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The impact of exchange rate misalignments on manufacturing investment in Brazil*

O impacto dos desalinhamentos cambiais sobre o investimento industrial no Brasil

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RESUMO: Analisamos a hipótese de que as variações do investimento manufatureiro são influenciadas pela diferença entre as taxas de câmbio reais efetivas e de equilíbrio industrial e pela diferença entre as taxas de câmbio em conta-corrente e de equilíbrio industrial (uma *proxy* para a doença holandesa). A taxa de câmbio de equilíbrio em conta-corrente é definida como a taxa que garante que a conta-corrente de um país esteja equilibrada intertemporalmente, e a taxa de câmbio de equilíbrio industrial corresponde à taxa que torna competitivas as empresas que produzem bens e serviços não *commodities* comercializáveis internacionalmente no chamado estado da arte. Primeiramente, são explicados os conceitos e metodologias para estimar a conta-corrente e a taxa de câmbio de equilíbrio industrial. Em seguida, para testar nossa hipótese, foi construído um banco de dados para 24 setores manufatureiros brasileiros de 2007 a 2017. Um modelo dinâmico de dados em painel foi adotado para estimar a relação entre esses desalinhamentos cambiais e o investimento industrial. Os resultados sugerem que a magnitude dessas diferenças influencia as decisões de investimento, contribuindo potencialmente para o crescimento e desenvolvimento econômico.
PALAVRAS-CHAVE: Taxas de câmbio reais; investimento industrial.

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ABSTRACT: We analyze the hypothesis that variations on manufacturing investment are influenced by the difference between the real effective and industrial equilibrium exchange rates and by the difference between the current account and industrial equilibrium exchange rates (a proxy for the Dutch disease). The current account equilibrium exchange rate is defined as the rate that guarantees that the current account of a country is balanced intertemporally, and the industrial equilibrium exchange rate corresponds to the rate that makes competitive those companies producing internationally tradable non-commodities goods and services in the so-called state-of-art. First, the concepts and methodologies for estimating the current account and industrial equilibrium exchange rate are explained. Then, to test our hypothesis, a database for 24 Brazilian manufacturing sectors was built from 2007 to 2017. A dynamic panel data model was adopted to estimate the relationship between these currency misalignments and the manufacturing investment. The results suggest that the magnitude of those differences influences investment decisions, potentially contributing to economic growth and development.
KEYWORDS: Real exchange rates; manufacturing investment.
JEL Classification: E22; F31; L60.

1. INTRODUCTION

The importance of maintaining a competitive exchange rate has gained attention in the economic development debate over the last decades, and recent studies have found robust indications that a competitive exchange rate is determinant for stimulating investment, structural change, and economic growth (Ferrari, Freitas, Barbosa Filho, 2013; Gala, 2008; Guzman, Ocampo, Stiglitz, 2018; Marconi et al., 2021; Missio et al., 2015; Rapetti, Skott, Razmi, 2012; Rodrik, 2008). This emerging body of empirical evidence is accompanied by many studies that aim to understand that relationship at a more disaggregated level, arguing that there are important differences among the economic sectors that would engender diverse responses of the economic actors to an exchange rate appreciation or depreciation.

For instance, studying the USA manufacturing industry, Campa and Goldberg (1995) and Campa and Goldberg (1999) found that exchange rate variations would impact differently sectoral investments according to their profit margin. Alternatively, Blecker (2007) observed that the main channel from which the exchange rate impacts investment in manufacturing sectors is through financial or liquidity constraints. Atella et al. (2003) and Nucci and Pozzolo (2001), using panel data regressions to study the Italian Manufacturing firms, have shown that the impact of the exchange rate on investment depends critically on export orientation and monopoly power of the diverse industries. The same has been observed in China manufacturing; the impact of the exchange rate on investment depends on the imported input coefficient and monopoly power of the firm (Li, Li, Wu, 2019). For Brazil, Baltar, Hiratuka and Lima (2016) achieve similar conclusions pointing to the importance of taking into consideration sector differences and Luporini and Alvez (2010) points to the opposite effect of the relationship in the short and long run. While the authors found a negative effect of currency devaluation on investment in the short run, they have found a positive effect in the long run.

At first, the literature on the topic reveals the importance to consider firms/sectors' monopoly power, exposure to the international market, and profit margin to empirically analyze the relationship between exchange rate and investment. Nevertheless, another important decision one must make to investigate the impact of variations of the exchange rate on investment is which exchange rate should be considered. Most of the studies are done adopting: i) the variations on the real exchange rate; ii) econometric methodologies to calculate over (under) appreciations (Rodrik, 2008) and iii) based on some concept of exchange rate equilibrium – for instance, the Fundamental Equilibrium Exchange Rate of Williamson (1983). The latter methodology is usually recommended and very utile if one wants to understand and calculate the 'ideal' exchange rate and to study currency misalignments.

Considering the exchange rate as a crucial variable for the theory of economic development and economic policy, this article aims to examine two measurements of equilibrium exchange rates developed by the New Developmentalism (henceforward also called ND) theory that critically assesses the Fundamental Equilibrium Exchange Rate: i) the current account equilibrium exchange rate (henceforth also referred as REER_CA) – that guarantees that the country's current account is balanced intertemporally, and ii) the industrial equilibrium exchange rate (hereafter also referred as IEER)- the one that makes competitive those companies producing internationally tradable non-commodities goods and services at the state-of-art. A divergence between the two equilibriums would be caused by the Dutch disease (Bresser-Pereira et al., 2014).

Moreover, to contribute to the discussion on the role played by the exchange rate in inducing investment, this paper uses the new measurements of the equilibrium exchange rates developed by the ND theory to investigate empirically their relationship with manufacture investment in Brazil from 2007 to 2017. The first hypothesis put forward by this research is that manufacturing investment will vary according to the difference between the real effective and industrial equilibrium exchange rates; this difference is one of our suggested measures for estimating exchange rate misalignments. The second hypothesis is that investment will vary according to the difference between the current account equilibrium and industrial equilibrium exchange rates; this difference is relevant when a country suffers a process of Dutch disease, and it is our proposed measure for estimating the magnitude of such disease.

The article is organized as follows: Section 2 discusses the theoretical advances of New Developmentalism Theory that puts the exchange rate at the center of the theory of macroeconomic development. Section 3 presents the two equilibrium exchange rates developed by the ND theory and the measurement of exchange rate misalignments. Section 4 presents the database created, a descriptive analysis of the variables considered, and the methodology adopted to test the research hypothesis. Section 5 contains the test results based on an econometric dynamic panel data model, and the conclusions are presented in Section 6.

2. CHRONICLE AND CYCLICAL APPRECIATION OF THE EXCHANGE RATE AND ITS CAUSES

The New Developmentalism Theory puts the exchange rate at the center of the theory of economic development for middle-income countries, especially Latin American countries. This theory contributes to the debate on the relationship between the exchange rate and growth by arguing about the importance of a competitive exchange rate to enable local entrepreneurs' access to domestic and global demand. It agrees that investment decisions depend on the expected rate of profit but argues that the latter depends not only on the effective demand but also on the capacity to access that demand. But what determines the access to the existing demand? On the one hand, from the supply-side, it depends on technical competitivity – appropriate capabilities, infrastructure, etc. On the other hand, from the demand-side, it is a function of the 'economic competitivity' – that depends on a macroeconomic environment – including a competitive exchange rate – beneficial for stimulating investment and economic growth. While the supply-side determinants are accepted in the literature, the latter is often questioned.

According to Bresser-Pereira (2012, p.10), "prior schools of thought had not adopted this position because they assume the exchange rate would be unbalanced only in the short term". That analysis includes Keynesian and Structuralist Schools that focus their critic on the Neoclassical theories of the exchange rate, specifically on its excessive volatility. The neoclassical literature, by assuming that volatility is only a short-run problem, argues that firms, when making their investment decisions, would consider only the average rate of the exchange rate. Some studies are defending this argument, as in Aghion et al. (2009), Barguellil, Ben-Salha and Zmami (2018), and Demir (2010); it is a very different assumption from that predicted by the ND theory, which is the first theory to propose that there is a tendency of a cyclical and chronic overvaluation of the exchange rate in some developing countries.

A cyclical and chronicle appreciation of the exchange rate negatively impacts investments and conduces to the reprimarization of the developing country productive structure. On the one hand, exporters do not get enough revenue in local currency to stimulate them to compete in the global market. On the other hand, imports of inputs and final consumer goods become more attractive in the internal market, thus, local producers lose competitiveness. Moreover, while commodity exporters are resilient to currency overvaluation due to its 'Ricardian Rents', entrepreneurs of sophisticated products – in manufacturing and modern tradable services that adopt the state-of-the-art technology – are not.

This phenomenon is the so-called Dutch disease, one important cause of currency appreciation[1]. Some sectors – as the commodity exporters – have a com-

[1] Bresser-Pereira and Nakano (2003) first wrote about this topic while criticizing the strategy of growth with external savings. Later Bresser-Pereira (2008), Bresser-Pereira and Marconi (2010) and Palma (2005) further developed the concept of Dutch disease (initially presented by Corden and Neary (1982)

parative advantage in the production of its goods and derivatives, and, therefore, a lower production cost, which generates Ricardian rents. Therefore, this sector has a higher profit margin and may coexist with a more appreciated exchange rate without harming its profitability to the point of making investments unviable. The same cannot be said about sectors that do not benefit from these comparative advantages, which are the producers of more sophisticated goods and services. Both sectors, the producers of primary and sophisticated goods, suffer a reduction in profit during exchange rate appreciation. However, due to the difference in their margins, an appreciation of the exchange rate may turn investment unviable for the producers of sophisticated goods and services, while it would not necessarily impact investment in the primary sectors that have greater profit margins. In this situation, there is a tendency towards reprimarization of the exports and the regression of the productive structure of the economy. If the process of Dutch disease will not be neutralized, the exchange rate may remain appreciated for a long period and the trade surplus in commodities may even enable a trade surplus, but this process will occur at the expense of the lower competitiveness of the manufacturing and other tradable sectors with narrow profit margins.

Nonetheless, the Dutch disease is not the only reason for currency overvaluation in developing countries. The ND argues that the cyclical and chronicle appreciation of the exchange rate is also caused by three economic policies implemented by the government and its Central Bank. First, the strategy of growth financed by external savings. Second, the use of the exchange rate as an anchor to control inflation. Third, the common practice of maintaining a high interest rate in a level substantially superior to the international interest rate to enable the two previous economic policies and due to the characteristics of the process of financial deepening in some developing countries.

The scarcity of domestic savings has led several middle-income countries to capture external savings instead of expanding domestic savings throughout exports (as opposed to the practice in Asian countries). To attract external resources, the policy used by those countries is to increase positively the interest rate differential. However, by the very character of the return associated with this differential, those resources not necessarily will be channeled to productive investments, but most probably to financial applications.

The capital inflow may provoke an appreciation of assets, a speculative bubble, a heating up of consumption due to the exchange rate appreciation, and a deficit in the current account that is financed, for a certain period, with external savings, which allows for the extension of the period of currency appreciation but, when the deficit is increasing and the same tendency is observed for the external debt, the country faces a financial and balance of payment crisis. At that critical point, the exchange rate suffers an overshooting. After the country recomposes its external

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applicable to the Latin American case, showing its impacts on the productive structure and economic growth rates.

accounts, the policies are once again implemented, illustrating the chronicle and cyclical character of the exchange rate appreciation.

According to the ND theory, the option to grow with foreign savings implies in consecutive deficits in the current account and the observation of an appreciated currency that also feeds this deficit. This is an important theoretical inversion proposed by the New Developmentalism. In general, it is argued that a period of exchange rate appreciation leads to a deficit in the current account. While this is true, the model presented here puts the strategy of growth with foreign savings, and therefore with deficits in current accounts, as an economic policy option that will necessarily imply currency appreciation, and the latter will further accentuate this choice.

Summing up, the Dutch disease, accentuated by the three economic policies mentioned above, engenders a process of chronicle and cyclical appreciation of the exchange rate that is harmful to investments in sophisticated sectors and leads to a reprimarization of the productive structure.

3. EXCHANGE RATE MISALIGNMENTS AND THE TWO EQUILIBRIUM EXCHANGE RATES

What has been the behavior and evolution of the exchange rate in Brazil? Has the country experienced cyclical and chronicle overvaluation over the last decades? Graph 1 (below) illustrates the evolution of the real bilateral exchange rate (Br/USA) in Brazil from 1950 to September 2021. The blue line is the real exchange rate (Br/USA), and the dotted red line is the real exchange rate adjusted by the effective tariff protection rate[2], in other words, the real exchange rate that would be observed in the absence of the tariffs. The graph illustrates three important elements of the evolution of the exchange rate in Brazil. First, it shows that the period with the highest effective import tariff was from 1968 to 1980, a period in which, consciously or not, the country might have neutralized the Dutch disease[3]. At that time, Brazil had a tariff system that positively influenced its competitiveness. Unfortunately, the capacity to implement similar tax policies has been considerably hampered by current trade agreements and organizations like WTO, reinforcing the need to think of possible alternatives – such as exchange rate policies and the creation of sovereign funds – to neutralize the Dutch disease.

Second, Graph 1 shows cyclical movements, mainly after the decade of 1970, from sharp depreciation in the exchange rate (for example from 1983 to 1985 and

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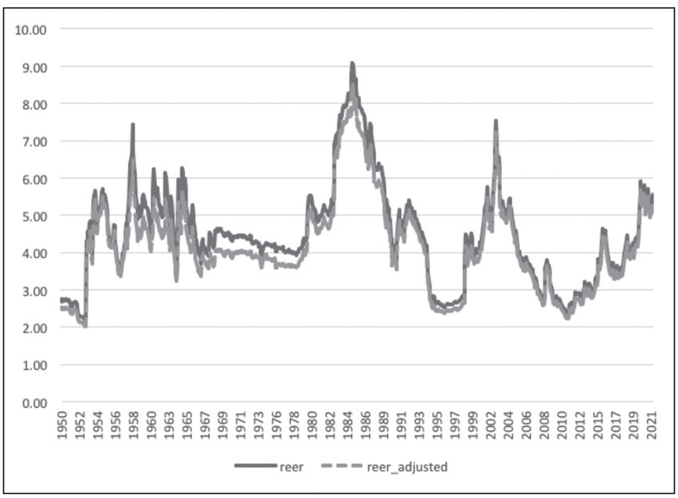
[2] The effective tariff protection rate is the ratio between total tax revenues from imports and total imports. From 1950 to 1987, data was collected at the Historical Statistics of IBGE. For 1988 and 1989, data on total imports was obtained at MDIC and information about tax revenues from imports were obtained at the National Accounts from IBGE. For the period after 1989, information was collected at IPEADATA.

[3] Moreover, it is also the period of the 'mini exchange rate devaluations' and the Brazilian 'economic miracle'.

from 1999 to 2003) followed by persistent and large periods of appreciation (for example, from 1986 to 1999 and from 2003 to 2012). We can observe a depreciation in the most recent years (2019-2021) due to, among other factors, a relevant reduction of the real interest rate that had not occurred for many years and break, at least during this period, with the binomial high interest rates-appreciated currency. Thirdly, it is possible to observe that for the most part of the period analyzed, the exchange rate volatility is substantial and there are only a few periods with some relative stability – for example, from 1968 to 1980 and from 1995 to 2000, after Plano Real (but in the first period the stability occurred at a higher exchange rate level, which was a relevant instrument to increase the manufacturing exports that contributed to the emerging of the Brazilian "economic miracle", whereas in the second period the exchange rate remained stable and appreciated, which seems to contribute to the declining of Brazilian manufacturing[4].

Graph 1: Real Exchange Rate (BR/USA) and Real Exchange Rate adjusted by effective tariff protection rate – Values in constant reais of September 2021



Source: Authors elaboration based on IGP-FGV, Bureau of Labor Statistics – Department of Labor (BLS), IBGE, MDIC and Ipeadata.

As argued in the theoretical discussion, a possible strategy to empirically investigate the relationship between exchange rate and investment decisions is to use the exchange rate misalignment as an explanatory variable, which is also a concept very suitable to investigate periods of cyclical and chronic appreciation/ depreciation of the exchange rate. Therefore, in addition to the REER, one must have a benchmark for what would be the 'ideal' rate – commonly called equilibrium exchange rate – to estimate the exchange rate misalignment.

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[4] Regarding the relationship between the appreciation observed in the decades of 1990 and 2000 and the deindustrialization, see Marconi and Rocha (2012).

The equilibrium exchange rate used by a great majority of mainstream economists and recommended for the developing countries is the Fundamental Equilibrium Exchange Rate of Williamson (1994). Alternatively, it can be called external debt exchange rate equilibrium because this equilibrium is associated with a deficit in current transactions that would be, according to the model, sustainable (or financeable) in the long run, because. Indeed, it is an exchange rate that is compatible with a deficit level that results on the increase in external debt lower than the growth rate of GDP – which therefore maintains the external debt to GDP ratio stable or declining. Ceteris paribus, it is an exchange rate that, supposedly, would prevent the developing countries from a balance of payment crisis and allow them to adopt a strategy of growth cum external debt[5].

The ND theory critically assesses the Fundamental Equilibrium Exchange Rate and claims the existence of two different equilibrium exchange rates. The first – the current account equilibrium exchange rate – is the one that guarantees that the country's current account is balanced intertemporally. The second – the industrial equilibrium exchange rate – is the one that makes competitive those companies producing internationally tradable non-commodities goods and services (Bresser-Pereira, 2008; Bresser-Pereira, Oreiro, Marconi, 2014).

3.1. The Current Account Equilibrium Exchange Rate

The current account equilibrium exchange rate is the one that guarantees that the country's current account is balanced intertemporally. It represents an important distinction with the Williamsons' Fundamental Exchange rate by explicitly excluding the "sustainable external debt limit" and by considering the current account as a relevant variable for determining the level of the exchange rate, as argued in the theoretical discussion in Section 2.

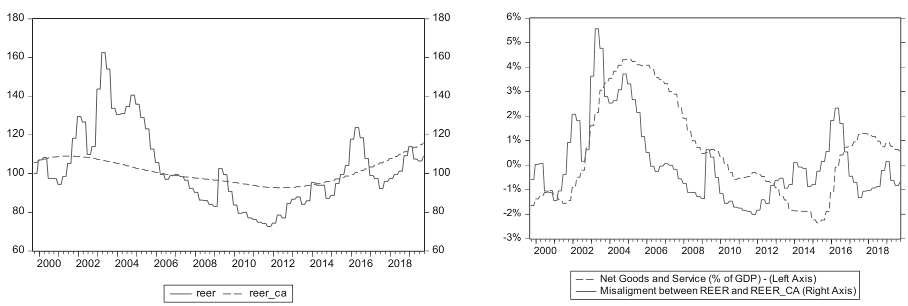
Bresser-Pereira et al. (2022, forthcoming) developed an econometric methodology for estimating the current account equilibrium exchange rate and presented original estimations for several Latin America countries. The proposed methodology is an adaptation of Baffes, O'Connell and Elbadawi (1999) and Edwards (1989) and provides a plausible way to incorporate the reality that both short-term policy variables and long-term structural variables can move permanently and change the trajectory of the exchange rate. Summarily, the estimation methodology consists in four steps: i) investigation of the long-run relationship to be estimated, adapting the existing theory to the characteristics of the Brazilian economy; ii) description of the long-term relationship in a model whose long-term parameters are estimated, using techniques appropriate to the characteristics of the time series included in such model; iii) employment of the estimated parameters to calculate the "equilibrium" exchange rate, that is, the exchange rate compatible with the crucial eco-

[5] More information about the methodology behind the Fundamental Equilibrium Exchange Rate and its recent estimation, see Cline (2008, 2017).

nomic variables, both short-term policy and long-term structural variables; iv) attribution of the value zero to the current account balance, in order to estimate the exchange rate compatible with current account balance in equilibrium.

The authors then executed a Vector Error Correction Model (VECM) for a benchmark model that integrate the terms of trade, current account, GDP per capita, country risk (EMBI+) and interest rate differential, and estimated the current account equilibrium exchange rate for Argentina, Brazil, Chile, and Colombia. The left graph of Figure 1 (below) shows the evolution of the current account equilibrium exchange rate (hereafter REER_CA) and the observed real exchange rate of Brazil (therefore REER) from the last quarter of 1999 to the last quarter of 2019. When REER is above REER_CA we consider that the exchange rate is depreciated. Inversely, when REER is below REER_CA, it is considered that the exchange rate is appreciated. It is possible to observe that REER is higher than REER_CA until 2005 and then REER became more appreciated than the REER_CA for approximately 9 years. After 2014, REER gravitated around the REER_CA.

Figure 1: Current Account Equilibrium Exchange Rate, Exchange Rate Misalignment (MIS = REER-REER_CA) and Net Trade of Goods and Services as a percentage of GDP



Source: Adaptation from Bresser-Pereira et al. (2022, forthcoming).

The right-hand-side graph of Figure 1 shows the exchange rate misalignment (MIS = REER-REER_CA) and the net trade of goods and services as a percentage of GDP (a proxy used for the current account). A positive inclination in the red and blue lines means that the REER is depreciating compared with the REER_CA and that the current account is improving, respectively. The figure demonstrates a positive correlation between exchange rate misalignment and the current account. In other words, real exchange rate appreciation (falling trend of the misalignment) in relation to the equilibrium level is associated with the deterioration of the trade balance. As argued before, we are possibly observing a bi-directional causality. On the one hand, a growth strategy based on foreign savings and, consequently, on the acceptance of current account deficits, would result in currency appreciation. On the other hand, currency appreciation impacts the current account negatively.

3.2. The Industrial Equilibrium Exchange Rate

The industrial equilibrium exchange rate level corresponds to the one necessary to ensure a sufficient profitability to efficient producers of the manufactured and modern service sectors – at the state-of-the-art technology – to compete efficiently in the domestic and foreign markets. In other words, it is the exchange rate level that enables efficient domestic producers to equalize, in average, their profit rates with the observed for their global competitors.

The methodology for estimating the IEER has been developed by Marconi (2012) that calculated the IEER for Brazil from 1988 to 2011. Recently, Marconi et al. (2021) estimated the IEER for 43 countries and empirically tested its influence on the process of structural change. A simple way to calculate the IEER corresponds to the estimation of the exchange rate that compensates the differential between unit labor costs in the country and its competing trade partners in the domestic and foreign markets[6]. Certainly, other costs are also relevant for manufacturing, but the unit labor costs are observed in all sectors and throughout the production chain; therefore, it is always relevant; and the inclusion of other costs in the estimation would make it unviable. The implicit idea is that the exchange rate cannot compensate for all inefficiencies observed in an economy, otherwise its inflationary impact would be large enough to minimize its effect on growth and development.

One important characteristic of the methodology for its calculation is that one must initially choose a base year in which we understand that the observed real effective exchange rate index is/was equivalent to a level that is/was competitive for manufacturing, that is, equal to the industrial equilibrium level.

In a country where Dutch disease is observed, the industrial equilibrium is, by definition, more depreciated than the current equilibrium, because the exchange rate that balances the current account is not enough to guarantee the sufficient profit rate for the manufacturing. Thus, in the year in which our manufacturing is competitive, that is, the observed exchange rate is at the industrial equilibrium level, a current account surplus should be observed. On the other hand, since the Dutch disease in the Brazilian economy is not serious but moderate, this surplus should be small. Therefore, for the Brazilian economy, the year 2005 has been chosen as the base year. This is because we understand that the exchange rate fluctuated around the industrial equilibrium in this period, since the current account balance was slightly positive in 2005 as well as in the two previous and subsequent ones, leading us to choose the intermediary year in this interval.

By defining 2005 as the base year, we equalize the index of IEER to 100 in this period and accumulate, over time, (prospectively and retrospectively) the variations of the unit labor cost differentials of Brazil in relation to its main trading partners. Given this definition, the differences found between the IEER and the REER over

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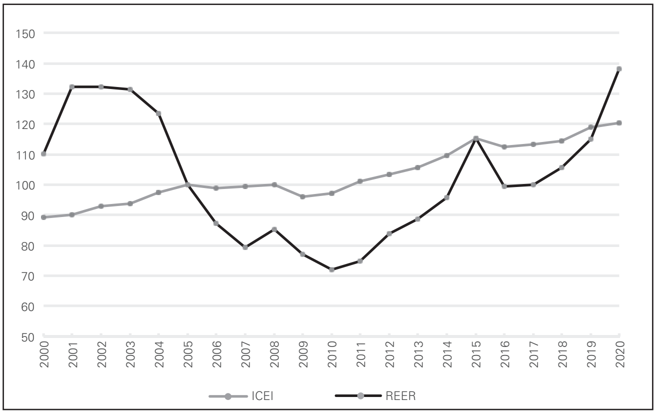
[6] In the estimations presented, ten main trade partners of Brazil have been considered. To avoid endogeneity bias, fixed periods of 5-year averages have been used in the weighting process.

time correspond to the deviations (appreciations or depreciations) of the observed exchange rate relative to the industrial equilibrium level.

Graph 2: Industrial Equilibrium Exchange Rate and Real Effective Exchange Rate (2005=100, 12 months moving averages)



Source: CND-FGV, available at: https://eaesp.fgv.br/centros/centro-estudos-novo-desenvolvimentismo/projetos/taxa-cambio-equilibrio-industrial.

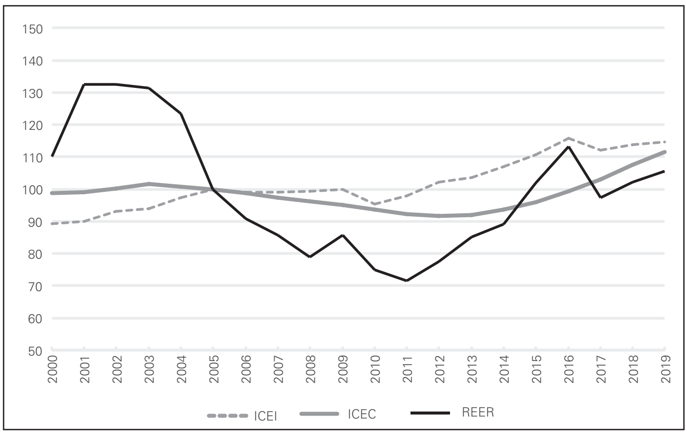
Graph 2 (above) shows the industrial equilibrium exchange rate and the real effective exchange rate for Brazil from 2000 to 2020. It is possible to observe that the Brazilian currency have been appreciated for most of the period analyzed. The figure illustrates a long cycle of appreciation from 2005 to 2014, interrupted by a sharp devaluation, followed by the second cycle of appreciation that has been interrupted by the recent economic and pandemic crisis. Apparently, the recent overshooting made the observed exchange rate overcome the industrial equilibrium.

3.3. The relationship between the Industrial and the Current Account Equilibrium exchange rate

In the preceding sections, we have shown the chronicle and cyclical appreciation of the observed exchange rate compared with both the current account equilibrium exchange rate and the industrial equilibrium exchange rate. But what is the difference between them? The industrial equilibrium is equal to the current equilibrium when there is no relevant Dutch disease in the country. In other words, the presence of Dutch disease implies in the difference between the two equilibrium exchange rates and magnitude of the difference is related to the intensity of the Dutch disease process. This difference occurs when a country is primarily a commodity exporter and therefore has the international price of commodities as the most important determinant of its exchange rate. As these commodities usually benefit from Ricardian rents and/or demand booms, the Dutch disease is configured: primary exporters manage to be competitive in the foreign market at an exchange rate substantially more appreciated than that required for industrial and modern services companies using the best available technology to be competitive, both in foreign and domestic markets; unlike manufacturing and modern services, primary sectors can achieve a satisfactory profit margin even with the currency appreciation, given the comparative advantages they explore.

The current equilibrium varies mainly as a function of variations in the terms of trade because commodities suffer price variations caused by very significant changes in supply and demand. Otherwise, the industrial equilibrium changes mainly as a function of the variations in the unit labor costs.

Graph 3: Industrial Equilibrium Exchange Rate, Current Account Equilibrium Exchange Rate, and Real Equilibrium Exchange Rate for Brazil (12 months – moving average)



Source: Authors elaboration based on CND-FGV.

Graph 3 (above) illustrates the industrial equilibrium exchange rate, the current account equilibrium exchange rate, and the real exchange rate for Brazil between 2000 and 2019. It is possible to observe that, after 2005, the IEER has been slightly and persistently above the REER_CA as expected for a country like Brazil that faces a moderate Dutch disease. The observed exchange rate was more appreciated than the current account and the industrial equilibrium until 2014, indicating that all sectors (but especially the manufacturing) had its competitiveness constrained.

This section demonstrated that the Brazilian exchange rate has passed throughout cycles of chronicle appreciation and analyzed possible ways to examine empirically this phenomenon backed by the theoretical framework and exchange rate definitions of the New Developmentalism. Nevertheless, the question that remains to be investigated is the impact of currency misalignments on investment decisions. More specifically, how do variations on the misalignment between the industrial equilibrium exchange rate and the real exchange rate influence the investment in the manufacturing sector? How does variations on the misalignment between the industrial equilibrium and current account equilibrium – thus, Dutch disease intensification or neutralization – affects the investment in the manufacturing sector?

4. EXCHANGE RATE MISALIGNMENT AND MANUFACTURING INVESTMENT: AN ECONOMETRIC EXERCISE

In the theoretical discussion, we defined the hypothesis that investment decisions in manufactures and modern services will depend on variations in the difference between the observed effective real exchange rate and the effective rate of industrial equilibrium. Nonetheless, we also argued that Dutch disease is prejudicial to investment decisions in the manufacture and modern services, and thus, the latter will also depend on variations in the difference between the current account equilibrium exchange rate and the effective rate of industrial equilibrium. To test our hypothesis, we structured two indexes: i) an index of the difference between the observed and the industrial equilibrium exchange rates and, ii) an index of the difference between the current account and the industrial equilibrium exchange rates. Since the base year for the comparison between the industrial equilibrium and the observed exchange rate index is 2005, as previously discussed, we will adopt the same base year for the series of current account equilibrium exchange rate index; but, regarding the comparison between the current and the industrial equilibrium, this definition is relevant only to stablish a period to assess the evolution of this difference, since the methodology to estimate both equilibrium exchange rates is diverse.

The relationships to be estimated can be summarized in the following equations:

$$I_{it} = \alpha_i + \beta_1(\left(\frac{REER}{IEER}\right) * 100)_{it} + \vartheta'_{it} + u_i \qquad (1)$$

$$I_{it} = \alpha_i + \beta_2(\left(\frac{REER\_CA}{IEER}\right) * 100)_{it} + \vartheta'_{it} + u_i \qquad (2)$$

where β1 and β2 are parameters that capture the relationship between the investment decisions and the difference between the observed exchange rate and that of industrial equilibrium and between the current account equilibrium and that of industrial equilibrium, respectively; i corresponds to each sector included in the sample, t is the annual period of time, u is the random error, and v represents the control variables that affect the relationship between the two theoretical model variables.

The estimated equations adopted the investment divided by the output as the dependent variable to make it possible neutralizing inflationary effects on the nominal value of investments and to consider the evolution of investments according to variations in the production. The control variables are: (a) Value Added, representing the aggregate demand; (b) Long-Term Interest Rate, which positively impact the cost of financing for investment and might affect negatively the aggregate demand; (c) Exchange Rate Volatility, that increases uncertainty and hinders the long term planning of investment return; (d) Net Exports Coefficient, which is proxy to measure the contribution of external sales to investments; (e) Import Penetration Coefficient, a proxy to measure the impact of imports on investments; and (f) Trade Openness, that capture the sector's external orientation and exposure to the foreign market; (g) Profit Margin, to control for the sectoral difference in profit margins, caused by the Dutch disease and other factors, which surely is relevant to define investments; furthermore, sectors with larger profit margins can better absorb the impact of exchange rate volatility or misalignment (h) Labor Factor Intensity Index, to control for changes in labor share on total expenses, therefore on profits and, finally, on investments. All variables are represented in logarithmic form; therefore, the coefficients may be analyzed as elasticities[7].

In order to present the empirical evidence and test our hypothesis, a database was constructed with information on investment and different sectoral characteristics that determine the relationship between exchange rate and investment, as discussed in the theoretical section, for 24 manufacturing sectors for the period from 2007 to 2017. The information, apart from the calculation of the exchange rate misalignments explained in the previous section, was obtained from the United Nations Industrial Development (UNIDO, 2020b, 2020a), PIA-IBGE and CNI. The list of sectors included in the sample is shown in Appendix 1; the description of the variables, information about their calculation criteria, and the sources of information used are found in Appendix 2; the descriptive statistics for the series included in the econometric exercise are presented in Appendix 3.

A dynamic panel data methodology is used to econometrically investigate our hypothesis. This model is efficient in the presence of endogeneity bias, which occurs when the explanatory variables simultaneously determine and are determined by the explained variable. More specifically, the empirical analysis is based on the System GMM estimator developed from Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998). It consists of estimating a system that comprises a first differentiated equation to eliminate fixed effects of the sector and an additional equation in level. Appropriate lagged values of levels and first differences can be used as instruments in these equations to address the problem of endogeneity. The validity of the instruments and the robustness of the model can be tested by the Sargan test statistics that checks the exogeneity of instruments and the Arellano-Bond test for AR (2), which checks second-order serial correlation in the error term.

5. RESULTS

The detailed results of the estimations are shown in Tables 1 and 2 (below). Table 1 shows that in all estimated models, the difference between the observed real effective and the industrial equilibrium exchange rate presented positive and significant coefficients. Similarly, the export coefficient presents positive and significative coefficient. Likewise, a rise in total value-added is associated with an increase in investment, even though the coefficient is not significant in all models. Inversely,

[7] To take the natural logarithm, the monotonic transformation was applied on variables composed of one or more negative values.

the long-term interest rate, exchange rate volatility and the labor intensity index present negative and significative coefficients. Finally, import penetration coefficient, profit-margin and trade openness did not show a significant coefficient. In all different models, the main result remained, that is, the positive relationship among differences in the exchange rates (estimated here as the ratio between observed and industrial equilibrium exchange rate) and the manufacturing investment.

Table 2 presents the same series of models but to test the impact of the magnitude of the Dutch disease – thus, the difference between the current account and the industrial equilibrium exchange rate – considering that a negative difference is an indicator of a Dutch disease process – on manufacturing investment. In all models estimated, except for model 3, the difference between the current account equilibrium exchange rate and the industrial equilibrium exchange rate presented positive and significant coefficients. Regarding the control variables, their coefficient remained equivalent to that of the models in Table 1. Nonetheless, the variable related to the long-term interest rate lost its significance.

Tables 1 and 2 also show that the impact of exchange rate movements on investment is not instantaneous, and takes time (in our model, 3 years) to impact investment decision, possibly indicating that businessmen and entrepreneurs analyze the intensity and extension of the exchange rate misalignment to decide about new investments. In addition, exchange rate fluctuation impact negatively investments, probably by increasing uncertainty and hampering the planning of investment returns.

As discussed in the literature, the sector's exposure and orientation towards the international markets are also very relevant in determining investments. We included different indicators to capture this phenomenon and the results show that the capacity to compete internationally and export may boost investment capacity. In addition, the results show that openness to trade is not necessarily positive for investment, possibly showing that larger imports not necessarily imply in the growth of investments. This may also be associated with the fact that opening to trade must be accompanied by other macroeconomic and sectoral policies that ensure global competitiveness to domestic producers (Bresser-Pereira, Araújo, Peres, 2020).

The expected negative sign of the long-term interest rate corroborates the vast literature that asserts having access to financing at a reasonable level is crucial to make investment decisions. Likewise, the positive sign of the profit margin may be associated with the increased capacity to finance investment internally or to guarantee a satisfactory profit even in challenging moments (for instance when a currency appreciates). Additionally, the growth of the sectoral aggregate demand (captured by the lagged value-added) impact positively investments, as expected. Finally, the negative coefficient of the index on labor intensity may have captured the adverse effects of the increase in labor costs on profit margins. In the one hand, from the demand side, increases in wages and labor costs impact positively the aggregate demand and thus, investment. On the other hand, from the supply side, it can affect profit margin negatively. The later mechanism might have prevailed in the period analyzed.

A crucial hypothesis for the validity of GMM and for the robustness of the results is the validity of the instruments and the absence of second-order serial cor-

Table 1: Determinants of investment: The role of the Industrial Equilibrium Exchange Rate

VARIABLES	(1) Log of Investment	(2) Log of Investment	(3) Log of Investment	(4) Log of Investment	(5) Log of Investment	(6) Log of Investment	(7) Log of Investment
Log of Investment (-1)	0.284**	0.286**	0.347**	0.325**	0.312**	0.123	0.289**
	(0.111)	(0.116)	(0.151)	(0.140)	(0.128)	(0.098)	(0.138)
Log of Value Added (-2)	-0.043	0.048	0.480**	0.281**	0.299	0.079	0.070
	(0.111)	(0.124)	(0.244)	(0.129)	(0.185)	(0.186)	(0.159)
Log of (REER/IEER) (-3)	1.776***	1.035***	0.931*	1.141**	1.185**	1.570***	1.016**
	(0.476)	(0.400)	(0.502)	(0.562)	(0.535)	(0.479)	(0.474)
Log of Long-Term Interest Rate	-0.809***	-0.546***	-0.179	-0.525**	-0.408*	-0.798***	-0.489**
	(0.151)	(0.192)	(0.285)	(0.219)	(0.228)	(0.297)	(0.223)
Exchange Rate Volatility (Dummy)		-0.055*	-0.118**	-0.077*	-0.114***	-0.054	-0.076*
		(0.033)	(0.047)	(0.040)	(0.042)	(0.046)	(0.039)
Log of Net Exports Coefficient (-1)			0.287**				
			(0.142)				
Log of Import Penetration Coefficient (-2)				0.020			
				(0.054)			
Log of Profit Margin (-2)					-0.100		
					(0.088)		
Log of Labor Factor Intensity Index						-1.329**	
						(0.574)	
Log difference of Trade Openness (-1)							0.244
							(0.193)
Constant	-8.729**	-7.307***	-17.170***	-13.089***	-13.267***	-13.107***	-7.678**
	(3.698)	(2.671)	(4.968)	(3.656)	(4.657)	(3.882)	(3.582)
Observations	190	190	189	182	189	190	182
Number of Sectors	24	24	24	24	24	24	23
Number of Instruments	15	18	21	21	21	21	21
AR(2)	1.5	1.56	1.3	1.76	1.72	1.19	1.21
Prob > z	0.13	0.119	0.193	0.078	0.085	0.23	0.22
Hansen	10.77	12.15	19.57	16.68	17.21	11.91	15.63
Prob > chi2	0.37	0.43	0.14	0.27	0.24	0.61	0.33

Note: Robust Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 2: Determinants of investment: The role of the Dutch disease

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	Log of Investment	Log of Investment	Log of Investment	Log of Investment	Log of Investment	Log of Investment	Log of Investment
Log of Investment (-1)	0.274**	0.285**	0.359**	0.263***	0.312**	0.151	0.281**
	(0.109)	(0.114)	(0.154)	(0.102)	(0.136)	(0.096)	(0.135)
Log of Value Added (-2)	-0.015	0.070	0.297*	0.238**	0.262	0.090	0.091
	(0.069)	(0.121)	(0.154)	(0.107)	(0.167)	(0.181)	(0.141)
Log of (REER_CA/IEER) (-3)	1.477***	1.204**	0.994	1.473*	1.425**	1.899***	1.100*
	(0.453)	(0.570)	(0.970)	(0.793)	(0.703)	(0.642)	(0.667)
Log of Long-Term Interest Rate	0.032	0.012	0.221	0.199	0.205	0.063	0.048
	(0.176)	(0.152)	(0.328)	(0.227)	(0.178)	(0.184)	(0.205)
Exchange Rate Volatility (Dummy)		-0.048	-0.105*	-0.130***	-0.101**	-0.052	-0.072*
		(0.036)	(0.054)	(0.041)	(0.042)	(0.046)	(0.041)
Log of Net Exports Coefficient (-1)			0.251*				
			(0.146)				
Log of Import Penetration Coefficient (-2)				-0.033			
				(0.055)			
Log of Profit Margin (-2)					-0.112		
					(0.081)		
Log of Labor Factor Intensity Index						-1.460**	
						(0.715)	
Log difference of Trade Openness (-1)							0.213
							(0.174)
Constant	-7.673***	-8.345***	-13.005**	-13.248***	-13.207***	-14.670***	-8.311**
	(2.602)	(2.846)	(6.035)	(3.574)	(4.475)	(3.775)	(3.701)
Observations	190	190	189	182	189	190	182
Number of Sectors	24	24	24	24	24	24	23
Number of Instruments	15	18	21	21	21	21	21
AR(2)	1.44	1.5	1.24	1.85	1.58	1.16	1.25
Prob > z	0.15	0.13	0.21	0.064	0.11	0.24	0.21
Hansen	11.12	11.92	20.37	14.33	15.87	10.51	15.22
Prob > chi2	0.34	0.45	0.11	0.42	0.32	0.72	0.36

Note: Robust Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

relation in the error term. One suitable test to verify exogeneity of the instruments is the Hansen test for overidentification restrictions. The null hypothesis of this test is that the model is correctly specified and that the instruments together are valid. For all the estimated models, the null hypothesis of the Hansen test is not rejected (Tables 1 and 2), showing that the instruments used in our models are valid. In all models, the Difference-in-Hansen tests of exogeneity of instrument subsets also indicate the validity of the instrument's subsets.

As for the problem of serial correlation in the error term, the Arellano-Bond AR(2) statistic is computed to verify the null hypothesis that there is no second-order serial correlation of the error term. It is presumed that there would be first-order correlation in AR(1) but not in any higher-order (Roodman, 2009). For all models estimated, the null hypothesis of no second-order serial correlation of the error term could not be rejected at 5% level of confidence (Tables 1 and 2).

The results remain equivalent by assuming time dummies as exogenous and including them as instruments. Moreover, results remain analogous by running the models without collapsing the instruments. Summarizing, the exercise of running the model with different specifications, the validity of the instruments, and the absence of second-order serial correlation confirms the robustness of the estimated models.

CONCLUSION

This article aimed at contributing to the theoretical and empirical literature showing, initially, that the Brazilian economy faced a process of chronic and cyclical tendency to the exchange rate appreciation after the decade of 1970, which was interrupted only recently. Furthermore, in this article we argue in favor of the importance of searching for a competitive exchange rate to promote investments in more dynamic and sophisticated sectors. More specifically, we discuss and test econometrically how the difference between the observed real effective exchange rate and the industrial equilibrium exchange rate, and the Dutch disease process – measured by the difference between the current account and the industrial equilibrium exchange rate – affects investment.

Regarding the tendency to appreciation, the bilateral real exchange rate series in the period between 1950 and 2021 in Brazil exhibits a huge volatility until mid-1960s, then a stability for approximately 10 years – between 1968 and 1979 (which seemed to be important to stimulate the large increase of manufacturing share in exports in that period) – and thereafter a relevant alternance of short periods of – sometimes sudden – depreciations and long periods of appreciations, which can be confirmed by the estimations of misalignments among observed, industrial and current account equilibrium exchange rates after 2000. It is possible to say that, from 1980s, the Brazilian economy experienced a process of chronic and cyclical exchange rate appreciation that was reversed only in the recent years.

Since these misalignments have been frequent in the Brazilian economy, we decide to investigate their impact on investment decisions. A database was constructed with data on investment for 24 manufacturing sectors of Brazil from 2007 to 2017. To test our hypothesis, an econometric test was performed based on a dynamic panel data model – more specifically – the system GMM. Based on the performed test, it is possible to say that maintaining the exchange rate at the industrial equilibrium level affects investment positively. Inversely, maintaining an appreciated exchange rate in relation to the industrial equilibrium level can affect investment negatively. Moreover, it is possible to assert that given the positive difference between the industrial and the current account equilibrium exchange rate during most of the period analyzed, the Brazilian economy suffers a process of Dutch disease, although it is not severe, because the magnitude of the difference between both equilibrium exchange rates is not too large. The tests allow to affirm that a reduction in the misalignment between the current account and industrial equilibrium may also positively impact investment decisions.

Therefore, the concept of the current account and industrial equilibrium exchange rate proved feasible and relevant for estimating exchange rate misalignment in Brazil and their impact on manufacturing investment. The results reinforce the argument in favor of avoiding currency appreciations as they may worsen manufacturing investments. Moreover, the reduction of the Dutch disease effected positively investment, thus, mechanisms for its neutralization may well be suitable for stimulating investments in the manufacturing industry.

Surely, there are other factors that influence investment decisions according to the sectoral characteristics of the economic activities. For instance, the characteristics of the panel data constructed for this article constrained the possibilities to deal with subsets of sectors according to its technological level. In particular, empirical results presented in this article reinforce the importance of analyzing the sectoral external orientation and exposure to better understand investment decisions. Thus, a potential future agenda is enlarging the database to expand the possibilities to investigate more disaggregated sectors. Additionally, the incorporation of variables that can interact with the exchange rate, for example, sectoral policies for strengthening sectoral capabilities, may also bring important insight from supply-side elements that may be crucial to guarantee access of the producers to the domestic and international markets, consequentially boosting investment in more sophisticated sectors.

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APPENDIX 1

List of Sectors: Manufacture of food products, Manufacture of beverages, Manufacture of textile products, Manufacture of wearing apparel and accessories, Preparation of leather and manufacture of leather goods, travel goods and footwear, Manufacture of wood products, Manufacture of pulp, paper and paper products, Printing and reproduction of recordings, Manufacture of coke, petroleum products and biofuels, Manufacture of chemicals, Manufacture of pharmaceutical and pharmaceutical products, Manufacture of rubber and plastic products, Manufacture of non-metallic mineral products, Metallurgy, Manufacture of fabricated metal products, except machinery and equipment, Manufacture of computer, electronic and optical products, Manufacture of electrical machinery, apparatus and materials, Manufacture of machinery and equipment, Manufacture of motor vehicles, trailers and buses, Manufacture of other transport equipment, except motor vehicles, Manufacture of furniture, Manufacture of miscellaneous products, Maintenance, repair and installation of machinery and equipment.

APPENDIX 2: SOURCES

Variable	Acronym:	Source:
Investment / Output	Investment	INDSTAT4 – UNIDO
Value Added	VA	INDSTAT4 – UNIDO
Industrial Equilibrium Exchange Rate	icei	The variable calculation methodology for the industrial equilibrium exchange rate (*IEER*) is based on real unit labour costs in the manufacturing sector, according to the following formula: $IEER_{i_t} = \frac{ULC_{i_t}}{\sum_j^n (ULC_{j_t} * pond_{i,j_T})}, i \neq j$, where: $ULC_{i_t} = \frac{W_{i_t}}{VA_{i_t}} = \frac{W_{i_t}/L_{i_t}}{VA_{i_t}/L_{i_t}} = \frac{\omega_{i_t}}{\zeta_{i_t}}$ where ULC is the unit labour cost, W is the mass wages, VA is the added value, L is the number of employees, ω is the average wage and ζ is the labour productivity (always in manufacturing). As the ratio between the two nominal variables (W and VA) becomes a real variable, the ULC s were calculated generally using nominal variables, sometimes replaced by real variables when the nominals were not available, but always making sure that the result was a real variable. When necessary, the series were deflated by the respective consumer price index. Source: CND-FGV, available at: https://eaesp.fgv.br/centros/centro-estudos-novo-desenvolvimentismo/projetos/taxa-cambio-equilibrio-industrial
Current Account Equilibrium Exchange Rate	reer_ca	Calculated in Bresser-Pereira et al. (2022, forthcoming)
Real Effective Exchange Rate	reer	CND-FGV, available at: https://eaesp.fgv.br/centros/centro-estudos-novo-desenvolvimentismo/projetos/taxa-cambio-equilibrio-industrial
dummy_volatility_reer	dummy_ volatility_reer	Brazilian Central Bank (BCB). It is estimated based on the coefficient of variation of the Real Effective Exchange Rate. The number 1 was attributed to years that the Coefficient of Variation was higher than the average coefficient of variation for the years 2007 to 2017. The number Zero was attributed to years that the Coefficient of Variation was smaller than the average coefficient of variation for the years 2007 to 2017.
Import Penetration Coefficient	Penet_Imp	CNI
Net Export Coefficient	Coef_Exp_líq	CNI

Total Profit Margin	mt	Calculated by CND based on PIA-IBGE
Labor Factor Intensity Index	IFT	PIA-IBGE
Trade (imports + exports) (% of Output)	openess	ISDB – UNIDO
Long Term Interest Rate	tjlp	IPEADATA

APPENDIX 3: DESCRIPTIVE STATISTICS

	Number of Observations	mean	sd	min	max
Value Added (USD Million)	264	10900	9890	1020	51800
ICEI	264	104.16	6.20	95.75	113.83
REER_CA	264	91.78	4.20	87.43	101.59
REER	264	87.70	12.29	71.64	113.43
Net Export Coefficient	253	14.54	12.05	0.50	57.60
IFT	264	0.18	0.07	0.07	0.42
Openness to Trade	253	0.31	0.26	0.00	2.31
Total Profit Margin	264	7.21	6.24	-12.54	28.49
Investment Rate	264	0.16	0.14	-0.04	1.10
Long Term Interest rate	264	0.50	0.06	0.41	0.60
Import Penetration Coefficient	253	2.33	0.96	-0.36	3.78

Source: Authors' elaboration.