# THE QUALITY OF BRAZILIAN EXPORTS: A CROSS STATE, SECTORAL AND TECHNOLOGICAL CONTENT ANALYSIS

Helio de Sousa Ramos Filho [*]
Rennan Kertlly de Medeiros [†]
Vinícius Phillipe de Albuquerquemello [‡]

## Abstract

This paper aimed to analyze the evolution of Brazilian exports' quality in an interestate (regional), sectoral and by degree of technological content. The data used correspond to the products exported by Brazilian manufacture industry to 193 countries, between 1997 and 2014. The results showed an increase in the exports' quality of South and Southeast regions of Brazil; in sectors of high and medium technological intensity; in 17 industrial sectors. Although the augment in the quality of these segments, aggregated analysis pointed out no improvement in general exports' quality during the period of study.

**Keywords**: Brazilian exports. Product quality. Manufacture industry.
**JEL Classification:** C25, F14, L15.

## Resumo

Este artigo objetiva analisar a evolução da qualidade das exportações brasileiras em nível inter-estadual (e regional), setorial e por grau de conteúdo tecnológico. Os dados utilizados correspondem aos produtos exportados pela indústria de transformação brasileira para 193 países, entre 1997 e 2014. Os resultados mostram que houve aumento na qualidade dos produtos exportados pelas regiões Sul e Sudeste do Brasil; nos setores de alto e médio conteúdo tecnológico; e, em 17 setores industriais. Apesar do crescimento da qualidade nesses segmentos, a análise agregada aponta que não houve melhorias na qualidade geral das exportações durante os 17 anos investigados.

**Palavras-chave**: Exportações brasileiras. Qualidade do produto. Indústria de transformação.

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[*]Professor of the Department of Economics, UFPB, Brazil. E-mail:helioramos@hotmail.com.
[†]Graduate Program in Applied Economics,UFPB, Brazil. E-mail:rennanmedeiros22@hotmail.com.
[‡]Graduate Program in Applied Economics, UFPB, Brazil. E-mail:vinicius.phillipe@hotmail.com.

# 1  Introduction

Recent studies investigate the importance of product quality in creating comparative advantages and in the direction of trade (HALLAK; SCHOTT, 2011; KHANDELWAL; SCHOTT; WEI, 2013). As a result, rich countries tend to import relatively more from countries that produce high quality goods (SCHOTT, 2004; HALLAK, 2006). Therefore, it is a precondition for the success of exports and economic growth.

However, only a few countries are capable of producing and exporting high quality goods. since its production requires the use of quality inputs (MANOVA; ZHANG, 2012; KUGLER; VERHOOGEN, 2012), good institutional background (LEVCHENKO, 2007; FALKOWSKI; CURZI; OLPER, 2015) and a favorable credit market (FAN; LAI; LI, 2015; CIANI; BARTOLI et al., 2015).

In Brazil, empirical evidence regarding the quality of exported products and their conditioners remains scarce. This problem becomes even more relevant due to Brazil's remarkable position among the 25 largest exporters and importers in the world (IMF, 2012). In this sense, it is important to assess the quality of Brazilian exports, contributing to foreign importers evaluation of Brazil. Furthermore, aiding the formation of lasting relationships of commerce and formulation of proper sectoral policies.

In this sense, this paper analyzes the evolution of the quality of products exported by the Brazilian processing industry in the period between 1997 and 2014. The main objectives are: i) Investigate if the products' quality has changed; ii) Study the exports' quality standard by degree of technological content and sector; iii) analyze the evolution of exports' quality in each Brazilian state and region.

The approach we used in this study assumes that the quality of exported products is attributed by the foreign consumer, hence, it will seek to measure Brazilian products quality from the importer perception. This technique was developed by (BERRY, 1994) and first applied to foreign trade data by (KHANDELWAL, 2010). The choice of this procedure fitted better for Brazil than the unit prices analysis used by (HALLAK, 2006) and (HALLAK; SCHOTT, 2011) or the ISO certifications utilized by (PINHEIRO; MARKWALD; PEREIRA, 2002), as we could consider sectoral aspects and technological levels through the use of a Nested Logit Demand System. The study period chosen (1997:2014) is based on the longitudinal database available on the OECD website.

Besides this introduction, the present study is structured in five sections. The second section is reserved for a review of empirical literature, and has the purpose of introducing some evidences about the commercialized products quality. The third section shows off the main methodological tools used to analyze Brazilian products quality. The fourth section is dedicated to the presentation of research results and discussions. Finally, a fifth section is devoted to the conclusions.

# 2  The quality of exports: a brief review

Economists have long been trying to understand what are the cross-country transactions determinants. From the existing literature, it is predominantly cited the existence of comparative advantages, production scales, technology, among others. (HELPMAN, 2011). Recently, a new factor has been focused: the quality of exported

goods and services. But what is a quality? How to estimate it? What is its role in determining the volume of goods and services commercialized?

According to Pinheiro, Markwald and Pereira (2002), quality is a multidimensional concept, determined by measurable and immeasurable characteristics. In the first group, the authors mention: performance, conformity, durability and appearance. In the second, tradition, reputation and cultural factors was given as examples. These aspects are taken into account by economic agents when buying a commodity, thus people around the world are trying to define international acceptance standards for consumer markets, for example through the implementation of ISO certifications.

Data on the quality of internationally traded goods and services are not readily available, this fact is in part due to the subjective nature of quality, making it difficult to measure. In addition, this information involves different countries, each with its specifics, making this determination even harder. Thus, economists have tried to infer the quality of exports and imports indirectly, by observing other economic variables such as unit prices (HALLAK, 2006; HALLAK; SCHOTT, 2011), market share (KHANDELWAL, 2010) and ISO certification (VERHOOGEN, 2008).

As aforementioned, a commonly used way to measure exports quality is to use unit prices as proxy variables for quality. These unit prices are calculated by dividing the value of exports by the measured quantity. So, the higher the unit prices, the higher is the product quality. According to Helpman (2011), if we also take into account the fact that exports with higher unit prices are generally sold by developed countries, we will found that nations' level of income per capita is positively correlated with exports quality.

The use of unit price analysis was contested by several authors, among them, Hallak (2006), who stated that unit prices are very imprecise measures of exports quality, since they may reflect: fluctuations in the costs of production factors, tariffs and taxes; variations in the horizontal products differentiation [1]; currency fluctuations.

Given this fact, Hallak and Schott (2011) have developed a methodology that can purge the effects of product diversification from quality measures by conducting a study on exports quality from 43 countries to the United States between 1989 and 2003. However, this analysis is still subject to the other errors aforementioned.

Another way of analyzing the quality of exports has been done by Verhoogen (2008), who, instead of using unit prices, applied quality certifications as proxy variables, to investigate whether there has been an improvement in the quality of products and services exported by Mexico after a currency shock. However, this study has also received considerable criticism because of the assumptions about quality measures which were undertaken.

Last but not least, it is necessary to cite Khandelwal (2010), who applied the model developed by Berry (1994) on American foreign trade data. In his approach, the author was able to improve the estimation of exports quality, considering sectoral aspects and technological levels through the use of a Nested Logit Demand System. Thus, given the occurrence of increases in prices, for example, products that maintain the largest market shares are revealed as the ones with higher quality.

Certainly, this incessant search for a better understanding of products quality and their effects on foreign trade will allow the shaping of trade policies and sectoral

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[1] In this case, indicating brands diversity rather than variations in quality, in this sense, countries with more diversified exports would have exports with lower unit prices

incentives, hence, augmenting exports and aiding the economic development of the nation.

# 3 Methodological

As mentioned in the previous sections, this paper is concerned in inferring products quality from the demand pattern. In this sense, the empirical model was developed from the simple model proposed by Khandelwal, Schott and Wei (2013), which is capable of measuring quality as a demand shock. These disturbances include relevant features which are not observable to the product and/or the market. The model description is presented below.

## 3.1 Empirical model

Let Equation 1 be a CES utility function, which defines the consumer utility for variety h (product j for exporting country k):

$$U = \int_{g \in G} [\varphi(g)q(g)]^{\frac{\sigma-1}{\sigma}}. \tag{1}$$

where $\sigma(h)$ and $q(h)$ correspond to the quantity and quality level of the variety h sold to country k, while sigma represents the elasticity of substitution. The maximization of utility subject to the budget constraint results in Equation 2 and Equation 3 of demand:

$$U = (\varphi_{jik}^{\sigma-1})(p_{jk})^{\sigma} P_{jk}^{\sigma-1} Y_k. \tag{2}$$

where $p_{jik}$ is the price of the good j sold by state i to country k; $P_{jk}$ and $Y_{jk}$ represents the price index and income in sector g of country k, respectively. When Applying ln to Equation 2, we obtain Equation 3:

$$lnq_{jk} + \sigma * lnp_{jk} = \alpha_j + \alpha_k + e_{jk}. \tag{3}$$

where on the left side $\alpha_k$ and $\alpha_j$ refer to the fixed effects of the product and buyer country, respectively. In turn, the disturbance term is represented by $e_{jk}$. Thus, the quality of the exported product is inferred dividing the residuals of Equation 3 by product j elasticity of substitution in country k minus one, as presented in Equation 4:

$$quality = \hat{\sigma} \equiv \frac{\hat{e}_{jk}}{(\sigma - 1)}. \tag{4}$$

We estimate Equation 3 separately to each pair of countries (importer-industry) through Ordinary Least Squares (OLS).

Schott (2004), Hallak (2006) and Khandelwal (2010) highlight the quality of exports depend on the level of economic development of the exporter country. In this sense, we use the specification that relates quality and exporter's GDP per capita:

$$quality_{ht} = \alpha_{ht} + \beta * lnY_{it} + \nu_{ht}. \tag{5}$$

where $quality_{ht}$ is the estimated quality of state i's export in product j (variety h) at time t and $Y_{it}$ is state c's GDP per capita. The inclusion of a product-year dummy, $\alpha_{ht}$, indicates that the regression considers the cross-sectional relationship between quality and income within products. We run the regression for Equation 5 to prove that rich state, on average, export higher quality varieties within products.

## 3.2   Data

Data collected from the Foreign Trade Secretary (SECEX) of the Ministry of Industry, Commerce and Services (MDIC) correspond to the period from 1997 to 2014 and are disaggregated to 8 digits, according to the Mercosul Common Nomenclature (NCM). The database has more than 600,000 observations and contains information on 2,410 products exported by Brazil to 193 countries. The products under 8-digit NCM classification were mapped in 25 industries according to the International Standard Industrial Classification of All Economic Activities (ISIC), revision 4, through correspondence tables provided by the Brazilian Institute of Geography and Statistics (IBGE).

Then, we estimate Equation 3 using the elasticities of substitution provided by Broda, Greenfield and Weinstein (2006), available at three-digits under Harmonized System (HS). The correspondence between the elasticities and export databases was carried out using the three-digit classification, since the first six-digits of the NCM belong to the HS classification.

Finally, after inferred the levels of quality, it was undertook disagregated analyses by states and regions of Brazil, types of industry and technological intensity of the exported product. The inter-state and regional analysis is necessary, given the diversity of the Brazilian manufacturing industry and inequalities in income flows by locality.[2]

The analysis by types of industry and technological intensity is based on the Organization for Economic Cooperation and Development (OECD) rank for industrial sectors. According to their relative level of expenditure on research and technological development (R & D), OECD typifies products in four classes: high, medium-high, medium-low and low.

# 4   Results

This section is dedicated to presenting and discussing the quality of Brazilian exports from 1997 to 2014. In this sense, subsection 4.1 brings an analysis of the temporal behavior of Brazilian exports quality. In subsection 4.2 is carried out a discussion about the quality of Brazilian exports by technological intensity. subsection 4.3 presents the results for the products exported by each Brazilian state. Finally, subsection 4.4 deals with the stratification of the quality of Brazilian exports by industrial sector.

## 4.1   The quality of Brazilian exports (1997-2014)

Figure 1 presents a box plot which shows the distribution of the quality of Brazilian exports from 1997 to 2014. In this box plot, the square height express the quality differential between the exported products (Quality Ladder) – so that, a bigger box demonstrate that the exports quality varies a lot among themselves –, the line within each box represents the median of quality and the little diamonds express the quality average for every year of the study. The points above and below each box

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[2]   Brazil is subdivided into 5 regions, North, Northeast, Middle West, South and Southeast, each of them with its geographical specifics, such as climate, form of the land and demography. The richest regions are South and Southeast, which enjoy soil and climate more conducive to agriculture, as well as industrial pole, technological concentration and human capital originating from the colonial period.

denotes the outliers and inliers of the historical series, respectively. From the graphical analysis three phases can be identified: decline (1997-2003), recovery (2004-2008) and stabilization (2009-2014).

The first phase, 1997 to 2003, is marked by the reduction of the quality of products exported by Brazil. A number of factors may explain this phenomenon: adverse external conditions (Russian, Mexican and Argentine crises)[3]; decrease in indicators of human capital; lack of industrial and technological policies.
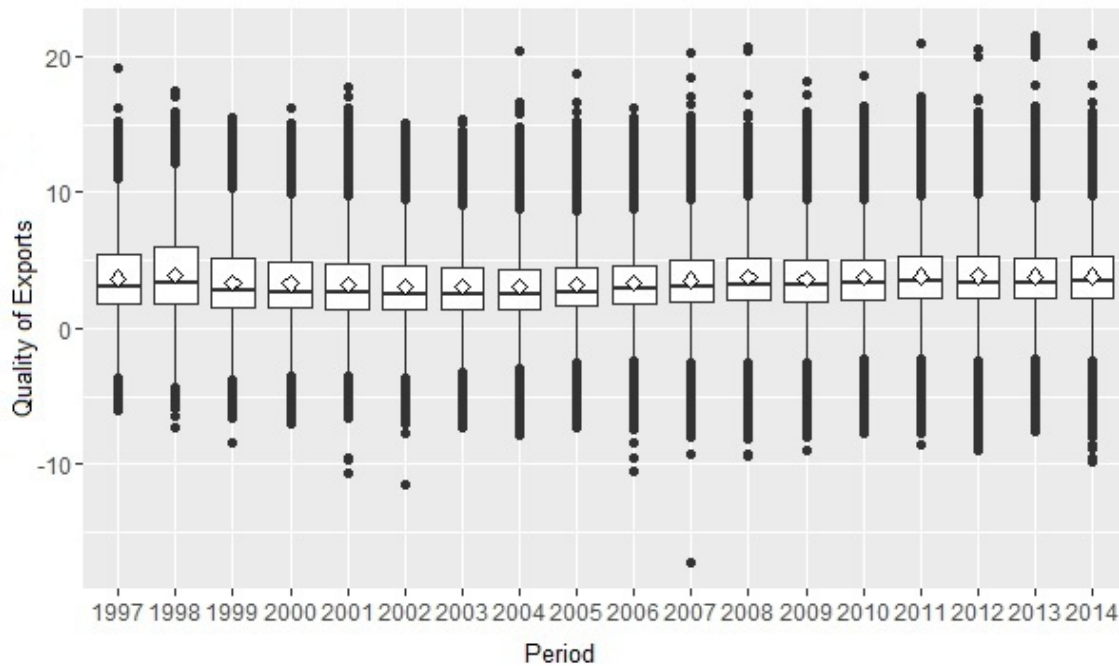


Figure 1: Brazilian manufacturing industry exports quality.

In the second phase, 2004 to 2008, the results suggest an augment in products quality. This fact may be related to the growth of productivity and human capital indicators, exchange rate appreciation (this fact reduces the cost for importing inputs) and the implementation of Industrial Policy and Foreign Trade (PITCE), in 2004, which aimed to strengthen and expand industrial base through innovation and value added to Brazilian processes, products and services. In addition, in this phase the taxation of product innovation grew in relation to the first phase (1997-2003), moving from 18.96% to 35.73%, on average (CAVALCANTE; NEGRI, 2011).

In the third and last phase, from 2009 to 2014, there is a stagnation of quality levels. This fact is perhaps due to: the US Financial Crisis in 2008 (which negatively affected some relevant factors to the growth of Brazilian products quality, such as the exchange rate); reduction in the rate of product innovation (36.5%) and decrease of productivity. The creation of the Productive Development Policy (PDP), launched in May 2008, and the Brazil Maior Plan, launched in August 2011, sought to combat the negative effects of the crisis by adopting measures of protectionism or sectoral incentive, as mentioned by Almeida (2011) and Morais (2008).

In general, as Figure 1 did not point out any big oscillation of median and average quality (represented by the horizontal lines and diamonds in the middle of

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[3] During external crises, dollar depreciates, hence increases the costs of acquiring inputs, stimulating its substitution for poor quality inputs, which are cheaper.

each box, respectively), Brazilian exports did not show any signs of quality upgrading during the period analyzed. This result highlights the need for new trade, industrial and technological policies. However, when it comes to quality ladders (the degree of quality differentiation among products), we have that after 1997 there was a reduction in the heterogeneity. This fact instigates an investigation of the quality behavior by technological content, helping to comprehend if that bigger homogeneity is devoted to production and exportation of a higher percentage of primary products or industrialized goods, which have technology added to its value.

## 4.2 Technological content and product quality

The analysis of the quality of Brazilian exports by technological content, is presented in Figure 2. As it can be seen, between 1998 and 2014, there was an increase in the exports quality of high and medium-high technology goods, only decreasing in 2002.
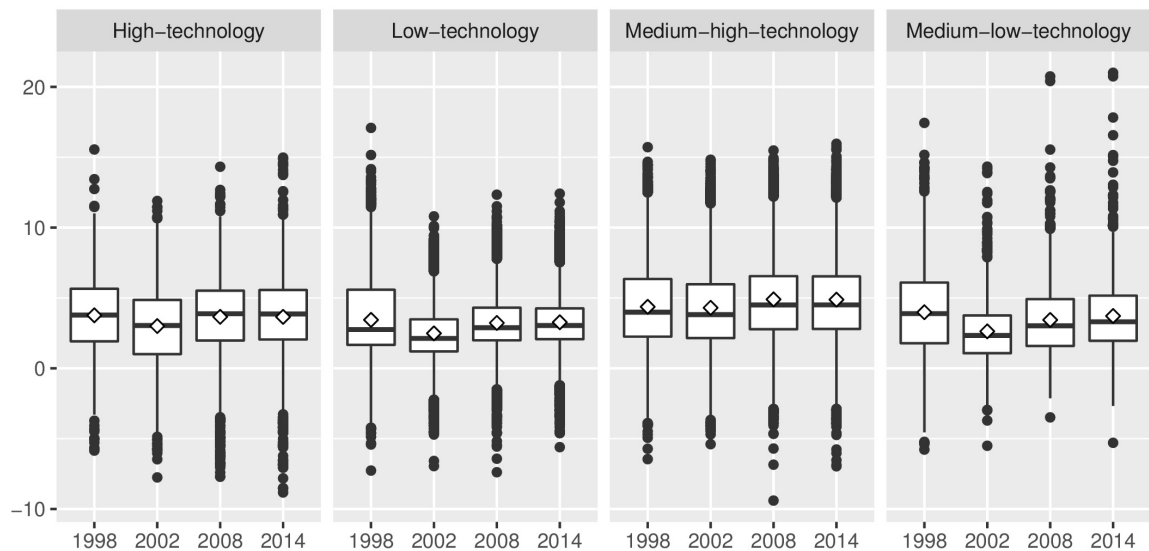


Figure 2: Brazilian exports quality by technological intensity.

According to Figure 2, the Brazilian industry with high technological content faced difficulties or lacked interest in improving products, that is, in performing quality upgrading. In turn, the industry with medium high technological intensity presented quality upgrading. This pattern of quality upgrading stems from the fact that in these industries there is a flow of knowledge whenever quality improvement occurs. Thus, development and improvement of techniques and inputs, for example, is rapidly disseminated among firms in the industry (HENN; PAPAGEORGIOU; SPATAFORA, 2013).

Meanwhile, low and medium-low-tech goods fell in quality in 2014 compared to 1998. This suggests that the advantages of product quality are derived from technological intensity (R&D intensity). Negri et al. (2005) highlights that between 2000 and 2003, Brazilian exports of high technology products seem not to be influenced by product innovations.The main consequence is that it inhibits the growth of the extensive margin (diversification) and expands the intensive margin (volume).

## 4.3 Cross-state differences

Table 1 shows the evolution of the quality of products exported by the five regions and 27 Brazilian states. At the regional level, product quality in South has been growing more slowly than in Southeast. While the North, Northeast and Middle-West showed a reduction in the quality of exported products. But there is considerable heterogeneity within regions. Among the 27 federated units of Brazil (including the Federal District, Brasília), it is observed that only twelve exhibit quality upgrading over the seventeen years of study (1998-2014), namely: Acre, Alagoas, Amapá, Ceará, Distrito Federal, Mato Grosso, Minas Gerais, Pará, Pernambuco, Rio de Janeiro, Rio Grande do Norte, Rio Grande do Sul, Rondônia, Roraima, Santa Catarina, São Paulo, Sergipe and Tocantins.

Table 1: Exports quality by Brazilian states.

| Region/State | 1998 | | | 2014 | | | Situation |
|---|---|---|---|---|---|---|---|
| | Average | Median | Ladder | Average | Median | Ladder | |
| *NORTH* | *5.14* | *5.91* | *2.68* | *3.78* | *3.94* | *5.72* | - |
| Acre | 5.26 | 6.15 | 2.27 | 5.77 | 6.58 | 2.78 | + |
| Amapá | 3.56 | 3.78 | 0.69 | 6.26 | 6.83 | 1.63 | + |
| Amazonas | 3.23 | 3.07 | 4.54 | 1.88 | 1.77 | 5.14 | - |
| Pará | 5.89 | 6.13 | 1.01 | 5.75 | 6.60 | 3.37 | + |
| Rondônia | 5.89 | 6.07 | 0.85 | 5.15 | 6.53 | 4.47 | + |
| Roraima | 5.64 | 5.57 | 0.66 | 5.05 | 6.86 | 4.10 | + |
| *NORTHEAST* | *3.89* | *2.81* | *4.79* | *2.77* | *2.45* | *1.68* | - |
| Alagoas | 5.47 | 5.28 | 0.62 | 5.23 | 6.15 | 0.20 | + |
| Bahia | 5.55 | 6.20 | 1.71 | 3.58 | 2.89 | 2.71 | - |
| Ceará | 2.89 | 2.06 | 1.68 | 2.29 | 2.22 | 1.35 | + |
| Maranhão | 5.62 | 5.08 | 2.85 | 4.60 | 2.92 | 5.06 | - |
| Paraíba | 2.69 | 2.16 | 1.70 | 2.01 | 1.73 | 1.44 | - |
| Pernambuco | 2.48 | 1.82 | 2.19 | 2.89 | 2.34 | 2.58 | + |
| Piauí | 5.03 | 4.14 | 5.54 | 3.97 | 3.29 | 2.53 | - |
| Rio Grande do Norte | 2.48 | 1.92 | 1.96 | 3.05 | 2.63 | 2.69 | + |
| Sergipe | 4.51 | 4.87 | 4.49 | 3.48 | 2.81 | 3.46 | - |
| Tocantins | 2.97 | 2.29 | 0.22 | 3.20 | 2.84 | 0.25 | + |
| *MIDDLE-WEST* | *4.89* | *5.41* | *4.22* | *4.10* | *3.40* | *3.74* | - |
| Distrito Federal | 3.70 | 2.83 | 2.35 | 3.34 | 3.13 | 2.14 | + |
| Goiás | 4.62 | 5.18 | 5.01 | 3.80 | 3.16 | 3.55 | - |
| Mato Grosso | 5.49 | 5.81 | 1.72 | 5.98 | 6.64 | 1.23 | + |
| Mato Grosso do Sul | 4.57 | 5.27 | 3.94 | 3.68 | 3.05 | 3.45 | - |
| *SOUTHEAST* | *3.87* | *3.32* | *4.14* | *3.95* | *3.63* | *2.95* | + |
| Espírito Santo | 4.38 | 4.65 | 4.25 | 4.05 | 3.80 | 2.01 | - |
| Minas Gerais | 3.96 | 3.62 | 3.64 | 3.93 | 3.78 | 2.62 | + |
| Rio de Janeiro | 3.51 | 2.70 | 4.35 | 3.92 | 3.78 | 2.13 | + |
| São Paulo | 3.90 | 3.36 | 4.18 | 3.96 | 3.54 | 3.30 | + |
| *SOUTH* | *3.74* | *3.28* | *3.77* | *3.80* | *3.39* | *2.76* | + |
| Paraná | 4.47 | 4.48 | 3.59 | 4.25 | 3.85 | 3.16 | - |
| Rio Grande do Sul | 3.56 | 3.11 | 3.19 | 3.78 | 3.53 | 2.41 | + |
| Santa Catarina | 3.41 | 2.63 | 4.02 | 3.52 | 2.95 | 2.66 | + |
| BRAZIL | 3.88 | 3.37 | 4.09 | 3.82 | 3.43 | 3.03 | + |

Note: Ladder means the quality variation in a given year. In this sense, it means the quality differentiation between the higher and the lower quality indicator. Situation indicates a variation of the median quality between the last and the first year of study. Positive value quality representation, the opposite holds true for negative value.

According to Table 1, in the North, the states of Acre, Amapá, Pará, Rondônia, Roraima and Tocantins presented an improvement in the quality of their exported products. When it comes to the Northeast region, four of the nine states showed quality upgrading, namely: Alagoas, Ceará, Pernambuco and Rio Grande do Norte. In the Middle-West, only Brasília and Mato Grosso demonstrated quality upgrading. In the

most developed regions of the country, South and Southeast, only Paraná and Espírito Santo did not present quality upgrading, in the last seventeen years.

With the results presented previously, it can be seen that the states with higher GDP (São Paulo, Rio de Janeiro and Minas Gerais, respectively) obtained a greater improvement in the quality of their exports. The Appendix C shows the Federated Units GDP per capita variation. To test this hypothesis we estimate Equation 4. Table 2 presents the results of this estimation. Appendix A presents a boxplot with the analysis of Brazilian exports quality by federated unit (similarly to subsection 4.1 and subsection 4.2).

Table 2: Export quality and GDP per capita: OLS estimates

| Variables | Coeficient | Std.Dev |
|---|---|---|
| Ln(GDP) | 0.2450*** | (0.0000) |
| Constant | 1.0966*** | (0.0000) |
| N | 424673 | |
| $R^2$ | 0.7075 | |
| Product-year FE | YES | |

*** indicates significance at 1% level or higher.

It shows that the coefficient on the exporting state's GDP per capita is positive and statistically significant (0.245 at 1% level of significance). Richer states, on an average, export higher quality varieties, within products. Thus, these results are consistent with the hypothesis that more advanced states (or countries) will manufacture higher quality products (SCHOTT, 2004; HALLAK, 2006; KHANDELWAL, 2010).

## 4.4 Sectoral differences

Table 3 shows the evolution of product quality by sectors of the Brazilian manufacturing industry. Among the twenty-three group of products exported by Brazilian industrial sector, seventeen showed quality upgrading namely: Aircraft, Beverages, Leather artifacts, Computer accessories, Timber, Equipment, Electrical machines, Metallurgy, Furniture, Other, Rubber products, Metal products, Tobacco products, Minerals, Automobiles, Railway vehicles and Clothing.

According to Table 3, in particular, we highlight Aircraft exports, once these not only presented quality upgrading, but it also had the highest average and median among all industrial products in 2014. In addition, this group of products is very representative on Brazilian exports agenda. On the other hand, Maritime Vessels showed a decrease in quality, once in 1998 it had a greater average and median than in 2014. Appendix B presents a boxplot with the analysis of Brazilian exports quality by industrial sectors.

Therefore, although Brazil is considered a developing country, having in its export agenda a great representation of primary products, we observe that its industrial sector has shown improvement. In this sense, as suggested by Khandelwal (2010), one of the ways to gain productivity on commerce and increase the export revenues, is the diversification of products. Still according to this author, the potential for quality upgrading tends to be higher in manufactured products when compared to primary products.

Table 3: Exports quality by industrial sector.

| Industry | 1998 | | | 2014 | | | Situation |
|---|---|---|---|---|---|---|---|
| | Average | Median | Ladder | Average | Median | Ladder | |
| Aircraft | 7,01 | 7,27 | 3,66 | 10,96 | 11,11 | 4,75 | + |
| Beverages | 0,85 | 0,33 | 1,28 | 0,96 | 0,82 | 1,24 | + |
| Cellulose, paper | 4,63 | 5,88 | 2,66 | 3,97 | 3,97 | 0,84 | - |
| Leather artifacts | 2,24 | 2,36 | 1,12 | 2,88 | 2,90 | 1,50 | + |
| Crude oil derivatives | 5,15 | 5,80 | 2,60 | 3,13 | 1,36 | 6,82 | - |
| Maritime Vessels | 10,05 | 8,52 | 7,50 | 9,19 | 8,51 | 4,34 | - |
| Computer accessories | 3,70 | 3,79 | 3,97 | 3,69 | 3,94 | 3,76 | + |
| Timber | 5,74 | 5,96 | 1,01 | 6,04 | 6,25 | 1,63 | + |
| Equipments | 5,13 | 4,77 | 4,68 | 5,82 | 5,49 | 4,31 | + |
| Electrical machines | 2,87 | 2,65 | 3,59 | 3,53 | 3,41 | 3,71 | + |
| Metallurgy | 5,75 | 6,17 | 1,35 | 9,37 | 10,14 | 0,09 | + |
| Furniture | 3,99 | 4,02 | 1,39 | 4,29 | 4,28 | 1,30 | + |
| Other | 2,28 | 1,89 | 4,15 | 2,42 | 2,19 | 2,86 | + |
| Foods | 6,44 | 6,89 | 2,43 | 6,87 | 6,37 | 1,16 | - |
| Rubber products | 3,22 | 3,05 | 3,19 | 3,91 | 4,14 | 1,91 | + |
| Metal products | 3,88 | 3,89 | 3,44 | 4,32 | 4,67 | 3,65 | + |
| Tobacco products | 3,04 | 2,50 | 0,50 | 2,79 | 3,20 | 1,51 | + |
| Minerals | 2,68 | 1,79 | 2,36 | 2,31 | 2,27 | 1,46 | + |
| Chemicals | 5,52 | 6,16 | 2,90 | 1,93 | 2,25 | 2,31 | - |
| Textile | 3,46 | 2,95 | 3,14 | 3,27 | 2,93 | 2,16 | - |
| Automobiles | 3,46 | 3,13 | 2,08 | 4,28 | 4,07 | 2,79 | + |
| Railway vehicles | 4,16 | 3,69 | 4,20 | 5,90 | 5,53 | 4,78 | + |
| Clothing | 1,95 | 1,96 | 1,30 | 2,95 | 2,86 | 1,56 | + |

Note: Ladder means the quality variation in a given year. In this sense, it means the quality differentiation between higher and lower quality indicator. Situation indicates a variation of the median quality between last and first year of study. The plus sign represents an increase in quality whilst minus sign means the opposite.

In the empirical literature, other studies give support to the idea of diversifying the export agenda. Baldwin and Robert-Nicoud (2014), for example, mention that once China is one of the top exporters in the segment of Electronics, one way to improve its exports quality with low cost is investing in other sectors.

## 5   Conclusions

This paper analyzed the quality of Brazilian exports from 1997 to 2014. In a more aggregated way, it can be concluded that the quality of goods exported by Brazil remained practically unchanged during the study period, with exceptions for the years 2002 and 2008, when a reduction in it was found. However, these declines should not be taken into account, since they are probably correlated with the international macroeconomic situation, for example, the Sub-prime crisis in 2008.

It is also important to point out that, although the general quality of exports remained at the same level, the amount exported in that period more than tripled. According to SECEX (2016), in 1997 Brazil exported approximately US$ 48,448 billion whilst in 2014 US$ 207,610 billion. This fact is very relevant as maintaining the level of quality while strongly intensifying foreign trade is often problematic.

When it came to the disaggregated analysis by degree of technological intensity employed in the production of the exports, we found out two situations. On one hand, sectors technology-intensive (High and Medium-High) showed quality upgrading between 1998 and 2014. On the other hand, sectors of Low technological content (Low and Medium-Low) presented a reduction in the quality of their products. These facts were expected, given the review of the empirical literature, but they need to be investigated more deeply, to discover its reasons. The quality ladder did not vary very much in

high-tech sectors, but it decreased in low-tech ones. This evidence is probably related to the death of commercial relations involving poor quality products, what results in a greater homogeneity in the exports quality of these sectors.

Regarding the quality of exports by Brazilian states and regions, the study pointed out that only seventeen of all the Brazilian federated units presented quality upgrading throughout the period 1998-2014. The states that presented improvements in quality are: Acre, Amapá, Pará, Rondônia, Roraima and Tocantins (North Region); Alagoas, Ceará, Pernambuco and Rio Grande do Norte (Northeast Region); Distrito Federal, Goiás and Mato Grosso (Middle-West Region); Minas Gerais, Rio de Janeiro and São Paulo (Southeast Region); Rio Grande do Sul and Santa Catarina (South Region).

This increase in quality is due to the fact that localities with high GDP per capita are more susceptible to improvements in the standard quality of their products, since they have high capital-labor, high innovation tax and high capital human level. This evidence is very important, once an increase in the product quality implies an increase the inter-regional inequalities. Thus, it is necessary directing resources and public policies in favor of advances in the quality of exports in less developed regions of the country have greater efficiency.

In relation to the quality of Brazilian exports by industrial sector, it is verified that seventeen of the 23 classes of products exported showed improvement in their quality. They were: Aircraft, Beverages, Leather artifacts, Computer accessories, Timber, Equipment, Electrical machines, Metallurgy, Furniture, Other, Rubber products, Metal products, Tobacco products, Minerals, Automobiles, Railway vehicles and Clothing. Aircraft was the class that presented the highest quality upgrading. It also had the highest average and median quality among all classes.

In summary, although the aggregate analysis did not detect high standards of quality upgrading in Brazilian exports, relative improvement was found in terms of technological content, regional and sectoral production. Thus, there is much heterogeneity in the pace of quality upgrading This fact corroborates the intensification of public policies, specially those which encourage the diversification of production or offer an incentive to less developed regions. Future research should focus on identifying more clearly the drivers of this heterogeneity.

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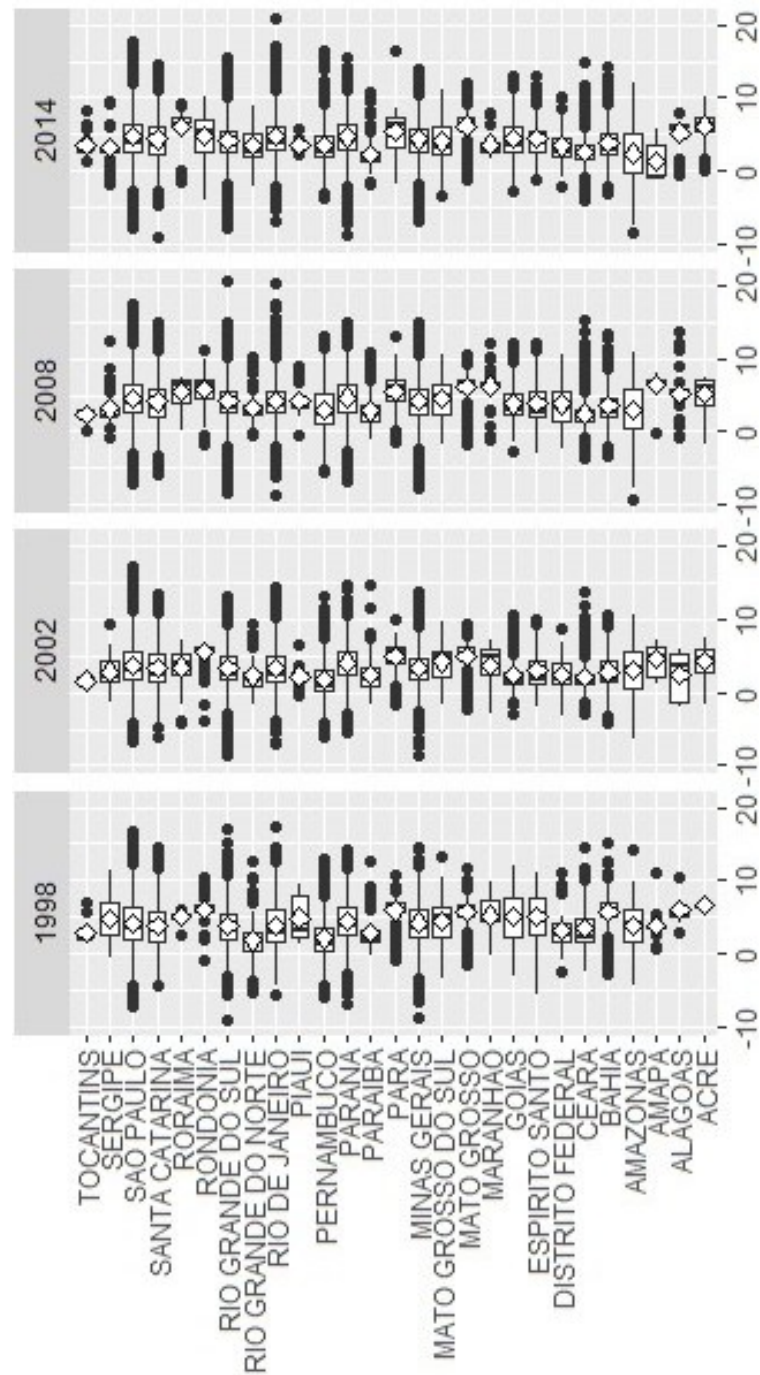
APPENDIX B – Brazilian exports quality by Industrial sectores.
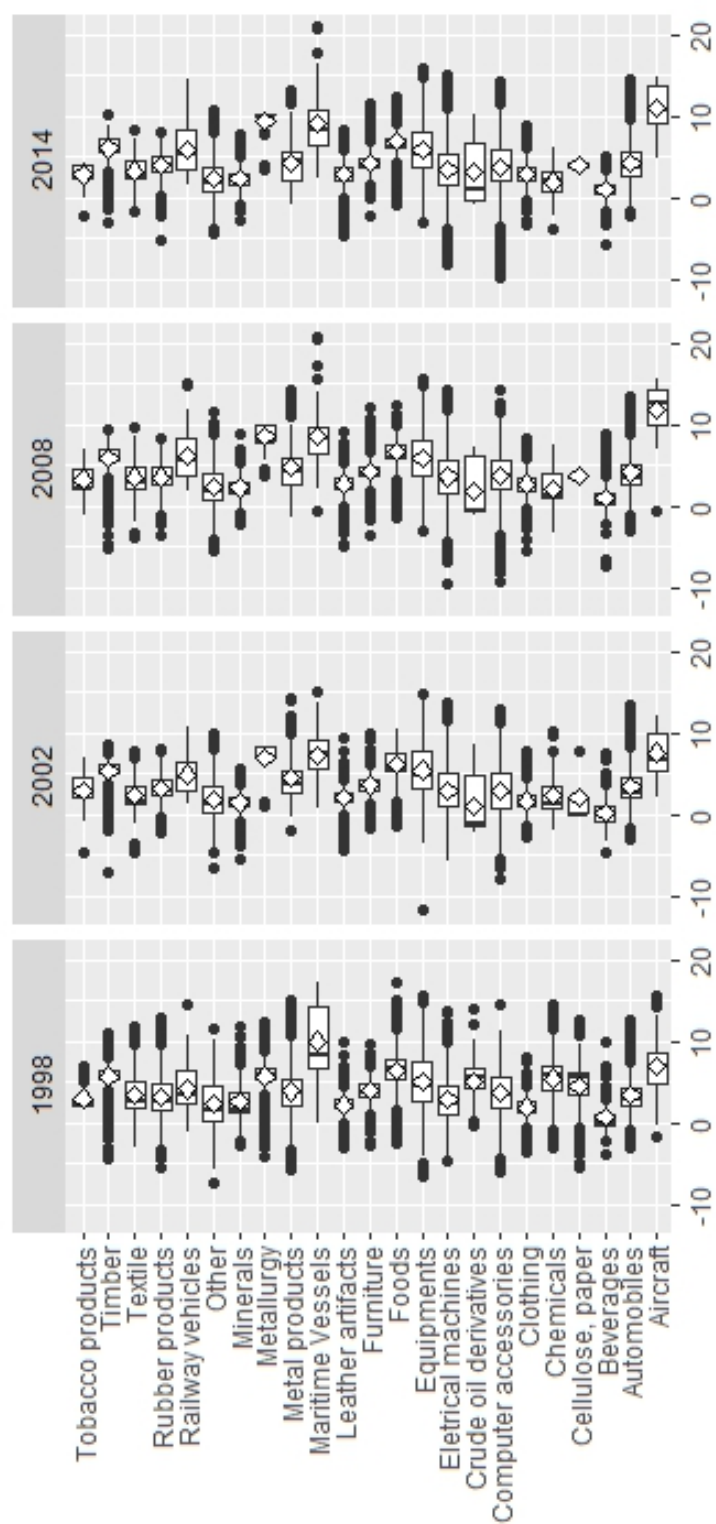
# APPENDIX C – GDP per capita variation of Brazilian states: 1998-2011 (%).

| Region/State | 1998 | 2011 | Variation (%) |
|---|---|---|---|
| **Brazil** | **339,07** | **465,97** | **37,43** |
| **Northeast** | **61,21** | **85,42** | **39,55** |
| Maranhão | 4,68 | 7,34 | 56,84 |
| Piauí | 4,75 | 7,33 | 54,32 |
| Ceará | 6,97 | 9,64 | 38,31 |
| Rio Grande do Norte | 7,93 | 10,55 | 33,04 |
| Paraíba | 5,71 | 8,74 | 53,06 |
| Pernambuco | 7,91 | 11,01 | 39,19 |
| Alagoas | 6,45 | 8,49 | 31,63 |
| Sergipe | 8,86 | 11,72 | 32,28 |
| Bahia | 7,95 | 10,6 | 33,33 |
| **North** | **65,81** | **93,75** | **42,46** |
| Rondônia | 8,74 | 16,51 | 88,90 |
| Acre | 8,39 | 11,02 | 31,35 |
| Amazonas | 12,36 | 17,06 | 38,03 |
| Roraima | 10,66 | 14,12 | 32,46 |
| Pará | 7,99 | 10,74 | 34,42 |
| Amapá | 9,59 | 12,25 | 27,74 |
| Tocantins | 8,08 | 12,05 | 49,13 |
| **South** | **53,96** | **69,27** | **28,37** |
| Paraná | 15,31 | 21,29 | 39,06 |
| Santa Catarina | 20,14 | 25,02 | 24,23 |
| Rio Grande do Sul | 18,51 | 22,96 | 24,04 |
| **Middle-West** | **83,65** | **116,31** | **39,04** |
| Mato Grosso do Sul | 12,98 | 18,58 | 43,14 |
| Mato Grosso | 11,68 | 21,71 | 85,87 |
| Goiás | 11,80 | 17,11 | 45,00 |
| Distrito Federal | 47,19 | 58,91 | 24,84 |
| **Southeast** | **74,44** | **101,22** | **35,98** |
| Minas Gerais | 13,67 | 18,3 | 33,87 |
| Espírito Santo | 15,57 | 25,75 | 65,38 |
| Rio de Janeiro | 21,30 | 26,83 | 25,96 |
| São Paulo | 23,90 | 30,34 | 26,95 |

Source: adapted from IBGE.