Effective and Potential Quality Indexes for Brazilian exports

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Abstract

This paper develops new estimates of export quality, which account for Brazil's characteristics. We estimate a set of 15,114,700 observations, which is composed of 5,230 products, in the HS6 nomenclature, and 170 countries, for the period 2002-2018, through a micro-based index. We also estimate potential quality indexes for the varieties out of the market. We are the first researchers to estimate potential quality and we notice that this can help *policymakers* to know which varieties are closer to penetrate new markets. We found statistical validity in the theory with a Probit Panel. We also found that higher quality increases the probability of an export happen, that higher trade barriers in the destinations markets reduce it and that Unit Values are poor *proxies* for quality. We analyze quality time trajectory at country mean and product mean level. We notice that, while the categories "capital goods" and "transport and equipment" have always the higher potential quality, they usually have the lower effective ones. Our study suggests that, to transform potential exports into effective, one should focus on quality improvements, since exporter probability grows with quality, and try to reach the destination markets consumers with marketing campaigns.

Keywords: Export quality index; Export probability; Potential Quality.

Resumo

Este artigo desenvolve novas estimativas para a qualidade das exportações que consideram as características do Brasil. Foi estimado um conjunto de 15.114.700 observações, compostas de 5.230 produtos, na nomenclatura HS6, e 170 países, para o período 2002-2018, a partir de um índice micro embasado. Também foram estimados índices de qualidade potencial para variedades fora do mercado. Esta é a primeira pesquisa a fazer isso e nota-se que isto pode ajudar *policymakers* a saber quais as variedades mais próximas de penetrar novos mercados. Foi encontrada validade estatística na teoria implícita com um Painel Probit. Também encontramos que aumentos na qualidade elevam a probabilidade de uma exportação acontecer, que aumentos nas barreiras comerciais nos mercados de destino a reduz, e que os valores unitários são *proxies* ruins para a qualidade. Foi analisada a trajetória temporal da qualidade pela média entre os países e entre os produtos. Nota-se que, enquanto as categorias "bens de capital" e "transporte e equipamentos" sempre tiveram a maiores qualidades potenciais, normalmente apresentam as menores qualidades efetivas. Este estudo sugere que, para transformar exportações potenciais em efetivas, deve-se focar em melhoras na qualidade, uma vez que a probabilidade de exportação cresce com a qualidade, e em alcançar os consumidores nos mercados de destinos com campanhas publicitárias.

Palavras-Chaves: Índice de Qualidade das Exportações; Probabilidade de exportação; Qualidade Potencial.

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1. INTRODUCTION

The quality of products is considered an important factor for foreign trade to promote economic development (IMF, 2014), while it is argued that the income differentials in the export sectors of a given type of product is partly determined by the quality differential (Khandelwal, 2010). Countries that produce lower-quality products survive in a smaller number of markets, so there is a positive relationship between income and quality in the export sector (Sutton and Trefler, 2016; Hummels and Klenow, 2005; Khandelwal, 2010).

One of the problems when analyzing the quality of exported products is that it is not directly observable, and unit values are often use (IMF, 2014). Those are define as the ratio between the value of exports and the quantity produced for each category of products, which, in turn, may vary with other factors, such as supply and demand shocks. To circumvent this situation, it is common in the literature to micro-base models for estimating the quality observed (Hallak, 2006; Khandelwal, 2010; Hallak and Schott, 2011; Feenstra and Romalis, 2014; Henn, et al., 2017).

According to Henn et al. (2017), there is a significant cross-country heterogeneity in the growth rate of quality; this highlights the necessity of methodologies that accounts for the differences between countries when estimating quality. Since Brazil has a continental size, quality estimates for this country should not reflect other countries means. For this, we estimate quality in commerce from the Brazilian exporter perspective. The data consists in 5,230 products, for 170 countries, during 17 years. This yields a data set of 15,114,700 observations.

We notice an exponential growth in China's imports from Brazil. We attribute this to its entering at the World Trade Organization at December 2001. By 2008 at *Cost, Insurance and Freight* (CIF) terms, China was the biggest destination of Brazilian exports. By 2018, this market was still growing. With this in mind, we concentrate the analysis at the interval 2002 to 2018. We also notice that the highest quality products concentrate at the developed countries and at Mercosur members.

We postulate the existence of stochastic marginal costs and that quality can only improve trough higher costs. Exporters only observe their quality levels when they enter the market, but those that are out also have implicit marginal costs that they can transform into quality, with a fixed elasticity of transformation, as soon as they start export. With these assumptions, we estimate potential quality indexes to the exporters out of the market too. We are the first researchers to estimate potential quality, which capture the quality that a product-country relation would have if the export happened. We test this index validity with a Probit Panel that measures the probability that an export occurs. We found that quality improvements increased the probability of an export to be successful in the period, and that higher trade barriers, represented by fixed costs in the Cut Off condition, generated reductions in this chance.

We also study the quality trajectory between the years. We divide our results by country mean and by product mean. In the former, we found that reductions in trade barriers facilitates exports. In the product mean analyses, we notice that the categories of goods "Capital goods (except transport equipment), and parts and accessories thereof", and "Transport equipment and parts and accessories thereof" are the ones with higher mean potential quality and, simultaneously, with lower mean effective quality. Our framework suggests two kinds of policies that can transform the potential exports into effective ones. First, an exporter can reach more markets if she produces higher quality goods. Second, since quality is perceive in a subjective manner in each destination market publicity can help exports reach more people and make them feel more satisfied about Brazilian products. One can also disaggregate these indexes to see which of the potential qualities have higher values and, hence, have higher export probability. We also found correlation between income and quality, as states Linder's Hypothesis. The low R-squared, of 0.45, in a linear regression between Unit Values and Quality highlights the necessity of these estimations and the inaccuracy of the former as a *proxy* for the latter.

The reminder of the paper is organized as follows: section 2 presents some related literature, section 3 the theoretical framework, section 4 the procedures to estimate quality, section 5 the data base, section 6 the results, and section 7 the conclusions.

2. RELATED LITERATURE

Melitz (2003) studied the effects between industries of international trade in a dynamic model for heterogeneous firms. He shows how exposure to the outside induces the most productive to export, keeps some of the least efficient ones in the domestic markets and make others leave. According to the author, the growth in aggregate productivity contributes to welfare gains due to the reallocations of the productive sectors.

Within the scope of the Heckscher-Ohlin models, Schott (2003) tested the presence of multiple equilibrium cones, which allow countries to specialize in a subset of goods based on their endowments, in contrast to the single cone equilibrium, which allows the production for each product only with the same technique. Schott (2004) found that, while the data rejected the hypothesis of a country specializing in products based on its initial allocations, the association was positive for specialization within the same category. High-income countries add differentials and quality to their products, unlike low-income ones (Schott, 2004; Verhoogen, 2008).

One of the problems when analyzing the quality of exported products is that it is not directly observable and some authors use unit values as proxies. They are define as the ratio between the value of exports and the quantity produce for each category of products, which, in turn, may vary with other factors, such as supply and demand shocks. To circumvent this situation, it is common in the literature to fundament models to estimate quality (Hallak, 2006; Khandelwal, 2010; Hallak and Schott, 2011; Feenstra and Romalis, 2014; Henn, et al., 2017).

As a way of understanding the concept of quality in export, consider the definition of Deardoff's (2016). Quality is a margin on which products can be differentiate, with different comparative advantages in the production of quality and variations in preferences for it, given the existence of a heterogeneous population. Still according to Deardoff (2016), exporters can improve quality as a way to sell at higher prices and produce more profit. For this reason, export prices, measured as unit values, are the closest proxy that can be observe (IMF, 2014). Henn, et al. (2017) provide a broad database of estimates, covering 166 countries between 1962 and 2014 for the Standard International Trade Classification (Revision 1) increased by 4 digits (SITC 4-digit-plus), which covers 835 product baskets.

The first study to find relevance in quality as a determinant of trade was Linder (1961). He argued that high-income countries spend more on high-quality products. Schott (2004) showed that unit values grow with the exporter's income and relative capital and labor endowment. Hummels and Klenow (2005) find that quality is essential to explain the variation in unit prices. The authors used some proxies for the number of varieties as explanatory and worked with HS6 for imports from the United States in 1995, covering 5,017 products.

Khandelwal (2010) estimated quality indicators for 1,059 products in the SITC nomenclature (revision 2) aggregated at the industrial level for manufactured goods, according to the Standard Industrial Classification (SIC) classification for imports from the United States from 1989 to 2001. The author found that higher quality is relate to products with higher market shares.

Hallak and Schott (2011) worked with HS10 for imports from the United States. They worked with balance of payments data to break down exports unit prices into due to quality and adjusted for quality. They find that countries with trade surpluses tend to offer higher quality in exports and that this converges more quickly than income. Feenstra and Romalis (2014) worked with a monopolistic competition model where firms determine both price and quality. Countries have non-homothetic demands and their choice reflects this phenomenon together with production costs.

Traditional trade literature overlooks the possibility of unstable trade as a frequent phenomenon. However, in Melitz (2003), firms make irreversible investment to enter the industry and faces initial uncertainty in concern to its productivity, which generates instability in the entry and exit of exporters. Baldwin and Harrigan (2011) propose a variant of Melitz model where higher quality firms are the most competitive. In their framework, quality raises with marginal costs and only the most productive firms can export higher quality products. Yan (2017) postulates the same relation to study how credit restrictions affects trade growth, where quality choices are endogenous, and found a positive, empiric tested, relation between quality and exports.

Another type of theoretical explanations for the relation between quality and exports are the incomplete contracts and asymmetric information literatures. For example, Rauch and Watson (2003) suppose that initial trade values are a determinant of trade duration. The importer buys a small amount of the good to test its quality and then decide whether to buy more or not. Higher initial trade values contributes to the maintenance of long run relations. One empirical work in this line is Besedes and Prusa (2006), which tests Rauch and Watson (2003) hypothesis as a determinant of duration and shows that initial size and search costs are relevant explanations for trade relationships. Araujo, Mion and Ornelas (2016) endorse this with Panel Data for the Belgian firms. They also find a two-fold relation between exports dynamic and institutional quality: export growth decreases with the quality of the country's institutions and; better contracting institutions contribute to higher probabilities of exports.

3. THEORETICAL FRAMEWORK

The theoretical framework, which we use to analyze our subsequent empirical results, comes from the model developed by Hallak (2006). In his work, each country has its utility function that takes into account the quantity c and quality q of each variety of products i. Furthermore, consider that the elasticity of these arguments is the same and constant in each i:

$$U_i^k = \left[\sum_{i \in \Theta} \left(c_i^k q_i^{\gamma_i^k} \right)^{1-\frac{1}{\sigma_i}} \right]^{1-\frac{1}{\sigma_i}}, \qquad \sigma_i > 1. \tag{1}$$

In equation (1), σ represents the elasticity parameter and Θ the set of all consumed goods. The utility function U is for each country k, which represents a structure like that of Dixit and Stiglitz (1977) increased for quality. γ_i^k is the intensity of the preference for quality of k. Let p_j be the price of variety j. Thus, the function that minimizes the expenses from k in product i is:

$$c_j^k p_j^k = \left[\left(\frac{p_j^k}{q_j^{\gamma_j^k}} \right)^{1-\sigma_j} \Bigg/ \sum_{i \in H} \left(\frac{p_i^k}{q_i^{\gamma_i^k}} \right)^{1-\sigma_i} \right] E^k = s^k(j) E^k. \tag{2}$$

In equation (2), everything that is spent by country k, E^k, multiplied by the share that each k spends in $j \in H$, $s^k(j)$, is equal to the expenditures of k with j, $c_j^k p_j^k$. H is the set of all products. Now consider that each country l sells N_{lj} different varieties, as well as a parameter τ_{lj}^k for transportation costs from l to k in j. Multiplying (2) by N_{lj}:

$$Imp_{lj}^k = N_{lj} \left[\left(\frac{p_{lj} \tau_{lj}^k}{q_{lj}^{\gamma_j^k}} \right)^{1-\sigma_j} \Bigg/ \sum_{i \in H} \left(\frac{p_i \tau_i^k}{q_i^{\gamma_i^k}} \right)^{1-\sigma_i} \right] E^k. \tag{3}$$

In equation (3), the expenditures of k with j, multiplied by the total j goods that l exports, N_{lj}, are equal to the imports of k, in product j, of origin l. We use the relation $p_{lj}^k = p_{lj} \tau_{lj}^k$, which has the price charged per *l* as a base price plus transaction costs for exporting j to *k*. Taking the natural logarithm of equation (3):

$$\ln Imp_{lj}^{k} = \ln N_{lj} - \sigma_j^* \ln p_{lj} + \ln \sum_{i \in H} \left(\frac{p_i \tau_i^k}{q_i^{\gamma_i^k}} \right)^{\sigma_i^*} + \ln E^k - \sigma_i^* \ln \tau_{li}^k + \sigma_j^* \gamma_j^k \ln q_{jl}$$

$$\sigma_i^* = \sigma_i - 1 \ . \tag{4}$$

The first two terms on the right side of (4) are constant for any export destination in country *1*, while the third and fourth are the same for imports of *k*. Therefore, in what follows, they will be grouped into constants φ_{li} and ψ_i^k. Consider that transaction costs are given by the distance between *l* and *k*, $DIST_l^k$, and by a set $\boldsymbol{I}_l^k$ with the determinants of the gravitational literature, as in Head and Mayer (2014):

$$\ln \tau_{li}^k = \eta_i \ln DIST_l^k + \beta_i^* \boldsymbol{I}_l^k. \tag{5}$$

Replacing (5) in (4) and considering that *k* imports are exports of *l*:

$$\ln exp_{ki}^l = \varphi_{li} + \psi_i^k - \sigma_i^* \eta_i \ln DIST_l^k + \beta_i \boldsymbol{I}_l^k + \sigma_i^* \gamma_i^k \ln q_{ki}, \tag{6}$$

where $\beta_i = -\beta_i^* \sigma_i^*$. Equation (6) determines the demand for exports for country *k* of origin *l*. There is a negative relationship with distance. For the supply side, we consider Baldwin and Harrigan (2011).

In a Melitz's type model, Baldwin and Harrigan (2011) consider a direct relation between quality and marginal costs. The firm only knows the latter after entering the market and incurring the initials costs. This, however, is determined ex-ante and is exogenous. We re-write this relation as the equation below,

$$q_i^{\gamma_i^k} = c_{li}^{1+\theta_i^l}, \qquad \theta_i^l > -1.$$

The c_{li} is the marginal cost of the exporter country *l* of final destination *k* producing good *i*. $1 + \theta_i^l$ is a term that represents the elasticity in which the producer transforms its marginal costs in quality. An empirical implication of this is that, for example, firms need to invest in Research and Development (R&D) to produce higher quality products. Since this is a Melitz's type model and every firm has an implicit marginal cost, each firm has an implicit quality-index, even those out of the market. These, however, only observe its quality when selling in the market. Considering *U* as the total utility of the importing country *k* for products of *l*, we can define the vector:

$$U_k^l = \left[U_{k1}^l, U_{k2}^l, \dots, U_{ki}^l, \dots, U_{kn-1}^l, U_{kn}^l\right] \forall\, i \in \Theta, \mathrm{n} = \sup \Theta.$$

This characterize the total utility that the *k* countries of the world get from the exporter *l* in the n products. The term $\sup \Theta$ states that n is the supremum of the set Θ. This allow us to concentrate our analyze at a finite and limited amount of goods. If we consider the case of *l*=1, then we can use the results in Baldwin and Harrigan (2011) and work with a supply relation between quality and exports. If we substitute, through the endogenously determine wages, their Cut-Off condition on their firms' profit maximization results, we arrive at the following equation:

$$\ln exp_i^k = b_k + f_i - \sigma_i^* 2 \ln \tau_{ki} + \frac{1}{1 + {}^{1}\!/_{\theta_i^{lCO}}} \sigma_i^{*CO} \gamma_i^{lCO} \ln q_i^{CO} + \frac{1}{1 + {}^{1}\!/_{\theta_i^{l}}} \sigma_i^* \gamma_i^k \ln q_{ki} \tag{7}$$

Where we grouped $b_k = 2 \ln B_k$ and $f_i = -\ln F_i + \ln \left(\frac{\sigma_i^*}{\sigma_i}\right)^{2\sigma_i^*} \frac{1}{\sigma_i}$, which are constant terms between countries of final destination and products, respectively. q_i^{CO} is the Cut Off quality, which is the minimum necessary for the exporter country to sell variety *i* in international markets. $\ln \tau_{li}$ are transaction costs, as in equation (5).

4. ESTIMATING QUALITY

To estimate the quality index, we use a two-steps estimator. As in Hallak (2006) and Henn, et al. (2017), we suppose that export prices are govern by a gravitational model:

$$lnp_{kit} = \zeta_0 + \zeta_1 lnq_{kit} + \zeta_2 lny_{kt} + \zeta_3 lnDIST_{kl} + \xi_{kit}, \tag{8}$$

where subscripts *k*, *t* and *i* represent the importer, the time, and the products, respectively. As higher quality products are expected to be more expensive, $\zeta_1 > 0$. y is the GDP per capita of the importing country. The sign of ζ_2 is ambiguous and governed by comparative advantages. If the country's goods have similar comparative advantages as the higher income ones, then the sign is negative because it will encounter more competition in higher income countries. The opposite applies when the comparative advantages is more similar with the small income countries. $DIST_{kl}$ measures the distance of the importing and exporting country, as in Mayer and Zignago (2011). The objective is to control for *Washington apples* effect[3]. So, ζ_3 must be positive.

Now we have a system of two equations. Our objective is to estimate $\sigma_i^* \gamma_i^k \ln q_{kit}$. At this point, it will help us to apply the mean deviations format, as in equation (9) bellow. Doing so, we can estimate the quality-adjusted index in the form they are present in equation (6), as we demonstrate in the sequence of the text.

$$\ln q_{kit} = E[\ln q_{kit}] + \frac{1}{\zeta_1}\left(\widehat{\ln p_{kit}}\right) - \frac{\zeta_2}{\zeta_1}\left(\widehat{\ln y_{kt}}\right) - \frac{\zeta_3}{\zeta_1}\left(\ln \widehat{DIST}_{kl}\right) - \frac{\xi_{lit}}{\zeta_1}. \tag{9}$$

The ^ symbol represents deviations from the mean of the variable. Substituting this relationship in the demand equation (6), we arrive at:

$$\ln exp_{kit}^l = \varphi_{li} + \psi_i^k - \left(\sigma_i^* \eta_i + \sigma_i^* \gamma_i^k \frac{\zeta_3}{\zeta_1}\right) \ln DIST_l^k + \beta_i \boldsymbol{I}_l^k + \frac{\sigma_i^* \gamma_i^k}{\zeta_1}\left(\widehat{\ln p_{kit}}\right) - \frac{\sigma_i^* \gamma_i^k \zeta_2}{\zeta_1}\left(\widehat{\ln y_{kt}}\right) + \sigma_i^* \gamma_i^k \frac{\zeta_3}{\zeta_1} E[\ln DIST_{kl}] + \sigma_i^* \gamma_i^k E[\ln q_{kit}] - \sigma_i^* \gamma_i^k \frac{\xi_{kit}}{\zeta_1}. \tag{10}$$

According to Baltagi (2013), in databases that have units of time and cross-section, as is the case of equation (10), it is possible to apply the Panel Data methodology. This considers the existence of unobserved effects specific to the temporal and cross-section units. From equation (10), Panel data estimates imply a regression of the form:

$$\ln exp_{kit}^l = FE_l + FE_k + \alpha_1 \ln DIST_l^k + \alpha_2 \boldsymbol{I}_l^k + \alpha_3\left(\widehat{\ln p_{kit}}\right) + \alpha_4\left(\widehat{\ln y_{kt}}\right) + \varepsilon_{kit}^l \tag{11}$$

$FE_l = \varphi_{li}$ and $FE_k = \psi_i^k$ represent the effects of the exporting, in this empiric only Brazil, and importing countries, respectively. $\alpha_1 = -\left(\sigma_i^* \eta_i + \sigma_i^* \gamma_i^k \frac{\zeta_3}{\zeta_1}\right)$, $\alpha_2 = \beta_i$, $\alpha_3 = \frac{\sigma_i^* \gamma_i^k}{\zeta_1}$ and $\alpha_4 = -\frac{\sigma_i^* \gamma_i^k \zeta_2}{\zeta_1}$ are the estimated coefficients for the relationship between exports and distance, the variables of the gravitational model, the unit value deviations, and income deviations, respectively. $\varepsilon_{ki}^l = \sigma_i^* \gamma_i^k \frac{\zeta_3}{\zeta_1} E[\ln DIST_{kl}] + \sigma_i^* \gamma_i^k E[\ln q_{kit}] - \sigma_i^* \gamma_i^k \frac{\xi_{kit}}{\zeta_1}$ is an error term. Notice that ξ_{kit} explain the prices in (9). This implies the existence of a correlation between the residues and an explanatory variable, which generates inconsistency in the estimates.

[3] This effect says that the composition of the goods baskets tends towards higher priced products as the distance between countries increases. This concept is due to Alchian and Allen (1964).

For the estimates to have consistency, we can use an instrumental variable. It must correlate with $\widehat{\ln p_{klt}}$ and not with the error term. One possibility, already used by Hallak (2006) and Henn, et al. (2017), is to consider a lag. Therefore, to estimate equation (11), we use $\ln \widehat{p_{kit-1}}$ as an instrument for $\ln \widehat{p_{kit}}$.

With these estimates, we can construct the quality index. For this purpose, we highlight that the distance variable can affect quality trough the *Washington apples* effect and/or the transport costs effects. The former is represent by $\sigma_i^* \gamma_i^k \frac{\zeta_3}{\zeta_1}$ and later by $\sigma_i^* \eta_i$ in equation (10). If we multiply (9) by $\sigma_i^* \gamma_i^k$, isolate $\sigma_i^* \gamma_i^k \frac{\zeta_3}{\zeta_1} E[\ln DIST_{kl}] + \sigma_i^* \gamma_i^k E[\ln q_{kit}]$ and replace the result in (9), we arrive in the following relation for quality and distance:

$$\sigma_i^* \gamma_i^k \ln q_{kit} + \sigma_i^* \gamma_i^k \frac{\zeta_3}{\zeta_1} \ln DIST_{kl} = \ln exp_{kit}^l - \ln \widetilde{exp_{kit}^l} + \alpha_3 \left(\widehat{\ln p_{kit}}\right) + \alpha_4 \left(\widehat{\ln y_{kt}}\right). \tag{12a}$$

If we add and subtract the term $\alpha_1 \ln DIST_l^k$ in this relation, we arrive at:

$$\sigma_i^* \gamma_i^k \ln q_{kit} - \sigma_i^* \eta_i \ln DIST_{kl} = \ln exp_{kit}^l - \ln \widetilde{exp_{kit}^l} + \alpha_3 \left(\widehat{\ln p_{kit}}\right) + \alpha_4 \left(\widehat{\ln y_{kt}}\right) + \alpha_1 \ln DIST_l^k. \tag{12b}$$

The term $\ln \widetilde{exp_{kz}^l}$ represents the predict values of $\ln exp_{kz}^l$. With the coefficients estimated in equation (11) and the relationships (12a) and (12b), it is possible to obtain estimates for the logarithm of quality-adjusted by sector elasticities and intensity of demand. However, there is another factor in the left-hand side of the equation. When confronted with this problem, Henn, et al. (2017) normalized the results using the 90th percentile of their quality estimates for each product, since they were studying quality differentials between varieties. Since our attentions lies on the demand responses for quality, we use another method. First, to control for it, we use an auxiliary regression on the predict value of (12b):

$$\sigma_i^* \gamma_i^k \ln q_{kit} - \sigma_i^* \eta_i \ln DIST_{kl} = \beta_0 - \beta_1 \ln DIST_{kl} + \varepsilon; \tag{13}$$

The dependent variable is the estimates in (12b), while the independent is the natural logarithm of the distance. It is reasonable to expect that $\beta_1 = \sigma_i^* \gamma_i^k$ and $\beta_0 = E\left[\sigma_i^* \gamma_i^k \ln q_{kit}\right]$. So, to validate the equality above, it must be that $\varepsilon = \sigma_i^* \gamma_i^k \ln q_{kit} - E\left[\sigma_i^* \gamma_i^k \ln q_{kit}\right]$. Summing the estimated constant with the error term of equation (12), we arrive at:

$$\beta_0 + \ \varepsilon = E\left[\sigma_i^* \gamma_i^k \ln q_{kit}\right] + \sigma_i^* \gamma_i^k \ln q_{kit} - E\left[\sigma_i^* \gamma_i^k \ln q_{kit}\right] = \sigma_i^* \gamma_i^k \ln q_{kit}. \tag{14}$$

This is a quality-adjusted index. We can follow a similar line of thought to equation (12a), but since we are using an auxiliary regression to remove the effects of the distance variable, the predict quality of both should be identical.

In the end, we test the supply side from the Baldwin and Harrigan (2011) model. Since our specification highlights the entry costs, given by the Cut Off condition, we estimate equation (7) trying to capture the probability of an export happening and not focusing on a long-run perspective. For this reason, we test it with a Probit Panel. The probability that a variety *i*, be imported by *k* at *t* is

$$P\left(exp_i^k \middle| b_{kt}, f_{it}, \tau_{kit}, \ln q_{it}^{CO^{\sigma_{it}^{*CO} \gamma_{it}^{lCO}}}, \ln q_{kit}^{\sigma_{it}^* \gamma_{it}^k}\right)$$
$$= \Phi\left(\lambda_0 + \mathbf{\Lambda I}_l^k + \lambda_1 \ln DIST_{kl} + \lambda_2 \sigma_{it}^{*CO} \gamma_{it}^{lCO} \ln q_{it}^{CO} + \lambda_3 \sigma_{it}^* \gamma_{it}^k \ln q_{kit} + \eta_{it}^k\right).$$

Φ is the normal distribution, $\boldsymbol{I}_l^k$ is the same set of gravity variables as in (11) and η_{it}^k controls for individuals effects. $\sigma_{it}^* \gamma_{it}^k \ln q_{kit}$ are the estimates from (14). To construct the Cut Off quality, we consider the minimum quality for variety *i* at time *t* as the Cut Off level for the effective qualities. For the varieties in which the export values at *t* are “zero”, that is, the potential quality, we consider the maximum. Since a Fixed Effects Probit can incur in the “incidental parameter problem”, as can be seen in Baltagi (2013), we estimate a Random Probit Panel in the final regression.

5. DATA AND TIME SELECTION

The data consist of a three-dimensional panel of Brazilian exports. It contains 5,230 products of the Harmonized System nomenclature at 6-digit (HS6), for 170 countries from 2002 to 2018. This implies 15,114,700 observations. For the exports, we consider the *Cost, Insurance and Freight*[4] (CIF) nomenclature. According to the *International Merchandising Trade Statistics: Concepts and Definitions*, United Nations (2011), is recommended that the Statistical Units of a country report imports by the concept of country of origin and exports by that of last known destination, which is followed on the United Nation Statistical Division (2020) database (COMTRADE). It also recommends that the report of exports values be on *Free On Board* (FOB) nomenclature and imports on the CIF, so we consider importing country report as CIF and exporting country as FOB. However, in the case of exports, countries often do not differentiate country of consignment and country of last known destination, which causes comparability issues (United Nations, 2011). For example, in 2015, the difference between FOB and CIF, through this methodology, for Netherlands was -53.8 %, which leads us to the wrong conclusion that freight, insurance and other transports costs were negative. With that in mind and considering the demand nature of equation (6), we use importing countries reports to Brazilian exports on the CIF basis. In the data, there are fifteen countries with no imports from Brazil. They were maintain in the regression with “zeros” as its importing values. By doing so, we can estimate the “potential quality” of the Brazilian firms in those sectors, which agrees with the supply side of our theoretical framework.

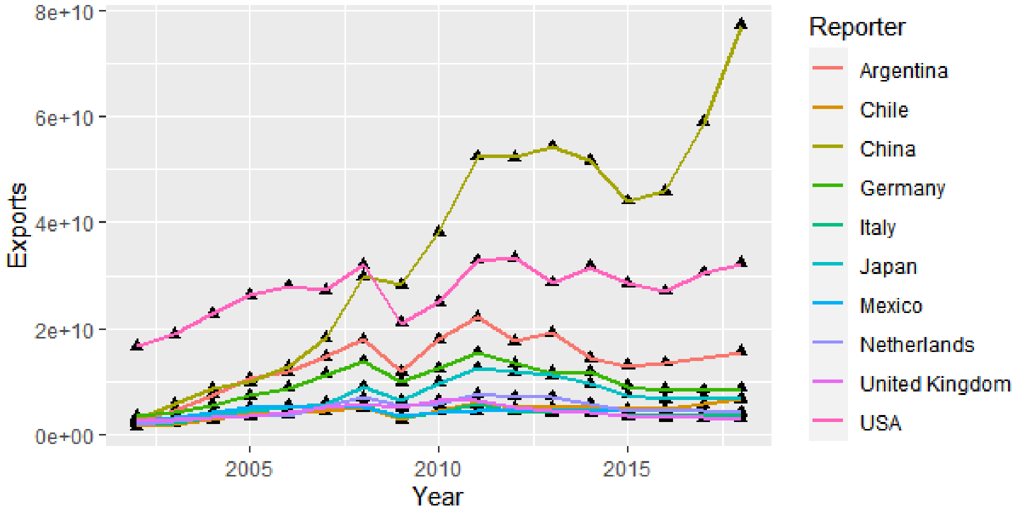
As regards the period sample, we consider the existence of one outlier, as can be seen in Figure 1, which was construct by summing the total exports between products and considering the ten biggest by the mean value of the period. There, we highlight that China was the smallest CIF value destination at the beginning of the period but then, by 2009, it became the biggest one with a rapid ascension. Commerce with Argentina has also grown but in minor proportion, while that with USA was more stable. For the gravity set, we consider common language, common frontier, and common colonizer from Head and Mayer (2014). For regional trade agreements, we follow World Trade Organization, WTO (2020), information.[5] The distance variable is from Mayer and Zignago (2011)[6].

[4] “The FOB-type values include the transactions value of goods and the value of services performed to deliver goods to the border of the exporting country”. (United Nations 2011, p. 39-40) The CIF-type contains de FOB-type values and “…the value of services performed to deliver the goods from the border of the exporting country to the border of the importing country” (United Nations 2011, p. 40).

[5] Available in: <http://rtais.wto.org/UI/PublicSearchByMemberResult.aspx?MemberCode=076&lang=1&redirect=1>.

[6] Available in: <http://www.cepii.fr/CEPII/en/bdd_modele/download.asp?id=8>.

Figure 1 – The sum of Brazilian exports between products (2002 – 2018): selected countries



Source: Authors' elaboration base on COMTRADE data.

In Table 1 we present a descriptive analysis. The Unit-Values are calculate as the ratio between the trade value and the unit of measure, proxy for quality. The maximum value shows the presence of outliers, given the low mean and standard errors. The distance variable is from Mayer and Zignago (2011). The most distant country is Palau (a small country at the Philippine Sea) and the nearest is Paraguay. The income is represent by PIB *per capita*, from WDI (2020) data set and is at 2011 dollars.

Table 1 – Descriptive Analysis

	Mean	**Standard Deviation**	**Min**	**Max**
Unit-Values	16.70	7,222.67	0.00	20,647,643.00
Distance	9,464	4,121.80	1,633	18,512.18
PIBpc	17,751.91	20,223.51	613	134,960.00
Exports	142,042.80	18,097,856	0	23,934,908,557.00

The exports are in current dollars disaggregated at the HS6. Table 2 contains some examples of the Harmonized System nomenclature. This is to provide an example of the product detail level. For example, 02.07 is the HS4 code for "Meat and edible offal, of the poultry of heading", while 0207.41 and 0207.42 are HS6 codes specifics for ducks not cut in pieces, the former stands for fresh or chilled and latter for the frozen ones. We notice that the HS system not only differentiate chickens and ducks, but also how they were cut and storage.

Table 2 – Products disaggregation

Codes	**Products**
02.07	Meat and edible offal, of the poultry of heading
0207.41	Ducks not cut in pieces, fresh or chilled
0207.42	Ducks not cut in pieces, frozen
12.07	Other oil seeds and oleaginous fruits, whether or not broken.
1207.30	Castor oil seeds
1207.60	Safflower (Carthamus tinctorius) seeds

The second example is the HS4 code 12.07 "Other oil seeds and oleaginous fruits, whether or not broken". Every HS6 category good is inside a HS4, so the codes 1207.30 and 1207.60, which stand for Castor oil seeds and Safflower seeds, are inside the 12.07 HS4. By assuming the HS6 codes, we reduce the "Other oil seeds…" group and allow for a better measure for our quality index, which should rank the level of vertical difference perceived as better by the consumers. Even if there are no difference between plant seeds at the destinations countries, the quality index may differ since it involves a subjective utility function for every country *l*. When we consider the HS6 nomenclature, we find 5,230 products in our data.

6. RESULTS

We built a Panel Data considering 170 countries, 17 years, and 5,230 products, which imply 15,114,700 observations. Since it has two cross-sectional sets of observations (country and product), we use the pseudo-panel structure to study quality by country. In doing so, we consider the products as a cohort and estimate a country-year panel using its mean between countries. Since this methodology limits the predict values to the country-year relation, we also divide the period in four (2003-2006, 2007-2010, 2011-2014 and, 2015-2018). This allows structural changes in the economy and the adjustment of the estimates. At these panels, we control fixed effects by country and product-year. Then, to test the supply side, use a Probit Panel. Since a Fixed Effects Probit can incur in the "incidental parameter problem", as can be seen in Baltagi (2013), we estimate a Random Probit Panel in the final regression. For brevity, we will call the pseudo-panel results as "countries results" and the other one by "products results".

First, since the theoretical model suggests the presence of individual effects in equation (11), we consider a Least Square Dummy Variable model (LSDV)[7]. The results are in Table 3.

Table 3 – First regression: the "countries results" and the "products results"

	Least Square Dummy Variables	**Poisson Pseudo-Maximum Likelihood**	**2003 - 2006**	**2007 - 2010**	**2011 - 2014**	**2015 - 2018**
Unit-Values	1.06 (0.07)***	0.73 (0.05)***	1.55 (0.00)***	1.31 (0.00)***	1.34 (0.00)***	1.27 (0.00)***
PIB*pc*	0.20 (0.06)***	1.19 (0.10)***	0.38 (0.03)***	0.88 (0.03)***	0.06 (0.03)**	-0.01 (0.03)
Distance	-1.67 (0.81)***	-7.42 (1.94)***	-2.34 (0.19)***	-5.46 (0.21)***	-0.97 (0.19)***	-0.77 (0.22)***
Regional Trade Agreements	0.29 (0.15)***	0.45 (0.36)	-0.02 (0.02)	0.78 (0.02)***	0.23 (0.02)***	0.21 (0.02)***
Colonial Linkage	1.56 (0.34)***	4.28 (0.76)***	2.35 (0.09)***	2.73 (0.10)***	1.25 (0.09)***	1.42 (0.10)***
Common Official Language	-2.39 (0.78)***	-7.24 (1.88)***	-3.40 (0.18)***	-4.92 (0.19)***	-1.83 (0.17)***	-1.98 (0.19)***
Conitguity	-1.68 (0.73)***	-6.23 (1.72)***	-1.17 (0.18)***	-6.25 (0.20)***	-1.10 (0.18)***	-0.86 (0.20)***
Intercept	15.47 (7.34)***	68.74 (17.57)***	-	-	-	-
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	No	No	No	No
Product-Time	No	No	Yes	Yes	Yes	Yes
Observations	15,114,700	15,114,700	3,556,400	3,556,400	3,556,400	3,556,400

Note[1]: Heteroskedastic Robust Standard deviations in parenthesis.
Note[2]: '***','**' and '*' indicates significance levels of 1%, 5% and 10%, respectively.

We also report the Pseudo-Poisson Maximum Likelihood (PPML) estimation, as suggested in Yotov, et. al (2016), as a robustness check to the "countries results". This consist of estimating the model in the exponential form and maximizing the Likelihood function under the assumption that it follows a Poisson

[7] We also test it with Breusch-Pagan (1980), Honda (1985), and King and Wu (1997). They confirm the theory.

distribution. The method also admits that some observations follow another distribution not identifiable, as is implicit in the Quasi-Maximum Likelihood methodology.

In Table 3 all the results, but the Regional Trade Agreements in PPML and the period 2003-2006, were significant. From our knowledge, there aren't publications that estimated this functional form. The closest ones are Hallak (2006) and Henn, et al. (2017). The former estimated one regression by sector using a cross-sectional Panel for USA in 1995 and the latter estimated one regression by product in a Panel dataset with 166 countries. At the HS6 level with one country, we cannot replicate their methods due to variability issues that arrive at this level of detail, but we notice that the sign of Regional Trade Agreements, Distance, and Colonial Linkages agree with their median results. The differences on the sign of Common Official Langue and Contiguity is a Brazilian particularity. We also highlight that all variables results are according to the theoretical framework. The positive sign at the PIB*pc* coefficient indicates that Brazilian products face higher competition at higher income countries. We also notice that this value became zero by 2015-2018. The sign pattern also agrees with the Dixit-Stiglitz approach that postulates $\sigma_i > 1$.

Next, we estimate the auxiliary regression. First, we construct the predict value in (12b) for the "countries results". We know that the term $\sigma_i^* \eta_i \ln DIST_{kl}$ is due to transport costs. Shipping products through longer distances can lead to losses in quality. This work as "*iceberg costs*" for quality. There are authors that highlights the "*Washington apples*" effects relating quality and distance. For example, Alchian and Allen (1964), Hallak (2006), Henn, et al. (2017) and, Feenstra and Romalis (2014). In our empirics, this term is control as $\sigma_i^* \gamma_i^l \frac{\zeta_3}{\zeta_1} \ln DIST_l^k$. We expect that when we aggregate products in the country-year locus, as in the "countries results", transport costs should be more relevant to determine quality. However, at the country-year-product locus, products characteristics become more relevant. So, when we consider the "products results", we use the estimations (12a). With these predict values, we estimate equation (13) and report the results at Table 4.

Table 4 – Auxiliary Regression

	Countries Results	**2003 - 2006**	**2007 - 2010**	**2011 – 2014**	**2015 - 2018**
Mean Quality	1.07	-3.72	-5.50	-3.51	-4.30
	(0.20)***	(0.03)***	(0.03)***	(0.03)***	(0.02)***
Distance	-1.79	0.39	0.61	0.40	0.49
	(0.02)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Observations	2,890	3,556,400	3,556,400	3,556,400	3,556,400

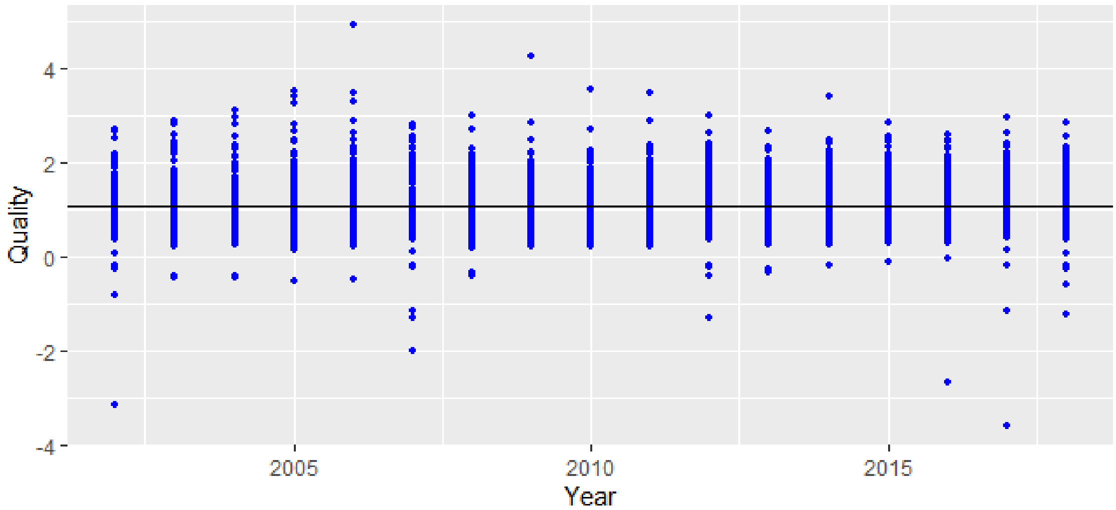
Note[1]: Heteroskedastic robust Standard deviations in parenthesis.
Note[2]: '***','**' and '*' indicates significance levels of 1%, 5% and 10%, respectively.

We found the existence of a composition bias of -1.79% times distance for the "countries results", indicating the presence of transport costs. For the other regressions, this value is positive and agrees with the *Washington Apples* effect. We remove these by summing the Mean Quality with the error term, as stated in (14). The intercept of the estimates indicate that the Mean Quality equals 1.07 for the "countries results". We also found -3.72, -5.50, -3.51 and, -4.30, for the periods 2003-2006, 2007-2010, 2011-2014 and, 2015-2018, respectively.

We start by analyzing the "countries quality" estimates, which comes from the "countries results". In Figure 2, we plot the distribution of quality between periods[8]. The black line is the Mean Quality and the blue dots are the quality of each country destination.

[8] We kept quality in the logarithm scale.

Figure 2 – Mean and dispersion of the Quality Index for the "geographic quality"



Source: Authors' elaboration.

We see that the quality index estimates, along the years, is distribute around the mean value 1.07. The smallest value is the quality for Argentina in 2017, of -3.58, and the biggest is 4.90 for Venezuela in 2006. The mean value of quality for Argentina, 2017 apart, was 2.35, which is above the mean. According to Neves (2010), during a general strike in 2007 and after a *coup d'etat* attempt at Venezuela, the Brazilian government sent cargo ships with gasoline to help the country. In this same year, Venezuela entered Mercosur. These events contributed to the higher level of the index that year. The mean value of the quality index for Venezuela, 2006 apart, was 0.72, which is below the mean. In Table 5, we report the mean period quality for all of Brazilian exports disaggregated by country.

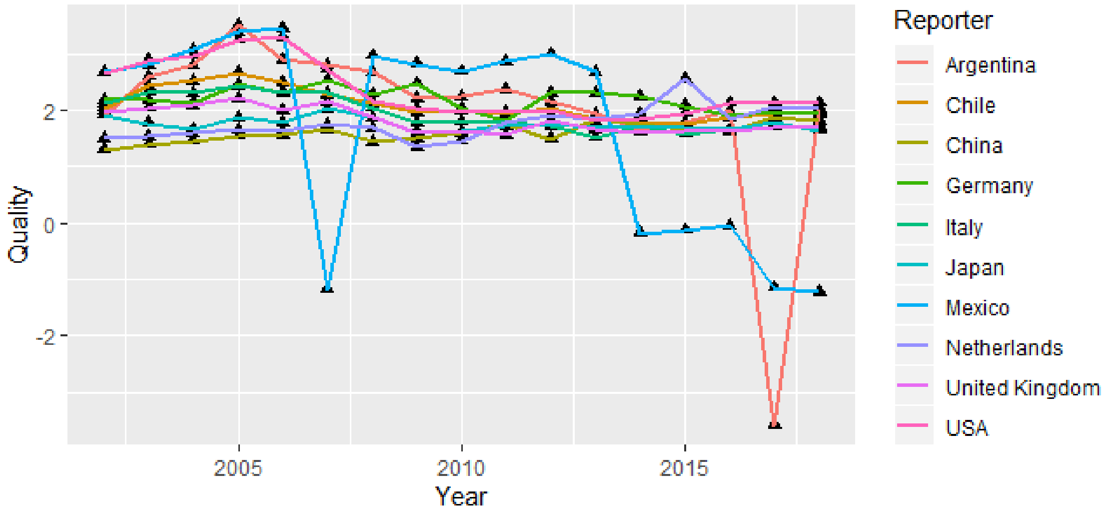
Table 5 – Begin, end and mean period Quality estimated from equation (12)

Country	Mean	2002	2018	Country	Mean	2002	2018	Country	Mean	2002	2018
USA	2.35	2.66	2.13	**Oman**	1.25	1.36	1.35	**Grenada**	0.80	0.88	0.87
Germany	2.19	2.18	1.94	**Croatia**	1.24	1.35	1.07	**Rep. of Moldova**	0.79	0.76	0.75
Chile	2.09	2.04	1.96	**Hungary**	1.24	1.63	1.32	**Samoa**	0.79	0.87	0.86
France	2.02	1.89	1.63	**Lebanon**	1.24	1.29	1.14	**Saint Vincent and the Grenadines**	0.78	0.83	0.83
Argentina	2.00	1.92	1.99	**Romania**	1.23	1.16	1.24	**Tonga**	0.78	0.86	0.85
Spain	2.00	2.08	1.77	**Panama**	1.22	0.07	0.06	**Uzbekistan**	0.78	0.86	0.98
Italy	1.93	2.12	1.68	**Kazakhstan**	1.19	0.93	1.41	**Cabo Verde**	0.77	0.54	0.53
Switzerland	1.93	1.73	2.28	**Lithuania**	1.14	1.34	1.26	**Dominica**	0.77	0.84	0.84
Canada	1.90	2.49	0.54	**Malta**	1.14	1.31	1.17	**Lao People's Dem. Rep.**	0.77	0.85	0.85
Uruguay	1.89	1.71	1.79	**Trinidad and Tobago**	1.13	0.67	0.66	**Myanmar**	0.72	0.76	0.95
Portugal	1.88	2.04	1.88	**Belarus**	1.12	1.02	1.32	**Nigeria**	0.72	0.53	0.52
Colombia	1.86	1.32	1.97	**India**	1.12	-0.25	1.77	**FS Micronesia**	0.72	0.80	0.79
United Kingdom	1.81	1.98	1.72	**Algeria**	1.11	0.87	0.52	**Congo**	0.71	0.74	0.73
Netherlands	1.77	1.49	2.03	**Bulgaria**	1.11	1.19	1.02	**Guyana**	0.71	0.55	0.54
Japan	1.75	1.92	1.63	**Mauritius**	1.11	1.06	1.28	**Marshall Islands**	0.71	0.80	0.79
Peru	1.74	1.68	1.99	**Nicaragua**	1.10	0.75	1.21	**Papua New Guinea**	0.71	0.85	0.76
Singapore	1.70	1.75	2.20	**Angola**	1.09	-0.28	2.31	**Bangladesh**	0.70	0.78	0.62

Australia	1.69	1.67	1.44	**Indonesia**	1.09	0.51	1.98	**Yemen**	0.70	0.72	0.71
Paraguay	1.69	-3.15	2.55	**Latvia**	1.07	1.14	1.15	**Tuvalu**	0.69	0.78	0.77
Austria	1.68	1.62	1.74	**Bahamas**	1.06	1.09	1.08	**Zambia**	0.68	0.65	0.85
Mexico	1.68	2.68	-1.22	**Tunisia**	1.06	1.02	0.59	**Cambodia**	0.67	0.71	0.88
Belgium	1.65	1.29	1.79	**Equatorial Guinea**	1.04	1.13	1.12	**Kyrgyzstan**	0.67	0.72	0.78
Norway	1.65	1.59	1.81	**Honduras**	1.04	0.19	-0.20	**Vanuatu**	0.67	0.75	0.74
Rep. of Korea	1.63	1.31	1.97	**Puerto Rico**	1.04	1.13	1.12	**CÃ´te d'Ivoire**	0.65	0.44	0.99
China	1.60	1.30	1.82	**Seychelles**	1.04	1.14	1.27	**Kenya**	0.65	0.79	0.53
United Arab Emirates	1.57	0.66	2.85	**Palau**	1.03	1.11	1.11	**Cameroon**	0.64	0.60	0.59
Costa Rica	1.56	-0.84	1.70	**North Macedonia**	1.02	0.97	1.10	**Ghana**	0.64	0.44	1.21
Czechia	1.55	1.48	1.67	**Libya**	1.01	1.10	1.09	**Nepal**	0.61	0.67	0.66
South Africa	1.54	1.32	0.86	**Bosnia Herzegovina**	1.00	0.74	1.15	**Solomon Isds**	0.60	0.68	0.67
Sweden	1.54	1.58	1.63	**Jordan**	0.98	0.86	0.97	**Kiribati**	0.60	0.68	0.67
Bolivia (Plurinational State of)	1.52	1.63	2.07	**Saint Kitts and Nevis**	0.98	1.05	1.04	**Madagascar**	0.60	0.56	0.68
Finland	1.51	1.50	1.64	**Azerbaijan**	0.97	0.95	1.25	**Tajikistan**	0.60	0.69	0.68
Kuwait	1.51	1.02	1.94	**Venezuela**	0.97	0.80	0.79	**Comoros**	0.59	0.68	0.67
Ecuador	1.49	1.58	2.01	**Sri Lanka**	0.96	1.03	0.83	**Mauritania**	0.59	0.67	0.66
Poland	1.49	0.64	1.81	**Egypt**	0.96	0.67	0.66	**Senegal**	0.59	0.46	0.45
New Zealand	1.48	1.41	1.54	**Maldives**	0.95	1.01	1.05	**Zimbabwe**	0.58	0.56	0.79
Turkey	1.48	1.02	1.55	**Antígua and Barbuda**	0.94	1.02	1.01	**Lesotho**	0.55	0.64	0.63
Qatar	1.47	1.28	1.28	**Iraq**	0.94	1.03	1.02	**Uganda**	0.53	0.50	0.72
China. Hong Kong SAR	1.45	1.68	1.29	**Gabon**	0.93	0.99	0.98	**Ethiopia**	0.50	0.37	0.36
Denmark	1.44	1.48	1.36	**Barbados**	0.91	0.90	0.89	**Gambia**	0.50	0.58	0.57
Guatemala	1.43	1.22	-0.62	**Botswana**	0.91	0.98	0.97	**Chad**	0.49	0.58	0.57
Thailand	1.43	1.04	1.77	**Mongolia**	0.91	0.93	1.16	**Benin**	0.48	0.56	0.55
Ireland	1.42	1.47	1.49	**Jamaica**	0.90	0.56	0.55	**Mali**	0.47	0.52	0.51
Luxembourg	1.42	1.36	1.67	**Turkmenista n**	0.90	0.99	0.98	**Rwanda**	0.47	0.53	0.52
China. Macao SAR	1.40	1.52	1.42	**Fiji**	0.89	0.91	0.96	**Mozambique**	0.45	0.59	1.06
Brunei Darussalam	1.39	1.41	1.52	**Albania**	0.88	0.89	0.90	**Guinea**	0.44	0.51	0.50
Slovenia	1.34	1.36	1.47	**Armenia**	0.87	0.81	1.05	**Burkina Faso**	0.44	0.47	0.46
Slovakia	1.33	1.40	1.43	**Namibia**	0.87	0.74	0.95	**Haiti**	0.43	0.52	0.51
Iceland	1.32	1.36	1.38	**Viet Nam**	0.86	0.55	1.30	**Malawi**	0.42	0.45	0.44
Saudi Arabia	1.32	1.26	0.71	**Georgia**	0.85	0.87	0.86	**Togo**	0.41	0.46	0.45
Israel	1.31	1.35	1.44	**Pakistan**	0.84	0.47	1.02	**Guinea-Bissau**	0.40	0.49	0.48
Bahrain	1.30	1.29	1.65	**Philippines**	0.84	0.93	0.92	**Sierra Leone**	0.37	0.46	0.45
Malaysia	1.30	1.43	1.55	**Bhutan**	0.83	0.92	0.91	**Central African Rep.**	0.35	0.43	0.42
Estonia	1.26	1.28	1.37	**Suriname**	0.82	0.79	0.78	**Liberia**	0.35	0.44	0.43
Dominican Rep.	1.25	-0.26	-0.27	**Saint Lucia**	0.81	0.88	0.87	**Niger**	0.34	0.45	0.38
El Salvador	1.25	1.09	1.46	**Eswatini**	0.81	0.87	0.95	**Burundi**	0.33	0.41	0.40
Greece	1.25	1.32	1.23	**Belize**	0.80	0.77	1.08				

We reported the results on a mean quality decreasing order. We notice that the quality mean of the period for Argentina is 2.00, which is the 6th biggest. If we consider the mean value without 2017, it would tie with USA at the 1th position, with 2.35. We notice that China is at the 24th position. We also notice that only two South American countries have quality below the mean. They are Venezuela and Suriname. These two aside, the worst position is that of Peru, the 34th, and the first is Chile, at 3th. In Figure 3, we consider the 10 biggest destinations of Brazilian exports, in CIF terms, as in Figure 1, and plot the time variation of the quality index for these countries.

Figure 3 – Evolution of the quality index for the ten biggest export destinies



Source: Authors' elaboration.

We see that Argentina and USA had the higher quality goods at the beginning of the period, together with Mexico. We see an above average demand for quality in Mexico at the beginning of the period (it was the higher in the ten biggest at 2006), with a fall at 2007. This is due to the "*Tortilla*'s crisis". According to Thomaz and Carvalho (2011). Mexico faced a series of manifestations because the price of *tortillas* went from R$5.00 to R$20.00 in one year. This happened together with lots of problems as financial instability, climate changes and higher prices in other types of foods. At 2008, the quality levels were back to values similar as the 2006 ones. We observe a downturn in the quality of exports from 2012 onwards. At February 2012, following Itamaraty (2020). Brazil and Mexico started more frequent negotiations around free trade agreements and. between 2012 and 2018, there have been 30 meetings between them regarding bilateral trade[9]. If the approximation of the parties lead to a decrease in commercial marginal costs, which can happen, for example, as consequence of tariffs cut, the Cut Off condition for entering the market in the Melitz's model will be lower and. consequently. lower quality Brazilian products enter Mexico. This does not mean that there have been a reduction in the quality of the exports in general. It means that the reduction in trade barriers allows firms with lower marginal costs, and hence lower quality, to enter the Mexican market. This allow Brazilian firms to fulfill a demand for quality differentiation by the Mexican consumer that would had not been fulfill without the diplomatic approximation between the parties. This indicates an opportunity for Brazilians producers to grow in size through the Mexican markets and win gains of scales for competing at higher quality markets. The positive relation between product quality and market shares have been highlight by Khandelwal (2010), which found a positive correlation.

As regarding the other nine countries, there have been more stability in the index. All of them had quality above the mean 1.07. This, together with the results at Table 5, shows that the Brazilian products with the highest quality are export to its biggest markets destinations.

At Table 6, we analyze the correlation between quality and other variables. The objective is to test some general results commonly analyzed in the literature. First, we notice that, as first studied by Linder

[9] We have accounted only for the meetings reported at Itamaraty (2020) website.

(1961), there should be a positive relation between quality and income, since rich countries spent a larger proportion of their income. By estimating this relation through OLS, with found a positive and significate relation.

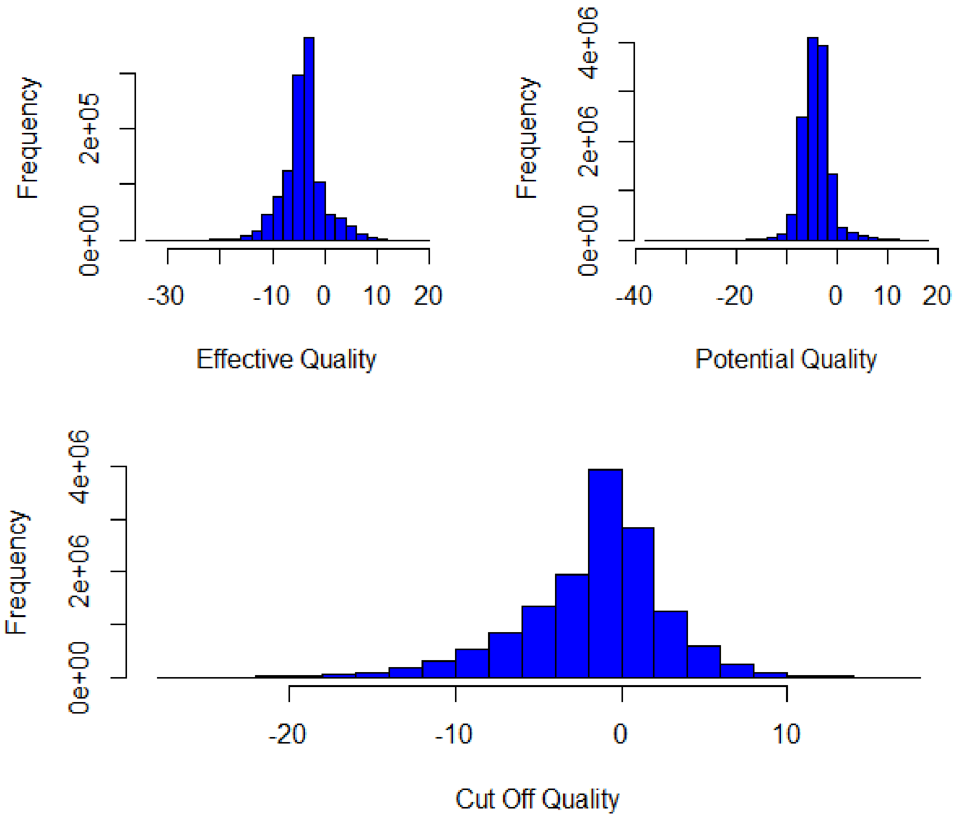
Table 6 – Correlation between quality and income, contiguity, Regional Trade Agreements and Unit Values

	Linder's Hypothesis	**Contiguity**	**Regional Trade Agreements**	**Unit Values**
(Intercept)	1.07 (0.01)***	1.05 (0.01)***	1.06 (0.01)***	1.07 (0.01)***
Estimates	0.31 (0.01)***	0.42 (0.08)***	0.06 (0.03)**	1.32 (0.05)***
R^2	0.39	0.02	0.00	0.45

Note[1]: Heteroskedastic robust Standard deviations in parenthesis.
Note[2]: '***'.'**' and '*' indicates significance levels of 1%. 5% and 10%, respectively.

We also encounter a positive relation between Contiguity and Quality, as we guessed by the analysis of the export quality to South American Countries. It is also significant the correlation between quality and the Unit Values, which some authors use as a *proxy* for quality. This correlation is positive, but the R-squared of the regression is of only 0.45, which shows that this is a poor *proxy* for quality and highlights the necessity to use qualities estimates instead of Unit Values. This is in line with Hallak and Schott (2011) and Khandelwal (2010). Now we focus on the "products results". In Figure 4 we plot histograms of the predict effective quality, potential quality and Cut Off Quality.

Figure 4 – Histograms of effective quality, potential quality and Cut Off Quality



Source: Authors' elaboration.

We first notice that the potential quality estimates are much more frequent than the effective ones. We also see that the values of the former are smaller than the latter ones at their mean values. The median of potential quality is -4.50 and the mean is -4.33. Both of them have a symmetric distribution. The Cut Off quality is concentrated more to the right than the other two and has positive asymmetry.

In Table 7, we pool the predict qualities of the period regressions 2003-2006, 2007-2010, 2011-2014 and, 2015-2018 and use the results to test the supply curve, equation (7), through the Probit Random Panel[10]. The dependent variables assumes the value 1 when exports are positive and zero otherwise. We control for product-time and countries effects.

We also notice that improvements in quality leads to better chances that an export happen.

Table 7 – Supply Curve estimated trough Random Probit Panel

	Supply Curve
Ln Quality	0.025 (0.000)***
Ln Cut Off Condition	-0.077 (0.001)***
Ln Distance	-0.288 (0.001)***
Conitguity	0.730 (0.003)***
Regional Trade Agreements	0.234 (0.001)***
Colonial Linkage	-0.177 (0.003)***
Common Official Language	0.258 (0.003)***
Intercept	0.627 (0.013)***
Effects term (Product-time and Country)	0.990 (0.002)***
Observations	14.225.600

Note[1]: '***'.'**' and '*' indicates significance levels of 1%. 5% and 10%, respectively.

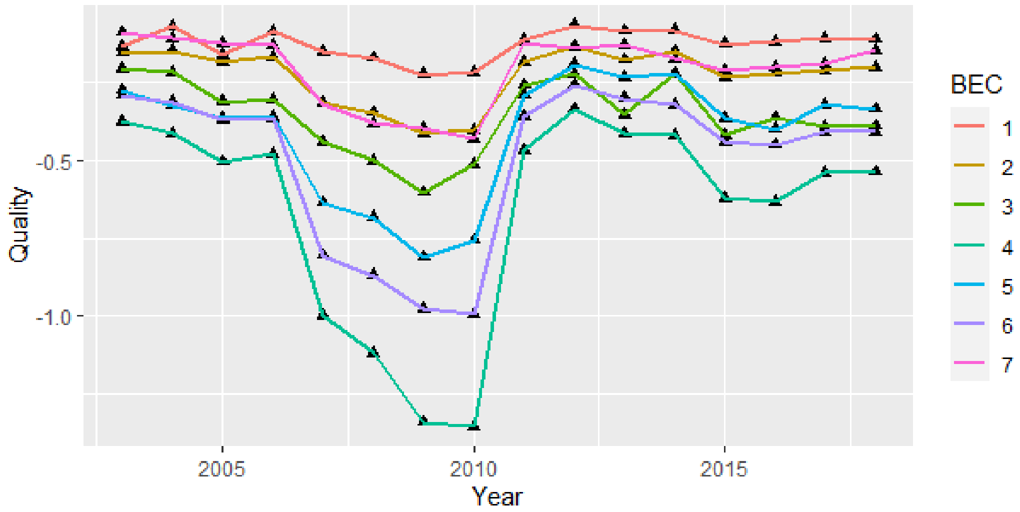
From the gravitational set, we notice that only distance and colonial linkage have a negative effect. We found a negative sign for the Cut Off Condition. This confirms that reductions at the marginal costs of commerce leads to more exports at the destination markets, since lower quality products can now supply more easily at those markets.

Having found the statistical significance of quality in the model, we plot in Figure 5 the time trajectory of the effective quality, in which we aggregate by the mean in terms of the Broad Economic Category (BEC) nomenclature. The number 1 stands for "Foods and Beverages"; 2 is "Industrial supplies not elsewhere specified"; 3 is "Fuel and lubricants"; 4 is "Capital goods (except transport equipment), and parts and accessories thereof"; 5 is "Transport equipment and parts and accessories thereof"; 6 is "Consumer goods not elsewhere specified": and 7 is "Goods not elsewhere specified".

By looking at Figure 5, we notice that a fall in quality levels between 2007 and 2010, indicating that the "subprime crisis" might have had an impact in the quality level of Brazilian exports. Since the crisis lowered income in the destination countries, consumers might have consumed lower quality products to save more money during these years. We also see that the category "Fuel and lubricants" have above mean quality; and that "Capital goods (except transport equipment), and parts and accessories thereof" have the lowest quality in the entire period.

[10] This is to avoid the "incidental parameter problem" found in the Fixed Effects Probit estimator.

Figure 5 – Time trajectory of effective quality in terms of the Broad Economic Category nomenclature



Source: Authors' elaboration.

Finally, we observe that "Foods and Beverages" are the products with better quality between Brazilian exports in all but two years. In those years, the categories "Goods not elsewhere specified"[11] presented better perceive quality. In Figure 6, we plot the time trajectory of the potential quality estimates.

Contrasting, we observe at Figure 6, that the categories 4 and 5, that is. "Capital goods (except transport equipment), and parts and accessories thereof", and "Transport equipment and parts and accessories thereof", respectively, are the ones with most potential for growth. We also notice that crises affect the potential for quality improvements, since there are two breaks in the series. The first one, between 2007 and 2010, is due to the "subprime crises". The second one, from 2015 onwards, is due to Brazilian political crisis.

Figure 6 – Time trajectory of potential quality in terms of the Broad Economic Category nomenclature

Source: Authors' elaboration.

In Figures 5 and 6 we notice that the categories "Capital goods (except transport equipment), and parts and accessories thereof", and "Transport equipment and parts and accessories thereof" are the ones with higher mean potential quality and, simultaneously, with lower mean effective quality. Our framework

[11] There are 17 HS6 goods in this category. For example, "880400 - Parachutes (including dirigible parachutes and paragliders) and rotochutes; parts thereof and accessories thereto", "880510 - Aircraft launching gear, deck-arrestor or similar gear and parts thereof" and, "930200 - Revolvers and pistols; other than those of heading no. 9303 or 9304".

implies two kinds of policies that can transform the potential exports into effective exports. First, an exporter can reach more markets if she produces higher quality goods. Second, since quality is perceive in a subject manner in each destination market, (which we represented by γ_i^k in the theoretical model) marketing focused on the international consumers can help exports to reach more people and make them feel more satisfied about Brazilian products. This will help exports to penetrate more consumer markets and have a better perceive quality. One can also disaggregate these indexes to see which of the potential qualities have higher values and, hence, have higher export probability.

7. CONCLUSIONS

We studied the relation between quality and exports. This study is the first one to estimate potential quality. We tested this index validity with a micro-based Probit Panel that measures the probability that an export occurs. We found that quality improvements increased the probability of an export to be successful in the period, and that higher trade barriers, represented by fixed costs in the Cut Off condition, generated reductions in this chance. We postulated the existence of stochastic marginal costs, that quality can only improve trough higher costs, that exporter only know their quality levels when they enter the market, and that those out also have implicit marginal costs that they can transform into quality, with a fixed elasticity of transformation, as soon as they start export. With these assumptions, we estimated effective and potential quality indexes.

We also study the quality trajectory between the years. We divide our results by country mean and by product mean. In the former, we found that reductions in trade barriers facilitates exports. In the product mean analyses, we notice that the categories of goods "Capital goods (except transport equipment), and parts and accessories thereof", and "Transport equipment and parts and accessories thereof" are the ones with higher mean potential quality and, simultaneously, have lower mean effective quality. Our framework implies two kinds of policies that can transform the potential exports into effective ones. First, an exporter can reach more markets if she produces higher quality goods. Second, since quality is perceive in a subjective manner in each destination market publicity can help exports reach more people and make them feel more satisfied about Brazilian products. This can help exports to penetrate more markets and have a better perceive quality. As a suggestion for future research, one can disaggregate these indexes to see which of the varieties have higher potential qualities and, hence, have higher export probability.

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