# IMPORT COMPETITION INDUCED QUALITY CHANGE? THE IMPACT OF IMPORTS ON BRAZILIAN WAGES

## *A CONCORRÊNCIA DAS IMPORTAÇÕES INDUZIU UMA MUDANÇA NA QUALIDADE? O IMPACTO DAS IMPORTAÇÕES NOS SALÁRIOS BRASILEIROS*

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**Abstract**
Many economies seek to raise the quality of their products in order to gain improved access to the importing market, enhance competitiveness in international trade, increase productivity, pay higher wages, and raise product prices. This paper aimed to explore the link connecting import competition, quality upgrading and wages paid in the destination country. The analyses documented in this paper sought to establish a relationship between the quality of imports and wages paid in Brazil. The main findings suggested that as the quality of imports increases, products facing foreign competition lead to a rise in wages paid in Brazil. In order to fight international competition, local firms might resort to quality upgrading by hiring skilled workers who, in turn, earn higher wages.
**Keywords:** Import Competition, Quality Upgrading, Wages, Unconditional Quantile Regression.

***Resumo***
*Muitas economias procuram melhorar a qualidade de seus produtos, a fim de obter melhor acesso ao mercado importador, aumentar a competitividade no comércio internacional, aumentar a produtividade, pagar salários mais altos e aumentar os preços dos produtos. Este artigo teve como objetivo explorar o vínculo que liga a concorrência da importação, a melhoria da qualidade e os salários pagos no país de destino. As análises documentadas neste trabalho procuraram estabelecer uma relação entre a qualidade das importações e os salários pagos no Brasil. As principais conclusões sugeriram que, à medida que a qualidade das importações aumenta, os produtos que enfrentam a concorrência externa levam a um aumento nos salários pagos no Brasil. Para combater a concorrência internacional, as empresas locais podem recorrer à melhoria da qualidade contratando trabalhadores qualificados que, por sua vez, ganham salários mais altos.*
***Palavras-chave:*** *Concorrência das Importações, Melhoria da Qualidade, Salários, Regressão Quantílica Incondicional.*

## 1. Introduction

In the past decades, world interactions have played an important role in the intensification of international trade. Countries have more and more engaged in strengthening foreign transactions aiming to provide their citizens with commodities they lack in exchange for those they produce in abundance. Global trade has become a key aspect of the development of modern economies, especially due to its relevance to national income generation and a nation's living standards.

When it comes to the participation of Brazil in the international market, the country has shown interesting changes along the years. For instance, from 1997 through 2000, the trade balance of the country registered negative figures, meaning that during the time, Brazil's import trade value surpassed its exports. From that time on, the country has altered this condition and has developed its commercial structure into becoming a net exporter. Nevertheless, imports

showed, between 1997 and 2016, an average annual increase of 1.24% and nearly 138 billion dollars' worth of imported goods in 2016 (Comexstat 2019).

According to data from MDIC (2019), a closer outlook of the importing schedule of Brazil allows to draw some early assumptions. For instance, in 2016, the country mainly imported mineral, manufactured and pharmaceutical goods. Conversely, most products comprising its exporting schedule in that year related to agricultural commodities. Therefore, it is possible to note that the country's imports were predominantly concentrated on capital-intensive goods yet its exports were labor intensive.

Analyzing more aspects of a country's imports allows to better understand how import competition affects the domestic economy and the welfare of its population. For instance, from 1997 through 2016, various Brazilian products faced direct competition from foreign-made varieties (PIA 2018; Comexstat 2019). In other words, Brazil both produced and imported a set of similar products, meaning that the local industry had the challenge of competing against internationally-made products.

In this context, other aspects of trade such as the quality of the output assumes importance. Among the countries that trade the same goods in the international market, a given economy might have more incentives to respond to import competition by differentiating in terms of the quality of these products (Amiti and Khandelwal 2013). Recent studies have observed a positive association between higher-end products and productivity, wages, prices of goods and income, resulting in a possible improvement in the terms of trade (Bastos and Silva 2010; Jaimovich and Merella 2015).

Brambilla and Porto (2016) note that countries exporting higher-end goods do pay higher wages. These authors observe that the production of quality is closely connected to skills and therefore conclude that skilled-workers produce higher-quality varieties and thus command a higher payment. Amiti and Khandelwal (2013) investigate how import competition affects a firm's decision to quality-upgrade. These researchers observe that industries facing international competition have an extra incentive to quality-upgrade in order to compete against foreign commodities.

The analysis of cross-sectional data from PIA (2018) and Comexstat (2019) combining information on wages paid in Brazil and the quality of imports (import trade value/quantity), respectively, allowed to identify those products facing direct foreign competition in Brazil. These data also shed light on a possible correlation between the quality of imports entering the Brazilian market and the wage levels paid in the country. The channel connecting these ideas imply that the quality of products destined to Brazil could put pressure on domestic firms to modify the production process, become more intensive in skilled labor, enhance product quality, and consequently pay higher wages.

As long discussed in Brambilla and Porto (2016), the production of higher-quality goods requires qualified workers who consequently earn higher wages. Hence, such a relationship between skills and wages could also produce an end effect in the importing country resorting to quality upgrading. In other words, importers might feel encouraged to attract skilled workers so they can enhance the quality of their output and compete with international higher-end goods.

Unlike the existing studies in the trade literature, this chapter aimed to explore the relationship between the quality of imports and wages paid in Brazil from 1997 to 2016. Specifically, this research examined how the quality of Brazilian imports originating in its main trade partners affects wages paid in the country. The analyses performed in this chapter considered the 60 main exporters to Brazil or approximately 90% of the country's total imports during the timeframe combining information on quality and wages at the product level.

This study mostly distinguishes from the related trade literature by conducting an investigation on the effects of quality on wages paid in the destination country. Brambilla and Porto (2016) and Verhoogen (2008), for instance, analyzed the effects of quality on wages paid in the country of origin. Moreover, for a more disaggregated understanding, an additional analysis was carried out considering the income groups of Brazil's main trade partners. Hallak and Schott (2011), Hummels and Klenow (2005) and Schott (2004) note that richer countries tend to produce and export higher-quality goods. For this reason, imports coming from higher-income nations could affect Brazilian wages differently with respect to those shipped from poorer economies.

This research looks to contribute to shaping adequate policies with a focus on quality and career advancement in Brazil. A deeper understanding of the relationship between the quality of imports and wages paid in Brazil yields interesting implications. The results obtained in this research works in favor of the government efforts to protect Brazilian producers and to provide firms with the necessary means to quality-upgrade. Furthermore, results presented in this chapter allow lawmakers to evaluate the need for labor qualification incentives and technology adoption subsidies. To end, an increase in wages has the potential to have a marked effect on income gains for workers translated into higher purchasing power and welfare.

This chapter comprises four other sections, besides this introduction. The second section presents the theoretical framework. The third introduces the methodology and the fourth exhibits the results and discussion. Lastly, the fifth section shows the conclusions.

## 2. Theoretical framework

Previous studies devoted considerable attention to the investigation of the relationship between skill upgrading and wage inequality (Bernard and Jensen 1997; Juhn, Murphy, and Pierce 1993). These researches have widely observed that wages and output rise steeply in skill, meaning that wage discrepancies are attributable mostly to rises in skill upgrading. Nonetheless, these studies have not taken into account the eventual effects of skill upgrading on the quality of the output.

Verhoogen (2008) advances on Bernard and Jensen (1997) and Juhn, Murphy, and Pierce (1993) and proposes a quality-upgrading mechanism linking trade and wage inequality. The author considers that firms are heterogeneous in productivity and incur fixed costs to enter the export market in a way that only the most productive plants within each industry export. Verhoogen (2008) assumes that varieties are differentiated in quality and that consumers differ in income and in their willingness to pay for higher-quality goods. The author suggests that the production of higher-end varieties requires skilled workers, and that these high-quality workers must be paid higher-wages.

More recently, Brambilla and Porto (2016) have laid out a theoretical framework of export destinations, quality and wages. Their model relies on the mechanism that rich countries demand quality, and that the supply of quality is intensive in skilled labor and commands higher wages. A similar effect is expected in the case of the quality of imports. In this context, to become more competitive, domestic firms may pay higher wages to attract skilled professionals, produce higher-quality goods and compete against foreign-made varieties.

Brambilla and Porto (2016) also consider that firms differ in productivity, incur fixed costs to enter the export market and that countries value quality differently. The model presented by these authors consider a differentiated good $k$ with quality $\theta_k$ and price $p_k$. The demand function for this good is $q(p_k\theta_k)$ and firms are in a monopolistic competition framework that faces this demand function. These authors assume that firms have to choose the quality of the physical units and its selling price. The total cost of producing good $k$ depends

upon quantities $q_k$ as well as on the quality $\theta_k$ of the good, $C_k(q_k\theta_k)$. The authors consider that the production technology is such that varieties are produced under constant marginal costs. Thus, their model defines a marginal cost function $C_k(\theta_k)$ that depends on quality.

To better characterize the model, Brambilla and Porto (2016) felt the need to describe the function $C_k(\theta_k)$. The authors consider that the production of quality demands higher-end inputs (labor and intermediate goods), which are costly to obtain. For them, the production of one unit of physical output requires $1/l$ units of labor. Their model considers that workers are heterogeneous in skills. For this reason, higher-skilled workers are able to produce $l$ units of higher-quality $\theta_k$ varieties. To model quality production, Brambilla and Porto (2016) follow Kugler and Verhoogen (2012) and Hallak and Sivadasan (2013) and assume that the production of quality represents a combination of skilled labor S and capability $\lambda$, as follows:

$$\theta_k = \lambda_k S_k^{\sigma} \quad (1)$$

where $\lambda$ and $\sigma$ both indicate positive parameters and determine the returns to skills in quality production. The authors suggest that Eq. (1) delivers a positive relationship between skills $S_k$ and the production of quality $\theta_k$, meaning that an increase in $S_k$ results in an increase in $\theta_k$.

To attract higher skilled workers, firms face an upward sloping wage schedule as in Verhoogen (2008). Brambilla and Porto (2016) provide a simple functional form:

$$S_k = w_k^{\xi} \quad (2)$$

where $w_k$ represents the wage offered to skill level $S_k$ and $\xi > 0$ governs the sensitivity of the skill level offered to wages. The authors suggest that Eq. (2) could be interpreted as a representation of an efficiency-wage model or a profit-sharing model.

Eqs. (1) and (2) illustrate the quality mechanism proposed by Brambilla and Porto (2016) in which the production of quality requires skills and higher-quality workers are paid higher wages. For a firm, the cost of producing one unit of output of quality $\theta_k$ is the cost of hiring $1/l$ workers of skill $S_k$ at the wage $w_k$. Taking Eqs. (1) and (2), the marginal cost of producing a physical unit of good *k* is

$$C_k(\theta_k) = \frac{1}{l}\left(\frac{\theta_k}{\lambda_k}\right)^{\frac{1}{\xi\sigma}} \quad (3)$$

with $c' > 0$ e $c'' > 0$, provided that $\xi\sigma > 1$, that is, as long as quality does not rise too rapidly with skills, and skills do not rise too fast with wages.

Brambilla and Porto (2016) consider that quality is costly; in other words, to produce higher-quality goods, firms must attract skilled workers who are paid more. This mechanism could also occur when analyzing the effect of the quality of imports on wages. Foreign competition may encourage domestic firms to become more competitive against imports via quality upgrading. In order to fight international competition, firms resorting to enhancing the quality of the output might as well seek to attract skilled workers so as to produce better products. Consequently, these firms would need to respond to a higher-quality workforce by providing them with higher wages.

To end, this theoretical framework shows that firms choose to increase quality and this raises average wages. These worker-quality wage schedules can be justified on the basis of a couple of other complementary models besides Brambilla and Porto (2016). For instance, Kremer (1993) rationalizes such an idea through a model in which worker quality represents general skills, workers are heterogeneous in skill levels within each occupational category, and plants must pay high wages to attract skilled workers. Lastly, Akerlof (1982), Shapiro and Stiglitz (1984) and Bowles (1985) present a model in which worker quality represents effort and plants do offer efficiency wages to induce workers to supply it.

## 3. Methodology

This section is divided in four parts. The first of them expands on the proxy used to estimate the quality indicator of the Brazilian imports. The second subsection exhibits the empirical model used in the analysis of the quality of imports and wages paid in Brazil. The third part elaborates on the strategy used in the empirical estimations. Lastly, the fourth subsection shows the source of the data used in this chapter.

### 3.1.The quality indicator (unit value)

One common limitation of the existing trade literature is the difficulty in defining the quality of the output. Product quality variations represent a broad concept gathering varied features such as product performance, durability, reputation and origin country specific cultural aspects, which are tough to measure (Pinheiro, Markwald, and Pereira 2002).

Some researchers have discussed the challenges to measure quality (Schott 2004; Hummels and Klenow 2005; Hallak, 2006). Ramos Filho, Medeiros, and Albuquerquemello (2017) note that data on the quality of internationally traded varieties are scarce, possibly due to the subjective nature of quality. These authors highlight that information on quality involves different nations, each with its specifics, making this measurement even harder.

Previous studies have attempted to infer the quality of the output indirectly, by observing, for instance, output prices or unit values[1]. The unit price (i.e., the total industry export/import value divided by the quantity exported/imported by the industry) indicates a common proxy variable to measure quality, meaning that higher unit prices result in higher-quality goods. Hence, this study used such a proxy to evaluate the relationship between the quality of imports and wages.

Schott (2004) argues that better-endowed nations use their endowment advantage to produce vertically superior varieties; in other words, goods that are relatively capital or skill intensive and demonstrate added features or higher quality, thereby commanding a relatively higher price. More recently, Anwar and Sun (2018) show that the industry export quality is directly related to the industry export price. These authors confirm that the effect of foreign direct investment on industry export quality can be identified from its impact on the industry export price, thus providing a theoretical justification for a number of empirical studies, where export unit value is used as a measure of product quality.

### 3.2.Empirical specification

The following model based on Brambilla and Porto (2016) sought to analyze the effect of import quality on wages paid in Brazil.

$$\ln(W_{k,t}) = \beta_0 + \beta_1 \ln(P_{ki,t}^{IM}) + \beta_2 \ln(GDPpc_t) + \beta_3 \ln(Output_{k,t}) + \vartheta_i + \gamma_k + \varepsilon_{k,t} \quad (4)$$

where $W_{k,t}$ refers to the total wage[2] paid by a set of firms producing good $k$[3] in the importing country (Brazil) at time $t$ (1997-2016), as in Brambilla and Porto (2016) and Flach (2016)[4].

One significant feature of Eq. (4) is a novel perspective regarding the analysis of quality. Unlike Brambilla and Porto (2016) and Verhoogen (2008), Eq. (4) looked to investigate the effects of the quality of the output on wages paid in the importing country. Contrarily, the aforesaid authors evaluated the impact of quality on wages paid in exporting countries.

[1] See Alcalá (2016), Bastos and Silva (2010), Brambilla and Porto (2016), Flach (2016), Hallak (2006), Hallak and Schott (2011); Hummels and Klenow (2005), etc.

[2] Wages of workers with or without employment relationship and, of workers on holidays, medical leave, etc. Wages of members of the administrative, director or fiscal councils are not included. Wages of workers who did not develop any other activity in the company, who are self-employed, and the staff who work within the company, but is paid by other companies are not included.

[3] This study includes information on all products reported in the PIA database corresponding to the 8-digit level of the NCM.

[4] These authors use a slightly different approach, analyze average wages paid in the export country and rely on data at the firm level.

In this model, the variable of interest $P_{ki,t}^{IM}$ corresponds to the quality indicator and is proxied as the import unit price (unit value) of product *k* from country *i*[5] to Brazil in *t*. Estimates for this variable could provide ambiguous coefficients since an increase in the import price might result in either higher wages (via demand for skilled workers) or unemployment/wage cuts. The theories in Aghion and Howitt (2005) and Aghion et al. (2009) and the findings in Amiti and Khandelwal (2013) support this assumption. On the one hand, these authors note that the escape-competition effect might induce a firm close to the quality frontier to invest in quality upgrading to survive competition from potential new entrants. On the other hand, the authors highlight that the "appropriability" effect discourages firms distant from the frontier from investing in quality upgrading because they are too far from being able to compete with potential new entrants.

$GDPpc_t$ refers to the *per capita* gross domestic product of Brazil in *t*. Estimates for this control variable were expected to generate positive and statistically significant coefficients, meaning that an increase in the Brazilian product could affect the average wages paid in that country positively. This assumption was based on the early findings shown in Brambilla and Porto (2016) in which the authors note a positive correlation between product level and wages.

$Output_{k,t}$ corresponds to the gross value of industrial production[6] of product *k* in the importing country (Brazil), in *t*. Coefficients for this variable, as found in Brambilla and Porto (2016), were expected to produce a positive and statistically significant effect on wages paid in the importing country, suggesting that products generating higher revenue in a given sector or industry would have a positive impact on wages.

To end, $\vartheta_i$ and $\gamma_k$ refer to exporter and product fixed effects, correspondingly, and $\varepsilon_{k,t}$ to an exogenous disturbance.

### 3.3.Empirical strategy

To identify the effects of quality upgrading on wages, Eq. (4) was first estimated using a fixed effects model, and then, the unconditional quantile regression approach proposed by Firpo *et al.* (2009). Based on an influence function, this method considers that regressors may have a contrasting impact across the quantiles of the distribution. Thus, this method allowed the investigation of the effects of the independent variables presented in Eq. (4) on different wage quantiles.

Along with the unconditional quantile regression method, this study also used the concept of Recentered Influence Function. The influence function $IF(w; \upsilon, F_w)$ consists of the relative effect (influence) of each observation on a distribution statistic $\upsilon(F_w)$. The incorporation of $\upsilon(F_w)$ in the influence function defines the so-called Recentered Influence Function or RIF. This method allowed to analyze the effects of a set of covariates on the statistical distribution of interest, in this case, the distribution of quantiles.

The $\tau$-*th* quantile $(q_\tau)$ of the wage distribution is defined as $q_\tau = \upsilon_\tau(F_w) = inf_q\{q: F_w(q) \geq \tau\}$, and its influence function $IF(w; q_\tau, F_w)$ as:

$$IF(w; q_\tau, F_w) = \frac{\tau - 1\{w \leq q_\tau(F_w)\}}{f_w(q_\tau(F_w))} \quad (5)$$

where $1\{w \leq q_\tau(F_w)\}$ corresponds to an indicator function, which showed whether the variable $W_{k,t}$ (wage paid by a set firms producing product *k* in Brazil at time *t*) is less than or equal to

[5] The list of Brazil's main trade partners is included in Table 7 in Appendix. This list comprises 60 economies exporting to Brazil from 1996 to 2017 or nearly 90% of the total imports of Brazil.

[6] Sum of sales of industrial products and services (net industrial revenue), variation of inventories of finished products and in preparation, and own production made for fixed assets.

the quantile $q_\tau$, and $f_w(q_\tau(F_w))$ refers to the marginal density function of the distribution of $W_{k,t}$ evaluated in $q_\tau$.

Then, the recentered influence function, which replaced the dependent variable $W_{k,t}$ in the unconditional quantile analysis, was defined by the sum of the distribution statistics and their respective influence function, $RIF(w;\upsilon,F_w) = \upsilon(F_w) + IF(w;\upsilon,F_w)$. For the $\tau$-*th* quantile $(q_\tau)$, the RIF is given by:

$$RIF(w;\upsilon,F_w) = q_\tau + \frac{\tau - 1\{w \le q_\tau(F_w)\}}{f_w(q_\tau(F_w))} = c_{1\tau}.1\{w \le q_\tau(F_w)\} + c_{2\tau} \quad (6)$$

where $c_{1\tau} = \frac{1}{f_w(q_\tau)}$ and $c_{2\tau} = q_\tau - c_{1\tau}.(1-\tau)$ and the conditional expectation is the distribution statistic $\mathrm{E}\lfloor RIF(w;\upsilon,F_w)\rfloor = \upsilon(F_w)$.

From that, the model assumed a covariate vector *X* and the conditional expectation of the RIF as a function of *X*, i.e. $\mathrm{E}\lfloor RIF(w;\upsilon,F_w)|X = x\rfloor$. Then, the function could be represented as a linear regression in function of $X, RIF(w;\upsilon,F_w) = X\beta + \varepsilon$. Considering $\mathrm{E}[\varepsilon|X] = 0$ and applying the Law of Iterated Expectations, the unconditional quantile regression was defined as follows:

$$\upsilon(F_w) = \mathrm{E}_x\left[\mathrm{E}\lfloor RIF(w;\upsilon,F_w)\rfloor\right] = \mathrm{E}[X].\beta \quad (7)$$

where *w* refers to the total wage paid by firms producing good *k* in Brazil at time *t*; $RIF(w;\upsilon,F_w)$ is the recentered influence function; *X* is the vector of explanatory variables (described in the section 3.2); and $\beta$ refers to the coefficients. Finally, these coefficients were estimated by OLS.

The unconditional quantile regression approach proposed by Firpo et al. (2009) used in this essay is different from the conditional quantile regression proposed by Koenker and Basset (1978). While the latter approach solely allows within-group estimations, the unconditional quantile approach allows the analysis of both within- and between-group effects.

### 3.4.Data

This study was conducted with product-level annual data from 1997 to 2016. The timeframe comprises the years after the Brazilian trade openness, in which the country underwent many transformations and was able to develop its trade until recent years (IPEA 2010).

The data in this study are merged from multiple sources. Data on wages are from the *Pesquisa Industrial Anual* (PIA) corresponding to the 4-digit level of the *Classificação Nacional de Atividades Econômicas* (CNAE). Information on wages was then converted into 8-digit product level data of the *Nomenclatura Comum do Mercosul* (NCM) through the correspondence tables from the *Instituto Brasileiro de Geografia e Estatística* (IBGE). The cross-country data on Brazilian import values (US$) and quantities (kg) are from the *Secretaria de Comércio Exterior* (SECEX). The classification of products in this database also followed the NCM. Data on GDP *per capita,* PPP (current international US$) of Brazil are from the World Bank. To end, data on gross value of industrial production (US$) are from PIA.

## 4. Results and discussion

This section is divided into two parts. The first of them shows the descriptive statistics of the variables used. The second part presents the results of the fixed effects and the unconditional quantile regression models relating the quality of Brazilian imports and wages paid in the country.

### 4.1.Descriptive statistics

Prior to heading to the results of Eq. (4), a descriptive analysis is presented so as to provide a better perception of the sampled partner countries and the Brazilian product-level

data. Table 1 shows averages, standard deviations and extreme values for wages paid in Brazil, the quality of the country's imports, import values between 1997 and 2016, import quantity, GDP *per capita*, output, and the number of observations of the baseline sample.

The average wage paid by firms producing a given product *k* in Brazil was 869 million dollars. The highest wage was noted for 'Petroleum oils, oils from bituminous minerals' (NCM 27101999) reaching 27 billion dollars' worth of wages in 2016. The lowest value for this variable was 661 thousand dollars and refers to 'Coal gas, water gas, producer gas and similar gases, other than petroleum gases and other gaseous hydrocarbons' (NCM 27050000) in 1999.

Table 1 - Summary statistics of the variables included in this study

| Variable | Obs. | Mean | Std. Deviation | Min | Max |
|---|---|---|---|---|---|
| *Wage (US$)* | 254,835 | 869 mi | 1,37 bi | 661,265.30 | 27,1 bi |
| *Quality (log of unit price)* | 254,835 | 2.96 | 1.99 | -7.31 | 15.43 |
| *Import value (US$)* | 254,835 | 1,4 mi | 22,2 mi | 1 | 4,72 bi |
| *Net weight (tons)* | 254,835 | 1,478.53 | 57,200 | 000.1 | 9,56 mi |
| *GDP per capita (US$)* | 254,835 | 12,103.12 | 2,666.99 | 8,547.34 | 16,195.87 |
| *Output (US$)* | 254,835 | 7,59 bi | 13,9 bi | 2,76 mi | 352 bi |

Source: Author's calculations.
Note: Quality refers to the logarithm of the unit price (import value divided by net weight). Numbers rounded to two decimal places.

Quality presented extreme values ranging from -7.31 to 15.43. The highest quality level was associated with imports of 'Hormones, prostaglandins, thromboxanes and leukotrienes; their derivatives and structural analogues' (NCM 29375000) exported from Canada in 2015. The lowest quality value corresponds to imports of 'Acids; saturated acyclic monocarboxylic acids; acetic acid' (NCM 29152920) shipped from Germany in 2016.

Table 1 also indicates that, between 1997 and 2016, exports to Brazil from its main trade partners reached, on average, 1,4 million dollars and 1,478.53 tons. The GDP *per capita* in Brazil varied from 8,547.34 dollars in 1998 to virtually 16 thousand dollars in 2014.

The variable output presented a mean value of 7,59 billion dollars and extreme values varying significantly with a high standard deviation of 13,9 billion dollars. This may indicate a large discrepancy between the production levels in Brazil. The lowest output level was for 'Precious metal ores and concentrates; excluding silver' (NCM 26169000); its output equaled 2,76 million dollars in 2006. The highest output was noted for 'Petroleum oils, oils from bituminous minerals' (NCM 27101999) totaling an amount of 352 billion dollars in 2016.

This analysis of Table 1 shows that the highest output was noted for 'Petroleum oils, oils from bituminous minerals' (NCM 27101999), which has also shown the highest figures for wages. The association between output and wages could certainly be noted given that higher levels of production requires a larger number of workers and therefore results in higher volumes of wages.

This preliminary analysis provides an indication of a positive correlation between output and wages. However, it yet does not deliver consistent basis to draw further conclusions regarding the relationship between the quality of imports and wages. This study considers solely the Brazilian products that face import competition. Therefore, the quality of imports may have a contrasting effect on the wages paid in Brazil regardless of how large the output level of that product is.

Table 2 presents descriptive statistics for the variable quality considering the income groups of Brazil's main trade partners[7]. A significant number of empirical papers studying trade prices predicts a positive relation between a country's income *per capita* and average trade prices, suggesting that high-income countries consume and produce goods of higher quality (Hallak 2006; Hummels and Klenow 2005; Schott 2004). In this context, having a deeper understanding of the income structure of the main countries exporting to Brazil between 1997 and 2016 allows to sketchily infer some traits of the quality of Brazil's imported goods.

Table 2 – Mean value and standard deviation of variable quality for income subsamples

| | | Quality (log of unit price) | | Quality (unit price) | |
|---|---|---|---|---|---|
| *Income group* | Obs. | Mean | Std. Deviation | Mean | Std. Deviation |
| *High income* | 203,753 | 3.08 | 1.98 | 300.29 | 14,576.85 |
| *Upper middle income* | 36,452 | 2.41 | 1.93 | 189.64 | 6,161.49 |
| *Lower middle income* | 14,630 | 2.63 | 1.91 | 293.29 | 19,981.75 |

Source: Author's calculations.

Table 2 allows to note that nearly 80% of the sampled countries have a high-income structure what may give an early indication that most of Brazil's imports are of higher quality. High-income origin countries also show the highest mean value for the variable quality suggesting that the countries in this grouping export, on average, higher-quality goods to Brazil.

Lower middle-income economies represent only 5.7% of the baseline sample. Although these countries present a slightly similar (in comparison to high-income countries) mean value for the quality of their exports, the standard deviation for this grouping is relatively high and the number of observations is drastically smaller, suggesting that the subsample is rather heterogeneous.

Figure 1 complements the previous analysis and shows the distribution of the variable quality for the income subsamples presented in Table 2. The top-left panel refers to the quality of imports originated in the main trade partners of Brazil. The remaining panels analyze the distribution of the variable quality for high-, upper middle-, and lower middle-income origin countries.

It is possible to note in Fig. 1 that the variable quality is distributed similarly to a normal distribution for all income groupings. However, slight differences might be observed among them. Most observations in the panels representing both the full sample and high-income partners lie in a higher-density region when comparing with the bottom panels. Such a finding is not surprising whatsoever given that most of Brazil's imports originated in countries with a high-income level, as shown in Table 2.

The most apparent discrepancies are noted for the quality of imports shipped to Brazil from upper middle- and lower middle-income countries. Comparing these two subsamples, it is possible to notice that the mean value for upper middle-income exporters leans a bit towards the left tail showing moderately lower quality levels. On the other hand, the bottom-right panel implies a lower density or a higher variation among quality levels. Such variability may be related to a more limited capacity of lower middle-income economies to quality upgrade their exports homogeneously. In other words, some of these countries may not have the necessary productive means to enhance the quality of certain goods.

[7] Lower middle-income economies are those with a gross national income (GNI) *per capita* between $996 and $3895; upper middle-income economies are those with a GNI *per capita* between $3896 and $12055; high-income economies are those with a GNI per capita of $12056 or more (World Bank 2019).

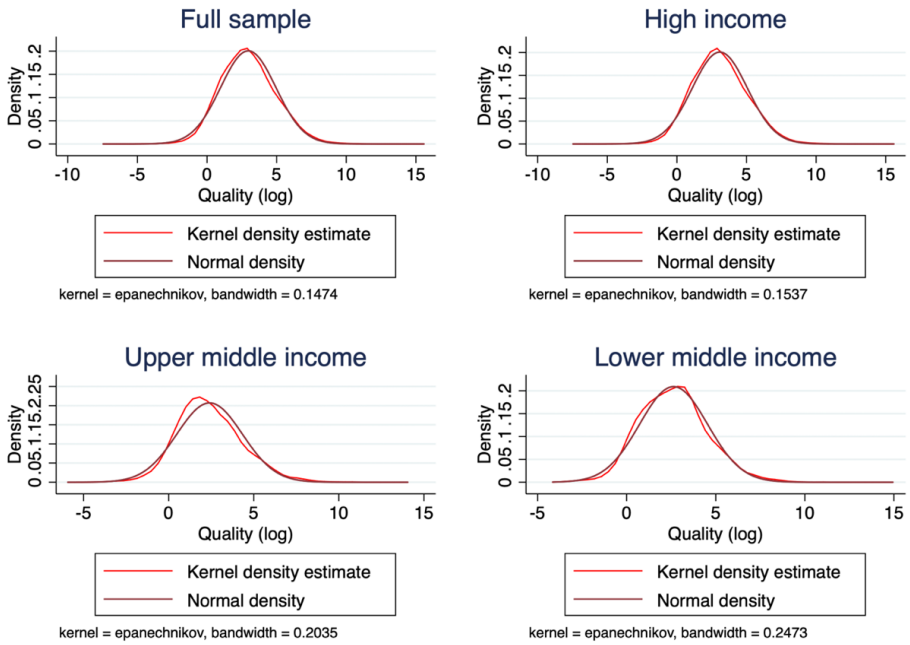


Figure 1 – Density distribution of the variable quality divided by partner income groups
Source: Author's calculations.

Table 3 displays the mean value of the quality of exports destined to Brazil for fifteen selected industries (HS02) along with their origin countries and income groups[8]. The industries presented in Table 3 are those registering the highest quality levels between 1997 and 2016. Therefore, these industries comprise those imports with the highest quality levels, which might stimulate competition in the Brazilian market.

Table 3 allows a better picture of the product groupings that most promote high-end import competition in Brazil. The list presented in Table 3 encompasses varied industries and consequently a large number of products. From the analysis of Table 3, it is possible to notice that the highest quality levels are observed for 'Aircraft, spacecraft, and parts thereof', 'Optical, photo, technical, medical, etc. apparatus', and 'Pharmaceutical products'. The quality figures for these industries were not unexpected given that these imply capital- and skill-intensive goods.

Most high-end selected industries presented in Table 3 originate from high-end income countries with the exception of 'Articles of apparel, accessories, knit or crochet' imported from Romania, confirming the analysis presented in Table 2. Among the fifteen highest-quality industries, 'Articles of apparel, accessories, not knit or crochet', 'Articles of apparel, accessories, knit or crochet', 'Nuclear reactors, boilers, machinery, etc.', and 'Headgear and parts thereof' were those with lower average quality levels, originated in the United States, Romania, Chile, and Taiwan, respectively.

The analyses performed in this section aimed to better perceive the data used in this chapter as well as augment the understanding of Brazilian products competing against foreign-made goods. Nevertheless, for more conclusive evidence, the following subsection leads to the results of the econometric estimations, which allow for more precise verification of the assumptions and analyses here presented.

[8] The classification of products in this analysis followed the NCM whose first four digits correspond with the HS. Therefore, the analysis of average industry (HS02) quality was possible without any correspondence tables.

Table 3 - Average quality of Brazilian imports for selected industries between 1997 and 2016.

| HS02 | Industry | Quality | Exporter | Income group |
|---|---|---|---|---|
| 88 | Aircraft, spacecraft, and parts thereof | 5.89 | FIN | High income |
| 90 | Optical, photo, technical, medical, etc. apparatus | 5.00 | CHE | High income |
| 30 | Pharmaceutical products | 4.99 | IRL | High income |
| 71 | Pearls, precious stones, metals, coins, etc. | 4.67 | DNK | High income |
| 43 | Furskins and artificial fur, manufactures thereof | 4.44 | DNK | High income |
| 91 | Clocks and watches and parts thereof | 4.30 | TWN | High income |
| 85 | Electrical, electronic equipment | 4.17 | FRA | High income |
| 50 | Silk | 4.12 | ESP | High income |
| 75 | Nickel and articles thereof | 4.11 | JPN | High income |
| 81 | Other base metals, cermets, articles thereof | 4.04 | GBR | High income |
| 93 | Arms and ammunition, parts and accessories thereof | 4.04 | USA | High income |
| 62 | Articles of apparel, accessories, not knit or crochet | 3.85 | USA | High income |
| 61 | Articles of apparel, accessories, knit or crochet | 3.64 | ROM | Upper middle |
| 84 | Nuclear reactors, boilers, machinery, etc. | 3.51 | CHL | High income |
| 65 | Headgear and parts thereof | 3.26 | TWN | High income |

Source: Research data.

### 4.2. The quality of imports and wages paid in Brazil

This subsection shows the estimations regarding the relationship between wages paid in Brazil and the quality of the country's imports between 1997 and 2016. First, Table 4 introduces the results of the OLS fixed effects model. Then, Table 5 displays the estimates of the RIF regressions for the unconditional wage distribution quantiles of the logarithm of annual wages. Table 6 advances a little on the results displayed in Table 5 and considers the income groupings of Brazil's main trade partners.

Results presented in Table 4 provide a more general analysis of the effects of the quality of imports entering the Brazilian market on wages paid in the country. Alternatively, the analysis presented in Table 5 uncovered the effect of import quality upgrading on different wage quantiles. The estimated coefficients of the RIF regressions have shown variations along the wage distribution quantiles with respect to the estimated coefficients obtained for the mean. Therefore, these results reinforce the need to use the unconditional quantile regression approach.

Table 4 allows to infer that, for most OLS-FE regressions, there exists a positive and statistically significant relationship between the quality of Brazilian imports and local wages, meaning that as the quality of imports increases, wages paid in Brazil are affected positively. Similarly, Brambilla and Porto (2016) also found a positive association between these two variables. Nevertheless, these authors investigated whether the quality of a country's exports affected the average wage paid in the exporting country.

As noted in Table 4, from the perspective of import competition, the quality of imports penetrating the Brazilian market has shown to produce a positive effect on local wages. The probable channel causing such an increase relates to the need of the workforce to skill-upgrade, and consequently, be more capable of enhancing the quality of domestically produced goods.

Like Brambilla and Porto (2016), this study considers that the production of high-end goods requires skilled professionals who subsequently are paid higher wages. Thus, via the

skill-upgrading mechanism, local firms producing the most varied products *k* are able to produce higher-quality goods and compete against imported higher-end products, as noted in Maia (2013).

Estimates for the variable quality, shown in columns (1), (3) and (5) in Table 4, indicate that such a variable has a rather small effect on wages paid in Brazil. This order of magnitude could be due to the fact that import quality upgrading affects Brazilian wages indirectly via skill upgrading. Hence, results in Table 4 suggest that as the quality of Brazilian imports increases, there might exist domestic pressure for local firms to enhance the quality of their product. In order to do so, Brazilian firms might respond to this pressure by hiring qualified professionals who earn higher wage levels.

Table 4 - OLS-FE estimations

| Variables | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| *Quality* | 0.1238129*** | 0.001371$^{NS}$ | 0.0186283*** | | 0.0029925*** |
| | (0.0015069) | (0.0009826) | (0.0006214) | | (0.0005881) |
| *Per capita GDP* | | 3.767584*** | | 1.037244*** | 1.0332860*** |
| | | (0.0062015) | | (0.0054438) | (0.0054988) |
| *Output* | | | 0.8668912*** | 0.7189751*** | 0.7189973*** |
| | | | (0.0007686) | (0.0010668) | (0.0010688) |
| *Intercept* | -21.48137*** | -13.839778*** | 0.0072567$^{NS}$ | -6.04996*** | -6.0162730*** |
| | (0.2826747) | (0.1895349) | (0.1168124) | (0.113853) | (0.1140398) |
| Observations | 254,835 | 254,835 | 254,835 | 254,835 | 254,835 |
| R-squared | 0.4297 | 0.7677 | 0.9052 | 0.9168 | 0.9168 |
| Adj. R-squared | 0.4270 | 0.7666 | 0.9047 | 0.9164 | 0.9164 |

Source: Research results

Note: Dependent variable is wages. Controls in all columns: exporting country effects, product effects (HS04). Standard errors in parentheses. Significance at 1% level indicated by *** and non-significant indicated by NS.

Exploring Table 4 also allows to verify other variables producing a positive effect on Brazilian wages across those products facing import competition. Coefficients for the variable *per capita* GDP confirmed throughout regressions (3), (4), and (5) the assumption presented in subsection 3.2 that such a variable would deliver positive and statistically significant coefficients. These results reveal that an increase in the Brazilian product causes a rise in the country's average wage. The idea behind this relationship relates to the fact that an increase in the domestic product may be the result of a rise in the number of workers, which consequently has a ripple effect on the overall wage level. As noted in Gremaud, Vasconcellos, and Toneto Junior (2012), as the economic activity grows, unemployment reduces and wage rates tend to raise.

Coefficients for the variable output also exhibited a positive association with the dependent variable. This finding shows that an increase in the output results in a rise in wages paid in Brazil. This relationship could be explained by the fact that as firms producing variety *k* increase their total production level, they require a larger number of workers and for this reason the overall wage raises. As noted in Brambilla and Porto (2016), such a relationship insinuates that a group of higher performance firms producing product *k* would have the necessary means to pay higher wages.

Table 4 showed that there exists a positive relationship between this study's variable of interest – quality – and wages paid by firms producing the most varied products in Brazil. What still remains uncovered is the possibility of import quality upgrading having contrasting effects

on different wage levels. Therefore, Table 5 displays the results of the unconditional quantile regression, which tackles this possible issue, and delivers more consistent estimates.

Similarly to Table 4, results displayed in Table 5 suggest a relatively small effect of the quality of imports across the wage distribution quantiles. More specifically, coefficients for the variable quality reveal a positive correlation with the dependent variable for the first two wage quantiles, q10 and q30. These results indicate that lower wage levels suffer an increase of 1.58% and 1.04% for the q10 and q30 quantiles, respectively, as the quality of imports rises.

Table 5 - Unconditional quantile regression estimation

| Variables | q10 | q30 | q50 | q70 | q90 |
|---|---|---|---|---|---|
| *Quality* | 0.0158882*** | 0.0104357*** | -0.0059146*** | -0.0051266*** | -0.0069043*** |
| | (0.0028322) | (0.0017108) | (0.0016840) | (0.0016493) | (0.0021595) |
| *Per capita GDP* | 0.2822422*** | 0.6477333*** | 2.0650870*** | 2.376012*** | 0.5293485*** |
| | (0.0319692) | (0.177594) | (0.0175474) | (0.0171632) | (0.0189508) |
| *Output* | 0.7477799*** | 0.8227827*** | 0.7812522*** | 0.6080472*** | 0.6676340*** |
| | (0.0077477) | (0.0036831) | (0.0035410) | (0.0034683) | (0.0047137) |
| *Intercept* | -2.241158*** | -5.833741*** | -16.70304*** | -13.76878*** | 1.9880340*** |
| | (0.3441127) | (0.2468109) | (0.2842881) | (0.2734008) | (0.6832195) |
| Observations | 254,835 | 254,835 | 254,835 | 254,835 | 254,835 |
| R-squared | 0.5030 | 0.6558 | 0.6806 | 0.6233 | 0.4353 |
| Adj. R-squared | 0.5006 | 0.6542 | 0.6790 | 0.6215 | 0.4326 |

Source: Research results

Note: Dependent variable is wages. Controls in all columns: exporting country effects, product effects (HS04). Standard errors in parentheses. Significance at 1% level indicated by ***.

Brambilla and Porto (2016) uncover that wages and skills are closely intertwined and that skilled workers are paid higher wages. For this reason, goods produced by lower-paying firms are more likely to be comprised of low-skilled workers. The positive association between quality and the lower bands of the wage distribution could be comprehended by the fact that low-skilled workers show greater potential for skill upgrading given that, as opposed to skilled workers, they are more distant from the skill frontier. In other words, low-skilled workers have a wider spectrum for skill upgrading. Thus, they are more apt to respond (via skill upgrading) to the pressure caused by the quality of international goods.

These results are in line with Aghion and Howitt (2005) and Aghion et al. (2009) and the findings in Amiti and Khandelwal (2013) who noted that import competition might cause higher wages (via demand for skilled workers). These authors stressed that the escape-competition effect might induce firms to invest in quality upgrading to survive competition from potential new entrants.

The analysis of higher quantiles discloses an opposing relationship between quality and wages with respect to lower quantiles. Negative and statistically significant coefficients were observed for all upper quantiles, i.e. q50, q70 and q90. Estimates for these quantiles suggest that as the quality of Brazilian imports increases, there exists a decrease in wages paid by firms producing those corresponding goods. Comparing q70 and q90, it is possible to observe that the expected wage reduction is even higher for the extreme quantile. For instance, results in Table 5 imply that the quality of foreign goods entering the Brazilian market would cause a wage reduction of nearly 0.69% for the q90 quantile.

The negative relationship between quality and upper wage quantiles could be better perceived from the probable skill endowment of the workers comprising higher-paying firms.

The upper band of the wage distribution encompasses those firms paying the highest wage levels for a given product *k*. Hence, these are the firms whose workers tend to be highly skilled. Given that high-skilled workers have a narrower range for skill upgrading or, in other words, are closer to the skill frontier, enhancing the quality of the domestic output might not be feasible.

These findings follow Amiti and Khandelwal (2013) who also note that import competition discourages those firms distant from the possibility of investing in quality upgrading because they might simply be unable to compete against potential new entrants. Then, a worst-case scenario could be imagined where firms may terminate their operations and workers are likely to lose their jobs. Thus, firms most likely to close down induce an increase in the supply of skilled workers, causing employment in that industry to inevitably decline, and wages to face cuts, as noted by Chamon (2015).

*Per capita* GDP and output showed a positive relationship with the dependent variable across the wage distribution quantiles, as shown in Table 5. The magnitude of such a relationship, however, has varied as different quantiles were considered. Estimates for the *per capita* GDP showed a larger impact on wages for the q50 and q70 quantiles. Gremaud, Vasconcellos, and Toneto Junior et al. (2012) confirm that as the product grows, unemployment rates fall and wages tend to increase. A possible explanation for this specific upward movement could be that as the economic activity of Brazil grows, the set of firms paying the wage bands considered in the q50 and q70 quantiles are those demanding the highest number of workers. Consequently, these firms hire more and the wage level in those quantiles face a more significant rise. Output did not show a great discriminatory effect across the quantiles analyzed, implying that the effect of the output onto contrasting wage levels is reasonably homogenous.

Even though results shown in Table 5 reveal that there exist differences in the way the quality of foreign goods interact with wages paid across Brazilian products, it is possible to also notice (as shown in Table 4) that the magnitude of all coefficients are fairly small. This outcome gathers evidence that import quality upgrading has a minor effect on wages paid in the destination country probably because such an effect works its ways indirectly through the skill upgrading mechanism.

Recent literature on quality upgrading has noted that richer countries demand and produce higher-quality goods (Brambilla and Porto 2016; Caron, Fally, and Markusen 2014). In an attempt to advance on the analyses presented so far, Table 6 displays the results of the RIF regressions for three origin country income groups: high-, upper middle- and lower middle-income economies. These results aimed to provide an additional analysis and verify whether the quality of Brazilian imports originated in richer countries had a contrasting impact on wages paid in Brazil.

By reducing the sample to high-income origin countries exporting to Brazil between 1997 and 2016, it is possible to note that coefficients for quality varied insignificantly with respect to the full sample (Table 5). Such slight alterations could be explained by the fact that most of the sampled origin countries are high-income economies, as shown in Table 6. Consistently, the effect of the quality of imports on wages paid in Brazil is small. These results suggest that the quality of products exported to Brazil from rich economies affects lower quantiles of the wage distribution positively and that higher bands of the wage distribution, as noted for the full sample, are negatively affected by the quality of imports.

Turning now to the comparison among income groups, estimates for high- and upper middle-income countries were expected to deliver higher coefficients for the variable quality when compared to those observed for lower middle-income origin countries. This relationship relates to the income structure of the richer exporting country that, in theory, is better-endowed

in terms of capital and skilled labor and consequently has the necessary means to produce higher-quality products (Brambilla and Porto 2016).

Table 6 - Unconditional quantile regression estimations for origin country income groups.

| | High-income origin countries | | | | |
|---|---|---|---|---|---|
| Variables | q10 | q30 | q50 | q70 | q90 |
| Quality | 0.0143911*** | 0.0114447*** | -0.010529*** | -0.0058554*** | -0.0082992** |
| | (0.0030282) | (0.0024827) | (0.0019377) | (0.0014781) | (0.0033266) |
| *Per capita* GDP | 0.083083** | 0.4077167*** | 2.078283*** | 2.129300*** | 0.80497228*** |
| | (0.0347389) | (0.025852) | (0.020196) | (0.0160187) | (0.0291589) |
| Output | 0.7493854*** | 1.118331*** | 0.8232761*** | 0.4961158*** | 0.9313234*** |
| | (0.1575168) | (0.0054893) | (0.0041443) | (0.0032362) | (0.0071466) |
| Intercept | -0.6133238* | -10.59408*** | -17.82733*** | -9.613629*** | -5.384259*** |
| | (0.3299779) | (0.3056079) | (0.3081361) | (0.248899) | (1.118669) |
| Observations | 203,753 | 203,753 | 203,753 | 203,753 | 203,753 |
| R-squared | 0.5072 | 0.6596 | 0.6830 | 0.6345 | 0.4419 |
| Adj. R-squared | 0.5043 | 0.6576 | 0.6811 | 0.6323 | 0.4386 |
| | Upper middle-income origin countries | | | | |
| Variables | q10 | q30 | q50 | q70 | q90 |
| *Quality* | 0.002316$^{NS}$ | 0.105025** | 0.0052033$^{NS}$ | -0.0067092$^{NS}$ | -0.0123411*** |
| | (0.0078215) | (0.0043243) | (0.0038833) | (0.0066294) | (0.004282) |
| *Per capita GDP* | 0.8642831*** | 0.5624953*** | 1.867296*** | 2.829645*** | 0.3163844*** |
| | (0.0833165) | (0.0429168) | (0.0392787) | (0.0598727) | (0.0343756) |
| *Output* | 0.6226924*** | 0.7777757*** | 0.6301289*** | 0.8487639*** | 0.494301*** |
| | (0.0197665) | (0.0086493) | (0.0077118) | (0.0121225) | (0.0087244) |
| *Intercept* | -4.010176*** | -3.56098*** | -10.56553*** | -25.80314*** | 6.769600*** |
| | (0.5449129) | (0.373731) | (0.3596365) | (0.8365792) | (0.5877155) |
| Observations | 36,452 | 36,452 | 36,452 | 36,452 | 36,452 |
| R-squared | 0.5086 | 0.6767 | 0.7054 | 0.6128 | 0.4850 |
| Adj. R-squared | 0.4933 | 0.6666 | 0.6962 | 0.6007 | 0.4689 |
| | Lower-middle income origin countries | | | | |
| Variables | q10 | q30 | q50 | q70 | q90 |
| *Quality* | 0.0452689*** | 0.0327605*** | 0.0082805$^{NS}$ | -0.0093592$^{NS}$ | -0.0238114*** |
| | (0.0135469) | (0.0066298) | (0.0084358) | (0.0086681) | (0.0060079) |
| *Per capita GDP* | 0.8878566*** | 0.0986888$^{NS}$ | 1.782532*** | 1.274969*** | 0.2859052*** |
| | (0.1421637) | (0.0666606) | (0.0821905) | (0.0758205) | (0.0460345) |
| *Output* | 0.7213897*** | 0.7880526*** | 0.9196413*** | 0.8101934*** | 0.4667745*** |
| | (0.0330733) | (0.0122096) | (0.0152694) | (0.0151353) | (0.0112877) |
| *Intercept* | -11.56723*** | 0.8365503$^{NS}$ | -16.41474*** | -7.827658*** | 9.787451*** |
| | (1.013298) | (0.5131405) | (0.6137687) | (0.5837989) | (0.365335) |
| Observations | 14,630 | 14,630 | 14,630 | 14,630 | 14,630 |
| R-squared | 0.5208 | 0.6944 | 0.7083 | 0.6315 | 0.5057 |
| Adj. R-squared | 0.4885 | 0.6737 | 0.6886 | 0.6067 | 0.4724 |

Source: Research results

Note: Dependent variable is wages. Controls in all columns: exporting country effects, product effects (HS04). Standard errors in parentheses. Significance at 1%, 5% and 10% levels indicated by ***, ** and *. Statistically non-significant indicated by NS.

Nevertheless, results presented in Table 6 for lower middle-income countries show that as the quality of imports sent to Brazil increases, its effect on wage is higher than when these goods come from richer nations. The outcome of this estimation could be understood from the possible lower quality scope of imports produced in poorer economies penetrating the Brazilian market. As Caron, Fally, and Markusen (2014) noted, richer countries have the potential to produce higher-end varieties. For this reason, it is sensible to affirm that products originating in lower middle-income economies are of lower-quality in respect of richer nations. These imports are believed to allow a more substantial effect onto wages paid in Brazil given that the quality gap between the domestic and foreign products is narrower. Hence, in this scenario, local firms are capable of responding to import competition faster through the skill upgrading mechanism, which results in a rise in local wages.

These results are consistent with the distance-to-the-frontier models discussed in Amiti and Khandelwal (2013), in which the authors observe that the relationship between import competition and quality depends on the distance of the product to the quality frontier. In their research, the authors drew on the model by Aghion and Howitt (2005), that allows the relationship between competition and innovation to depend on the distance of the product to the quality frontier. Their model highlights two forces. First, for firms far from the frontier, an increase in competition reduces incentives to innovate because *ex-post* rents from innovation are eroded by new entrants. Alternatively, as firms approach the frontier, however, competition can increase incentives to innovate because it reduces firms' pre-innovation rents by more than it reduces their post-innovation rents.

Therefore, imports shipped from lower middle-income countries to Brazil might be closer in quality to domestic products in comparison to foreign-made varieties coming from richer nations. These goods, in turn, offer local firms an incentive to enhance the quality of domestically produced goods and thus compete against international products. To enhance the quality of the output, local firms feel the need to hire qualified professionals who are paid higher wages.

Another possible reason why the quality of goods sent to Brazil from all the varied income groupings behaves towards the results presented in Table 6 is the demand-side driver. For instance, Brambilla and Porto (2016) and Caron, Fally, and Markusen (2014) discuss the intensity of trade among rich nations. For the authors, given the fact that richer economies demand and produce higher-quality goods, as a consequence, trade between rich economies is more intense, especially in higher-end varieties. According to the World Bank (2019), Brazil is considered an upper middle-income country, meaning that its population consists of consumers that are moderately demanding when it comes to quality but still not as demanding as those from developed richer economies. These perceptions could explain why the quality of imports produces a rather small effect on wages paid in Brazil from the demand-side perspective.

The analysis of Table 6 also allows to observe that for all income groups *per capita* GDP affects wages positively across all wage distribution quantiles. Coefficients did not allow for the observation of a clear pattern among income groups. Similarly, output did not show any strong evidence that such a variable may affect wages differently when considering contrasting income groupings.

## 5. Conclusions

This study aimed to investigate the relationship between the quality of Brazilian imports and wages paid in the country from 1997 to 2016. On average, results denote a positive effect of the quality of imports on Brazilian wages, suggesting that as the quality of imported goods increases, the average wage in Brazil also rises. Nevertheless, when the analysis was conducted

for contrasting wage quantiles, it was possible to observe that the quality of foreign products in the Brazilian market affects wage bands differently. The outcome of this analysis revealed that the quality of imports has a positive effect on lower band wage quantiles. Contrarily, the upper band quantiles of the wage distribution exhibited a negative relationship with the variable of interest – quality.

This study also provided an additional analysis and observed whether quality affected differing wage quantiles when considering the income levels of the exporting country shipping its products to Brazil. Results indicated that the quality of imports originated from poorer economies affects wages paid in Brazil slightly more in respect of richer countries (high- and upper middle-income nations).

This study unveiled that the effect of the quality of Brazilian imports on wages is rather small. This outcome was observed in the analysis of the full sample regressed on average wages, and along the wage distribution quantiles for the whole sample and also when taking into account the origin country's income differentials, regardless of their relationship: positive or negative. The magnitude of the coefficients might narrate the indirect association between the quality of foreign goods in competition with locally produced varieties and their effects onto wages paid in Brazil between 1997 and 2016.

Throughout the all the analyses conducted in this research, it was possible to also gather evidence of other variables affecting the wage levels in the Brazilian economy. The investigation of the connection between the national product and wages paid by firms producing goods that face import competition as well as the association between output and wages showed that as the average *per capita* product and output increase, wages are positively affected. This outcome was also observed along differing wage quantiles and for different origin country income groups.

With respect to limitations, this study faced the challenge of working with product-level data. In other words, information on wages referred to the total wage paid by a set of firms producing a given product *k.* The use of more disaggregated information, at the firm level, for instance, would have the potential to allow for capturing the differentiating components of goods exported to Brazil within each firm. This means that each firm could export differing variations of products in terms of quality and direct them to different markets. Data at the firm level could also allow for more precise information on wages paid by each firm facing import competition instead of the sum of wages paid by a whole set of local organizations.

Another limitation to this study is the proxy for the quality of imports. Although it has been long addressed in several papers in the trade literature (Bastos and Silva 2010; Brambilla and Porto 2016; Flach 2016; Hallak 2006), the most recent studies have not yet found a common ground when it comes to an ideal measurement of such a variable. Future studies on the topic might as well explore the quality calculation more intensively and strive to improve it, in order to approximate as much as possible to a more realistic quality measure.

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## Appendix

Table 7 - Main trade exporters to Brazil and average share of Brazilian imports between 1997 and 2016.

| Exporter | Share | Exporter | Share | Exporter | Share |
|---|---|---|---|---|---|
| United States | 16,74% | Malaysia | 0,92% | Egypt | 0,09% |
| China | 12,33% | Thailand | 0,88% | Tunisia | 0,06% |
| Argentina | 8,19% | Uruguay | 0,87% | Slovakia | 0,06% |
| Germany | 7,14% | Indonesia | 0,72% | Ecuador | 0,05% |
| Japan | 3,79% | Australia | 0,63% | New Zealand | 0,05% |
| South Korea | 3,57% | Peru | 0,63% | Latvia | 0,03% |
| Italy | 3,09% | Austria | 0,62% | Oman | 0,02% |
| France | 2,87% | Venezuela | 0,61% | Sri Lanka | 0,02% |
| Mexico | 2,09% | Colombia | 0,52% | Lithuania | 0,01% |
| Chile | 2,06% | Finland | 0,47% | Croatia | 0,01% |
| India | 2,03% | Hong Kong | 0,46% | Guatemala | 0,01% |
| Spain | 1,75% | Morocco | 0,45% | Iceland | 0,01% |
| United Kingdom | 1,75% | Norway | 0,41% | Cyprus | 0,01% |
| Algeria | 1,58% | Portugal | 0,39% | Honduras | 0,00% |
| Canada | 1,50% | Denmark | 0,34% | Jordan | 0,00% |
| Switerland | 1,44% | Ireland | 0,33% | El Salvador | 0,00% |
| Saudi Arabia | 1,42% | Poland | 0,26% | Mauritius | 0,00% |
| Bolivia | 1,30% | Hungary | 0,17% | Madagascar | 0,00% |
| Netherlands | 1,11% | Costa Rica | 0,14% | Central African Rep. | 0,00% |
| Sweden | 1,00% | Romania | 0,10% | Belize | 0,00% |

Source: Author's calculations.