Exchange Rate and Prices: An Extended Kaleckian Approach for Brazilian Manufacturing Sectors (2010-2019)

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Abstract
The objective of this article is twofold. The first goal is to comprehend the effect of exchange rate on prices using the Kaleckian approach. The study aims at understanding the determinants of exchange rate pass-through into prices. The basic model showed that the greater the share of imported inputs in costs more powerful is the pass-through. Considering inflation as a real phenomenon derived from social conflict, the theoretical model indicated that the magnitude of salaries in costs potentializes the effects of wage changes on prices via the exchange rate pass-through. Thus, the exchange rate pass-through of sectors with a small (great) share of salaries in costs is less (more) sensitive to salary changes. The basic Kaleckian model was extended to endogenize the pass-through in relation to the effects of a regime of exchange rate for development in markup rate and in the economy's structural composition. The industrial development induced by the regime of exchange rate for development reduces the import of inputs leading to the declining of pass-through. The second goal of the article was to provide time-series evidence on the exchange rate pass-through manufacturing sectors' prices for the Brazilian economy over the period from 2010 until 2019. Empirical results deliver evidence that pass-through is partial and varies across sectors. The study reveals that the sectoral differences of pass-through are associated with the markup rate, the degree of outward orientation, the competition between firms, and the share of imported inputs of each sector.

Resumo
Este artigo possui dois objetivos. O primeiro é entender o efeito da taxa de câmbio na inflação utilizando o arcabouço teórico kaleckiano. Procurou-se compreender os determinantes do repasse cambial para os preços. O modelo básico sugeriu que este repasse está associado à importância dos custos importados. Por outro lado, ao considerar a inflação como um fenômeno real (resultado do conflito distributivo), o modelo indicou que a magnitude relativa dos custos com trabalho potencializa o efeito inflacionário de desvalorizações cambiais. Isto sugere que o repasse cambial para os preços é mais forte em economias em que a estrutura produtiva é mais intensa em trabalho do que capital. O modelo levou em consideração o efeito de desvalorizações cambiais na distribuição de renda e na estrutura produtiva, indicando que a industrialização induzida pela adoção de um regime de câmbio competitivo pode amenizar o conflito distributivo, bem como seus efeitos redistributivos. O segundo objetivo foi mensurar o repasse cambial para os preços dos setores industriais da economia brasileira entre 2010 e 2019. Os resultados das estimações econométricas indicaram que o repasse é parcial e varia entre os setores. O estudo, por fim, mostrou que estas diferenças estão relacionadas com características setoriais como poder de mercado, inserção no comércio interacional, competição entre firmas e custos importados.
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1- Introduction

Many authors stressed the importance of the exchange rate in promoting economic growth. Pursuing a devalued exchange rate potentializes the fundamentals of long-run growth (education, saving/investment, good institutions, technological innovation etc.), but it does not substitute its importance (Eichengreen, 2008). Devaluations of the exchange rate act as a second-best mechanism to foster growth (Rodrik, 2008).

There exist many transmission channels that justify the positive effects of a weak national currency on growth. Exchange rate devaluations make the tradable goods cheaper in the international currency, which expands exports and generates more rapid growth (Rodrik, 2008). A weak national currency enhances profitability and enlarges internal funds to firms finance new investments, encouraging production and employment (Frenkel and Ros, 2006). Such an effect is reinforced by smaller real wages sparked by higher domestic prices. Exchange rate devaluations generate inflation because firms increase their markup to benefit from higher competitiveness in relation to foreign goods (Blecker, 1989) and because firms increase their prices to transfer the more significant costs associated with imported inputs. A regime of exchange rate for development drives the long-run growth by influencing the composition of national income towards saving/investment and exports, and the productive structure towards manufacturing and sectors more complex.

The other part of the story is that the exchange rate, as a relative price, affects the domestic prices: devaluations make domestic prices more expensive and international prices cheaper. However, strong devaluations may corrode the gains of competitiveness of national goods in international markets: by increasing the costs with imported inputs or due to social conflict between workers (real wage) and entrepreneurs (markup rate). Considering inflation as a real phenomenon resulted from social conflict, a certain inflationary acceleration within an economy under an exchange rate regime for development is inescapable. Devaluations of exchange rate have a distributive effect in favor of firms (markup rate) as real wages are eroded. However, if neither workers nor firms accept a smaller real income, the regime of exchange rate for development may engender an inflationary spiral, and the increasing inflation worsens the competitiveness of national goods, weakening the effects of exchange rate on growth.

The regime of exchange rate effectiveness for development, by promoting exports and growth, depends on the exchange rate pass-through into prices. The smaller the effect of the exchange rate on prices greater the gain of competitiveness; thus, the economy tends to grow more rapidly.[3] Put differently, the exchange rate is crucial in determining the international competitiveness of national goods. However, the exchange rate's devaluations change the income distribution between workers and firms, strengthening the social conflict around real income. A possible consequence is an accelerating inflation as neither workers nor firms may not be willing to accommodate the costs of a weak national currency, which reduces the effects on growth. The inflationary effects of exchange rate devaluations should be the tinier as possible to make feasible and potentialize the export-led growth strategy. This story suggests that the effectiveness of the regime of exchange rate for development requires that workers accept smaller real wages, in the short-run, in exchange for possible higher real wages in the long-run; it is a tradeoff with distributive effects in the present and possible gains in future (Guzman *et al*, 2018).

It turns out that the advocates of regime of the exchange rate for the development focus on studying the association between exchange rate and long-run growth. Little attention is paid to understand the effects

[3] This is an alternative vision to the Purchasing Power Parity according to which exchange rate equilibrates the divergence between foreign and national prices and changes in domestic prices are a monetary phenomenon (exchange rate does not influence prices). Consequently, there is no room for debate on a growth strategy based on a weak national currency. Still, there is much evidence in the literature that indicates that: (i) the exchange rate is not a simple outcome from an equilibrium between national and foreign prices and (ii) national prices are affected by the exchange rate.

of exchange rate on prices *pari passu* the adoption a strategy for development based on a weak national currency. This paper aims to fill this gap in the literature. The first goal is to understand the effect of devaluations of exchange rates on prices using the cost-push approach provided by Kalecki (1956). In particular, the objective is to comprehend the determinants of exchange rate pass-through on prices and the required conditions for a controlled/stable inflation within an economy under regime of exchange rate for development. An extended version of the Kaleckian approach is developed endogenizing the distributive effects of exchange rate devaluations and productive structure changes.

In other respects, literature points out that the adjustment of prices to exchange rate movements is incomplete and varies across countries, periods; moreover, it is associated with many macro and microeconomic aspects (Campa and Goldberg, 2002). Exchange rate pass-through is associated with industry characteristics such as product substitutability, the number of domestic and foreign firms, and market structure (Dornbusch, 1987). It is supposed that each industry has a specific dynamic of price adjustment after movements in the exchange rate (Dornbusch, 1987). The incomplete exchange rate pass-through also occurs because export firms absorb exchange rate devaluations by raising the prices. (Krugman, 1987). Prices of exporters do not follow *pari passu* changes in exchange rate because firms increase markup by taking benefits from market power and pricing goods discriminated in accordance with characteristics of the end market (Krugman, 1987). Arestis and Milberg (1993), in turn, argue that firms pass, partially, increases in costs due to exchange rate devaluations because of the degree of competition within the industry. Hence, a lower markup rate absorbs the increased costs (Arestis and Milberg, 1993). The second goal of this article is to provide time-series evidence on exchange rate pass-through into the prices of 23 manufacturing sectors of the Brazilian economy over the period from 2010 until 2019 and explaining the results in light of these approaches.

The article consists of seven parts. Section 2 discusses the Kaleckian approach for determining industrial prices and the role played by the exchange rate. An extended model is developed in Section 3. Section 4 discusses the empirical strategy and database employed in estimates. Section 5 presents the estimates performed by the Generalized Method of Moments and the estimates performed by Vector Autoregressive models. Section 6 associates the empirical results with stylized facts of the Brazilian economy. Lastly, the concluding remarks end the article with the main conclusions derived from the theoretical model and empirical estimates.

2- The Kaleckian Approach to Pricing

A pricing theory describes the behavior of agents in determining prices; the post-Keynesian theory is essentially a cost-plus pricing framework (Lavoie, 2014). The Kaleckian approach is a branching of this perspective as it prescribes a cost-oriented theory for the pricing setting of firms. Kalecki (1956) has drawn a distinction between two kinds of prices. The prices of primary commodities are demand-determined because supply is given and constant in the short-run (Kalecki, 1956). Consequently, increases in demand greater than supply lead to higher prices, and the market-clearing mechanisms are valid to explain it. In contrast, the prices of manufactured goods are cost-determined (Kalecki, 1956). The Kaleckian approach's *rationale* is that industrial firms operate below full capacity, keeping a certain level of idle capacity installed. Supply is elastic, and demand pressures do not lead to higher prices because firms fill the idle capacity installed (Kalecki, 1956). Nonetheless, demand pressures may increase manufacturing prices, but such influence occurs by means of rising input costs or when there is no idle capacity (Kalecki, 1956).

The Kaleckian approach explains the industrial pricing taking costs as the main determining component. Kalecki (1956) states that firms set prices applying a markup rate on average variable costs (inputs and salaries), which is represented as:

$$P_{t,s} = C_{t-1,s}e^{\mu t} \quad (1)$$

where the subscripts *t* and *s* stand for time and sector, *P* represents price and *C* the average variable costs. Kalecki (1956) assumes that firms operate under non-competitive markets; hence markup rate μ is positive. The variable *C* is formalized in the following way:

$$C_{t,s} = N_t^{\psi} + W_t^{1-\psi} \quad (2)$$

where the parameter ψ is the share of inputs *N* in costs and (1- ψ) represents the share of salaries *W* in costs, ψ ranges from 0 to 1. The averaged costs with inputs are represented as:

$$N_{t,s} = (E_t M_{t,s})^{\theta} Z_{t,s}^{1-\theta} \quad (3)$$

where θ is the share of inputs that comes from abroad (ranging from 0 to 1), and (1-θ) is the share of inputs in national currency, *M* represents the imported costs in foreign currency, *Z* the costs in national currency, and *E* the real exchange rate that denotes the price of domestic currency in foreign currency (increases/decreases represent devaluations/overvaluations of national currency). Putting (3) into (2) leads to:

$$C_{t,s} = ((E_t M_{t,s})^{\theta} Z_{t,s}^{1-\theta})^{\psi} + W_t^{1-\psi} \quad (2.1)$$

Introducing (2.1) into (1) leads to:

$$P_{t,s} = [((E_{t-1} M_{t-1,s})^{\theta} Z_{t-1,s}^{1-\theta})^{\psi} + W_{t-1}^{(1-\psi)}] e^{\mu t} \quad (1.1)$$

Taking the first difference with respect to time of equation (1.1) in logarithmic form:

$$p_{t,s} = \mu + [\psi\theta(e_{t-1} + m_{t-1,s}) + \psi(1-\theta) z_{t-1,s} + (1-\psi) w_{t-1,s}] \quad (4)$$

where the lowercase letters denote variables in growth rate. Assuming that *m* and *z* are null (for the sake of simplicity):

$$p_{t,s} = \mu + [\psi\theta(e_{t-1}) + (1-\psi)\, w_{t-1,s}] \quad (5)$$

Equation (5) means that inflation is determined by markup rate, exchange rate and nominal wage growth. Increases in markup rate and in nominal wages rise the prices, just like a devalued exchange rate, everything else remaining equal; however, such an effect depends on the magnitude of the parameters ψ and θ. The greater the share of inputs in all costs and the share of imported inputs in all input costs, the stronger is the effects of devaluations of exchange rate in prices. Similarly, the greater the share of labor costs in all costs, the stronger the effects of readjustments in nominal wages in prices.

In accordance with equation (5), the necessary condition for stable inflation over time, combined with devaluations of exchange rate, is that workers or entrepreneurs accommodate a weak national currency's costs via lower real wages/markup rate. Given the parameters ψ and θ, the exchange rate pass-through on prices is given by $\psi\theta$, and this is the magnitude that markup rate or real wage should decrease to reach a stable inflation after a devaluation of 1%. Therefore, distributive effects are inevitable for a stable inflation in an economy under exchange regime for development, unless some acceleration in the price change's pace may be acceptable.

3- Extending the Kaleckian Approach

This section extends the basic Kaleckian model presented earlier. Firstly, it makes the markup rate endogenous to the exchange rate and considering the effects of the exchange rate regime for development on the economy's structural composition. Secondly, the structuralist notion of neutral inflation is introduced into the theoretical model.

3.1- Endogenizing the markup rate and productive structure

Kalecki (1956) indicates that the markup rate is associated with each industry's idiosyncrasies, as industrial concentration, fixed costs, labor unions, and costs. Blecker (1989) argues that, within an open economy, the exchange rate influences the markup rate. Devaluations expand the markup rate because firms increase domestic prices to benefit from higher competitiveness in relation to foreign goods (Blecker,

1989). Nevertheless, when the real exchange rate appreciates, firms reduce markups to offset the loss of competitiveness (Blecker, 1989). Blecker (1989) formalizes the influence of exchange rate on markup rate as:

$$\mu = \mu^{d} + \eta e_{t-1} \quad (6)$$

where μ^d represents the desired markup rate and η is the price-cost margin elasticity to real exchange rate, which is assumed to be positive. Equation (6) says that increases in desired markup rate and/or in exchange rate lead to a higher markup rate. Introducing (6) into (1.1):

$$P_{t,s} = [((E_{t-1}M_{t-1,s})^{\theta}Z_{t-1,s}^{1-\theta})^{\psi} + W_{t-1}^{(1-\psi)}]e^{(\mu d + \eta e)t} \quad (7)$$

Taking the first difference with respect time of equation (7) in logarithmic form:

$$p_{t,s} = \mu^{d} + \eta e_{t-1} + [\psi\theta(e_{t-1} + m_{t-1,s}) + \psi(1-\theta)z_{t-1,s} + (1-\psi)w_{t-1,s}] \quad (8)$$

This is the equation that expresses the price changes of manufacturing firms in an open economy according to the Kaleckian approach considering the markup rate endogenous to the exchange rate. In accordance with equation (8), the necessary condition for stable inflation combined with devaluations of the exchange rate is that workers accommodate the costs of a weak national currency via lower real wages. The expanded markup rate is a further source of inflationary acceleration, in addition to the costs due to the devaluation. Given the parameters η and θ, the exchange rate pass-through on prices is given by the sum of η and $\psi\theta$. A devalued exchange rate of 1% increases the prices by ($\eta + \psi\theta$) %. As the markup rate depends on the exchange rate, a weak national currency increases the markup rate in η% and (given μ^d, η and θ), then, real wages should decrease ($\eta + \psi\theta$) % to reach stable inflation after a devaluation of 1%. In this case, the real wage squeeze is inevitable for stable inflation in an economy under an exchange regime for development, unless some acceleration in the pace of price changes may be acceptable. That is, the growth rate of nominal wages should be smaller than the change in prices for a stable inflation.

On the other side, many authors stressed the influence of the exchange rate on the economy's structural composition. A weak national currency is associated with manufacturing development or a structural change towards a more diversified productive structure. A devalued currency works as a uniform subside (tariff) on exports (imports), benefiting the national manufacturing sectors (Frenkel and Ros, 2006). Devaluations of exchange rate influence profitability because it increases exports and reduces salary costs due to the smaller real wages. Moreover, such expanded profitability encourages production and investment (Frenkel and Ros, 2006).

The argument pursued here is that economies with an industrialized productive structure are less dependent on imports because the domestic production internalizes manufacturing inputs. Thus, the parameter θ is endogenous to structural change (the degree of complexity of productive structure) and devaluations of exchange rate reduce the magnitude of θ:

$$\theta_t = \theta_0 e^{-\sigma IND t} \quad (9)$$

where θ_0 is the initial value of θ, *IND* represents structural change, σ is a negative parameter that captures industrial development's influence in the share of imported inputs. Equation (9) means that structural change toward manufacturing sectors lowers the imports of inputs. Consequently, the parameter θ decreases as the industrializing process is carried out.

In turn, the influence of the exchange rate on the sectoral composition of economy (*IND*) is expressed as a positive and linear function of *e*:

$$IND_t = \delta + \lambda(e_{t-1}) \quad (10)$$

the parameter λ is the sensitivity of structural change towards manufacturing sectors to exchange rate; the constant δ captures other elements that influence structural change (which is assumed to be positive). Equation (10) says that devaluations (overvaluations) of exchange rate promote structural change within the economy towards manufacturing (non-manufacturing) sectors. Introducing equation (10) into (9):

$$\theta_t = \theta_0 e^{-\sigma(\delta + \lambda(e))t} \quad (11)$$

This equation means that exchange rate devaluations reduce the share of imported inputs as it induces a structural change towards manufacturing and internalizes the production of inputs.

Introducing equation (11) into (8) and assuming that *m* and *z* are null leads to:

$$p_{t,s} = \mu^{d} + (\eta + \psi\theta_0 e^{-\sigma(\delta + \lambda(e))t})\, e_{t-1} + (1-\psi)w_{t-1,s} \quad (12)$$

the novelty of equation (12) is that the markup rate and the parameter θ_t are not constant over time, as it used to be before. The exchange rate influences both vectors: devaluations increase the markup rate and reduce the parameter θ_t.

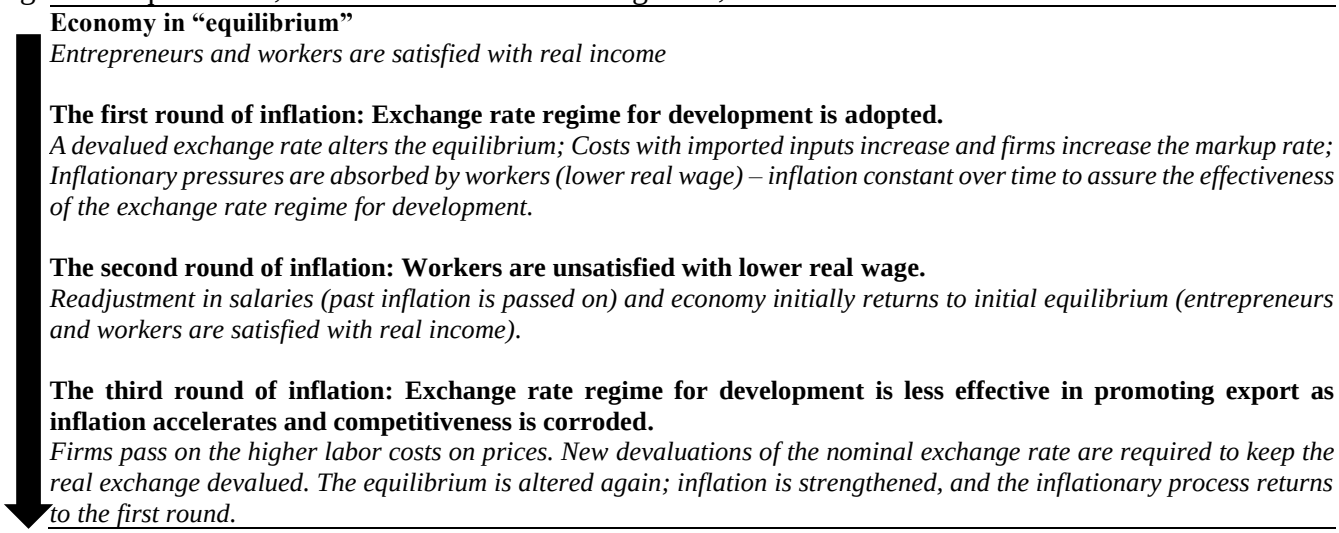
Equation (12) means that the structural change induced by devaluations of the exchange rate may reinforce/mitigate the distributive the effects of exchange rate regime for development. The exchange rate pass-through on prices is still given by ($\eta + \psi\theta$). However, the parameter θ is not constant over time anymore. As the exchange rate regime for development induces industrialization, the required imported inputs lower. As a result, the parameter θ_t becomes smaller. This opens room for two possibilities in the context of social conflict and stable inflation over time. Firstly, the reduced costs induced by devaluations are fulfilled by a greater markup rate. Entrepreneurs embrace by themselves the benefits of a productive structure more diversified. This way, structural change potentializes the boosting effect of devaluations over the markup rate. The second possibility is that structural change mitigates the redistributive effects of exchange rate regime for development on workers. The fruits of a modern productive structure are distributed between entrepreneurs and workers. The falling trend of the parameter θ induced by the exchange rate regime for development allows that nominal wages increase at the same pace or more rapidly than prices without profit squeezing and with stable inflation over time.

3.2- Income Distribution and Neutral Inflation: the structuralist approach

The Latin American structuralists Noyola (1957), Sunkel (1958), and Furtado (2009) argue that inflation is a real phenomenon associated with social conflict. Inflation comes from the attempt to change the relative prices and defend the respective real income. The prices are readjusted to pass on the expanded costs due to higher wages or input costs (i.e., past inflation is passed on current prices) in order to keep the markup rate unchanged.

In this regard, devaluations of the exchange rate strengthen the social conflict around real income by creating misalignments of relative prices (i.e., national goods are cheaper in international markets to the detriment of higher prices in the national market). The smaller real wage induced by the exchange rate regime for development increases workers' claims for readjustments. As a result, the cost pressures due to readjustments of wages and the expanded costs caused by devaluations of exchange rate lead the firms to pass it on to prices. The bottom line is an inflationary process in which firms and workers defend the respective real income. Therefore, inflation results from the attempt of agents to neutralize the distributive effects of exchange rate devaluations. This is what Furtado (2009) calls neutral inflation. Figure 1 summarizes the notion of neutral inflation in an economy under an exchange rate regime for development.

Figure 1- Equilibrium, devaluations of the exchange rate, and neutral inflation



Devaluations of exchange rate alter the economy's equilibrium by transferring income from workers to firms (higher markup rate). Inflation is the mechanism through which such income transfer occurs - assuming that the economy is initially under the equilibrium position (both entrepreneurs and workers are satisfied with income distribution). The adoption of an exchange rate regime for development *pari-passu* with stable inflation over time leads to the real wage squeeze, as equation (12) has shown ("first round of inflation"). It turns out, though, that workers will not accept a smaller real wage for a long time. Labor unions will claim readjustments in wages to restore the initial equilibrium in terms of the income distribution ("second round of inflation"). In turn, firms will pass on the higher labor costs on prices to defend the markup rate. As expected, the acceleration in the pace of changes in prices reduces the effectiveness of the exchange rate regime for development in promoting exports because inflation corrodes the international competitiveness of national goods. Therefore, a more substantial devaluation in the nominal exchange rate is required to keep the real exchange rate devalued, to the restored equilibrium be altered again ("third round of inflation"). As a result, inflation strengthens, as long the social classes attempt to restore the initial equilibrium (neutral inflation), *pari-passu* the adoption of exchange rate regime for development.

The inflationary dynamic of an economy under an exchange rate regime for development, associated with the Furtadian notion of neutral inflation, means that all agents reproduce past inflation (costs) in the current prices ($p_{t-1,s} = w_t = p_t$). That is, firms not only pass on the expanded costs due to exchange rate devaluations on prices but increase the markup rate as the real exchange rate remains devalued (equation 12). In turn, workers claim that the real wage grows at same pace that prices are determined by firms (constant real wage). Therefore, assuming that $p_{t-1,s} = w_t = p_t$, equation (12) becomes:

$$p_t = \mu^d/\psi + [(\eta + \psi\theta_0 e^{-\sigma(\delta + \lambda(e))t})/\psi]\, e_{t-1} \qquad (13)$$

Equation (13) represents the effects of exchange rate pass-through on prices considering the social conflict that produces neutral inflation. It indicates that the social conflict and a productive structure strongly dependent on imports potentialize the inflationary effects of devaluations; the higher the parameters μ^d, η, θ stronger the exchange rate pass-through on prices. It should be noticed that if the parameter ψ equals 1 (only inputs costs), the effect of 1% devalued exchange rate pass-through is $(\eta + \theta)$ %. Nevertheless, if the parameter ψ equals 0 (only labor costs), the inflationary process tends to be explosive. However, it is likely that the parameter ψ ranges between 0 and 1. So, lower values for the parameter ψ (or greater values for $(1-\psi)$, which means strong social conflict is more intense because labor represents a larger share of costs)

intensify, the inflation associated with the exchange rate regime for development with no distributive effects.

4- Empirical strategy and database

The empirical strategy consists of estimating the effects of the exchange rate on industry prices of 23 sectors of CNAE 2.0 (Standard Industrial Classification 2.0)[4] following two different procedures. Following Campa and Goldberg (2002) strategy:

$$p_{t,s} = \alpha + b_1 x_t + \beta_j e_{t-j} + \varepsilon_t \quad (14)$$

where the subscripts *t* and *s* stand for time and sector, *p* represents price variation of industry, *e* the exchange rate and *x* a vector of controls, ε is the error term. Campa and Goldberg (2002) introduced lagged exchange rate values in the right side of equation (14) to capture the gradual adjustment of prices to exchange rate. The short-run relationship between exchange rate and industrial prices is given by the estimated coefficient β_0, whereas the long-run relationship is given by the sum of the coefficients on the contemporaneous exchange rate and its lagged values $\sum_{t=0}^{t} \beta_{t-j}$ (Campa and Goldberg, 2002).[5]

Campa and Goldberg (2002) have estimated the equation (14) for 25 OECD countries using *Ordinary Least Square* (OLS) estimators controlling for energy costs and real GDP. The exchange rate is represented by the nominal exchange rate. Our estimates are performed using the *Generalized Method of Moments* (GMM) to address the endogeneity issues. Many non-controlled variables likely influence the exchange rate, leading to biased estimates. The GMM estimator solves this problem using lagged values of covariates as instruments, which are valid since the Hansen's (1982) test (test-J) does not reject the null hypothesis that instruments are exogenous. It is used a *heteroskedasticity- and autocorrelation- consistent* (HAC) estimators for the variance-covariance (Bartlett Kernel), being its lags chosen by the *Newey-West method*.

Two specifications of equation (14) were performed. As our data is monthly, the first specification employs only contemporaneous and eleven lags of the exchange rate. No other explanatory variable was considered to minimize collinearity issues and to ensure that freedom degrees are scarce. It is important to notice that the degrees of freedom of test-J are the difference between moments and estimated parameters. Many instruments reduce the accuracy of test-J. Two sets of instruments are used with 4 and 5 degrees of freedom:

Instruments 1: constant, (lags: e_{t-12} until e_{t-27}) - 4 degrees of freedom
Instruments 2: constant, (lags: e_{t-12} until e_{t-28}) - 5 degrees of freedom

The second specification of equation (14) introduces the first lag of inflation to capture inertial inflation, sectoral production *q* to represent demand pressures, and oil price *o* as a measure of imported costs in addition to the exchange rate. Contemporaneous and lagged values of these variables were considered, using three lags of each variable as instruments as follow:

Instruments: constant, (p_{t-2}, p_{t-3}, p_{t-4}; e_{t-2}, e_{t-3}, e_{t-4}; q_{t-2}, q_{t-3}, q_{t-4}; o_{t-2}, o_{t-3}, o_{t-4}) - 5 degrees of freedom

This specification does not estimate the long-run pass-through of exchange rate into sectoral prices (over a year); it captures the short-run effect of the exchange rate in industrial prices (at least until the preceding month), controlling for other variables.

The second strategy consists of estimating a *Vector Autoregressive* (VAR) to explore the results of *Impulse Response Function* (IRF), seeking to investigate how sectoral price reacts after a positive shock in the exchange rate (of one standard deviation). The long-run pass-through is calculated as the accumulated change of sectoral inflation after a shock of one standard deviation in the exchange rate (Cumulative

[4] Not presented due the limited pages, but it is available upon request.
[5] Using quarterly data, Campa and Goldberg (2002) introduced three lags of the exchange rate to capture the sluggish price adjustment to exchange rate over a year.

Impulse Response Function – CIRF). Another result delivered by VAR estimates is the *Forecast-Error Variance Decomposition* (FEVD) that allows accounting what percentage of inflation's forecasted variance is due to exchange rate movements. Following McCarthy (2007), Belaisch (2003), Nogueira, Mori and Marçal (2013), and Correa (2017) a further estimate of pass-through is calculated in which the cumulative change of inflation (after a shock of one standard deviation in exchange rate) is standardized with respect to the cumulative change of the exchange rate after such shock. In this fashion, the pass-through is inflation response due to an increase of 1% in the exchange rate (devaluation).

The VAR model is estimated using three endogenous variables (inflation, production, and exchange rate) and one exogenous variable (oil price). Small lag lengths generate a model misspecified, whereas long lag lengths produce inefficient estimates (Enders, 2003). The appropriated lag length was chosen by analyzing the usual *information criterion of Akaike* (AIC), *Hannan-Quinn* (HQIC), and *Schwarz* (SBIC). However, it should be noticed that the lag lengths suggested by the information criterion is not always enough to vanish residual correlation. In this case, further lags are necessary in order to the LM teste does not reject the null hypothesis of no residual correlation, which enlargers the variance of errors and the probability to include the zero in the interval of confidence of IRF (non-statistically significance). Still, a VAR model is not interested in estimated parameters (due to the high collinearity), but in determining the interrelationship between variables – which has been made by means of IRF (Sims, 1980). Therefore, our guide to select the number of lags is the information criterion.[6]

The VAR model does not allow to identify all parameters in its structural form because there is a feedback between the endogenous variables in the system (Enders, 2003). This leads to the necessity of imposing restrictions on the contemporaneous feedback effect. Sims (1980) has solved it, making the upper triangular part of the covariance matrix equals zero (Enders, 2003). This is known as Cholesky decomposition. It turns out that this solution imposes arbitrarily the contemporaneous causality (restrictions) between endogenous variables - which is not always in agreement with economic theory, leading to different results of IRF (Enders, 2003).

Our strategy is to estimate the VAR model with two different orders of endogenous variables to circumvent the identification issue. Estimates assume that the exchange rate is the most exogenous variable (influenced contemporaneously by no variable). The first system adopts the following ordering [*e*; *q*; *p*] to capture the possible effect of the exchange rate in sectoral demand and, then, on sectoral inflation. There are two arguments for that. First, sectors with higher external demand are expected to be more benefited by exchange rate devaluations in a manner that such greater demand puts pressure on prices up. Second, another transmission channel from exchange rate into demand is the protection of the domestic market from international competition provided by exchange rate devaluation prices. The second system adopts the following ordering [*e*; *p*; *q*] to capture the possible demand-induced effect of exchange rate on sectoral inflation and, then, on sectoral production.[7] The *rationale* is that exchange rate devaluations increase prices,

[6] In the case that the lag length that minimizes the information criterion was not enough to vanish residual autocorrelation, additional specifications with further lags were performed (until the Lagrange Multiplier test does not reject the null hypothesis of no residual autocorrelation). This is a problematic issue when the econometrician is concerned with parameters estimated by ordinary least squared (OLS) as the tests t and F are not valid anymore due to the biased error variance. As I am interested in IRF and FEVD of VAR estimates, the more parsimonious model (according to the information criterion) was chosen since the addition of further lags (used to vanish residual correlation) increase the error variance, as far as one further lag means the addition of one parameter of cross-correlation for each endogenous variable/equation. Thus, the results with further lags produced large confidence intervals in IRF, confirming that the model more parsimonious suits better. The results were similar to some extent, indicating the results' robustness (using the more parsimonious specification).

[7] Assuming that demand can be higher than supply in the short-run, but it equals supply in the long-run.

which leads firms to increase production. It should be noticed that the exchange rate influences contemporaneously inflation in both systems.

Data from 23 industrial sectors of Standard Industrial Classification 2.0 (CNAE 2.0) are used in this study. The data are monthly and covers the period between 2010:1 through 2019:12 (120 months). The Producer Price Index (PPI) comes from the Brazilian Institute of Geography and Economy (IBGE) and represents the sales prices received by firms free of taxes, tariffs, and freight. The pass-through is calculated using the nominal and the sectoral effective exchange rate to obtain robust results. Such variables are the price of Real (R$) in Dollar (US$) expressed in growth rate; hence, positive (negative) values denote devaluations (overvaluations). The sectoral demand is represented by the industrial production that comes from Monthly Industrial Survey Production (PIM-PF) in growth rate. It should be noted that both PPI and sectoral demand variables are seasonally adjusted. The oil price is represented by the price of Brent Crude in US$, denoted in growth rate and came from the Federal Reserve of ST. Louis. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were performed and assured that all variables are stationary.[8]

5- Empirical results

The empirical findings are discussed in what follows.

5.1- Estimates I: Generalized Method of Moments (GMM)

Table 1 reports the long-run exchange pass-through estimated using GMM.[9] Using nominal exchange rate as independent variable, the results suggested that the pass-through from 1% of exchange rate devaluation into aggregated IPP is 18% and 17%, respectively for specifications 1 and 2. Only the following sectors have a pass-through greater than 50%: 12 (75% and 80%), 17 (64% and 65%), 20c (63% and 76%) and 30 (78% and 99%), in specifications 1 and 2 respectively. Whereas the sectors 10, 11, 13, 14, 15, 16, 21, 22, 23, 25, 26, 28, 29 and extractive industry have a pass-through lesser than 50%: (47% and 48%), (0% and 11%), (13% and 1%), (33% and 30%), (26% and 25%), (32% and 33%), (10% and 0%), (7% and 7%), (15% and 24%), (23% and 24%), (35% and 34%), (8% and 6%), (3% and 3%) and (20% and 21%), respectively in specifications 1 and 2. The sectors 18, 20b, 27 and 31 have anomalous results once its exchange rate pass-through into prices was negative.

Table 1 - Sectoral Pass-Through (long-run: 12 months): GMM estimates

	Nominal exchange rate pass-through				*Sectoral effective exchange rate*			
	First Specification		*Second Specification*		*First Specification*		*Second Specification*	
Devaluation/ Sector	*1%*	*1 s.d.*[a]	*1%*	*1 s.d.*[a]	*1%*	*1 s.d.*[b]	*1%*	*1 s.d.*[b]
10	0.47	2.14	0.48	2.18	0.15	0.56	0.13	0.49
11			0.11	0.50	-0.12	-0.47	-0.13	-0.51
12	0.75	3.42	0.80	3.64	0.80	3.09	0.87	3.36
13	0.13	0.59	0.01	0.04			0.06	0.22
14	0.33	1.50	0.30	1.36	-0.38	-1.55	-0.12	-0.49
15	0.26	1.18	0.25	1.14	0.23	0.95	0.35	1.45
16	0.32	1.45	0.33	1.50	0.34	1.39	0.38	1.55
17	0.64	2.91	0.65	2.96	0.50	1.95	0.72	2.81

[8] The ADF test was performed with constant, no constant, trend, and drift, while the PP test with constant, no constant, and with a trend. All tests suggested the stationarity of variables. The tests, as well as the descriptive statistics of variables, are available upon request.

[9] The full output of GMM estimates is available upon request.

18	-0.17	-0.77	-0.03	-0.13				
19							0.16	0.75
20b	-0.22	-1.0	0.00	0.0				
20c	0.63	2.87	0.76	3.46				
21	0.10	0.45	0.46	2.09	-0.05	-0.16	-0.23	-0.75
22	0.7	0.31	0.07	0.31				
23	0.15	0.68	0.24	1.09	0.46	2.18	0.53	2.52
24							0.01	0.04
25	0.23	1.04	0.24	1.09	0.04	0.16	0.04	0.16
26	0.35	1.59	0.34	1.55				
27	-0.4	-0.18	-0.08	-0.36			-0.07	-0.26
28	0.8	0.36	0.06	0.27				
29	0.3	0.13	0.03	0.13	0.09	0.37	0.03	0.12
30	0.78	3.55	0.99	4.51	0.11	0.55	0.08	0.40
31	-0.1	-0.04	0.00	0.0	0.17	0.66	0.17	0.66
Extractive	0.20	0.91	0.21	0.95	0.27	1.17	0.53	2.30
PPI	0.18	0.82	0.17	0.77	0.34	1.47	0.41	1.78

Notes: (1) specification 1 was run using 4 degrees of freedom of test-J (the instruments regressions contains a constant and 16 lags of exchange rate variable - from 12 until 27 periods); (2) specification 2 was run using 5 degrees of freedom of test-J (the instruments regressions contains a constant and 17 lags of exchange rate variable- from 12 until 28 periods); (3) the long-run pass-through is calculated as the sum of statistically significant parameters (at least at 10%); (4) the instruments has been valid for all regressions; (5) empty cells mean that no parameter was statistically significant; [a]1 standard deviation of the nominal exchange rate (4.56%); [b]1 standard deviation of the sectoral effective exchange rate.

Using the sectoral effective exchange rate instead nominal exchange rate, results are different, but the incomplete pass-through remains. The pass-through from effective exchange rate to aggregated IPP is 27% and 53%, respectively, for specifications 1 and 2. The sectoral effective exchange rate's pass-through has shown more modest than that from nominal exchange rate. Only the following sectors have a pass-through greater than 50%: 12 (80% and 87%) and 17 (50% and 72%). Whilst the sectors 10, 13, 15, 16, 19, 23, 24, 25, 29, 30, 31 have a pass-through lesser than 50%: 10 (15% and 13%), 13 (0% and 6%), 15 (23% and 35%), 16 (34% and 38%), 19 (0% and 16%), 23 (46% and 53%), 25 (4% and 4%), 29 (9% and 3%), 30 (11% and 8%), 31 (17% and 17%) and extractive industry (27% and 53%), respectively, for specifications 1 and 2. The sectors 11, 14, 21, and 27 presented negative exchange rate pass-through.

Although the results suggest that no sector has a full pass-through of exchange rate devaluations (either nominal or real) around 1% into prices, the analysis changes when exchange rate devaluations are analyzed in terms of one standard deviation. A devaluation of 4.56% in the nominal exchange rate is fully passed to industries' prices and larger than 100% for various sectors. Only sectors 11, 13, 22, 28, 29, and extractive industries do not have a full pass-through. The same applies to a devaluation of 1 standard deviation in the sectoral effective exchange rate. In this case, only the prices of sectors 15, 25, 29, 30, and 31 increase less than 100% after an exchange rate devaluation of 1 standard deviation.

The estimates of second specification of equation (14)[10] controlling other covariates using both nominal as effective exchange rate delivered evidences that industrial prices accommodate partially exchange rate devaluations of 1% in short-run. The estimates estimates using nominal exchange rate and suggests that the pass-through of a devaluation of 1% into aggregated PPI is 9% and 41% in terms of an exchange rate devaluation of a standard deviation. While the pass-through into prices has shown statistically significant (at least at 10%) only for the sectors 10, 12, 15, 17, 25, 30 and extractive industry with the respective pass-through of exchange rate devaluation of 1%: 31%, 29%, 17%, 33%, 18%, 49% and 9% - which correspond to 141%, 132%, 77%, 150%, 82%, 223% and 41% after an increasing of 1 standard deviation in nominal exchange rate.

[10] Not presented due the limit of pages, but it is available upon request.

Lastly, the estimates using the effective exchange rate indicate that the pass-through of a devaluation of 1% into aggregated PPI is 25% and 108% in terms of an increase of 1 standard deviation in the effective exchange rate. Despite the anomalous result for sectors 11 and 18 (negative pass-through), the pass-through to prices was statistically significant (at least at 10%) only for the sectors 17, 24, 30 and extractive industry with the respective pass-through exchange rate devaluation of 1%: 24%, 24%, 35% and 27% - which correspond to 93%, 111%, 175% and 117% after an increase of 1 standard deviation in the sectoral effective exchange rate.

5.2- Estimates II: Vector Auto Regressive (VAR)

This section discusses the results of VAR's estimates. The estimates have been proved robust to the different orders of endogenous variables (different systems produced the same IRF and FEVD), and all eigenvalues lie inside the unit circle. The long-run pass-through after a shock of 1 standard deviation in the exchange rate and after an increase of 1% in the exchange rate (pass-through standardized) are summarized in Table 2.[11]

Table 2 - Sectoral Pass-Through (long-run: 12 months): VAR's Results

	Nominal exchange rate				*Sectoral effective exchange rate*			
Sector	*Pass-Through*[a]	*FEVD*[b]	*Month*[c]	*Pass-Through standardized* [d]	*Pass-Through*[a]	*FEVD*[b]	*Month*[c]	*Pass-Through standardized* [d]
10	135%	21%	12	34%	64%	9%	2	17%
11		3%				16%		
12	213%	65%	12	61%	138%	34%	12	39%
13		5%				2%		
14	22%	2%	1	5%	26%	1%	1	5%
15	125%	42%	12	29%	109%	36%	12	20%
16	132%	38%	12	32%	86%	35%	12	17%
17	154%	36%	12	37%	136%	36%	12	41%
18		2%			-66%	12%	10	-17%
19	79%	9%	12	21%	-61%	15%	1	-13%
20b		2%				4%		
20c	182%	29%	12	49%	84%	14%	3	31%
21		2%				2%		
22	32%	6%	12	8%	67%	19%	12	25%
23	34%	7%	12	8%	71%	14%	12	12%
24	75%	16%	12	21%	39%	6%	1	7%
25	75%	42%	12	19%	93%	39%	12	21%
26	42%	6%	12	11%	50%	8%	12	7%
27		3%			33%	7%	12	7%
28	30%	12%	12	7%	31%	10%	12	6%
29	20%	12%	12	4%	20%	10%	12	3%
30	216%	68%	12	58%	224%	66%	12	41%
31	33%	13%	12	8%	39%	18%	12	10%
Extractive	72%	53%	12	19%	69%	44%	12	15%
PPI	83%	59%	12	22%	100%	59%	12	24%

Notes: [a] inflation's IRF (after a shock of 1 standard deviation in the exchange rate) represented by the value of the last month in which CRIF is statistically significant (when 0 is not within confidence interval); empty cells mean that no value of CRIF was statistically significant, [b] in the case that no value of CRIF is statistically significant, the value of FEVD represents the twelfth month; [c] last month in which CRIF is statistically significant; [d] standardized following the procedure of McCarthy (2007) to express the response of inflation to a shock of 1% in the exchange rate, which is calculated dividing the cumulative change of

[11] The full results of VAR are available upon request.

inflation after a shock in exchange rate by the cumulative change of exchange rate after such shock. The calculations of pass-through standardized are carried out using the values of cumulative change in the exchange rate of the value of the last month in which CRIF of inflation is statistically significant.

Estimates using the nominal exchange rate indicate that pass-through into aggregated IPP (after a shock of 1 standard deviation in exchange rate) is around 83%. The same applies for the sectors 14, 19, 22, 23, 24, 25, 26, 28, 29, 31 and extractive industry once the estimated pass-throughs are 22%, 79%, 32%, 34%, 75%, 75%, 42%, 30%, 20% and 33%, respectively. The FEVD for these sectors is lower than average (19%) (except for the sector 25): 14 (2%), 19 (9%), 22 (6%), 23 (7%), 24 (16%), 25 (42%), 26 (6%), 28 (12%), 29 (12%), 31 (13%). The pass-through is larger than 100% for the remaining sectors: 12 (232%), 15 (125%), 16 (132%), 17 (154%), 20c (182%) and 30 (216%). The respective FEVD are higher than average: 12 (65%), 15 (42%), 16 (38%), 17 (36%), 20c (29%) and 30 (68%), suggesting that exchange rate explain more the prices of these sectors.

The results using sectoral effective exchange rate indicate that pass-through into aggregated IPP (after a shock of 1 standard deviation in the exchange rate) is 100%. The pass-through is larger than 100% for the sectors: 12 (138%), 15 (109%), 17 (136%), and 30 (224%). The FEVD corroborated the importance of sectoral effective exchange rate in influencing prices of these sectors once it is greater than the average (18%): 12 (34%), 15 (36%), 17 (36%), and 30 (66%). The same does not apply for the remaining sectors because its pass-through is lesser than 100%, and FEVD is lesser than the average in most sectors.

Estimates suggest that the pass-through standardized is incomplete. Using nominal exchange rate, the pass-through into aggregated IPP is 22%. While the sectoral pass-through is: 10 (34%), 12 (61%), 14 (5%), 15 (29%), 16 (32%), 17 (37%), 19 (21%), 20c (49%), 22 (8%), 23 (8%), 24 (21%), 25 (19%), 26 (11%), 28 (7%), 29 (4%), 30 (58%), 31 (8%) and extractive industry (19%). This result is confirmed by regressions employing effective exchange rate. The pass-through into aggregated IPP is 24%. Whilst the sectoral pass-through is: 10 (17%), 12 (39%), 14 (5%), 15 (20%), 16 (17%), 17 (41%), 18 (-17%), 19 (-13%), 20c (31%), 22 (25%), 23 (12%), 24 (7%), 25 (21%), 26 (7%), 27 (7%), 28 (6%), 29 (3%), 30 (41%), 31 (10%) and extractive industry (15%).

The estimates of exchange rate pass-through are robust. Both GMM as VAR estimates go in the same direction and suggest that prices increase less than 1% due to a 1% devaluation in the exchange rate - employing nominal or effective exchange rate. This is valid for aggregated and sectoral estimates. Therefore, Brazilian manufacturing sectors do not entirely pass devaluations of 1% in exchange rate into prices. Results are like those obtained by Correa (2017). Interestingly, all findings point out that the exchange rate pass-through estimated using nominal exchange rate is greater than that estimated using the effective exchange rate in both estimates.

6- Explaining the Pass-through for Brazilian Economy

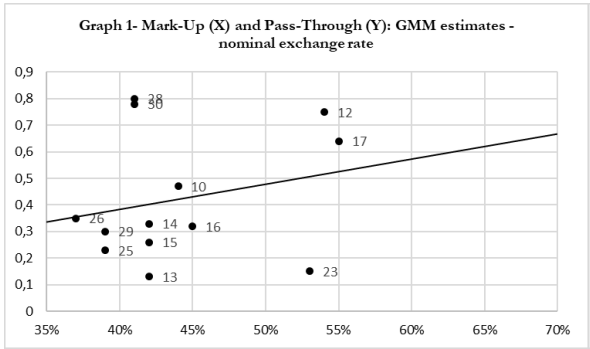
The previous section demonstrated the prevalence of partial exchange rate pass-through for devaluations of 1% in the exchange rate on prices of Brazilian manufacturing sectors over the period between 2010 and 2019, and large variation of pass-through across the sectors. This section aims at exploring the previous findings in light of stylized sectoral facts (markup rate, outward orientation, competition among national and foreign firms, and costs with imported inputs) to offer possible explanations for those sectoral differences.

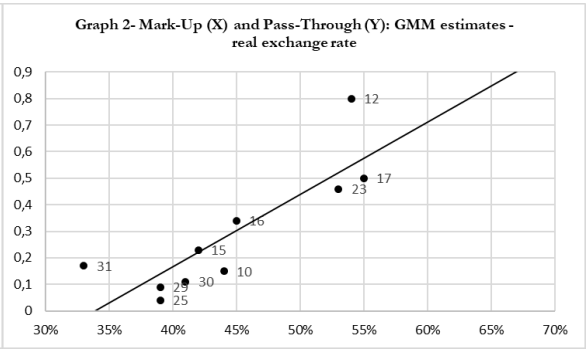
6.1. Market Power

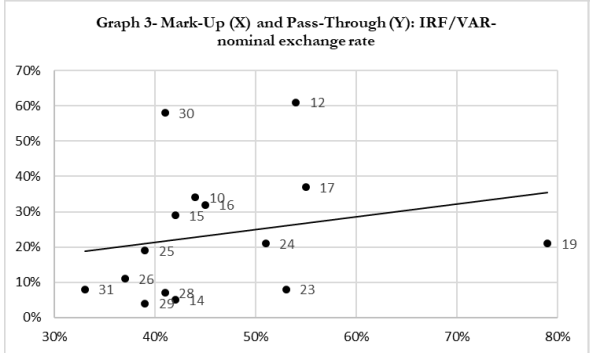
According to the theoretical model developed earlier, larger the markup rate stronger is the effects of devaluations of the exchange rate in prices, and the degree of imported inputs in costs intensifies such effect. The larger the share of imported inputs in costs, the higher is the increase in exchange rate pass-through due to an increase in markup rate, all else constant.

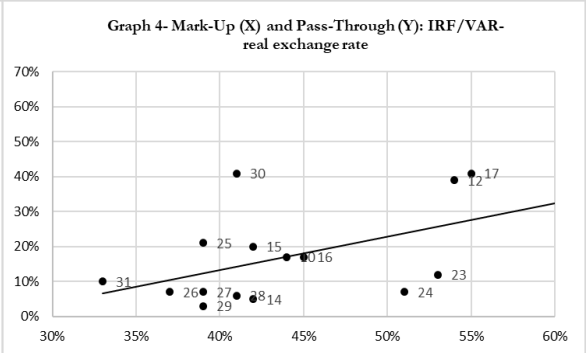
The association between markup rate and pass-through is performed by a graphical analysis. This strategy is the only one possible because there is no monthly data that allows the use of econometric methods. The markup variable was constructed using the annual data from Annual Industry Survey (PIA) from IBGE over the period between 2010 and 2017. The methodology of computation is the same as Nucci and Pozzolo (2001).

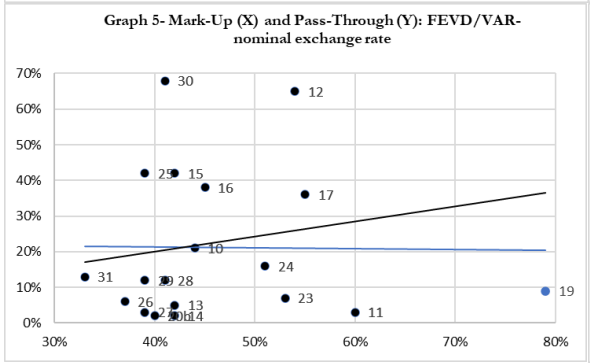
Graphs 1 and 2, below, present the correlogram for the average of the markup over the period 2010-2017 and the estimated pass-through by GMM (estimated using 4 degrees of freedom) . Both graphs suggest a positive association between mark-up rate and exchange rate pass-through. The higher is the mark-up, the stronger is the effect of exchange rate devaluations in prices. Sectors with higher market power are more capable to pass exchange rate devaluations into prices because of increased costs, or because of competitiveness gain.

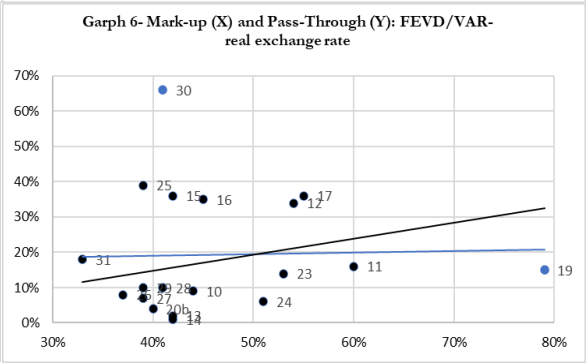








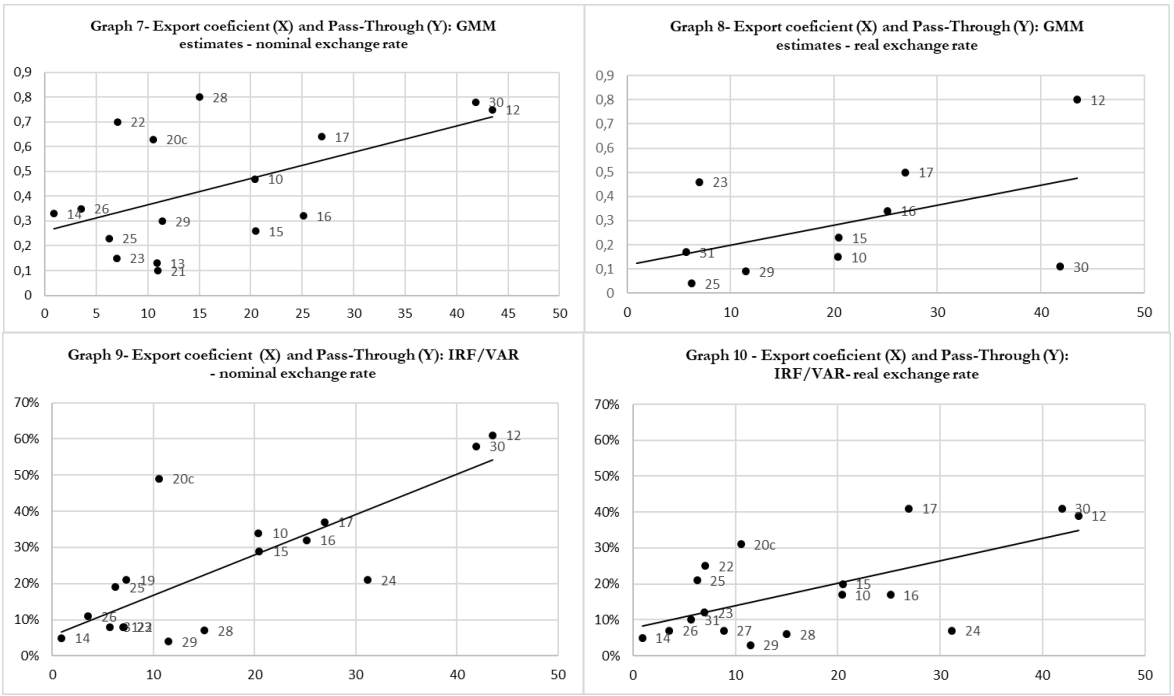




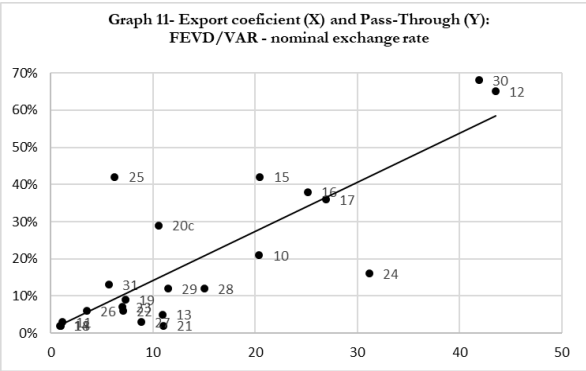
The correlogram for the average of the markup over the period 2010-2017 and the estimated pass-through (standardized) and the FEVD are reported in Graphs 3, 4, 5 and 6.
The graphs confirmed the previous findings; the higher is market power, the higher is the capability of firms to pass on exchange rate devaluations into prices. The correlogram also suggested a positive association between FEVD[12] and markup rate, indicating that the exchange rate explains more the price changes of sectors in which markup is higher.

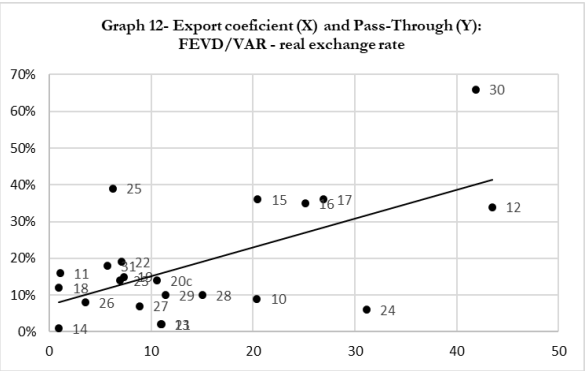
6.2. Outward Orientation

Krugman (1987) argues that the incomplete exchange rate pass-through occurs because export firms absorb exchange rate devaluations rising prices (Krugman, 1987). Exporters increase the price to take benefits from market power and discriminate prices in accordance with features of the end market (Krugman, 1987). Exchange rate devaluations are not passed fully into prices (in dollar), which increases the markup rate of these firms, *ceteris paribus*. Following this explanation, all else constant, it is expected that the effects of exchange rate devaluations are stronger for exporter firms. Graphs 7 and 8 present the correlogram for the average export coefficient (share of revenue that comes from exports) for the period 2010-2018 and the estimated pass-through by GMM (using nominal and effective exchange rate).[13] The correlograms indicate a positive association between export coefficient and pass-through. The outward orientation matters as export firms have a higher pass-through because of the adoption to some extent of price-to-market discrimination.



[12] Sectors with extreme values were removed from correlograms (black line). The trend line of the correlogram with all sectors is represented by the one with the blue line.
[13] The export coefficient came from National Conference Industry and represented the share in a percentage of revenues associated with exports. The GMM estimates refer to the equation performed with four freedom degrees.



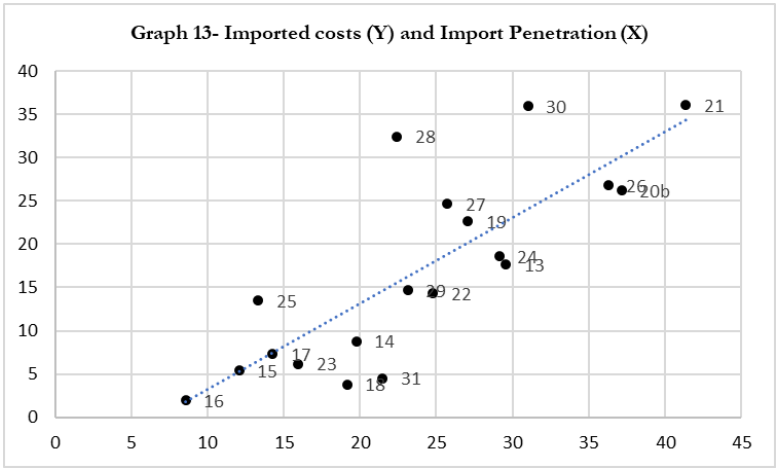


The correlogram for the average export coefficient for the period 2010-2018 and the estimated pass-through (standardized), and the FEVD (using nominal and effective exchange rate) are reported in Graphs 9, 10, 11 and 12. The graphs confirmed the results that the higher is the outward orientation, the higher is the pass-through. The correlogram suggests a positive association between FEVD and export coefficient, indicating that the exchange rate explains more the price changes of sectors more outward-oriented.

6.3. Competition and Costs

A result of the Kaleckian approach is the association between the magnitude of exchange rate pass-through and the share of imported inputs in costs. The higher is the importance of imports in costs, stronger is the pass-through, *ceteris paribus*. The intuitive implication is that sectors that import more inputs are more affected by the exchange rate and pass more the devaluations into prices to defend markup rate, all else constant. Yet, Arestis and Milberg (1993) argue that the incomplete exchange rate pass-through occurs because firms absorb exchange rate devaluations reducing markup rate. This is due to the degree of competition among firms (Arestis and Milberg, 1993). Firms with a high share of imported inputs in costs nestled in an industry with fierce competition cannot pass devaluations of exchange rate into prices, absorbing it by means of a reduced markup rate.

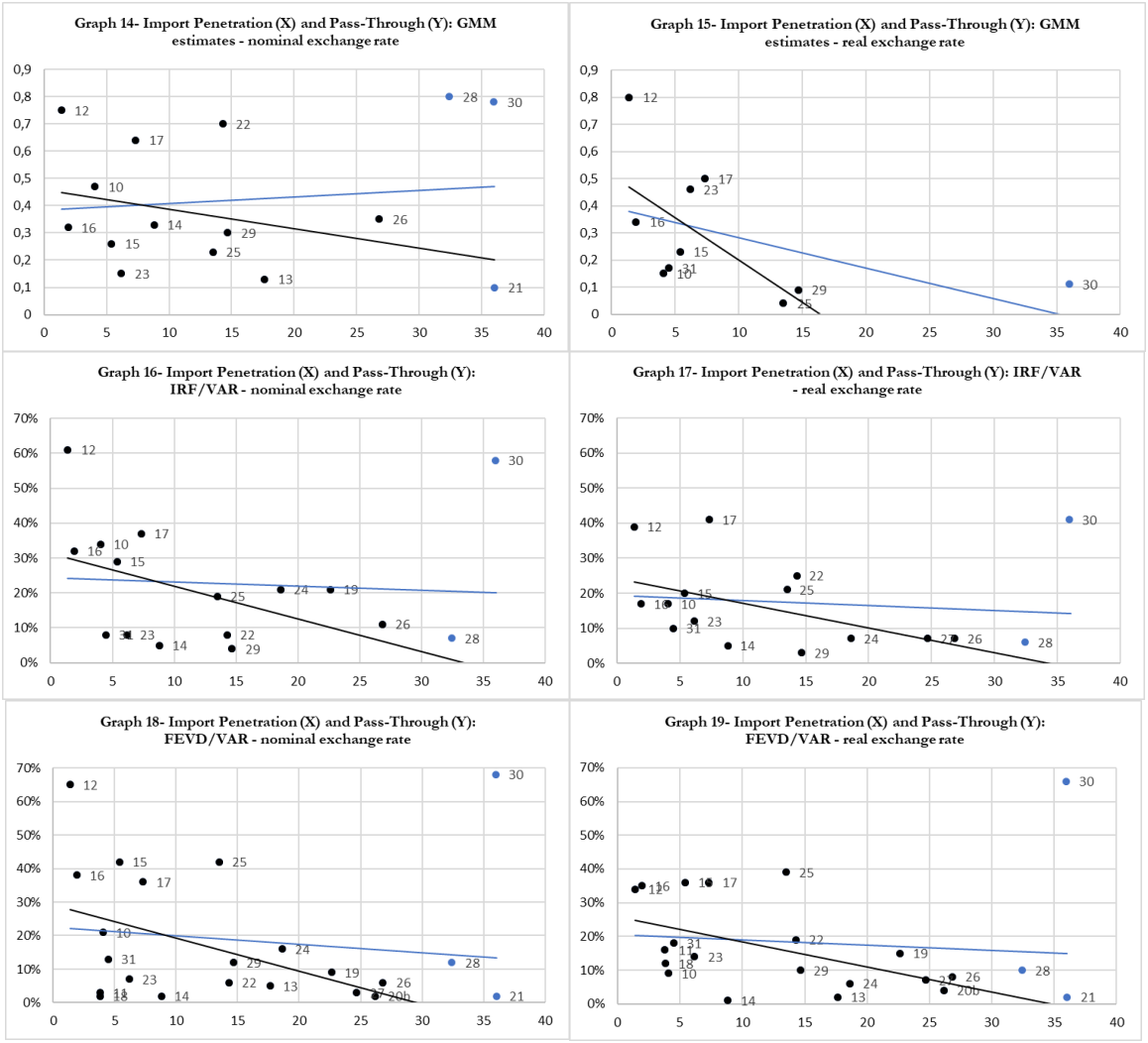
Taking the import penetration as a measure of competition between national and foreign firms[14], Graph 13 present the correlogram for the average share of imported inputs in costs and import penetration over the period 2010-2018.



[14]The import penetration is the share of national consumption that is imported. The higher is the sectoral import penetration, the stronger is the competition that national manufacturing sectors face against foreign firms.

Graph 13 indicates a positive association between the degree of competition among national and foreign firms and the share of imported inputs in costs. A stylized fact derived from it is that sectors that face strong competition with foreign firms have a higher share of imported inputs in costs. As a result, it is expected that firms of those sectors do not pass exchange rate devaluations entirely into prices and absorb it by reducing markup rate, all else constant.[15]

Graphs 14 and 15 present the correlogram for the average import penetration over the period 2010-2018 and the estimated pass-through by GMM (using nominal and effective exchange rate).[16] Both graphs suggest a negative association between competition among firms and pass-through. National firms nestled in an industry with a fierce (weak) competition with foreign firms have lower (higher) pass-through.



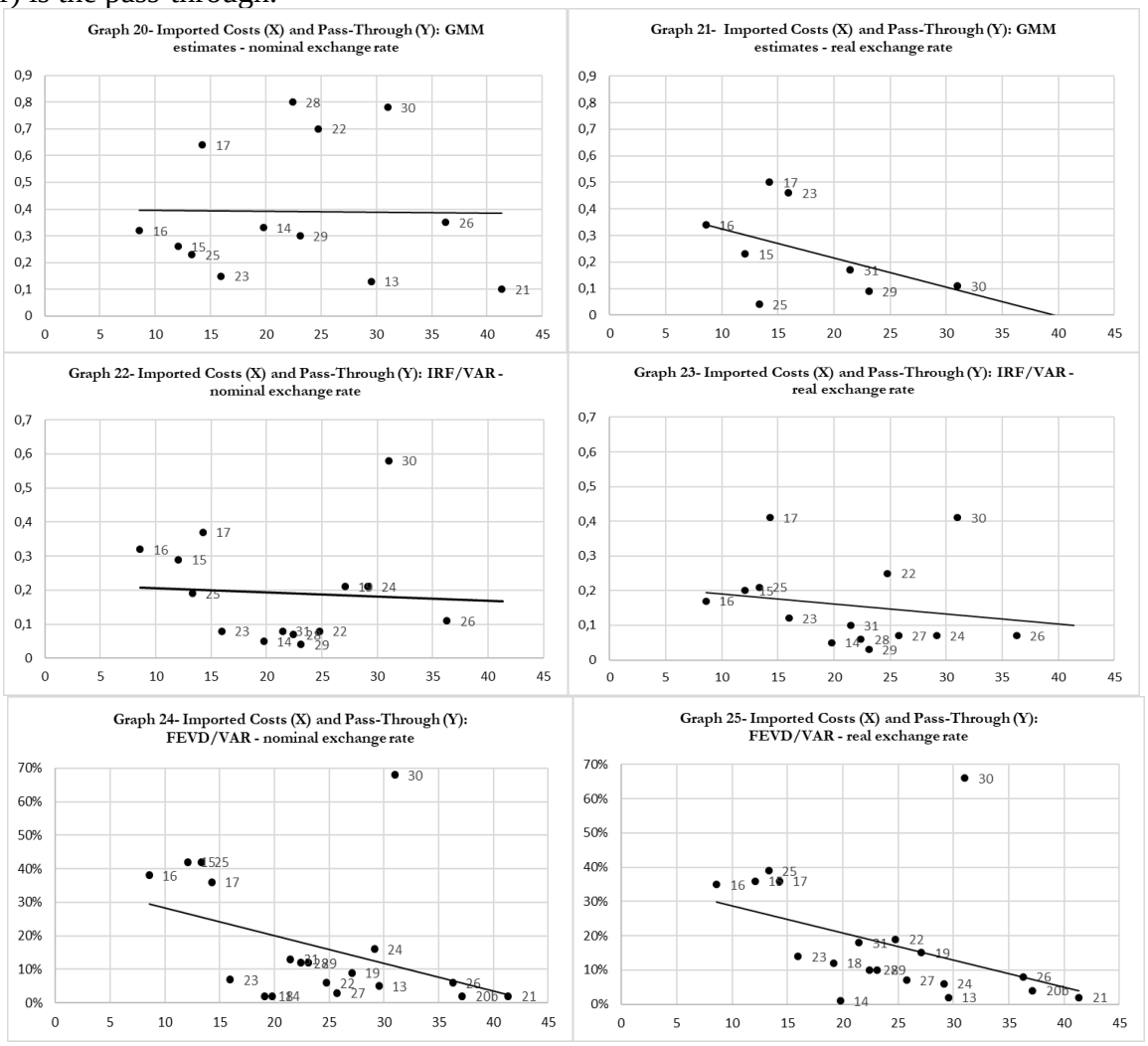
The correlogram for the average import penetration over the period 2010-2018 and the estimated pass-through (standardized) and the FEVD (using nominal and effective exchange rate) are reported in

[15] Given the peripheric condition and the strong deindustrialization process experienced by the Brazilian economy, it is plausible assuming that foreign firms have higher productivity growth than national firms.

[16] Sectors with extreme values were removed from the correlograms (black line). The trend line of correlogram with all sectors is represented by the one with the blue line.

Graphs 16, 17, 18 and 19. The previous results are confirmed. The correlogram suggests a negative association between pass-through estimated by VAR and competition among national and foreign firms. Such pattern is also valid for FEVD, which indicates that exchange rate explains more the price changes of sectors less exposed to competition with foreign firms.

Graphs 20 and 21 report the correlogram for the average share of imported inputs in costs and the estimated pass-through by GMM using nominal and effective exchange rate. While the correlogram using the pass-through estimated employing the nominal exchange rate produced a horizontal line (which does not allow to identify pattern between the variables). The correlogram using the pass-through estimated employing the effective exchange rate suggests a negative association between imported inputs' share in costs and pass-through. Thus, the higher (lower) is the share of imported inputs in costs, the weaker (stronger) is the pass-through.



The correlogram for the average share of imported inputs in costs over the period 2010-2018 and the estimated pass-through (standardized) and the FEVD (using nominal and effective exchange rate) are reported in Graphs 22, 23, 24 and 25. The correlograms suggest a negative association between pass-through estimated by VAR and the share of imported inputs in costs, even that it is weaker for the pass-through of the nominal exchange rate. Such a negative association also applies to the FEVD and indicates that exchange the rate explains more the price changes of sectors with the least share of imported inputs in costs. Although this result is counter-intuitive, the argument is that the firms with a higher share of imported

inputs in costs are nested within an industry more exposed to competition with foreign firms (as Graph 13 has shown). This way, those firms cannot pass on the higher cost due to devaluations of exchange rate into prices, which is absorbed in a reduced markup rate, as Arestis and Milberg (1993) have argued.

Concluding Remarks

The objective of this article was twofold. The first goal was understanding the effect of exchange rate on prices using the Kaleckian cost-push approach. The basic model has indicated that the exchange rate pass-through on prices is associated with firms' cost structure and wage growth. The higher the share of imported inputs (salaries) in costs, the greater is the effects of exchange rate (wage growth) in prices. Furthermore, the necessary condition for a stable inflation, combined with an exchange rate regime for development, is that workers or entrepreneurs accommodate the expanded costs due to a weak national currency via lower real wages/markup rate.

By endogenizing the markup rate to exchange rate, the extended model indicated that the necessary condition for stable inflation over time combined with an exchange rate regime for development is that wages reduce at the same pace that prices change due to exchange rate devaluations, everything else constant. However, by considering the effects of the exchange rate on productive structure, the results indicated that the structural change induced by a weak exchange rate might reinforce/mitigate the distributive effects of exchange rate devaluations. That is, industrialization reduces the dependence on imports. Hence, the exchange rate pass-through on prices falls, which opens the room to increase the markup rate or to mitigate the distributive effects on workers by allowing the real growth in wages with stable inflation over time. The structuralist notion of neutral inflation was introduced into the extended Kaleckian model. The results indicated that the social conflict between workers and entrepreneurs around the real income potentializes the inflationary effects of exchange rate devaluations on prices. The greater the labor costs are, the stronger the inflation without distributive effects within an economy under an exchange rate regime for development.

The second goal of this article was to provide time-series evidence on the exchange rate pass-through into the prices of manufacturing sectors for the Brazilian economy over the period from 2010 until 2019. The results demonstrated the prevalence of partial pass-through for devaluations of 1% in the exchange rate and a large variation of pass-through across the sectors. A discussion about the empirical findings in light of stylized facts of Brazilian manufacturing sectors indicated three explanations to the differences in pass-through across the sectors. First, there is a positive association between markup rate and pass-through. Sectors with high market power are more capable of passing on the exchange rate devaluations. Second, evidence indicates price-to-market discrimination of export firms because there exists a positive association between export coefficient and pass-through. Export firms absorb devaluations in the exchange rate, increasing their prices (markup rate). Third, results revealed that firms with a high share of imported inputs in costs, inserted in an industry with fierce competition with foreign firms, cannot devaluations of the exchange rate, absorbing it by means of a reduced markup rate.

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