable can be added to control trade barriers that are not accounted for through relative prices.

Also adding the constant factor $c_{kijI'}$, we obtain the following equation:

$$\log{(mshare)_{kijI't}} = -(\alpha_p - 1)\log(price_{kijI't}) + \alpha_g(variety_{kijI't}) + \alpha_q \log(quality_{kijI't}) - e_d \log(dist_{ijI'}) + Interc + u_{kijI't} \tag{11}$$

We are interested in the price elasticity of demand for imports α_p, and in the elasticity of quality α_q between the various varieties of good k.

Testable hypothesis:

- The traditional equations of demand for imports do not incorporate product differentiation and its impact on prices. Thus, the conventional calculation of price elasticity leads to a bias, since the price coefficient partially captures the behavior of variables not included in the model. In this context, the negative effect of price will be higher than expected. With the introduction of the new variables, the positive impact of quality no longer influences the price coefficient.

3.2. Variables and data

This study used annual data for the period from 1996 to 2013, considering the 20 main trading partners of Brazil.[4] The panel thus formed consists of 340 observations (20 countries × 17 years).[5]

The model contains unobservable or imperfectly measured variables, which have to be replaced by proxies, the first of which refers to price. We used the price index for imports as a proxy, and calculated it according to a methodology developed by the Center for Foreign Trade Studies Foundation (FUNCEX).[6]

For the variable variety, two proxies will be considered, the first of which was suggested by Krugman (1980), based on sectoral production or, preferably, sectoral GDP. Krugman (1980) established the existence of a positive relationship between production and the number of varieties at the sectoral level, but in a less general theoretical structure, considering the monopolistic competition model with high number of firms.

According to Acemoglu and Ventura (2002), the variety proxy captures the effect of varieties on export potential because the number of employees in a specific sector (which directly relates to the level of production) is proportional to the number of varieties that the sector produces. Thus, an exporting country with greater export potential (proxied by greater employment) tends to export increasing varieties of goods compared to its competitors. This means that the importing country prefers to import more goods in relation to its competitors so as to provide higher varieties of the same good to its consumers.

Due to the difficulty in obtaining sectoral GDP data, Crozet and Erkel-Rousse (2004) suggest an approximation for this measure. The authors use aggregate GDP and introduce an auxiliary variable, relative specialization,[7] to capture the sectoral structure of GDP. The product of these two variables (aggregate GDP and relative specialization) constitutes a proxy for sectoral GDP and, consequently, for the number of varieties.

The second proxy suggested in the literature for the variety variable derives from the decomposition of intra-industry trade (IIT) into vertical intra-industry trade (VIIT) and horizontal intra-industry trade (HIIT), following the methodology of Abd-el-Rahman (1991) and Greenaway et al. (1994).[8]

We considered two proxies for the quality variable. The first derives from the methodology described above, specifically considering superior vertical intra-industry trade ($VIIT_{sup}$). The second derives from the methodology proposed by Hausmann et al. (2007), which classifies traded goods according to their implicit productivity, from which the degree of sophistication of baskets of goods is calculated. To improve the representativeness of the index as a proxy for the quality of imported goods, we proceed to quality adjustment as proposed by Xu and Lu (2010).[9]

We collected import data from the COMTRADE (Commodity Trade Statistics) database, and deflated the data by using the American producer price index (PPI). We extracted the GDP of each trade partner from the World Bank (WB) database. We obtained the values for the variable $dist_{ijI'}$ from the *Centre d'Études Prospectives et d'Informations Internationales* (CEPII).

We classified the tariff on imports of basic goods and manufactures according to the United Nations Conference on Trade and Development (UNCTAD),[10] which uses the Standard International Trade Classification (SITC) nomenclature.

The present analysis considers the following models: pooled least squares method, fixed effects model (LSDV), and random effects model (GLS). Estimation includes different econometric models so as to verify the consistency of the results, making the analysis more robust.

[4] The selection criterion considers the average share of imports in the total imported from each country. The selected countries accounted, on average, for approximately 70% of the total imported by Brazil. See Annex B.

[5] The countries considered are: China, United States, Argentina, Germany, India, Italy, Japan, France, Mexico, Chile, Spain, Bolivia, the United Kingdom, Russia, Canada, Uruguay, Belgium, Peru, Paraguay, Venezuela.

[6] See Annex A.

[7] See Annex A.

[8] See Annex A.

[9] See Annex A.

[10] http://unctadstat.unctad.org/EN/Classifications.html.

Variable	Obs	Mean	Std. Dev.	Min	Max
pb	323	.5195356	.28009	.03	1.78
pm	323	1.743777	.6474177	.47	5.92
vb	323	15398.67	8861.125	489	73049.7
vm	323	11746	15420.53	397.9	141977
qb	323	1033562	1381490	6952	8040851
qm	323	1752129	6149967	2840.8	4.55e+07
mb	323	.0528337	.0744871	.0037	.3986
mm	323	.0527307	.0656534	.0009	.3537
dist	323	9296.684	4684.704	1633	17982

Fig. 1. Descriptive statistics.
Source: Results obtained by the author with research data through the software Stata 11.0.

3.3. Data analysis

The figure below summarizes the database we used for the estimates. After some exclusions due to lack of data, which made it impossible to calculate some indicators, the total was 323 observations. Fig. 1 presents the descriptive statistics of the price indices of basic goods and manufactures (*pb* and *pm*);the number of varieties for both groups (*vb* and *vm*) and their results for the quality indicator (*qb* and *qm*); participation in total imports (*mb* and *mm*); and the distance between Brazil and its partner.

On average, as expected, the price index of basic goods was lower than that of manufactures. There is also greater variability between manufactures prices, with a wide variation depending on the country of origin. Even when belonging to the same category, each good presents different levels of technological processing, which affects the final price. On average, basic goods showed a lower number of varieties; however, disaggregate analysis pointed to higher values of this indicator for manufactures. The quality variable followed the same pattern.

The results for the intra-industry indicator[11] show that the majority of intra-industrial exchanges occurred in vertically (or quality) differentiated varieties. As a rule, the quality of the varieties exported by Brazil is inferior to the quality of the varieties exported by most of the countries analyzed,[12] since the inferior vertical intra-industry trade indicator showed higher values.

4. Results

4.1. Empirical analysis

Before presenting the results, it is interesting to analyze the correlation between the model variables. Theoretically, price and quality correlate positively, as well as quality and volume of imports. In turn, an increase in the number of varieties, ceteris paribus, will likely reduce prices due to greater competition.

According to Crozet and Erkel-Rousse (2004), the expected result of the relationship between price and volume of imports is more ambiguous; if the price effect predominates, the correlation between price and import quantum must be negative, given that relatively high prices represent a competitive disadvantage leading to a reduction in imports. If, however, the dimension of quality that is implicitly inserted in the price is dominant, the sign of this correlation can be reversed, since high prices can signal that the quality is higher, which, according to the author, stimulates the purchase of goods.

[11] See Annex B.
[12] See Annex A.

Table 1
Correlation matrix applied to the model variables (1997–2013).

Variable	Manufactures					
	$M_{manufact.}$	Price	VIIT	HIIT	PRODY	$GDP_{Sectoral}$
$M_{manufact.}$	1.00					
Price	−0.20	1.00				
VIIT	0.26	0.02	1.00			
HIIT	−0.04	−0.06	0.06	1.00		
PRODY	0.44	0.13	0.29	0.03	1.00	
$GDP_{Sectoral}$	−0.07	−0.06	0.08	0.14	−0.01	1.00
	Basic G					
	M_{basic}	Price	VIIT	HIIT	PRODY	$GDP_{Sectoral}$
M_{basic}	1.00					
Price	−0.31	1.00				
VIIT	−0.16	0.10	1.00			
HIIT	−0.11	−0.06	−0.31	1.00		
PRODY	−0.13	0.21	0.29	0.18	1.00	
$GDP_{Sectoral}$	−0.07	−0.18	−0.20	0.37	0.03	1.00

Source: Results obtained by the author with research data through the software Stata 11.0.

Table 1 shows the correlation between the variables we used in the model.

The correlations show that the traditional relationship between price and import quantum seems to predominate. In both sectors, the simple correlation between relative prices and relative imports turns out to be negative, which shows that prices have a predominant role in Brazilian import decisions. This behavior is understandable when we analyze the main markets of origin of Brazilian imports. China[13] occupies the first position in this list; this market is known for its high price competitiveness, which corroborates the high influence of prices as a determinant of Brazilian imports. As expected, given the relative homogeneity of these goods, the category of basic goods has a stronger negative relationship. For this type of product, selling at low prices appears to play a crucial role in trade performance.

Crozet and Erkel-Rousse (2004) analyze this result for OECD countries. Contrary to expectations, the study found a positive relationship between price and import quantum. In this case, according to the authors, the positive effect of quality predominates over the negative effect of price.

The two variables used as proxies for quality (PRODY and VIIT) correlate positively with the import quantum of manufactures, whereas for basic goods this correlation was negative. Other authors also observed this result. Crozet and Erkel-Rousse (2004) argue that individuals find it difficult to define the quality of products with more homogeneous characteristics. In this case, "high quality" usually relates directly to "lower price". Therefore, the negative correlation between quality and import quantum in the basic segment may be a consequence of the positive correlation between quality and price, since the increase in quality induces an increase in price, which indirectly reduces imports.

The correlation between variables does not seem to compromise model estimation when assuming a strong correlation between variables for absolute values greater than 0.8, as is usual in the literature. To verify whether there is multicollinearity in the model, we calculated the variance inflation factor (VIF). In the presence of severe multicollinearity, the coefficients may not reflect the particular effect of the explanatory variable on the dependent variable due to the effect of other variables, explaining only part of it. The literature considers the presence of severe multicollinearity when the VIF exceeds 5. In this case, the VIF was less than 5 for all variables in our model. Thus, the model did not exclude any variables.

We estimated pooled (OLS), fixed effects (LSDV), and random effects (GLS) panels, with robust errors for heteroskedasticity. The tests performed were Breusch-Pagan (random effects versus pooled OLS regressions) and Hausman (random effects versus fixed effects), which pointed to the use of the fixed effects model. However, as the significance of both tests was relatively low, we will present all models.

[13] 16.3% of the total Brazilian imports in 2014 originated in China.

Table 2
Import demand function of manufactures (1997–2013).

Variable	Pooled		Fixed effects (LSDV)		Random effects (GLS)	
	Abs. quality	Pres. quality	Abs. quality	Pres. quality	Abs. quality	Pres. quality
PriceElast. $(1-e_p)$	−1.049	−1.328	−1.088	−1.397	−0.890	−1.139
	(−4.98)*	(−5.95)*	(−4.90)*	(−5.95)*	(−8.35)*	(−9.54)*
PRODY (e_q)		0.273	–	0.279	–	0.241
	–	(6.87)*	–	(6.80)*	–	(9.66)*
SectoralGDP (e_g)	0.465	0.337	0.486	0.359	0.284	0.205
	(4.22)*	(3.24)*	(4.27)*	(3.36)*	(4.18)*	(3.17)*
Distance (e_d)	−1.12	−0.825	−1.144	−0.833	−0.943	−0.878
	(−10.51)*	(−7.57)*	(−2.39)**	(−2.46)**	(−12.82)*	(−14.66)*
Constant	−17.35	−17.13	16.25	−17.54	−14.08	−16.11
	(−10.26)*	(−10.92)*	(−12.11)*	(−10.77)*	(−15.15)*	(−17.80)*
Dummy per country and/or time	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.31	0.41	0.35	0.44	0.39	0.45
No. of observations	340	340	340	340	340	340

Source: Results obtained by the author with research data through the software Stata 11.0.
* Statistically significant at 1%.
** Statistically significant at 5%.
***Statistically significant at 10%.
NS, not statistically significant.

Initially, we estimated the import demand function for the group of manufactures, considering as quality proxy the import productivity index (PRODY) adjusted for quality, and sectoral GDP for the variety variable, as suggested by Krugman (1979a, b). Then, we made estimates considering the class of basic goods. Subsequently, we introduced new proxies for quality and variety in both models to verify the consistency of the results. For that, we used the vertical and horizontal intra-industry trade indices.

Table 2 presents the results of the first set of estimates for manufactures. Estimating regressions in each particular sector allow eliminating sectoral heterogeneity between the data. To analyze the effects of introducing new variables on the price coefficient, we estimated two models: one with the presence of the quality variable and one without it.

The relative price coefficient $(1-e_p)$ has a negative and significant relationship with relative imports in all estimated models. The relative price considered is the price of the imported good in relation to the price of the competing good. Therefore, according to these results, if the price of goods imported from country j is higher than the average price of goods imported from country i, consumers prefer to buy from i.

Imports of manufactures were price elastic. Considering estimates without the quality variable, variation of 1% in prices leads to a variation of approximately 1% in the import quantum. After adding the new variable, the price coefficient increased by approximately 0.3%.

As Crozet and Erkel-Rousse (2004) suggest, following Krugman (1980), the coefficient associated with the variety proxy is usually equal to or at least lower than the unit. The results for the sectoral GDP coefficient agree with the theory since the variable in question presented positive values less than one in all estimated models. After the introduction of the quality proxy, this coefficient decreased in all estimates.

As we expected, the distance variable varies negatively with trade flows. As longer distances increase transport costs, countries tend to negotiate more with neighboring countries. Thus, the distance between trading partners proved to be an important variable in determining trade flows.

Table 3 presents the estimation results for basic goods.

The results show that the effect of prices is lower for this group of products than for manufactures. This characteristic of price elasticity for this segment can be explained by the greater degree of dependence on the import of these goods for the economy. In this case, price variations will have a lesser effect on the import quantum. On the other hand, in the case manufactures, countries import nonessential products; thus, variation in their demand due to a change in prices may be greater.

The impact of the quality of imports varies when we consider homogeneous goods, as is the case of basic goods. The coefficients of the PRODY variable were negative in all estimates, and not significant for fixed effects. These results

Table 3
Import demand function of basic goods (1997–2013).

Variable	Pooled		Fixed effects (LSDV)		Random effects (GLS)	
	Abs. quality	Pres. quality	Abs. quality	Pres. quality	Abs. quality	Pres. quality
PriceElast. $(1-e_p)$	−0.64	−0.74	−0.84	−0.83	−0.76	−0.64
	(−3.37)*	(−3.84)*	(−8.19)*	(−8.03)*	(−7.30)*	(−6.09)*
PRODY (e_q)	–	−0.07	–	−0.01	–	−0.06
	–	(−2.72)*	–	(−0.31)NS	–	(−4.62)*
Sectoral GDP (e_g)	0.08	0.07	−0.03	−0.02	−0.11	−0.07
	(1.04)NS	(0.95)NS	(−0.61)NS	(−0.54)NS	(−1.13)**	(−1.07)***
Distance (e_d)	−0.43	−0.42	−1.12	−1.14	−0.36	−0.31
	(−3.80)*	(−3.78)*	(1.89)NS	(−2.35)**	(−3.21)*	(−4.10)*
Constant	−7.67	−6.75	−4.12	−5.63	−3.93	−4.05
	(−4.85)*	(−4.22)*	(−4.61)*	(−5.56)*	(−5.33)*	(−5.39)*
Dummy per country and/or time	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.42	0.50	0.56	0.64	0.36	0.43
No. of observations	340	340	340	340	340	340

Source: Results obtained by the author with research data through the software Stata 11.0.
* Statistically significant at 1%.
** Statistically significant at 5%.
*** Statistically significant at 10%.
NS, not statistically significant.

corroborate those found for the simple correlation between the variables and agree with Crozet and Erkel-Rousse (2004).[14] As in our model high quality leads to a higher price (since the correlation between PRODY and price was positive for the basic goods category), high quality ends up negatively impacting imports in this segment.[15]

Introducing the quality proxy for this group did not significantly affect price elasticities. Sectoral GDP did not show the expected sign in some cases and its coefficient was statistically insignificant in most of the estimated models. Finally, the distance showed the expected sign; however, it had a lower impact when compared to the model with manufactures.

To verify the consistency of the results, we estimated the model using new proxies for quality and variety, applying the intra-industry trade index decomposed into vertical intra-industry trade and horizontal intra-industry trade. Table 4 shows the results for manufactures.

The results corroborate the estimates found with the other proxies for manufactures: price elasticity was negative in all models. Not with standing, prices have a greater impact on relative imports; a 1% variation in prices reduces the relative imports of manufactures by approximately 1.5%.

The new variable, considered as a proxy for quality, positively affected the relative imports. In addition, its coefficient showed a higher value when compared to the first model using PRODY. However, the coefficients are less significant. Introducing the quality proxy reduced the elasticity coefficients as in the previous model, but the variation caused in the price coefficient was much smaller. Considering the new proxy for variety, the coefficients were lower except for the random effects method, but they remain positive and significant. Table 5 shows the results for basic goods.

The results for the basic goods segment followed the same trend as the model presented in Table 3. Price elasticities remain lower than in the model for manufactures, and the impact of the new proxy for quality on relative imports was negative and not significant. Introducing the quality proxy did not significantly affect price coefficients.

In general, the results using the new proxies for quality and variety were consistent, and the impact of each representative variable remained. However, the PRODY variable showed a higher level of significance.

The results show an increase in price elasticity when adding quality, which corroborates the results of Crozet and Erkel-Rousse (2004) and Zagamé and Thanagopal (2005), but only in the manufactures segment. According to the authors, this is because in models that exclude quality, the relative price coefficient considers a pure price effect (which

[14] According to the authors, in the case of homogeneous goods, the lower the price, the more attractive the market of origin of imports.
[15] See Table 1.

Table 4
Import demand function of manufactures with new proxies for quality (1997–2013).

Variable	Pooled		Fixed effects (LSDV)		Random effects (GLS)	
	Abs. quality	Pres. quality	Abs. quality	Pres. quality	Abs. quality	Pres. quality
PriceElast. $(1-e_p)$	−1.52	−1.55	−1.61	−1.65	−1.41	−1.54
	(−6.24)*	(−6.15)*	(−6.23)*	(−6.14)*	(−6.02)*	(−6.34)*
VIIT (e_q)	–	0.588	–	0.593	–	0.12
	–	(2.26)**	–	(2.20)**	–	(1.07)^{NS}
HIIT (e_g)	0.22	0.19	0.25	0.15	0.55	0.55
	(3.50)*	(3.03)*	(3.42)*	(6.95)*	(7.96)*	(7.32)*
Distance (e_d)	−1.15	−0.97	−1.10	−0.89	−0.93	−0.84
	(−4.63)*	(−4.70)*	(2.46)**	(2.50)**	(−7.51)*	(−7.37)*
Constant	−20.06	−19.92	−21.68	−17.69	−12.02	−19.79
	(−26.38)*	(25.69)*	(−28.51)*	(−22.35)*	(−13.44)*	(−63.09)*
Dummy per country and/or time	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.44	0.50	0.52	0.60	0.36	0.47
No. of observations	340	340	340	340	340	340

Source: Results obtained by the author with research data through the software Stata 11.0.
* Statistically significant at 1%.
** Statistically significant at 5%.
***Statistically significant at 10%.
NS, not statistically significant.

Table 5
Import demand function of basic goods with new proxies for quality (1997–2013).

Variable	Pooled		Fixed effects (LSDV)		Random effects (GLS)	
	Abs. quality	Pres. quality	Abs. quality	Pres. quality	Abs. quality	Pres. quality
PriceElast. $(1-e_p)$	−0.508	−0.504	−0.558	−0.555	−0.577	−0.608
	(−2.53)*	(−2.52)*	(−2.61)*	(−2.61)*	(−3.75)*	(−3.85)*
VIIT (e_q)	–	−0.022	–	−0.021	–	−0.05
	–	(−1.67)***	–	(−1.18)^{NS}	–	(−0.54)***
HIIT (e_g)	0.213	0.184	0.217	0.188	0.198	0.208
	(4.24)*	(3.47)*	(4.20)*	(3.45)*	(6.48)*	(6.32)*
Distance (e_d)	−0.49	−0.473	−1.198	−1.281	−0.374	−0.345
	(−5.48)*	(−5.27)*	(−1.82)**	(−1.92)**	(−6.69)*	(−6.77)*
Constant	−6.96	−6.84	−6.92	−6.81	−6.08	−6.06
	(−9.43)*	(−9.23)*	(−8.75)*	(−8.60)*	(−12.76)*	(−12.85)*
Dummy per country and/or time	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.35	0.44	0.43	0.55	0.29	0.34
No. of observations	340	340	340	340	340	340

Source: Results obtained by the author with research data through the software Stata 11.0.
* Statistically significant at 1%.
** Statistically significant at 5%.
*** Statistically significant at 10%.
NS, not statistically significant.

is negative) plus the indirect positive effect of product quality on relative imports. Thus, adding the two effects reduces[16] the real impact of prices. When considering quality, its coefficient captures this indirect effect, which disappears from the price coefficient, correcting its bias.

International literature shows that several problems arise from excluding the quality proxy from the model, which occurs in most empirical studies on import demand equations. One of these problems is that the estimated price elasticity falls significantly below the unit value, regardless of the model. In the Brazilian case, the price elasticity

[16] Considering the absolute value.

is above one in all models with manufactures, with and without quality. Although introducing quality increases the elasticity coefficients, the impact of this introduction is less relevant than in the models applied to other countries. This indicates that for the Brazilian economy price plays a more important role than quality in determining trade flows. The same occurs with the demand for basic goods: price elasticities were lower than the unit. However, unlike the international literature, the inclusion of the new variable did not show a significant effect.

Introducing the proxy for quality reduces the value of the variety coefficients in most models with significant coefficients. In fact, in the equations excluding quality, the coefficients of variety proxies include the direct effect of variety plus the indirect effect of quality, since the latter is not explicit in the model. The same occurred in some cases for price. Introducing quality in the equation removes this effect from the variety coefficients.

Confirming expectations, the distance between capitals variable showed a negative sign in all estimated models.

Table 6 presents national estimates on import price elasticity, with high methodological variability. Some authors disaggregate their estimates for different sectors or categories of use, such as Zini (1988), Castro and Cavalcanti (1997), and Carvalho et al. (1999). Nonetheless, most studies present an aggregate analysis. As in the latter case the comparison would be even more difficult, we present only two of these events.

In the work of Zini (1988), less differentiated sectors showed higher price elasticities, corroborating the results of the present study. In contrast, Castro and Cavalcanti (1997) show little variability between sectors.

Aggregate estimates – Dib (1985), Skiendziel (2008), and Santos et al. (2011) – showed relatively low values. Comparison is much more difficult in these cases because the studies do not consider sectoral heterogeneity.

Carvalho and De Negri (2000) calculate elasticities for the agricultural sector assuming a small economy. Results show an elasticity of approximately 1.34%. This value is well above those found in other studies on basic goods; however, they are closer to the estimates of the present study.

When estimating disaggregate functions, the aforementioned authors show similar results; less differentiated sectors show lower price elasticities. In turn, aggregate estimates reveal lower values. We emphasize again that these estimates are not directly comparable since there is great variability in the methodological procedures used by the authors. International literature on elasticity is vast; notwithstanding, as already mentioned, direct comparison is even more difficult due to the variability of models and specificities of each economy.

Estimates using similar models allow a more direct comparison; however, there is no knowledge of their application to the Brazilian economy. The basic literature for the present study is still scarce even internationally. Even so, although there are different data treatments and estimation methods, it is possible to compare the results more adequately.

Table 7 shows some results of international studies that use models similar to that of the present study. These models followed a similar pattern; nevertheless, their estimates were more consistent. This is partly due to the better quality and quantity of data available in the regions where they were applied, allowing more accurate and reliable estimates.

Using a similar model for a set of twelve OECD countries, Erkel-Rousse and Gallo (2002) found a price elasticity of approximately 0.25 without introducing the quality proxy. After adding the proxy, this value ranged from −0.03 to −0.23, depending on the model. The study showed a positive value for elasticity before the introduction of the proxy. According to the author, this behavior is due to the strong influence of quality on import demand in more developed countries. When not explicitly included, the effect of quality is partly added to the negative effect of price. In this case, this effect was so significant that it overcame the negative impact of price. The quality coefficient varied between 0.28 and 0.42.

The results of Crozet and Erkel-Rousse (2004) with aggregate data considering four major EU countries (France, Germany, Italy, the United Kingdom) also showed a positive value for the price elasticity of imports before introducing the proxy quality, between 0.06 and 0.22. With the introduction of quality, these values ranged from −0.15 to −0.16, depending on the model. The quality coefficient was approximately 0.20 in the estimated models.

Likewise, Zagamé and Thanagopal (2005) estimated the impact of introducing quality in the import demand model of Europe using a more robust panel. The authors confirm the results obtained by Erkel-Rousse and Gallo (2002); however, the impact of quality was greater, around 1.20. The study concludes that quality is important for trade, especially for differentiated products.

Comparing these results with those of the present study, the impact of quality is smaller, especially in the basic segment. Introducing the new variable did not significantly affect price elasticities, as shown in Table 7. This shows that the demand for Brazilian imports is mainly determined by price.

The results presented above refer to developed economies, where products generally present a superior quality because competitiveness is largely based on this trait. Comparison between economies shows that quality is more

Table 6
Estimates of the price elasticity of import demand for Brazil.

Author	Aggregation level	Period	Trade flow	Equation type	Price index	Disaggregation level	Price elasticity
Dib (1985)	Aggregate data				Actual effective cost of imports (considers the international price of imports, real exchange rate, and tariff index)		Short-term: −1.05; long-term: −1.76
Zini (1988)		1970–1986 Quarterly	Bilateral	Import demand function		By activity sector	Industrialized: −1.85. Agricultural: −0.43; mineral: −0.05
Castro and Cavalcanti (1997)	By category of use	1955–1995 Annual	Bilateral	Import demand function	Real exchange		Total imports: −0.45; capital goods: −0.56; intermediate goods: −0.55; consumer goods: −0.49
	By category of use	1978–1996 Monthly	Bilateral	Imperfect substitution model (long-term)	Real exchange		Capital goods: −1.9; intermediate goods: −2; nondurable goods: −1.4; durable goods: −2.9; fuels: −0.56
Carvalho and De Negri (2000)	Group of agricultural products	(1977–1998) Quarterly	Bilateral	Imperfect substitution model	Agricultural product price indices (FGV)	Panel data disaggregated by industry	−1.342
Skiendziel (2008)	Aggregate data	1991–2007 Quarterly	Bilateral		import price indices (FUNCEX)		Short-term: −0.11; long-term: −0.55
Santos et al. (2011)	Aggregate data	1992–1997	Bilateral	Import demand function	Real exchange		Between −0.39 and −0.44
Kawamoto et al. (2013)	Group of manufactures, aggregated by CNAE codes	2003–2010 Monthly	Bilateral	Thirlwall model (1979)	Import price indices (FUNCEX)	Panel data disaggregated by manufacturing category	Between −0.08 and −0.19, depending on the model

Table 7
Import demand function at the international level.

Estimation method	Erkel-Rousse and Gallo (2002)				Crozet and Erkel-Rousse (2004)				Zagamé and Thanagopal (2005)			
	Abs. quality		Pres. quality		Abs. quality		Pres. quality		Abs. quality		Pres. quality	
	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
Price $(1-\sigma)$	0.25	0.24	−0.03	−0.23	0.06	0.22	−0.15	−0.16	−0.11	−0.15	−0.6	−0.91
Quality	–	–	0.28	0.42	–	–	0.22	0.23	–	–	1.18	1.21

Source: Elaborated by the author.

important for developed countries when compared to developing countries such as Brazil, where price seems to have a more important role.

This result also occurs when we analyze Brazilian trading partners. The main source of Brazilian imports is China, an economy known for its expressive competitiveness via price and not via quality, which leads us to conclude that Brazilian imports from that country are basically determined by price.

5. Study limitations

The present study has significant limitations, especially with regard to the quality variable. As we have already mentioned, this is an inaccurate variable due to subjective elements that are unlikely to be captured. According to Pinheiro et al. (2002), quality is a multidimensional concept, determined by measurable and immeasurable characteristics. In the first group, the authors mention: performance, conformity, durability, and appearance. Examples of the second group are tradition, reputation, and cultural factors. Economic agents consider these aspects when buying a commodity. In addition, this information involves different countries, each with its own details, making this determination even more difficult.

The increase in the Brazilian real income between the years 1997 and 2013 may have affected preferences regarding quality, which the indicators generally used are unable to capture. Likewise, changes in tariff legislation over these years may have affected intra-industry trade and, consequently, the quality indicators used.

As we mentioned above, many authors[17] usually measure export quality using unit prices as proxy variables for quality. Notwithstanding, unit prices are very inaccurate measures of export quality, since they can reflect: fluctuations in the costs of production factors, tariffs, and taxes; variations in horizontal differentiation; and currency fluctuations, which may correlate with the estimated model price.

Finally, we emphasize that the present study has several limitations that prevent obtaining more accurate and reliable estimates. This problem is recurrent in studies that use inaccurate variables such as quality. For this variable, there are no directly observable measures, which leads us to build proxies for it; yet there are subjective elements that are unlikely to be captured. This limitation must be considered in the results obtained.

6. Conclusions

In this article, we estimated import demand equations using proxies for product quality to evaluate the impact of this variable on the price elasticities of Brazilian imports. The relevant literature points to underestimation of price elasticities in international trade. One way to correct this bias is considering the effects of quality on the model, which can help to estimate the actual values of the elasticities.

When considering quality as a determinant of the relative import demand of Brazil, we found that its impact on imports of manufactures is positive and significant. For the set of basic goods, in turn, the variable had a negative and insignificant coefficient in most estimates.

[17] Hallak (2006, 2011) and Schott (2011).

Price coefficients corroborated the results obtained internationally by Crozet and Erkel-Rousse (2004), mainly for imports of manufactures. In this case, variation in the price elasticity of imports was higher after introducing the quality proxy.

Comparison with international literature showed that the Brazilian demand for imports is more influenced by prices than by quality. In more developed countries, in turn, quality has a more important role in import decisions. This is evident from the significant variation in price elasticities after introducing the quality proxy.

Although to a lesser extent, quality seems to play an important role in determining Brazilian trade flows. However, this role may be limited by the influence of price, since if quality improvement leads to significant price increases, the positive impact of quality will be diluted by the strong negative influence of price.

Although the debate on the magnitude of price elasticity is far from over, the present study has evidenced certain peculiarities of the Brazilian case. These include the supremacy of price in determining import flows, as well as the reduced importance of new variables on the demand for less industrialized products.

We emphasize that the present study has several limitations that prevent obtaining more accurate and reliable estimates. This problem is recurrent in studies that use inaccurate variables such as quality. For this variable, there are no directly observable measures, which leads us to build proxies for it; yet there are subjective elements that are unlikely to be captured. This limitation must be considered in the results obtained.

Even in the face of limitations, the results were coherent and raise the need for improvement in trade models. The incorrect estimation of trade elasticities compromises the correct assessment of the implications of trade policies for an economy, thus generating measures that are unable to achieve the desired goals.

Future research steps in improving the estimation of price elasticities in international trade depend not only on the availability of disaggregate data with a view to consider sectoral heterogeneity, but also on better data on relative prices and better proxies for product quality.

Annex A Methodology for the variables

A.1 Price index

We calculated the price index from the Fisher method, in which the prices of a good in a given period are compared with the prices of the same good in a base period. Therefore, the price index for period 1 in relation to period 0 is obtained by the following expression:

$$I_p^{0,1} = \left\{ \left[\left(\sum p_i^1 .x_i^0 \right) / \left(\sum p_i^0 .x_i^0 \right) \right] \left[\left(\sum p_i^1 .x_i^1 \right) / \left(\sum p_i^0 .x_i^1 \right) \right] \right\}^{1/2} \tag{12}$$

where p is the average price of good i in each period, and x is the weight (in tons) of good i imported in each period (0, 1). We transformed bilateral annual comparisons into annual series by using the chained form conversion, determining the variation between $t-1$ and $t+1$ from the product of the variations between $t-1$ and t and between t and $t+1$. Chaining leads to transitive indices, increases index coverage, and reduces the bias of sequential comparisons.

A.2 Sectoral specialization

Sectoral specialization is given by:

$$spe_{kijI'} = (X_{ki}/X_i)/(\overline{X_{kI'}^j/X_{i'}^j}) \tag{13}$$

where:

$$\overline{\left(X_{kI'}^j/X_{i'}^j\right)} = \prod_{i' \in I'} (X_{ki'}/X_{i'})^{a_{Ki'j}}$$

$X_{kI'}^j$ refers to exports of good k by country j considering a set of I's partners.

$X_{i'}^j$ refers to total exports from country j to country $i' \in I'$.

To perform the calculations, we used the GDP of each trade partner of Brazil, which we collected from the World Bank database, at 2005 prices.

A.3 Horizontal and vertical intra-industry trade index

According to Greenaway et al. (1994) and Fontagné and Freudenberg (1997), the construction of this variable relies on the product similarity criterion. This criterion defines the pattern of product differentiation from the ratio (λ) obtained by dividing the unit value of the product (k) exported (VUX_{kijt}) and imported (VUM_{kijt}) between countries i and j in year t, that is: $\lambda = VUX_{kijt}/VUM_{kij}$. If the ratio between the unit values (λ) remains close to the unit, the products sold do not differ significantly. Therefore, they will be defined as horizontally differentiated, which characterizes horizontal intra-industry trade (HIIT). Otherwise, when the ratio between the unit values deviates from the unit, the products sold are vertically differentiated. In this situation, the intra-industry trade will be vertical (VIIT).

The criterion used to define whether λ is close to or distant from the unit relies on the dispersion interval, defined by: $[(1-\alpha); (1+\alpha)]$. Thus, when λ belongs to this range, the products sold are horizontally differentiated; otherwise, they will be defined as vertically differentiated. In cases where the products are vertically differentiated, we can define the IIT, from the point of view of the exporting country, as inferior vertical ($VIIT_{inf}$) or superior vertical ($VIIT_{sup}$) when $\lambda < (1-\alpha)$ or$\lambda > (1+\alpha)$, respectively. In the first case, the products of the exporting country have higher quality than imported products, and the opposite occurs in the second situation.

We used the ratio λ as the variable of the model. When the terms of trade are not very different and are within a given range (for example, between 0.85 and 1.15), we say that the products have the same quality, that is, they are horizontally differentiated. If the terms of trade are outside the range, we say that the quality of the products is different, that is, the products are vertically differentiated. Underlying this methodology is the hypothesis that the unit prices of exports in relation to the unit prices of imports (the terms of trade) reflect differences in quality.

The literature usually defines horizontal intra-industry trade (HIIT) as the simultaneous exchange of horizontally (or variety) differentiated products, and vertical intra-industry trade (VIIT) as the simultaneous exchange of vertically (or quality) differentiated goods. In theory, horizontal intra-industry trade (HIIT) should occur mainly between trade partners with similar income levels, while vertical intra-industry trade (VIIT) should occur between countries with different income levels (Ekanayake et al., 2007). The new theory of international trade (Krugman, 1979a, b, 1980, 1981; Helpman and Krugman, 1985; Lancaster, 1980) explains horizontal intra-industry trade (HIIT) from theoretical models that admit monopolistic competition, horizontal product differentiation, and increasing returns of scale. In turn, traditional theories of international trade xplain vertical intra-industry trade (VIIT) from the comparative advantages of countries (Falvey, 1981; Falvey and Kierzkowski, 1987; Flam and Helpman, 1987). Thus, adjustment cost and welfare analyses will be quite different depending on the type of intra-industry trade (Brülhart and Elliott, 2002).

A.4 Sophistication indicator with quality adjustment

Some authors (Lall et al., 2005; Rodrik, 2006; Hausmann et al., 2007; Xu and Lu, 2010; Schott, 2008; Van Assche and Gangnes, 2007) constructed a productivity index called PRODY to measure the sophistication of production and examine its relationship with technological development. This index is defined by the weighted average of the per capita income of countries exporting a given product, representing the level of income associated with each of them. According to Kume et al. (2012), the basic idea is that, when exporting goods, countries "reveal" their degree of productivity in a similar way to the concept of revealed comparative advantage. As wages are higher in rich countries, exports will only be viable if they are offset by better technology. This higher productivity may be due not only to more advanced technology, but also to other factors, such as endowment of factors, infrastructure, trade techniques, and fragmentation of production. Thus, the measure of productivity called degree of sophistication can be attributed to any category of exported products. According to Lall et al. (2005), sophistication correlates very well with technology.

Each country is indexed by j, and products by k, the total value of exports from country j being given by:

$$X_j = \sum_k x_{jk} \tag{14}$$

With the per capita income of the country j denoted by Y_j, the productivity level associated with product k is given by:

$$PRODY_k = \sum_j \frac{(x_{jk}/X_j)}{\sum_j (x_{jk}/X_j)} Y_j \tag{15}$$

where:

$PRODY_k$ is the productivity of product k;
x_{jk} is the export value of product k by country j; X_j is the total export value of country j;
Y_j is the per capita income of country j;

The fraction numerator, x_{jk}/X_j, is the share of the good in the total exports of country j; the denominator, $\sum_j (x_{jk}/X_j)$, aggregates the exports of all countries exporting the good k. This index represents the weighted average of the per capita income, where the weight corresponds to the revealed comparative advantage of each country in good k.

The weight of per capita income is the indicator of comparative advantage revealed by Balassa (1965), normalized so that the sum is equal to one.[18]

The degree of sophistication of exports from country j ($EXPY_{jt}$), for each year t, is given by:

$$EXPY_{jt} = \sum_k \frac{X_{jkt}}{X_{jt}} PRODY_k \tag{16}$$

Expression (3) represents the productivity of each product k weighted by its participation in the export basket of country j.

Hausmann et al. (2007) calculated the PRODY for each year between 2003 and 2005. The authors then analyzed the weighted average of the three years. In the present study we follow the same steps, but the period will be updated for the 2010–2012 period.

The authors acknowledge that the new index does not capture quality differences that may exist in the same product between countries. As Rodrik (2006) shows, there are great differences in the unit values of the same products exported by different countries, which partly reflects the different levels of quality.

Xu and Lu (2010) state that sophistication does not perfectly reflect the level of technological processing of a country's exports. According to the author, however, evidence shows that these values reflect the technological content of exports to some degree. The author presents correlations between the export sophistication index and the spending on R&D of OECD countries. Correlations were all positive, and only three industries with an intensive use of natural resources showed statistically insignificant estimates. The author also calculated correlations by country, whose results indicate a positive correlation of the sophistication index with the R&D and GDP ratio. Thus, the author concludes that the sophistication indicator is not a perfect measure, but reflects to a certain extent the technological content of exports.

To measure quality "within the product", Xu and Lu (2010) construct the following price index:

$$q_{iJ} = \frac{p_{iJ}}{\sum_{j \in J} (\mu_{ij} p_{ij})} \tag{17}$$

where:

p_{ij} is the price of good i exported by country j.

[18] The traditional comparative advantage index of Balassa (1965) measures, in the denominator, the share of world exports of a given product in total world exports. Thus, if the share of exports of this good in the country's total exports (numerator) is higher than the share of world exports of the same product in the total world exports, the index will be greater than 1. Otherwise, the index will be less than 1. If country j does not export good k, the comparative advantage index will be zero. The adjustment made to the index allows the sum of the comparative advantage indices of all countries to be equal to 1.

The denominator is the weighted average of the prices of good i, exported by all J countries, with μ_{ij} being the share of exports of good i by country j in the total exports of good i, which reflects the relative importance of country j in exports of this good.

Xu and Lu (2010) show that, for the same product, there is a positive correlation between a country's export price and its per capita income. These results confirm the hypothesis that rich countries export higher quality products and poor countries in general export lower quality products. Given the importance of quality, the author incorporates product prices (as a quality proxy) in measures of sophistication. For that, Xu and Lu introduce a quality multiplier that adjusts the productivity index (PRODY), defined by the following expression:

$$QPRODY_{ij} = (q_{ij})^{\theta} \times PRODY_i \tag{18}$$

where:

$(q_{ij})^{\theta}$ represents the quality multiplier;
θ is the parameter that measures the degree of quality adjustment, where = 0 represents no quality adjustment.

From these results we obtain a productivity indicator adjusted by prices for each product, which will be used as a proxy for the quality of imported goods.

Annex B Tables

Table 1B
Share of each country in total Brazilian imports (1997–2013).

Year	CHN	USA	ARG	BEL	CAN	CHL	GER	SPA	FRA	GBR
1997	0.0195	0.2294	0.1329	0.0102	0.0237	0.0163	0.083	0.0191	0.0274	0.083
1998	0.0179	0.234	0.1389	0.0111	0.0232	0.0141	0.0909	0.0207	0.0341	0.0909
1999	0.0237	0.2381	0.1179	0.0094	0.0198	0.0146	0.0967	0.0239	0.0403	0.0967
2000	0.0219	0.231	0.1225	0.0099	0.0195	0.0173	0.0793	0.02	0.0337	0.0223
2001	0.0239	0.2321	0.1116	0.01	0.0167	0.0152	0.0868	0.022	0.0374	0.0224
2002	0.0329	0.2178	0.1004	0.0112	0.0157	0.0137	0.0935	0.0206	0.0375	0.0284
2003	0.0444	0.198	0.0967	0.0104	0.0155	0.017	0.087	0.0202	0.0365	0.025
2004	0.0591	0.1807	0.0886	0.0099	0.0138	0.0223	0.0807	0.0187	0.0364	0.0216
2005	0.0728	0.1721	0.0848	0.0098	0.0138	0.0237	0.0835	0.0181	0.0367	0.0187
2006	0.0875	0.1605	0.0882	0.0105	0.0131	0.0314	0.0712	0.0157	0.0311	0.0155
2007	0.1046	0.1552	0.0863	0.0095	0.0142	0.0287	0.0719	0.0153	0.0292	0.0162
2008	0.1159	0.1482	0.0766	0.0095	0.0186	0.0228	0.0695	0.0143	0.027	0.0147
2009	0.1246	0.1568	0.0883	0.009	0.0125	0.0209	0.0773	0.0153	0.0283	0.0189
2010	0.1408	0.1488	0.0794	0.0083	0.0149	0.023	0.0691	0.0153	0.0264	0.0174
2011	0.1449	0.1501	0.0747	0.0082	0.0157	0.0201	0.0672	0.0146	0.0242	0.0149
2012	0.1535	0.145	0.0737	0.0093	0.0138	0.0187	0.0637	0.0159	0.0265	0.0157
2013	0.1556	0.1502	0.0687	0.0084	0.0125	0.018	0.0633	0.0187	0.0271	0.0151

Source: Calculated by the author.

Table 2B
Share of each country in total Brazilian imports (1997–2013). Continuation.

Year	IND	ITA	JPN	MEX	PER	PAR	RUS	URU	VEN	Total
1997	0.0036	0.0569	0.0592	0.0196	0.0045	0.0087	0.0054	0.0162	0.0168	0.835
1998	0.0037	0.0564	0.0567	0.017	0.0037	0.0061	0.0051	0.018	0.0131	0.856
1999	0.0034	0.0527	0.0522	0.0125	0.0039	0.0053	0.0064	0.0131	0.0198	0.85
2000	0.0049	0.0388	0.053	0.0135	0.0038	0.0063	0.0102	0.0108	0.0238	0.742
2001	0.0098	0.0393	0.0551	0.0125	0.0041	0.0054	0.0084	0.009	0.0134	0.735
2002	0.0121	0.0372	0.0497	0.0123	0.0046	0.0081	0.0091	0.0103	0.0134	0.729
2003	0.0101	0.036	0.0522	0.011	0.0049	0.0098	0.0115	0.0111	0.0057	0.703
2004	0.0088	0.0326	0.0457	0.0112	0.0056	0.0047	0.0129	0.0083	0.0032	0.665

Table 2B (*Continued*)

Year	IND	ITA	JPN	MEX	PER	PAR	RUS	URU	VEN	Total
2005	0.0163	0.0309	0.0463	0.0115	0.0062	0.0043	0.0098	0.0067	0.0035	0.67
2006	0.0161	0.0281	0.042	0.0143	0.0086	0.0032	0.0103	0.0068	0.0065	0.661
2007	0.018	0.0278	0.0382	0.0164	0.0083	0.0036	0.0142	0.0065	0.0029	0.667
2008	0.0206	0.0267	0.0394	0.0181	0.0055	0.0038	0.0193	0.0059	0.0031	0.659
2009	0.0172	0.0287	0.042	0.0218	0.0038	0.0046	0.0111	0.0097	0.0046	0.695
2010	0.0233	0.0266	0.0384	0.0212	0.005	0.0034	0.0105	0.0087	0.0046	0.685
2011	0.0269	0.0275	0.0348	0.0227	0.0061	0.0032	0.013	0.0078	0.0056	0.682
2012	0.0226	0.0278	0.0347	0.0272	0.0058	0.0044	0.0125	0.0081	0.0045	0.683
2013	0.0265	0.028	0.0295	0.0242	0.0074	0.0043	0.0112	0.0074	0.0049	0.681

Source: Calculated by the author.

Table 3B
Share of basic goods in total Brazilian imports (1997–2013).

Year	GER	ARG	BEL	CAN	CHL	CHN	COL	CS	SPA
1997	0.09	0.02	0.02	0	0.08	0.07	0.01	0.02	0.04
1998	0.09	0.02	0.02	0.07	0.07	0.07	0.01	0.02	0.04
1999	0.1	0.01	0.01	0.07	0.08	0.08	0.01	0.02	0.03
2000	0.09	0.01	0.01	0.05	0.09	0.1	0.02	0.03	0.03
2001	0.1	0.01	0.01	0.05	0.08	0.12	0.01	0.03	0.04
2002	0.1	0.02	0.02	0.03	0.06	0.15	0.01	0.02	0.03
2003	0.09	0.02	0.02	0.04	0.07	0.19	0.01	0.01	0.03
2004	0.08	0.01	0.01	0.03	0.11	0.25	0.02	0.02	0.03
2005	0.07	0.01	0.01	0.03	0.1	0.26	0.01	0.02	0.03
2006	0.06	0.02	0.02	0.03	0.13	0.3	0.01	0.02	0.03
2007	0.06	0.01	0.01	0.02	0.11	0.33	0.01	0.01	0.02
2008	0.05	0.01	0.01	0.03	0.08	0.35	0.02	0.02	0.02
2009	0.05	0.01	0.01	0.02	0.08	0.38	0.02	0.03	0.02
2010	0.04	0.01	0.01	0.02	0.07	0.38	0.02	0.04	0.02
2011	0.04	0.01	0.01	0.02	0.06	0.38	0.02	0.04	0.02
2012	0.04	0.01	0.01	0.02	0.06	0.4	0.02	0.03	0.02
2013	0.04	0.01	0.01	0.01	0.06	0.4	0.02	0.03	0.03

Source: Calculated by the author.

Table 4B
Share of basic goods in total Brazilian imports (1997–2013). Continuation.

Year	FRA	HOL	IND	ITA	JAP	MEX	PAR	UK	RUS	USA
1997	0.05	0.02	0.01	0.08	0.04	0.03	0.04	0.03	0.01	0.34
1998	0.05	0.02	0	0.07	0.04	0.03	0.03	0.03	0.01	0.32
1999	0.05	0.02	0	0.07	0.04	0.02	0.02	0.04	0.01	0.31
2000	0.05	0.02	0.01	0.05	0.04	0.02	0.03	0.04	0.02	0.28
2001	0.05	0.01	0.04	0.05	0.04	0.01	0.03	0.03	0.01	0.28
2002	0.05	0.03	0.04	0.05	0.04	0.01	0.04	0.04	0.01	0.25
2003	0.05	0.02	0.03	0.04	0.04	0.01	0.05	0.04	0.01	0.22
2004	0.04	0.02	0.02	0.04	0.03	0.01	0.02	0.02	0.02	0.21
2005	0.03	0.01	0.05	0.04	0.03	0.01	0.02	0.02	0.01	0.21
2006	0.03	0.01	0.04	0.03	0.03	0.01	0.01	0.02	0.01	0.18

Table 4B (*Continued*)

Year	FRA	HOL	IND	ITA	JAP	MEX	PAR	UK	RUS	USA
2007	0.03	0.02	0.05	0.03	0.03	0.01	0.01	0.02	0.01	0.19
2008	0.02	0.02	0.05	0.03	0.03	0.01	0.01	0.02	0.03	0.19
2009	0.03	0.01	0.03	0.03	0.03	0.02	0.02	0.03	0.01	0.18
2010	0.02	0.02	0.05	0.02	0.03	0.02	0.01	0.02	0.02	0.19
2011	0.02	0.02	0.06	0.02	0.02	0.02	0.01	0.01	0.02	0.21
2012	0.02	0.03	0.04	0.03	0.02	0.02	0.01	0.02	0.02	0.19
2013	0.02	0.02	0.06	0.02	0.02	0.02	0.01	0.01	0.01	0.2

Source: Calculated by the author.

Table 5B
Share of manufactures in total Brazilian imports (1997–2013).

Year	GER	ARG	BEL	CAN	CHL	CHN	COL	CS	SPA	FRA
1997	0.130	0.132	0.014	0.000	0.006	0.013	0.007	0.039	0.024	0.038
1998	0.136	0.133	0.015	0.024	0.004	0.009	0.008	0.026	0.027	0.049
1999	0.144	0.096	0.013	0.030	0.005	0.007	0.009	0.032	0.035	0.059
2000	0.122	0.094	0.016	0.020	0.007	0.009	0.014	0.043	0.030	0.050
2001	0.129	0.093	0.015	0.022	0.006	0.009	0.013	0.045	0.031	0.055
2002	0.147	0.074	0.016	0.020	0.007	0.014	0.014	0.039	0.031	0.058
2003	0.143	0.070	0.016	0.018	0.008	0.020	0.020	0.041	0.032	0.059
2004	0.137	0.074	0.017	0.018	0.008	0.029	0.023	0.053	0.030	0.062
2005	0.148	0.083	0.016	0.018	0.008	0.039	0.018	0.062	0.026	0.066
2006	0.133	0.095	0.016	0.016	0.007	0.050	0.018	0.068	0.023	0.058
2007	0.132	0.097	0.016	0.022	0.007	0.066	0.027	0.057	0.026	0.055
2008	0.134	0.097	0.016	0.027	0.008	0.073	0.001	0.064	0.025	0.052
2009	0.142	0.114	0.015	0.015	0.007	0.069	0.002	0.065	0.025	0.050
2010	0.134	0.116	0.014	0.023	0.007	0.080	0.002	0.086	0.025	0.049
2011	0.133	0.104	0.015	0.025	0.007	0.095	0.002	0.085	0.024	0.045
2012	0.123	0.108	0.014	0.023	0.008	0.096	0.002	0.077	0.026	0.050
2013	0.125	0.112	0.014	0.022	0.007	0.101	0.003	0.078	0.025	0.053

Source: Calculated by the author.

Table 6B
Share of manufactures in total Brazilian imports (1997–2013). Continuation.

Year	HOL	IND	ITA	JAP	MEX	PAR	UK	RUS	USA
1997	0.012	0.005	0.085	0.095	0.028	0.004	0.036	0.007	0.325
1998	0.015	0.006	0.081	0.085	0.021	0.003	0.036	0.008	0.314
1999	0.016	0.005	0.076	0.080	0.017	0.003	0.034	0.009	0.330
2000	0.018	0.007	0.060	0.087	0.020	0.003	0.032	0.014	0.354
2001	0.013	0.008	0.060	0.087	0.020	0.002	0.033	0.013	0.344
2002	0.012	0.011	0.058	0.082	0.022	0.002	0.043	0.014	0.335
2003	0.013	0.011	0.058	0.094	0.020	0.002	0.035	0.020	0.321
2004	0.012	0.012	0.056	0.085	0.021	0.002	0.037	0.023	0.300
2005	0.011	0.015	0.051	0.087	0.022	0.001	0.031	0.018	0.280
2006	0.012	0.016	0.051	0.082	0.030	0.001	0.028	0.018	0.276
2007	0.011	0.019	0.050	0.075	0.034	0.002	0.026	0.027	0.253
2008	0.010	0.023	0.050	0.079	0.040	0.001	0.026	0.030	0.244
2009	0.011	0.025	0.050	0.076	0.042	0.001	0.029	0.020	0.243
2010	0.011	0.027	0.049	0.072	0.041	0.001	0.028	0.014	0.222
2011	0.010	0.024	0.053	0.069	0.046	0.001	0.026	0.022	0.216
2012	0.010	0.026	0.050	0.069	0.057	0.002	0.027	0.021	0.211
2013	0.009	0.026	0.052	0.056	0.050	0.002	0.027	0.019	0.218

Source: Calculated by the author.

Table 7B
Superior vertical intra-industry trade (1997–2013), in %.

Year	GER	ARG	BEL	CAN	CHL	CHN	COL	CS	SPA
1997	0.07	0.26	0.05	0.34	0.06	0.32	0.56	0.68	0.63
1998	0.07	0.2	0.03	0.28	0.08	0.34	0.62	0.65	0.58
1999	0.08	0.24	0.03	0.29	0.09	0.48	0.61	0.64	0.56
2000	0.08	0.3	0.03	0.3	0.07	0.44	0.64	0.72	0.6
2001	0.08	0.28	0.03	0.26	0.07	0.52	0.7	0.71	0.61
2002	0.08	0.27	0.05	0.24	0.07	0.47	0.72	0.6	0.62
2003	0.09	0.25	0.05	0.21	0.05	0.49	0.69	0.61	0.68
2004	0.08	0.24	0.04	0.21	0.04	0.45	0.68	0.66	0.7
2005	0.07	0.24	0.05	0.34	0.04	0.52	0.64	0.62	0.69
2006	0.07	0.24	0.06	0.32	0.03	0.48	0.58	0.69	0.67
2007	0.08	0.24	0.05	0.4	0.02	0.5	0.66	0.67	0.66
2008	0.07	0.23	0.06	0.39	0.03	0.49	0.54	0.62	0.67
2009	0.09	0.26	0.05	0.26	0.05	0.51	0.54	0.65	0.68
2010	0.08	0.2	0.04	0.35	0.04	0.59	0.56	0.65	0.59
2011	0.07	0.2	0.06	0.42	0.03	0.59	0.58	0.67	0.66
2012	0.07	0.17	0.12	0.39	0.05	0.52	0.57	0.68	0.68
2013	0.07	0.14	0.07	0.37	0.05	0.46	0.62	0.68	0.73

Source: Calculated by the author.

Table 8B
Superior vertical intra-industry trade (1997–2013), in %. Continuation.

Year	USA	FRA	HOL	IND	ITA	JAP	PAR	UK	RUS
1997	0.06	0.1	0.09	0.26	0.12	0.26	0.7	0.07	0.8
1998	0.07	0.08	0.14	0.3	0.11	0.27	0.71	0.08	0.92
1999	0.09	0.07	0.15	0.18	0.11	0.26	0.68	0.12	0.92
2000	0.11	0.08	0.17	0.26	0.1	0.27	0.71	0.15	0.82
2001	0.12	0.08	0.12	0.16	0.1	0.27	0.71	0.15	0.95
2002	0.12	0.08	0.12	0.11	0.09	0.26	0.73	0.09	0.92
2003	0.1	0.08	0.14	0.13	0.1	0.27	0.75	0.07	0.86
2004	0.12	0.09	0.11	0.21	0.1	0.29	0.69	0.07	0.83
2005	0.09	0.09	0.15	0.2	0.13	0.33	0.63	0.08	0.88
2006	0.07	0.09	0.17	0.22	0.13	0.36	0.54	0.08	0.91
2007	0.09	0.1	0.15	0.24	0.11	0.35	0.6	0.11	0.89
2008	0.11	0.08	0.2	0.24	0.12	0.4	0.63	0.14	0.92
2009	0.09	0.08	0.28	0.17	0.08	0.36	0.61	0.19	0.9
2010	0.06	0.09	0.29	0.19	0.13	0.44	0.61	0.2	0.92
2011	0.06	0.08	0.24	0.19	0.17	0.45	0.66	0.22	0.93
2012	0.07	0.07	0.25	0.17	0.16	0.4	0.62	0.23	0.87
2013	0.07	0.07	0.18	0.17	0.12	0.43	0.63	0.2	0.87

Source: Calculated by the author.

Table 9B
Inferior vertical intra-industry trade (1997–2013), in %.

Year	GER	ARG	BEL	CAN	CHL	CHN	COL	CS	SPA	USA
1997	0.35	0.47	0.81	0.6	0.76	0.62	0.17	0.32	0.23	0.78
1998	0.39	0.53	0.85	0.67	0.79	0.6	0.18	0.34	0.3	0.78
1999	0.36	0.46	0.8	0.63	0.77	0.47	0.19	0.35	0.35	0.78
2000	0.4	0.42	0.83	0.61	0.75	0.52	0.2	0.28	0.33	0.75
2001	0.4	0.44	0.84	0.64	0.79	0.44	0.16	0.28	0.32	0.75
2002	0.4	0.42	0.8	0.64	0.77	0.48	0.13	0.38	0.31	0.75
2003	0.42	0.41	0.82	0.58	0.77	0.47	0.15	0.38	0.26	0.76
2004	0.43	0.41	0.81	0.63	0.78	0.5	0.16	0.32	0.24	0.76

Table 9B (*Continued*)

Year	GER	ARG	BEL	CAN	CHL	CHN	COL	CS	SPA	USA
2005	0.4	0.42	0.8	0.53	0.76	0.42	0.19	0.37	0.24	0.79
2006	0.4	0.45	0.82	0.59	0.85	0.45	0.27	0.31	0.27	0.79
2007	0.4	0.46	0.82	0.48	0.86	0.41	0.21	0.33	0.27	0.77
2008	0.41	0.48	0.8	0.5	0.86	0.46	0.26	0.37	0.28	0.76
2009	0.38	0.47	0.82	0.63	0.85	0.45	0.26	0.33	0.28	0.77
2010	0.42	0.53	0.82	0.63	0.85	0.37	0.22	0.33	0.37	0.79
2011	0.41	0.55	0.8	0.56	0.87	0.38	0.21	0.32	0.3	0.78
2012	0.41	0.57	0.75	0.59	0.83	0.44	0.22	0.31	0.26	0.77
2013	0.4	0.61	0.81	0.61	0.84	0.5	0.19	0.3	0.22	0.79

Source: Calculated by the author.

Table 10B
Inferior vertical intra-industry trade (1997–2013), in %. Continuation.

Year	FRA	HOL	IND	ITA	JAP	PAR	UK	RUS
1997	0.8	0.81	0.55	0.86	0.73	0.2	0.9	0.16
1998	0.8	0.7	0.56	0.87	0.72	0.19	0.89	0.06
1999	0.79	0.67	0.72	0.87	0.73	0.21	0.84	0.07
2000	0.81	0.7	0.51	0.88	0.71	0.2	0.8	0.17
2001	0.81	0.76	0.43	0.89	0.71	0.2	0.81	0.04
2002	0.8	0.74	0.3	0.89	0.72	0.19	0.85	0.07
2003	0.81	0.73	0.32	0.88	0.71	0.19	0.82	0.12
2004	0.8	0.6	0.5	0.89	0.69	0.23	0.9	0.15
2005	0.8	0.76	0.39	0.85	0.66	0.27	0.88	0.1
2006	0.78	0.74	0.26	0.85	0.62	0.36	0.86	0.08
2007	0.78	0.7	0.27	0.87	0.63	0.3	0.78	0.09
2008	0.8	0.74	0.26	0.86	0.58	0.28	0.77	0.06
2009	0.81	0.65	0.48	0.9	0.62	0.29	0.7	0.07
2010	0.8	0.65	0.32	0.85	0.53	0.28	0.69	0.06
2011	0.8	0.7	0.17	0.81	0.53	0.23	0.7	0.05
2012	0.82	0.65	0.21	0.83	0.57	0.27	0.72	0.11
2013	0.8	0.63	0.22	0.86	0.55	0.27	0.77	0.09

Source: Calculated by the author.

Table 11B
Horizontal intra-industry trade (1997–2013), in %.

Year	GER	ARG	BEL	CAN	CHL	CHN	COL	CS	SPA	USA
1997	0.58	0.27	0.14	0.06	0.18	0.07	0.27	0	0.14	0.16
1998	0.54	0.26	0.12	0.05	0.14	0.06	0.2	0	0.12	0.14
1999	0.57	0.31	0.16	0.08	0.14	0.05	0.2	0.01	0.09	0.14
2000	0.52	0.28	0.14	0.09	0.17	0.04	0.16	0	0.07	0.13
2001	0.52	0.29	0.12	0.1	0.14	0.04	0.14	0.01	0.07	0.12
2002	0.52	0.31	0.15	0.12	0.16	0.05	0.15	0.02	0.06	0.12
2003	0.5	0.34	0.13	0.21	0.18	0.04	0.16	0.01	0.06	0.13
2004	0.49	0.35	0.15	0.16	0.17	0.05	0.16	0.02	0.06	0.12
2005	0.54	0.34	0.15	0.12	0.2	0.06	0.17	0.02	0.07	0.12
2006	0.53	0.31	0.12	0.09	0.12	0.07	0.15	0.01	0.06	0.14
2007	0.52	0.3	0.14	0.12	0.12	0.09	0.14	0.01	0.07	0.14
2008	0.52	0.29	0.14	0.11	0.11	0.05	0.2	0.01	0.05	0.13
2009	0.53	0.27	0.13	0.11	0.1	0.04	0.21	0.02	0.05	0.14
2010	0.51	0.26	0.14	0.02	0.11	0.03	0.22	0.02	0.04	0.14
2011	0.53	0.26	0.14	0.02	0.1	0.03	0.21	0.02	0.04	0.16
2012	0.51	0.25	0.13	0.02	0.12	0.04	0.21	0.01	0.06	0.16
2013	0.53	0.24	0.12	0.02	0.11	0.04	0.2	0.02	0.05	0.14

Source: Calculated by the author.

Table 12B
Horizontal intra-industry trade (1997–2013), in %. Continuation.

Year	FRA	HOL	IND	ITA	JAP	PAR	UK	RUS
1997	0.1	0.11	0.18	0.02	0.01	0.1	0.03	0.04
1998	0.12	0.16	0.14	0.02	0.02	0.11	0.04	0.02
1999	0.13	0.18	0.1	0.02	0.02	0.12	0.05	0
2000	0.11	0.13	0.23	0.02	0.02	0.09	0.06	0.01
2001	0.11	0.12	0.41	0.02	0.02	0.09	0.04	0.01
2002	0.12	0.14	0.59	0.02	0.02	0.08	0.06	0.01
2003	0.11	0.12	0.55	0.02	0.02	0.06	0.11	0.02

Table 12B (*Continued*)

Year	FRA	HOL	IND	ITA	JAP	PAR	UK	RUS
2004	0.11	0.29	0.29	0.02	0.02	0.08	0.03	0.03
2005	0.11	0.09	0.41	0.02	0.02	0.1	0.05	0.02
2006	0.13	0.09	0.52	0.02	0.02	0.1	0.06	0.01
2007	0.12	0.16	0.49	0.02	0.02	0.11	0.1	0.02
2008	0.12	0.07	0.5	0.02	0.02	0.09	0.08	0.02
2009	0.11	0.06	0.35	0.02	0.02	0.11	0.11	0.03
2010	0.12	0.06	0.49	0.02	0.02	0.11	0.1	0.02
2011	0.12	0.06	0.64	0.01	0.02	0.11	0.07	0.02
2012	0.11	0.1	0.61	0.01	0.03	0.11	0.05	0.02
2013	0.13	0.19	0.61	0.01	0.02	0.1	0.03	0.04

Source: Calculated by the author.

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