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Real Exchange Rate, Wage-Led Policies, and Demand Growth in Brazil: A Regime Switching and Time Sensitive Study

Summary: The aim of this article is twofold. First, we discuss stylized facts about the Brazilian economy related to the redistribution of income to labor, and the appreciation of the real exchange rate, examining their influence on demand growth. Second, the article empirically investigates the influence that both increasing real wages and depreciating the real exchange rate had on the short-term performance of Brazilian manufacturing between 2002 and 2020. To this end, a set of time series regressions is estimated using two methods. Markov-switching model estimates provide some evidence that reducing the real wage, or appreciating the national currency, had some positive influence on growth in industrial demand during normal periods, however, this did not apply during periods of crisis. On the other hand, wavelet estimates suggest that, between 2002 and 2005, a growth strategy based on increasing the real minimum wage was a coherent policy for boosting short-term industrial demand.

Keywords: Real exchange rate, Wage-led policies, Income distribution, Demand growth, Brazil.

JEL: E00, E24, O15.

The influence that income distribution and the real exchange rate (RER) have exerted over economic growth in the Brazilian economy has been the subject of debate among heterodox economists. Recently, some of those involved in this debate have opposed both social-developmentalist analysts, who argue in favor of wage-led policies (increasing real wages and/or RER appreciation) to boost economic performance through rising consumption, and new-developmentalist analysts, who support the need to pursue a devalued RER and a moderate increase in real wages in order to obtain a maintainable growth rate over the medium and long term, based on exports and capital accumulation.

New developmentalism proposes an export-led growth strategy, based on pursuing a competitive, lower real wage in order to encourage exporting companies to make new investments, creating space for sustainable gains in future real wages (Luiz Carlos Bresser-Pereira 2016). This approach argues in favor of an active RER policy in order to neutralize the Dutch disease, promoting industrialization and sophistication in the economic structure (Bresser-Pereira 2020). The new developmentalist doctrine

underestimates the multifaceted nature of economic development by overplaying the role of RER in the catch-up between poor and rich countries (Carlos Aguiar de Medeiros 2020). Exports (profits) are placed above the domestic market (real wage) as a source of demand for manufacturing goods (Medeiros 2020). For its part, social developmentalism is an approach oriented towards consumption *via* a wage-led growth strategy (Bresser-Pereira 2016). With reduced income inequality, by increasing the real wage (either by raising the minimum wage or through an appreciated RER), income is transferred to workers, whose propensity to save is relatively low, with a consequent increase in demand. Supporters of social developmentalism are assumed to be in favor of the complementarity between the internal (*via* real wages and credit for household consumption) and external markets (Medeiros 2020).

The aim of this article is twofold. First, we discuss stylized facts about the Brazilian economy in relation to the above-mentioned aspects and their influence on demand growth, focusing on the distributive conflict in the debate between the social-developmentalist and new-developmentalist approaches. Second, the article empirically investigates the influence of increasing real wages and depreciating the real exchange rate on the short-term performance of Brazilian industry, between 2002 and 2020. To this end, a set of time series regressions was estimated applying two methods, namely: Markov-switching models and wavelet analysis. Estimates from Markov-switching models provide some evidence to suggest that reducing the real wage, or appreciating the national currency, exerts some positive influence over growth in industrial demand during normal periods, although this does not apply to periods of crisis. On the other hand, wavelet estimates suggest that, between 2002 and 2005, the growth strategy based on increasing the real minimum wage is a coherent policy for boosting short-term industrial demand. However, evidence suggests that this cornerstone of social developmentalist economics only plays a limited role in promoting maintainable economic growth, since the wavelet outcome indicates that, between 2017 and 2020, raising the real minimum wage had a negative effect on growth in industrial demand over the medium term.

This article is divided into four sections including this introduction. Section 1 analyzes some stylized facts about Brazil, while Section 2 outlines the empirical strategy and database employed in the estimates. Section 3 discusses the empirical findings, and the study ends with a section focused on our conclusions.

1. Literature Review and Stylized Facts: Income Distribution, RER, and Demand Growth

During the 1990s, growth in the Brazilian economy was volatile and relatively weak; events in the 2000s represented a turning point in its evolution. From 2002 until the 2008 crisis, economic growth was faster and less volatile. This period was characterized by a favorable international scenario: (i) a boom in capital flow toward emerging economies; and (ii) an upward trend in prices and external demand for primary goods, which increased exports and contributed to the accumulation of international reserves (Philip Arestis, Carolina Tronsoco Baltar, and Daniela Magalhães Prates 2015). Indeed, exports help to explain the solid expansion of the Brazilian economy, particularly

since the country eased external constraints. However, although investment also increased relatively quickly, it did not operate on its own - the second main growth driver was private consumption (consumption represents roughly 60% of Brazilian GDP. As we can see in Table 1, between 2008 and 2020, the accumulated growth rate remained above the GDP accumulated growth rate, meaning that (on average) the consumption growth rate was greater than the GDP growth rate). While, on the one hand, domestic demand (consumption and investment) was more important in explaining effective demand than exports (Arestis, Baltar, and Prates 2015), on the other, following the expansion of the Brazilian economy, imports rose considerably. It is important to note that our focus is on income distribution policies and the historical evolution of the real exchange rate. See Nelson H. Barbosa-Filho and J. A. P. de Souza (2010), Luiz Fernando de Paula, André de Melo Modenesi, and Manoel Carlos C. Pires (2015), Fernando J. Cardim de Carvalho (2016), Franklin Serrano and Ricardo Summa (2017), Barbosa-Filho (2018), Eliane Araujo and Arestis (2019) and João Sicsú, Andre de Melo Modenesi, and Débora Pimentel (2020) for detailed discussions about the multiple macroeconomic variables that influenced the Brazilian economy's macroeconomic performance.

A short discussion is required to avoid possible pitfalls in the identification of the variables of aggregate demand that acted as the drivers of Brazilian growth after the 1990s. Assuming that output equals the sum of consumption C, investment I, government consumption G, and net exports NX:

$$Y_t = C_t + I_t + G_t + NX_t, \tag{1}$$

where the subscript t stands for time. Assuming a time continuous version of (1), we take the natural logarithm of equation and derive it in relation to time:

$$\hat{y}_t = \left(\frac{Ct}{Yt}\right)\hat{c}_t + \left(\frac{It}{Yt}\right)\hat{\imath}_t + \left(\frac{Gt}{Yt}\right)\hat{g}_t + \left(\frac{NXt}{Yt}\right)\widehat{nx}_t, \tag{1.1}$$

where the lower-case hat variables represent the variable growth rate. Rewriting Equation (1) in terms of sectoral share of GDP:

$$Y_t = A_t + M_t + S_t, \tag{2}$$

where A, M and S stand for production in the agriculture, manufacturing, and services sectors, respectively. Assuming a time continuous version of (2), we take the natural logarithm of equation and derive it in relation to time:

$$\widehat{y_t} = \left(\frac{At}{Yt}\right)\hat{a}_t + \left(\frac{Mt}{Yt}\right)\widehat{m}_t + \left(\frac{St}{Yt}\right)\widehat{s_t}. \tag{2.1}$$

Equations (1.1) and (2.1) demonstrate certain important features: (i) the share of a GDP component increases if its growth rate is greater than the GDP growth rate; (ii) the share of a GDP component may be significant, however, if its growth rate is less than that of the GDP, it will decrease; (iii) the growth rate of a growth-drive variable is the rate that accelerates the GDP growth rate.

1.1 Income Distribution and Demand Growth

Table 1 presents Brazil's economic dynamics in terms of the cumulative growth of the components in Equations (1.1) and (1.2). All variables come from the Brazilian Institute of Geography and Statistics (IBGE). The rationale is that a variable is a growth driver if its growth rate is greater than the GDP growth rate. The variables represent the growth rate (accumulated over 12 months) of the GDP components over the same period in the previous year. Table 1 indicates that the 2008 crisis constituted a breaking point in the Brazilian economy's favorable evolution. Since then, growth-performance has decelerated and become more volatile. Since 2015, the Brazilian economy has experienced either a downturn, or very modest economic growth. This downward trend further, and brutally, accelerated in 2020, owing to the coronavirus pandemic, a year in which GDP fell 4.1%, followed by a fall of 5.5%, 0.8% and 1.8% in consumption, investment and exports, respectively. The weak and volatile economic performance post 2008 is reflected in the erratic behavior of imports.

Table 1 Growth Rate in Consumption, Investment, Exports, Imports, Manufacturing Activities, Services and GDP (2002-2020): Not Weighted, or Weighted according to Their Respective Shares of GDP

	Consumption		Investment		Exports		Imports		Manufacturing[a]		Services		GDP
		weighted[b]		*weighted*[b]		*weighted*[b]		*weighted*[b]		*weighted*[b]		*weighted*[b]	
2002	1.3	1.0	-1.4	-0.2	6.5	0.9	-13.3	-1.7	2.1	0.3	3.1	2.1	3.1
2003	-0.5	-0.4	-4	-0.6	11	1.7	-0.5	-0.0	2.7	0.4	1	0.7	1.1
2004	3.9	3.1	8.5	1.4	14.5	2.3	10.4	1.4	9.1	1.6	5	3.3	5.8
2005	4.4	3.4	2	0.3	9.6	1.6	7.5	1.0	2.2	0.4	3.7	2.4	3.2
2006	5.3	4.2	6.7	1.2	4.8	0.7	17.8	2.3	1.2	0.2	4.3	2.9	4
2007	6.4	5.0	12	2.3	6.2	0.8	19.6	2.5	6.1	1.0	5.8	3.9	6.1
2008	6.5	5.1	12.3	2.6	0.4	0.1	17	2.2	4.1	0.7	4.8	3.3	5.1
2009	4.5	3.6	-2.1	-0.3	-9.2	-1.1	-7.6	-0.9	-9.3	-1.4	2.1	1.4	-0.1
2010	6.2	4.9	17.9	4.0	11.7	1.3	33.6	4.7	9.2	1.4	5.8	4.0	7.5
2011	4.8	3.8	6.8	1.5	4.8	0.5	9.4	1.1	2.2	0.3	3.5	2.4	4
2012	3.5	2.8	0.8	0.1	0.7	0.1	1.1	0.1	-2.4	-0.3	2.9	2.0	1.9
2013	3.5	2.8	5.8	1.2	1.8	0.2	6.7	0.9	3	0.4	2.8	1.9	3
2014	2.3	1.8	-4.2	-0.8	-1.6	-0.1	-2.3	-0.3	-4.7	-0.5	1	0.7	0.5
2015	-3.2	-2.6	-13.9	-2.3	6.8	0.8	-14.2	-1.7	-8.5	-1.0	-2.7	-1.9	-3.5
2016	-3.8	-3.2	-12.1	-1.8	0.9	0.1	-10.3	-1.3	-4.8	-0.6	-2.2	-1.6	-3.3
2017	2	1.6	-2.6	-0.3	4.9	0.6	6.7	0.8	2.3	0.3	0.8	0.6	1.3
2018	2.4	2.0	5.2	0.7	4.1	0.5	7.7	0.9	1.4	0.2	2.1	1.5	1.8
2019	2.2	1.8	3.4	0.5	-2.4	-0.3	1.1	0.1	0	0.0	1.7	1.2	1.4
2020	-5.5	-4.6	-0.8	-0.1	-1.8	-0.2	-10	-1.3	-4.3	-0.5	-4.5	-3.3	-4.1

Notes: [a] manufacturing industry (excluding the extractive sectors); [b] growth rate of the GDP component multiplied by its share of GDP.

Source: Prepared by the authors based on data from the Brazilian Institute of Geography and Statistics (IBGE 2021a, b)[1][2].

[1] **Brazilian Institute of Geography and Statistics - IBGE.** 2021a. https://sidra.ibge.gov.br/tabela/5932 (accessed March 31, 2021).

[2] **Brazilian Institute of Geography and Statistics - IBGE.** 2021b. https://www.ibge.gov.br/estatisticas/economicas/contas-nacionais/9052-sistema-de-contas-nacionais-brasil.html (accessed April 04, 2021).

Table 1 confirms the importance of consumption as a growth driver between 2002 and 2020. During this period, consumption increased faster than GDP, at thirteen points. However, up to 2011, investment was the main growth driver, given that this variable has increased more than both GDP and consumption. From that year on, the pace of capital accumulation was slow, which was also true of exports. With a few exceptions, since 2015, both variables have somewhat underperformed. In general, the dynamic of the Brazilian economy upheld and reinforced the role of consumption as the main driver of economic growth, as indicated by Marcos Tostes Lamonica and Sergiany da Silva Lima (2018). This is especially valid after 2012, since when the pace of capital accumulation has sharply declined. Given that the growth rate in investments and exports has been slower than that of GDP, the GDP relative share of consumption has grown over time. As a consequence, growth is increasingly dependent on stimulating consumption. Exports rose between 2002 and 2011. Following the 2001-2003 economic downturn, in 2004 the Brazilian economy recovered, boosted by commodity exports resulting from greater economic growth in the global economy, and increased consumption due to government credit incentives and an increase in household purchasing power (Andrés Ernesto Ferrari Haines, Fernando Ferrari-Filho, and Hernan Neyra 2020).

During the 2000s, domestic market expansion was part of the Worker Party governments' deliberate growth strategy, in line with social developmentalism. The rationale behind this strategy was to pursue more egalitarian income distribution in order to boost mass consumption (Ricardo Bielschowsky 2012; Pedro Rossi and Guilherme Mello 2016). As well as raising the minimum wage, consumption expanded through other policies: household credit, formal sector job creation, and public cash transfers to households (Serrano and Summa 2015). This redistributive bias in favor of workers (real wages) was an explicit public policy directive as part of the government's economic plan from 2003 onwards, in order to strengthen worker bargaining power (Barbosa-Filho and Souza 2010). An increase in the real minimum wage would increase the absorption of growing labor productivity (Barbosa-Filho and Souza 2010). Minimum wage readjustments were set by a formula that took account of past inflation and real GDP growth, rather than growth in labor productivity (Carvalho 2016).

By reducing income inequality and poverty *via* social policies and with gains in real minimum wages, the conditions were created for an era of economic growth based on the expansion of the domestic market (Governo do Brasil 2003, 2007, 2011, 2015). Enhanced demand growth, boosted by redistributive polices, increased manufacturing profitability and investment (Governo do Brasil 2003, 2007, 2011, 2015). Labor productivity and real wages would thus steadily increase, laying the foundation for the growth strategy's long-term sustainability: demand grows by stimulating consumption (wages); higher profit-rates for industrial firms encourage them to make new investments; industrial labor productivity grows due to increasing returns of scale and greater capital accumulation (Governo do Brasil 2003, 2007, 2011, 2015). This is the essence of growth in social developmentalism. Exogenous changes in real wages (i.e., wage-led policies that increase worker salaries) expand consumption and consequently aggregate demand, with positive effects on private investment and labor productivity. In this approach, the expansion of the domestic market is supposed to drive capital

accumulation, labor productivity gains, and the diversification of the productive structure (Medeiros 2020).

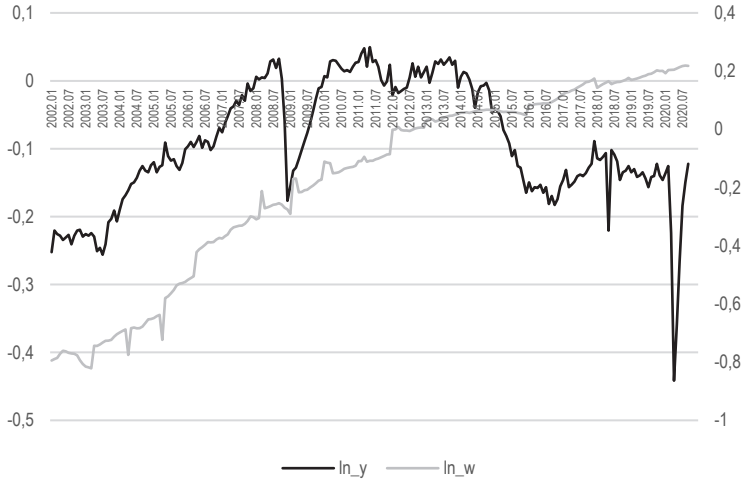
There is evidence in the literature to suggest that income policies based on raising real wages contributed to a decrease in income inequality (Alessandra Brito, Miguel Foguel, and Celia Kerstenetzky 2017), suggesting that 64% of the 14% reduced income inequality seen between 1995 and 2014 was due to the real valorization of the minimum wage. Moreover, income inequality fell in both personal (Gini index) and functional (wage-share in total income) terms, as well as in relation to the poverty rate (Prates, Barbara Fritz, and de Paula 2017), increasing the distributive conflict, sparking an economic growth-cycle (Claudio Roberto Amitrano 2017; Serrano and Summa 2017; Baltar 2020). In this sense, various studies have investigated the association between income distribution and demand growth in Brazil. Carmem Aparecida Feijó, Felipe Figueiredo Câmara, and Luiz Fernando Cerqueira (2015) indicated the existence of a profit-led demand regime between 1951 and 1989, while, in contrast, Lamonica and Lima (2018) described the existence, of a wage-led demand regime between 1993 and 2013.

Although this cycle may be explained by increased consumption caused by wage-led policies, expanded consumption also had a positive influence on capital accumulation (Bielschowsky 2012; Baltar 2020), at least up to 2011, as indicated in Table 1.

The favorable economic context for workers reinforced the real wage gains sparked by the minimum wage policy (Summa and Serrano 2017). Worker bargaining power increased significantly as a result of a hot labor market, and improved social and labor insurance, which led to a greater number of strikes and working hours spent on strike (Summa and Serrano 2017). Erik S. Katovich and Alexandre Gori Maia (2018) demonstrated that, between 1996 and 2014, the real wage rose more than labor productivity, although this behavior was specific to each sector. We therefore suggest that the distributive conflict between workers and capitalists was exacerbated, especially given the slow pace of growth in labor productivity.

Although raising the real wage boosts demand for wage goods, when real wages increase more rapidly than growth in labor productivity, profit and then investments fall (Carvalho 2016). In this sense, the empirical findings of Feijó, Marcos Tostes Lamônica, and Sergiany da Silva Lima (2021) have indicated that the financial fragility of industrial firms in the Brazilian economy observed between 2010 and 2017 was associated with a slowdown in demand growth and more significant labor costs. There is therefore some evidence that wage-led policies surpassed real economic possibilities, represented by labor productivity growth, exerting a negative influence on investments at times of weak demand growth.

Figure 1 illustrates the minimum wage evolution in US$ (purchasing power parity) and the growth in industrial demand between 2002 and 2020. The positive trend in worker purchasing power, particularly up to 2012, is quite clear; following this, the redistributive process, at least *via* minimum wage policies, began to slow down.



Source: Prepared by the authors using the database described in Table 2.

Figure 1 Minimum Real Wage w (Right Axis) and Demand Growth y (Left Axis): 2002-2020

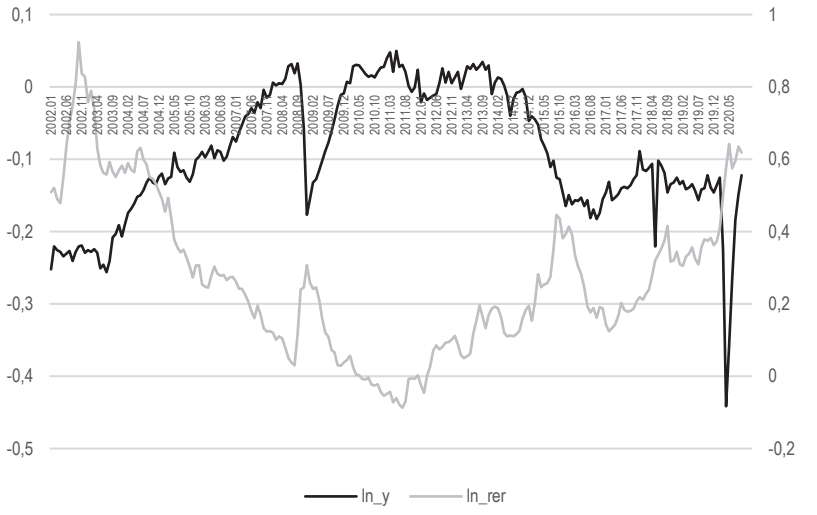
Figure 1 also indicates a fairly close connection between the behavior of the real minimum wage[3] and industrial demand[4]. To some extent, the evolution of gains in worker purchasing power seems to occur alongside growth in industrial demand. Figure 1 provides some evidence that the rising trend in the minimum wage was not associated with worsening distributive conflict, since it suggests that demand growth grew sufficiently to incorporate income redistribution to workers. This is valid until approximately 2011, at which point there is a slowdown in economic activity, although the redistributive process of raising the minimum real wage remained in force. It is likely that after 2011 the combination of a slowdown in economic activity, increased real wages and greater worker bargaining power produced a profit-squeeze, which was reinforced by the sharp decrease in demand after 2015.

[3] The variable we used to analyze the effects of wage-led policies on demand growth is the minimum real wage. To our knowledge, this variable is the sole monthly indicator capable of capturing the impacts on demand growth of the wage-led policies implemented by the Brazilian Government between 2002 and 2020. The wage share in national income is only available on a quarterly basis, and other variables, such as average or median real wage, are not consistently available for the whole period. Additionally, these variables are endogenous to the business cycle and do not therefore adequately reflect our argument that "exogenous" changes in real wage resulting from government-led wage policies are related to demand growth over the period under discussion.

[4] Our variable, employed as a proxy for demand growth in the Brazilian economy, is demand growth in the manufacturing sectors, as computed by the Brazilian Institute of Geography and Statistics. We acknowledge that this variable represents only a small portion of national production. However, it is imperative to note that we have chosen this variable due to its monthly availability, which, to the best of our knowledge, is the only one of its kind. Monthly data allows for a greater time span compared to quarterly variables, such as GDP growth, thereby facilitating econometric analyses with improved asymptotic properties. Furthermore, our focus is specifically on demand growth in the manufacturing sectors, in accordance with the Kaleckian literature, rather than on services or primary sectors.

1.2 Real Exchange Rate and Demand Growth

Figure 2 shows the evolution of RER and growth in industrial demand between 2002 and 2020. Since both variables were normalized and used in logarithmic form, the negative (positive) values of RER mean that it has devalued (valued) compared to its 2010 values. Figure 2 suggests a strong and inverse relationship between these variables. Episodes of peak economic activity seem to be inversely associated with RER.



Source: Prepared by the authors using the databases described in Table 2, below.

Figure 2 RER (Right Axis) and Demand Growth (Left Axis): 2002-2020

Figure 2 suggests that RER behavior was characterized by an appreciation trend between 2003 (following the crisis related to the 2002 election) and 2011, despite the sharp devaluation in the last quarter of 2008. This period of strong real appreciation of Brazil's currency is associated with the pursuit of a low inflation rate and is consistent, on the one hand, with the three-pronged approach of an inflation-targeting regime: an inflation target, a floating exchange rate and primary surplus (de Paula, de Melo Modenesi, and Pires 2015; Prates, Fritz, and de Paula 2017) and, on the other, with a growth-strategy grounded in consumption/raising real wages, since the evidence suggests that the price effect (exports) of devaluing the RER is smaller than the income effect (consumption and investment) (de Paula, de Melo Modenesi, and Pires 2015). In other words, in the short term, the RER appreciation exerted an expansionary influence on demand growth *via* enhanced consumption and investment (Barbosa-Filho 2018).

Since 2008, this trend for the real appreciation of Brazil's currency, due to strong trade and capital flow performance, has reversed (Prates, Fritz, and de Paula 2017). Figure 2 indicates a trend for the depreciation of the RER between 2012 and 2020, with two peaks of strong depreciation in the first quarter of 2015 and throughout

2020. Since 2011, the Central Bank of Brazil has adopted a policy of currency devaluation (de Paula, de Melo Modenesi, and Pires 2015; Barbosa-Filho 2018). Carvalho (2016) argues that, from 2015, the combination of increased labor costs and the expectation of higher inflation (which has materialized), within a context of declining labor productivity and ongoing deindustrialization, explains the weak influence of nominal exchange rate devaluations on growth.

This debate has divided analysts into those who argue that a devalued RER exerts a negative influence on economic growth; and those who support the need to pursue a devalued RER (despite the contractionary effects in the short term), in order to obtain maintainable growth over the medium and long term, based on exports and capital accumulation.

In this context, New Developmentalism emphasizes the importance of pursuing a competitive RER to promote economic development (Bresser-Pereira 2016, 2020). The main argument is that managing the RER is a crucial tool to counteract the effects of the Dutch disease, since there is a tendency in developing countries for overvaluation of the RER, due to various factors, such as commodity booms, economic growth reliant on foreign savings, high interest rate levels, and the use of the RER to control inflation rates (Bresser-Pereira 2016, 2020). A competitive RER forms the cornerstone of New Developmentalism's growth strategy, since this variable is closely linked to the profitability of the tradable sectors and private investment (Bresser-Pereira 2016). A competitive RER reduces real wages and increases exports, thus boosting the funds required to finance new investments (Bresser-Pereira 2016).

Several studies have empirically corroborated the hypothesis that a competitive RER favors long-term growth (e.g., William Easterly 2001; Paulo Gala 2007; Dani Rodrik 2008; Flavio Vilela Vieira, and Ronald MacDonald 2012; Martin Rapetti 2020). One of its transmission channels is its effect on capital accumulation, since the RER is associated with entrepreneur profitability. A competitive RER boosts the profit-rate of the tradable sectors (Rodrik 2008; Surjit Singh Bhalla 2012) by transferring income from workers (whose propensity to save is lower than that of capitalists) to firms (Mohsen Bahmani-Oskooe and Massomeh Hajilee 2010; Pablo Alfredo Glüzmann, Eduardo Levy-Yeyati, and Federico Sturzenegger 2012). In other words, a competitive RER reduces labor costs, which encourages investments, because it increases profitability (Bhalla 2012). By increasing the profit-rate, a competitive RER therefore encourages firms to further invest, increasing long-term growth. In contrast, a competitive RER may harm economic performance in economies with a wage-led demand regime (Amit Bhaduri and Stephen Marglin 1990), because a smaller real wage may reduce consumption and investment (Carlos F. Diaz Alejandro 1963; Medeiros 2020).

We need to consider two further issues. First, a competitive RER might have an influence on company profitability in the opposite direction to that expected, since it makes imported inputs more expensive (Bahmani-Oskooe and Hajilee 2010). Smaller real wages should therefore offset greater costs, which is especially important for deindustrialized economies, which depend heavily on imports – as is the case with Brazil. Second, the growth-effect of a competitive RER through worse income distribution is

controversial. A growth strategy grounded in such terms constitutes a trade-off between lower real-wages over the short term in order, perhaps, to reach greater real-wages in the medium and long term *via* enhanced labor productivity (greater capital-worker ratio) (Martin Guzman, Jose Antonio Ocampo, and Joseph E. Stiglitz 2018). It turns out that there is no guarantee that a greater profit-share of GDP will increase capital accumulation or that its fruits (greater labor productivity) will be shared in the future (Guzman, Ocampo, and Stiglitz 2018). This is especially valid for countries such as Brazil, characterized by structural heterogeneity. Moreover, a competitive RER may have a negative effect on long-term growth, if the negative effects of worse income distribution are stronger than the positive effects in the form of improved technological capabilities (Rafael S. M. Ribeiro, John S. L. McCombie, and Gilberto Tadeu Lima 2020).

The next section outlines the empirical strategy and the database employed for our estimates.

2. Empirical Strategy: Specification, Methods, and Database

The empirical strategy consists of estimating econometric regressions to explain short-term performance, applying time series methods to data referring to the Brazilian economy between January 2002 and September 2020 (225 months). The dependent variable is industrial demand. We took this variable from the Brazilian Institute of Geography and Statistics. The basic equation is as follows:

$$g_t = b_0 + b_1.g_{t-n} + b_2.rer_{t-n} + b_3.r_{t-n} + b_4.w_{t-n} + e_t, \quad (3)$$

where t and n are the time index and the number of lags, e_t is the error term, and g_{t-n} represents the dependent variable's lagged values. The variable rer_{t-n} is the RER measure employed in estimates, r_{t-n} is the real value of the short-term interest rate (SELIC), w_{t-n} is the minimum wage in US dollars and purchasing power parity. All the dependent variables were taken from the Institute of Applied Economic Research and are summarized in Table 2, below. The dependent variables are lagged to ensure that the causality runs from the right to the left of the equation.

Table 3, below, presents the Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) unit root tests. The results, employing level variables, indicate that the null hypothesis for the existence of the unit root is not rejected, except in variable r_t. Variables g_t and rer_t are non-stationary at their levels. For its part, the alternative hypothesis for the non-existence of the unit root is accepted when the variables are employed in the first difference.

Table 4, below, includes our equation 1 results for the Johansen test for cointegration. Since the SBIC (Schwarz Bayesian Information Criterion) indicated that the best number of lags was 1, the Johansen test was performed using 1 lag (available by e-mail on request). The outcome suggests the existence of three cointegrating vectors. This allowed us to estimate time series regressions using non-stationarity variables, producing stationary residuals and eliminating the possibility of spurious results.

Table 2 Variables: Definition, Source, and Statistics

Variable	Definition	Source	Basic statistics	
Demand growth g_t	Seasonally-adjusted industrial demand (2012 average = 100); this variable employs logarithmic normalized values	IBGE - Brazilian Institute of Geography and Statistics[a]	Mean	-0.09
			Median	-0.10
			S.D.	0.08
Real exchange rate rer_t	Effective real exchange rate for manufactured goods exports (2010 average = 100); this variable employs logarithmic normalized values	IPEA - Institute of Applied Economic Research[b]	Mean	0.26
			Median	0.24
			S.D.	0.21
Interest rate r_t	Accumulated SELIC (over) rate for the month (2012 average = 100) - adjusted using the CPI index (IPCA); this variable employs logarithmic normalized values plus one	IPEA - Institute of Applied Economic Research[b]	Mean	1.57
			Median	1.57
			S.D.	0.004
Minimum wage w_t	Minimum wage in US$ (purchasing power parity) (2012 average = 100); this variable employs logarithmic normalized values	IPEA - Institute of Applied Economic Research[b]	Mean	-0.17
			Median	-0.10
			S.D.	0.32

Notes: (1) all variables are employed on a monthly basis; (2) the variable g_t was seasonally adjusted by the IBGE; (3) the variables r_t and w_t were seasonally adjusted by the authors using the X-13 ARIMA seasonal adjustment.

Source: [a] IBGE (2021c)[5]; [b] IBGE (2021d)[6].

Table 3 Unit Root Tests

Variable	Unit root test					
	Level variables: I(0)					
	Augmented Dickey-Fuller			*Philips-Perron*		
	constant	no constant	with trend	constant	no constant	with trend
g_t	-2.6*	-2.0**	-2.6	-2.6*	-2.0**	-2.5
rer_t	-0.9	-0.4	-0.3	-1.3	-0.68	-0.8
r_t	-5.8***	-0.4	-6.8***	-5.7***	-0.61	-6.8***
w_t	-0.1	-2.8**	-1.6	-1.9	-3.5***	-1.0
Variables in the first difference: I(1)						
g_t	-14.2***	-14.2***	-14.2***	-14.2***	-14.2***	-14.2***
rer_t	-11.2***	-11.2***	-11.3***	-11.2***	-11.2***	-11.3***
r_t	-17.8***	-17.8***	-17.8***	-19.0***	-19.1***	-19.0***
w_t	-19.5***	-18.5***	-19.6***	-20.6***	-18.6***	-21.0***

Notes: *, **, *** denote statistical significance at 10%, 5% and 1%, respectively.

Source: Authors' calculations.

Table 4 Johansen Test for Cointegration

Maximum rank	Parms	LL	Eigenvalue	Trace statistic
		Variables: {g_t ; rer_t ; r_t ; w_t}		
0	8	2465.6		125.5
1	15	2503.4	0.28	49.8
2	20	2518.4	0.12	19.9
3	23	2528.3	0.08	0.07***
4	23	2528.4	0.00	

Notes: (1) the Johansen test for cointegration was performed in accordance with the best number of lags indicated by the SBIC (1, in this case); (2) *, **, *** denote statistical significance at 10%, 5% and 1%, respectively.

Source: Authors' calculations.

[5] **Brazilian Institute of Geography and Statistics - IBGE.** 2021c. https://sidra.ibge.gov.br/tabela/3653 (accessed February 06, 2020).

[6] **Brazilian Institute of Geography and Statistics - IBGE.** 2021d. http://ipeadata.gov.br/Default.aspx (accessed February 06, 2020).

Two methods were employed to perform these estimates. First, a series of regressions was made using the Markov-switching dynamic regression with the intercept, variance and parameters varying by regime/state. The unique independent variable introduced into the estimates, without the parameter varying by regime, is the interest rate. The criterions of information suggested that the appropriate number of regimes was two, while the optimal lag number of independent variables was one. This methodology was used because it captures the asymmetrical behavior response of demand growth to changes in income distribution and the RER over the economic cycle, as James D. Hamilton (1989) argues. In other words, Markov-switching dynamic regressions estimate different parameters according to the regime. Moreover, it also provides the probabilities of changing (the closer to one, the less persistent the process) or remaining in the regime (the closer to one, the more persistent the process).

A second set of quantitative analyses was performed using wavelet methodology, which is a non-econometric way of decomposing a time-series into time and frequency domains. Although there are still relatively few economics studies that employ wavelet analysis, it provides fruitful insights about the influence of RER and income distribution on demand growth over time. The rationale for wavelet analysis arises from its capacity to capture the unobservable relationship between economic variables over time (James B. Ramsey 2002). The main result derived from wavelet analysis is wavelet coherence, which measures the local correlation between two time-series within the time-frequency domain. This technique produces an analysis complementary to the Markov-switching regression results, because it enables us to capture changes to the relationship between two variables over time, for the short-, medium- and long-term variable cycles.

The wavelet estimates were performed using three combinations of variables: (i) g_t and w_t; (ii) g_t and rer_t; (iii) g_t and r_t. The aim is to identify the co-movements of growth in industrial demand in relation to the behavior of income distribution, the RER and the short-term interest rate. This co-movement can be decomposed into a continuous exponential vector from a few months to four years, and can also analyze whether movement in one variable sparks the same movement in the other. However, this does not mean that co-movement should be understood as causation movement. Although it is not appropriate to think of it in terms of causation in a broad sense, co-movement detection in wavelet analysis may be more informative than Granger Causalities tests. The former informs researchers which variable in which time frame leads to another. The latter only provides information about the statistical significance of one lagged variable to explain another, without revealing anything about direction.

All variables were in level (or original) form, since this method does not need to use stationary variables. Wavelet techniques are applied to continuous and discrete methods in different ways. On the one hand, the continuous method allowed us to perform wavelet coherence analysis, which generates information about the correlation of waves between the series over time, and during the period under consideration. It also revealed whether one wave's signal preceded or succeeded another, providing that signal's significance level. The discrete method, on the other hand, allowed us to perform a specific time period decomposition leading to the short-, medium- and long-term variable cycles. The advantage of this decomposition is the possibility of transforming

a stochastic time series into a sinusoidal one, improving our analysis of events in the same period.

The next section presents the results of these estimates.

3. Results

The estimates performed using the Markov-switching and wavelet methodologies are presented below.

3.1 Markov-Switching Model Estimates

The Markov-switching model estimates are presented in Table 5, below. Various specifications, with four different combinations of independent variables, were estimated to test result robustness. In graphic terms (not presented here, due to limited space), it is quite clear that the estimate residuals of our four equations are centered around zero, although there are substantial deviations at the following times: the 2008 crisis; the truck driver strike in mid-May 2018; and the coronavirus pandemic mid-first quarter of 2020. The basic residual statistics confirmed a mean around zero, and a standard deviation around 0.02. Further, the unit root tests indicated that the residuals were stationary. Performing equations using level variables (non-stationary and cointegrated) therefore produces stationary residuals and reliable estimates.

The results are quite robust in suggesting that no variable is statistically significant in the state 01 estimates. Only the lagged value of the dependent variable is statistically significant at 10% critical values and around 0.5. In contrast, this variable's estimated parameter for state 02 is statistically significant at 1% critical values and around 0.9.

The Equation (1) estimate is displayed in column (1). In state 2, the estimated parameter for the r_{t-1} variable is statistically significant at 5% critical values and equals -0.58, which indicates that an increase of 1% in the real interest rate reduces demand growth by 0.58%. The constant is statistically significant in both states. However, it equals 0.84 in state 01, and 0.92 in state 02. This suggests that state 01 represents a regime of modest demand growth, while state 02 characterizes a regime of demand growth at a faster pace. In turn, the Equation (1) state 02 estimate indicates that all the parameters are statistically significant at 1% critical values. The values of the estimated parameters are -0.04 and -0.01 for the rer_{t-1} and w_{t-1} variables, respectively. A devaluation of 1% in RER cuts demand growth by 0.04%, whereas an increase of 1% in minimum wage lowers demand growth by 0.01. The estimates of the other specifications, with different independent variable combinations, as seen in columns (2) and (3), confirmed these results. There is little evidence suggesting that the dependent variables exert much influence on demand growth in state 01. Conversely, there is strong evidence in favor of the contractionary influence of increases in minimum wage and RER devaluation on demand growth in state 2.

A further result refers to the probability of switching the state of the Brazilian economy. If the process starts in state 01, the probability of it remaining in state 01 is 0.77. The probability of switching from state 01 to state 02 is therefore 0.23. On other hand, the probability of switching from state 02 to state 01 is 0.01. Similarly, if the

process starts in state 2, the probability of remaining in state 02 is 0.99. These results suggest that state 02 is a very persistent process, and that the Brazilian economy is expected to remain there over an extended period.

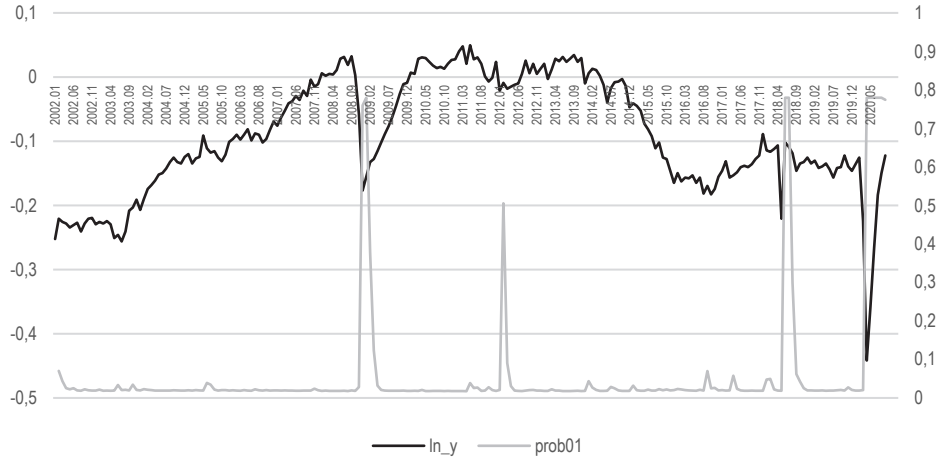
Table 5 Markov-Switching Model Estimates

	(1)	(2)	(3)	(4)
r_{t-1}	-0.58**		0.09	0.06
	(0.29)		(0.25)	(0.27)
State 1				
g_{t-1}	0.54*	0.55*	0.56*	0.54**
	(0.29)	(0.29)	(0.30)	(0.25)
rer_{t-1}	-0.01	-0.01	-0.04	
	(0.25)	(0.24)	(0.24)	
w_{t-1}	-0.04	-0.03		-0.05
	(0.17)	(0.16)		(0.15)
constant	0.84*	-0.07	-0.22	-0.19
	(0.46)	(0.08)	(0.40)	(0.43)
State 2				
g_{t-1}	0.89***	0.91***	0.93***	0.98***
	(0.02)	(0.02)	(0.02)	(0.01)
rer_{t-1}	-0.04***	-0.03***	-0.01**	
	(0.01)	(0.009)	(0.008)	
w_{t-1}	-0.01***	-0.01***		-0.003
	(0.004)	(0.003)		(0.003)
constant	0.92**	0.002		-0.10
	(0.46)	(0.001)		(0.43)
Sigma1	0.08	0.08	0.08	0.08
	(0.01)	(0.01)	(0.01)	(0.01)
Sigma2	0.01	0.01	0.01	0.01
	(0.0006)	(0.0006)	(0.0006)	(0.0006)
p_{11}	0.77	0.77	0.76 (0.14)	0.76
	(0.13)	(0.13)		(0.14)
p_{21}	0.01	0.01	0.01	0.01
	(0.009)	(0.01)	(0.009)	(0.009)
AIC	-5.4	-5.4	-5.3	-5.3
HQIC	-5.3	-5.3	-5.2	-5.2
SBIC	-5.2	-5.2	-5.1	-5.1
Log likelihood	619	617	611	609

Notes: (1) estimates performed on all level variables; (2) *, **, *** denote statistical significance at 10%, 5% and 1%; (3) the standard deviation is in parentheses

Source: Authors' calculations.

Figure 3 presents: the estimated probability of remaining in state 01, when the process starts in that state; the Equation (1) estimate (see column 1, Table 5); and the evolution of industrial demand over the period under analysis.



Notes: The predicted probability arises from the results of the first specification estimate.

Source: Authors' calculations.

Figure 3 Predicted Probability of Changing the Brazilian Economy's Regime (p_{11})

State 02 is more persistent and is the predominant state. One interesting aspect suggested in Figure 3 is that, during normal periods, the probability of staying in state 01, when the process begins there, is incredibly low, almost null. In other words, during normal periods, the probability of switching from regime 01 to 02, when the process starts in state 01, is very high, almost one. However, we note that during periods of crisis this analysis changes drastically. Figure 3 also suggests that the probability of staying in state 01, when the process started in state 01, was around 0.8 during the crisis periods of 2008, the truck driver strike in mid-May of 2018, and the coronavirus pandemic in the middle of the first quarter of 2020.

3.2 Wavelet Analysis

The wavelet results are presented in Figures 4 and 5. The horizontal axis represents the wavelet analysis time, while the vertical represents the period (the inverse of frequency) (from 1 month to 4 years). Grayscale colors represent the intensity value of the co-movement, which ranges from 0 (dark gray) to 1 (dark gray). The arrows indicate the phase between series. If the arrows point to the right (left), there is a phase (anti-phase) movement between changes in demand and minimum wage: an increase in one series is followed by a simultaneous increase (decrease) in the other. If the arrows point down (up), the minimum wage is leading the movement; changes occur first in wages (demand) and then in demand (wages).

Figure 4 displays the wavelet coherence for the g_t demand growth variable against minimum wage w_t.

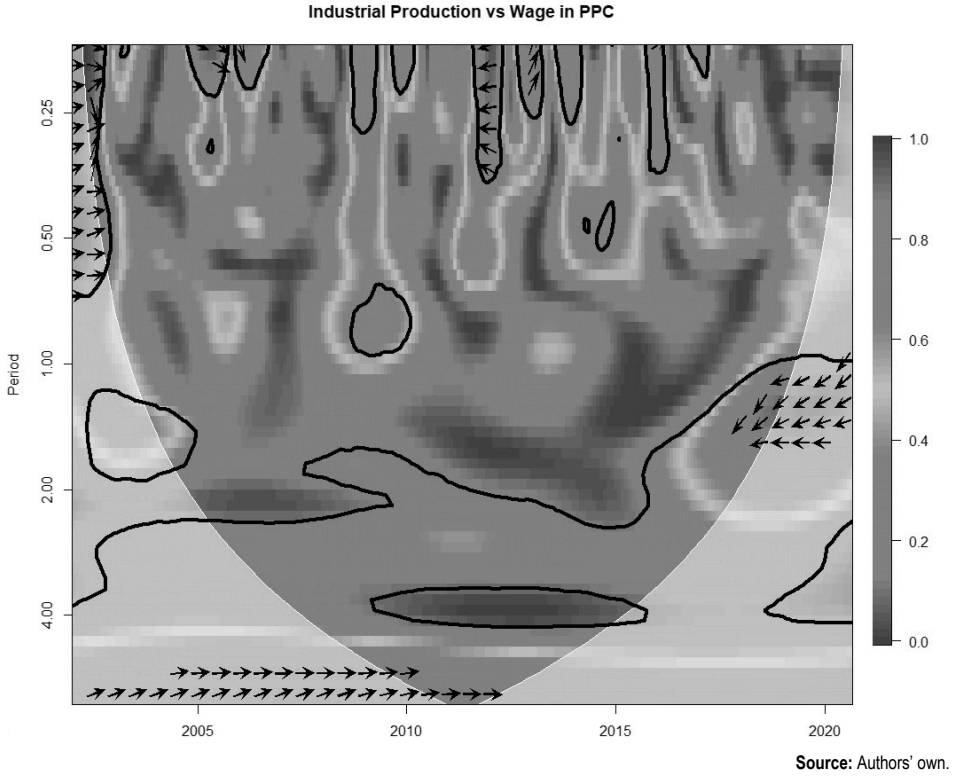
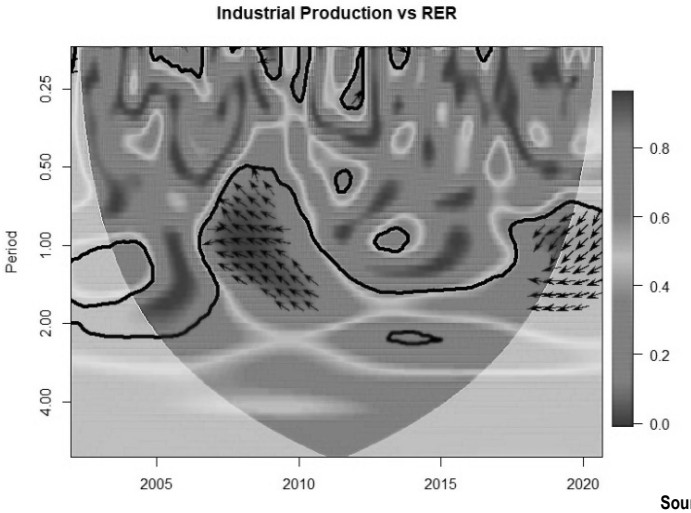


Figure 4 Wavelet Coherence Phase Diagram: Industrial Demand x Minimum Wages

In the short-run (from one to six months), there are four episodes of co-movement with high correlations, three episodes of phase movement and one anti-phase. Two episodes of phase movement, characterized by the positive influence that changes in demand exert over income distribution, occurred over two periods: 2002-2003 and 2013-2014. On the other hand, the episode of phase movement characterized by the positive influence that changes in income distribution have on demand growth occurred between 2005 and 2006. For its part, the anti-phase episode took place in 2012. In this case, increases in minimum wage were negatively associated with demand growth. Furthermore, Figure 4 also suggests that, in the medium term (from one to two years), between 2017 and 2020, there was one episode of co-movement with high correlation. This episode featured an anti-phase movement, in which a higher minimum wage was negatively associated with demand growth. This also indicates that, over the long-run (four years), between 2002 and 2013, there was one episode of co-movement with high correlation. This episode is characterized by one phase movement and by the positive influence that changes in demand have on income distribution.

Figure 5 presents the wavelet coherence phase diagram for the demand growth and RER variables.



Source: Authors' own.

Figure 5 Wavelet Coherence Phase Diagram: Industrial Demand x RER

The results provide little evidence in favor of a possible association between RER and demand. However, Figure 5 suggests the existence of two anti-phase movement episodes in the medium term. The first episode, between 2006 and 2013, is characterized by the negative influence of increases in demand on RER. For its part, the second episode, between 2018 and 2020, features the negative influence of RER devaluations on demand growth. We plotted a wavelet coherence phase diagram for Industrial Demand and Real Interest Rate. However, its results provided little evidence that the interest rate was associated with Industrial Demand.

4. Concluding Remarks

This paper sought to study the influence that income distribution and RER in Brazil exerted on demand growth between 2002 and 2020, in light of the heterodox debate between social- and new-development analysts. To this end, we estimated a set of time series regressions using Markov-switching model estimates and wavelet estimates.

The Markov-switching model estimates indicated the existence of two states in the Brazilian economy over the period in question. Within the (first) regime of modest demand growth, neither income redistribution, nor the real exchange rate were statistically significant. In contrast, within the (second) regime of faster paced demand growth, both variables were statistically significant. In this case, the results suggest that increases in the real minimum wage, or depreciation of the national currency in real terms, is negatively associated with industrial demand. The findings suggest that the second state of the Brazilian economy is more persistent and predominant. One interesting aspect suggested by the Markov-switching model estimates is that when the process begins in the (first) regime of modest demand growth, the probability of staying in that state during normal periods is incredibly low. In other words, in normal times, the probability of switching from the (first) regime of modest growth to the

(second) regime of faster paced demand growth is incredibly high. However, this analysis changes drastically in periods of economic crisis, with a sharp decline in economic activity instigated by exogenous elements. When the process begins in the (first) regime of modest demand growth, the probability of staying within it is much higher during crises, such as that of 2008, the truck driver strike in mid-May 2018, and the coronavirus pandemic in the middle of the first quarter of 2020.

Our wavelet results were in line with previous findings. In the short term (from one to six months), raising the real minimum wage had a positive influence on growth in industrial demand between 2005 and 2006, and a negative one in mid-2012. In the medium term (one to two years), the results indicate a negative association between increasing the real minimum wage and growth in industrial demand, from 2017 to 2020. There is no evidence of long-term effects. Regarding the influence of the real exchange rate between 2018 and 2020, estimates suggest that depreciating the national currency only exerted a negative influence on industrial demand over the medium term.

In a nutshell, our Markov-switching model estimates suggest that reducing the real wage, or appreciating the national currency, exerted a positive influence on growth in industrial demand in normal periods, but this did not apply to crisis ones. The wavelet estimates suggest that a growth-strategy based on raising the real minimum wage was a coherent policy for boosting industrial demand in the short term, especially between 2005 and 2006. However, this approach, considered the cornerstone of social-developmentalist economics, has been proven to only play a limited role in promoting maintainable economic growth, since the wavelet outcomes indicate the negative influence of raising the real minimum wage on industrial demand in the medium term, between 2017 and 2020. This suggests that the wage-led policies, particularly the increase in the real minimum wage, adopted in the early 2000s, lost their capacity to drive demand growth over time. Furthermore, the evidence of our wavelet estimates suggests that demand growth was negatively impacted by the expansions in the real minimum wage between 2017 and 2020. This suggests that, during this period, a turning point was reached concerning distributive policies and growth in industrial demand. Exploring why this has occurred is crucial for delineating future optimal redistributive policies. However, given the complexity of this subject, such a task is beyond the scope of our study. Finally, the wavelet outcome also provides strong evidence in favor of the negative influence devaluations of the RER have on industrial performance, as expected in the short term, since it erodes real wages and increases imported costs.

Ultimately, it is worth noting that the new developmentalist argument, according to which a competitive RER is crucial to encouraging long-term growth by promoting industrialization, should be understood according to the production structure's developmental stage. In this sense, given the weak sectoral linkages, the deindustrialization of the Brazilian economy has increased dependence on imports. Consequently, a more competitive RER has a more noticeable effect on inflation (and, thus, on monetary policy), because the production structure is strongly dependent on imports, leading to a sharp fall in real wages (unless inflationary acceleration is accepted and wages are adjusted in line with inflation), and economic recession, since consumption

constitutes a considerable share of GPD. The feasibility of the new developmentalist doctrine therefore depends on the initial conditions of the production structure, reinforcing Medeiros' argument that a broader set of economic policies is required, either to promote industrialization and economic complexity, or to mitigate the harmful effects of a competitive RER on worker income.

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