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Investigating the dynamics of the profit rate, the exchange rate, and terms of trade in Brazil

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Abstract:
This paper explores the intricate relationship between profit rates, exchange rates, and terms of trade in the Brazilian economy from 2000 to 2023. Building on Weisskopf's (1979) decomposition of the profit rate, we demonstrate how exchange rates and terms of trade affect profit share, the potential output-capital ratio, and capacity utilization. Our results reveal a nonlinear, U-shaped relationship between exchange rates and profit rates. While currency devaluation can boost profit rates by increasing the profit share, it may negatively affect the potential output-capital ratio. Conversely, currency appreciation can raise the potential output-capital ratio but reduce the profit share. We show that terms of trade play a key role in shaping profit rates. Improvements in terms of trade can elevate the profit share, the potential output-capital ratio, and capacity utilization, leading to higher profitability. However, the impact of terms of trade on profit rates is complex, as they also influence exchange rates. Our findings underscore the importance of understanding the dynamic interplay between exchange rate, terms of trade, and the profit rate for economists and policymakers.

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One crucial issue in economics is the relationship between exchange rates, terms of trade, and profitability. The profit rate is a key determinant of capital accumulation (Robinson, 1956; Kalecki, 1971; Marx, 1981). Firms base their investment decisions on the expected profit rate, which is influenced by the current profit rate. Understanding this interplay is essential for comprehending the dynamics of modern open economies, particularly in middle-income countries like Brazil, where both global trends and domestic policies shape economic conditions.

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Building upon Weisskopf's (1979) framework, which decomposes the profit rate into profit share, potential output-capital ratio, and capacity utilization, we explore how exchange rates and terms of trade affect profitability. We argue that exchange rates influence both profit share and the potential output-capital ratio by affecting the prices of tradable goods relative to consumer prices, the gross domestic product (GDP) deflator, and the capital goods deflator. These effects result in a nonlinear relationship between exchange rates and profit rates, with important implications for investment decisions.

We also highlight that improvements in terms of trade enhance the profit rate by increasing both profit share and the potential output-capital ratio. Higher terms of trade have a greater impact on the prices of tradable goods than on nontradable goods, which constitute a significant portion of workers' consumption baskets. This results in a larger increase in the GDP deflator than in the consumer price index. Additionally, higher terms of trade reduce the price of capital goods, many of which are imported, relative to the GDP deflator, increasing the potential output-capital ratio. This framework links the profit rate, the terms of trade, and economic growth, an issue central to many Latin American scholars (Prebisch, 1968; Ocampo and Parra-Lancourt, 2010).

The new developmentalist literature emphasizes the role of the real exchange rate on profit share through its impact on the markup for tradable goods (Bresser-Pereira et al., 2014; Feijó and Araújo, 2024). A real exchange rate devaluation enables domestic firms to expand their markup and reduce the wage share, as the price of imported goods in domestic currency rises. Conversely, the Dutch disease, common in natural-resource-rich countries, can lead to an overvalued real exchange rate that undermines the competitiveness of manufacturing, particularly those relying on advanced technologies (Bresser-Pereira, 2022). This occurs as the national currency appreciates due to high revenues from natural resource exports.

Moreover, pursuing high interest rates to attract international capital and avoid capital flight further pressures the exchange rate, leading to appreciation that reduces the markup and profit share in the tradable sector. Consequently, the profit rate in the tradable sector, particularly in manufacturing, declines, resulting in reduced capital accumulation and hindering technological advancements. This phenomenon has contributed to premature deindustrialization in in Brazil, where the share of manufacturing output and employment in the overall economy has been declining.

A large body of literature explores the relationship between exchange rates, structural change, and economic growth. Notable studies include Ros and Skott (1998), Rodrik (2008), Rapetti et al. (2012), Missio et al. (2015), Iasco Pereira and Missio (2022), among others. The effects of the real exchange rate on capital accumulation and economic growth have also been studied by Krugman and Taylor (1978), Frenkel and Taylor (2006), and Blecker (2023). Missio et al. (2015) highlight three key results from this literature: (1) an undervalued real exchange rate is associated with higher output growth; (2) this relationship is predominantly observed in developing countries; and (3) the relationship between the real exchange rate and growth is nonlinear, where moderate undervaluation tends to stimulate growth, while excessive undervaluation can harm economic performance.

Ribeiro et al. (2020) argue that the relationship between changes in the real exchange rate and output growth is characterized by two conflicting effects. On one hand, undervaluation stimulates output growth through technological progress and knowledge spillovers. On the other hand, undervaluation increases income inequality, which hampers output growth. They critique the literature for not fully considering the adverse distributional effects of undervaluation. However, the authors do not explore the possibility of a nonlinear relationship between real exchange rates and economic growth.

In classical-Marxian literature, the real exchange rate exerts contradictory effects on the profit rate, influencing both capital accumulation and economic growth. An undervalued exchange rate increases the profit share but raises the price of capital goods, boosting the profit share while lowering the potential output-capital ratio. In contrast, an overvalued exchange rate depresses the profit share but reduces the cost of capital goods, diminishing profit share but enhancing the potential output-capital ratio. An overvalued exchange rate increases capacity utilization by boosting household consumption, whereas a devalued exchange rate enhances capacity utilization through higher exports. The overall impact of the real exchange rate on the profit rate – and consequently on capital accumulation and economic growth – depends on the relative strength of these opposing effects and their interaction with other economic variables. This framework offers insights into the association between an undervalued real exchange rate and economic growth, as shown by Missio et al. (2015).

It is essential to consider the role of terms of trade in shaping profit rates and capital accumulation, especially for commodity-dependent economies. As Marquetti et al. (2024) suggest, fluctuations in terms of trade significantly impact these dynamics. Brazil's recent reprimarization, with an increased reliance on commodity exports such as soybeans, iron ore, and oil, exemplifies this trend. Favorable terms of trade tend to boost profit rates and appreciate the exchange rate, while deteriorating terms of trade have the opposite effect.

These effects highlight the importance of the exchange rate in shaping profitability and investment decisions. In developing countries, where commodity price cycles and sudden reversals in capital flows are common, exchange rate volatility is a major concern (Ocampo et al., 2009). The combined influence of exchange rate and terms of trade, alongside with distributive conflict and technical change, shapes profitability and the broader economic trajectory. This dynamic is arguably visible in Brazil's economic experience in the 21st century.

The present paper investigates the relationship between the profit rate, its determinants, the exchange rate, and terms of trade. First, we extend Weisskopf's decomposition to investigate the effects of exchange rates and terms of trade on the determinants of the profit rate, specifically, the profit share, the potential output-capital ratio, and capacity utilization. This methodological approach is followed by an empirical analysis of the Brazilian economy from 2000 to 2023. While Marconi et al. (2020) focus on the relationship between the real exchange rate and profit margins, they do not address the broader determinants of the profit rate. Our study aims to fill this gap by examining how exchange rates, terms of trade, and the profit rate, and its key determinants interrelate from 2000 to 2023.

The first two decades of the 21st century mark the period during which Brazil consolidated its fluctuating exchange rate regime, following a long period of inflation and a stabilization strategy based on an exchange rate anchor from 1994 to early 1999. This timeframe is ideal for investigating the effects of these relationships, which is the primary reason it was chosen. To our knowledge, this is the first paper to consider these combined effects on the profit rate and its determinants.

The article is structured as follows: the second section explores how exchange rates and terms of trade influence the profit rate and its key determinants. The third section presents an empirical investigation using local regression and visual analysis, in contrast to traditional econometric methods. The fourth section concludes.

1. The dynamics of profit rate, exchange rate, and terms of trade

The profit rate r_t is calculated as the ratio of profits Z_t, a flow variable at current prices, for each period t, to the total advanced capital K_t, a stock variable, also expressed at current prices. Thus, the profit rate for period t is determined as follows:

$$r_t = \frac{Z_t}{K_t} \tag{1}$$

This definition of the profit rate is referred to by Duménil and Lévy (1993) as the profit rate *à la* Marx. Weisskopf (1979) proposed a decomposition of the profit rate, enabling analysts to identify whether changes over time are attributable to variations in the profit share π_t, the potential output-capital ratio ρ_t, the level of capacity utilization u_t, or a combination of these factors. The identity emphasizes the variable driving changes in the profit rate. The decomposition can be expressed as:

$$r_t = \left(\frac{Z_t}{X_t}\right) \cdot \left(\frac{X_{P,t}}{K_t}\right) \cdot \left(\frac{X_t}{X_{P,t}}\right) = \pi_t \cdot \rho_t \cdot u_t \tag{2}$$

where X_t is the net output and $X_{P,t}$is the net potential output measured at current prices.

The profit share π_t reflects the effects of functional income distribution between profits $Z_t$and wages $W_t = X_t - Z_t$ on the profit rate. The potential output-capital ratio, or potential capital productivity, ρ_t, reflects changes in the organic composition of capital. The level of capacity utilization u_t displays fluctuations in aggregate demand.

The profit rate path is related to three factors that explain the sources of cyclical movements in a capitalist economy (Weisskopf, 1979). Firstly, the decline in the profit share is due to workers' greater bargaining power, with wages rising faster than labor productivity. Secondly, the potential output-capital ratio declines due to the increasing organic composition of capital, a phenomenon linked to technical change and capital accumulation (Weisskopf, 1979, p. 342).

According to Marx (1981), technical change in capitalist societies results in higher labor productivity and lower capital productivity, driven by the increasing use of machinery over living labor. Foley et al. (2019) termed this type of technical change Marx-biased. This process tends to reduce the profit rate over time, assuming the profit share remains constant. The cheapening of capital goods and the reduced cost of imported tradable goods through foreign trade are countertendencies to the declining profit rate. Long- and short-term factors affect the potential output-capital ratio (Marquetti et al., 2019). Thirdly, the level of capacity utilization declines due to reduced aggregate demand.

To determine the growth rate of the profit share, we first decompose it as follows:

$$\pi_t = \left(\frac{Z_t}{X_t}\right) = \left(\frac{X_t - W_t}{X_t}\right) = \left(1 - \frac{W_t}{X_t}\right) = \left(1 - \frac{w_t}{x_t}\right) = \left(1 - \frac{w_t}{p_t^X x_{C,t}}\right) \tag{3}$$

where $w_t = W_t \,/\, N_t$ is the average nominal wage, $x_t = X_t \,/\, N_t$ is the nominal labor productivity, with N_t as the workforce, p_t^X denotes the GDP deflator, and $x_{C,t}$ is the real labor productivity, being all variables considered at the same period t. Then, the growth rate of the profit share g_{π_t} is given by:

$$g_{\pi_t} = \left(\frac{1-\pi_t}{\pi_t}\right)\left(g_{p_t^X} - g_{w_t} + g_{x_{C,t}}\right), \tag{4}$$

with $g_{p_t^X}$, g_{w_t} and $g_{x_{C,t}}$ the corresponding growth rate of the variables p_t^X, w_t, and $x_{C,t}$.

To maintain a stable functional income distribution, the growth rate of nominal wages should equal the sum of inflation as measured by the GDP deflator and the growth rate of real labor productivity. This ensures that wages increase at the same rate as labor productivity, thereby keeping the labor share constant.

There are two aspects to consider in the equation above. Firstly, based on the hypothesis that exchange rate depreciation affects the GDP deflator p_t^X more than nominal wage w_t and does not impact real labor productivity $x_{C,t}$, it leads to an increase in the profit share. Conversely, in the case of exchange rate appreciation, the negative impact on the GDP deflator is greater than on nominal wages, which results in a decline in the profit share π_t. Thus, an undervalued exchange rate typically results in a higher profit share. Secondly, a higher wage share relative to the profit share will amplify these effects. Interestingly, as shown in equation (3), any change in the variables p_t^X, w_t, and $x_{C,t}$ also affects the variable π_t. When combined with equation (4), this implies that even a linear variation in the growth rates $g_{p_t^X}$, g_{w_t} or $g_{x_{C,t}}$, can result in a nonlinear variation of the growth rate g_{π_t}, due to the potential nonlinearly behavior of the first factor in equation (4).

The hypothesis of a nonlinear relationship between the exchange rate and the profit share will be tested later in the article. The factor $(1-\pi_t)/\pi_t$ may also exhibit nonlinear behavior with respect to the exchange rate. Additionally, nonlinearity can result from the set of equations and identities considered, such as the relationship between the profit share and the exchange rate presented in equation (11).

It is worth noting that some studies adopt simplifying assumptions to ensure linearity in the model, which is appropriate for analyzing local behavior with small changes in variable values. In contrast, this paper avoids such assumptions and aims to offer a more comprehensive perspective on the topic under study.

To investigate the relationship between profit rate and exchange rate further, consider the following equation for the nominal wage:

$$w_t = w_{R,t}\, p_t^C = w_{R,t} \cdot (e_t p_t^T)^{\mu} (p_t^N)^{1-\mu} \tag{5}$$

where $w_{R,t}$ is the real wage, p_t^C is the consumer price index composed of tradable and nontradable goods, e_t is the exchange rate measured in direct quotation, indicating how many local currency units are needed to buy one foreign currency, p_t^T is the price of tradable goods in foreign currency, p_t^N is the prices of nontradable goods in national currency, and μ represents the share of tradable goods in the consumer price index. Furthermore, let the GDP deflator be expressed by:

$$p_t^X = (e_t p_t^T)^{\theta} (p_t^N)^{1-\theta}, \tag{6}$$

where $0 < \theta < 1$ represents the share of tradable goods in the GDP deflator. We assume that the share of tradable goods in the GDP deflator is higher than in the consumer price index, meaning $\mu < \theta$. This allows us to rewrite equation (3) as:

$$\pi_t = 1 - \frac{w_{R,t} \cdot (e_t p_t^T)^{\mu} (p_t^N)^{1-\mu}}{(e_t p_t^T)^{\theta} (p_t^N)^{1-\theta} x_{C,t}} = 1 - \left(\frac{w_{R,t}}{x_{C,t}}\right) \cdot \left(\frac{p_t^N}{e_t p_t^T}\right)^{(\theta-\mu)} \quad (7)$$

In this way, we have an explicit relationship between the exchange rate and the profit share, allowing us to determine the rate of variation of the latter in relation to the former. However, the terms of trade also play a role in determining prices and the exchange rate. It is important to consider the terms of trade, defined as $T_t = p_t^{TX}/p_t^{TM}$ in the equation, that is, the relative price of exports, p_t^{TX}, in terms of the price of imports, p_t^{TM}. Equation (8) presents the effect of terms of trade on the consumer price index, where the α parameter is the share of export prices, and $1 - \alpha$ is the share of import prices. Similarly, equation (9) shows the effects of the terms of trade on the GDP deflator, where ω is the share of export prices and $1 - \omega$ is the share of import prices. Assuming that terms of trade had a higher impact on the GDP deflator than on the consumer price index implies that $\omega - \alpha > 0$.

$$(p_t^T)^{\mu} = (p_t^{TX})^{\alpha} (p_t^{TM})^{1-\alpha} = (T_t)^{\alpha} p_t^{TM}, \quad (8)$$

$$(p_t^T)^{\theta} = (p_t^{TX})^{\omega} (p_t^{TM})^{1-\omega} = (T_t)^{\omega} p_t^{TM}, \quad (9)$$

We also consider the effect of terms of trade on the exchange rate. We claim that a raise in the terms of trade leads to an exchange rate appreciation. Moreover, considering B as a parameter that contains all other determinants of the exchange rate, we can write:

$$e_t(T) = B {T_t}^{-\lambda} \quad (10)$$

where B and λ are greater than zero.

By combining equations (9) and (8) with equation (7), we obtain the following result:

$$\pi_t = 1 - \left(\frac{w_{R,t}}{x_{C,t}}\right) \cdot \left(\frac{1}{T_t^{\omega-\alpha}}\right) \left(\frac{p_t^N}{e_t}\right)^{(\theta-\mu)} \quad (11)$$

Equations (12), (13), and (14), show how changes in nontradable prices, terms of trade, and the exchange rate affect the profit share. We assume that the variables are exogenous to the exchange rate, except for the terms of trade.

$$\frac{\partial \pi_t}{\partial p_t^N} = -(\theta - \mu) \frac{(1-\pi_t)}{p_t^N} < 0, \quad (12)$$

$$\frac{\partial \pi_t}{\partial T_t} = \frac{(1-\pi_t)}{T_t} [(\omega - \alpha) - \lambda(\theta - \mu)] > 0, \quad (13)$$

$$\frac{\partial \pi_t}{\partial e_t} = (\theta - \mu) \frac{(1-\pi_t)}{e_t} > 0 \quad (14)$$

An increase in nontradable prices reduces the profit share, as it is assumed that nontradable prices are a larger portion of the consumer price index than of the GDP deflator. In contrast, an exchange rate increase (domestic currency devaluation) boosts the profit share, as it raises the GDP deflator more than it raises the consumer price index. The effects of the terms of trade will be positive if $(\omega - \alpha) > \lambda(\theta - \mu)$. The first term indicates a direct effect of terms of trade on the profit share. An improvement in the terms of trade increases the profit share by exerting a greater effect on the GDP deflator than on the consumer price index. The second term gives the indirect impact of the terms of trade through the channel of the exchange rate. An expansion in the terms of trade, dependent on the λ magnitude, appreciates domestic currency and lowers the profit share as it reduces the GDP deflator more than the consumer price index. In developing countries, we can assume that the direct effect is higher than the indirect effect.

It is possible to observe the effects of the variables' growth rates on the growth rate of the profit share. Specifically, we can analyze these relationships using the framework presented in equation 7, which is conceptually similar to equation 4; we can deduce:

$$g_{\pi_t} = \left(\frac{1-\pi_t}{\pi_t}\right)\left(g_{x_{C,t}} - g_{w_t} + (\omega - \alpha)g_{T_t} + (\theta - \mu)\left(g_{e_t} - g_{p_t^N}\right)\right), \tag{15}$$

Equation 15 illustrates the combined effects of real labor productivity, real wages, the price of imports, terms of trade, the exchange rate, and the price of nontradables on profit share. The magnitude of the price components' effects depends on the term $(\theta - \mu)$. This term reflects the difference between the tradable goods composition of the GDP deflator and the tradable goods composition of the consumer price index. It is reasonable to assume that $0 \leq \theta - \mu \leq 1$.

The increase in the profit share can result from an improvement in the terms of trade, a depreciation of the exchange rate, and a decline in nontradable prices, or a combination of those factors. Interestingly, even when wages grow faster than real labor productivity, movements in the terms of trade and exchange rates can still support a rising profit share.

The potential output-capital ratio fluctuations may be impacted by the exchange rate through its effects on the GDP deflator and the price of capital goods. In the one-sector theoretical growth models, the potential output-capital ratio is assumed to remain constant in the post-Keynesian tradition (Dutt, 1990), to decline in the classical-Marxian tradition (Foley et al., 2019). In the neoclassical framework, the potential output-capital ratio decreases in economies with a capital-labor ratio below the steady state in exogenous growth models but remains constant in AK models (Marquetti, 2007).

Following Marquetti et al. (2019), the potential output-capital ratio can be written as:

$$\rho_t = \left(\frac{p_t^X}{p_t^K}\right) \cdot \left(\frac{X_{PC,t}}{K_{C,t}}\right) = p_t^R \cdot \rho_{C,t} \tag{16}$$

where p_t^K denotes the capital goods deflator, $X_{PC,t}$ is the potential output at constant prices, K_C is the capital stock at constant prices, p_t^R is the relative price between the GDP deflator and the capital goods deflator, and $\rho_{C,t}$ is the potential productivity of capital at a constant price. The growth rate of the potential output capital ratio is:

$$g_{\rho_t} = g_{p_t^X} - g_{p_t^K} + g_{\rho_{C,t}} = g_{p_t^R} + g_{\rho_{C,t}} \tag{17}$$

The relative price can be further decomposed, considering that the capital goods deflator is given by:

$$p_t^K = (e_t p_t^T)^{\delta}(p_t^N)^{(1-\delta)} \tag{18}$$

where $0 < \delta < 1$ represents the share of tradable goods in the capital goods deflator. We consider the hypothesis that $\theta - \delta < 0$, where the share of tradable goods in the capital goods deflator is higher than in the GDP deflator. The relative price can be written as:

$$p_t^R = \frac{(e_t p_t^T)^{\theta}(p_t^N)^{(1-\theta)}}{(e_t p_t^T)^{\delta}(p_t^N)^{(1-\delta)}} = \frac{e_t^{\theta-\delta}(p_t^T)^{(\theta-\delta)}}{(p_t^N)^{(\theta-\delta)}} \tag{19}$$

Decomposing $p_t^{T^{\delta}}$, or the capital goods component in terms of trade, we obtain:

$$(p_t^T)^{\delta} = (p_t^{TX})^{\beta}(p_t^{TM})^{1-\beta} = (T_t)^{\beta} p_t^{TM}. \tag{20}$$

Manipulating equation (9) and combining equations (14), and (15) gives us equation (21):

$$p_t^R = (T_t)^{\omega-\beta}\left(\frac{e_t}{p_t^N}\right)^{\theta-\delta} \tag{21}$$

Taking the derivatives, we obtain:

$$\frac{\partial p_t^R}{\partial p_t^N} = -\frac{(\theta-\delta)}{p_t^R} \cdot p_t^R > 0 \tag{22}$$

$$\frac{\partial p_t^R}{\partial T_t} = \frac{p_t^R}{T}[(\omega-\beta) - \lambda(\theta-\delta)] > 0 \tag{23}$$

$$\frac{\partial p_t^R}{\partial e_t} = \frac{(\theta-\delta)}{e_t} \cdot p_t^R < 0 \tag{24}$$

An increase in nontradable prices raises the relative prices between GDP deflator and capital goods deflator, and therefore the potential output-capital ratio, since $\theta - \delta < 0$, (i.e. the share of tradable goods in the GDP deflator is lower than in capital goods deflator). In the case of an exchange rate depreciation, the relative prices decrease, leading to a decline in the potential output-capital ratio, since the foreign prices have a greater influence on the capital goods deflator than on the GDP deflator. An exchange rate depreciation raises the relative costs of capital costs, reducing profitability through a potential output-capital ratio. In the case of cambial appreciation, the relative prices increase leading to a rise in potential output-capital ratio. As before, both a direct effect and an indirect effect of the terms of trade can be identified. The direct effect, associated with $\omega > \beta$, is that an improvement in the terms of trade has a greater impact on the GDP deflator than on the capital goods deflator, particularly in the case of developing countries. The indirect effect is also positive. An improvement in the terms of trade causes the domestic currency to appreciate, raising the GDP deflator more than the capital goods deflator, also increasing the potential output-capital ratio.

Exchange rate fluctuations affect the potential output-capital ratio through changes in the GDP deflator and the price of capital goods, with a reduced impact on the real potential output-capital

ratio. Typically, exchange rate devaluation has a higher effect on the price of capital goods, which largely consist of tradable goods, compared to the GDP deflator, which encompasses prices across both tradable and nontradable sectors. Moreover, following the structuralists, a steep price inelastic demand for capital goods is a stylized fact in Brazil and many other Latin American countries (Câmara and Vernengo, 2004). Conversely, exchange rate appreciation has a lower impact on the GDP deflator compared to the price of capital goods. In this sense, devaluated exchange rates are associated with a lower potential output-capital ratio.

The impacts of exchange rate movements on the profit rate are difficult to untangle. A devalued exchange rate typically corresponds with a higher profit share but a lower potential output-capital ratio. Conversely, an overvalued exchange rate often leads to a lower profit share and a higher potential output-capital ratio. These observations indicate a nonlinear relationship between the exchange rate and the profit rate, suggesting that overvalued or undervalued exchange rates may be associated with higher profit rates. The dominant effect is relevant to the analysis of economic trajectories, especially in peripheral countries subject to exchange rate fluctuations. In the next section, we provide an empirical perspective on the relation between the exchange rate, terms of trade and the profit rate.

2. Exploring the empirical relationship between profit rate, real exchange rate, and terms of trade

In this section, we explore the empirical links between the profit rate, the real exchange rate, and terms of trade in Brazil from 2000 to 2023, utilizing local regression, a nonparametric method for estimating a smooth curve without assuming a predefined global functional form (Cleveland, 1993). Nonlinear relationships between variables emerge from the data itself rather than being imposed by a predefined functional form.

Local regression allows for visualizing the relationship between dependent and independent variables by fitting a locally smoothed curve at each point. This is done by defining a neighborhood around a given value of the independent variable, comprising a subset of nearby observations, with the neighborhood size determined by a bandwidth parameter. The bandwidth controls the smoothness of the fit, and its value can be selected using criteria like generalized cross validation or Akaike's information criterion.

The method involves fitting a polynomial of a specified degree within each local neighborhood, with the degree chosen based on diagnostic plots following recommendations by Loader (1999). This process is repeated for each point of interest, producing an estimated regression function that smoothly connects the data points.

Local regression assumes that errors are normally and independently distributed. Assumptions of normality and constant variance of residuals can be assessed using diagnostic plots, as suggested by Loader (1999) and Cleveland and Devlin (1988). Fan and Gijbels (1996) provide a foundational discussion of the statistical inference framework for local regression, while Marquetti and Viali (2004) offer a series of empirical applications in economics.

The data source for the profit rate and its components is Marquetti et al. (2023). The profit rate is calculated as the ratio of net profit to net fixed capital stock, both measured at current prices. The wage share was computed using the method of Miebach and Marquetti (2022). The potential output-capital ratio is defined as the ratio of value added to net fixed capital stock at current prices, adjusted for the level of capacity utilization. For the real exchange rate, we employ the real effective exchange rate IPCA index provided by Banco Central do Brasil (2024), the Brazilian central bank. This index, which has an average value of 100 for the period 2000-2023,

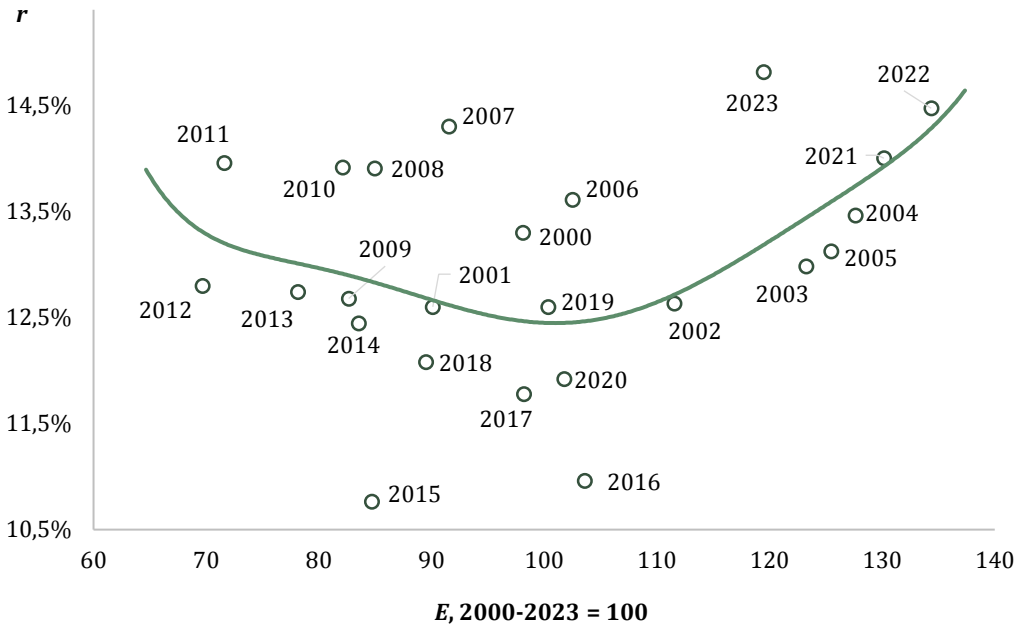
increases as the real exchange rate depreciates. The terms of trade are calculated as the ratio of the export price index to the import price index, using data from the Fundação Centro de Estudos do Comércio Exterior (FUNCEX, 2024), with 100 as the average value for the 2000-2023 period. Values for the real exchange rate exceeding 100 indicate undervaluation relative to its mean, while terms of trade values below 100 signify overvaluation relative to their average.

Figure 1 shows the pair real exchange rate and profit rate, (E, r), along with its local regression fit for the period 2000-2023. As expected, it exhibits a nonlinear U-shaped curve consistent with our analysis. The profit rate tends to be higher when the exchange rate is either undervalued or overvalued, and lower at the average real exchange rate. This suggests that, in the case of an undervalued exchange rate, the effects of a rising profit share dominate, while the effects of a higher potential output-capital ratio prevail when the exchange rate is overvalued.

We consider that a change in the real exchange rate within a given year affects the profit rate in the subsequent year. The least squares estimation of the function $r = aE^2 + bE + c + \varepsilon$, where c is a constant and ε is the error term, yielded $a = 0.00001151$ and $b = -0.002377$, both statistically significant at the 10% level. This result aligns with the U-shaped curve obtained from the local regression fit.

However, understanding the complex relationship between these two variables requires a detailed analysis, including an in-depth examination of how the exchange rate interacts with other factors that influence the profit rate.

Figure 1 – *The pair real exchange rate and the profit rate (E, r) and their local regression fit, 2000-2023*



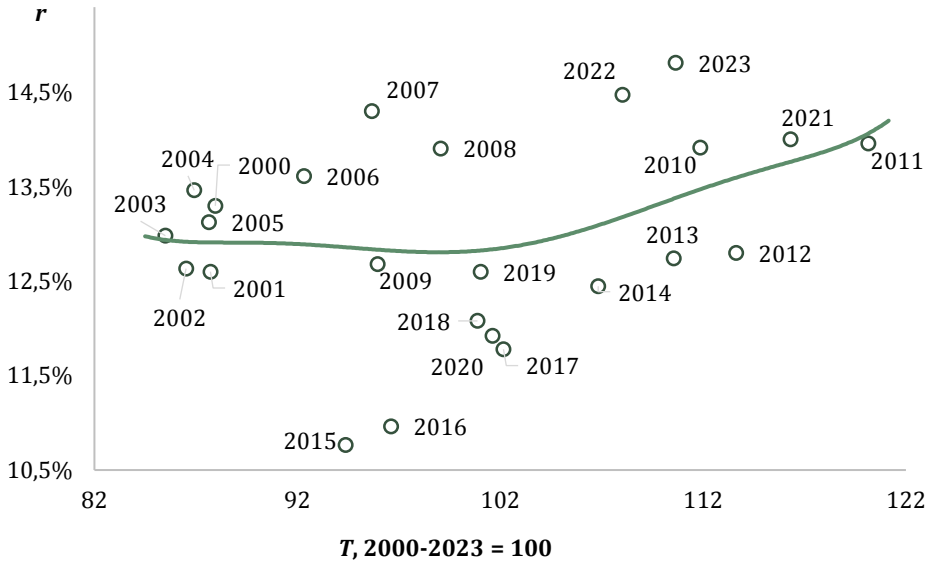
Source: Marquetti et al. (2023) and Banco Central do Brasil (2024).

Figure 2 illustrates the relationship between terms of trade and the profit rate (T, r) for the period 2000-2023. The local regression fit indicates a positive correlation, with the profit rate showing an increase as terms of trade improve. When terms of trade were below average, the estimated fit for the profit rate remained relatively stable. However, at higher terms of trade values, the relationship shifted, with the profit rate increasing. This highlights the crucial role of favorable terms of trade in enhancing economic performance and profitability during the analyzed period.

Figure 3 presents the real exchange rate and the profit share (E, π), along with their local regression fit for the period 2000-2023. A positive nonlinear relationship emerges, suggesting that the profit share tends to increase as the exchange rate depreciates, with the rise intensifying as the depreciation continues. This finding is consistent with our analysis of the determinants of the profit share and aligns with the principles outlined in the New Developmentalist literature.

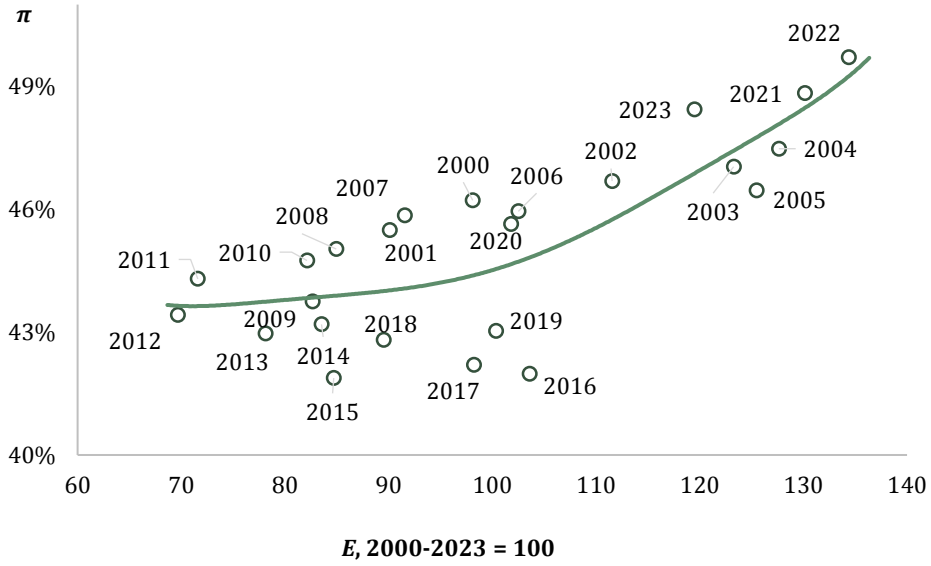
In our view, this pattern mainly results from the different impact of the exchange rate on prices and on nominal wages. Figure 4 illustrates the relationship between the real exchange rate and the growth rate of the GDP deflator, alongside their local regression fit as a dotted line. Additionally, it shows the relationship between the real exchange rate and the growth rate of nominal wages, along with their respective local regression fit as a solid line. For an overvalued real exchange rate, the average growth rate of nominal wage is greater than the growth rate in the GDP deflator, and the opposite occurs when the real exchange rate is undervalued. The growth rate of nominal wages declines, and the growth rate of the GDP deflator rises with the devaluation of the real exchange rate. This result is consistent with the hypothesis that the exchange rate devaluation has a higher pass-through effect on the GDP deflator than on nominal wages.

Figure 2 – *The pair terms of trade and the profit rate (T, r) and their local regression fit, 2000-2023*



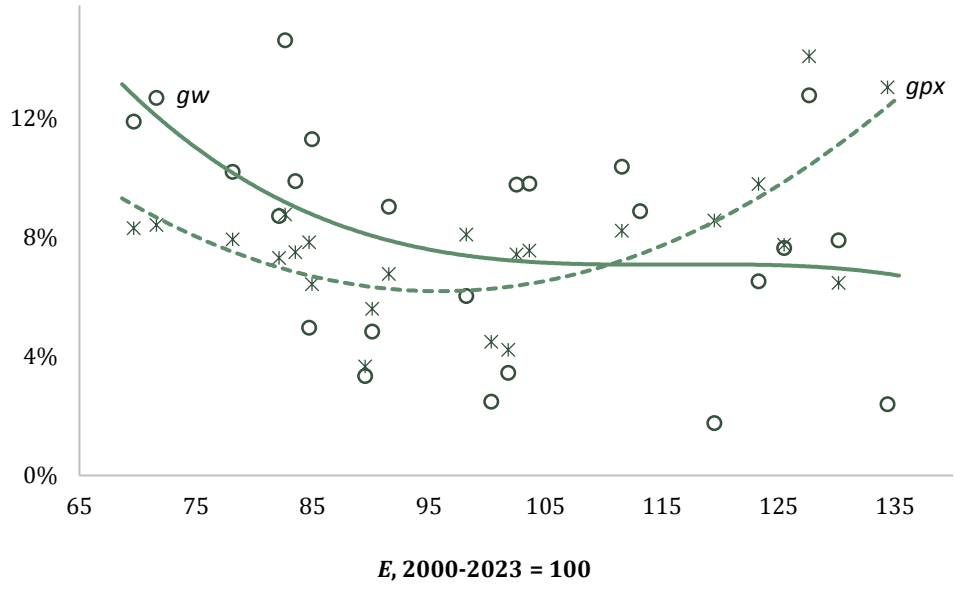
Source: Marquetti et al. (2023) and FUNCEX (2024).

Figure 3 – *The pair real exchange rate and the profit share (E, π) and their local regression fit, 2000-2023*



Source: Marquetti et al. (2023) and Banco Central do Brasil (2024).

Figure 4 – *The pairs real exchange rate and the growth rate of the GDP deflator (E, gpx), as well as the real exchange rate and the growth rate of nominal wages (E, gw), and their local regression fits*



Source: Marquetti et al. (2023) and Banco Central do Brasil (2024).

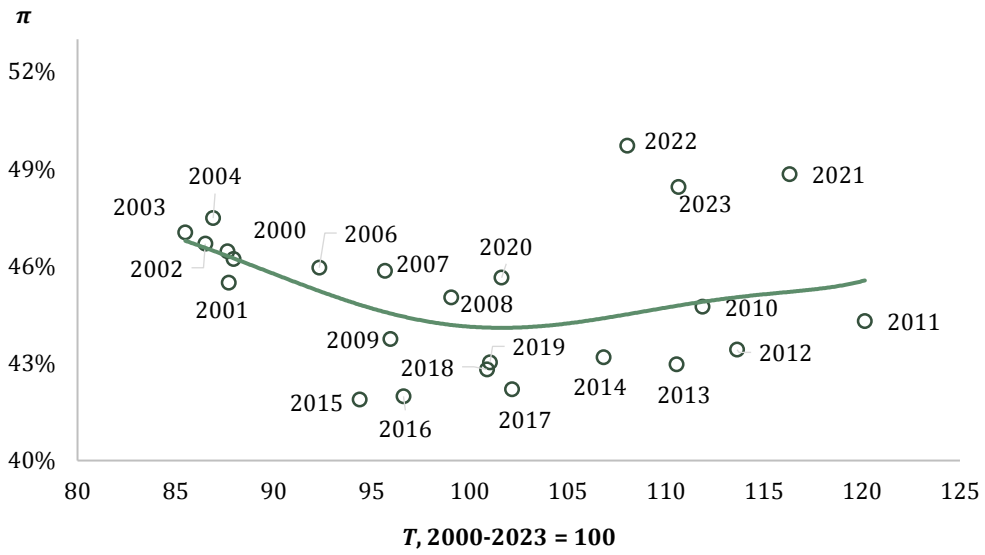
Figure 5 displays the relationship between terms of trade and profit share (T, π). The local regression fit reveals a nonlinear trend, particularly influenced by observations from the 2000-2005 period, which aligns with the early phase of the Pink Tide in Brazil. Interestingly, the negative segment of the fit contradicts our analysis in section 2. However, during this time, the Workers' Party administration, which took office in 2003, utilized the improvement in terms of trade to raise workers' incomes, consistent with the party's political base (Marquetti et al., 2020).

The relationship between the real exchange rate and the potential output-capital ratio, the pair (E, ρ), is illustrated in figure 6. It reveals a linear negative correlation, indicating that, as the exchange rate increases, reflecting currency depreciation, the potential output-capital ratio declines. This suggests that currency devaluation adversely impacts on the potential output-capital ratio, which in turn negatively impacts the profit rate.

The negative relationship aligns with our hypothesis. This pattern arises because the GDP deflator includes a lower percentage of tradable goods compared to the capital goods deflator, which encompasses a higher percentage of tradable goods. A high dependency on imported capital goods is a well-documented characteristic of the Brazilian economy (Câmara and Vernengo, 2004).

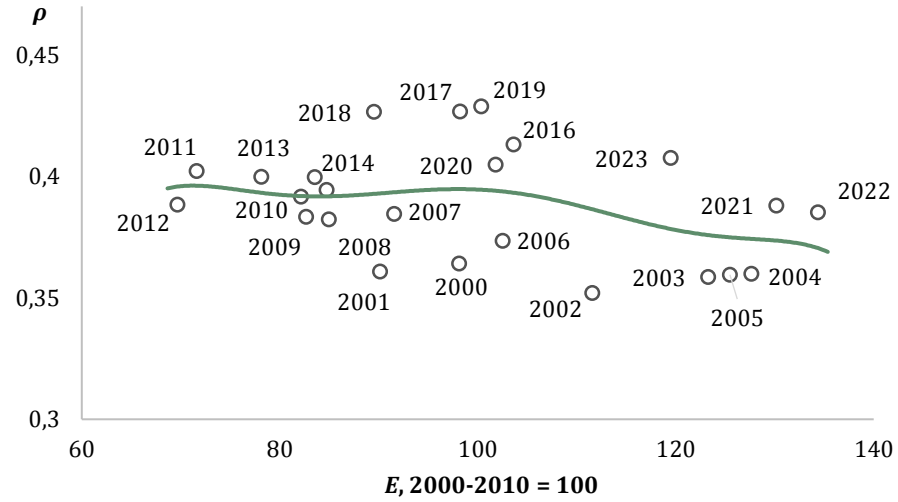
Figure 7 displays the relationship between the real exchange rate and the growth rate of the GDP deflator, with their local regression fit represented as a dotted line. It also shows the relationship between the real exchange rate and the growth rate of the capital goods deflator, with their local regression fit depicted as a solid line. When the real exchange rate is overvalued, the average growth rate of the GDP deflator is higher than that of the capital goods deflator. However, beyond a certain threshold of exchange rate devaluation, the capital goods deflator begins to grow at a faster pace than the GDP deflator. The growth rate of the capital goods deflator exceeds that of the GDP deflator when the real exchange rate is undervalued.

Figure 5 – *The pair terms of trade and the profit share (T, π) and their local regression fit, 2000-2023*



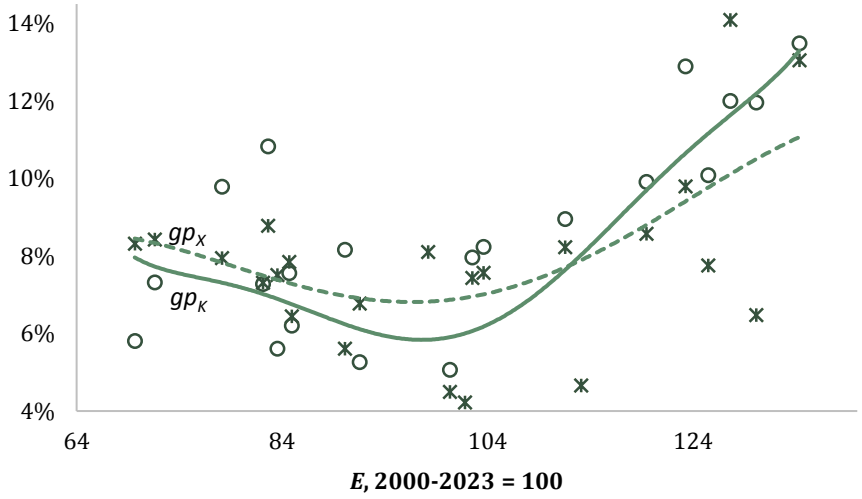
Source: Marquetti et al. (2023) and Banco Central do Brasil (2024).

Figure 6 – *The pair real exchange rate and the potential output-capital ratio (E, ρ) and their local regression fit, 2000-2023*



Source: Marquetti et al. (2023) and Banco Central do Brasil (2024).

Figure 7 – *The pairs real exchange rate and the growth rate of the GDP deflator (E, gp_X), as well as the real exchange rate and the capital goods deflator (E, gp_K), and their local regression fits, 2000-2023*



Source: Marquetti et al. (2023) and Banco Central do Brasil (2024).

The impact of the exchange rate on prices significantly influences the distribution of income and the potential productivity of capital. Depreciation increases the profit share by affecting the GDP deflator more than nominal wages. However, it simultaneously reduces the potential

productivity of capital by impacting the prices of capital goods more than the GDP deflator, leading to a contradictory effect on the profit rate. When the real exchange rate is overvalued, the positive effects on the potential productivity of capital dominate, whereas when the real exchange rate is undervalued, the impact on the profit share prevails. As a result, the profit rate tends to be higher when the real exchange rate is either overvalued or undervalued.

Figure 8 presents the relationship between terms of trade and potential output-capital ratio, (T, ρ), alongside its local regression fit. As expected, the potential output-capital ratio shows an upward trend as the terms of trade improve. This positive relationship is particularly pronounced at lower levels of the terms of trade, where even modest improvements appear to boost the potential output-capital ratio significantly. The potential output-capital ratio exhibits greater stability when terms of trade are high. The increase in terms of trade raises the relative price of the GDP deflator compared to the capital goods deflator, as the latter has a higher proportion of tradable goods in its composition.

Another determinant of the profit rate is the level of capacity utilization. Figure 9 shows the relationship between the real exchange rate and the level of capacity utilization (E, u), along with their local regression fit. As expected, the relationship is nonlinear. This finding suggests that, when the real exchange rate is overvalued and the wage share is higher, demand is driven primarily by household consumption. Conversely, when the real exchange rate is undervalued, demand is boosted by exports.

Figure 10 presents the relationship between the terms of trade and capacity utilization (T, u), along with its linear regression fits. There was a structural break between the periods 2000-2009 and 2010-2023, caused by the financial crisis. Our analysis indicates a positive association between these two variables, suggesting that periods of increasing terms of trade are accompanied by higher capacity utilization.

Finally, figure 11 illustrates the relationship between the terms of trade and the real exchange rate. As expected, improvements in the terms of trade are associated with an appreciation of the real exchange rate. This highlights the indirect effect of the terms of trade on profit rates, as it influences the exchange rate, which in turn affects profitability.

Our findings show that the real exchange rate has a nonlinear, U-shaped effect on the profit rate, while the terms of trade have a positive impact, a key discovery of our analysis.

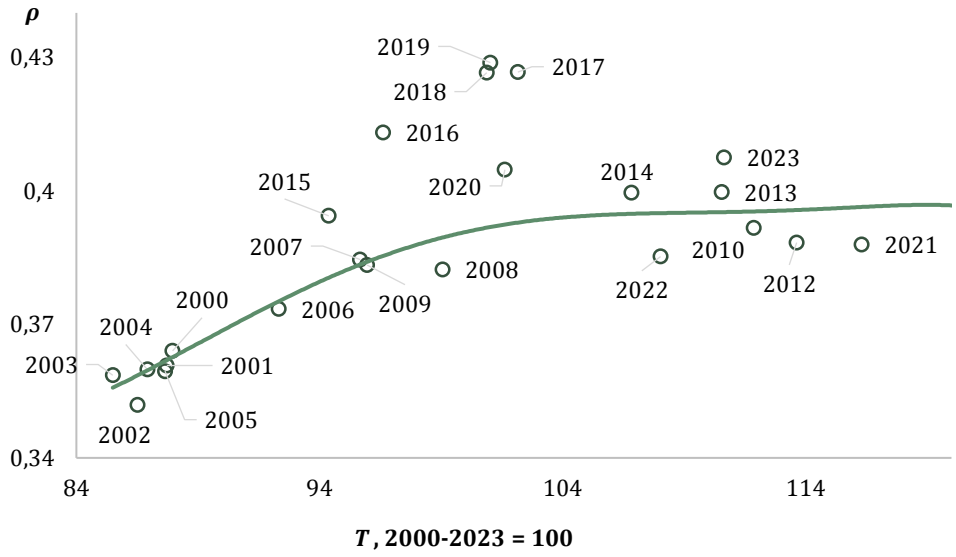
Our empirical investigation highlights the role that the terms of trade and the exchange rate played in shaping the Brazilian economy in the 21st century. Between 2000 and 2023, Brazil experienced a commodities boom, the global financial crisis, the domestic crises of 2015 and 2016, and the COVID-19 pandemic and its aftermath. Each of these events impacted both the terms of trade and the exchange rates.

During most of the 2000s, the terms of trade improved, and the exchange rate appreciated. This period saw a rise in the wage share and the growing potential output-capital ratio. The nominal wage growth outpaced the GDP deflator, whereas the capital goods deflator increased at lower rates than the GDP deflator. This favorable combination allowed for a rise in wage share, alongside with an increase in the profit rate, an outcome observed by Marquetti et al. (2020).

However, this balance changed following the 2008 financial crisis, when external conditions shifted. As terms of trade deteriorated and the exchange rate depreciated, the opposite occurred: the capital goods deflator grew faster than the GDP deflator, and wage share compression became necessary to preserve profitability. These dynamics contributed to the origins of the 2015 and 2016 crisis.

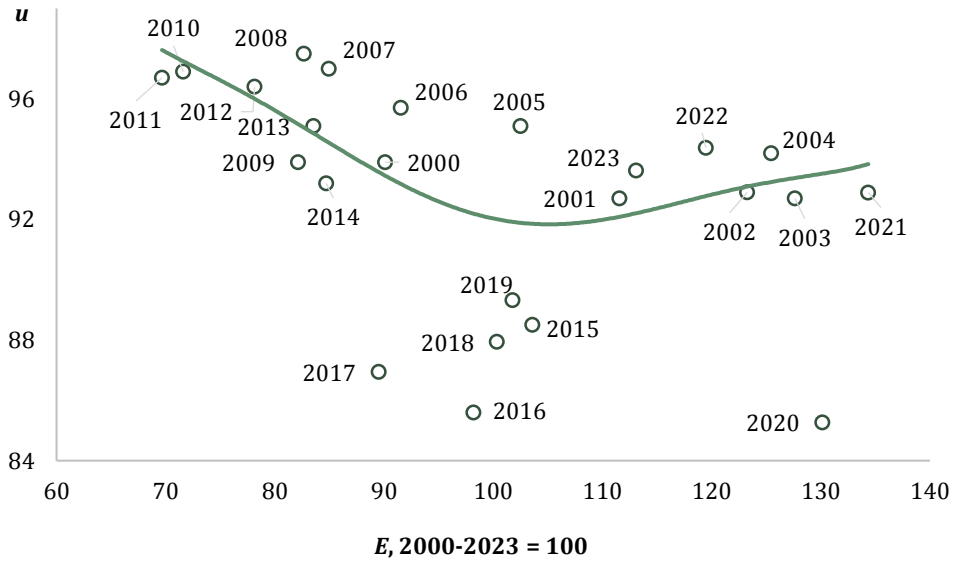
The evidence presented underscores the significant influence of terms of trade and exchange rates on the determinants of the profit rate.

Figure 8 – *The pair terms of trade and the potential output-capital ratio (T, ρ) and their local regression fit, 2000-2023*



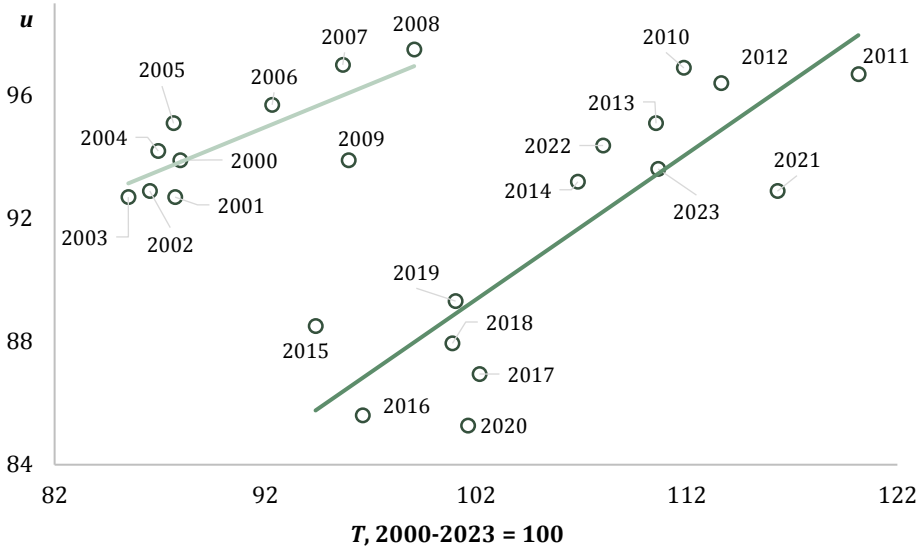
Source: Marquetti et al. (2023) and Banco Central do Brasil (2024).

Figure 9 – *The pair real exchange rate and level of capacity utilization (E, u) and their local regression fit, 2000-2023*



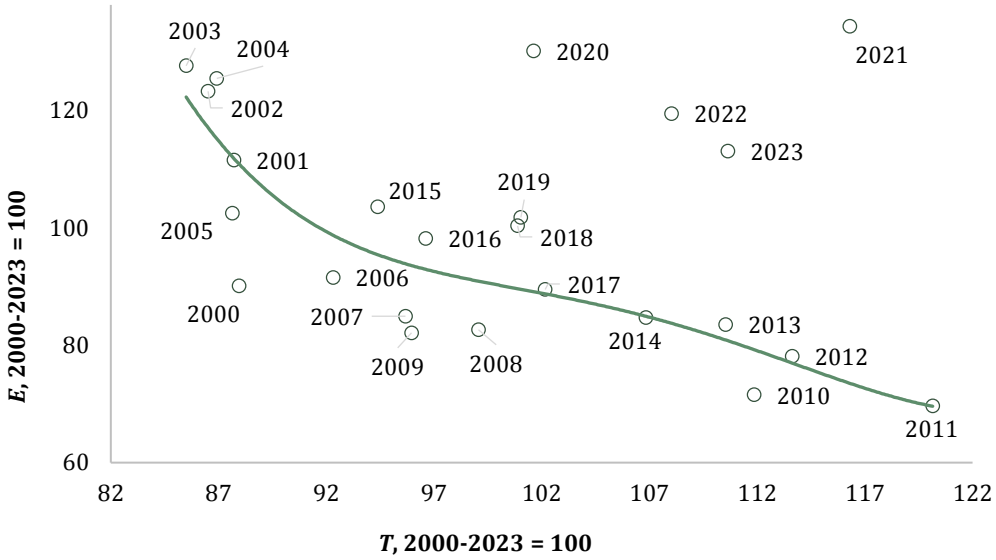
Source: Marquetti et al. (2023) and Banco Central do Brasil (2024).

Figure 10 – *The pair terms of trade and level of capacity utilization (T, u) and their local regression fit, 2000-2023*



Source: Marquetti et al. (2023) and Funcex (2024).

Figure 11 – *The pair terms of trade and the real exchange rate (T, E) and their local regression fit 2000-2023*



Source: Marquetti et al. (2023), Banco Central do Brasil (2024), and Funcex (2024).

3. Final remarks

This article examines the relationship between profit rates, exchange rates, and terms of trade in the Brazilian economy from 2000 to 2023. It investigates how fluctuations in exchange rates and changes in terms of trade impact profit rates and introduces a decomposition of the profit rate that incorporates these variables as a basis for the empirical analysis.

The study reveals a nonlinear, U-shaped relationship between the profit rate and the exchange rate. Currency devaluations can temporarily boost profit share by increasing the GDP deflator more rapidly than nominal wages. However, this benefit comes with a trade-off, as a devalued currency can also diminish the potential output-capital ratio with negative effects on the profit rate.

The terms of trade also play a crucial role influencing profit rates. The research reveals that improvements in the terms of trade affect the profit rate by increasing the profit share, the potential output-capital ratio, and capacity utilization. Additionally, the terms of trade indirectly impact the profit rate through their effect on the exchange rate. For example, lower terms of trade lead to currency devaluation, which increases the profit share but reduces the potential output-capital ratio. Conversely, improvements in terms of trade, coupled with exchange rate appreciation, allow both a higher wage share and a rise in the profit rate. This reduces the conflict of interests between workers and capitalists, workers benefit from higher real wage while capitalists see enhanced profitability driven by the higher potential output-capital ratio.

The findings underscore the intricate effects of exchange rates and terms of trade on profit rates, capital accumulation, and economic growth. A deep understanding of these dynamics is essential for policymakers and economists, as their movements influence not only Brazil's economic trajectory and exchange rate policies but also the broader economic outlook of many developing countries, which are highly vulnerable to shifts in currency flows and international price fluctuations.

In the Brazilian context, as Marquetti et al. (2020) analyzed, profit rates rose in the early 21st century, driven by an initial improvement in terms of trade and exchange rate appreciation. This process led to a higher potential output-capital ratio, increased real wages, and greater capacity utilization, temporarily easing the class struggle between workers and capitalists. Both the wage share and the profit rate grew simultaneously, despite a decline in the profit share. However, this situation became unsustainable as external conditions changed, and real wages rose, leading to a profit squeeze. As terms of trade deteriorated and the exchange rate depreciated, reducing the wage share became the primary strategy to maintain profitability.

These external conditions influenced Brazil's recent economic and societal trajectory through a less commonly discussed channel: the profit rate. The analysis provides crucial insights into the limitations of the country's growth cycle during the early 21st century, highlighting how shifts in the global economy and their impact on terms of trade and exchange rates shaped domestic economic dynamics.

From a broader perspective, a failure to grasp these dynamics can lead to mistaking cyclical fluctuations for structural changes, potentially leading to misguided policy decisions, particularly in developing countries. To address this challenges, further research is essential to deepen our understanding of the complex interplay between exchange rates, terms of trade, and profit rates.

References

Banco Central do Brasil, *Sistema Gerenciador de Series Temporais*. Available online.

Blecker R. (2023), "How important is the real exchange rate for exports and growth?", *European Journal of Economics and Economic Policies*, 20(2), pp. 250-265.

Bresser-Pereira L. (2022), "Quase estagnação no Brasil e o novo desenvolvimentismo", *Brazilian Journal of Political Economy*, 42, pp. 503-531.

Bresser-Pereira L., Oreiro J. and Marconi N. (2024), *Developmental Macroeconomics: New Developmentalism as a Growth Strategy*, Abingdon (UK) and New York: Routledge.

Câmara A. and Vernengo M. (2004), "Allied, German and Latin theories of inflation", in Forstater M. and Wray R. (eds), *Contemporary Post-Keynesian Analysis* (pp. 172-184), Cheltenham and Northampton: Edward Elgar.

Cleveland W. (1993), *Visualizing Data*, Summit: Hobert Press.

Cleveland W. and Devlin S. (1988), "Locally weighted regression: An Approach to regression analysis by local fitting", *Journal of the American Statistical Association*, 83(403), pp. 596-610.

Duménil G. and Lévy D. (1993), *The Economics of the Profit Rate*, Aldershot: Edward Elgar.

Dutt A. (1990), *Growth, distribution and uneven development*, Cambridge: Cambridge University Press.

Fan J. and Gijbles I. (1996), *Local Polynomial Modelling and its Applications*, New York: Chapman & Hall.

Feijó C.and Araujó E. (2024), "O papel da taxa de câmbio na teoria novo desenvolvimentista", *Cadernos Gestão Pública Cidadania*, 29, pp. 1-12. Available online.

Foley D., Michl T. and Tavani D. (2019), *Growth and distribution*, Cambridge: Harvard University Press.

Frenkel R. and Taylor L. (2006), "Real Exchange Rate, Monetary Policy and Employment", *DESA Working Paper*, no. 19 ST/ESA/2006/DWP/19, February, New York: United Nations Department of Economic and Social Affairs. Available online.

FUNCEX – Fundação Centro de Estudos DO Comércio Exterior (2024), *Funcex Data*. Available online.

Iasco-Pereira H.C. and Missio F.J. (2022), "Real exchange rate and structural change: theory and empirical evidence", *Investigación Economica*, 81(320), pp. 81-107. Available online.

Kalecki M. (1971), *Selected essays on the dynamics of the capitalist economy, 1933-1970*, Cambridge: Cambridge University Press.

Krugman P. and Taylor R. (1978), "Contractionary effects of devaluation", *Journal of International Economics*, 8(3), pp. 445-456.

Loader C. (1999), *Local Regression and Likelihood*, New York: Springer-Verlag.

Marconi N., Magacho G., Machado J. and Leão R. (2020), "Profit margins, exchange rates and structural change: empirical evidences for the period 1996-2017", *Brazilian Journal of Political Economy*, 40, pp. 285-309. Available online.

Marquetti A. (2007), "A non-parametric test of the Solow-Swan growth model", *Análise Econômica*, 25, pp. 43-60.

Marquetti A., Maldonado Filho E., Miebach A. and Morrone H. (2023), "Uma Interpretação da economia brasileira a partir da taxa de lucro: 1950-2020", *Brazilian Journal of Political Economy*, 43, pp. 309-334. Available online.

Marquetti A., Morrone H., Miebach A. and Ourique L. (2019), "Measuring the profit rate in an inflationary context: the case of Brazil, 1955–2008", *Review of Radical Political Economics*, 51(1), pp. 52-74.

Marquetti A, Hoff C. and Miebach A. (2020), "Profitability and distribution: The origin of the Brazilian economic and political crisis", *Latin American Perspectives*, 47(1), pp. 115-133.Marquetti A., Miebach A. and Morrone H. (2024), *Unequal Development and Capitalism: Catching Up and Falling Behind in the Global Economy*, London: Routledge.

Marquetti A. and Viali L. (2004), "Princípios e aplicações de regressão local", *Análise Econômica*, 22(42), pp. 253-277. Available online.

Marx K. (1981), *Capital: Volume III*. London: Penguin Classics.

Miebach A. and Marquetti, A. (2023), "A distribuição funcional da renda no Brasil: 1947-2019", *Nova Economia*, *32*, pp. 585-615.

Missio F., Jayme JR F., Britto G. and Oreiro J.L. (2015), "Real exchange rate and economic growth: new empirical evidence", *Metroeconomica*, 66(4), pp. 686-714.

Ocampo J.A., Rada C. and Taylor L. (2009), *Growth and policy in developing countries: a structuralist approach*, New York: Columbia University Press.

Ocampo J.A. and Parra-Lancourt M. (2010), "The terms of trade for commodities since the mid-19th century", *Revista de Historia Economica – Journal of Iberian and Latin American Economic History*, 28(1), pp.11-43.

Prebisch R. (1968), *Dinâmica do desenvolvimento latino-americano*, Rio de Janeiro: Fundo de Cultura.

Rapetti M., Skott P. and Razmi A. (2012), "The real exchange rate and economic growth: are developing countries different?", *International Review of Applied Economics*, 26(6), pp. 735-753.

Ribeiro R., McCombie J. and Lima G. (2020), "Does real exchange rate undervaluation really promote economic growth?", *Structural Change and Economic Dynamics*, 52, pp. 408-417.

Robinson J. (1956), *The accumulation of capital*, London: Macmillan.
Rodrik D. (2008), "The real exchange rate and economic growth", *Brookings Papers on Economic Activity*, 2008(2), pp. 365-412.
Ros J. and Skott P. (1998), "Dynamic Effects of Trade Liberalization and Currency Overvaluation under Conditions of Increasing Returns", *The Manchester School of Economic & Social Studies*, 66, pp. 466-489.
Weisskopf T. (1979), "Marxian crisis theory and the rate of profit in the postwar US economy", *Cambridge Journal of Economics*, 3(4), pp. 341-378.