Income Distribution, Real Exchange Rate and Capital Accumulation: empirical evidences from Brazilian industrial sectors

Hugo C. Iasco Pereira[1]
Gilberto Libânio[2]
Fabrício J. Missio[2]

Abstract

This paper examines the relation between capital accumulation, income distribution and the real exchange rate in the Brazilian economy using a sectorially disaggregated database for the period 2007-2014. The industrial sectors are grouped into two categories according to the intensity of technological innovation: (i) medium-low and low; and (ii) medium-high and high. Two different methodologies are used for estimations: (i) the Arellano–Bond GMM method to handle the endogeneity between investment and the profit share; and (ii) panel vector autoregression to capture the impact of exchange rate devaluation on capital accumulation, taking into account the feedback of the profit share, labour costs and degree of capacity utilization. The results suggest a non-linear relationship between investment and income distribution in the Brazilian economy for both groups of sectors. However, the pattern of the relation between capital accumulation and income distribution differs according to the intensity of innovation. The results also indicate that an exchange rate devaluation has a positive effect on capital accumulation, particularly for the sectors more intense in technology innovation.

Keywords: Income Distribution, Real Exchange Rate, Capital Accumulation

Resumo

O objetivo deste trabalho é examinar a relação entre acumulação de capital, distribuição de renda e a taxa real de câmbio para a economia brasileira em um nível setorialmente desagregado para o período entre 2007 e 2014. Para tanto, os setores foram agrupados conforme a intensidade tecnológica: (i) média-baixa e baixa, e (ii) média-alta e alta. Utilizou-se duas metodologias econométricas: (i) um painel estimado por Arellano-Bond visando lidar com a possível endogeneidade entre investimento e o profit-share setorial, (ii) um modelo de painel com vetores autoregressivos para capturar o efeito de feedback entre as variáveis. Os resultados sugeriram uma relação não-linear entre o investimento e a distribuição de renda setorial, mas com diferentes funções entre as varáveis de acordo com a intensidade de inovação tecnológica setorial. Além disso, a taxa real de câmbio se mostrou um importante vetor para a promoção da acumulação de capital, particularmente para os setores mais intensos em inovação tecnológica.

Palavras-Chave: Distribuição de Renda, Taxa de Câmbio Real, Acumulação de Capital

Área ANPEC: Crescimento, Desenvolvimento Econômico e Instituições

Código JEL: O, O4

[1] PhD student at UFMG-CEDEPLAR. Email: hclpereira@cedeplar.ufmg.br
[2] Professors at UFMG-CEDEPLAR

Introduction

Income distribution is a central variable in the determination of capital accumulation. In this context, changes in income distribution between capitalists and workers can boost investment because the profit is related to the availability of funds to finance capital accumulation. From this perspective, Lima (2004) argues that investment is a non-linear function of income distribution. His point is that capitalists invest in technologies to decrease labour costs. Then, sectors with a small profit share (or high labour costs) have high capital accumulation. On the other side, according to the structuralist macroeconomic theory, the real exchange rate is a fundamental variable in the promotion of capital accumulation A devaluated or competitive exchange rate means a profit-led policy insofar as it increases the profit share in the national income. Depending on the structural characteristics of the economy, exchange devaluation policies can trigger investment in technological progress.

The contribution of this paper is twofold. Firstly, to examine the relation between capital accumulation, income distribution and real exchange rate for Brazilian industrial sectors. Secondly, to assess the possibility that the relation between income distribution and capital accumulation follows a non-linear pattern, testing if such function is concave or convex. To this end, we employed a sectorially disaggregated database for the period between 2007 and 2014. Two different methodologies are used for estimation: (i) Arellano and Bond's GMM method to handle the endogeneity between investment and the profit share; and (ii) panel vector autoregression to capture the impact of exchange rate devaluation on capital accumulation, taking into account the feedback of the profit share, labour costs and degree of capacity utilization.

In addition to estimating these models for the Brazilian economy as a whole, this paper analyzes two groups of sectors according to the intensity of technological innovation: (i) medium-low and low and (ii) medium-high and high intensity (Galindo-Rueda and Verger, 2016). To the best of our knowledge, the analysis of the effects of income distribution and exchange rates on capital accumulation, taking into account a distinction between sectors by technological intensity, represents an original contribution to the literature.

The remainder of the paper is organized as follows. The first section discusses the relation between income distribution and economic growth from the Kaleckian perspective as well as the non-linear relation between income distribution and technological progress. The structuralist macroeconomic perspective on the importance of the exchange rate is discussed in the second section. The third section presents the empirical literature on income distribution, real exchange rate and growth. In the fourth section, the empirical strategy adopted in the paper is presented, while the database of the estimations is discussed in the fifth section. The results of the regressions are discussed in the sixth section. The paper ends with the conclusion.

1- Income Distribution and Growth

The importance of income distribution in the understanding the economic growth has been a field of research since the seminal work of Kalecki (1954). In the 1980s, some authors explored the Kaleckian idea that the income distribution between workers and capitalists is a central variable explaining economic growth (Rowthorn, 1981; Dutt, 1984, 1987; Taylor, 1985; Amadeo, 1986a, 1986b, 1987). According to them, increases in the wage share always promote the expansion of aggregated demand, capital accumulation and, hence, economic growth. Grounded on Steindl (1979) and Kalecki (1954), Bhaduri

and Marglin (1990) and Kurz (1990) developed more flexible theoretical models in which the economy can be wage-led or profit-led. In these models, changes in the functional income distribution and its impacts on economic performance depend on the structural characteristics of the economy. Thus, the economy is not always wage-led, as for the neo-Kaleckians. The Bhaduri/Marglin–Kurz models are known as post-Kaleckian models (Hein, 2014; Lavoie, 2014).

Following the Hein's (2014) synthesis of the post-Kaleckian theory, the basic equations are as follows:

$$r = h\frac{u}{v} \tag{1}$$

$$h = 1 - \frac{1}{1+m} \tag{2}$$

$$\sigma = s_\pi h\frac{u}{v},\ 0 < s_\pi \leq 1 \tag{3}$$

$$g = \frac{I}{K} = \alpha + \beta u + \tau h;\ \beta, \tau > 1 \tag{4}$$

where *r* is the rate of profit, *h* is the profit share, *v* is the capital–potential output ratio, *m* is the markup, *s* is the saving rate, s_π is the propensity to save out of the total profits, *g* is the capital accumulation, where α represents the animal spirits, and *u* is the rate of utilization. The condition of equilibrium is for investment to be equal to saving:

$$g = \sigma \tag{5}$$

$$\frac{\partial \sigma}{\partial u} - \frac{\partial g}{\partial u} > 0, \text{ so } s_\pi \frac{h}{v} - \beta > 0 \tag{6}$$

Satisfying the condition of equilibrium, the equilibrium rate of capacity utilization is:

$$u^* = \frac{\alpha+\tau h}{s_\pi \frac{h}{v} - \beta} \tag{7}$$

Replacing the equilibrium rate of capacity utilization in the equation of capital accumulation, the equilibrium accumulation and saving rates are:

$$g^* = \sigma^* = \alpha + \beta\frac{\alpha+\tau h}{s_\pi \frac{h}{v} - \beta} + \tau h = \frac{(\alpha+\tau h)s_\pi \frac{h}{v}}{s_\pi \frac{h}{v} - \beta} \tag{8}$$

Taking the first difference of equations (7) and (8) in relation to the profit share, it obtains:

$$\frac{\partial u^*}{\partial h} = \frac{\tau - s_\pi \frac{u}{v}}{s_\pi \frac{h}{v} - \beta} \tag{9}$$

$$\frac{\partial g^*}{\partial h} = \frac{s_\pi \frac{1}{v}(\tau h - \beta u)}{s_\pi \frac{h}{v} - \beta} \tag{10}$$

According to equations (9) and (10), the effects of changes in the income distribution on the equilibrium rate of capacity utilization (output gap) and capital accumulation (investment) depends on the parameters of the saving and investment functions.

Equation (9) shows that an increase in the profit share will create a positive effect on the economy if the elasticity of investment in relation to the profit share is higher than the propensity to save. Economies with this characteristic have profit-led, or *exhilarationist* properties. Otherwise, if redistribution of income in favor of workers creates a positive effect on capacity utilization, the economy has wage-led properties or a *stagnationist* regime (Bhaduri and Marglin, 1990). In turn, equation (10) indicates that redistribution of income to capitalists will enhance (decrease) capital accumulation if the elasticity of investment is higher (lower) than the sensibility of investment to capacity utilization. In this case, the economy follows a profit (wage)-led regime. In sum, the

relation between income distribution and economic performance depends on the structural characteristics of the economy, that is, whether the economy is profit or wage-led.

1.1- Investment and Income Distribution: A Non-linear Relation

An important hypothesis raised by Lima (2004) is the non-linearity of capital accumulation regarding to income distribution between capitalists and workers. It assumes that investment is endogenous to income distribution in two manners: a) as long as the investment has a saving-labour nature in a capitalist economy, higher wage shares constitute incentive to capital accumulation; b) the profit share is related to the availability of own funds to finance capital accumulation. Such endogeneity between capital accumulation and income distribution entails a non-linear investment function represented by:

$$\mathrm{d} = \Omega - \Omega^2 \tag{11}$$

where *d* is investment in technological innovation and **Ω** is income distribution represented by the wage share. This function is a concave-down parabola with two real roots, h(0)=h(1)=0, so vector *d* is positive over the domain given by the values of σ between 0 and 1 (Lima, 2004). The level of distribution that maximizes technological innovation in σ^* is 0.5. In this specification, extreme values of income distribution correspond to lower values of technological innovation, while intermediary values of income distribution correspond to higher levels. Lima (2004) explains this pattern as follows:

> (…) the rate of innovation is lower for both low and high levels of wage share, it being higher for intermediate ones. While at high levels of profit share the availability of funding for innovation is high but the incentives to innovate are low, at low levels of profit share the incentives to innovate are high but the availability of funding is low. (Lima, 2004, p. 391)

When the wage share is higher (lower), the investment in technologies – which increase productivity and decrease the number of workers employed, is higher (lower) (Lima, 2004). The non-linearity is justified by the fact that, in sectors in which the wage share is larger (smaller), the own funds to finance new investments are lower (higher). In short, there is a feedback effect between investment and income distribution. In sectors with a larger wage share, capitalists are encouraged to invest in technological progress to decrease employment and, thereafter, increase the profit share.

2- Growth, Capital Accumulation and Real Exchange Rate

In the Kaleckian distribution and growth models the role played by the real exchange rate on the open economy analysis depends on the relationship between income distribution, the real exchange rate and demand/growth regimes, as well as on the analysis of the relationship between domestic redistribution and international competitiveness. The real exchange rate is an argument in function of exports and imports and as an indicator of international competitiveness (Blecker, 1989; Bhaduri and Marglin, 1990) in a manner that increasing competitiveness can be caused by an increasing nominal exchange rate, hence a nominal depreciation of the domestic currency, increasing foreign prices or declining domestic prices. The effect of changes in distribution on international competitiveness will depend on the cause of distributional change (Hein, 2014). In other

words, the real exchange rate becomes a fundamental element in the analysis of growth because it affects the price competitiveness of exports.

On the other hand, following the Keynesian-structuralist framework especially the Kaldorian approach and the balance-payment growth theory, a consensus has emerged that the management of real exchange rate is a necessary condition for adequate long-run macroeconomic performance of developing countries. In theoretical terms, the real exchange rate is the central variable in promoting capital accumulation and the growth of developing countries, as it allows companies to acquire frontier technologies and improve the competitiveness of national production (Bresser-Pereira, 2012).

In this sense, Frenkel and Taylor (2006) show that a weak real exchange rate is a necessary condition for development inasmuch as it defends the profitability of industry from the competition with imports. They suggest that higher prices of imported goods stimulate the internal demand. In turn, this upward movement of demand leads to increases in productivity through a mechanism *a la* Verdoorn (1949), which reinforces the exportation growth. Therefore, the real exchange rate can be used to alter the structural parameters of economic system (Barbosa-Filho, 2006).

Gala (2007) argues that real exchange rate affects the long-run growth through investment and technological change. He introduces this variable into Bhaduri and Marglin's (1990) model, showing that the real exchange rate is an important determinant of income distribution, influencing the capital accumulation. Gala (2007) concludes that exchange devaluation causes an income transfer in favor of capitalists, which means a profit-led policy. Gala and Libânio (2011) qualify this point by arguing that exchange devaluation improves investment if the gains in profit make up for the loss in capacity utilization due to the decline in the real wage.

Missio (2012) demonstrates that changes in the real exchange rate alter the income distribution, influencing companies' decision to invest in technological progress, arguing that companies' financing of investments in technological progress depends on their own funds through retained earnings. Thus, changes in real exchange rate alters the income distribution through the production costs (real wage), promoting the investment in technological progress. Ribeiro *et al*. (2016) build a model to investigate the effects of exchange devaluation in non-price competitiveness via changes in income distribution and the rate of technological innovation. It is concluded that exchanged devaluation turn the price of the imported intermediate inputs in the unit production cost (reducing the profit share) and shift the monopoly power of domestic firms (in this case the profit share and the RER are positively related). Therefore, the theoretical literature points that the transmission channel by which the real exchange rate affects the growth is the income distribution.

3- Empirical Literature

Regarding the Brazilian case[3], several empirical works employed various databases and time series econometric methodologies, with non-conclusive results on the effects of income redistribution on economic performance.

Araújo e Gala (2012) employed single-equation time series methodology to assess what are the regimes of demand and capital accumulation for a quarterly database for period 2002-2008. They conclude that the demand regime is wage-led while the capital accumulation regime is profit-led. Feijó *et al* (2015b) studied the demand regime for the period 1951-1989 using a yearly database through DGLS methodology, their results

[3] This section focuses on empirical works related to Brazilian case, see Chapter 4 of Hein (2014) for a survey of empirical literature related to international experience.

pointed that Brazilian demand regime is profit-led. Feijó *et al* (2015b) seek to comprehend the regime of capital accumulation during 1995-2009. To this end, the authors used a SVAR model to show that Brazilian economy is under a wage-led regime of capital accumulation.

Morrone (2015) used the Granger test to assess the hypothesis that profit-share granger-causes the investment for the period 1950-2008. Such hypothesis was not corroborated leading the author to affirm the possibility that Brazilian economy has a wage or profit-led in certain periods. Avirtzer *et al* (2015) assess the effect of income distribution in favor of wage share by level and growth effects, it is not found empirical evidences in favor of growth effects for period 1952-2001. However, the level effect has proved valid since 1994. Tomio (2016) studied the demand regime for the period 1956-2008 through single equation methodology, concluding that demand regime of Brazilian economy is wage-led. Jesus *et al* (2017) used VAR and Granger causality to study the growth and demand regimes for the period 1970-2008. The authors showed that both regimes are profit-led. The Table 1 summarizes the already shortly discussed empirical literature.

Table 1- Empirical Literature for Brazilian Case: Income Distribution and Growth

Paper	Methodology	Observations	Results
Jesus *et al* (2017)	VAR and Granger Causality	Yearly: 1970-2008	Profit-Led
Tomio (2016)	Single Equation	Yearly: 1956-2008	Wage-Led
Avritzer *et al* (2015)	VAR and Granger Causality	Yearly: 1952-2011	Non-conclusive
Morrone (2015)	Granger Causality	Yearly: 1950-2008	Ambiguous
Feijó *et al* (2015a)	SVAR	Quarterly: 1995-2009	Wage-Led
Feijó *et al* (2015b)	DGLS	Yearly: 1951-1989	Profit-Led
Araújo e Gala (2012)	Single Equation	Quarterly:2002-2008	Growth Pattern: Wage-Led Accumulation Pattern: Profit-Led

Source: Authors

There is a vast literature of empirical works that displays the importance of real exchange rate for economic growth (Blecker, 2007; Rodrik, 2008; Bahmani-Oskooe and Hajilee, 2010; Rapetti *et al*, 2014; Vaz and Baer, 2014; Missio *et al*, 2015).

Confirming the robustness of relation between real exchange rate and growth, there is a specific literature that explored the such empirical relation for Brazilian economy. In this line, Oreiro *et al* (2011) employed a quarterly database to assess the relation between real exchange rate and economic growth, their empirical evidences showed that exchange appreciations are related to minor growth rates during 1994-2007. Oreiro and Araújo (2012) tested the non-linear relation between capital accumulation and real exchange rate. The authors pointed a positive and diminishing relation between exchange depreciations and capital accumulations (convex function). Missio *et al* (2018) investigated the relation between real exchange rate and capital accumulation for the period 1996-2017, it is concluded that such relation is positive and non-linear (convex function).

Baltar *et al* (2016) tested how the sectorial investment is affected by real exchange devaluations during 1996-2011, they concluded that exchange devaluations are related to expansions in capital accumulations of industrial sectors.

Nonetheless, there is a literature which relates the real exchange rate to structural change process – deindustrialization. Marconi and Rocha (2012) investigated how the real exchange rate affected the deindustrialization of Brazilian economy between 1995 and 2008. They concluded that the valuated real exchange rates contributed to Brazilian deindustrialization. Araújo and Peres (2018), employing a sectorial database for 1996-2012 period, showed that the periods with an appreciated real exchange rate changed the Brazilian productive structure in favor of primary activities in detriment of sector more technologically advanced. Therefore, in Kaldorian terms, the real exchange rate is an important variable in order to promote the long-run growth thought structural change. The Table 2 summarizes the empirical literature on real exchange rate and growth.

Table 2- Empirical Literature for Brazilian Case: Real Exchange Rate and Growth

Paper	Methodology	Observations	Effects of exchange devaluations
Oreiro *et al* (2011)	IV regressions	Quaterly:1994-2007	+
Oreiro and Araújo (2012)	VECM	Quaterly:1994-2008	+
Marconi and Rocha (2012)	GMM Panel	Quarterly:1995-2008	+
Baltar *et al* (2016)	GMM Panel	Yearly: 1996-2011	+
Araújo and Peres (2018)	GMM Panel	Yearly: 1996-2012	+
Missio *et al* (2018)	Single equation	Quarterly:1996-2017	+

Source: Authors

In sum, several empirical works showed the importance of functional income distribution and real exchange rate to explain the economic performance as much to international as to Brazilian experience. Such literature is overwhelmingly orientated to explain the economic growth by employing aggregated cross-country databases. It is obvious that this literature makes some generalizations on sectorial, regional homogeneity (among other aspects), which is clearly an oversimplification facing the complexity of modern capitalist economies. Using sectorial-level data allows us to capture specificities observed across sectors according the intensity of technological innovation.

4- Empirical Strategy

4.1- Panel Estimation

The empirical strategy consists of estimating four specifications for three groups of sectors according to the intensity of innovation.[4] The first specification aims to capture

[4] The sectors are split into two groups according to the intensity of technological innovation following Galindo-Rueda and Verger (2016). The two groups are defined as medium high and high intensity (MHH) and medium low-low (MLL) intensity.

the relation between sectorial investment $I_{t,n}$ and the profit share $\pi_{t-1,n}$, non-linear profit share $\pi^2_{t-1,n}$, real exchange rate $\theta_{t,n}$ and wage share of costs $\omega_{t-1,n}$, where *n* and *t* stand for sectors and time, respectively:

$$I_{t,n} = b_0 + b_1 I_{t-1,n} + b_2 \pi_{t-1,n} + b_3 \pi^2_{t-1,n} + b_4 \theta_{t,n} + b_5 \omega_{t,n} + \varepsilon_{t,n} \quad (13)$$

The second specification is the latter equation with a dummy for sectors in which the profit share is larger than the average of all sectors.[5] This variable is important, because sectors with a larger profit share can have a specific pattern of capital accumulation, since their funds to finance the investment tend to be larger:

$$I_{t,n} = b_0 + b_1 I_{t-1,n} + b_2 \pi_{t-1,n} + b_3 \pi^2_{t-1,n} + b_4 \theta_{t,n} + b_5 \omega_{t,n} + b_6 \text{dummy} + \varepsilon_{t,n} \quad (14)$$

The third specification contains a vector to capture the relation between the wage costs and the profit share represented by $\lambda_{t-1,n}$. Such vector is the ratio between the profit share and the payroll, representing the notion presented by Lima (2004) according which the capital accumulation is a function between income distribution between capitalists and workers. By introducing the term $\lambda_{t-1,n}$ squared, it is possible capture the non-linearity relation describe by Lima (2004). Moreover, the advantage of this specification is the lower number of variables and the removal of a source of collinearity between the labour costs and the profit share, which means an efficiency gain:

$$I_{t,n} = b_0 + b_1 I_{t-1,n} + b_2 \lambda_{t-1,n} + b_3 \lambda^2_{t-1,n} + b_4 \theta_{t,n} + \varepsilon_{t,n} \quad (15)$$

The fourth specification is equation (15) with a dummy for sectors in which the profit share is larger than the average of all sectors:

$$I_{t,n} = b_0 + b_1 I_{t-1,n} + b_2 \lambda_{t-1,n} + b_3 \lambda^2_{t-1,n} + b_4 \theta_{t,n} + b_5 \text{dummy} + \varepsilon_{t,n} \quad (16)$$

In empirical terms, there are two problems in the specifications: the endogeneity between the investment and the profit share/income distribution and the serial correlation caused by the introduction of lagged independent variables as explanatory variables. To solve these problems, the study adopted the methodology of Arellano and Bond's GMM estimator.

4.2- PVAR Estimations

By using PVAR, the empirical strategy consists on estimating one model to all sectors with two lags according the criteriums of information. It is estimated only one specification with the variables: sectorial investment, real exchange rate, non-linear ratio between the profit share and the payroll and the degree of utilizing capacity[6]. The degree of utilizing capacity is an important determinant of capital accumulation. However, this variable is introduced just in the PVAR estimations. The reason for this is the strong correlation between the degree of utilizing capacity and the others explanatory variables, which can cause a kind of bias and enlarger the variance of errors in the estimations using Arellano-Bond GMM estimator. It should be noted that this is not a problem for the PVAR estimations because just the impulse response function (IRF) will be analyzed.

Introduced by Holtz-Eakin, Newey and Rosen (1988), the panel of autoregressive vectors (PVAR) is originated from the original VAR model developed by Sims (1980). The idea is that the variables are endogenous and interrelated, as the original model, but the PVAR considers the cross-sectional correlation and the dynamics over time, as an econometric panel. These characteristics mean that this methodology take into account the heterogeneity cross section, which enforces a specific structure to covariance matrix

[5] This vector's mean values equal one in sectors in which the profit share is larger than the average profit share and zero in sectors in which the profit share is smaller.

[6] We chose don't split the database according the intensity of technological innovation in the PVAR estimations because the integration between the sectors can change the results of IRF.

(Canova and Cicarelli, 2013). We estimated a PVAR model according Abrigo and Love (2016), with a fixed effect structure, as follow:

$$y_{i,t} = y_{i,t-1}A_1 + y_{i,t-2}A_2 + \cdots + y_{i,t-p+1}A_{p-1} + y_{i,t-p}A_p + x_{i,t}B + u_i + e_{i,t} \quad (17)$$

where $y_{i,t}$ is a vector (1xk) of dependent variables, $x_{i,t}$ is a vector (1xL) of exogenous variables, u_i is the fixed effect, $e_{i,t}$ the idiosyncratic errors, A and B are the estimated parameters. In relation to the errors, it is assumed that $E[e_{i,t}] = 0$, $E[e'_{i,t}\, e_{i,t}] = \Sigma$ e $E[e'_{i,t}\, e_{i,s}] = 0 \; \forall \; t>s$. Re-writing the equation (1) as $y^*_{i,t} = \overline{y^*_{i,t}}A + e^*_{i,t}$, where $y^*_{i,t}$ is the first difference $y^*_{i,t} = y_{i,t} - y_{i,t-1}$ and $\overline{y^*_{i,t}} = (y_{i,t} - y_{i,t-1}) + \cdots + (y_{k,t} - y_{k,t-1})$, the error therm is $e^*_{i,t} = (y^*_{i,t} - \overline{\overline{y^*_{i,t}}})\sqrt{T_{i,t}/(T_{i,t}+1)}$, $\overline{\overline{y^*_{i,t}}}$ is the average of $y^*_{i,t}$. Thus, the GMM estimator is:

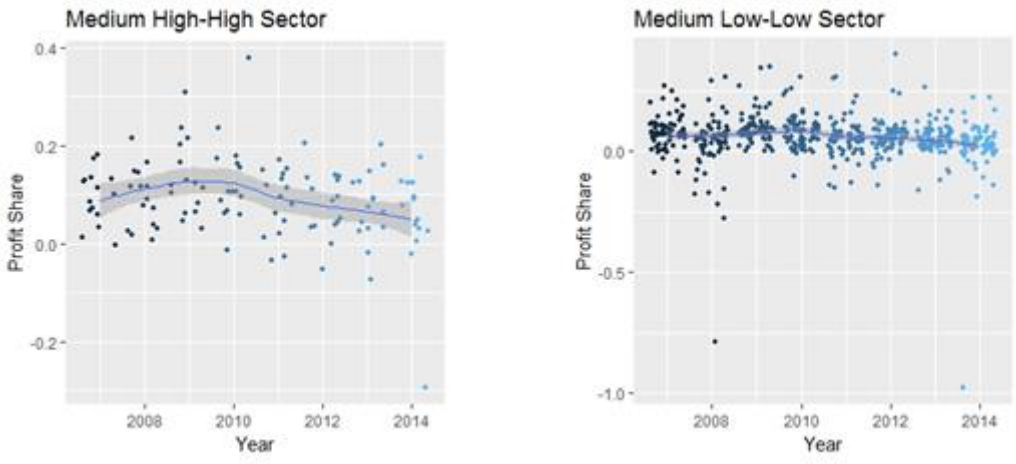
$$\mathrm{A} = (\bar{y}^{*\prime}\mathrm{Z}\widehat{W}\mathrm{Z}'\bar{y}^{*})^{-1}(\bar{y}^{*\prime}\mathrm{Z}\widehat{W}\mathrm{Z}'\bar{y}^{*}) \quad (18)$$

where $\widehat{W}$ is a matrix of weight (LxL) non-singular, which increases the efficiency. In the next section, it discussed the database.

5- The Database

The variables utilized in this work are described in Table A1 (Appendix A). The database is yearly, between 2007 and 2014. The sectors correspond to CNAE 2.0. The proxy for profit share is computed from the available data of the IBGE-PIA.[7] The computation procedure takes the difference between the total revenue and the total costs for each sector, dividing this result by the sum of the aggregated value of all sectors. Using the same database, the wage share in the costs is calculated by dividing the total sum of the payroll of each sector's companies by the total costs. The sectorial investment is taken from the IBGE-PIA data too. The real exchange rate of each sector is calculated by the IPEA considering 23 countries and 2010 as the base year[8] (2010=100). The variable rate of capacity utilization is obtained from the National Confederation of Industry.[9] The dynamics of each variable is presented in the graphs below.

Graph 1 – Profit Share

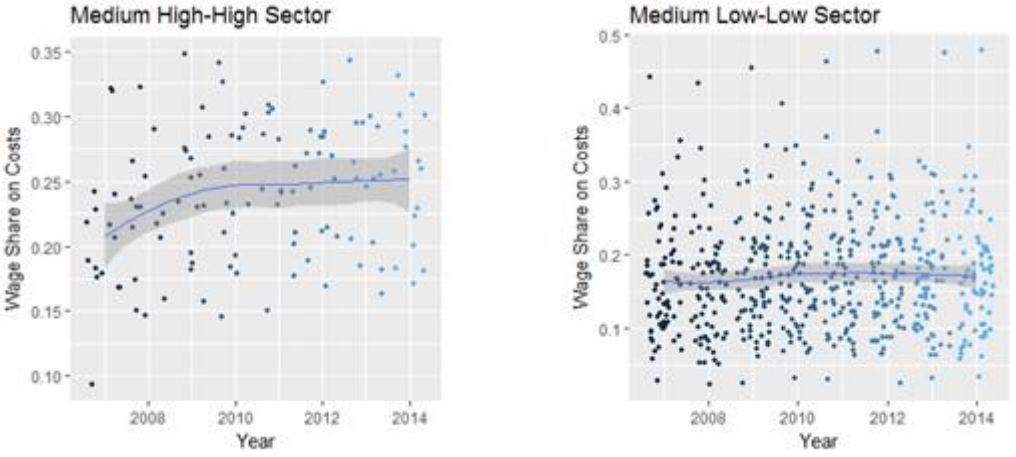


[7] See www.ibge.gov.br/home/estatistica/economia/industria/pia/empresas/defaultempresa.shtm (accessed 1 July, 1, 2017).

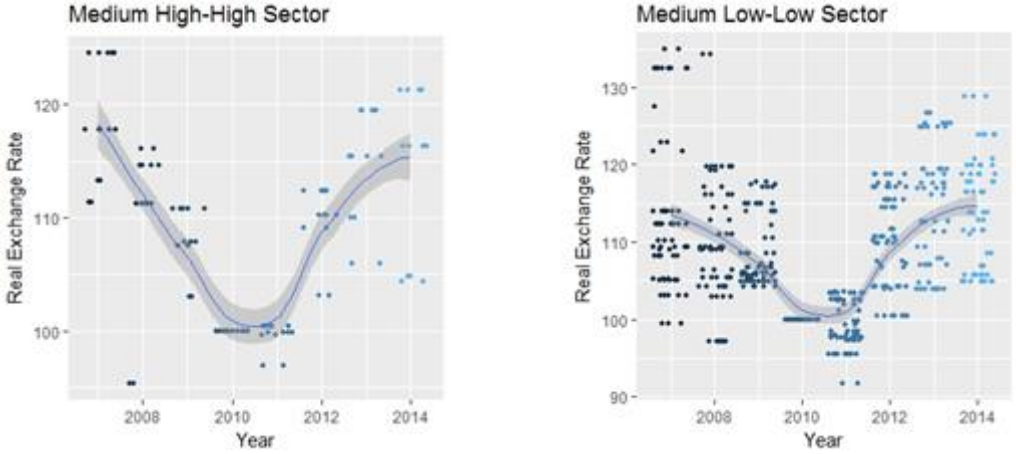
[8] See www.ipeadata.gov.br/Default.aspx (accessed July,1, 2017).

[9] See www.portaldaindustria.com.br/cni/ (accessed July, 1, 2017).

Graph 2 – Wage Share of Costs



Graph 3 – Real Exchange Rate



Graph 4 – Investment

Graph 5 – Occupied Industrial Capacity

Analyzing the graphs, it is possible realize the existence of different patterns for all variable according the innovation intensity.

6- Empirical Results

6.1- Panel Results

The regressions of the first specification are presented in Table 3.[10] The results (with or without the dummy for the sector with a larger profit share) suggest that only the parameters of the linear version of the profit share and wage share of costs are statistically significant when considering all sectors at the 1% critical level. The signals of these variables are negative and positive, respectively. The results for the sectors with medium-low and low innovation intensity show that the parameter of the linear profit share is negative and significant at the 1% critical level. The variable wage share of costs is positive and significant at the 1% critical level. The other variables are not significant with the exception of lagged investment, which is significant without the dummy but non-significant with its introduction. In relation to the sectors with medium-high and high intensity of innovation, the regressions show that the linear profit share is positive and statistically significant at the 10% critical level. The variable real exchange rate is positive and significant at the 10% critical level.

The results of the first specification suggest that the non-linear profit share is not significant for the three groups of sectors as well as the dummy for the sectors in which the profit share is larger than average. Though the linear profit share is significant for the three groups of sectors, the signal is negative for all sectors and the medium-low and low sectors, which suggests that these sectors have wage-led properties. In turn, such signal is positive for medium-high and high sectors, pointing that these sectors have profit-led

[10]One of the assumptions of the instrumental variable is the absence of correlation between the instruments and the independent variable. The Sargan or Hansen test (when the robust variance–covariance matrix is used) has the null hypothesis that the instruments are exogenous. The Hansen test suggests the acceptance of the null hypothesis of all the regressions. In turn, the Arellano–Bond test for autocorrelation has the null hypothesis that the error does not follow an AR (1) or AR (2) process. However, it is usual for the Arellano–Bond test to reject the null hypothesis of autocorrelation of order (1), because the term e_{nt} is present in $\Delta e_{m,t-1}$and in $\Delta e_{m,t-2}$. The Arellano–Bond test for AR (2) is more important for detecting autocorrelation. In the regressions, the Arellano–Bond test accepts the null hypothesis of AR (1) and AR (2) autocorrelation of errors.

properties. That is, an income distribution police in favor of workers or capitalists has different effects according the intensity of innovation.

The variable real exchange rate is significant and positive only for the sectors with medium-high and high innovation intensity, which means that real devaluation of the exchange rate increases investment in sector more intensive in technology. Such result is attuned to theoretical literature since those sectors are profit-led. In another hand, the statically significance of wage share of costs and the positive signal for all sectors and medium-low and low innovation intensity entails that investment of these sectors respond positively to increases in costs with labour, as pointed by Lima (2004).

Table 3 – First and Second Specifications

Variable	ALL Sectors		MLL Sectors		MHH Sectors	
	Without Dummy	With Dummy	Without Dummy	With Dummy	Without Dummy	With Dummy
Profit Share	-2.47*** [0.01]	-3.26*** [0.01]	-2.05*** [0.00]	-3.12*** [0.00]	9.13* [0.07]	9.35* [0.07]
Profit Share Non-linear	1.09 [0.54]	-0.32 [0.89]	1.46 [0.21]	-0.19 [0.89]	-12.40 [0.22]	-12.77 [0.23]
Dummy for Larger Profit Share		-0.23 [0.46]		-0.35 [0.20]		0.30 [0.20]
Wage Share of Costs	16.50*** [0.00]	17.72*** [0.00]	20.13*** [0.00]	22.95*** [0.00]	5.24 [0.13]	3.81 [0.29]
Lagged Investment	0.36 [0.14]	0.22 [0.50]	0.39** [0.04]	0.23 [0.35]	-0.23 [0.22]	-0.23 [0.23]
Real Exchange Rate	-0.007 [0.24]	-0.009 [0.15]	-0.006 [0.25]	-0.008 [0.16]	0.03* [0.06]	0.02* [0.08]
Wald Test	13.67 [0.01]	14.19 [0.02]	17.11 [0.00]	15.18 [0.01]	38.25 [0.00]	26.69 [0.00]
Arellano–Bond Test for AR (1)	-1.82 [0.06]	-1.73 [0.08]	-1.80 [0.07]	-2.01 [0.98]	-1.11 [0.26]	-1.15 [0.25]
Arellano–Bond Test for AR (2)	-0.40 [0.69]	-0.68 [0.49]	-0.50 [0.61]	-0.8 [0.42]	-1.66 [0.09]	1.51 [0.13]
Sargan Test	1.04 [1.00]	0.74 [1.00]	3.36 [0.97]	2.30 [0.98]	11.60 [0.31]	11.10 [0.27]
Hansen Test	2.69 [0.98]	1.47 [0.99]	5.86 [0.82]	4.34 [0.88]	12.76 [0.23]	10.79 [0.29]

Source: Author's estimations. *Notes*: The p-value is between brackets. * Significant at 10%; ** significant at 5%; and *** significant at 1%. The robust matrix of variance–covariance is used.

The advantage of the second specification is the smaller number of explanatory variables and the lesser degree of collinearity, since there is a correlation between the profit share (linear and non-linear) and the wage share of costs. For this reason, the efficiency of the second estimation tends to be greater when compared with the first model. In turn, a smaller error variance reduces the probability of type II errors. Beyond that, the correlation between one explanatory variable and one instrument may create bias in the specification. The estimations of the second specification are presented in Table 4. The econometric testes indicated that the regressions fit well.[11]

[11] The Hansen test suggests non-rejection of the null hypothesis that the instruments are exogenous, and the Arellano–Bond test indicates the non-existence of autocorrelation of order (2) for all the regressions.

The results of the regressions considering all the sectors (without the dummy) show that the linear version of the ratio between the profit share and the payroll share of costs is significant at the 1% critical value and negative, while the non-linear vector is positive and significant at the 5% critical value. By introducing the dummy for the sectors with a larger profit share, the results changed. The linear version of the ratio between the profit share and the payroll share of costs is not significant, but the non-linear vector is statistically significant at the 5% critical level and positive. The dummy, in turn, is significant at the 1% critical level and positive. Meanwhile, the parameter of the real exchange rate is positive and significant at the 10% critical level.

The regressions for the sectors with medium-low and low innovation intensity (without the dummy) indicate that the linear version of the ratio between the profit share and the payroll share of costs is significant at the 5% critical level and negative, while the non-linear version is significant at the 1% critical level and positive. The real exchange rate is positive and significant at the 1% critical level. When the dummy for the sectors with a larger profit share is introduced, the linear version of the ratio between the profit share and the payroll share of costs is not significant. However, the non-linear vector remains unchanged (positive and significant). The variable dummy for sectors with a greater profit share is positive and statistically significant, just like the real exchange rate.

With respect to the estimations for the sectors of medium-high and high intensity of innovation (with or without the dummy), both linear and non-linear parameters of the ratio between the profit share and the payroll on costs are significant and, respectively, positive and negative. The dummy for larger profit share is statically significant at 10% level and positive. By introducing it, the already results obtained kept unchanged, but the real exchange rate becomes significant at the 1% level and positive.

Table 4 – Second and Third Specifications

Variable	ALL Sectors		MLL Sectors		MHH Sectors	
	Without Dummy	With Dummy	Without Dummy	With Dummy	Without Dummy	With Dummy
Ratio between Profit Share and Payroll	-5.13*** [0.00]	3.16 [0.14]	-3.40** [0.05]	4.05 [0.11]	27.93*** [0.01]	51.33*** [0.00]
Ratio between Profit Share and Payroll Non-linear	99.96** [0.02]	41.63* [0.07]	84.58*** [0.00]	51.71** [0.02]	-166.38** [0.04]	-307.23*** [0.00]
Dummy for Larger Profit Share		0.35*** [0.00]		0.36*** [0.00]		0.51* [0.06]
Lagged Investment	0.66 [0.05]	0.09 [0.80]	0.44 [0.12]	0.14 [0.74]	0.07 [0.73]	-0.37 [0.10]
Real Exchange Rate	0.009 [0.11]	0.01* [0.07]	0.17*** [0.01]	0.01* [0.08]	0.005 [0.36]	0.21*** [0.01]
Wald Test	53.66 [0.00]	25.42 [0.00]	52.76 [0.00]	28.94 [0.00]	35.05 [0.00]	122.58 [0.00]
Arellano–Bond Test for AR (1)	-2.53 [0.01]	-1.25 [0.21]	-2.24 [0.02]	-1.19 [0.23]	-1.86 [0.06]	-1.59 [0.11]
Arellano–Bond Test for AR (2)	1.07 [0.28]	0.01 [0.99]	0.57 [0.56]	0.03 [0.97]	0.62 [0.53]	-1.30 [0.19]
Sargan Test	1.36	8.02 [0.62]	2.52 [0.96]	9.11 [0.52]	3.91 [0.86]	15.11 [0.12]

	[0.99]					
Hansen Test	4.95 [0.76]	4.84 [0.90]	4.42 [0.81]	8.70 [0.56]	10.73 [0.21]	12.16 [0.27]

Source: Author's estimations. *Notes*: The p-value is between brackets. * Significant at 10%; ** significant at 5%; and *** significant at 1%. The robust matrix of variance–covariance is used.

The estimations of the second specification show that the sectors in which the profit share is larger than average have higher levels of capital accumulation, indicating that these sectors own more funds to finance investments. More than that, by introducing such dummy variable the magnitude and significance of real exchange rate parameter changed in the three cases: i- it became significant and positive for all sectors; ii- it reduced from 0.17 (statistically significant at 1%) to 0.01 (statistically significant at 10%) for sectors with low and medium-low intensity of innovation; iii- such parameter became positive and around 0.21 for sectors with high and medium-high intensity of innovation. Such results suggest that the real exchange rate – given its relation with sectorial profit share – influences capital accumulation via profitability so that the effects of devaluations are stronger in sectors more intensive in technology.

The results also confirmed the non-linear relation between income distribution and investment. Nonetheless, the curve that describes this relation differs across the sectors. Whilst the shape of the curve for the Brazilian economy (all sectors) and the sectors with medium-low and low innovation intensity is convex, the curve for the sectors with medium-high and high innovation intensity is concave.

The different patterns of the curve that describes the relation between capital accumulation and profit share are suggestive of unlike sectorial behaviors in relation to investment and income distribution. Lima's (2004) hypothesis is valid for the sectors with medium-high and high innovation intensity. That is, these sectors have high (low) investment when the ratio between the profit share and the wage share of costs is low (high). Considering that capital accumulation is endogenous in relation to income distribution, the entrepreneurs of these sectors increase the investment when the wage share of costs increases. However, though the non-linearity is valid, the results confirm that Lima's (2004) hypothesis is not valid for the Brazilian economy (all sectors) and for the sectors with medium-low and low innovation intensity. That is, these sectors have high (low) investment when the ratio between the profit share and the wage share of costs is high (low). This means that the entrepreneurs of these sectors increase the capital accumulation when the wage share of costs decreases.

6.2- PVAR Results

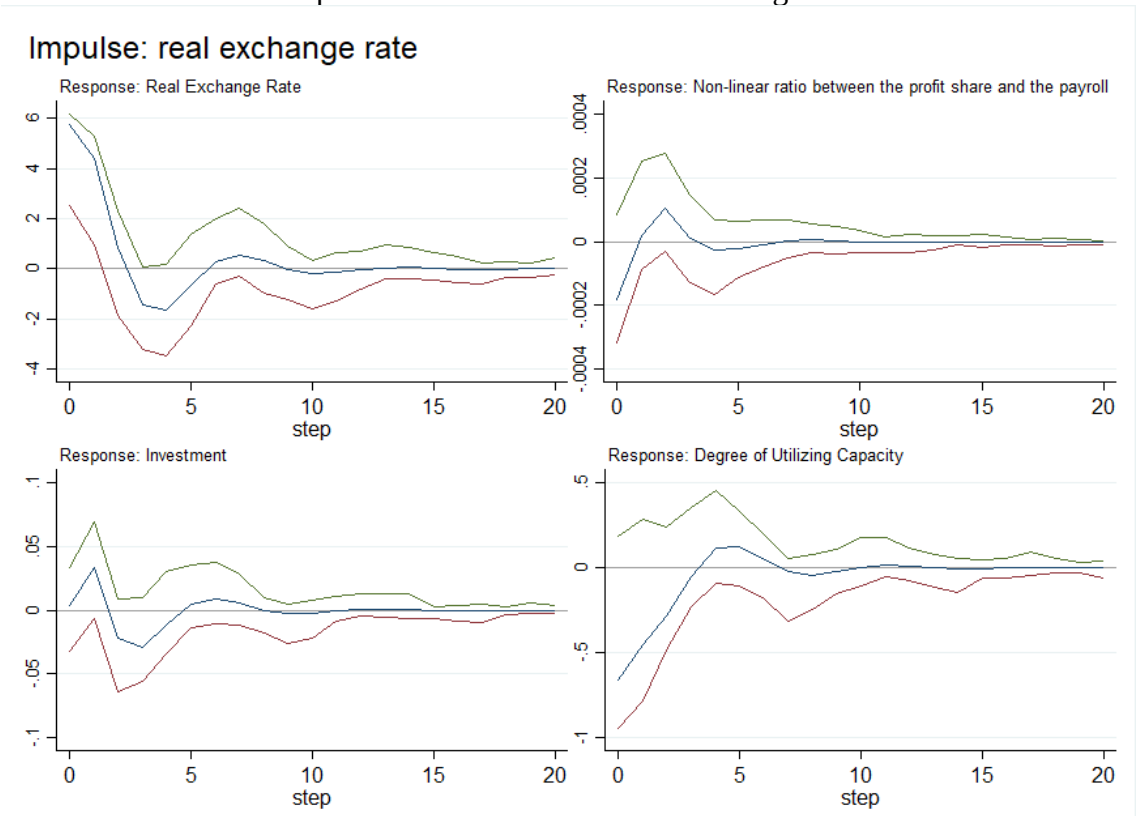
The impulse response function (IRF) is presented in the Graphs 6[12]. The Graph 6 illustrates how the PVAR system reacts to one positive shock[13] in the real exchange rate (exchange devaluation). The IRF shows that an exchange devaluation increases the ratio between the profit share and the payroll (i.e. promotes a redistribution of income in favor of capitalists), which means that the profit share increases or that payroll decreases. In both cases the accumulated earnings of capitalists increases, which leads to greater own funds and, hence, boosting the capital accumulation. It should be noted that, during this dynamic, the degree of utilizing capacity has upward dynamic from the fourth year

[12] It is presented just the IRF from a shock in the real exchange rate because this is the focus of this paper. There is no necessity to discuss the other IRF focusing in a shock in income distribution, investment or in the degree of utilizing capacity.

[13] Shock of one standard deviation.

onward. This finding is in line with the results of the estimations for the second specification to Brazilian economy (all sectors) that increases in profit share (or decreases in costs with labour) decreases the investment, demonstrating robustness of our regressions.[14]

Graph 6- IRF: A Shock in Real Exchange Rate



Source: Authors estimations using the package to Stata developed by Abrigo and Love (2016). *Notes*: We used two lags to estimates the PVAR and 200 replications of Monte Carlo to construct the confidence interval of bootstrap.

Conclusions

This paper examined the relation between income distribution, the real exchange rate and capital accumulation in the Brazilian economy using a sectorially disaggregated database for the period 2007-2014. It estimated two specifications using the GMM methodology of Arellano and Bond to handle the endogeneity between the profit share and investment. The first specification rejected the hypothesis of a non-linear relationship between income distribution and capital accumulation. Furthermore, the results also pointed that Brazilian economy (all sectors) and the medium-low and low sectors are wage-led, whereas the medium-high and high sectors are profit-led. In turn, the variable real exchange rate is significant and positive only for the sectors with medium-high and high innovation intensity, which means that real devaluation of the exchange rate increases investment in more technology-intensive sectors.

However, the results of the first specification are not fully trustworthy, because (i) the correlation between the instruments and the explanatory variables enlarges the error variance (collinearity), which increases the probability of a type II error and (ii) it can

[14] Nonetheless, it should be highlighted that the zero is contained in the confidence interval of IRF in a manner that there is the possibility that IRF are statistically non-significant, rigorously.

generate some kind of bias. To solve this problem, the authors created a vector to depict the income distribution, represented by the ratio between the profit share and the payroll share of costs. Under this specification, Lima's (2004) hypothesis of non-linearity has proven to be valid.

Nonetheless, the curve that describes the relation between income distribution and investment has a distinct pattern for different sectors according to the intensity of innovation. The estimations showed that this relation has a convex curve for the Brazilian economy (all sectors) and sectors with medium-low and low innovation intensity while it is concave for the sectors with medium-high and high innovation intensity. These results mean that the sectors with medium-low and low innovation intensity have high (low) investment when the ratio between the profit share and the wage share of costs is high (low), while the sectors with medium-high and high intensity have high (low) investment when the ratio between the profit share and the wage share of costs is low (high). The results of the second specification indicated that sectors with a larger profit share than average have more own funds to finance capital accumulation; hence, investment is larger. Such results suggest that the real exchange rate – given its relation with sectorial profit share – influences capital accumulation via profitability so that the effects of devaluations are stronger in sectors more intensive in technology. On this line, the PVAR results suggested that the transmission channel from exchange devaluation to capital accumulation occurs through income distribution; that is, exchange devaluation increases the profit share (or decreases the payroll share of costs), boosting the available funds to finance investment.

References

Abrigo, R. M. M, Love, I. Estimation of panel vector autoregression in Stata. Stata Journal. Vol. 16, nº3, p. 778-804, 2016.

Amadeo, E. J. "Notes on capacity utilization, distribution and accumulation", *Contributions to Political Economy*, Vol. 5, p. 83–94, 1986a.

Amadeo, E. J. "The role of capacity utilization in long period analysis", *Political Economy*, Vol. 2, p. 147–160, 1986b.

Amadeo, E. J. "Expectation in a steady-state model of capacity utilization", *Political Economy*, Vol. 3, p. 75–89, 1987.

Araújo, E. Gala, P. Regimes de Crescimento econômico no Brasil: evidências empíricas e implicações de política. Estudos Avançados, v. 26, n. 75, p. 41-56, 2012.

Araújo. E. Peres, S. Exchange Rate Policy, Productive Structure and Economic Growth: Theoretical and Empirical Evidence for Brazil in the 1996-2012 period. Análise Econômica, v. 36, n. 39, p. 67-107, 2018.

Avritzer, J. Freitas, F. Braga, J. Crescimento e a Distribuição Funcional da Renda no Brasil Entre 1952 e 2011. In: Encontro Nacional de Economia, 2015, Florianópolis. Anais do 43º Encontro Nacional de Economia, 2015.

Bahmani-Oskooee, M. & Hajille, M. “On the relation between currency depreciation and domestic investment”, Journal of Post Keynesian Economics, v. 32, n. 4, p. 645-660, 2010.

Baltar, C. Hiratuka, C. Lima, G. Real exchange rate and investment in the Brazilian manufacturing industry. Journal of Economic Studies, v. 43, p. 1-34, 2016.

Barbosa-Filho, N. “Exchange rates, growth and inflation”, paper presented in the Annual Conference on Development and Change, Brazil, 2006.

Bhaduri, A. and Marglin, S. “Unemployment and the real wage: the economic basis for contesting political ideologies”, *Cambridge Journal of Economics*, Vol. 14, pp. 375–393, 1990.

Bresser-Pereira, L. “A Taxa de Câmbio no Centro da Teoria do Desenvolvimento”, *Estudos Avançados*, Vol. 26, Number 75, 2012.

Blecker, R. “The Economic Consequences of Dollar Appreciation for US Manufacturing Investment: A Time Series Analysis”. International Review of Applied Economics, Number 21, Volume 4, Pages 491-517, 2007.

Canova, F. and Ciccarelli, M. “Panel vector autoregressive models: a survey”, Working Paper Series 1507, European Central Bank, 2013.

Dutt, A.K. “Stagnation, income distribution and monopoly power”, *Cambridge Journal of Economics*, Vol. 8, pp. 25–40, 1984.

Dutt, A.K. “Alternative closures again: a comment on growth, distribution and inflation”, *Cambridge Journal of Economics*, Vol. 11, pp. 75–82, 1987.

Dutt, A.K. Growth, Distribution and Uneven Development. Cambridge, Cambridge University Press, 1990.

Feijo, C. A. Câmara, F. F. Cerqueira, F. L. Inflation, growth, and distribution: The Brazilian economy after the post war. Journal of Post Keynesian Economics. Volume 38. Number 4, Pages 616-636, 2015.

Feijo, C. A. Lamonica, T. M. Bastos, A, C, J. Accumulation pattern of the Brazilian economy in the 1990’s and 2000’s. International Review of Applied Economics, v. 29, n. 1, p. 15–31, 2015.

Frenkel, R. and Taylor, L. “Real exchange rate, monetary policy and employment”, DESA Working Paper Number 19, 2006.

Gala, P. “Real exchange rate levels and economic development: theoretical analysis and empirical evidence”, in *Proceedings of 35th Brazilian Economics Meeting*, 2007.

Gala, P. and Libânio, G. “Taxa de Câmbio, Poupança e Produtividade: Impactos de Curto e Longo Prazo”, *Economia e Sociedade*, Vol. 20 No. 2, pp. 229–242, 2011.

Galindo-Rueda, F. and Verger, F. “OECD taxonomy of economic activities based on R&D intensity”, OECD Science, Technology and Industry Working Papers, 2016/04, OECD Publishing, Paris, 2016.

Hein, E. *Distribution and Growth after Keynes: A Post-Keynesian Guide*, Edward Elgar Publishing Limited, MA, USA, 2014.

Hein, E. The Bhaduri/Marglin post-Kaleckian model in the history of distribution and growth theories – an assessment by means of model closures. Working Paper, Nº. 66/2016, Institute for International Political Economy Berlin, 2016.

Jesus, C. Araujo, A. R. Drumond, C. E. An Empirical test of Post-Keynesian growth model applied to functional income distribution and the growth regime in Brazil. International Review of Applied Economics, v. 31, p. 1-22, 2017.

Kalecki, M. *Theory of Economic Dynamics*, Allen & Unwin, London, 1954.

Kurz, H.D. “Technical change, growth and distribution: a steady-state approach to unsteady growth”, in Kurz, H.D. (Ed.), *Capital, Distribution and Effective Demand*, Cambridge: Polity Press, 1990.

Lavoie, M. *Post-Keynesian Economics: New Foundations*, Edward Elgar Publishing Limited, MA, USA, 2014.

Lima, G. T. “Endogenous technological innovation, capital accumulation and distributional dynamics”, *Metroeconomica*, Vol. 55 No. 4, pp. 386–408, 2004.

Marconi, N. Rocha, M. Exchange rate, foreign trade and early deindustrialisation – the case of Brazil. Economia e Sociedade, v. 21 (Special Issue), p. 853-888, 2012.

Marglin, S. A. Growth, Distribution and Prices, Cambridge, MA: Harvard University Press, 1984a.

Marglin, S. A. ‘Growth, distribution and inflation: a centennial synthesis’, Cambridge Journal of Economics, 8, 115-144, 1984b.

Missio, F. *Câmbio e Crescimento na Abordagem Keynesiana Estruturalista*. PhD Thesis. UFMG, CEDEPLAR, 2012.

Missio, F. Jayme Junior, F. Britto, G. Oreiro, J. Real Exchange Rate and Economic Growth: New Empirical Evidence. Metroeconomica, v. 66, p. 686-714, 2015.

Missio, F. Jayme Junior, F. Barbosa, L. Iasco-Pereira, H. (2018). Política cambial, produtividade e crescimento sustentado no Brasil pós crise. *Brazilian Keynesian Review*. Dossiê V da AKB, 2018. See https://associacaokeynesianabrasileira.org/2018/07/18/dossie-v-da-akb-o-brasil-pos-recessao-das-origens-da-crise-as-perspectivas-e-desafios-futuros/

Morrone. H. Do demand and profitability stimulate capital accumulation? An analysis for Brazil. Cepal Review, n. 116, p. 159-170, 2015.

Rapetti, M, Skott, P. & Razmi, A. The real exchange rate and economic growth: Are developing countries different?, International Review of Applied Economics, Volume 26, Number 6, Pages 735-753, 2012.

Ribeiro, R. S. M.; McCombie, J. S. L. ; Lima, G. T. Exchange rate, income distribution and technical change in a balance-of-payments constrained growth model. Review of Political Economy, v. 28, p. 545-565, 2016.

Rodrik, D. The Real Exchange Rate and Economic Growth. Brookings Papers on Economic Activity, Fall, 2008.

Rowthorn, R.E. "Demand, real wages and economic growth", *Thames Papers in Political Economy*, Autumn, pp. 1–39, 1981.

Sims, C.A. "Macroeconomics and reality", *Econometrica*, Vol. 48, pp. 1–48, 1980.

Steindl, J. "Stagnation theory and stagnation policy", *Cambridge Journal of Economics*, Vol. 3, pp. 1–14, 1979.

Taylor, L. "A stagnationist model of economic growth", *Cambridge Journal of Economics*, Vol. 9, pp. 383–403, 1975.

Tomio, T. B. Understanding the Brazilian demand regime: A Kaleckian Approach. Working Paper, Institute for International Political Economy Berlin, Number 73/2016, 2016.

Oreiro, J. Punzo, L. Araújo, E. Squeff, G. Taxa real de câmbio, desalinhamento cambial e crescimento econômico no Brasil (1994-2007). *Revista de Economia Política*, *v.* 31, n. 4, p. 551-562., 2011.

Oreiro, J. Araújo, E. Exchange Rate Misalignment, Capital Accumulation and Income Distribution: Theory and Evidence from the Case of Brazil. *Panaeconomicus*. Number 3 (Special Issue), p. 381-396, 2013.

Vaz, P. H. Baer, W. "Real Exchange Rate and Manufacturing Growth in Latin America", Latin American Economic Review, Volume 23, Number 2, Pages 1-17, 2014.

Verdoorn. P.J. "Fattori che regolano lo sviluppo della produttività del lavoro", *L'industria*, Vol. 1, pp. 3–10, 1949.

Appendix A

Table A1 – List of Variables – Description and Source

Variable	Description	Source
$\pi_{t,n}$ Profit Share	Difference between the total revenue and the total costs for each sector divided by the sum of the aggregated value of all sectors	Made by the authors using the data from the IBGE (PIA)
$\lambda_{t,n}$ Ratio between Profit Share and Payroll	Ratio between the profit share and the payroll	Made by the authors using the data from the IBGE (PIA)

$\omega_{t,n}$ Wage Share of Costs	The share of labour costs in the total costs	Made by the authors using the data from the IBGE (PIA)
$\theta_{t,n}$ Real Exchange Rate	Weighted average of the bilateral real exchange rate for 23 selected countries for each sector (2010 average = 100)	IPEA: Institute of Research of Applied Economics
$I_{t,n}$ Investment	Logarithm of the value of capital acquisition for each sector	IBGE (PIA): Brazilian Institute of Geography and Statistics
$u_{t,n}$ Degree of Capacity Utilization	Index that represents the level of occupied industrial capacity (average of quarterly data to each year and sector)	NIC: National Industry Confederacy

Source: the authors