Preliminary Working Draft
Please do not quote or cite without authors' permission
Contact: patieene.passoni@feac.ufal.br

Decomposing the effective rate of protection in Brazil between 2005 and 2023: trade policy or technical change effects?

Patieene Alves-Passoni
Professor at the Faculty of Economics, Administration, and Accounting at the Federal University of Alagoas (UFAL), Brazil, and researcher at the Industry and Competitiveness Group at the Federal University of Rio de Janeiro (GIC-UFRJ).
Marta Castilho
Professor at the Institute of Economics at UFRJ and researcher at the GIC-UFRJ.
Marcelo Tonon
PhD candidate in Economics at the Institute of Economics at UFRJ and researcher at the GIC-UFRJ.
Adriano Duarte
PhD student in Economics at the Institute of Economics at UFRJ and researcher at the GIC-UFRJ.

ABSTRACT

This study aims to analyze the evolution of the effective rate of protection (ERP) for Brazilian tradable goods from 2005 to 2023 through a structural decomposition analysis. The ERP, as conceptualized by Corden (1971), measures the protection afforded to final goods by accounting for tariffs on inputs weighted by their significance. Using partial equilibrium analysis, this study evaluates changes in domestic value added against a counterfactual free market scenario. The ERP is defined as the percentage variation in protected domestic value added due to tariffs on final goods and inputs. The decomposition categorizes effective protection into three components: nominal tariffs on imported goods, domestic inputs, and imported inputs, employing the Bennet method as suggested by de Boer and Rodrigues (2020). Findings indicate a decline in effective protective tariffs, influenced more by nominal tariffs than by changes in technical coefficients of inputs. Despite imported inputs constituting 30% of total inputs, they significantly contribute to decreasing effective protection due to their rising relative price and increased dependency.

Key words: Effective rate of protection. Nominal import tariffs. Domestic inputs. Imported inputs. Strucutral Decomposition analysis.

1. Introduction

The nominal tariff imposed on a country's goods helps to understand the country's tariff barriers and import policy over time. However, this type of assessment has significant limitations when qualitatively comparing the level of protection granted to different sectors and its impact on economic activity. This is because the production chains of different goods rely on various technologies with different complexities. Therefore, quantifying the protection effectively provided to national goods should also consider the protection given to suppliers of inputs used in the production process.

The main goal of this study is to thoroughly examine the changes in the effective protection rate (ERP) for Brazilian tradable goods from 2005 to 2023. As defined by Corden (1971), the

ERP evaluates the level of protection applied to final goods, taking into account the tariffs on inputs weighted by their significance in the value of the final product. The ERP assesses the relative incentives provided to different sectors through customs tariffs, considering the protection applied to final goods and the inputs used in their production via estimates of the effective protection rate.

In practice, import policy is complex, as changes in nominal rates can have unexpected effects depending on the specific industry structure. The policy can create negative incentives for domestic production, leading to adverse impacts on industries' value added. There are two ways in which the change in tariffs affects the domestic value added. First, from a production perspective, applying a tariff to a final product aims to promote domestic production of that product because the imported alternative becomes more expensive.

However, there is a second effect because since this product can also be used as an input in other production processes, the imposed tariff can decrease the value added in other sectors. So, in terms of production costs and competitiveness, if the protection provided to final goods is lower than the protection given to input goods, this tariff structure can lead to lower prices for imported goods than similar domestic products, resulting in reduced competitiveness and disincentives for domestic production. In practical terms, the import policy may not effectively protect domestic production.

The effective protection rate (ERP) is calculated using a partial equilibrium analysis, which considers the production structure and compares changes in domestic value added to a hypothetical scenario of a free market. Essentially, the rate measures the difference between observed added value and the hypothetical added value when there are no tariffs on the activity and its inputs. This disparity is expressed as the percentage change in protected domestic value-added, influenced by tariffs on the final product and imported inputs. The ERP depends on three main factors: i) the nominal tariffs on both final products and inputs, and the total technical coefficients required for production, which are divided into ii) domestic and iii) imported. Therefore, a structural breakdown will help understand how the ERP changes and distinguish between the effects of trade policy and technical changes.

The proposed structural decomposition analysis (SDA) of ERP allows changes to be categorized into three components: the impact of changes in nominal tariffs on imported goods and the domestic and imported technical coefficients. Since the ERP is affected by both real and hypothetical value added simultaneously, a specialized treatment for the SDA is necessary, as discussed in the methodology. The Bennet method, suggested by de Boer and Rodrigues (2020), is employed for this purpose.

The data used to calculate the ERP includes the nominal tariff protection structure provided by the Secretariat of Foreign Trade (SECEX) of the Brazilian Ministry of Development, Industry, and Commerce and the production structure obtained from national Input-Output Tables (IOT). The Brazilian Institute of Geography and Statistics (IBGE) releases the official data at five-year intervals ending in zero and five. This study utilizes IOT estimates by Alves-Passoni and Freitas (2023) for non-corresponding years.

Previous studies, such as Castilho et al. (2015), Castilho and Miranda (2018), Bloch and Soares (2018), have estimated Brazil's ERP and others have done so for other countries[1]. However, these studies have not identified the key elements explaining the changes in ERP. The closest they have come is calculating the correlation between the nominal tariff and the ERP. When

[1] Chen, Ma, and Jacks (China), Trinh and Kobayashi (Vietnam), Pathania and Bhattacharjea (India), Marks and Rahardja (Indonesia), Ndlovu (Zimbabwe), and Burnete (Mexico) have significantly contributed to the understanding of this topic in their respective national contexts.

the correlation is closer to 1, it indicates that changes in ERP are more closely related to the nominal tariff. However, this analysis is limited in determining whether changes were due to increased tariffs or shifts in technical coefficients. The novelty of this study lies in its methodology, which unravels the changes in effective protection between two periods, thereby determining the contributions of tariff changes and technical coefficients (domestic and imported) to effective protection in percentage terms.

2. Methodology

2.1. The effective rate of protection

The concept of "effective rate of protection" (ERP) was initially introduced by Balassa in 1971 and further developed by Corden in 1971. It has become a crucial reference in this area. The ERP measures the level of protection given to final goods by adjusting for the protection on inputs. This adjustment is weighted by their contribution to the value of the final good, using technical coefficients obtained from input-output tables.

This makes ERP a useful tool for evaluating incentive differences across various economic sectors (Corden, 1971; Balassa, 1971), and potentially between different economies if a consistent calculation methodology is applied. This indicator allows for the deduction of nominal tariffs applied to final goods in different sectors from the tariffs on their inputs, considering the significance of these inputs in the sector's production structure.

Constructing the EPR involves a partial equilibrium analysis using data on production structure, comparing the observed domestic value added to a free-market counterfactual scenario.

The methodological approach used here closely follows the frameworks established by Corden (1971) and Castilho and Miranda (2017). Effective protection for an activity is defined as the difference between the "true" and the hypothetical value added that would exist without tariffs on the activity and its inputs. Thus, the effective protection for activity j (π_j) is expressed as the percentage change in protected domestic value added (VAP_j) under the influence of tariffs, compared to the hypothetical value added in a free trade scenario (VAL_j).Therefore, the EPR can be defined as:

$$\pi_j = \frac{VAP_j \; - VAL_j}{VAL_j}. \quad (1)$$

Castilho and Miranda (2017) explain that, unlike the straightforward economic interpretation of nominal tariffs, which directly increase the price of imported goods, effective protection rates reflect the variations in sectoral value added (VAP_i) compared to a hypothetical free trade situation (VAL_j).

After a few procedures, the previous equation can be expressed in terms of the tariffs, such as:

$$\pi_j = \frac{\left(t_j \; - \sum_i (a_{ij}^L t_i)\right)}{\left(1 - \sum_i a_{ij}^L\right)}. \quad (2)$$

where: t_j is the nominal tariff imposed on product j; t_i is the nominal tariff imposed on input i; and a_{ij}^L is the coefficient that measures the share of input i in the total production cost of one unit of product j, measured in international prices, or the technical coefficient of free trade.

The method proposed by Corden (1971), adopted in this study, suggests a way to estimate a_{ij}^L and then obtain the EPR. As mentioned earlier, technical coefficients are measured by the participation of input i in the total production cost of product j:

$$a_{ij}^{LC} = {p_{ij}^{*}q_{ij}} \Big/ {p_j^{*}q_j} \qquad (3)$$

where p_{ij}^{*} and q_{ij} are the international price and quantity of the i inputs used in the production of the j sector, and p_j^{*} and q_j are the international price and quantity of the production of the j sector.

We must sum the technical coefficient of input i produced domestically, measured at domestic prices (d_{ij}), and the technical coefficient of imported inputs i, measured at international prices (m_{ij}) to obtain the "actual" a_{ij}, such as:

$$a_{ij} = d_{ij} + m_{ij}(1 + t_i) \qquad (4)$$

To accurately measure the production cost, we need to account for the cost of importing inputs and paying the corresponding tariff of the i inputs used to produce the j gross output. This means we must multiply m_{ij} by $(1 + t_i)$.

The domestic technical coefficient is defined by:

$$d_{ij} = {p_{ij}^{d}q_{ij}^{d}} \Big/ {p_j^{d}q_j^{d}} \qquad (5),$$

where p_i^{d} and q_i^{d} are the domestic price and quantity of the i inputs used in the production of the j sector, and p_j^{d} and q_j are the domestic price and quantity of the production of the j sector.

The same is observed for the imported technical coefficient, and we define it as:

$$m_{ij} = {p_{ij}^{*}q_{ij}^{m}} \Big/ {p_j^{d}q_j^{d}} \qquad (5b)$$

Assuming that the domestic prices (p_i^{d}) are equal to international prices (p_j^{*}) plus the import tariff, that is, $p_j^{d} = p_j^{*}(1 + t)$, and substituting into equations (5a) and (5b), expression (3) can be rewritten as:

$$a_{ij}^{L} = d_{ij}\frac{(1 + t_j)}{(1 + t_i)} + m_{ij}(1 + t_j) \qquad (6)$$

Substituting expression (6) into (2) yields the final form of the estimated ERP, estimating the technical coefficients of free trade using the method proposed in Corden (1971):

$$\pi_j = \frac{t_j - \sum_i \left[\left(d_{ij}\frac{(1 + t_j)}{(1 + t_i)} + m_{ij}(1 + t_j)\right)t_i\right]}{1 - \sum_i \left(d_{ij}\frac{(1 + t_j)}{(1 + t_i)} + m_{ij}(1 + t_j)\right)} \qquad (7)$$

The equation shows that the level of protection depends on the tariffs applied to inputs, final goods, and both domestic and imported technical coefficients. The exact impact of changes in in $t_j$and t_i on π_j is not clear and depends on the specific values of technical coefficients. It also relies on the relative magnitudes of t_j and t_i. This emphasizes the complex relationship between tariff policies and production dynamics, emphasizing the need for a detailed understanding of these factors in influencing trade outcomes.

However, this analysis assumes that there are no changes in relative prices (p_{ij}^{*}/p_j^{d} and p_{ij}^{d}/p_j^{d}) and that the exchange rate remains constant. If there are changes, they should not affect the technical coefficients or induce changes in the production structure.

2.2. Decomposition

As briefly discussed in the previous section, interpreting tariff changes over time, particularly between two periods, presents a significant challenge. To address this, we propose a structural decomposition that allows for the disaggregation of variations over time into changes in tariffs, domestic inputs, and intermediate inputs.

To facilitate the analysis, we will break down equation (7) into three groups:

$$\pi_j = \frac{t_j}{1-\sum_i d_{ij}\frac{(1+t_j)}{(1+t_i)} - \sum_i\left(m_{ij}(1+t_j)\right)} \quad \text{Group I} \tag{8}$$

$$= -\frac{\sum_i d_{ij}\frac{(1+t_j)}{(1+t_i)}\times t_i}{1-\sum_i d_{ij}\frac{(1+t_j)}{(1+t_i)} - \sum_i\left(m_{ij}(1+t_j)\right)} \quad \text{Group II}$$

$$-\frac{\sum_i\left(m_{ij}(1+t_j)\right)t_i}{1-\sum_i d_{ij}\frac{(1+t_j)}{(1+t_i)} - \sum_i\left(m_{ij}(1+t_j)\right)} \quad \text{Group III}$$

Thus, the variation will be given by:

$$\Delta\pi_j = \pi_j(1) - \pi_j(0) \tag{9}$$

However, the variation of $\Delta\pi_j$ (9) will be given by each element of the equation (8), being equivalent to:

$$\Delta\pi_j = \Delta\pi_{j_{GI}} - \Delta\pi_{j_{GII}} - \Delta\pi_{j_{GIII}} \tag{10}$$

Now, focusing on the decomposition of each group ($\Delta\pi_{j_{GN}}$, with N=1,2,3), we note that since it consists of three elements, there are six possible ways to disaggregate each of them, as given by n! (Miller, Blair, 2009; Dietzenbacher e Los, 1998). In our case, with three variables (t, d and m), we have six possible decompositions. A crucial aspect of this process is the presence of "dependent" variables, meaning the same variable appears multiple times within the same equation, either in the numerator, denominator, or in multiple terms (see eq. 8). To address this, we assume that when a variable changes within each equation, the same time index (zero and one) should be applied consistently to all its occurrences.

Let A, B and C be the indices for t, d and m, which can take values corresponding to either the initial period (0) or the final period (1). Thus, for each value of $\Delta\pi_{j_{GN}}$, it would be possible to have multiple combinations of the indices, with (100)-(000) appearing twice, (110)-(010) appearing once, (101)-(001) also appearing once, and (111)-(011) appearing twice. Therefore, we would have:

$$\Delta\pi_{j_{GI}} = \frac{t_j(A)}{1-\sum_i\left(d_{ij}(B)\frac{(1+t_j(A))}{(1+t_i(A))}\right)-\sum_i\left(m_{ij}(C)(1+t_j(A))\right)} - \frac{t_j(A)}{1-\sum_i\left(d_{ij}(B)\frac{(1+t_j(A))}{(1+t_i(A))}\right)-\sum_i\left(m_{ij}(C)(1+t_j(A))\right)} \tag{11}$$

$$\Delta\pi_{j_{GII}} = \frac{\sum_i\left(d_{ij}(B)\frac{(1+t_j(A))}{(1+t_i(A))}\times t_i(A)\right)}{1-\sum_i\left(d_{ij}(B)\frac{(1+t_j(A))}{(1+t_i(A))}\right)-\sum_i\left(m_{ij}(C)\left(1+t_j(A)\right)\right)} - \frac{\sum_i\left(d_{ij}(B)\frac{(1+t_j(A))}{(1+t_i(A))}\times t_i(A)\right)}{1-\sum_i\left(d_{ij}(B)\frac{(1+t_j(A))}{(1+t_i(A))}\right)-\sum_i\left(m_{ij}(C)\left(1+t_j(A)\right)\right)} \quad (12)$$

$$\Delta\pi_{j_{GIII}} = \frac{\sum_i\left(m_{ij}(C)\left(1+t_j(A)\right)\right)t_i(A)}{1-\sum_i d_{ij}(B)\frac{(1+t_j(A))}{(1+t_i(A))}-\sum_i\left(m_{ij}(C)\left(1+t_j(A)\right)\right)} - \frac{\sum_i\left(m_{ij}(C)\left(1+t_j(A)\right)\right)t_i(A)}{1-\sum_i d_{ij}(B)\frac{(1+t_j(A))}{(1+t_i(A))}-\sum_i\left(m_{ij}(C)\left(1+t_j(A)\right)\right)} \quad (13)$$

In other words, for the equations $\Delta\pi_{j_{GI}}$, $\Delta\pi_{j_{GII}}$ e $\Delta\pi_{j_{GIII}}$, there are six possible combinations that can be calculated using the previously mentioned indices. We also clarify that the effects of change in the tariffs between the final goods and their inputs we be computed together, because there are many that are used in the same industry, which means j=i.

Typically, the literature employs the average of polar decompositions, as recommended by Dietzenbacher and Los (1998). However, this method overlooks other forms of decomposition. In this study, we chose to use Siegel's (1945) generalization of Bennet's indicator. De Boer (2009) and de Boer and Rodrigues (2020) demonstrate that it is equivalent to the arithmetic mean of all elementary decompositions. This approach results in a perfect decomposition, utilizing all possible decompositions. It has desirable properties from the perspective of Structural Decomposition Analysis (SDA), such as consistency in aggregation, robustness to zero values and changes in sign, and completeness at both the aggregate and disaggregate levels. Specifically, robustness to changes in sign is particularly relevant for the case of tariffs and technical coefficients, further justifying its use.

To arrive at a single effect from the six possible decompositions, we use the weights given by the formula proposed by Siegel (1945), which is a generalization of the Fisher index. In this formula, the weighting indices for the average are calculated based on the number of times each possible decomposition appears.

Unlike simpler decompositions, where we can directly obtain the variation of the variables, in this case, the values equivalent to Δt, Δd, and Δm will only be obtained a posteriori. Thus, each group will have the variation of the three factors we want to determine: tariff, imported technical coefficient, and domestic technical coefficient. Therefore, for each $\Delta\pi_{j_{GN}}$ will be:

$$\Delta\pi_{j_{GN}} = \Delta\mathrm{t} + \Delta\mathrm{d} + \Delta\mathrm{m} \quad (14)$$

To find the variation of each of the three elements, it will be necessary to sum the corresponding parts from Groups 1, 2, and 3:

$$\Delta\mathrm{t} = \Delta\mathrm{t}_{\mathrm{GI}} + \Delta\mathrm{t}_{\mathrm{GII}} + \Delta\mathrm{t}_{\mathrm{GIII}} \quad (15)$$

$$\Delta\mathrm{d} = \Delta\mathrm{d}_{\mathrm{GI}} + \Delta\mathrm{d}_{\mathrm{GII}} + \Delta\mathrm{d}_{\mathrm{GIII}} \quad (16)$$

$$\Delta\mathrm{m} = \Delta\mathrm{m}_{\mathrm{GI}} + \Delta\mathrm{m}_{\mathrm{GII}} + \Delta\mathrm{m}_{\mathrm{GIII}} \quad (17)$$

In this way, we obtain the total sum of the tariff variation:

$$\Delta\pi_j = \Delta\mathrm{t} + \Delta\mathrm{d} + \Delta\mathrm{m} \quad (18)$$

2.3. Data

The previous decomposition requires two sets of information. Firstly, information about the nominal import tariff imposed on products (t_j) and on inputs along the production chain (t_i).

The first set of data for the year 2023[2] was obtained from Castilho, Passoni, and Duarte (2024). For 2005, the compilation of tariff data at the NCM level was sourced from Castilho and Miranda (2017). These sources consider the Common External Tariff (TEC) of Mercosur provided by the Secretariat of Foreign Trade (SECEX) of the Ministry of Development, Industry, and Commerce (MDIC). The tariff data incorporate all modifications relevant to the set of products, disregarding measures not applicable to the group of countries or suppliers of imported goods. This includes ignoring commercial preferences from trade agreements, anti-dumping measures, and certain special regimes that provide reductions depending on the use of imported goods.

Secondly, information is needed about the production structure of each sector, the technical coefficients. The Brazilian Institute of Geography and Statistics (IBGE) releases official Input-Output Matrices (IOTs) only every five years, for years ending in zero and five. Since the years calculated here differ from the official IOT years published by IBGE, we use the ones estimated by Alves-Passoni and Freitas (2023) within the Industry and Competitiveness Group the Institute of Economics at the Federal University of Rio de Janeiro (GIC-UFRJ) of. These estimates are based on the Supply and Use Tables (SUT) published annually by IBGE, albeit with a two-year reference lag.[3].

In the years prior to 2010, due to the methodological transition from the BSNA 2000 to the BSNA 2010, we opted to use the series of Input-Output Tables (IOTs). Another important aspect is that the ones published before the BSNA 2010 are not compatible with the ones published before, due to the methodological transition from the BSNA 2000 to the BSNA 2010. The series estimated by Alves-Passoni and Freitas (2023) covers 42 sectors and 91 products. Consequently, it was necessary to reassess the nominal tariffs, recalculating them based on the existing tariff data by NCM) for this classification for 2005 and 2023.Since the 2023 SUT or the IOT is not yet available, we have decided to use the data from 2019. We preferred this over the 2021 data because it still reflects the significant effects of the COVID-19 pandemic.

As tariffs are applied to products and have a more direct correspondence with NCMs (Common Nomenclature of Mercosur), we have chosen to calculate effective protection by product. This methodological approach differs from that of Castilho and Miranda (2017). To "transform" the information on intermediate consumption carried out by activities in the calculation of technical coefficients, it is assumed that this has the same structure as the products produced by the activities, using market share matrices. Therefore, this matrix ($\boldsymbol{H}$, with dimensions 42 x 91) provides the proportion of how much each activity is responsible for the production of each product.

Therefore, to obtain $\boldsymbol{D}$, where $i = j$ for the commodities (42 x 91), the following steps are taken:

$$\boldsymbol{D} = \boldsymbol{B_d H} \tag{10}$$

where $\boldsymbol{B_d}$ (91×42) is the matrix of domestic technical coefficients, which indicates the intermediate consumption of domestic inputs i by activities j for their sectoral production.

The same is done for the matrix of imported technical coefficients ($\boldsymbol{B_m}$, 91×42) which indicates the intermediate consumption of imported inputs i by activities j for their sectoral production, to obtain the coefficients $\boldsymbol{M} = m_{ij}$:

$$\boldsymbol{M} = \boldsymbol{B_m H} \tag{11}$$

[2] Valid at August 13, 2023.
[3]The most recent SUT is from 2021, published on November 8, 2023.

As we noted before, the model does not differentiate the tariff of final goods and inputs. The classification of which good is a final good or input is done according to the input-output model, so the supply is the information in the rows, and the inputs is the information in the columns.

As Cordon (1971) and Castilho and Miranda (2017) suggest, in calculating effective protection, the intermediate consumption of non-tradable goods and inputs such as energy, rent, insurance, and other services are not considered. This is because their availability is typically limited to the domestic market and is not guided by international prices, thus remaining unaffected by tariffs. So, among the 91 commodities, we will only consider the 72 products are related to agriculture, extractive industries, and manufacturing (see appendix for the commodities list).

3. Results

Table 1 displays the ERP values for 2005 and 2023, along with the decomposition results and the percentage contribution of the nominal tariff, domestic, and imported technical coefficients. The text is: "It is displayed from the highest change in the ERP to the lowest one." Upon analyzing the decomposition, it becomes evident that the primary factor influencing changes in ERP is the alteration in nominal tariff rates. This outcome is expected, given that tariff values are significantly larger in magnitude compared to technical coefficients. Following the nominal tariff rates, domestic technical coefficients are the next most influential, with imported coefficients ranking third.

The first interesting observation when analyzing the ERP between 2003 and 2023 is that the average decreased. While this was largely due to the reduction in the nominal tariff (9.8% to 8.4%), the decrease in the ERP was less significant (11.4% to 10.9%). This is because there was a decrease in domestic technical coefficients, indicating lower use of inputs. However, imported technical coefficients contributed positively to the increase in tariffs, but to a lesser extent than the decline in domestic coefficients. Therefore, despite falling nominal tariffs, combining these effects meant that the ERP drop was smaller.

Another remarkable aspect is the transmission effect between the sign of the difference in the variables in level and their contribution to the decomposition. The data showing the levels of the variables and their changes is presented in Table A.1 of the appendix. The difference surges because the changes are weighted by the values of the other variables. For the contribution of nominal tariffs, 88% of products exhibit the same trend. This means that an increase or decrease in nominal tariffs leads to a positive or negative contribution to the ERP decomposition. In the case of domestic technical coefficients, the sign reversal happens more often, and 58% of cases follow the same direction. For imported technical coefficients, 69% of the analyzed commodities have the same positive or negative sign. This underscores the importance of decomposition analysis, as it allows for a comprehensive evaluation of the effects of changes on the effective rate of protection for each commodity, depending on production structure.

When examining the decomposition for 2005-2023, it was observed that 21 products experienced an increase in their ERP, representing 30% of the 72 analyzed products. Among these, 12 saw an increase in their nominal tariff, indicating that the contribution of the nominal tariff was in the same direction as the nominal variation. The products where this occurred are as follows: "Ethanol and other biofuels," "Tobacco products," "Other dairy products," "Clothing and accessories," "Manufacture of other textile products," "Beverages," "Automobiles, trucks, and utility vehicles," "Trucks and buses, including cabins, bodies, trailers, parts, and accessories," "Footwear and leather goods," "Household appliances," "Rubber articles," "Cast steel and non-ferrous metal parts."

Table 1 - Effective rate of protection for 2005 and 2023 and structural decomposition results

Rank	Commodity	ERP 2005	ERP 2023	Decompostion: Tarriff	Technical coefficients: Domestic	Technical coefficients: Imported	Total change
1	Ethanol and other biofuels	-0.575	28.681	29.140	-0.005	0.121	29.256
2	Tobacco products	-3.423	20.131	24.321	-0.805	0.038	23.554
3	Other dairy products	11.563	32.015	22.156	-2.127	0.423	20.452
4	Clothing and accessories	20.484	39.794	20.460	-1.785	0.634	19.309
5	Manufacture of other textile products	22.275	39.497	23.371	-7.741	1.592	17.222
6	Beverages	13.023	27.787	16.496	-2.080	0.348	14.765
7	Automobiles, vans, and utility vehicles	60.553	70.346	5.653	-6.084	10.224	9.793
8	Trucks and buses, incl. cabins, bodies, and trailers, parts, and accessories	18.236	25.330	7.748	-1.628	0.974	7.094
9	Footwear and leather goods	11.222	17.879	7.469	-0.822	0.011	6.657
10	Household appliances	14.964	20.867	6.430	-1.304	0.777	5.903
11	Rubber articles	10.727	14.637	4.305	-0.807	0.413	3.910
12	Cast steel and non-ferrous metal castings	19.621	22.918	3.922	-1.564	0.939	3.297
13	Coal	-4.624	-2.505	0.742	1.418	-0.041	2.119
14	Non-metallic minerals	0.973	1.828	-0.047	0.911	-0.009	0.855
15	Products derived from wheat, cassava, or corn, including balanced animal feed	10.426	11.063	1.010	-0.457	0.084	0.637
16	Metal products, excl. machinery and equipment	14.883	15.484	0.384	-0.228	0.445	0.600
17	Gasohol	-4.523	-3.984	1.925	-1.678	0.293	0.539
18	Fuel oil	-4.523	-3.984	1.925	-1.678	0.293	0.539
19	Cow's milk and milk from other animals	-2.834	-2.364	0.899	-0.005	-0.423	0.471
20	Plastic articles	14.080	14.387	0.782	-1.068	0.593	0.307
21	Cement	1.585	1.669	-0.238	0.474	-0.153	0.084
22	Poultry and eggs	0.772	0.721	0.270	-0.037	-0.284	-0.051
23	Paper, cardboard, packaging, and paper products	13.787	12.769	-1.000	-0.179	0.162	-1.017
24	Agricultural pesticides and household disinfectants	13.120	12.076	-0.266	-2.016	1.239	-1.044
25	Various chemical products	10.992	9.694	-0.936	-1.127	0.765	-1.298
26	Pigs	-1.005	-2.364	-0.959	-0.013	-0.386	-1.358
27	Poultry meat	11.623	10.152	-1.293	-0.248	0.070	-1.471
28	Other petroleum refining products	-0.740	-2.231	-0.260	-1.307	0.076	-1.491
29	Processed and finished textile fibers	20.515	18.922	-0.113	-1.901	0.422	-1.592
30	Chilled, sterilized, and pasteurized milk	15.817	14.130	-0.520	-1.298	0.131	-1.687
31	Measurement, testing, and control equipment, optical and electromedical furniture, and other products from various industries	14.260	12.542	-1.475	-0.435	0.193	-1.717
32	Processed coffee	16.961	15.186	-0.609	-1.368	0.201	-1.775
33	Non-ferrous metallic minerals	-0.122	-1.939	-2.899	1.127	-0.045	-1.817
34	Orange	11.384	9.533	-1.891	-0.140	0.180	-1.851
35	Processed rice and rice products	12.930	11.069	-1.558	-0.388	0.084	-1.862
36	Semi-finished, flat, long, and steel tube products	18.072	16.188	-5.012	2.564	0.564	-1.884
37	Wood products, excluding furniture	9.284	7.215	-1.773	-0.238	-0.058	-2.069
38	Pharmaceutical products	5.932	3.847	-2.073	0.011	-0.023	-2.084
39	Beef and other meat products	10.216	7.957	-2.022	-0.269	0.031	-2.259
40	Cassava, leaf tobacco, and other products and services from temporary and permanent crops	8.957	6.687	-2.203	-0.112	0.045	-2.270

…continue

… continuing

Rank	Commodity	ERP		Decompostion			
		2005	2023	Tarriff	Technical coefficients		Total change
					Domestic	Imported	
41	*Other food products*	16.478	14.140	-1.264	-1.207	0.133	-2.337
42	*Pork meat*	12.789	10.388	-1.932	-0.564	0.094	-2.402
43	*Office machines and computer equipment*	7.846	5.434	-2.721	0.524	-0.215	-2.412
44	*Electronic material and communication equipment*	9.267	6.683	-2.716	0.331	-0.199	-2.584
45	*Iron ore*	1.207	-1.473	-2.857	0.230	-0.053	-2.680
46	*Cattle and other live animals, animal products, hunting, and services.*	5.028	2.336	-2.476	-0.065	-0.152	-2.693
47	*Other non-metallic mineral products*	12.918	10.162	-2.600	-0.270	0.114	-2.756
48	*Inorganic chemical products*	5.536	2.740	-2.811	-0.086	0.100	-2.796
49	*Fruit, vegetable, other vegetable preserves, and fruit juices*	18.258	15.460	-1.968	-1.054	0.224	-2.798
50	*Petroleum, natural gas, and support services*	1.344	-1.683	-2.431	-0.188	-0.409	-3.028
51	*Machinery and equipment*	12.370	9.318	-2.943	-0.095	-0.013	-3.052
52	*Sugar*	23.309	20.102	-2.060	-1.489	0.342	-3.207
53	*Machines, appliances, and electrical materials*	15.796	12.551	-3.063	-0.577	0.395	-3.245
54	*Industrialized fish*	15.452	11.503	-3.288	-0.804	0.142	-3.950
55	*Paints, varnishes, enamels, and lacquers*	20.076	16.082	-2.923	-3.672	2.601	-3.995
56	*Fishing and aquaculture (fish, crustaceans, and mollusks)*	12.535	8.436	-4.142	-0.140	0.184	-4.099
57	*Organic chemical products*	6.760	2.147	-4.604	-0.221	0.212	-4.613
58	*Resins, elastomers, and artificial and synthetic fibers*	20.737	15.615	-6.892	-3.239	5.009	-5.122
59	*Coffee beans*	11.355	5.464	-5.866	-0.105	0.080	-5.891
60	*Pig iron and ferroalloys*	10.825	4.478	-7.860	1.422	0.091	-6.347
61	*Vegetable and animal oils and fats*	15.497	8.883	-6.134	-0.581	0.102	-6.614
62	*Products of non-ferrous metal metallurgy*	13.183	6.527	-5.942	-0.695	-0.018	-6.656
63	*Perfumery, soaps, and cleaning articles*	22.577	15.466	-5.693	-2.575	1.156	-7.111
64	*Sugarcane*	11.384	3.868	-7.452	-0.108	0.044	-7.516
65	*Soybeans*	9.907	2.287	-7.499	-0.091	-0.031	-7.621
66	*Printing and reproduction services*	16.208	8.520	-7.887	0.061	0.139	-7.687
67	*Rice, wheat, and other cereals*	10.996	2.513	-8.394	-0.092	0.003	-8.483
68	*Aircraft, vessels, and other transportation equipment*	16.552	7.516	-9.145	-0.067	0.176	-9.036
69	*Cellulose*	10.753	1.406	-9.712	0.311	0.054	-9.347
70	*Products of forest exploitation and forestry*	11.128	1.204	-9.812	-0.089	-0.022	-9.924
71	*Herbaceous cotton, other fibers from temporary crops*	13.771	3.710	-10.047	-0.121	0.106	-10.062
72	*Corn in grain*	11.384	0.725	-10.542	-0.092	-0.026	-10.659

Source: Own elaboration based on SECEX (2023), Castilho e Miranda (2017) and Alves-Passoni and Freitas (2023).

Something interesting is that for these same commodities, there was a negative contribution from domestic technical coefficients, meaning that the change in inputs used in production aimed to reduce the effective tariff. This movement is largely interconnected with the decline in domestic technical coefficients, implying that fewer inputs are needed to produce the same unit of product. In other words, if it weren't for the decrease in domestic inputs, these sectors would have seen a larger increase in effective protection.

In the case of the "Clothing and accessories" product, it's interesting to note that it had the largest increase in the nominal tariff, rising from 18.6% to 32.3%. However, the increase in its ERP only ranks fourth, increasing from 20.5% to 39.8%, due to the negative effect of domestic technical coefficients. There was an 8% drop in domestic inputs to produce this commodity, resulting in a contribution of -1.8p.p. to the total variation of 19.3%. The nominal tariff contributed an increase of 20.4 p.p., while the imported technical coefficients increased by 0.6 p.p.

Among the 12 commodities, only the "Automobiles, trucks, and utility vehicles" had a negative contribution related to them with a contribution of -6.08 percentage points. This product has the highest ERP, and it changed from 60,6% to 70.3%, an increase of 9.8p.p. In this case, an increase in domestic technical coefficients (by 1%) was observed, but with a negative contribution to the tariff. Considering that the nominal tariff for this product also increased, the explanation for this negative contribution would be the difference between t_j and t_i, meaning that it is likely that the inputs used in the production of this product have increased relatively more than the product itself.
The remarkable aspect of this product is that the main factor driving its growth is the increase in imported technical coefficients, which contributed 10.2 percentage points to the growth of EEP. When examining the imported technical coefficients, it was found that in 2005, 0.08 units of imported inputs were needed to produce one unit of the gross product of this commodity, while in 2019, 0.145 units were needed, representing a 65% increase. In contrast, the nominal tariff only contributed 5.7 percentage points.

In the case of the contribution from imported coefficients, there is an amplified effect contributing to the increase in effective tariff for 73% of the products. Among these, only "Cow's milk and other animal milks," "Cement," "Poultry and eggs," "Swine," "Wood products, excluding furniture," "Office machines and data processing equipment," "Electronic material and communications equipment," "Cattle and other live animals, animal products, hunting, and services" had a negative contribution to effective protection. However, all these sectors (except for "Oil, natural gas, and support services") experienced increased imported coefficients.

The effect of imports' positive contribution to the effective protection tariff stems from intrinsic changes in the Brazilian economy, where more imported inputs are used in production than domestic ones. Comparing total inputs, that is, the sum of domestic and imported inputs, the observed decline in domestic inputs is greater than that for total inputs. This indicates that the national industry has lost competitiveness compared to the imported industry.

However, there can be an increase in the effective tariff even with a reduction in the nominal tariff. This is because what also matters for calculating the effective tariff is the relative change between the tariffs of the final good and its production chain, as will be further discussed. The products in which such movements were observed were: "Coal," "Non-metallic minerals," "Products derived from wheat, cassava, or corn, including balanced animal feed," "Metal products, excluding machinery and equipment," "Gasohol," "Fuel oil," "Cow's milk and other animal milks," "Plastic articles," and "Cement."

The products that experienced the largest decrease in effective protection tariff are generally agricultural products, such as "Fishing and aquaculture (fish, crustaceans, and mollusks)," "Coffee beans," "Vegetable and animal oils and fats," "Sugarcane," "Soybeans," "Rice, wheat, and other cereals," "Pulp," "Products of forestry and logging," "Cotton, other temporary crop fibers," and "Corn."

Among these, all saw a reduction in nominal tariff and, for the most part, also a negative contribution from domestic technical coefficients. However, there is significant dispersion between the values of changes in technical coefficients and their contribution, indicating a shift in the sectoral composition between the tariffs of final goods and inputs, with the latter reducing less proportionally.

Notably, the product "Aircraft, boats, and other transport equipment," which historically has great innovative potential in Brazil, is ranked 68th in tariff change, mainly affected by the decline in nominal tariff. Other capital-intensive products that reduced their effective tariffs include "Office machines and data processing equipment," "Electronic material and communications equipment," "Machinery and equipment," and "Machinery, appliances, and electrical materials," largely due to the reduction in nominal tariffs.

4. Conclusions

In this study, our goal was to thoroughly analyze the changes in the effective protection rate (ERP) for Brazilian tradable goods from 2005 to 2023. We aimed to offer a more nuanced understanding of the impact of tariff barriers on different sectors by considering the protection provided to suppliers of inputs used in the production process. Our findings indicate that evaluating ERP provides a more accurate reflection of protection levels than nominal tariffs alone. This highlights the complexities of import policy and its effects on domestic value-added and production competitiveness.

Our methodology involved a structural decomposition analysis (SDA) to categorize the changes in ERP into three components: changes in nominal tariffs on imported goods, domestic technical coefficients, and imported technical coefficients. The Bennet method, as suggested by de Boer and Rodrigues (2020), was employed to achieve a perfect decomposition of these changes. Using data from the Secretariat of Foreign Trade (SECEX) and national Input-Output Tables (IOT), we could estimate the ERP for various sectors, providing insights into the interplay between tariff policies and production structures.

The results indicate that the primary factor influencing changes in ERP was the alteration in nominal tariff rates. This was expected, given the significant magnitude of tariff values compared to technical coefficients. However, domestic technical coefficients also played a crucial role, with changes in these coefficients indicating shifts in the use of inputs in production processes. The analysis revealed that while nominal tariffs decreased over the period, the ERP drop was less pronounced due to these underlying shifts in production inputs, highlighting the importance of considering both tariffs and technical coefficients in policy assessments.

It is important to consider both tariffs and technical coefficients in policy assessments. Our study observed the transmission effect between changes in nominal tariffs, domestic technical coefficients, and imported technical coefficients. Changes in nominal tariffs generally aligned with their contribution to ERP changes, while domestic technical coefficients often exhibited sign reversals. This shows the complexity of tariff impacts, as changes in input usage and production structures significantly influence the effective protection experienced by different sectors. The decomposition analysis provided a detailed evaluation of these effects, demonstrating the interconnectedness of tariff policies and sectoral dynamics.

When examining specific products, we found that 30% of the analyzed products experienced an increase in their ERP between 2005 and 2023. For example, products like "Clothing and accessories" saw significant increases in nominal tariffs but had offsetting negative contributions from domestic technical coefficients. This highlights the intricate balance between tariff rates and input usage, where increases in nominal tariffs do not always translate directly to higher ERP due to changes in production inputs. The case of "Automobiles, trucks, and utility vehicles" further illustrated this, with increases in imported technical coefficients driving the ERP increase despite nominal tariff changes.

Our analysis also revealed the amplified effect of imported technical coefficients on ERP, with 73% of products showing a positive contribution from imports. This trend reflects broader changes in the Brazilian economy, where the reliance on imported inputs has increased, affecting the overall competitiveness of domestic production. The decrease in domestic technical coefficients suggests a shift towards greater use of imported inputs, which has implications for the national industry's competitive position relative to international markets.

Overall, our study highlights the importance of a detailed, decompositional approach to understanding tariff impacts. By breaking down the contributions of nominal tariffs, domestic, and imported technical coefficients, we provided a clearer picture of how trade policies affect different sectors. This approach not only offers a more accurate assessment of protection levels but also informs policymakers on the nuanced effects of tariff changes, guiding more effective trade and industrial policies. Our findings emphasize the need for continuous monitoring and adjustment of trade policies to ensure they support the desired economic outcomes in a dynamic global trade environment.

5. References

Alves-Passoni, P., & Freitas, F. (2023). Estimação de matrizes insumo-produto anuais para o Brasil no sistema de contas nacionais: referência 2010. **Política e Planejamento Econômico, 53**(1). https://repositorio.ipea.gov.br/handle/11058/13265

Balassa, B., et al. (1971). **The structure of protection in developing countries**. Baltimore: Johns Hopkins University Press.

Bennet, T. L. (1920). The theory of measurement of changes in the cost of living. **Journal of the Royal Statistical Society, 83**, 455–462.

Bloch, C., & Soares, S. (2018). **Proteção efetiva no Brasil: 2000 a 2015** (No. 2432). Texto para Discussão.

Burnete, S. (2017). Outsourcing under threat: Estimated impact of potential tariffs on US imports from Mexico. **Expert Journal of Economics, 5**(3). https://economics.expertjournals.com/23597704-511/

Castilho, M., & Miranda, P. (2017). Tarifa aduaneira como instrumento de política industrial: a evolução da estrutura de proteção tarifária no Brasil no período 2004-2014. In A. Messa & I. M. Oliveira (Eds.), **A política comercial brasileira em análise**. Brasília: Ipea.

Castilho, Passoni, & Duarte. (2024). Proteção tarifária nominal e efetiva no Brasil: estrutura e mudanças recentes. **Mimeo**.

Chen, B., Ma, H., & Jacks, D. S. (2017). Revisiting the effective rate of protection in the late stages of Chinese industrialisation. **The World Economy, 40**(2), 424-438.

Corden, W. (1971). **The theory of protection**. Oxford: Clarendon Press.

De Boer, P., & Rodrigues, J. F. (2020). Decomposition analysis: When to use which method?. **Economic Systems Research, 32**(1), 1-28.

De Boer, P. (2009). Multiplicative decomposition and index number theory: an empirical application of the Sato–Vartia decomposition. **Economic Systems Research**, *21*(2), 163-174.

Dietzenbacher, E., & Los, B. (1998). Structural decomposition techniques: sense and sensitivity. **Economic Systems Research**, *10*(4), 307-324

Marks, S. V., & Rahardja, S. (2012). Effective rates of protection revisited for Indonesia. **Bulletin of Indonesian Economic Studies, 48**(1), 57-84.

Ndlovu, L. B. (2018). **The system of protection and industrial development in Zimbabwe**. London: Routledge.

Pathania, K., & Bhattacharjea, A. (2020). Inverted duty structures and the paradox of negative effective protection in India, 2000–2014. **Foreign Trade Review, 55**(2), 139-167.

Secretaria de Comércio Exterior (SECEX). (2023). Sistema de Análise das Informações de Comércio Exterior. In Câmara do Comércio Exterior (CAMEX). **Tarifas Vigentes/Lista de Bens sem Similar Nacional (Lessin)**. Retrieved from https://www.gov.br/produtividade-e-comercio-exterior/pt-br/assuntos/camex/estrategia-comercial/listas-vigentes

Siegel, I. H. (1945). The generalized 'ideal' index-number formula. **Journal of the American Statistical Association, 40**, 520–523.

Trinh, B., & Kobayashi, K. (2010). Measuring the effective rate of protection in Vietnam's economy with emphasis on the manufacturing industry: an input-output approach. **Depocenwp, series, (2010/12)**.

APPENDIX

Table A.1 - Values and change of nominal tariff, domestic and imported technical coefficient, for 2005 and 2023

Rank	Commodity	Nominal tariff			Domestic technical coefficient			Imported technical coefficient		
		2005	2023	Change	2005	2023	Change	2005	2023	Change
1	*Ethanol and other biofuels*	4.667	14.400	9.733	0.739	0.733	-0.005	0.155	0.271	0.116
2	*Tobacco products*	3.692	12.894	9.202	0.841	0.723	-0.119	0.071	0.099	0.028
3	*Other dairy products*	9.838	16.800	6.962	0.771	0.751	-0.020	0.028	0.038	0.010
4	*Clothing and accessories*	18.609	32.349	13.740	0.516	0.475	-0.041	0.059	0.074	0.015
5	*Manufacture of other textile products*	16.885	25.275	8.390	0.658	0.549	-0.109	0.045	0.073	0.028
6	*Beverages*	10.444	15.294	4.849	0.779	0.752	-0.027	0.022	0.024	0.001
7	*Automobiles, vans, and utility vehicles*	31.619	34.269	2.650	0.663	0.669	0.006	0.088	0.145	0.057
8	*Trucks and buses, incl. cabins, bodies, and trailers, parts, and accessories*	15.857	19.465	3.608	0.629	0.588	-0.041	0.149	0.294	0.144
9	*Footwear and leather goods*	11.467	16.424	4.957	0.650	0.529	-0.121	0.036	0.053	0.018
10	*Household appliances*	13.397	15.022	1.625	0.623	0.541	-0.082	0.176	0.212	0.036
11	*Rubber articles*	10.931	11.565	0.634	0.617	0.547	-0.070	0.106	0.166	0.060
12	*Cast steel and non-ferrous metal castings*	13.333	13.533	0.200	0.654	0.596	-0.058	0.050	0.103	0.053
13	*Coal*	0.000	0.000	0.000	0.611	0.480	-0.130	0.091	0.091	0.001
14	*Non-metallic minerals*	3.667	3.083	-0.584	0.609	0.485	-0.124	0.072	0.129	0.057
15	*Products derived from wheat, cassava, or corn, including animal feed*	9.385	8.379	-1.006	0.761	0.738	-0.023	0.030	0.041	0.011
16	*Metal products, excl. machinery and equipment*	13.763	12.736	-1.027	0.525	0.526	0.001	0.187	0.223	0.036
17	*Gasohol*	0.000	0.000	0.000	0.621	0.673	0.052	0.121	0.105	-0.017
18	*Fuel oil*	0.000	0.000	0.000	0.621	0.673	0.052	0.117	0.106	-0.011
19	*Cow's milk and milk from other animals*	0.000	0.000	0.000	0.390	0.397	0.007	0.026	0.058	0.032
20	*Plastic articles*	12.456	11.456	-1.000	0.614	0.546	-0.067	0.060	0.077	0.017
21	*Cement*	4.000	3.200	-0.800	0.649	0.607	-0.042	0.061	0.078	0.017
22	*Poultry and eggs*	2.615	2.133	-0.482	0.390	0.397	0.007	0.026	0.058	0.032
23	*Paper, cardboard, packaging, and paper products*	12.043	9.974	-2.070	0.622	0.589	-0.033	0.057	0.083	0.026
24	*Agricultural pesticides and household disinfectants*	10.114	8.656	-1.458	0.641	0.535	-0.106	0.146	0.219	0.074
25	*Various chemical products*	9.170	7.438	-1.732	0.640	0.554	-0.086	0.152	0.234	0.082
26	*Pigs*	1.333	0.000	-1.333	0.390	0.397	0.007	0.026	0.058	0.032
27	*Poultry meat*	10.000	8.000	-2.000	0.739	0.740	0.001	0.031	0.042	0.011
28	*Other petroleum refining products*	1.150	0.495	-0.655	0.606	0.667	0.060	0.022	0.027	0.005

… continue

… continuing

Rank	Commodity	Nominal tariff			Domestic technical coefficient			Imported technical coefficient		
		2005	2023	Change	2005	2023	Change	2005	2023	Change
29	*Processed and finished textile fibers*	16.259	15.519	-0.740	0.635	0.523	-0.112	0.078	0.110	0.032
30	*Chilled, sterilized, and pasteurized milk*	11.800	10.133	-1.667	0.752	0.707	-0.045	0.031	0.042	0.012
31	*Measurement, testing, and control equipment, optical and electromedical furniture, and other products from various industries*	12.960	11.020	-1.940	0.480	0.434	-0.046	0.057	0.062	0.005
32	*Processed coffee*	12.000	10.200	-1.800	0.780	0.747	-0.033	0.030	0.042	0.012
33	*Non-ferrous metallic minerals*	2.875	0.400	-2.475	0.607	0.479	-0.128	0.031	0.042	0.011
34	*Orange*	10.000	8.000	-2.000	0.390	0.397	0.007	0.026	0.058	0.032
35	*Processed rice and rice products*	10.571	8.457	-2.114	0.722	0.729	0.008	0.030	0.043	0.012
36	*Semi-finished, flat, long, and steel tube products*	13.017	9.397	-3.620	0.591	0.668	0.077	0.137	0.161	0.023
37	*Wood products, excluding furniture*	9.667	7.220	-2.446	0.548	0.552	0.004	0.082	0.095	0.013
38	*Pharmaceutical products*	6.269	4.331	-1.938	0.376	0.392	0.016	0.105	0.169	0.063
39	*Beef and other meat products*	9.278	6.918	-2.360	0.778	0.755	-0.023	0.031	0.042	0.011
40	*Cassava, leaf tobacco, and other products and services from temporary and permanent crops*	8.353	6.145	-2.208	0.389	0.397	0.007	0.026	0.058	0.032
41	*Other food products*	12.430	10.501	-1.929	0.712	0.666	-0.046	0.031	0.042	0.011
42	*Pork meat*	10.333	8.000	-2.333	0.781	0.759	-0.021	0.030	0.041	0.012
43	*Office machines and computer equipment*	9.689	7.055	-2.634	0.475	0.427	-0.048	0.117	0.164	0.047
44	*Electronic material and communication equipment*	10.450	7.827	-2.623	0.481	0.432	-0.049	0.186	0.213	0.027
45	*Iron ore*	2.667	0.000	-2.667	0.406	0.426	0.020	0.092	0.091	-0.001
46	*Cattle and other live animals, animal products, hunting, and services.*	5.632	3.233	-2.399	0.390	0.397	0.007	0.026	0.058	0.032
47	*Other non-metallic mineral products*	10.545	8.363	-2.182	0.639	0.608	-0.031	0.112	0.137	0.025
48	*Inorganic chemical products*	5.476	2.974	-2.502	0.570	0.522	-0.048	0.155	0.274	0.119
49	*Fruit, vegetable, other vegetable preserves, and fruit juices*	12.589	10.233	-2.356	0.772	0.756	-0.016	0.030	0.041	0.011
50	*Petroleum, natural gas, and support services*	2.400	0.000	-2.400	0.338	0.379	0.041	0.081	0.079	-0.002
51	*Machinery and equipment*	12.006	9.296	-2.711	0.480	0.434	-0.046	0.102	0.167	0.065
52	*Sugar*	14.500	11.911	-2.589	0.772	0.753	-0.019	0.031	0.042	0.011

… continue

… continuing

Rank	Commodity	Nominal tariff			Domestic technical coefficient			Imported technical coefficient		
		2005	2023	Change	2005	2023	Change	2005	2023	Change
53	*Machines, appliances, and electrical materials*	13.796	10.949	-2.847	0.627	0.548	-0.079	0.116	0.160	0.045
54	*Industrialized fish*	11.395	8.492	-2.903	0.783	0.760	-0.023	0.030	0.041	0.011
55	*Paints, varnishes, enamels, and lacquers*	12.884	10.344	-2.540	0.643	0.537	-0.106	0.111	0.144	0.033
56	*Fishing and aquaculture (fish, crustaceans, and mollusks)*	10.774	7.287	-3.486	0.390	0.397	0.007	0.092	0.091	-0.001
57	*Organic chemical products*	6.027	2.778	-3.249	0.568	0.525	-0.044	0.159	0.278	0.119
58	*Resins, elastomers, and artificial and synthetic fibers*	11.945	8.082	-3.863	0.572	0.522	-0.050	0.153	0.234	0.081
59	*Coffee beans*	10.000	5.333	-4.667	0.388	0.396	0.008	0.026	0.058	0.032
60	*Pig iron and ferroalloys*	9.238	4.114	-5.124	0.592	0.673	0.081	0.111	0.136	0.025
61	*Vegetable and animal oils and fats*	11.667	7.433	-4.234	0.751	0.725	-0.026	0.031	0.042	0.011
62	*Products of non-ferrous metal metallurgy*	10.000	5.512	-4.488	0.660	0.601	-0.060	0.133	0.163	0.030
63	*Perfumery, soaps, and cleaning articles*	14.871	11.479	-3.392	0.667	0.578	-0.089	0.085	0.110	0.024
64	*Sugarcane*	10.000	4.267	-5.733	0.390	0.397	0.007	0.026	0.058	0.032
65	*Soybeans*	9.000	3.200	-5.800	0.390	0.397	0.008	0.026	0.058	0.032
66	*Printing and reproduction services*	15.000	8.800	-6.200	0.435	0.454	0.019	0.121	0.105	-0.017
67	*Rice, wheat, and other cereals*	9.760	3.345	-6.415	0.387	0.395	0.008	0.026	0.058	0.032
68	*Aircraft, vessels, and other transportation equipment*	15.422	8.433	-6.989	0.465	0.407	-0.058	0.181	0.213	0.032
69	*Cellulose*	10.353	3.200	-7.153	0.624	0.591	-0.033	0.082	0.096	0.014
70	*Products of forest exploitation and forestry*	9.829	2.462	-7.367	0.390	0.397	0.008	0.026	0.058	0.032
71	*Herbaceous cotton, other fibers from temporary crops*	11.600	4.160	-7.440	0.390	0.397	0.007	0.026	0.058	0.032
72	*Corn in grain*	10.000	2.133	-7.867	0.390	0.397	0.007	0.026	0.058	0.032

Source: Own elaboration based on SECEX (2023), Castilho e Miranda (2017) and Alves-Passoni and Freitas (2023).