THE DYNAMIC OF BRAZILIAN EXPORTS: NEW QUALITY INDEX AND PROBABILITY OF EXPORT

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ABSTRACT

This paper aims to study quality from the Brazilian exports perspective. We develop 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 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.

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

RESUMO

O presente artigo tem como objetivo estudar qualidade da perspectiva das exportações brasileiras. Foram desenvolvidas 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. 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.

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

JEL: F12; D20; D40.
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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. The level of aggregation in other estimates may also limit the scope of some studies and lead to aggregation biases. 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 after its entering at the World Trade Organization at December 2001. Other reason for this is that, as state Costa and Pessoa (2020), the increased income in China contributed mostly to trigger a commodity boom in Brazil, while China's tastes over products contributed moderately. 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 found that Unit-Values are a poor *proxy* for quality, which is in line with other works in the literature. We also found that there´s a positive correlation of quality with contiguity and Regional Trade Agreements, but that these variables are not good at predicting quality levels and destinations, which we conclude by a small R-square. However, there is significance between quality and income, which is a restatement of Linder's hypothesis that states that higher income countries demand higher quality goods.

We postulate the existence of stochastic marginal costs and that quality can 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. This 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 barrier, represented by fixed costs in the Cutoff condition, generated reductions in this chance. In short, we are contributing to the literature by estimating quality in a new manner and studying its implications.

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 relating quality and export probability, 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). After modeling how economic agents behave, there are econometrics methods that can remove those shocks effects, but since there are many ways to model supply and demand, many articles estimate quality in different theoretical and practical contexts.

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.

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. In other words, the Potential Quality answers the question: "If a product that was not exported by the country in a given year had been exported, what quality it would have?" and is a natural extension of Melitz (2003), where firms draw their initial productivity parameter (and hence quality) from a common distribution[3]. Considering U as the total utility of the importing country k for products of l, we can define the vector:

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

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 Cutoff 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 Cutoff 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 AND EXPORT PROBABILITY

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[3] "Higher productivity may also be thought of as producing a higher quality variety at equal cost." (Melitz, 2003, p. 1699)

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

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

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[4]. 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.

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

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

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

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:

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

$FE_l = \varphi_{li}$ 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.

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 $\widehat{\ln p_{kit-1}}$ as an instrument for $\widehat{\ln p_{kit}}$.

[4] 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).

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 Cutoff 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

$$P\left(exp_i^k \middle| b_{kt}, f_{it}, \tau_{kit}, \ln q_{it}^{CO^{\sigma_{it}^{*CO}\gamma_{it}^{lCO}}}, \ln q_{kit}^{\sigma_{it}^{*}\gamma_{it}^{k}}\right) = \Phi\left(\lambda_0 + \mathbf{\Lambda I}_l^k + \lambda_1 \ln DIST_{kl} + \lambda_2\sigma_{it}^{*CO}\gamma_{it}^{lCO}\ln q_{it}^{CO} + \lambda_3\sigma_{it}^{*}\gamma_{it}^{k}\ln q_{kit} + \eta_{it}^k\right). \tag{15}$$

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 Cutoff quality, we consider the minimum quality for variety *i* at time *t* as the Cutoff 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. When we consider this estimator, we suppose that the unobserved heterogeneity, that is, the individual effects are not correlate with the independent variables. This is the orthogonality assumption.

The "incidental parameter problem" states that, in the context of the limited qualitative dependent variable model, the fixed effects estimator has a statistical problem. As Baltagi (2013) argues, the model cannot be estimate consistently. In our context, this happens because even if the numbers of products exported, or years in the sample, grows indefinitely, the fixed effects probit cannot converge in practice because the number of countries is fixed. This is not a problem in the linear regression with fixed effect because, as Baltagi (2013) exposes, we can get rid of the countries fixed effect with a within transformation, which gives results equivalently to the Least Square Dummy Variables estimator. This is different to the case for the limited qualitative dependent variable model, which follows a predetermined statistical distribution and is thus not linear. For example, the probit estimator supposes that the functional form of the regression follows a normal distribution, while the logit model supposes a logistic distribution. One way to control for fixed effects in this kind of regressions is to condition the estimates on the minimum sufficient statistic, which is not available for the normal distribution and, consequently, for the probit model.

5. DATA AND DESCRIPTIVE STATISTIC

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*[5] (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.

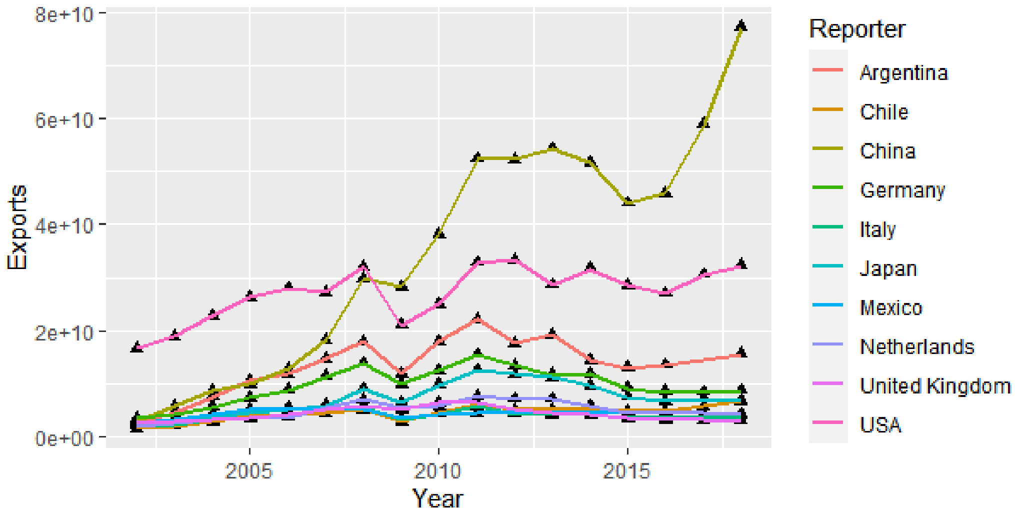
As regards the period sample, we consider the existence of one outlier, as can be seen in Figure 1, which was construct by summing the total exports between products and considering the ten biggest by the mean value of the period. There, we highlight that China was the smallest CIF value destination 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.[6] The distance variable is from Mayer and Zignago (2011)[7].

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

[5] "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).

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

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



Source: Authors' elaboration based 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 FOR QUALITY AND EXPORT PROBABILITY

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. Hereafter, 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)[8], as described in section 5. 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 distribution. The method also admits that some observations follow another distribution not identifiable, as is implicit in the Quasi-Maximum Likelihood methodology. The results are in Table 3.

Table 3 – First-step regressions: the "countries results" and the "products results". Dependent variable: logarithm of exports

	Least Square Dummy Variables	**Poisson Pseudo-Maximum Likelihood**	**2003 - 2006**	**2007 - 2010**	**2011 - 2014**	**2015 - 2018**
Unit-Values	1.06	0.73	1.55	1.31	1.34	1.27
	(0.07)***	(0.05)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
PIB*pc*	0.20	1.19	0.38	0.88	0.06	-0.01
	(0.06)***	(0.10)***	(0.03)***	(0.03)***	(0.03)**	(0.03)
Distance	-1.67	-7.42	-2.34	-5.46	-0.97	-0.77
	(0.81)***	(1.94)***	(0.19)***	(0.21)***	(0.19)***	(0.22)***
Regional Trade Agreements	0.29	0.45	-0.02	0.78	0.23	0.21
	(0.15)***	(0.36)	(0.02)	(0.02)***	(0.02)***	(0.02)***
Colonial Linkage	1.56	4.28	2.35	2.73	1.25	1.42
	(0.34)***	(0.76)***	(0.09)***	(0.10)***	(0.09)***	(0.10)***
Common Official Language	-2.39	-7.24	-3.40	-4.92	-1.83	-1.98
	(0.78)***	(1.88)***	(0.18)***	(0.19)***	(0.17)***	(0.19)***
Conitguity	-1.68	-6.23	-1.17	-6.25	-1.10	-0.86
	(0.73)***	(1.72)***	(0.18)***	(0.20)***	(0.18)***	(0.20)***
Intercept	15.47	68.74	-	-	-	-
	(7.34)***	(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.

[8] We also test it with Breusch-Pagan (1980), Honda (1985), and King and Wu (1997). They confirm the presence of unobserved heterogeneity.

Note[2]: '***','**' and '*' indicates significance levels of 1%, 5% and 10%, respectively.

In Table 3 all the results, but the Regional Trade Agreements in PPML and the period 2003-2006, were significant. The closest works to estimate this functional form 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

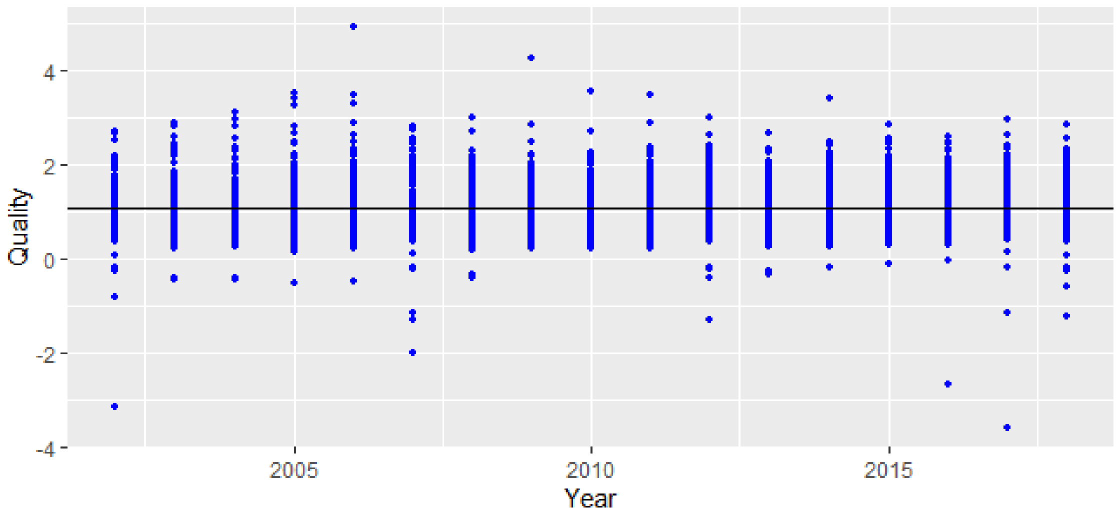
Note[1]: Heteroskedastic robust Standard deviations in parenthesis.
Note[2]: '***','**' and '*' indicates significance levels of 1%, 5% and 10%, respectively.

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[9]. The black line is the Mean Quality and the blue dots are the quality of each country destination.

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

[9] We kept quality in the logarithm scale.



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)

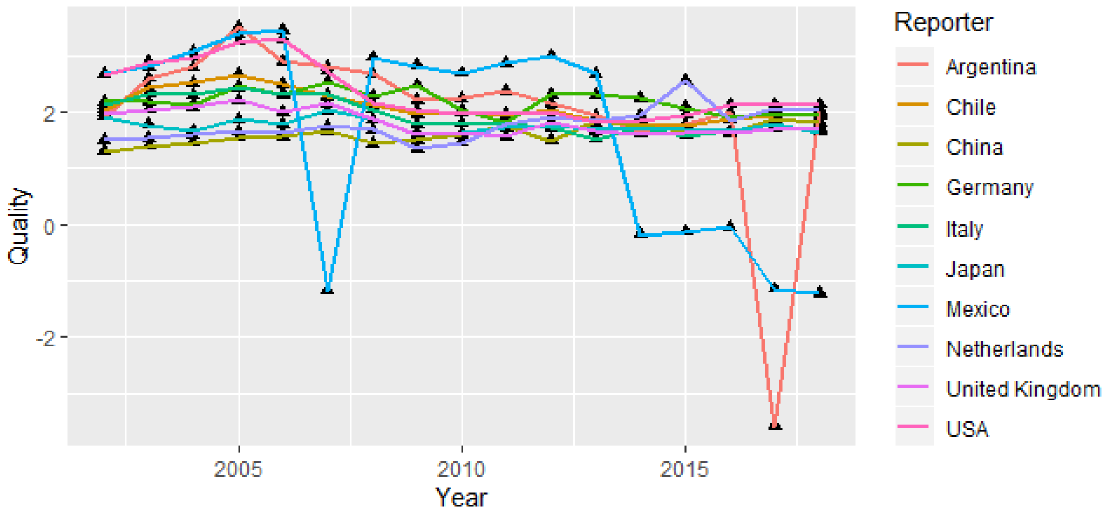
Country	Mean	2002	2018	Country	Mean	2002	2018
Albania	0.88	0.89	0.9	**Latvia**	1.07	1.14	1.15
Algeria	1.11	0.87	0.52	**Liberia**	0.35	0.44	0.43
Angola	1.09	-0.28	2.31	**Libya**	1.01	1.1	1.09
Antígua and Barbuda	0.94	1.02	1.01	**Lithuania**	1.14	1.34	1.26
Azerbaijan	0.97	0.95	1.25	**Luxembourg**	1.42	1.36	1.67
Argentina	2	1.92	1.99	**China, Macao SAR**	1.4	1.52	1.42
Australia	1.69	1.67	1.44	**Madagascar**	0.6	0.56	0.68
Austria	1.68	1.62	1.74	**Malawi**	0.42	0.45	0.44
Bahamas	1.06	1.09	1.08	**Malaysia**	1.3	1.43	1.55
Bahrain	1.3	1.29	1.65	**Maldives**	0.95	1.01	1.05
Bangladesh	0.7	0.78	0.62	**Mali**	0.47	0.52	0.51
Armenia	0.87	0.81	1.05	**Malta**	1.14	1.31	1.17
Barbados	0.91	0.9	0.89	**Mauritania**	0.59	0.67	0.66
Belgium	1.65	1.29	1.79	**Mauritius**	1.11	1.06	1.28
Bhutan	0.83	0.92	0.91	**Mexico**	1.68	2.68	-1.22
Bolivia (Plurinational State of)	1.52	1.63	2.07	**Mongolia**	0.91	0.93	1.16
Bosnia Herzegovina	1	0.74	1.15	**Rep. of Moldova**	0.79	0.76	0.75
Botswana	0.91	0.98	0.97	**Mozambique**	0.45	0.59	1.06
Belize	0.8	0.77	1.08	**Oman**	1.25	1.36	1.35
Solomon Isds	0.6	0.68	0.67	**Namibia**	0.87	0.74	0.95
Brunei Darussalam	1.39	1.41	1.52	**Nepal**	0.61	0.67	0.66
Bulgaria	1.11	1.19	1.02	**Netherlands**	1.77	1.49	2.03

Myanmar	0.72	0.76	0.95	**Vanuatu**	0.67	0.75	0.74
Burundi	0.33	0.41	0.4	**New Zealand**	1.48	1.41	1.54
Belarus	1.12	1.02	1.32	**Nicaragua**	1.1	0.75	1.21
Cambodia	0.67	0.71	0.88	**Niger**	0.34	0.45	0.38
Cameroon	0.64	0.6	0.59	**Nigeria**	0.72	0.53	0.52
Canada	1.9	2.49	0.54	**Norway**	1.65	1.59	1.81
Cabo Verde	0.77	0.54	0.53	**FS Micronesia**	0.72	0.8	0.79
Central African Rep.	0.35	0.43	0.42	**Marshall Islands**	0.71	0.8	0.79
Sri Lanka	0.96	1.03	0.83	**Palau**	1.03	1.11	1.11
Chad	0.49	0.58	0.57	**Pakistan**	0.84	0.47	1.02
Chile	2.09	2.04	1.96	**Panama**	1.22	0.07	0.06
China	1.6	1.3	1.82	**Papua New Guinea**	0.71	0.85	0.76
Colombia	1.86	1.32	1.97	**Paraguay**	1.69	-3.15	2.55
Comoros	0.59	0.68	0.67	**Peru**	1.74	1.68	1.99
Congo	0.71	0.74	0.73	**Philippines**	0.84	0.93	0.92
Costa Rica	1.56	-0.84	1.7	**Poland**	1.49	0.64	1.81
Croatia	1.24	1.35	1.07	**Portugal**	1.88	2.04	1.88
Czechia	1.55	1.48	1.67	**Guinea-Bissau**	0.4	0.49	0.48
Benin	0.48	0.56	0.55	**Puerto Rico**	1.04	1.13	1.12
Denmark	1.44	1.48	1.36	**Qatar**	1.47	1.28	1.28
Dominica	0.77	0.84	0.84	**Romania**	1.23	1.16	1.24
Dominican Rep.	1.25	-0.26	-0.27	**Rwanda**	0.47	0.53	0.52
Ecuador	1.49	1.58	2.01	**Saint Kitts and Nevis**	0.98	1.05	1.04
El Salvador	1.25	1.09	1.46	**Saint Lucia**	0.81	0.88	0.87
Equatorial Guinea	1.04	1.13	1.12	**Saint Vincent and the Grenadines**	0.78	0.83	0.83
Ethiopia	0.5	0.37	0.36	**Saudi Arabia**	1.32	1.26	0.71
Estonia	1.26	1.28	1.37	**Senegal**	0.59	0.46	0.45
Fiji	0.89	0.91	0.96	**Seychelles**	1.04	1.14	1.27
Finland	1.51	1.5	1.64	**Sierra Leone**	0.37	0.46	0.45
France	2.02	1.89	1.63	**India**	1.12	-0.25	1.77
Gabon	0.93	0.99	0.98	**Singapore**	1.7	1.75	2.2
Georgia	0.85	0.87	0.86	**Slovakia**	1.33	1.4	1.43
Gambia	0.5	0.58	0.57	**Viet Nam**	0.86	0.55	1.3
Germany	2.19	2.18	1.94	**Slovenia**	1.34	1.36	1.47
Ghana	0.64	0.44	1.21	**South Africa**	1.54	1.32	0.86
Kiribati	0.6	0.68	0.67	**Zimbabwe**	0.58	0.56	0.79
Greece	1.25	1.32	1.23	**Spain**	2	2.08	1.77
Grenada	0.8	0.88	0.87	**Suriname**	0.82	0.79	0.78
Guatemala	1.43	1.22	-0.62	**Eswatini**	0.81	0.87	0.95
Guinea	0.44	0.51	0.5	**Sweden**	1.54	1.58	1.63
Guyana	0.71	0.55	0.54	**Switzerland**	1.93	1.73	2.28
Haiti	0.43	0.52	0.51	**Tajikistan**	0.6	0.69	0.68
Honduras	1.04	-0.19	-0.2	**Thailand**	1.43	1.04	1.77
China, Hong Kong SAR	1.45	1.68	1.29	**Togo**	0.41	0.46	0.45
Hungary	1.24	1.63	1.32	**Tonga**	0.78	0.86	0.85
Iceland	1.32	1.36	1.38	**Trinidad and Tobago**	1.13	0.67	0.66
Indonesia	1.09	0.51	1.98	**United Arab Emirates**	1.57	0.66	2.85
Iraq	0.94	1.03	1.02	**Tunisia**	1.06	1.02	0.59

Ireland	1.42	1.47	1.49	**Turkey**	1.48	1.02	1.55
Israel	1.31	1.35	1.44	**Turkmenistan**	0.9	0.99	0.98
Italy	1.93	2.12	1.68	**Tuvalu**	0.69	0.78	0.77
Côte d'Ivoire	0.65	0.44	0.99	**Uganda**	0.53	0.5	0.72
Jamaica	0.9	0.56	0.55	**North Macedonia**	1.02	0.97	1.1
Japan	1.75	1.92	1.63	**Egypt**	0.96	0.67	0.66
Kazakhstan	1.19	0.93	1.41	**United Kingdom**	1.81	1.98	1.72
Jordan	0.98	0.86	0.97	**USA**	2.35	2.66	2.13
Kenya	0.65	0.79	0.53	**Burkina Faso**	0.44	0.47	0.46
Rep. of Korea	1.63	1.31	1.97	**Uruguay**	1.89	1.71	1.79
Kuwait	1.51	1.02	1.94	**Uzbekistan**	0.78	0.86	0.98
Kyrgyzstan	0.67	0.72	0.78	**Venezuela**	0.97	0.8	0.79
Lao People's Dem. Rep.	0.77	0.85	0.85	**Samoa**	0.79	0.87	0.86
Lebanon	1.24	1.29	1.14	**Yemen**	0.7	0.72	0.71
Lesotho	0.55	0.64	0.63	**Zambia**	0.68	0.65	0.85

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. We highlight that 55.29% of the countries demand quality above the mean, which shows a small tendency for higher quality products. 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.

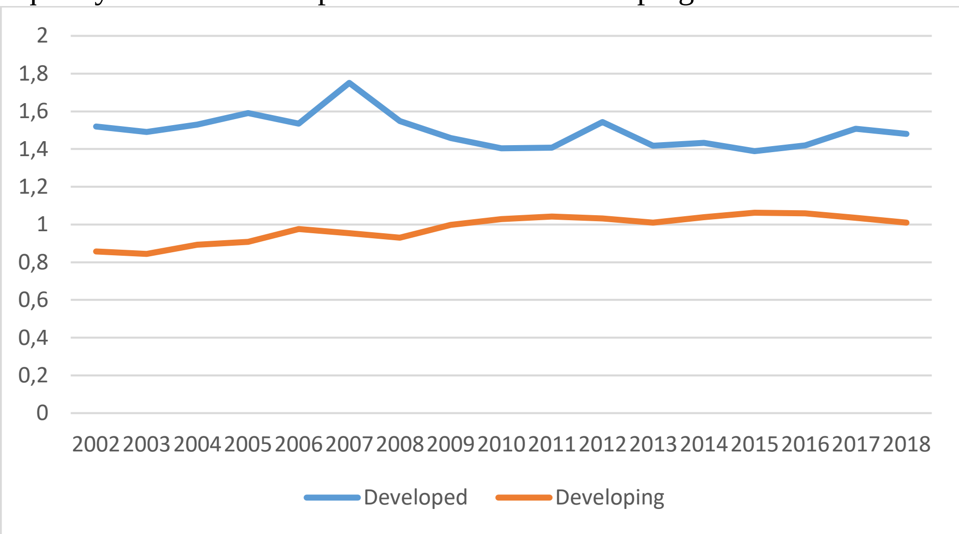
We see that Argentina and USA had the higher quality goods at the beginning of the period, together with Mexico. We see an above average demand for quality in the latter country at the beginning of the period (it was the higher in the ten biggest at 2006), with a fall at 2007. This is due to the "*Tortilla*'s crisis". According to Thomaz and Carvalho (2011). This nation 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[10]. 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 Cutoff condition for entering the market in the Melitz's model will be lower and. Consequently, lower quality Brazilian products enter new markets.

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 a new 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 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 regard 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. In Figure 4, we plot de mean quality between the countries grouped by Developed and Developing.

Figure 4 – Mean quality between developed countries and developing countries from Countries Results



Source: Authors' elaboration.

We notice by the figure that Brazilian exports were always better to developed countries, but that the quality to the developing ones increased systematically. If this pattern is maintain, then the "countries quality" estimates will be bigger in mean values to the latter in the years to come. 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 (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)***

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

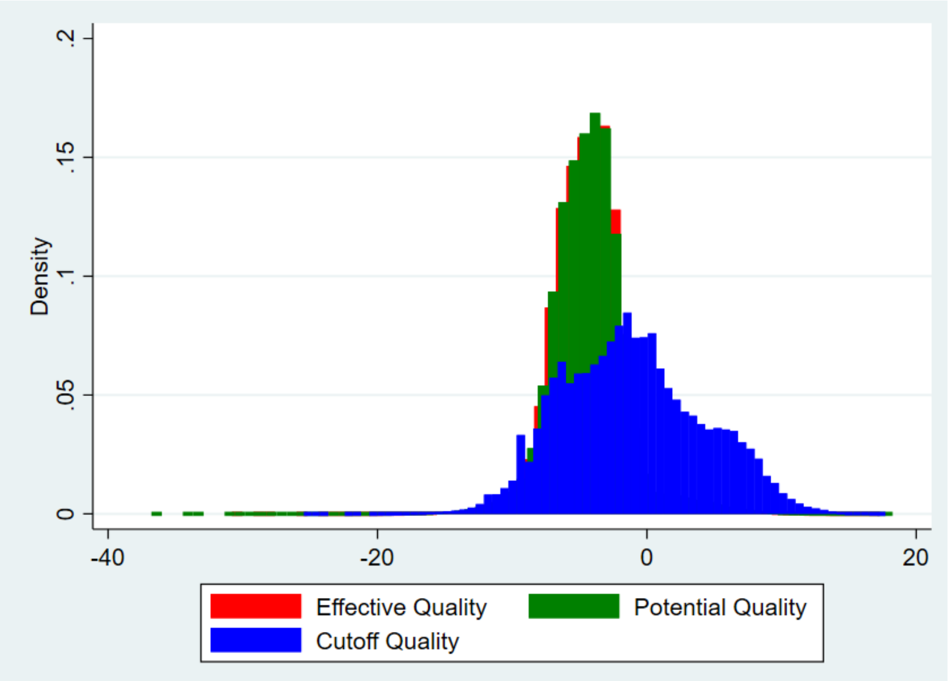
Estimates	0.31 (0.01)***	0.42 (0.08)***	0.06 (0.03)**	1.32 (0.05)***
R^2	0.39	0.02	0.00	0.45

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 the South American Countries. Since the R-square of the regression is of 0.02, we notice that this variable is not a good predictor to quality. 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). We also see that there is positive correlation with Regional Trade Agreements, implying that higher quality goods are sent to partner countries, but with an R-square close to 0.00, we don't expect these agreements to be good at explaining quality destination.

Now we focus on the "products results". In Figure 5, we plot histograms of the predicted "effective quality", "potential quality" and "Cutoff Quality". We call "effective quality" the quality of the exports that have a value bigger than "zero" in the panel data. "Potential quality" is the quality whose export values are "zero" in the same set. Since the Cutoff quality is the minimum quality that is necessary for an exporter to sell in one specific market, we consider as a *proxy* the bounds of the sets of "effective quality" and "potential quality".

Figure 5 – Histograms of effective quality, potential quality and Cutoff Quality



Source: Authors' elaboration.

For example, consider 1 product and the 180 countries. If, in 2003, this product was export to 25 countries, then we notice that the "effective quality" in these is above the Cutoff quality. Otherwise, they would have not sell the product. With this in mind, we attribute, to these 25 countries, the minimum quality in this set as the "Cutoff quality". Regarding the others 155, we attribute to them the maximum "Potential quality" in the group. By definition, if their product quality were above the Cutoff one, they would have sold it. In practice, we created a *proxy* to the Cutoff quality, which is not observable, with its upper- and lower- bounds, which were estimate. In the next year, 2004, we repeat the same procedure.

We first notice that the Potential Quality and the Effective Quality estimates have a similar frequency distribution, but that the Cutoff Quality has more dispersion. Looking at Figure 5, we notice that the Cutoff Quality is concentrated more to the right than the other two. Do and Levchenko (2009) models the Cutoff condition as endogenously determined by institutional quality and found that, when a country is small relative to the rest of the world and captures a large share of the world trade in an industry that is subject to rent-seeking activities, than the Cutoff conditions will be higher in that country. The channel is through an increase in fixed costs due deteriorations in institutions quality. This result implies that one possible way to transform Potential Exports into Effective is by improvements on the country's institutions, which will reduce the Cutoff conditions, as in Do and Levchenko (2009).

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

Table 7 – Supply Curve estimated trough Random Probit Panel

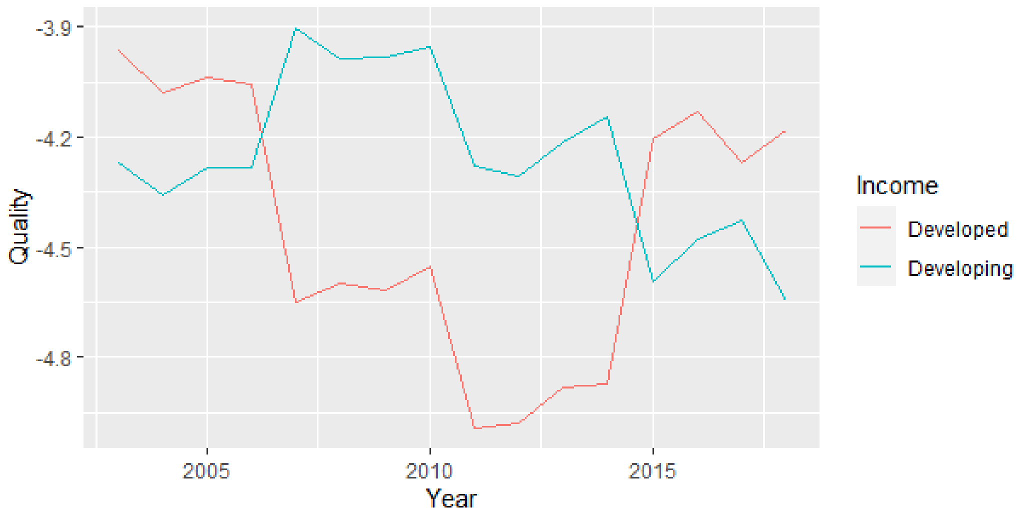
Variable	**(1)**
Ln Quality	0.025 (0.000)***
Ln Cutoff Condition	-0.077 (0.001)***
Ln Distance	-0.288 (0.001)***
Conitguity	0.730 (0.003)***
Regional Trade Agreements	0.234 (0.001)***
Colonial Linkage	-0.177 (0.003)***
Common Official Language	0.258 (0.003)***
Intercept	0.627 (0.013)***
Effects term (Product-time and Country)	0.990 (0.002)***
Observations	14,225,600

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

We notice that improvements in quality leads to better chances that an export happen. From the gravitational set, we notice that only distance and colonial linkage have a negative effect. We found a negative sign for the Cutoff 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.

In Figure 6, we plot the mean quality between products divided in Developed and Developing countries. We note that, by 2007, the mean export quality to the Developing countries was bigger than that for the Developed ones. This pattern persisted until 2015, when it reversed. This contrast with the pattern in Figure 4, where the quality exported to Developed countries was always bigger. One possible explanation for this is shift may be changes in the consumption patterns between countries and years.

Figure 6 - Mean Quality between Developed and Developing countries from Product Results



Source: Authors' elaboration.

If the developing countries demand more intensively some specific product, or group of products, than the developed ones, and since when we consider the "products results" we highlight more products characteristic than in the "countries results", then we expect the level of mean quality between products to change due to some outliers. The same reasoning applies to the case where the developed countries have high aversion to some specific products.

7. CONCLUSIONS

In this study, we estimate a quality index to Brazilian exports and we analyze the relationship 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 found that Unit-Values are a poor *proxy* for quality, which is in line with other works in the literature. We also found that there´s a positive correlation of quality with contiguity and Regional Trade Agreements, but that these variables are not good at predicting quality levels and destinations, which we conclude by a small R-square. However, there is significance between quality and income, which is a restatement of Linder's hypothesis that states that higher income countries demand higher quality goods.

As regard the quality estimates, we found that, when we work with the mean of the products as in the "Countries Results", the quality estimated was always bigger to the developed countries. Contrasting, when we control for the products heterogeneity, as in the "Product Results", we found that in some years quality destined to the developing countries was bigger. This can happen because, in the latter case, we allow for the existence of *outliers* between the products.

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