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ESSAYS ON AGGREGATE DEMAND, PRODUCTIVITY AND EXCHANGE RATE

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Douglas Alcantara Alencar

ESSAYS ON AGGREGATE DEMAND, PRODUCTIVITY AND EXCHANGE RATE

This dissertation is submitted to the Graduate Program in Economics of the Center for Development and Regional Planning (Cedeplar) of Federal University of Minas Gerais as partial requirement for the degree of PhD in Economics.

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Co-supervisor: Professor Gustavo de Britto Rocha

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CONTENTS

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RESUMO

O objetivo dessa tese é analisar, sob a perspectiva Pós-Kaleckiana, a interação entre taxa de câmbio real, produtividade e regime de demanda agregada, no Brasil entre 1960 e 2011. O ponto de partida é o de que a acumulação de capital e o crescimento econômico são liderados pela demanda. A pesquisa compreende os seguintes passos: i) uma avaliação crítica da literatura sobre regimes de crescimento, com ênfase particular em questões relacionadas à produtividade e e modelos Pós-Kaleckianos; ii) entender a relação entre a taxa de câmbio real, produtividade e os regimes de crescimento; iii) propor três modelos teóricos que relacionem a taxa de câmbio real, a produtividade e o regime de crescimento; iv) melhorar o modelo com base na revisão da literatura; v) interpretando os resultados estatísticos à luz da abordagem Pós-Kaleckiana para uma amostra de países da América Latina. No campo teórico, o estudo desenvolve um modelo que mostra as interações entre demanda agregada, taxa de câmbio real, produtividade e salários reais. Além disso, há uma falta de estudos teóricos e empíricos sobre a relação entre a demanda agregada, a taxa de câmbio real, a produtividade e os salários reais, que essa pesquisa tenta cobrir.

Palavras-chave: Teoria Pós-kaleckiana, demanda agregada, taxa de câmbio real, produtividade, salários reais.

ABSTRACT

This dissertation analyses, from a Post-Kaleckian perspective, the interactions among aggregate demand, the real exchange rate, productivity and real wages in the Brazilian economy, from 1960 to 2011. It does so from the longstanding perspective that demand is the driver of capital accumulation and economic growth. The research comprises the following steps: i) A critical assessment of the growth regimes literature, with a particular emphasis on issues related to productivity and the real exchange rate; ii) Understanding the relationship between the real exchange rate, productivity and growth regimes; iii) Proposing a theoretical model that relates the real exchange rate, productivity and the growth regime; iv) Improving the model based on the literature review; v) An empirical test of the interaction between the real exchange rate, productivity and the growth regime; vi) Interpreting the statistical results in light of the post-Keynesian framework for a sample of Latin American countries; vii) Analysing the implications for macroeconomic policies. The next step consists in carrying out empirical exercises. In the theoretical field, the study develops a model which shows the interactions between aggregate demand, the real exchange rate, productivity and real wages. Furthermore, there are, a lack of theoretical and empirical studies about the relationship between aggregate demand, the real exchange rate, productivity and real wages, which we are trying to cover in this research.

Keywords: Post-Keynesian, aggregate demand, real exchange rate, productivity, real wages.

CHAPTER 1: INTRODUCTION

The aim of this dissertation is to discuss the productivity growth theory considering the Post-Kaleckian theory as well as its empirical applications. It follows the work of Bhaduri and Marglin (1990), Naasteped (2006), Hein and Tarassow (2010) and Missio and Jayme Jr (2013). The research on demand regimes and productivity growth has reserved limited space to the role played by the real exchange rate. Missio and Jayme Jr. (2013), Bresser-Pereira (1991, 2006, 2010, 2012), Bresser-Pereira and Gala (2010), Ferrari-Filho and Fonseca (2013) Bresser-Pereira, Oreiro and Marconi. (2012, 2014), amongst others emphasized the impact of the real exchange rate devaluation on productivity. This discussion is important mainly for Latin American countries, specifically Brazil, in which the real exchange rate has been central in economic policy debates. The main question is: does the real exchange rate have a positive or negative impact on productivity growth for Latin American countries and Brazil?

The specific objectives of this research include: i) study the relationship between real wage or employment growth (as a proxy for real wage growth) and productivity growth for Latin American countries; ii) understand the relationship between real exchange rate devaluation and productivity growth; iii) discuss a model that integrates a Post-Kaleckian model with real exchange rates; iv) combine in a Post-Kaleckian framework the variables productivity growth, investment, saving out wages and profits, and real exchange rate; and, finally v) discuss a Post-Kaleckian model that takes under consideration aspects of the Balance of Payment Constrained Growth theory.

The recent literature, for instance Missio and Jayme Jr. (2013), Bresser-Pereira (1991, 2006, 2010, 2012), Bresser-Pereira and Gala (2010), Ferrari-Filho and Fonseca (2013) Bresser-Pereira, Oreiro and Marconi (2012, 2014), recommends to raise labour productivity through devaluation of the real exchange rate, since this mechanism increases inflation (caused by the devaluation of real exchange rate), and real wages would fall in the short term, assuming sticky nominal wages, which would raise profits and consequently, the profit share. By raising profit share, firms would increase the P&D investment, then productivity. This strategy considers, a priori, that the demand regime is profit-led. However, as pointed out by Bhaduri and Marglin (1990), Foley and Michl (1999), Naastepad (2006), Storm and Naastepad (2007, 2012) among others, demand regimes can be either profit or wage-led, which is essentially an empirical question. In a wage-led demand regime, a real devaluation of the exchange rate can reduce aggregate demand, which negatively impacts capital accumulation and reduces productivity by reducing real wages (Naastepad 2006, Hein and Tarassow 2010, and Hein 2014). Therefore, the recent literature does not take into account that real exchange rate devaluation, if a Post-Kaleckian model is considered, it can have a negative impact on productivity growth. Moreover, the Post-Kaleckian literature that considers productivity growth does not explore the impact of real exchange rate variation on productivity growth, in addition, there are no studies of Post-Kaleckian model with productivity applied to Latin American countries.

The main contributions of this research are: i) in the theoretical field, the study develops three models which shows the interactions between aggregate demand, the real exchange rate, productivity and real wages; and ii) in the empirical field, it tests empirically, for some Latin American countries and Brazil, the relationship between aggregate demand, the real exchange rate, productivity and real wages.

This research follows the Post-Kaleckian approach, in the sense that the capital accumulation and economic growth are driven by the growth of demand (Setterfield, 2003; Sawyer, 2012). This central tenet does not, however, rule out the importance of supply side factors to economic growth. This work incorporates productivity growth, through the Kaldor-Verdoorn effect, to analyse its interaction with the real exchange rate and real wages (Kaldor, 1966; Naastepad, 2006; Naastepad; Storm, 2007; Storm; Naastepad, 2012). It does so for the Brazilian economy, between 1960 and 2011, as well as for a sample of Latin American Countries.

There are theoretical relationships between aggregate demand, real exchange rate, productivity and real wages. The novelty of this research is to argue that under an aggregate wage-led regime, exchange rate devaluations can have a positive impact on productivity growth. On the other hand, if the demand regime is profit-led, exchange rate devaluations can affect productivity and, thus, economic growth, adversely.

As it was argued before in this introduction, the main objective of this research is to study the relationship between productivity growth and real exchange rate devaluation, considering the Post-Kalechian approach. However, due to the Post-Kaleckian framework discuss the impact on productivity growth in the case of real wage growth, it is important to understand this relationship for Latin American countries (object of this work), since the Latin American Structuralist Approach (LASA) has a specific way to look at this relationship (productivity growth and real wage growth). The study of this relationship is made on chapter two. The novelty of chapter two relies on using a Post-Kaleckian standard approach to study Latin American countries and its results confirm the LASA findings that real wage growth or employment growth does not impact positively productivity growth for Latin American countries.

In chapter two, the Post-Kaleckian model as proposed by Bhaduri and Marglin (1990) is presented. This model is discussed and applied for a sample of Latin American countries. The purpose of the chapter is to analyse whether productivity growth is affected by income growth and employment growth in Argentina, Brazil, Bolivia, Chile, Colombia, Mexico, Uruguay and Venezuela.

In the third chapter, the relationship between productivity growth and real exchange rate variation is studied in a simple model based on Hein and Tarassow (2010). As in the Post-Kaleckian framework the role of Kaldor-Verdoorn coeficiente and real wage growth are also considered, these variables are also discussed. In this third chapter a simple model is discussed, in general terms, at the same time, the model discussed in this chapter is more complex than the model discussed in chapter two, in which the contribution to the literature is mostly empirical. In chapter three there are two contributions, one theoretical and other empirical. The novelty of this chapter is the introduction of productivity growth and the real exchange rate as a separate argument in the productivity equation. Moreover, following Hein and Tarassow (2010), the productivity equation is incorporated into the investment equation. With this modification, the real exchange rate devaluation will have an ambiguous impact on economic growth, depending on the parameters and whether the economy regime is wage-led or profit-led. Then, an empirical experiment is undertaken. It consists of estimating the productivity growth equation for the sample of Latin America countries.

In chapter four, the Post-Kaleckian model is applied as presented by Naastepad (2006) The purpose of this chapter four is to analyse the interaction between productivity growth, labour unit cost, real exchange rate and real wages growth for the Brazilian economy, between 1960 and 2011. The time period is limited by the availability of the data.

Chapter five evaluates whether the Brazilian economy operates under a wage-led or profit-led regime between 1960 and 2011, considering a model that integrates features of the Post-Kaleckian and Balance of Payment constrained Growth (BPCG) approaches. To answer this question, a simple model that integrates these two strands of the heterodox literature is introduced. The model suggests that a wage-led regime is more likely, if compared with Naastepad (2006), when Post-Kaleckian and BPGC features are combined. Moreover, for the Brazilian case, a wage-led regime is achieved when a BP constrained growth is taken into consideration. However, the real exchange rate has a positive impact on productivity growth. This result is a novelty in the recent literature about the relationship between real exchange rate and economic growth within a Post-Kaleckian model.

Finally, in chapter six it is discussed the final consideration.

CHAPTER 2: DISTRIBUTION AND PRODUCTIVITY GROWTH: AN EMPIRICAL EXERCISE APPLIED TO SELECTED LATIN AMERICAN COUNTRIES

2.1 Introduction

The effect of income distribution on productivity growth is undoubtedly a question of utmost importance for Latin American countries. Partial answers can be found in research stirred by early models such as the seminal work by Bhaduri and Marglin (1990) and applications such as that presented by Bowles and Boyer (1995), who show that aggregate demand and capital accumulation can be either wage- or profit-led, suggesting that there may be different patterns of interaction between real wage growth, productivity growth, and output. In this sense, further developments of the same models came to consider productivity growth as an endogenous variable. Rowthorn (1981), Cassetti (2003), Dutt (2003), Naastepad (2006), and Hein and Tarassow (2010) have introduced models in which income distribution explicitly affects productivity growth. These models set the real wage growth and income growth as explicative variables in relation to the growth in productivity.

On the empirical front, there is a large body of evidence on the relationship between output and productivity growth—the so-called Kaldor-Verdoorn coefficient—for Latin American countries, as in Acevedo et al. (2009), Borgoglio and Odisio (2015), Britto and McCombie (2015), Carton (2009), Destefanis (2002), Libanio (2006), and others.

However, there is still little evidence on the relationship between real wage growth and productivity growth in the region. Following Cassetti (2003), Naastepad (2006), and Hein and Tarasoww (2010), real wage growth gives firms an additional incentive to increase resources dedicated to innovation. In the words of Hein and Tarassow (2010, 735):

Low unemployment and increasing bargaining power of employees and their labour unions will speed up the increase in nominal and real wages, which will finally generate a rising wage share and hence a falling profit share. This will accelerate firms' efforts to improve productivity growth in order to prevent the profit share from falling.

This argument has strong empirical evidence for developed economies such as Austria, France, Germany, the Netherlands, the United Kingdom, and the United States. We investigate here whether the same can be said of Latin American economies.

While an increase in real wage growth (or employment growth as a proxy for real wage growth) has a positive impact on productivity growth in advanced countries, in Latin American economies this relationship can be negative. As argued by the Latin American structuralist authors, the way productivity is spread in developing countries is quite different from its diffusion in advanced economies. In the Latin American countries, sectors with high and low productivity coexist. This structural heterogeneity among sectors slows down the productivity transmission throughout the economy. As a result, real wage growth (employment growth) might not be significant in econometrics terms, or this relationship can even be negative—profit-led in terms of Lavoie and Stockhammer (2012).

This article is organized as follows. In the second section, we present the main arguments of the Latin American structuralist approach and the difficulties for estimating the wage push coefficient, which means the impact of real wage growth on productivity growth. The discussion contributes to the design of the econometric exercise and to the interpretation of its results. The third section discusses the Bhaduri and Marglin (1990) post-Kaleckian model with productivity growth in a very simple fashion; the fourth section further discusses regimes of productivity growth; the fifth section presents our econometric experiment, where the objective is to analyze the Kaldor-Verdoorn parameter and the employment growth parameter; and a conclusion summarizes our findings.

2.2 The Latin American Structuralist School

The Latin American Structuralist Approach (LASA) is associated with the Economic Commission for Latin America and the Caribbean (ECLAC), especially with Raúl Prebisch's work. Structuralism regards traditional institutions, sociological factors, and particularities of the productive structure as key elements in order to better understand economic systems in terms of their concrete reality.

In his *Manifesto* (1949), Prebisch argues that the international economy is an integrated system whose dynamics are the result of the power relations embedded in a core-periphery hierarchy, and that the fate of Latin American primary goods-exporting economies is explained by the historical development of this international division of labor (Bielchowsky 1998; Missio and Oreiro 2015).

In addition, structuralism identifies the following characteristics in Latin American economies: i) the notion that the economic growth of the region is limited by the import capacity; ii) Latin America has experienced premature urbanization and service-sector expansion; iii) the region has an inefficient agricultural sector and tributary system; and iv) its economies are marked by reduced domestic market size. Hence, for the LASA, economic analysis should rely on the economic structure and target the transformation of such economies.

For Prebisch, one of the consequences of the international division of labor for developing countries is that the productivity gains derived from technological progress do not result in declining prices for industrial goods. Consequently, the periphery faces a deterioration of the terms of trade, exporting primary commodities and importing manufactured goods, and the results are balance of payment deficits and reduced capacity to import capital goods, which are needed to develop the industrial sector (Bianchi and Salviano 1999; Bianchi 2002; Ocampo 2011; Cimoli and Porcile 2013).

The LASA argues that, in countries of the industrialized north, technical progress would spread through the economy faster than in developing economies. In developed countries, labor scarcity and trade unions would push real wages up. Due to real wage increases, firms would have incentives to accelerate innovation and technological progress in order to substitute labor for capital. Thus, in advanced economies, there is a push towards increases in capital intensity, and, along with it, increases in the real wages and in labor productivity (Rodriquez 2009; Bresser-Pereira 2011; Missio and Oreiro 2015). Authors like Naastepad (2006), Storm and Naastepad (2007), Hein and Tarassow (2010), and Storm and Naastepad (2012) found robust econometric evidence in favor of this argument in European and advanced economies.

In the periphery, new technologies are implemented mostly in the primary export sector and a few related activities. Exporting sectors coexist with backward, low-productivity sectors. Thus, such economies have two main characteristics: the growth of productivity is directed towards the primary goods export sector, and the economic structure is heterogeneous in the sense that there is a productivity increase in the primary goods exporting sector while in backward sectors productivity growth is slow. Hence, in the periphery, technical progress does not spread to the whole economy. As a result, the growth of labor productivity is low, leaving little room for increases in real wages (Pinto 1976; Sunkel 1978; Rodriquez 2009; Cimoli and Porcile 2013; Missio and Oreiro 2015).

2.3 A Post-Kaleckian model

In post-Keynesian models, economic growth is an endogenous phenomenon. The foundation of these models is based on the theoretical contributions of Nicholas Kaldor, specifically the Cambridge Equation and endogenous economic growth [1]. Kaldor (1956) discusses the technical progress function, in which labor productivity depends on per capita capital growth and on the existence of the relationship between economic growth and the functional income distribution.

Stockhammer (1999), Bertella (2007), and Oreiro (2011) identified three generations of economic growth models in the post-Keynesian tradition. The first generation was developed by Kaldor (1956), Robinson (1956), Kalecki (1954), Harrod (1933), Domar (1946), and Pasinetti (1962). In this generation of models, the income distribution function is endogenous. In this approach, long-run economic growth is induced by investment. Thus, investment will increase if the profit share and/or the profit rate rises.

The second generation was proposed by Kalecki (1969) and Steindl (1952). Therein, the level of capacity utilization adjusts according to changes in savings and investment. Then, real wages' growth has a positive impact on capacity utilization, which triggers investment and then capital growth. The income distribution function is determined by the exogenously given markup level on direct costs.

Finally, the third generation has been presented by Bhaduri and Marglin (1990), Marglin and Bhaduri (1990), Dutt (1984), Naastepad (2006), Stockhammer (1999), and Hein (2014). In this line of models, the major innovation was to consider the degree of capacity utilization and the profit margin as distinct arguments in the investment function, rather than combining the arguments into the investment function. In this way, rising real wages may have a positive impact on the rate of profit (Stockhammer 1999; Bertella 2007; Foley and Michl 1999).

According to Bhaduri and Marglin (1990), an increase in aggregate demand and, therefore, of economic growth, may be achieved by increasing the profit rate and the wage share. The reasoning is that the increasing wage share would lead to a positive effect on consumption, which in turn would again improve capacity utilization and profit rates. The requirement for this mechanism is that the impact on capacity utilization must be higher than the reduction of the profit share. The opposite effect can also occur. Furthermore, the redistribution of income from profits to wages may have an ambiguous effect on aggregate demand and, thus, on economic growth.

The second generation of economic growth models has four major distinctions from the first one. First, prices are influenced by direct costs of production and the degree of monopoly. Second, the marginal costs of production are considered constant until the economy reaches full production capacity. Third, production capacity is not fully utilized. Fourth, the investment function depends on the profit rate and the degree of capacity utilization (Bertella 2007)[2].

The important innovation of the approach proposed by Bhaduri and Marglin (1990) was to consider the degree of capacity utilization and the profit margin as distinct parts in the investment function. Thus, an increase in real wages can have a positive impact in the profit rate (Stockhammer 1999; Bertella 2007).

Bhaduri and Marglin (1990) argue that, in a closed economy without government, an expansion of aggregate demand can be caused by an increase in wage share and/or profit share. Increasing the wage share would cause a positive impact on consumption and increase the use of a firm’s capacity utilization, which would in turn increase the profit rate. Indeed, to achieve this outcome, the impact on the capacity utilization must be greater than the impact of the reduction of the profit share in income. On the other hand, the rising wage share in income via higher real wages may increase the production costs, reducing profits, which could reduce investment and thus aggregate demand. The redistribution of income from profits to wages, or otherwise, may have an ambiguous effect on aggregate demand and economic growth.

Bhaduri and Marglin (1990) also analyze the relationship between wages and unemployment. In an open economy, the real wage can be increased due to foreign exchange adjustment, such as appreciation of the exchange rate. Therefore, they use the assumption that real wage rate ($w = W/p$), is an exogenous variable. The authors also adopt other hypotheses, such as: i) a short-term aspect; ii) the IS model; iii) consumption and/or investment can expand the aggregate demand; vi) a constant income fraction is saved. It is also assumed that the output (Y) is homogeneous. The capital-potential output ratio is ($b = K/Y^p$), where $Y^p$is assumed as the capital potential output, which is determined by the capital stock on full or normal capacity utilization. Also, u is the capacity utilization rate given by the capital stock. The labor-output ratio is ($a = L/Y$), with both a and b assumed to be constant.

The innovation introduced by Bhaduri and Marglin (1990), i.e., capacity utilization and profit share as separated arguments in the investment function, which creates the possibility of increases in real wages, leads to a rise in profit (r), as can be seen in the following equation:

$$g = \frac{I}{K} = \alpha + \beta u + \tau\pi;\ \alpha, \beta, \tau > 0 \quad (2.1)$$

In equation (2.1), capital accumulation depends on the “animal spirits,” the capacity utilization rate, and profit share.

The savings equation can be written in the following form:

$$\sigma = \frac{\sigma_\pi + \sigma_\omega}{pK} = \frac{\sigma_\pi \prod + \sigma_\omega (Y - \prod)}{pK} = [\sigma_\omega(1-\pi) + \sigma_\pi \pi]\left(\frac{u}{b}\right) = [\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{u}{b}\right) \quad (2.2)$$

in which σ_ω is the propensity to save out of wages. This employs the following assumption: $0 \leq \sigma_\omega < \sigma_\pi \leq 1$.

The equilibrium condition is given by:

$$g = \sigma \quad (2.3)$$

Again, it is possible to achieve the equilibrium rates of capital accumulation, profit, and capacity utilization merging equations (2.2) and (2.1) into equation (2.3), and solving for the equilibrium rates of u^*, g^*, and r^*, which results as follows:

$$u^* = \frac{\alpha + \tau\pi}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta} \quad (2.4)$$

$$g^* = \frac{(\alpha + \tau\pi)[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{u}{b}\right)}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta} \tag{2.5}$$

$$r^* = \frac{(\alpha + \tau\pi)\frac{\pi}{b}}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta} \tag{2.6}$$

The comparative statics is obtained taking the partial derivative of the equations above, first in relation to the propensity to save out of profits and wages as follows: $\frac{\partial u^*}{\partial \sigma_\pi} < 0$, $\frac{\partial u^*}{\partial \sigma_\omega} < 0$, $\frac{\partial g^*}{\partial \sigma_\pi} < 0$, $\frac{\partial g^*}{\partial \sigma_\omega} < 0$, $\frac{\partial r^*}{\partial \sigma_\pi} < 0$, $\frac{\partial r^*}{\partial \sigma_\omega} < 0$.

In Bhaduri and Marglin (1990), the paradox of saving holds that increases in the propensity to save out of profit (σ_π) or wages (σ_ω) cause a negative impact on capacity utilization, capital accumulation, and profit rate. The coefficients of the saving and investment functions define the impact of the variation in the profit share on u^*, g^*, and r^*. Depending on this impact, the growth regime may be wage-led or profit-led.

Taking the partial derivative from u^*, g^*, and r^* in relation to profit share (π) renders the following equations:

$$\frac{\partial u^*}{\partial \pi} = \frac{\tau - (\sigma_\pi - \sigma_\omega)\frac{u}{b}}{\{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta\}^2} \tag{2.7}$$

$$\frac{\partial g^*}{\partial \pi} = \frac{[\tau\sigma_\omega + (\sigma_\pi - \sigma_\omega)(\tau\pi - \beta u)]\frac{1}{b}}{\{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta\}^2} \tag{2.8}$$

$$\frac{\partial r^*}{\partial \pi} = \frac{[\alpha + 2\tau\pi - [\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{u}{b}\right)]\frac{1}{b}}{\{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta\}^2} \tag{2.9}$$

A wage-led demand regime is achieved through a low direct effect of profit share on investment (τ) and a substantial difference between the propensity to save out of profits and the propensity to save out of wages. In this case, an increasing wage share would lead to higher consumption, which in turn has a positive impact on the capacity utilization rate, therefore increasing investment. In a profit-led demand regime, the direct effect of profit share on investment, through the parameter (τ), is combined with a low propensity to save out of profits and a higher propensity to save out of wages. In this case, higher profit share would lead to higher investment.

From equation (2.7), assuming that the stability condition holds, which means that the denominator is bigger than zero, the following equation is obtained: $\frac{\partial u^*}{\partial \pi} > 0$ if: $\tau - (\sigma_\pi - \sigma_\omega)\frac{u}{b} > 0$. In this case, a profit-led demand regime is achieved. Otherwise, $\frac{\partial u^*}{\partial \pi} < 0$ if: $\tau - (\sigma_\pi - \sigma_\omega)\frac{u}{b} < 0$, which means that a wage-led demand regime is reached.

From equation (2.8), again assuming that the stability condition holds, the following equation is obtained: $\frac{\partial g^*}{\partial \pi} > 0$ if: $[\tau\sigma_\omega + (\sigma_\pi - \sigma_\omega)(\tau\pi - \beta u)]\frac{1}{b} > 0$. Hence, a profit-led capital accumulation growth regime is generated. On the other hand, when $\frac{\partial g^*}{\partial \pi} < 0$ if: $[\tau\sigma_\omega + (\sigma_\pi - \sigma_\omega)(\tau\pi - \beta u)]\frac{1}{b} < 0$.

Therefore, a wage-led capital accumulation growth regime is created. An intermediate regime can be reached when from equation (2.7) $\frac{\partial u^*}{\partial \pi} < 0$ and from equation (2.8) $\frac{\partial g^*}{\partial \pi} > 0$. In conclusion, a profit-led regime is achieved if $\frac{\partial u^*}{\partial \pi} > 0$ and $\frac{\partial g^*}{\partial \pi} > 0$, whereas a wage-led regime is obtained if both $\frac{\partial u^*}{\partial \pi} < 0$ and $\frac{\partial g^*}{\partial \pi} < 0$ inequalities hold.

So far, the models described closed economies without government.

Now we turn to an open economy. In order to analyze the effects of variations of the endogenous variables on distribution, imported input prices are assumed as exogenous, as well as the real exchange rate and foreign economic activity. Foreign imports increase competition in the domestic economy, which may lead in turn to reductions in the markup power of domestic firms.

In this post-Kaleckian open-economy model, the new variables are μ, which corresponds to unit raw material and semi-finished product inputs, p_f, the prices of imported foreign goods in foreign currency, and E as the nominal exchange rate. Taking these variables into consideration, the following price equation is reached:

$$p = (1 + m)(Wa + p_f E\mu), m > 0 \quad (2.10)$$

The variable γ is defined as the relationship between unit labor costs and unit material costs, as follows:

$$\gamma = \frac{p_f E \mu}{Wa} \qquad (2.11)$$

Thus, it is possible to rewrite the price equation as follows:

$$p = (1+m)Wa\left(1+\frac{p_f E \mu}{Wa}\right) = (1+m)Wa(1+\gamma) \qquad (2.12)$$

The profit share in this model is given by:

$$\pi = \frac{\Pi}{\Pi + W} = \frac{(1+\gamma)m}{\frac{1}{(1+\gamma)}+1} \qquad (2.13)$$

In an open economy, the profit share is determined by the markup and the parameter γ.

Assuming that the real exchange rate is an indicator for international competitiveness, the real exchange rate is given by:

$$\theta = \frac{Ep_f}{p} \qquad (2.14)$$

Increases in θ lead to a positive impact on international competitiveness. Taking the equation (2.14) in growth rates:

$$\hat{\theta} = \hat{E} + \hat{p}_f - \hat{p} \qquad (2.15)$$

From equation (2.15), an increase in the nominal exchange rate and/or in the level of international prices have a positive impact on international competitiveness. On the other hand, increases in domestic prices decrease international competitiveness.

Merging equations (2.10) and (2.14), and taking the partial derivative of the real exchange rate, first in relation to markup, second in relation to the nominal wage, and third in relation to the nominal exchange rate, and rearranging the terms, renders $\frac{\partial \theta}{\partial m} < 0$.

A rise in the markup implies an increase in the profit share and a reduction in international competitiveness. From $\frac{\partial \theta}{\partial W} < 0$, nominal wage expansion changes the relationship between labor costs and raw material costs. Thus, a rise in nominal wage implies a decrease in the profit share, which in this case reduces international competitiveness. Finally, from $\frac{\partial \theta}{\partial E} > 0$, an increase in the nominal exchange rate (depreciation) denotes a rise in the profit share and also in international competitiveness.

In order to analyze the distribution and growth in an open economy, the goods market equilibrium is defined as follows:

$$S = pI + pX - Ep_fM = I + NX \tag{2.16}$$

where S is total savings, pI the total nominal investment, pX the total nominal export, Ep_fM the total nominal imports, and NX the net exports. The division of equation (2.6) by the nominal capital stock (pK) renders i) $S/pK = s$; ii) $I/K = g$; iii) $NX/pK = nx$. Assuming that

$$\sigma = g + nx \tag{2.17}$$

and also assuming that the Marshall-Lerner condition holds, i.e., that the sum of the absolute values of the price elasticities of exports and imports elasticities exceed 1, the real exchange rate and world income have a positive influence on net export. On the other hand, domestic demand has a negative relationship with net exports.

Summarizing, the net export depends on the real exchange rate (θ); domestic capacity utilization (u) indicating domestic demand; and foreign capacity utilization (u_f) as an indicator for foreign demand. The net exports equation can be expressed as follows:

$$nx = \varsigma_1\theta(\pi) - \varsigma_2 u + \varsigma_3 u_f, \;\; \varsigma_1, \varsigma_2, \varsigma_3 > 0 \tag{2.18}$$

The stability condition is $\frac{\partial\sigma}{\partial u} - \frac{\partial g}{\partial u} - \frac{\partial nx}{\partial u} > 0 \Rightarrow [\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2$.

In this sense, the elasticity of saving is larger than the elasticity of investment and net exports. Merging equations (2.2), (2.1), and (2.18) into equation (2.17), and solving for capacity utilization, capital accumulation, profit rate, and net of export, the following equations are obtained:

$$u^* = \frac{\alpha + \tau\pi + \varsigma_1\theta(\pi) + \varsigma_3 u_f}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2} \tag{2.19}$$

$$g^* = \frac{(\alpha + \tau\pi)[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi + \varsigma_2] + \beta[\varsigma_1\theta(\pi) + \varsigma_3 u_f]}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2} \tag{2.20}$$

$$r^* = \frac{(\alpha + \tau\pi + \varsigma_1\theta(\pi) + \varsigma_3 u_f)\frac{\pi}{b}}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2} \tag{2.21}$$

$$nx^* = \frac{-\varsigma_2(\alpha + \tau\pi) + [\varsigma_1\theta(\pi) + \varsigma_3 u_f][\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi + \varsigma_2]}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2} \tag{2.22}$$

Taking the partial derivative of the equations above in relation to savings out of profit and wages, and in relation to profit share, the following expressions are obtained: $\frac{\partial u^*}{\partial \sigma_\pi} < 0$ and $\frac{\partial u^*}{\partial \sigma_\omega} < 0$; thus the paradox of thrift is revealed, i.e., increases in the propensity to save out of wages or profits lead to reductions in the level of capacity utilization.

From the set of equations above—(2.19), (2.20), (2.21), and (2.22)—it can be seen that:

$$\frac{\partial u^*}{\partial \pi} = \frac{\tau - (\sigma_\pi - \sigma_\omega)\frac{u}{b} + \varsigma_1\frac{\partial\theta}{\partial\pi}}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2} \gtreqless 0 \tag{2.23}$$

From equation (2.23), the relationship between capacity utilization and profit share can be positive or negative. A positive result of equation (2.23) means that the positive effect related with investment demand (τ) and with net exports ($\varsigma_1 \frac{\partial\theta}{\partial\pi}$) is bigger than the reduction in consumption ($(\sigma_\pi - \sigma_\omega)\frac{u}{b}$). In this case, a profit-led regime is obtained. Otherwise, a wage-led demand is reached.

Taking the partial derivative of capital accumulation in relation to saving out profits and wages, it is obtained that $\frac{\partial g^*}{\partial \sigma_\pi} < 0$ and $\frac{\partial g^*}{\partial \sigma_\omega} < 0$. Increasing propensity to save out wages and profits reduces capital accumulation.

In relation to profit share, the following equation can be obtained:

$$\frac{\partial g^*}{\partial \pi} = \frac{\tau\{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2\} - \beta(\sigma_\pi - \sigma_\omega)\frac{u}{b} + \beta\varsigma_1\frac{\partial\theta}{\partial\pi}}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2} \gtreqless 0 \tag{2.24}$$

The partial derivative of capital accumulation in relation to profit share is ambiguous, and its sign depends on the overall outcome of equation (2.24). In an open economy, it is less likely that the economy's accumulation and growth are wage-led. The overall outcome for equation (2.24) depends on the direct effect of the improvement in the profit ($\tau\{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2\}$), on the indirect effect of distribution ($\beta(\sigma_\pi - \sigma_\omega)\frac{u}{b}$), and finally, on the indirect effect of international competitiveness through net exports and domestic capacity utilization ($\beta\varsigma_1 \frac{\partial\theta}{\partial\pi}$).

A devaluation in the real exchange rate would increase competitiveness, increasing the set of parameters ($\beta\varsigma_1 \frac{\partial\theta}{\partial\pi}$), which would make the profit-led accumulation more likely. At the same time, if the income redistribution is in favor of wages, and this in turn is associated with a decrease in the markup pricing, the competitiveness will improve, thus increases in net exports can reinforce a wage-led regime. In the case of profit-led capital accumulation growth and a wage-led demand regime, an intermediary regime takes place.

Taking the partial derivative of the profit rate equation in relation to the endogenous variables renders $\frac{\partial r^*}{\partial\sigma_\pi} < 0$, $\frac{\partial r^*}{\partial\sigma_\omega} < 0$ and $\frac{\partial r^*}{\partial\pi} \gtrless 0$.

The overall outcome for profit rate is the same as in a closed economy, and the analysis applied for the profit share can be easily reproduced.

Taking the partial derivative of the net exports equation in relation to the propensity to save out of profit and wages, where $\frac{\partial nx^*}{\partial\sigma_\pi} > 0$, $\frac{\partial nx^*}{\partial\sigma_\omega} > 0$, the partial derivative of net exports in relation to propensity to save is, not surprisingly, positive. Increases in the propensity to save have a positive impact on net exports through a reduction in the domestic demand.

As for the profit rate and profit share:

$$\frac{\partial nx^*}{\partial\pi} = \frac{\varsigma_1 \frac{\partial\theta}{\partial\pi}\left\{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta\right\} + \varsigma_2[(\sigma_\pi - \sigma_\omega)\frac{u}{b} - \tau]}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2} \gtrless 0 \tag{2.25}$$

The relation between net exports and profit share is ambiguous. Assuming a wage-led regime, the second term in the numerator of equation (2.25) will be positive: ($\varsigma_2[(\sigma_\pi -$ $\sigma\omega ub - \tau > 0$).

At the same time, it is possible to assume that devaluation in the nominal exchange rate can boost competitiveness. Furthermore, if the effect of capacity utilization on investment is low, the first term of equation (2.25) can also be positive: ($\varsigma_1 \frac{\partial\theta}{\partial\pi}\{[\sigma_\omega + (\sigma_\pi -$ $\sigma\omega\pi 1b - \beta > 0$).

In this case, a wage-led regime can be verified, and nominal exchange rate devaluation increases competitiveness. Assuming a wage-led regime and that markup pricing is constant, increases in the wage share have a negative impact on net exports, which can reverse the overall result to a profit-led case. Nevertheless, in an open economy, domestic firms might have to reduce markup pricing due to international competition. If this situation increases labor bargaining power, it can reduce prices and thus increase competitiveness.

Summarizing, assuming a wage-led demand regime, the overall result of the model can be ambiguous. It will depend on the power of domestic enterprises to keep the markup constant. If the domestic firms can maintain the level of markup, the overall result might be profit-led, otherwise, wage-led. In a profit-led demand regime, with increasing profit share and devaluation of the nominal exchange rate, assuming that the Marshall-Lerner condition holds, the overall result should be profit-led.

2.4 Productivity growth approach

Having presented the Bhaduri and Marglin (1990) or the basic post-Kaleckian model, let us now turn to the effects of productivity growth.

The model relates profit-led and wage-led regimes with productivity. Thus, productivity can be considered wage-led in the case where an increase in wages raises productivity, enhancing capital investment; as a result, there is an increase in labor productivity growth. Nevertheless, in the case where real wages increase productivity, enhancing capital investment, the regime is wage-led (Lavoie and Stockhammer 2012, 15).

Considering a developing economy, in which the labor productivity is not spread towards the economy, such economy can be considered productivity growth profit-led, since increasing real wage growth would not have a positive impact on productivity growth.

In the model presented by Hein and Tarassow (2010), the capital accumulation equation considered the growth rate of productivity. Capital accumulation is positively related to profit share, capacity utilization, and productivity growth. The accumulation rate is positive whenever the expected profit rate exceeds the minimum profit rate. In contrast with the previous model (Bhaduri and Marglin 1990), Hein and Tarassow (2010) include the productivity term in the investment equation.

Both Naastepad (2006) and Hein and Tarassow (2010) suggest a simple equation with endogenous productivity growth as follows:

$$\hat{\lambda} = \beta_0 + \beta_1 \hat{y} + \beta_2 \hat{w};\ 0 < \beta_1 < 1;\ \beta_{2,} > 0 \tag{2.26}$$

in which $\hat{\lambda}$ is the labor productivity growth rate, $\hat{y}$ the real output growth rate, and $\hat{w}$ the real wage growth rate.

The coefficient β_1 is the Kaldor-Verdoorn coefficient, which means that productivity growth is caused by increasing output growth, which, going back to Kaldor's seminal works, can explained by improvements in the division of labour; learning-by-doing; and increasing investment, as new equipment and new methods can both enhance productivity (Storm and Naastepad 2012).

The coefficient β_2 in equation (2.26) reflects a positive relationship between real wages growth and productivity growth. As argued by the LASA, increases in the real wage raise firms' effort to accelerate innovation and technological progress. Furthermore, Hein and Tarassow (2010) argue that a high employment rate increases workers' bargaining power, leading to a rise in nominal and real wages. Therefore, the wage share rises, causing a reduction in the profit share and hence real wage increases will have a positive impact on productivity growth[3]. In the Hein and Tarassow model, β_2 is positive by definition. Due to their characteristic structural heterogeneity, which determines a backward pattern of productivity growth, this may not be the case for developing economies.

Three important works test equation (2.26). The first is Naastepad (2006). In this paper, the author tested not only equation (2.26) but a set of equations to determine whether the Netherlands operates under a wage- or profit-led regime. The second work is Naastepad and Storm (2007), in which the authors perform a similar empirical exercise for a larger sample of developed countries, including France, Germany, Italy, Japan, the Netherlands, Spain, the United Kingdom, and the United States. The third noteworthy empirical exercise was carried out by Hein and Tarassow (2010), who tested the equation for Austria, France, Germany, the Netherlands, the United Kingdom, and the United States.

The results from Naastepad (2006) and Naastepad and Storm (2007) are quite similar. The Kaldor-Verdoorn coefficient estimated in Naastepad (2006), or the parameter β_1, is 0.63, which is close to the estimation for OECD countries performed by León-Ledesma (2002). The wage-push coefficient, β_2, is 0.52. Both coefficients have the expected signs and are highly significant [4].

Considering the terminology used by Lavoie and Stockhammer (2012), the Netherlands can be considered wage-led, since increases in real wage are aligned with enhanced technological progress. Hein and Tarassow (2010) obtained a coefficient for the Netherlands (0.45), which is smaller than that of Naastepad (2006) [5]. The Kaldor-Verdoorn coefficient is smaller when compared with other studies for advanced countries. The authors attribute this difference to the introduction of lagged variables. It is interesting to note, though not surprising, that the wage-push coefficient is positive for all advanced economies, reinforcing the structuralist argument that technological progress spreads evenly throughout these economies and real wage growth has a positive impact on productivity growth.

As emphasized in the introduction, there is robust evidence for the Kaldor-Verdoorn law in relation to Latin American countries; such evidence has been shown by Acevedo et al. (2009), Borgoglio and Odisio (2015), Britto and McCombie (2015), Carton (2009), Destefanis (2002), Oliveira and Lemos (2006), and others.

2.5 Econometric exercise

The aim of this subsection is to compare outcomes for different Latin American countries. In order to do so, the major difficulty is data availability, given that the majority of international databases have a shortage of data in one form or another. Even CEPALSTAT, a database created by the Comisión Económica para América Latina y el Caribe, has data only for recent years, which makes comparable statistical analysis impossible. Consequently, proxies were used for some variables. A description of the data can be found in Table 2.1.

Table 2.1: Description of variables

Variable	Abbreviation	Period	Source
Productivity = GDP per capita, constant local currency	$ln\, \lambda$	Brazil: 1980–2014: Bolivia: 1980–2012; Chile: 1980–2012; Mexico:1989–2014; Venezuela:1981–2014	World Bank national accounts data, and OECD National Accounts data files
GDP = constant local currency	$ln\, y$		World Bank national accounts data, and OECD National Accounts data files
employment rate [7]	$ln\, e$		International Labour Organization, Key Indicators of the Labour Market database. Except Mexico: IMF-WEO

The estimated equation is:

$$\lambda = \beta_0 + \beta_1 y + \beta_2 e;\ 0 < \beta_1 < 1;\ \beta_2 \gtrless 0 \qquad (2.27)$$

in which λ is labor productivity, y the real output, and e the employment rate [6]. The estimates can be found in Table 2.2.

Table 2.2: Estimates of productivity equation (2.27), selected countries

Equation Productivity	Argentina	Brazil	Bolivia	Chile	Colombia	Mexico	Uruguay	Venezuela
Constant	-0.0009 (-0.33)	-0.005 (-0.48)	-0.02 (-2.91)	-0.0009 (-0.11)	-0.005 (-0.86)	-0.006 (-2.56)	0.006 (1.55)	-0.02 (-1.05)
$Dln\ y\ (-1)$	0.59 (4.22)	0.51 (3.07)	0.63 (4.54)	0.74 (6.16)	0.55 (3.49)	0.62 (6.66)	0.62 (3.54)	0.54 (1.86)
$Dln\ e\ (-1)$	0.12 (0.28)	-0.41 (-0.82)	-0.04 (-0.36)	0.40 (3.63)	0.56 (2.92)	-0.43 (-1.35)	0.94 (2.71)	-0.59 (-0.71)
$AR(1)$	Yes	No	No	Yes	Yes	No	No	-
$AR(2)$	No	Yes	No	Yes	No	No	No	-
$MA(1)$	Yes	Yes	No	Yes	Yes	Yes	Yes	-
$MA(2)$	Yes	Yes	No	Yes	No	No	Yes	-
Dummy	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.50	0.26	0.56	0.26	0.19	0.31	0.53	0.19
SE	0.04	0.02	0.01	0.02	0.02	0.01	0.02	-
D.W	1.82	2.14	1.94	2.00	2.10	2.03	2.30	-
F-stat.	6.252	2.76	14.12639	2.45	2.52	408.6	7.80	-
prob>F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-
obs.	34	34	32	32	34	33	31	33
Period	1980-2014	1980-2014	1980- 2012	1980- 2012	1980-2014	1981- 2014	1983-2014	1980- 2014

Note: The estimation method was least squares corrected by HAC standard errors and covariance (Bartlett kernel, Newey-West fixed) for Brazil, Chile, Colombia, Uruguay, and Venezuela. The estimation method was least squares corrected by White heteroskedasticity-consistent standard errors and covariance for Mexico. The t-statistics are the numbers in parentheses below each coefficient. SE is the standard error.

D.W. is the Durbin–Watson statistic. F is the F-statistic and prob > F is the probability associated with observing an F-statistic.

The overall estimation presents a high-adjusted R^2. The Durbin-Watson statistic does not suggest any problem with serial correlation. For most of the countries studied, it was not possible to reject the hypothesis of serial correlation and heteroskedasticity, except for Argentina.

For those countries that presented serial correlation and heteroskedasticity, the OLS corrected by the HAC standard errors and covariance (Bartlett kernel, Newey-West fixed) was applied. For Venezuela, we used the robust least squares method. The model *ARMA* was also applied when it was needed. We also applied the KPSS unit roots test on the series to verify whether the series were stationary. For most of the countries, the estimation did not reject the hypothesis that the series are stationary. The table with the tests is reported in the appendix.

The Kaldor-Verdoorn coefficient estimated was (0.59) for Argentina, (0.51) for Brazil, (0,63) for Bolivia, (0.74) for Chile, (0.55) for Colombia, (0.62) for Mexico, (0.62) for Uruguay, and (0.54) for Venezuela. These coefficients are similar to estimations from other studies.

Acevedo et al. (2009) studied the Kaldor-Verdoorn law for different sectors for a panel of 18 Latin American countries for the period 1950–2006. Using disaggregated data, the authors were able to calculate the elasticities of sectoral growth to overall output. Their results suggest not only that the manufacturing sector is one of the drivers of economic growth, but also that some sectors lead growth within the manufacturing industry. Their results also confirm that there is a negligible relationship between primary resource sectors and economic growth, which gives support for the structuralist thesis.

Borgoglio and Odisio (2015), using panel data, estimated the Kaldor-Verdoorn coefficient for Argentina, Brazil, and Mexico. Between 1951 and 1982, the estimated coefficient β_1 was 0.62, and 0.56 between 1983 and 2010. In their words, “Existe fuerte evidencia a favor de la vigencia de la [Law Kaldor Verdoorn] para el conjunto de Argentina, Brasil y México durante las seis décadas que transcurren entre 1950 y 2010 (Borgoglio and Odisio 2015, 205).” Carton (2008) estimated the Kaldor-Verdoorn coefficient for Argentina, Brazil, Chile, and Venezuela and found that β_1 was 0.78 between 1961 and 2005. Libânio (2006), using data for Argentina, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Mexico, Peru, Uruguay, and Venezuela from 1980 and 2006, found the coefficient β_1 to be between 0.64 and 0.69 depending on the estimation method that was implemented. Carton (2009) estimated β_1 to be 0.68 for Brazil, Bolivia, Ecuador, Paraguay, Colombia, Chile, Argentina, Uruguay, and Venezuela.

The employment push coefficient was not significant for the majority of the countries. The exceptions were Chile, Colombia, and Uruguay, which presented a positive and significant coefficient, which indicates a wage-led regime. Nonetheless, for the other countries these parameters were not significant, confirming the Latin American structuralist hypothesis that for Latin American countries productivity does not spread through the economy in the way it does in advanced economies. In this case, employment growth, which is used as a proxy for real wage growth, does not have a positive impact on productivity growth, as is the case in advanced economies.

2.6 Conclusion

This research concludes that the Kaldor-Verdoorn coefficients estimated here are similar to those obtained by other studies, such as those of Borgoglio and Odisio (2015), Britto and McCombie (2015), Carton (2009), Destefanis (2002), and others.

This study shows that the employment push coefficient was not significant for the majority of the countries in the sample. The exceptions are Chile, Colombia, and Uruguay, which showed a positive and significant coefficient, suggesting a wage-led regime. Nevertheless, for the other countries, these parameters were not significant, which is consistent with the LASA hypothesis. In fact, for Latin American economies, a pervasive feature is the fact that the heterogeneity of the productive structure does not tolerate a pattern of technological diffusion similar to what is observed in the economies of industrialized Northern countries. Therefore, a rise in real wage growth (or employment growth) does not have a positive impact on productivity growth.

In Latin American countries, structural heterogeneity indicates that high and low productivity sectors coexist, restricting the spread of productivity gains through the whole economy. One possible path to modify this structure is to increase the proportion of sectors with high productivity in the economy, as pointed out by recent research from the structuralist school.

CHAPTER 3: A POST-KALECKIAN MODEL WITH PRODUCTIVITY GROWTH AND REAL EXCHANGE RATE APPLIED FOR SELECTED LATIN-AMERICAN COUNTRIES

3.1 Introduction

The aim of this paper is to discuss the theory of productivity growth as well as its empirical applications. It follows the work of Hein and Tarassow (2010). The research on demand regimes and productivity growth reserves limited space for the role played by the real exchange rate. Bresser-Pereira (1991, 2006, 2010, 2012), Bresser-Pereira and Gala (2010), Ferrari-Filho and Fonseca (2013), Missio and Jayme Jr. (2013), and Bresser-Pereira *et al.* (2012, 2014), amongst others, emphasize the impact of real exchange rate devaluation on productivity. This discussion is particularly relevant to Latin American countries, in which the real exchange rate has been crucial to economic policy debates. The main question is: does the real exchange rate have a positive or negative impact on productivity growth?

To answer this question, the first step is to define a productivity equation that considers the relationship between productivity growth and the real exchange rate. Then, the real exchange rate is added to the equation proposed by Naastepad (2006) and Hein and Tarassow (2010). The second step is to discuss productivity growth in the context of demand regimes. The third step consists of carrying out an empirical experiment that estimates the productivity growth equation for a sample of Latin American countries, namely Argentina, Brazil, Bolivia, Chile, Colombia, Mexico, Uruguay and Venezuela. Together these countries represent 86% of the GPD of Latin America (WDI, 2013).

Following this short introduction, the paper is arranged as follows. In the second section, the productivity equation is defined. The third section is dedicated to discussing the formal model. The fourth section includes a discussion concerning empirical studies of productivity growth. The fifth section is dedicated to the empirical experiment. The last section presents the final considerations.

3.2 Productivity growth

According to Storm and Naastepad (2012), productivity growth is endogenous, depending on the rate of growth of both demand and real wages. Considering that the demand regime can be wage-led or profit-led, in both cases an increase in real wages can affect productivity positively through increased spending on R&D, investment and capital intensity in production. Naastepad (2006), Storm and Naastepad (2012) and Hein and Tarassow (2010) provide empirical evidence for this relationship in several European countries. The relationship between real wage growth and productivity growth is well established for European countries. However, the literature regarding this theme presents two important gaps. First, it lacks empirical studies for Latin American countries, the economies of which differ greatly from those of European countries. Second, the literature largely ignores the interactions between the real exchange rate and productivity growth. Hence, a detailed study addressing these issues is required.

The relationship between the real exchange rate and growth depends on the price-setting mechanisms. Hein and Tarassow (2010) argue that, if prices are set to follow the mark-up on unit variable costs, which are imported material costs and labour costs, variations in the profit share can be induced by a change in the mark-up in the ratio of imported materials to unit labour costs. When an increase in the profit share is created by a rising mark-up, domestic prices tend to increase and the real exchange rate and hence international competitiveness decline. Nevertheless, if an increase in the profit share originates from an increasing ratio of unit imported material costs to unit labour costs, the real exchange rate will also rise and international competitiveness will improve. The depreciation of the domestic currency in nominal terms, which means an increase in the nominal exchange rate or a decrease in the nominal wages, will raise the unit material costs to unit labour costs ratio and hence increase the profit share along with competitiveness. Although enlarging the profit share can have a positive or negative relation with competitiveness, it can be argued that the real exchange rate can increase or decrease productivity growth. Therefore, this relationship must be taken into consideration.

Since there is the possibility of a wage-led or a profit-led demand regime, it is interesting to consider external constraints. Basilio and Oreiro (2015) argue that for developing economies, if the demand regime is wage-led, the economic growth in the short term might be slow due to differences in the income elasticity of imports and exports. In a developing country, in general, the income elasticity of imports is higher than the income elasticity of exports. Therefore, increasing wage shares raise imports more than proportionally, thus generating an external constraint on economic growth, along the lines of Thirlwall's law.

The authors, however, do not consider the fact that the increasing wage share can have a positive impact on productivity growth. In any case, it is important to investigate the external constraints when studying the wage-led/profit-led approach.

Formally, a simple equation of endogenous productivity growth can be expressed as follows:

$$\hat{\lambda} = \beta_0 + \beta_1\hat{y} + \beta_2\hat{w} + \beta_3\hat{\theta};\ 0 < \beta_1 < 1;\ \beta_{2,} \lesseqgtr 0;\ \beta_3 \lesseqgtr 0 \qquad (3.1)$$

where $\hat{\lambda}$ is the growth rate of labour productivity, $\hat{y}$ the growth rate of real output, $\hat{w}$ the growth rate of the real wage and $\hat{\theta}$ the real exchange rate. Having defined the equation, the next step is to discuss the equation arguments.

3.2.1 Verdoorn effect

The coefficient β_1 is the Kaldor–Verdoorn coefficient. The relation between increasing productivity and demand growth can be expressed through the following channels: i) improvements in the division of labour; ii) learning by doing; and iii) increasing investment, as new equipment and new methods can both enhance productivity (Storm and Naastepad, 2012). One of the first papers to formalize Kaldor’s view on growth is by Dixon and Thirlwall (1975). The authors present a model to explain the differences in the economic growth rate among different regions. The central argument is that a region’s initial growth will be sustained dynamically through increasing returns to scale. In this way, all other things being equal, increasing returns to scale will give rise to income divergence among regions. There is vast empirical evidence on this relationship. Naastepad (2006), Storm and Naastepad (2012) and Hein and Tarassow (2010) provide strong econometric evidence. This theory is especially important for the development of countries’ economic growth, because the approach has the potential to clarify the role of the modern sectors and aggregate demand in productivity growth. It is critical for economic policy, since managing the aggregate demand is a relevant economic policy tool.

Originally, the Verdoorn–Kaldor coefficient was expressed as:

$$\lambda = \beta_0 + \beta_1 g \qquad (3.2)$$

where λ is the productivity growth, β_0 is the autonomous component of productivity and β_1 is the Verdoorn coefficient. Dixon and Thirlwall (1975) argue that the Verdoorn coefficient is the parameter that exaggerates the effect differences among regions.

There are some issues related to the Verdoorn–Kaldor coefficient. McCombie *et al.* (2002) stress two issues concerning this approach. The first is problems in the productivity equation, specifically the Verdoorn–Kaldor coefficient. The equation that relates the productivity growth to the income growth can be expressed as:

$$\lambda = \beta_0 + \beta_1 \hat{y} \qquad (3.3)$$

Following McCombie *et al.* (2002), the controversy is associated with the equation specification, which can display bias caused by a spurious correlation between productivity growth (λ) and income growth ($\hat{y}$). Since $\lambda = \hat{y} - \hat{e}$, it is possible to overcome the bias using the specification in which the employment growth rate is the dependent variable and the income growth is the independent variable. The problem arises from the fact that both the employment growth rate and the income rate are endogenous. Other alternatives involve using the capital stock, labour share and capital as the independent variable; however, the empirical evidence is poor.

Empirically, one way to overcome the spurious correlation is to lag the independent variable, which has the advantage of resolving complications connected with endogeneity. The econometric exercises in the Kaleckian tradition involving productivity regimes, such as those by Naastepad (2006), Storm and Naastepad (2012) and Hein and Tarassow (2010), usually work with lags on the independent variables to avoid simultaneity between the dependent and the independent variables; for example, the dependent variable taking in the contemporaneous form cannot determinate the past values of the independent variables, which are taken in the lag form. Thus, it is possible to use the income growth variable to capture the Verdoorn–Kaldor effect. Of course, it is important to understand and overcome such problems. An important guide to estimating the coefficient is to study the means by which the literature solves the problem.

3.2.2 Productivity and real wages

The coefficient β_2 in equation (3.1) reflects a positive relationship between real wage growth and productivity growth. A high employment rate, which possibly raises the workers' bargaining power, will quickly boost the nominal and consequently the real wages. In such a case, it is expected that the wage share will also increase in the total income of the economy, thus causing a reduction in the profit share. Firms and capitalists in turn have incentives to enhance productivity growth and avoid the profit squeeze. Therefore, increases in real wages can have a positive impact on productivity growth (Hein and Tarassow, 2009, p. 735).

There is empirical evidence for this relationship. Naastepad (2006) and Hein and Tarassow (2010) provide confirmation for European countries. It is important to note that the economic structure of European countries is different from that of Latin American countries. Because Latin American countries are less industrialized than European countries, the workers will have less bargaining power. Moreover, supposing that the workers do have bargaining power, it can be the case that firms will have difficulties in enhancing their productivity growth in the face of real wage growth. Hence, increasing real wage growth above productivity growth will reduce firms' profitability, and, if the investment decisions depend on profits, firms will reduce their investment and the productivity growth will fall. Whether this relationship is positive or negative is a question for an empirical experiment, which will be undertaken in this research.

Thus, increasing real wages lead to improvements in technical progress and innovation. Moreover, an increase in real wages can eliminate inefficient firms, favouring structural changes and enlarging the proportion of skilled workers in the economy. In this research it is argued that this positive effect is only possible when enterprises can innovate in the face of increasing real wages. For underdeveloped economies real wage increases above the productivity labour level can squeeze profits and hence reduce investments. Therefore, the relationship between real wages and productivity growth can be the reverse of that found elsewhere. It might be possible that the level of economic development can interfere with the dynamics of productivity growth over time.

3.2.3 Productivity and the real exchange rate

The coefficient β_3 in equation (3.1) reflects the indirect impact of the real exchange rate on productivity growth. Krugman and Taylor (1978) explain why the aggregate demand falls when the exchange rate is undervalued. The devaluation leads to increasing export and import prices. If the increase in import prices overcomes the variation in exports, the net result will be a reduction of the country's income. Additionally, if the import prices increase, imported machines and equipment will become more expensive, and this will have a negative impact on productivity growth.

On the other hand, the β_3 coefficient can be positive, and the main channel for this is described by Missio and Jayme Jr. (2013). They argue that a higher real exchange rate level (devaluation) increases the profit share and affects the planned spending decisions on business innovation, since it changes the availability of the funds necessary to finance investment and innovative activity (Missio and Jayme Jr, 2013). In this case devaluation of the real exchange rate increases profits, which increases investment and thus the aggregate demand. Implicitly, the authors consider that the aggregate demand regime is profit-led.

3.3 The model

Hein and Tarassow (2010) introduce the discussion regarding the effect of technical change and productivity on the aggregate demand. 'Productivity will be profit-led if an increase in wages discourages productivity-enhancing capital investment and, as a consequence, the growth of labour productivity slows down (as most forms of technological progress require capital investment, this is called embodied technological progress). Increases in wage growth may have a positive effect on productivity growth, if either firm's react by increasing productivity-enhancing investments in order to maintain competitiveness or if workers' contribution to the production process improves. This may be the case either because of enhanced workers' motivation or, in developing countries, if their health and nutritional situation improves. This case is often referred to as the efficiency wage hypothesis in the mainstream literature' (Lavoie and Stockhammer, 2012, p. 15). It is assumed that the output (Y) is homogeneous. The capital–potential output ratio is ($b = K/Y^p$), where Y^p is assumed to be the capital potential output. The parameter 'u' is the capacity utilization rate given by the capital stock. The labour–output ratio is ($a = L/Y$), and both 'a' and 'b' are assumed to be constant. The ($w = W/p$) is the real wage, (r) the rate of profit and (u) the capacity utilization rate.

Following the Kaleckian tradition, the model is built on the following equation:

$$r = \frac{\Pi}{K} = \frac{\Pi}{pY}\frac{Y}{Y^p}\frac{Y^p}{K} = \frac{pY-WL}{pY}\frac{Y}{Y^p}\frac{Y^p}{K} = \frac{Y-wL}{Y}\frac{Y}{Y^p}\frac{Y^p}{K} = (1-wa)u\frac{1}{b} = \pi\frac{u}{b} \qquad (3.4)$$

where π is the profit share.

The income distribution between the profit and the wage share is determined by the mark-up. As usual, if the material costs are excluded, firms apply a mark-up on the labour cost per unit of output (W/Y) that is assumed to be constant. Hence, the pricing equation is:

$$p = (1+m)\frac{W}{Y} = (1+m)wa, m > 0 \qquad (3.5)$$

where m is the mark-up. For a particular production technology, the real wage rate can be written as follows:

$$w = \frac{W}{p} = \frac{1}{(1+m)a} \qquad (3.6)$$

Therefore, the profit share can be defined as follows:

$$\pi = \frac{\Pi}{pY} = \frac{pY-W}{pY} = 1 - \frac{W}{(1+m)W} = 1 - \frac{1}{1+m} = \frac{m}{1+m} \qquad (3.7)$$

The saving equation can be written in the following form:

$$\sigma = \frac{\sigma_\pi + \sigma_\omega}{pK} = \frac{\sigma_\pi \Pi + \sigma_\omega (Y-\Pi)}{pK} = [\sigma_\omega(1-\pi) + \sigma_\pi \pi]\left(\frac{u}{b}\right) = [\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{u}{b}\right) \qquad (3.8)$$

in which σ_ω is the propensity to save wages. Employing the classical model assumption, $0 \leq \sigma_\omega < \sigma_\pi \leq 1$. Considering an open economy, the goods market equilibrium is defined as follows:

$$S = pI + pX - Ep_f M = I + NX \qquad (3.9)$$

where S is the total savings, pI the total nominal investment, pX the total nominal exports, $Ep_f M$ the total nominal imports and NX the net exports. Dividing the above equation by the nominal capital stock (pK), the following are obtained: i) $S/pK = \sigma$; ii) $I/K = g$; and iii) $NX/pK = nx$.

$$\sigma = g + nx \qquad (3.10)$$

Assuming that the Marshall–Lerner condition holds,[1] which states that the absolute values of export and import elasticities summed up exceed unity, the net exports depend on: i) the real exchange rate (θ); ii) domestic capacity utilization (u), indicating the domestic demand; and iii) foreign capacity utilization (u_f), as an indicator of the foreign demand. The net export equation can be expressed as follows:

$$nx = \varsigma_1\theta(\pi) - \varsigma_2 u + \varsigma_3 u_f,\ \ \varsigma_1, \varsigma_2, \varsigma_3 > 0 \qquad (3.11)$$

The stability condition is $\frac{\partial\sigma}{\partial u} - \frac{\partial g}{\partial u} - \frac{\partial nx}{\partial u} > 0 \Rightarrow [\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2$. In this sense the elasticity of saving is bigger than the elasticity of investment and net exports.

In this model the capital accumulation equation considers the growth rate of productivity. The capital accumulation is positivity related to the profit share, to capacity utilization and to productivity growth ($\hat{\lambda}$). The accumulation rate is positive whenever the expected profit rate exceeds a minimum profit rate (r_{min}).

$$g = \frac{I}{K} = \alpha + \beta u + \tau\pi + \vartheta\hat{\lambda};\ \alpha, \beta, \tau, \vartheta > 0;\ g > 0 \text{ to } r > r_{min} \qquad (3.12)$$

Assuming that the stability condition holds, plugging equations (3.8), (3.12) and (3.11) into equation (3.10) and solving for capacity utilization and capital accumulation, the following equations are achieved:

$$u^* = \frac{\alpha + \tau\pi + \varsigma_1\theta(\pi) + \vartheta\hat{\lambda} + \varsigma_3 u_f}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2} \qquad (3.13)$$

$$g^* = \frac{(\alpha + \tau\pi + \vartheta\hat{\lambda})[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi + \varsigma_2] + \beta(\varsigma_1\theta(\pi))}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2} \qquad (3.14)$$

Taking the derivative of the above equations in relation to the profit share:

$$\frac{\partial u^*}{\partial \pi} = \frac{\tau - (\sigma_\pi - \sigma_\omega)\frac{u}{b} + \varsigma_1\frac{\partial\theta}{\partial\pi}}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2} \gtrless 0 \qquad (3.15)$$

$$\frac{\partial g^*}{\partial \pi} = \frac{\tau\{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2\} - \beta(\sigma_\pi - \sigma_\omega)\frac{u}{b} + \beta\varsigma_1\frac{\partial\theta}{\partial\pi}}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2} \gtrless 0 \qquad (3.16)$$

[1] The supply elasticity tends to infinity.

A positive result from equation (3.15) means that the positive effect related to the investment demand (τ) and to the net exports ($\varsigma_1 \frac{\partial \theta}{\partial \pi}$) is bigger than the reduction in consumption ($(\sigma_\pi - \sigma_\omega)\frac{u}{b}$). In this case a profit-led demand is reached. Otherwise, a wage-led demand is achieved.

Taking the partial derivative of capital accumulation in relation to saving profits and wages, $\frac{\partial g^*}{\partial \sigma_\pi} < 0$, $\frac{\partial g^*}{\partial \sigma_\omega} < 0$ are obtained. An increasing propensity to save wages and profits reduces capital accumulation. The partial derivative of capital accumulation in an open economy makes it less likely for the economy's accumulation and growth to be a wage-led growth regime. The overall outcome of equation (3.16) depends on the direct effect of the improvement in the profit ($\tau\{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2\}$), the indirect effect of distribution ($\beta(\sigma_\pi - \sigma_\omega)\frac{u}{b}$) and finally the indirect effect of international competitiveness through net exports and domestic capacity utilization ($\beta\varsigma_1 \frac{\partial \theta}{\partial \pi}$).

Taking the partial derivative of the profit rate equation in relation to the endogenous variables, the overall outcome for the profit rate is the same as in a closed economy, and the analysis applied to the profit share can easily be reproduced.

The partial derivatives show the positive effect on capacity utilization and capital accumulation of investment and net exports. However, we have a negative effect in relation to consumption. The analysis of the demand regime depends on the magnitude of the effects of each of the components (elasticity investment and profit share on consumption) compared with the accumulation of capital and capacity utilization.

Productivity is positively related to capacity utilization and capital accumulation and negatively related to the profit share. An increase in capacity utilization requires companies to increase their efforts to raise productivity to reduce the impact of the larger wage share. As discussed before, the productivity equations can be defined as follows:

$$\hat{\lambda} = \beta_0 + \beta_1 u + \beta_2 \pi + \beta_3 \theta,\ 0 < \beta_1 < 1;\ \beta_{2,} \lesseqgtr 0;\ \beta_3 \lesseqgtr 0 \tag{3.17}$$

or

$$\hat{\lambda} = \beta_0 + \beta_4 y + \beta_2 \pi + \beta_3 \theta,\ 0 < \beta_1 < 1;\ \beta_{2,} \lesseqgtr 0;\ \beta_3 \lesseqgtr 0 \tag{3.18}$$

Assuming that equations (3.17) and (3.18) hold at the same time, $\beta_1 u = \beta_4 y$; thus, it is possible to work with either of these two equations. It is also important to notice that the profit share is negatively related to the productivity growth.

Merging equations (3.13) and (3.17), the long-run equilibrium rates for capacity utilization and productivity growth are achieved as follows:

$$u^{**} = \frac{\alpha + (\tau - \beta_2\vartheta)\pi + \varsigma_1\theta(\pi) + \vartheta(\beta_0 + \beta_3\theta(\pi)) + \varsigma_3 u_f}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \text{ϐ} + \varsigma_2 - \vartheta\beta_1} \quad (3.19)$$

$$\lambda^{**} = \frac{(\beta_0 - \beta_2\pi)\left\{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \text{ϐ} + \varsigma_2\right\} + \beta_1[\alpha + \tau\pi + \varsigma_1\theta(\pi) + \vartheta\beta_3\theta(\pi) + \varsigma_3 u_f]}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \text{ϐ} + \varsigma_2 - \vartheta\beta_1} \quad (3.20)$$

Substituting equations (3.19) and (3.20) into (3.12) obtains the long-run capital accumulation rate as follows:

$$g^{**} =$$

$$\alpha + \tau\pi + \text{ϐ}\{\frac{\alpha + (\tau - \beta_2\vartheta)\pi + \varsigma_1\theta(\pi) + \vartheta\beta_0 + \varsigma_3 u_f}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \text{ϐ} + \varsigma_2 - \vartheta\beta_1}\} +$$

$$+\vartheta\{\frac{(\beta_0 - \beta_2\pi)\left\{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \text{ϐ} + \varsigma_2\right\} + \beta_1[\alpha + \tau\pi + \varsigma_1\theta(\pi) + \vartheta\beta_3\theta(\pi) + \varsigma_3 u_f]}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \text{ϐ} + \varsigma_2 - \vartheta\beta_1}\} \quad (3.21)$$

The stability condition requires the slopes of the capacity utilization and capital accumulation equations to be bigger than the slope of the productivity equation. It is possible to make this condition explicit as follows:

$$[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \text{ϐ} + \varsigma_2 - \vartheta\beta_1 > 0 \quad (3.22)$$

$$(1 - \vartheta\beta_2)\{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) + \varsigma_2\} - \text{ϐ} > 0 \quad (3.23)$$

In the case in which those conditions are violated, the growth path of capacity utilization becomes explosive.

Taking the partial derivative of the long-run capacity utilization rate equation (3.19) in relation to the profit share, the following expression is achieved:

$$\frac{\partial u^{**}}{\partial \pi} = \frac{\tau - \vartheta\beta_2 - (\sigma_\pi - \sigma_\omega)\frac{u}{b} + \varsigma_1\frac{\partial\theta}{\partial\pi} + \beta_3\frac{\partial\theta}{\partial\pi}}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \text{ϐ} + \varsigma_2 - \vartheta\beta_1} \gtreqless 0 \quad (3.24)$$

The result is quite close to the result of an open economy model. If the overall result of equation (3.24) is positive, which means that the positive effect related to the investment demand (τ) and to the net exports ($\varsigma_1 \frac{\partial\theta}{\partial\pi}$), plus the effect of the real exchange rate on productivity ($\beta_3 \frac{\partial\theta}{\partial\pi}$), is bigger than the reduction in consumption ($(\sigma_\pi - \sigma_\omega)\frac{u}{b}$) and $\vartheta \beta_2$, the last term being related to the productivity growth equation. In this case the demand is profit-led. Otherwise, it is wage-led.

Taking the partial derivative of the capital accumulation rate in the long-run equilibrium (3.21) in relation to the profit share, the following equation is obtained:

$$\frac{\partial g^{**}}{\partial\pi} = \frac{(\tau - \vartheta\beta_2)\left\{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) + \varsigma_2\right\} - (\beta + \vartheta\beta_1)(\sigma_\pi - \sigma_\omega)\frac{u}{b} + (\beta + \vartheta)\varsigma_1\frac{\partial\theta}{\partial\pi} + \beta_3\frac{\partial\theta}{\partial\pi}}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2 - \vartheta\beta_1} \gtrless 0 \qquad (3.25)$$

From expression (3.25) wage-led accumulation and a growth regime are less likely. However, in this model, which includes productivity growth, the result is less profit-led growth if the profit share is negatively related to productivity growth.

The outcome of equation (3.25) depends on the direct effect of the improvement in profits ($(\tau - \vartheta\beta_2)\left\{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) + \varsigma_2\right\}$), in which in this case the parameters related to productivity ($\vartheta\beta_2$) can decrease this whole term. Regarding the indirect effect of distribution ($(\beta + \vartheta\beta_1)(\sigma_\pi - \sigma_\omega)\frac{u}{b}$), in this model the productivity term can make this term even bigger than in the model related to an open economy.

For the indirect effect of international competitiveness, net exports and domestic capacity utilization ($(\beta + \vartheta)\varsigma_1\frac{\partial\theta}{\partial\pi} + \beta_3\frac{\partial\theta}{\partial\pi}$), a positive feedback effect through international competitiveness on productivity (ϑ) is obtained in this model. Assuming that the Marshall–Lerner condition holds, devaluation in the real exchange rate would increase competitiveness, increasing the set of parameters $[(\beta + \vartheta)\varsigma_1\frac{\partial\theta}{\partial\pi} + \beta_3\frac{\partial\theta}{\partial\pi}]$, which would make profit-led accumulation more likely. As discussed for the model with an open economy, if the income redistribution favours wages, and this is associated with a decrease in the mark-up pricing, competitiveness will improve, thus increasing the net exports, which might reinforce a wage-led demand.

Finally, it is possible to analyse the relation between productivity growth and the profit share in the short term as follows:

$$\frac{\partial \hat{\lambda}^{**}}{\partial \pi} = \frac{\beta_1\left[\tau-(\sigma_\pi-\sigma_\omega)\frac{u}{b}+\varsigma_1\frac{\partial\theta}{\partial\pi}+\beta_3\frac{\partial\theta}{\partial\pi}\right]-\beta_2\{[\sigma_\omega+(\sigma_\pi-\sigma_\omega)\pi]\left(\frac{1}{b}\right)-\mathrm{в}+\varsigma_2\}}{[\sigma_\omega+(\sigma_\pi-\sigma_\omega)\pi]\left(\frac{1}{b}\right)-\mathrm{в}+\varsigma_2-\vartheta\beta_1} \gtrless 0 \qquad (3.26)$$

Changes in the profit share have two effects on the productivity growth rate in the long-run equilibrium. The first effect occurs through the goods market, expressed by the term ($\beta_1\left[\tau-(\sigma_\pi-\sigma_\omega)\frac{u}{b}+\varsigma_1\frac{\partial\theta}{\partial\pi}+\beta_3\frac{\partial\theta}{\partial\pi}\right]$). This term might be positive or negative. It depends on the demand regime, which can be profit-led or wage-led. The second effect arises through the term ($\beta_2\{[\sigma_\omega+(\sigma_\pi-\sigma_\omega)\pi]\left(\frac{1}{b}\right)-\mathrm{в}+\varsigma_2\}$), which is, by assumption, positive. This term is related to the negative effect of the profit share on productivity (β_2). The overall result can be positive or negative; it will depend on the relationship of the increased profit share and productivity growth.

The demand regime can be profit-led or wage-led, as discussed in this work, and it depends on the overall outcomes of equations (3.24), (3.25) and (3.26). In the case of $\frac{\partial u^{**}}{\partial \pi};\frac{\partial g^{**}}{\partial \pi}<0$, which means a wage-led demand regime, if the profit share increases, the impact on productivity growth ($\frac{\partial \hat{\lambda}^{**}}{\partial \pi}$) is negative. Under a profit-led demand regime ($\frac{\partial u^{**}}{\partial \pi};\frac{\partial g^{**}}{\partial \pi}>0$), an increase in the profit share will have a positive impact on $\frac{\partial u^{**}}{\partial \pi}$ and $\frac{\partial g^{**}}{\partial \pi}$, whereas it can have a positive or negative impact on $\frac{\partial \hat{\lambda}^{**}}{\partial \pi}$, depending on the sign of the parameters of equation (3.26).

3.4 Empirical studies

As explained by McCombie *et al.* (2002), there are several issues related to the specification of Verdoorn's law. An extensive review of this matter can be found in the study by McCombie *et al.* (2002). In this subsection some empirical applications of Verdoorn's law will be discussed.

León-Ledesma (2002) estimates the Verdoorn coefficient for OECD countries, finding a highly significant coefficient (0.672). Besides the productivity equation, the author tests the relationship between output growth and export growth. The estimated parameter is also significant.

Angeriz *et al*. (2009) estimate the Verdoorn law using the spatial econometric approach for individual manufacturing industries with EU regional data. Using other variables, such as industrial specialization and diversity, the authors confirm the results empirically and verify that the model is correctly specified. Alexiadis and Tsagdis (2010) apply spatial econometrics to EU regions during the period 1977–2005, using Verdoorn's law itself together with other contributing factors to explain labour productivity growth, such as manufacturing agglomeration and spatial interaction. The authors, based on the econometric findings, argue that there was a slowdown in labour productivity due to the economic policy.

Naastepad (2006), Naastepad and Storm (2007) and Storm and Naastepad (2012) test equation (26) below for a large sample of OECD and Latin American countries, for different periods, given the lack of data for many countries. To study the regime demand from the empirical point of view, the authors estimate the follow equation:

$$\hat{\lambda} = \beta_0 + \beta_1 \hat{y} + \beta_2 \hat{w};\ \beta_0, \beta_1 > 0; 0 < \beta_2 < 1 \tag{3.26}$$

in which $\hat{\lambda}$ is the productivity growth, $\hat{y}$ the income growth and $\hat{w}$ the real wage growth. The results show that the Verdoorn coefficient is significant. In addition, the parameter related to real wages (β_2) is positive and significant.

Hein and Tarassow (2010) conduct an empirical exercise to estimate the productivity regime for Australia, France, Germany, the Netherlands, the United Kingdom and the United States from 1960 to 2007. The authors use the Annual Macro-Economic Database of the European Commission (AMECO). They estimate the following equations to analyse the demand regime:

$$\hat{y} = f(\hat{Y}, \hat{w}, sh_m, GAP) \tag{3.27}$$

in which $\hat{y}$ is the labour productivity, *Y* is the GPD, *w* is the real wage, *sh* is the share of the manufacturing sector and GAP is the gap related to the US's labour productivity. Furthermore, the authors assess the possibility of structural breaks using *dummy variables*. The statistical methodology used in the paper is the autoregressive vectors (VEC).

This study finds that the economies of Germany, the UK and the USA were wage-led, and this was reinforced by the productivity regime. Thus, increases in the profit share had negative effects on the demand and hence on the economic growth. In France, despite the demand regime being wage-led, the authors find no significant effect of the profit share on the productivity regime; that is, in France the relationship between the demand regime and the productivity regime was unclear. For economies such as Australia and the Netherlands, the demand regime found was profit-led, reinforced by the productivity regime.

3.5 Econometric exercise

Besides the theoretical model, the real exchange rate squared is tested as indicated by Missio *et al*. (2015) to examine non-linearity in the real exchange rate as follows:

$$\hat{\lambda} = \beta_0 + \beta_1\hat{y} + \beta_2\hat{w} + \beta_3\hat{\theta} + \beta_3\hat{\theta}^2 \quad (3.1)$$

in which $\frac{\partial\hat{\lambda}}{\partial\hat{y}} > 0; \frac{\partial\hat{\lambda}}{\partial\hat{w}} \lesseqgtr 0; \frac{\partial\hat{\lambda}}{\partial\hat{\theta}} \lesseqgtr 0; \frac{\partial\hat{\lambda}}{\partial\hat{\theta}^2} \lesseqgtr 0.$

The estimation of equation (3.1) follows the traditional steps: i) stationarity tests; ii) a cointegration test; and iii) regressions.

Table 3.1: Variables for the productivity equation

Variable	Abbreviation	Period	Source
Productivity = variable is the gross value added at factor cost, constant local currency	Lnpr	Argentina, Brazil, Chile and Colombia: 1980–2014: Bolivia: 1980–2012; Mexico:1981–2014; Uruguay and Venezuela: 1981–2014	World Bank national accounts data and OECD National Accounts data files
GDP = constant local currency	Lny		World Bank national accounts data and OECD National Accounts data files
Employment rate	Lne		International Labour Organization, key indicators of the Labour Market database
The variable real effective exchange rate index (2010 = 100)	Lnrer		International Monetary Fund, International Financial Statistics

Sources: International Monetary Fund, International Financial Statistics and WDI – World Bank[2]

The estimation strategy used is the same as applied in the previous subsection. The first step is to determine in which case the variables are stationary for each variable and country. Hence, (KPSS) tests are applied. In the KPSS tests, the null hypothesis that the time series are stationary is verified for most countries (Mexico and Venezuela are exceptions when the variables are taken in levels), and the series are stationary in levels as well as in first differences. Hence, following a conservative strategy, all the series are integrated of order one, $I(1)$.

The next step is to carry out the multiple breakpoint test. This test finds breakpoints for the following countries: Argentina, Brazil, Chile, Colombia and Venezuela. As breakpoints are found in the series, dummy variables are included to correct the problem. The multiple breakpoint tests for the countries that present structural breaks are reported in the appendix.

An LS model is estimated, as indicated by the KPSS unit root test. All these results are reported in the appendix. The next step is to estimate the productivity equation for the selected countries.

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[2] Unfortunately, the variable real wage of the total worker's compensation is not found, although the unemployment total (% of total labour force) (national estimate) is found. To obtain the employment rate, the following account is made for each period: 100-unemployment.

Table 3.2: Estimates of productivity equation (3.1) – selected countries

Equation Productivity	Argentina	Brazil	Bolivia	Chile	Colombia	Mexico	Uruguay	Venezuela
Constant	-0.01 (-1.10)	-0.01 (-1.14)	-0.01 (-1.17)	0.06 (6.50)	-0.01 (-2.18)	-0.02 (-2.13)	-0.01 (-0.82)	-0.02 (-2.32)
$Dln\ y\ (-1)$	0.52 (2.06)	0.70 (2.46)	0.63 (2.60)	0.28 (3.45)	0.80 (4.47)	0.55 (2.39)	0.86 (3.34)	0.68 (2.99)
$Dln\ e\ (-1)$	-0.03 (-0.05)	-0.53 (-0.80)	-0.12 (-2.04)	0.66 (3.99)	0. 27 (1.06)	-0.88 (-1.56)	-1.12 (-1.73)	-0.30 (-0.44)
$Dln\ rer\ (-1)$	-0.04 (-0.93)	-0.05 (-1.95)	-0.05 (-7.93)	-0.10 (-1.46)	-0.03 (-1.31)	0.10 (1.47)	-0.19 (-4.55)	-0.19 (-4.67)
$Dln\ rer2(-1)$	0.19 (2.96)	0.08 (0.95)	-0.02 (-2.35)	-2.20 (-3.44)	-0.04 (-0.23)	0.49 (2.24)	1.02 (1.79)	-0.26 (-1.68)
Dummy	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
AR (1)	No	Yes	Yes	No	No	Yes	Yes	No
AR (2)	No	No	No	No	No	No	Yes	No
MA (1)	No	Yes	Yes	Yes	Yes	No	No	Yes
MA (2)	No	Yes	No	No	No	Yes	Yes	No
Adj. R^2	0.20	0.35	0.79	0.76	0.15	0.27	0.23	0.67
SE	0.05	0.02	0.01	0.02	0.02	0.02	0.03	0.03
D.W	2.33	2.12	1.89	1.83	1.94	1.55	2.00	2.02
F-stat.	2.69	3.43	16.86	17.82	1.98	2.64	2.05	12.15
prob>F	0.04	0.01	0.00	0.00	0.00	0.03	0.00	0.00
obs.	34	34	32	32	32	31	30	30
Period	1980-2014	1980-2014	1980-2012	1980- 2012	1980- 2014	1981- 2014	1983-2014	1983- 2014

Note: The first difference is applied to all the variables. The estimation method is least squares corrected by HAC standard errors and covariance (Bartlett kernel, Newey–West fixed). The t–statistics are the numbers in parentheses below each coefficient. SE is the standard error. D.W. is the Durbin–Watson statistic. F is the F-statistic, and prob>F is the probability associated with observing an F-statistic. Furthermore, dummy variables are applied when needed. All the tests that justify applying these methodologies are reported in the Appendix. To choose the best model, for instance AR(1), ARMA(1,1) and so on, the strategy is to combine i) F, the probability associated with observing an F-statistic close to zero; and ii) the Durbin–Watson statistic, which should be as close as possible to 2.00.

Table (3.2) shows the results of the estimated productivity equations. The regressions are performed using the least squares, robust least squares and least squares correcting the autocorrelation and heteroskedasticity with the HAC matrix. The overall outcome is that the Kaldor–Verdoorn coefficient is significant for all the countries: Argentina (0.52), Brazil (0.70), Bolivia (0.63), Chile (0.28), Colombia (0.80), Mexico (0.55), Uruguay (0.86) and Venezuela (0.86).

The parameters estimated in this research are similar to those estimated for Latin American countries by other authors (the exception is Chile, for which the parameter is smaller than the findings in the literature). The studies on this topic for Latin American countries include those by Acevedo *et al.* (2009), Borgoglio and Odisio (2015), Britto and McCombie (2015), Carton (2009), Destefanis (2002), Libanio (2006), Oliveira *et al.* (2006) and others.

The wage-push variable is the employment rate (DL_{ne}). The parameter is significant for Bolivia and Chile, and the parameters' values are -0.12 and 0.66, respectively, meaning that Bolivia is a profit-led regime and Chile a wage-led regime. In the case of Argentina, Brazil, Colombia, Mexico, Uruguay and Venezuela, the parameter is not significant. One possible explanation for these results comes from the Latin American Structuralist School, which argues that productivity growth is fundamentally different in developed and in developing countries. In the latter high- and low-productivity sectors coexist. This heterogeneity in the productive sector slows down the productivity transmission across the economic system. Therefore, the real wage growth (employment growth) is not statistically significant.

Regarding the real exchange rate parameter, the real exchange rate is tested and the real exchange rate squared to test for non-linearities. For all the countries, except Colombia, ($Dln\, rer\ (-1)$), $Dln\, rer2(-1)$ or both is/are significant, albeit negative. In the case of Colombia, both of the parameters are significant. Given the theoretical discussion presented earlier, these results may mean that real exchange rate devaluation increases the cost of imported capital, reducing productivity growth. This indicates that the level of the real exchange rate in these countries had a negative impact on productivity growth in the period under consideration. There is an extensive body of work on the relationship between the RER and growth, such as Rodrik (2008), Bragança and Libânio (2008), Araújo (2009), Rapetti *et al.* (2012), Oreiro and Araújo (2013), Nassif *et al.* (2015), Missio *et al.* (2015b), Cavallo *et al.* (1990), Dollar (1992), Razin and Collins (1997), Benaroya and Janci (1999), Acemoglu *et al.* (2002), Fajnzylber *et al.* (2002) and Gala (2008). However, most of the work on the theme focuses on exchange rate misalignments. In this research the focus is on the real exchange rate change and level. This difference is important, because the result reached in this research does not disagree with the results found in the literature. Finally, the real exchange rate coefficient for Chile is positive and significant, and the parameter is 0.17. In this case the real exchange rate has a positive impact on productivity growth.

3.6 Conclusion

The main goal of this research was to assess the relationship between the real exchange rate and productivity growth. The secondary objectives were to study the relationship between economic growth (through the so-called Verdoorn coefficient) and the interaction between productivity growth and real wage growth. These relationships (productivity growth, real wage growth and income growth) are explored in several earlier papers (for instance Naastepad, 2006; Hein and Tarassow, 2010).

One novelty in the present research is the presentation of a theoretical approach that establishes a relationship between the real exchange rate and productivity. In this case the real exchange rate is also related to the investment function, since productivity growth is a separate variable in the investment function. The second novelty is that, from a theoretical point of view, in a country in which the demand regime is profit-led, increases in the real wage can reduce productivity. At the same time, in a profit-led demand regime, real exchange rate devaluation can have a negative impact on productivity, because it can increase the capital cost of imported materials.

The overall outcome of the empirical experiment performed on Argentina, Brazil, Bolivia, Chile, Colombia, Mexico, Uruguay and Venezuela is that the Kaldor–Verdoorn coefficient is significant for all the analysed countries. Nevertheless, the estimated coefficients in this research are bigger than the parameters estimated for Latin American countries elsewhere. The wage-push variable is significant for only two countries, Bolivia and Chile, indicating that in Bolivia the regime is profit-led, whereas in Chile the regime is wage-led. Regarding the real exchange rate and this variable squared, the parameters are negative for all the countries, indicating that real exchange rate devaluation does not increase productivity growth. However, future studies should take into consideration exchange rate misalignments for these countries but use panel data analysis. This approach could result in different conclusions.

CHAPTER 4: PRODUCTIVITY, REAL EXCHANGE RATE AND AGGREGATE DEMAND: AN EMPIRICAL EXERCISE APPLIED TO BRAZIL FROM 1960-2011

4.1 Introduction

The purpose of this research is to analyse the interaction between productivity growth, labour unit costs, the real exchange rate and real wage growth for the Brazilian economy between 1960 and 2011. The chosen time period is limited by the data availability. The series related to unit labour costs, which are provided by the Brazilian Institute of Geography and Statistics (IBGE), are available until 2011. The Brazilian economy was chosen because it is one of the biggest Latin American economies.

Theoretical fundamentals suggest that there is a relationship between the aggregate demand, the real exchange rate, productivity and real wages. The novelty of this research is the argument that, even in a wage-led regime, exchange rate devaluation can have a positive impact on productivity. Besides, under a profit-led regime, exchange rate devaluation can affect productivity and thus economic growth adversely.

Missio and Jayme Jr (2013), Bresser-Pereira (1991, 2006, 2010, 2012), Bresser-Pereira and Gala (2010), Ferrari and Fonseca (2013) and Bresser-Pereira et al. (2012, 2014) recommend raising labour productivity through real exchange rate devaluation, since this mechanism increases prices (caused by real exchange rate devaluation), and real wages will fall in the short term, assuming sticky nominal wages. This strategy considers *a priori* that the regime is profit-led. However, as pointed out by Bhaduri and Marglin (1990), Foley and Michl (1999), Naastepad (2006), Naastepad and Storm (2007 Storm and Naastepad (2012), regimes can be profit-led or wage-led, which is essentially an empirical question. In a wage-led regime, real devaluation of the exchange rate can reduce the aggregate demand, which has a negative impact on capital accumulation and reduces productivity by reducing real wages.

To investigate these matters, the research follows these steps: i) a critical assessment of the growth regime literature, with a particular emphasis on the matters of productivity and the real exchange rate; ii) an assessment of the relationship between the real exchange rate, productivity and demand growth regimes; iii) the proposal of a theoretical model that relates the real exchange rate, productivity and growth regimes; iv) a review of the empirical methods found in the literature; and v) an empirical test of the interaction between the real exchange rate, productivity and growth regimes.

Following this introduction, the second section considers the interaction between demand regimes, productivity and the real exchange rate. The third section presents the empirical experiment. Finally, the fourth section concludes the research.

4.2 The model

Consider the following equation for growth rates:

$$y = c + i + x - m \tag{4.1}$$

where y is the output, c the aggregate consumption, i the aggregate investment, x the exports and m the imports. These variables are measured at constant prices.

Define $\omega = (W/P)\lambda^{-1} = w\lambda^{-1}$ as the real cost of labour per unit of output (Taylor, 1991), where ω is defined as the wage share, W as the nominal wage, P as the price and finally λ as the productivity.

The labour cost per unit of output in the growth rate can be obtained from:

$$\hat{v} = \hat{w} - \hat{\lambda} \tag{4.2}$$

where $\hat{v}$ represents the growth rate of the labour cost per unit of output, $\hat{w}$ the growth rate of the real wage and $\hat{\lambda}$ the growth rate of productivity. If $\hat{w}$ is greater than $\hat{\lambda}$, $\hat{v}$ will also grow. This means that the growth rate of $\hat{v}$ will affect the income distribution from profits towards wage. The opposite also occurs if $\hat{\lambda}$ is growing faster than $\hat{w}$. In this case income redistribution from wages to profits will occur (Naastepad and Storm, 2007).

The real profit share is defined as:

$$\pi = 1 - \omega \tag{4.3}$$

Equation (4.3) for the growth rate is:

$$\hat{\pi} = \frac{\Delta\pi}{\pi} = -\frac{v\Delta v}{\pi v} = -\alpha\hat{v} = -\alpha(\hat{w} - \hat{\lambda}) \qquad (4.4)$$

Note that $\alpha = w/\pi = w/(1-w) > 0$. If the real wage rises above productivity, the profit share growth will fall.

The marginal propensity to consume is denoted by σ, which is different for workers (σ_{ω}) and capitalists (σ_{π}). Therefore, the income is $(1-\sigma)$, where ($\sigma_{\omega} < \sigma_{\pi}$) means that the propensity to save of the workers is lower than that of the capitalists; thus, the propensity to consume of the workers is higher than that of the capitalists.

The consumption function can be written as:

$$c = (1-\sigma_{\omega})\omega y + (1-\sigma_{\pi})\pi y = [(1-\sigma_{\omega})\omega + (1-\sigma_{\pi})(1-\omega)]y;\ \sigma_{\pi} > \sigma_{\omega} \qquad (4.5)$$

To estimate the marginal propensity to consume, it is possible to use the following equation[3]:

$$\sigma = \frac{s}{y} = \sigma_{\pi} + (\sigma_{\omega} - \sigma_{\pi})\omega \qquad (4.6)$$

The import function is as follows:

$$m = \zeta y \qquad (4.7)$$

where ζ is the average marginal propensity to import. Substituting (4.5) and (4.7) into (4.1) and rearranging obtains:

$$y = \frac{i+x}{[1-\ (1-\sigma_{\omega})\omega + (1-\sigma_{\pi})(1-\omega) + \zeta]} = \mu^{-1}(i+x) \qquad (4.8)$$

Note that $\mu^{-1} = 1/[1-\ (1-\sigma_{\omega})\omega + (1-\sigma_{\pi})(1-\omega) + \zeta]$ is the Keynesian multiplier. The magnitude of the multiplier depends on ω, the income distribution, the real wage rate and the labour productivity. Differentiating the output growth rate and rearranging the terms, the following equation is obtained:

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[3] This equation is a modified version of the equation presented by Naastepad (2006).

$$\hat{y} = -\hat{\mu} + \frac{\mu^{-1}i}{y}\hat{\imath} + \frac{\mu^{-1}x}{y}\hat{x} = -\hat{\mu} + \psi_i\hat{\imath} + \psi_x\hat{x} \tag{4.9}$$

where ψ_i and ψ_x are the (adjusted multiplier) share of products in the investment and exports, respectively. Output growth is related to the growth rate of investment and exports. The multiplier is endogenous, since any change in the real cost of labour is reflected in μ. From μ it is possible to differentiate the output growth rate as a function of the growth rate of the unit labour cost as follows:

$$\hat{\mu} = -\frac{\omega}{\mu}(\sigma_\pi - \sigma_\omega)\omega = -\xi(\sigma_\pi - \sigma_\omega)\left[\hat{w} - \hat{\lambda}\right] \tag{4.10}$$

where ξ is a positive fraction of ω/μ. In this case the multiplier will fall when the real costs of the work unit increase.

Following Bhaduri and Marglin (1990) and Taylor (1991), the multiplier and the real costs of the work unit determine the growth rate of investment and exports, wherein i is positively related to the profit share π and y. The next step is to include the real exchange rate in the investment function, following Lima and Porcile (2013).

Rodrick (2008, p. 369) argues that real exchange rate devaluation could stimulate growth, notably for developing countries. The transmission channel for this relationship is through the industrial sector, especially the tradable sector. The author creates a real exchange index to analyse the impact of real exchange rate devaluation on income growth. "[The] index of undervaluation is essentially a real exchange rate adjusted for the Balassa–Samuelson effect: this measure of real exchange rate adjusts the relative price of tradables to nontradables for the fact that as countries grow rich, the relative prices of nontradables as a group tend to rise (because of higher productivity in tradables)."

Besides the Balassa–Samuelson effect channel, Rapetti (2014) discusses other conceivable channels through which real exchange rate devaluation leads to economic growth: i) a misaligned real exchange rate would bring disequilibrium to relative prices, which could lead to inefficiency in resource allocation, therefore hurting economic growth; ii) increases in the saving rate could accelerate capital accumulation and thus economic growth, although it is not clear how the real exchange rate would increase the saving rate; iii) real exchange rate devaluation could reduce real wages and transfer income to firms that increase their investment in capital accumulation; iv) real exchange rate devaluation could relax external constraints, as in the model of balance of payment constraint growth (BPCG); and v) as indicated by Missio *et al.* (2015b), real exchange rate devaluation can change the relationship between the elasticities of exports and imports within the BPCG model. Although all these channels can be valid, it is important to notice that real exchange rate devaluation can have a non-linear relation with economic growth, as pointed out by Rapetti *et al.* (2012), Missio *et al.* (2015b) and Oreiro and Araújo (2013).

Rappeti (2014) argues that the relationship between economic growth and the real exchange rate, to be meaningful, should be comparable across countries, across time or both. In general, this relationship is studied through panel data analyses. Furthermore, this type of study involves some notions of misalignment in the indexes of the actual and the equilibrium real exchange rate. There are two popular approaches to the misalignment index. The first is the Balassa–Samuelson effect, used by Rodrik (2008), Rapetti *et al.* (2012) and Missio *et al.* (2015b). The second introduces the notion that the real exchange rate should be consistent with the internal and external balance (Rappeti, 2014).

Rodrik (2008) provides robust econometric evidence for this relationship for developing countries. The author shows, by applying several fixed-effect panel data specifications, that there is a positive relationship between real exchange rate index devaluation and economic growth, especially for developing economies.

Rapetti *et al.* (2012) argue that the findings provided by Rodrik (2008) conceal nonlinearities that can be important in explaining the positive relationship between real exchange rate index devaluation and economic growth. Although the authors agree with the positive relationship already mentioned, they suggest that this relationship is sensitive to the regressions' specifications and to the criteria by which countries are divided into developed and developing economies.

Departing from the nonlinearity issue identified by Rapetti *et al.* (2012), Missio *et al.* (2015b) analyse empirically the nonlinear (quadratic) relation between real exchange rate devaluation and economic growth. The authors also use the real exchange rate index, as suggested by Rodrik (2008). By applying different econometric techniques, including panel data analyses and quantile regression, the authors conclude that maintaining the real exchange rate index at a competitive level has positive effects on economic growth, notably for developing countries in Latin America.

In this research, rather than focusing on RER misalignments, the attention falls on the relationship between the real exchange rate and investment growth. Formally:

$$i = f(\pi, y, \theta) \tag{4.11}$$

in which $\frac{\delta f}{\delta \pi} > 0$; $\frac{\delta f}{\delta y} > 0$; $\frac{\delta f}{\delta \theta} \gtrless 0$, meaning that the profit share and aggregate demand are positively related to investment, whereas the real exchange rate can be either positive or negative. On the one hand, real exchange rate devaluation can boost exports and trigger investment growth. On the other hand, real exchange rate devaluation might increase the import cost of imported physical capital, which leads to a decrease in investment, as indicated by Oreiro and Araújo (2013).

The Keynesian clue is essential to explaining increases in profits and investment, which are long-term variables (Kregel, 1976; Dutt, 1997). The parameter θ is the real exchange rate, and, following Lima and Porcile (2013), the exchange rate should be a separate component inside the investment function. This is because real exchange rate devaluation increases profits and investment. The following investment function, including the real exchange rate, is proposed by Blecker (2002):

$$i = a_i b^{\phi_0} \pi^{\phi_1} y^{\phi_2} \theta^{\phi_3} \quad \phi_0, \phi_1, \phi_2 > 0 \; ; \; \phi_3 \gtrless 0 \tag{4.12}$$

where a_i and b are positive constants. Taking the above equation in terms of growth rates:

$$\hat{i} = \phi_0 \hat{b} + \phi_1 \hat{\pi} + \phi_2 \hat{y} + \phi_3 \hat{\theta} \tag{4.13}$$

the coefficient ϕ_1 is the elasticity of investment in relation to the profit share, ϕ_2 is the elasticity of investment in relation to the demand (output) and ϕ_3 is the elasticity of investment in relation to the real exchange rate.

The export function is inversely related to the labour cost per unit of output and positively related to the world demand (z).

$$x = a_x z^{\epsilon_0} \left(\frac{v}{v_f}\right)^{-\epsilon_1} \tag{4.14}$$

where a_x is a positive constant, v_f the real cost of work associated with exports, ϵ_0 the elasticity of exports based on the world demand and ϵ_1 the elasticity of exports in relation to the labour cost per unit of output. If $\upsilon_f = 1$ and $\epsilon_0 = 1$, linearizing equation (4.14), the following equation is obtained:

$$\hat{x} = \hat{z} - \epsilon_1 \hat{\upsilon} \qquad (4.15)$$

The exports grow with an increasing foreign demand and with decreasing unit labour costs. Substituting equations (4.4), (4.10), (4.13) and (4.15) into (4.9), the following is achieved:

$$\hat{y} = \frac{[\psi_i \phi_0 \hat{b} + \psi_x \hat{z} + \psi_i \phi_0 \theta]}{[1 - \psi_i \phi_2]} + \frac{[\xi(\sigma_\pi - \sigma_\omega) - \psi_x \epsilon_1 - \psi_i \phi_1 \alpha]}{[1 - \psi_i \phi_2]} \left[\hat{w} - \hat{\lambda}\right] \qquad (4.16)$$

Some results regarding the growth of the output are the following:

1) For the autonomous components to be meaningful, it is required that $[1 - \psi_i \phi_2] > 0$; since $(0 < \psi_i < 1)$, elasticity should fall with: $0 \leq \phi_2 < (1/\psi_i)$.

2) In relation to the growth rate of the labour cost per unit of output $[\hat{v} = (\hat{w} - \hat{\lambda})]$, the impact of increased costs is ambiguous. If real wage growth exceeds productivity growth $(\hat{w} > \hat{\lambda})$, which means $(\hat{v} > 0)$, there will be two effects on output growth. On the one hand, it will reduce the export and investment growth and therefore the output. On the other hand, it will increase the Keynesian multiplier, which means that it will reduce the marginal propensity to save, distributing income from profits to wages.

3) The devaluation of the real exchange rate in a profit-led demand regime may increase the rate of demand growth, and the opposite happens if the demand regime is wage-led. In this case the impact of real depreciation of the exchange rate is also ambiguous.

If $(1 - \psi_i \phi_2) > 0$, differentiating equation (4.16) with respect to $\hat{w}$, the demand regime is wage-led, which is shown by the following equation:

$$\frac{d\hat{y}}{d\hat{w}} = (\sigma_\pi - \sigma_\omega) > \left(\frac{i}{\pi y}\right) \phi_1 + \left(\frac{x}{v y}\right) \epsilon_1 \qquad (4.17)$$

If the investment elasticity, based on the profit share, and the export cost elasticity are relatively smaller than the propensity to save (supposing that the saving propensity of capitalists is greater than the saving propensity of workers), then the demand regime is wage-led. In this scenario increases in the wage share will increase the aggregate demand.

Conversely, if the export demand and the investment demand elasticities are higher than the sum of the propensity to save profits and wages, the demand regime will be profit-led. This means that an increase in real wages will reduce economic growth.

The interaction between productivity and the demand regime, in a profit-led economy, is represented by the following expression:

$$\frac{d\hat{y}}{d\hat{\lambda}} > 0 \text{ if } (\sigma_\pi - \sigma_\omega) < \left(\frac{i}{\pi y}\right)\phi_1 + \left(\frac{x}{v y}\right)\epsilon_1 \qquad (4.18)$$

If the derivative is taken in equation (4.16) in relation to $\hat{\lambda}$, the opposite result occurs (in comparison with $d\hat{x}/d\hat{w}$).

Under the wage-led regime, we have

$$\frac{d\hat{y}}{d\hat{\lambda}} < 0 \text{ if } (\sigma_\pi - \sigma_\omega) > \left(\frac{i}{\pi y}\right)\phi_1 + \left(\frac{x}{v y}\right)\epsilon_1 \qquad (4.19)$$

The negative impact on output growth of income redistribution implies that the growth rate of productivity is greater than the effects of an increase in investments (via the profit share) and exports (via the costs).

The derivative of equation (4.16) taken in relation to $\hat{w}$ shows the demand-led growth model:

$$\frac{d\hat{y}}{d\hat{w}} = C = \frac{[\xi(\sigma_\pi - \sigma_\omega) - \psi_x\epsilon_1 - \psi_i\phi_1\alpha]}{[1 - \psi_i\phi_2]} \qquad (4.20)$$

which has an equivalent interpretation to equation (4.17).

In the next section, some empirical strategies are studied to estimate and determine whether an economy is wage-led or profit-led.

4.2.1 Relationship between the aggregate regime demand and productivity

In this section a model is presented that relates the demand regime, productivity and the real exchange rate. This model is based on Naastepad (2006), Storm and Naastepad (2007) and Naastepad and Storm (2007). The theoretical model is founded on the following equations:

$$\hat{\lambda} = \beta_0 + \beta_1\hat{y} + \beta_2\hat{w} + \beta_3\hat{\theta};\ 0 < \beta_1 < 1;\ \beta_{2,} > 0; \beta_3 \lesseqgtr 0 \qquad (4.21)$$

$$\hat{x} = C[\hat{w} - \hat{\lambda}] \tag{4.22}$$

$$\hat{l} = \hat{x} - \hat{\lambda} \tag{4.23}$$

Equation (4.22) presents demand growth as a function of real wages and productivity growth. Autonomous demand growth is represented by φ. C is the demand regime coefficient. If $C > 0$, an increase in the real wage growth increases the output. Therefore, the demand regime is considered to be wage-led. Higher real wage growth redistributes income from profits towards wages; therefore, consumption growth is greater than investment and export growth. If $C < 0$, an increase in the real wage growth influences the output growth negatively, and hence the regime is profit-led. Equation (4.23) expresses employment growth ($\hat{l}$) as the difference between demand and productivity growth.

Using equation (4.23), employment growth can be expressed as a function of output growth:

$$\hat{l} = (1 - \beta_1)\hat{x} - \beta_0 - \beta_2\hat{w} - \beta_3\hat{\theta} \tag{4.24}$$

Merging equations (4.21), (4.22) and (4.24), and solving for output, labour productivity and employment growth, the following are achieved:

$$\hat{y} = \frac{\varphi - \beta_0 C}{1+\beta_1 C} + \frac{(1-\beta_2)C}{1+\beta_1 C}\hat{w} + [-\frac{\beta_3 C}{1+\beta_1 C}]\hat{\theta} = \bar{\varphi} + \bar{\gamma}\hat{w} + \bar{\delta}\hat{\theta} \tag{4.25}$$

$$\hat{\lambda} = \beta_0 + \beta_1\bar{\varphi} + [\beta_2 + \beta_1\bar{\gamma}]\hat{w} + (\beta_3 - \beta_1\bar{\delta})\hat{\theta} \tag{4.26}$$

$$\hat{l} = -\beta_0 + (1 - \beta_1)\bar{\varphi} + [(1 - \beta_1)\bar{\gamma} - \beta_2]\hat{w} + [(1 - \beta_1)\bar{\delta} - \beta_3]\hat{\theta} \tag{4.27}$$

whereas: $\bar{\varphi} = \frac{\varphi - \beta_0 C}{1+\beta_1 C}$, $\bar{\gamma} = \frac{(1-\beta_2)C}{1+\beta_1 C}$ e $\bar{\delta} = -\frac{\beta_3 C}{1+\beta_1 C}$.

4.2.2 The relationship between the demand regime and the real wages

Equations (4.25), (4.26) and (4.27) show how output growth, productivity and employment are affected by changes in the real wages, in particular a reduction in the real wages.

From equation (4.25) is obtained:

$$\frac{d\hat{y}}{d\hat{w}} = \bar{\gamma} = \frac{(1-\beta_2)C}{1+\beta_1 C} \tag{4.28}$$

4.2.3 The relationship between the demand regime and the real exchange rate

Taking the derivative of equation (4.24) with respect to the real exchange rate, the following is achieved:

$$\frac{d\hat{y}}{d\hat{\theta}} = \bar{\delta} = [-\frac{\beta_3 C}{1+\beta_1 C}] \quad (4.29)$$

The parameter β_3 represents the relation between the real exchange rate and productivity. Therefore, we can have the following relations:

i) If $\beta_3 < 0$ and $C > 0$, the overall result is positive, which strengthens the wage-led regime. A decline in real wage growth has a negative impact on output growth, and real exchange rate devaluation has a negative impact on productivity;

ii) If $\beta_3 < 0$ and $C < 0$, depreciation of the exchange rate reduces productivity, and the overall sign of the derivative will be negative. Although the regime is profit-led, devaluation of the real exchange rate decreases economic growth;

iii) If $\beta_3 > 0$ and $C > 0$, the real exchange rate has a positive impact on productivity, and the regime is wage-led. In this case, even if the regime is wage-led, real exchange rate devaluation is positive in boosting productivity growth and consequently economic growth. The overall outcome is negative, since there is a negative sign at the beginning of equation (4.29);

iv) If $\beta_3 > 0$ and $C < 0$, the overall sign of the derivative will be positive, which means that exchange rate devaluation will increase the demand, reinforcing the profit-led regime.

4.2.4 The relationship between the demand regime and productivity

The total effect on productivity growth of a decline in real wage growth can be observed using equations (4.21) and (4.27):

$$\frac{d\hat{\lambda}}{d\hat{w}} = \beta_2 + \beta_1 \frac{d\hat{x}}{d\hat{w}} = \beta_2 + \frac{\beta_1(1-\beta_2)C}{1+\beta_1 C} = \frac{\beta_2+\beta_1 C}{1+\beta_1 C} \quad (4.30)$$

Two effects on productivity are related to the reduction of real wage growth. The direct effect occurs through the $\beta_2 \Delta\widehat{w}$, meaning that permanent reductions in real wages reduce the incentives for firms to invest in more efficient production techniques and therefore reduce the technical progress. The indirect effect arises through the Kaldor–Verdoorn coefficient β_1. If the demand regime is wage-led, the derivative $\frac{d\widehat{\lambda}}{d\widehat{w}}$ is always positive, and a reduction of real wage growth will also reduce the aggregate demand.

The total effect on productivity growth of real exchange rate devaluation can be observed using equations (4.21) and (4.29):

$$\frac{d\widehat{\lambda}}{d\widehat{\theta}} = \beta_3 + \beta_1 \frac{d\widehat{y}}{d\widehat{\theta}} = \beta_3 + \beta_1 \frac{-(\beta_3 C)}{1+\beta_1 C} \quad (4.31)$$

Productivity growth depends on the sign of β_3 and the demand regime (wage-led or profit-led). Productivity can increase (decrease) with devaluation (valuation) of the exchange rate. Whether a decrease or an increase in productivity occurs due to the real exchange rate will depend on the indirect effect of the Kaldor–Verdoorn coefficient (β_1).

4.2.5 The relationship between the demand regime and the employment level

The impact of real wage reduction on employment growth can be obtained from equations (4.27) and (4.28).

$$\frac{d\widehat{l}}{d\widehat{w}} = \frac{d\widehat{y}}{d\widehat{w}} - \frac{d\widehat{\lambda}}{d\widehat{w}} = (1-\beta_1)\frac{d\widehat{y}}{d\widehat{w}} - \beta_2 = \frac{(1-\beta_1-\beta_2)C-\beta_2}{1+\beta_1 C} \quad (4.32)$$

If ($C > 0$), the above-mentioned impact has the following channels:

i) the growth of employment declines due to the fall in output growth;

ii) employment growth increases due to the decrease in productivity (β_2);

iii) employment growth increases due to the decrease in productivity via the Kaldor–Verdoorn coefficient (β_1).

The overall effect on employment growth depends on the magnitude of the different parameters. In a profit-led demand regime, the impact of real wage reduction is higher than in a wage-led regime.

It is possible to analyse the impact of real exchange rate variation on employment through equations (4.28) and (4.30).

$$\frac{d\hat{l}}{d\hat{\theta}} = \frac{d\hat{x}}{d\hat{\theta}} - \frac{d\hat{\lambda}}{d\hat{\theta}} = \left[-\frac{\beta_3 C}{1+\beta_1 C}\right] - \left[\beta_3 + \beta_1 \frac{-(\beta_3 C)}{1+\beta_1 C}\right] \quad (4.33)$$

The result of the above equation is ambiguous and depends on the parameters.

4.3. Empirical studies

There are many empirical studies regarding economic growth and income distribution. It is possible to divide these studies into two categories. The first category is the single equation estimation approach and the second is the multiple equations estimation approach. The main differences between these empirical approaches stand on the endogeneity role of demand regime on economic growth. In the single equation approach, the economic growth determines whether the demand regime (or growth) is wage-led or profit-led. Therefore, economic growth itself will determine the demand regime. In the multiple equations approach, the demand regime is determined by institutional issues such as the workers bargaining power in relation to the real wage growth.

In order to understand the relationship between functional distribution, aggregate demand and capital accumulation many studies have been performed. One popular variety of econometric study among researchers is the multiple equations approach, which was introduced by Bowles and Boyer (1995). This methodology estimates at least three different equations to determine the aggregate demand regime and capital accumulation growth. These equations usually are: i) consumption (savings); ii) investment; and iii) net export. Usually national accounts are used to estimate these equations. The aggregate demand (Y) depends on consumption (C), investment (I) and net export (NX). Also, it can be introduced exogenous variables, such as government expenditure (G) and control variables (J). All variables are taken in real terms.

Consumption (savings) depends on income (Y) and profit share (π). Investment depends on income (Y), profit share (π) and control variables (J). Net exports depend on income (Y), profit share (π) and control variables (J). The aggregate demand function can be represented as follows:

$$Y^* = C(Y,\pi) + I(Y,\pi,J_I) + NX(Y,\pi,J_{NX}) \quad (4.34)$$

Taking the total differentiation of the above equation, it is obtained:

$$dY^* = \frac{\partial C}{\partial Y}dY + \frac{\partial C}{\partial \pi}d\pi + \frac{\partial I}{\partial Y}dY + \frac{\partial I}{\partial \pi}d\pi + \frac{\partial NX}{\partial Y}dY + \frac{\partial NX}{\partial \pi}d\pi \quad (4.35)$$

Rearranging the last equation, the following is achieved:

$$\frac{dY^*}{d\pi} = \frac{\frac{\partial C}{\partial \pi}+\frac{\partial I}{\partial \pi}+\frac{\partial NX}{\partial \pi}}{1-\left(\frac{\partial C}{\partial Y}\right)-\left(\frac{\partial I}{\partial Y}\right)-\left(\frac{\partial NX}{\partial Y}\right)} = \left[\frac{1}{1-\mu}\right]\left[\frac{\partial C}{\partial \pi} + \frac{\partial I}{\partial \pi} + \frac{\partial NX}{\partial \pi}\right] \quad (4.36)$$

where $\mu = \left(\frac{\partial C}{\partial Y}\right) - \left(\frac{\partial I}{\partial Y}\right) - \left(\frac{\partial NX}{\partial Y}\right)$ is the standard Keynesian multiplier. In order to analyse whether the regime is wage-led or profit-led, it is assumed that the multiplier is 1, then, it is achieved the following equation:

$$\frac{dY}{d\pi} = \frac{\partial C}{\partial \pi} + \frac{\partial I}{\partial \pi} + \frac{\partial NX}{\partial \pi} \quad (4.37)$$

Dividing the above equation by Y, and rearranging the terms, it is achieved the percentage point change in the aggregate demand caused by a one percentage point change in profit share:

$$\frac{\frac{dY}{Y}}{d\pi} = \frac{\frac{\partial C}{Y}}{\partial \pi} + \frac{\frac{\partial I}{Y}}{\partial \pi} + \frac{\frac{\partial NX}{Y}}{\partial \pi} \quad (4.38)$$

If $\frac{\frac{dY}{Y}}{d\pi} > 0 \Rightarrow$ profit-led regime; If $(\frac{\frac{dY}{Y}}{d\pi} < 0) \Rightarrow$ wage-led regime.

if $\frac{\frac{\partial I}{Y}}{\partial \pi} > 0 \Rightarrow$ profit-led growth regime; if $\frac{\frac{\partial I}{Y}}{\partial \pi} < 0 \Rightarrow$ wage-led growth regime. Furthermore,

if $(\frac{\frac{\partial C}{Y}}{\partial \pi} < 0) \Rightarrow$ wage-led demand regime; if $(\frac{\frac{\partial C}{Y}}{\partial \pi} > 0), \Rightarrow$ profit-led demand regime.

In other words, taking the total derivative of income in relation to profit share, the result can be either positive or negative. If this result is positive, a profit-led regime is reached, whereas in the case where this result is negative, a wage-led regime is obtained. In contrast, taking the partial derivative of investment in relation to profit share, the result can be positive or negative. In the case the outcome is positive, a profit-led growth regime is achieved, and otherwise a wage-led growth regime is reached. Finally, taking the partial derivative of consumption in relation to profit share, if the result is negative, the demand regime is wage-led, otherwise, it is profit-led.

4.3.1 Consumption

The first empirical study based on the Post-Kaleckian theory was performed by Bowles and Boyer (1995). The authors were interested in determining whether the regime is profit-led or wage-led. In order to reach this goal, they estimate a saving equation, investment equation and net export equation for the following countries: France, Germany, Japan, UK and US. The work performed by these authors is interesting because it was one of the first econometric experiments on the nature of economic growth when income distribution is taken in consideration, although the econometric exercise presents some problems (for instance, there is little worry about serial correlation, heteroskedasticity among others potential problems). Yet, it is an import work, mentioned by several authors, and it is discussed in this section.

The first step is to estimate the saving equation ($\sigma = \sigma_w + (\sigma_\pi - \sigma_w)\pi$), that is also equation (6) in this chapter. Where (σ_w) is the propensity to save out of wages and ($\sigma_\pi - \sigma_w$) is the propensity to save out of profits. The econometric exercise is reported in the following table:

Table 4.1: Saving equation - Bowles and Boyer (1995)

Country	σ_w	$\sigma_\pi - \sigma_w$	Trend	R^2	d.w
France	0.18	0.28	-0.002	0.19	1.16
	(19.3)	(2.8)	(2.8)		
Germany	0.06	0.45		0.82	1.80
	(1.4)	(3.0)			
Japan	0.15	0.69		0.92	1.81
	(3.7)	(3.3)			
UK	0.10	0.40		0.65	1.41
	(4.6)	(2.8)			
US	0.11	0.46		0.60	2.10
	(3.6)	(1.8)			

Source: Bowles and Boyer (1995)

The authors have not tested for serial correlation. The experiment suggests the propensity to save out of profit is bigger than the propensity to save out of wages. This suggestion on how to estimate the saving equation is probably the most popular way. In the empirical experiment performed further in this chapter applied to the Brazilian economy uses a similar saving equation.

Naastepad (2006), Naastepad and Storm (2007) and Storm and Naastepad (2012) studied the growth approach developed by themselves, which includes income distribution and productivity in European countries. Naastepad (2006) applied the model to study the impact of the decline in the real wage growth policy on economic growth and productivity between 1960 and 2000. In Naastepad and Storm (2007), the authors studied from an empirical approach the OECD's countries from 1960 to 2000. Regarding the consumption equation, they applied the same equation as presented in Bowles and Boyer (1995), with similar results. This evidence shows the robustness degree of the work performed by Bowles and Boyer (1995).

Hein and Vogel (2008) analysed the Post-Kaleckian model for 1960-2005. The countries are: Austria, Netherlands, France, Germany, UK and US. The data was found in the AMECO database of the European Commission. For the consumption function applied to UK were used the data from 1970-2005 (due to missing data). For every estimated equation (consumption, investment and net exports) the authors applied unit roots test, to analyse whether the series are stationary, or not. Moreover, they applied cointegration tests in order to test the hypothesis of long run relationship among the variables. In the case where a cointegration vector was found among the series; the vector error correction model (VEC) was applied. When the VEC was not possible to be applied, the strategy was to i) apply log on the series; ii) take the first difference and; iii) apply lags to the variables. In this way, it was possible to avoid problems related to spurious regression, simultaneity and autocorrelation. The econometric path chosen by the authors seems to be the correct one. The work does not appear to have any problem related to econometric tests.

Furthermore, the series for the consumption equation are stationary; however, there is no evidence for cointegration vector. Consequently, the consumption equation was estimated in first difference. The authors estimated the following consumption equation:

$$d[\log(C_t)] = c + a_1 d[\log(\prod_t)] + a_2 d[log(W_t)] + a_3 d[log(C_{t-1})] \qquad (4.39)$$

where C_t is the consumption in time t, $\prod_t$ is the profit in time t and C_{t-1} is the consumption lagged (to avoid first order autocorrelation in the residuals). The authors tested for misspecification by using the Ramsey RESET test, for first order autocorrelation by using the Durbin-Watson statistics and Q statistics, and for heteroskedasticity using the White test. Using this methodology the authors were able to find reasonable results, although for some variables they solved some problems correcting for outliers. Despite the fact that the method of excluding outliers is a valid one from the econometric point of view, however it sounds as if the authors modified the data structure, hence changing the regression outcomes. But, again, it is a valid tool.

Onaran, Stockhammer and Grafl (2009) studied the Euro area from a Post-Kaleckian approach by using the multiple equation approach. The econometric experiment outcome suggests a wage-led regime for the Euro economy. In this study, since there was indication for cointegration vector, the VEC methodology was applied; otherwise Unrestricted Autoregressive Distributed Lag (ADL) was applied. The innovation in this work was to apply the ADL methodology. The search for new econometric methodologies is import for the Post-kaleckian approach. It is a possible way to overcome other economic approaches.

The consumption function was estimated by applying the ADL modelling because the long run relationship among the variables was rejected. The following equation was used:

$$\Delta \ln C = contant + \Delta \ln W + \Delta \ln \prod \; + AR1 \qquad (4.40)$$

By applying log, first difference and autoregression, the problems with autocorrelation were solved. The ADL econometric modelling is interesting because it allows the use of time series even when there is no evidence for cointegration vector.

Stockhammer, Onaran, and Ederer (2009) used the same strategy mentioned above to estimate the consumption function to Netherlands in the period 1960-2005. The results (from an econometric point of view) are quite close to the results obtained by Onaran, Stockhammer and Grafl (2009).

Onaran and Galanis (2012) used a very similar strategy presented in Onaran, Stockhammer and Grafl (2009). They estimated the consumption, investment and net exports from 1960 to 2007, in order to verified whether the regime is profit-led or wage-led. The authors found that Germany, France, Italy, UK, Us, Japan, Turkey and Korea are wage-led regime. They found that Canada, Australia, Argentina, Mexico, China, India and South Africa are profit-led regime.

4.3.2 Investment

Bowles and Boyer (1995) estimated the following investment function:

$$\frac{I}{K} = I_0 + I/K_{-1} + I_{r-1} + I_{h-1} \tag{4.41}$$

where $(\frac{I}{K})$ is investment divided by capital stock, I/K_{-1} is investment divided by capital stock with one lag, the lag is used to avoid simultaneity problems, I_{r-1} is the elasticity of investment related with profit rate, and I_{h-1} is the elasticity of investment related with employment (h). The estimative are reported in the next table:

Table 4.2: Investment equation - Bowles and Boyer (1995)

Country	I/K_{-1}	I_{r-1}	I_{h-1}	R^2	d.w
France	0.68	0.08	0.17	0.96	2.31
	(12.0)	(3.6)	(4.9)		
Germany	0.37	0.21	0.13	0.96	1.34
	(3.1)	(4.7)	(2.6)		
Japan	0.53	0.25		0.91	1.84
	(4.0)	(3.0)			
UK		0.14	0.33	0.53	0.58
		(2.2)	(4.6)		
US		0.16	0.13	0.62	1.47
		(3.8)	(1.8)		

Source: Bowles and Boyer (1995)

The entries in each column are the estimations and the t-statistics are in parentheses, as it was already mentioned. The authors applied the Least Square Method for the period between 1953-87. In the estimative for Germany a dummy variable was included for the years after 1973 (the authors do not explain the dummy variables in this specific year). The entries are only for significant results. The results suggest that for those countries the profit rate and employment rate are important to determinate investment. It is interesting how the authors used the employment as independent variable as a proxy for demand.

Hein and Vogel (2008) estimated the following investment function:

$$I = f(Y, \pi, ir) \tag{4.42}$$

where I is the investment, π profit share and ir is the real long-term interest rate. This last variable is used as control variable for monetary factors that could have influence on investment. Only for Netherlands the authors applied VEC (because it was found indication for existence of cointegration vector), for the other countries, it was applied ADL methodology. For Netherlands it was applied the following equation:

$$\Delta[\ln(I_t)] = c + a_1 \ln(I_{t-1}) + a_2\, ln(Y_{t-1}) + a_3\pi_{t-1} + \sum_{i=0}^{n} b_i\Delta\, ln(I_{t-1}) + \sum_{i=0}^{n} c_i\Delta\, ln(Y_{t-1}) + i{=}0ndi\Delta\pi t{-}1 \quad (4.43)$$

Onaran, Stockhammer and Grafl (2009) used the above equation in order to estimate the investment for the Euro area.

For the remaining countries it was estimated the following equation:

$$\Delta[\ln(I_t)] = c + b_1\Delta\, ln(I_{t-1}) + b_2\Delta ln(Y_t) + b_3\Delta\pi_t \quad (4.44)$$

The investment equation can be estimated by using several methods, as shown in this section. It is possible to use the more appropriate approach to the data structure that the research will work with.

4.3.3 Net exports

Bowles and Boyer (1995), taking in consideration the results obtained for the other equations, without considering the net export, all five economies are wage-led regime. Nevertheless, some of the countries change the result after the net export was introduced. The authors suggest the following net export:

$$NX/Y = NX_0 + NX_r(\prod/K)_{-1} + NX_h h \quad (4.45)$$

where NX/Y is the net export divided by gross domestic product, $NX_r(\prod/K)_{-1}$ is the elasticity of net export related to profit rate and $NX_h h$ is the elasticity of the net export related with employment rate. The estimative is presented in the following table:

Table 4.3: Net export equation - Bowles and Boyer (1995)

Country	$NX_r(\prod/K)_{-1}$	$NX_h h$		r2	d.w
France	0.06			0.004	1.30
	(1.4)				
Germany	0.32		0.015	0.23	0.84
	(2.3)		(3.2)t		
Japan	0.22	-2.4	1.3	0.66	1.58
	(2.6)	(2.6)	(1.5)d		
UK	0.32	-0.51	-3.1	0.45	1.70
	(1.4)	(2.5)	(2.1)d		
US	0.24	-0.44	-2.7	0.78	1.23
	(3.4)	(3.6)	(9.1)d		

Source: Bowles and Boyer (1995)

For France and Germany estimation it was used the Least Square Method with AR (1) to Japan, UK and US. The entries are the coefficients for each country, and the t-statistic is parentheses. The period is 1961-87. The dummies are indicated by “d” and trend by “t”.

It is not clear in the text why the authors used the net export related with profit rate is with one lag and why net export related with employment rate is without lag. The results suggest the expected sign, which means that the net export is positively related with profit rate and negatively related with employment rate. The authors only report the significant results.

As indicated by equation (4.38), the sum of consumption, investment and Net export gives the outcome for a wage-led or profit-led regime. Taking in consideration net export, only UK and US remain wage-led regime, the other countries, France, Japan and Germany now are profit-led regime.

Considering an open economy model, the results suggest that is more likely that the economies become profit-led, if compared with a closed economy. These results are in line with the discussion made in the first chapter of this work.

Hein and Vogel (2008) also estimate the net exports equation. Because it was not found indication for cointegration vector, they estimated the net exports equation by using the Least Square Method, as follows:

$$\frac{NX_t}{Y_t} = c + a_1 \Delta\, ln(Y_t) + a_2 \Delta\, ln(Z_t) + a_3 \pi_t + a_4 \frac{NX_{t-1}}{Y_{t-1}} + a_5 \pi_{t-1} \qquad (4.46)$$

where $\frac{NX_t}{Y_t}$ is the net exports divided by income, Δ indicates first difference of the variable, Y_t is the domestic income; Z_t is the foreign income (the most important trade patterns of each country). Due to theoretical reason (the authors do not explain these reasons) the net exports and profit share were not used in first difference, instead those variables were lagged. It was applied tests for misspecification, autocorrelation and heteroskedasticity, and the results were robust.

Onaran, Stockhammer and Grafl (2009) estimated a similar equation for the Euro area, as follows:

$$\frac{NX_t}{Y_t} = c + a_1 \Delta\, ln(Y_t) + a_2 \Delta\, ln(Z_t) + a_3 TWER + a_4\, v + AR(1) \qquad (4.47)$$

where $TWER$ is the trade-weighted exchange rate, and v is the real unit labour cost. The exchange rate and real unit labour costs were introduced as control variables. Despite the fact that the estimation presented some autocorrelation problem, the authors accept the result as robust.

In addition, these authors performed estimation for exports and imports separately. The export equation was estimated as follows:

$$\Delta\, ln(X_t) = c + a_1 \Delta\, ln(Z_t) + a_2 \Delta \ln TWER_t + a_3 \Delta ln\, Px_t/Pm_t + AR(1) \qquad (4.48)$$

where $Px_t/Pm_t$is the export prices divided by import prices in real terms. This variable was included as a control variable.

The import equation was estimated as follows:

$$\Delta\, ln(M_t) = c + a_1 \Delta\, ln(Y_t) + a_2 \Delta\, ln\, TWER_t + a_3 \Delta ln\, Px_t/Pm_t + AR(1) \qquad (4.49)$$

Again, the term $Px_t/Pm_t$was introduced as control variable. The estimations are robust. The same strategy to estimate the investment function was used by Stockhammer, Onaran, and Ederer (2009) for Netherlands with robust outcomes. It is interesting to reinforce the idea that the net export inclusion might change the economy regime.

4.3.4 Other estimation strategies

Onaran and Stockhammer (2001) had applied empirically the Bhaduri and Marglin (1990) approach to the economy of Turkey from 1965 to 1997. The objective of the work was to analyse whether the regime is wage-led or profit-led. The result found by the authors was that the regime is wage-led in Turkey.

The accumulation I/K is the ratio between investment I and the capital stock K, which is positively related to the profit share π and capacity utilization u. In relation to the capacity utilization the authors use as *proxy* the ratio between output Y and capital stock K. The ratio of exports X and output is positively related with the profit share; in contrast, the ratio of imports M and output is negatively related with the profit share, and positively related with the capacity utilization and capital accumulation. The profit share is positively related to capacity utilization and negatively related to the employment rate "h". Changing in employment is positively related to the capital accumulation and the variation in capacity utilization. The capacity utilization is related negatively to the profit share and, as the marginal propensity to consume of the capitalists is lower than that of workers, capacity utilization is positively related to the accumulation of capital and the surplus of $(X/Y - M/Y)u$.

The authors perform two exercises; the first is to estimate using the vector autoregression methodology (VAR) to the following equation:

$$y = I/K + \pi + X/Y + M/Y + u + h \qquad (4.50)$$

The outcome, which the authors found with the estimates, is that Turkey's economy is wage-led. The interesting thing of the empirical analysis is that the results obtained with the SVAR were not higher than the results obtained with the traditional VAR.

Barbosa-Filho and Taylor (2006) conducted a study to test whether the US economy, in the period from 1929 to 2002, would be a profit-led or wage-led regime. By using VAR methodology to study the interaction between capacity utilization and the wage share, the authors concluded that the US economy operates under a profit-led regime.

4.3.5 Post-Kaleckian model applied to the Brazilian Economy

The first empirical exercises applied to the Brazilian economy were performed by Bruno (2003). The result indicates that the Brazilian economy operated under a wage-led regime between 1945 and 1974, profit-led between 1970 and 1990 and wage-led between 1991 and 2001. Following Bowles and Boyer (1995), the author estimated three equations:

$$I/K_t = \alpha + r_{t-1} + u_{t-1} \quad (4.51)$$

$$\sigma_t = contant + \sigma_\pi \prod_t + \sigma_\omega W_t \quad (4.52)$$

$$NEX_t = constant + \pi_{t-1} + u_{t-1} + \theta_{t-1} \quad (4.53)$$

where NEX is the net export normalized by real capital stock (K). The saving estimation appears to have problems with autocorrelation. There is no discussion about econometric problems in the results discussion. The other problem is related with the numbers of observations, which seems to be limited. It was used annual data.

Araujo and Gala (2012) applied the same equation as Bruno (2003) to study the regime demand to Brazil using quarterly data from 2002 to 2008. The result suggests a profit-led regime for the Brazilian economy for the analysed period.

Oreiro and Araujo (2013) build a growth model considering a non-linear real exchange rate. Also, the authors consider that there is a desired capital accumulation rate that is maximized by a critical value of the real exchange rate. In order to analyse non-linearities of the real exchange rate and possible deviations from the critical level that maximized the desired capacity utilization the authors estimated the following three equations using quarterly data from 1994 to 2008:

i) Capital accumulation equation:

$$lng = lnI/K_t = \alpha + ln\, \pi_{t-1} + ln\, u_{t-1} + ln\, \theta_{t-1} - ln\, \theta_{t-1}^2 \quad (4.54)$$

The real exchange rate is positively related with capital accumulation because devaluation on real exchange rate increase profit share, thus investment, and through the term ($ln\, \theta_{t-1}^2$) the real exchange rate will be negatively related with capital accumulation because part of the input used in production is imported, so devaluation on real exchange rate can have a negative impact on investment.

ii) Profit share equation

$$ln\, \pi_t = contant + ln\, \theta_{t-1} \quad (4.55)$$

iii) Capacity utilization equation

$$ln\, u_t = contant + ln\, \theta_{t-1} + ln\, \theta_{t-1}^2 \quad (4.56)$$

Because the series are stationary of order (1), and there is at least one cointegration vector, it was applied the Ordinary Lest Square methodology, with variables lagged. The parameters were considered significant different from zero and with the expected sign. Merging the equation for profit share and capacity utilization into capital accumulation equation, it was obtained the following equation:

$$lng = \alpha_1 + \alpha_2 ln\, \theta - \alpha_3 ln\, \theta^2 \quad (4.57)$$

Taking the partial derivative of the capital accumulation in relation to real exchange rate, equalling to zero and solving for real exchange rate, it is reached:

$$ln\, \theta^* = \frac{\alpha_2 x}{2\alpha_3} = e^{\frac{\alpha_2}{2\alpha_3}} \quad (4.58)$$

which is the real exchange rate that maximizes the desired capital accumulation rate.

The econometric exercise does not analyse possible problems related with autocorrelation, simultaneity or misspecification. Moreover, the authors give the impression that lags on the independent variables solve all possible problems.

The model is very interesting. An important question to ask to the model, and also to the empirical exercise is that would be possible that with different pools for different years, the level of real exchange rate that maximizes the desired capital accumulation would change or would be constant.

Oreiro, Abramo and Garrido (2016) applied a similar strategy as used by Oreiro and Araujo (2013). The difference is that in the capital accumulation equation, they added the real interest rate and a tendency term. The period analysed was from 1995 to 2008 in quarterly data. The results were in line with Oreiro and Araujo (2013), in which the regime found was profit-led.

Camara, Feijo and Cerqueira (2014) show using the approach proposed by Bhaduri and Marglin (1990), that the demand regime for the Brazilian economy between 1951 and 1989 was profit-led. The result is explained by the context of a closed economy, noting that this period was demarcated by the import substitution process, and also by high inflation. In this context, aggregate demand and thus the accumulation of capital were impacted by the increase in profits share in the macroeconomic income.

4.4 Econometric exercise

In this section we analyse the interaction between the aggregate demand, the real exchange rate, productivity and real wages for the Brazilian economy between 1960 and 2011 using the model developed above. At the moment when the data set was collected, the Brazilian Institute of Geography and Statistics (IBGE) had made available the data until 2011. The following equations were estimated:

Saving equation:

$$\sigma = \frac{s}{y} = \sigma_\pi + (\sigma_\omega - \sigma_\pi)\omega \tag{4.6}$$

Investment equation:

$$\hat{\imath} = \phi_0\hat{b} + \phi_1\hat{\pi} + \phi_2\hat{y} + \phi_3\hat{\theta} + \phi_4\hat{\theta}^2 \tag{4.13'}$$

Export equation:

$$\hat{x} = \hat{z} - \epsilon_1\hat{v} \tag{4.15}$$

In relation to the investment equation, a modified version of equation (4.13) is estimated. Besides the real exchange rate parameter ($\phi_3\hat{\theta}$), the real exchange rate squared ($\phi_4\hat{\theta}^2$) is introduced to test for nonlinearities.

The gross saving data are available from the IPEADATA database from 1960 to 2011. The gross saving is deflated by the Brazilian Index of Consumer Prices (IPCA). The gross domestic product (GDP), the GDP per capita (as a proxy for productivity) and the gross capital formation (as a proxy for investment) from 1960 to 2011 were also collected from the World Bank's World Development Indicators (WDI) database in constant values. For the wage share data from 1960 to 2008, the study uses the data presented by Marquetti and

Porsse (2013, 2014), and from 2009 to 2011 the data for this variable can be found on the National Account System (SCN) of the Brazilian Institute of Geography and Statistic (IBGE).

The profit share from 1960 to 2011 was obtained from Marquetti and Porsse (2013, 2014). The profit share is ($\pi = 1 - \omega$). In this case the data for the wage share are used.

The real exchange rate is calculated in the usual manner: $\theta = \frac{P^*}{P}E$, where P^* is the U.S. producer prices base of 100, in 2005, obtained from the IMF; P is the Brazilian consumer prices base of 100, in 2005, obtained from the IPEADA; E is the end-of-period nominal BRL/USD market exchange rate (buy); and θ is the real exchange rate from 1960 to 1979. From 1979 to 2011, the real effective exchange rate from the WDI (World Bank) is used.

The data for Brazilian exports and world income can be found on the WDI (World Bank) database from 1960 to 2011. To estimate equation (2), or ($\hat{v} = \hat{w} - \hat{\lambda}$), the data for the real wage growth rate are necessary. For 1960 to 2008, the data can be found in Marquetti and Porsse (2013, 2014), and, from 2009 to 2011, the data for this variable are available from the National Account System (SCN) of the Brazilian Institute of Geography and Statistics (IBGE).

To estimate the equations, many tests are carried out, such as the Breusch–Godfrey serial correlation test (LM), ARCH heteroskedasticity test, multiple breakpoint test, unit root test (KPSS) and cointegration test (in the case that the variable in a particular equation is stationary in the first difference). All the tables containing the test results are reported in the appendix.

Table 4.4: Estimates of saving, investment, export, and productivity equation

Equation	(4.18) $\hat{\lambda}$	(4.6) σ	(4.13) $\ln i$	(4.15) $\hat{x}$
Constant	-0.02		-0.01	
	(-1.76)		(-0.46)	
σ_π		0.42		
		(2.49)		
$(\sigma_\omega - \sigma_\pi)\omega$		-0.51		
		(-1.27)		
$ln\ \pi$ (-1)			-0.83	
			(-1.43)	
Dln y (-1)	0.50		1.63	
	(2.80)		(3.78)	
$Dln\ \theta$ (-1)	0.08		-0.14	
	(1.92)		(-1.99)	
$Dln\ \theta^2$ (-1)	-0.05		0.08	
	(-1.63)		(0.95)	
$\hat{z}$				4.04
				(1.91)
$\epsilon_1 \hat{v}(-1)$				-0.07
				(-0.10)
$Dln\ w$ (-1)	0.13			
	(1.73)			
Dummy	Yes	Yes	No	Yes
Adj. R^2	0.15	0.56	28	0.14
SE	0.03	0.03	0.09	0.25
D.W	1.93	1.70	2.17	2.02
F-stat.	2.48	22.76	3.31	NA
prob>F	0.03	0.00	0.00	NA
obs.	51	51	51	51
Period	1960-2011	1960-2011	1960-2011	1960-2011

Note: The estimation method was Least Squares corrected by HAC standard errors & covariance (Bartlett kernel, Newey-West fixed for equation all equations. The t–statistics are the numbers in parentheses below each coefficient. SE is the standard error. D.W. is Durbin–Watson statistic. F is the F-statistic and prob > F is the probability associated with observing an F-statistic. For the productivity and saving equation it was applied an AR (1) and for the investment equation it was applied an ARMA (2,2).

Productivity estimation

The productivity equation is estimated using an LS model corrected by the HAC matrix, and an AR (1) is applied, hence solving the issues related to autocorrelation and heteroskedasticity.[4] The estimated Kaldor–Verdoorn coefficient is 0.50. Marinho *et al.*'s

[4] The most appropriate model is the OLS corrected by the HAC matrix, since this methodology corrects problems related to autocorrelation and heteroskedasticity.

(2002) coefficient is 0.45. The estimation in the present research is quite close to the results obtained by Hein and Tarassow (2010) in a study of Europe. At the same time, the results found in this study are smaller than those of Naastepad (2006) and Naastepad and Storm (2007).

The real wage coefficient presents a positive sign, and it is significant at the 10% level. Because the parameter is positive, this indicates a wage-led regime.

The real exchange rate ($Dln\ \theta$ (-1)) coefficient is 0.08, and it is significant at the 5% level. The real exchange rate squared ($Dln\ \theta^2$ (-1)) is negative and significant at the 10% level. This result can be explained by two factors. First is the possibility that the real exchange rate can be nonlinear in relation to productivity. The idea is similar to the argument put forward by Missio and Jayme Jr (2013), in which the real exchange rate can have a nonlinear relation with capital accumulation. In the case of this study, until a certain level, real exchange rate devaluation can increase the profit share, which increases firms' internal funds, so it can increase productivity due to higher innovation levels. Real exchange rate devaluation can increase the import prices of production components, exerting a negative impact on productivity.

Saving estimation

In relation to the saving equation, since there is evidence that the series are stationary, it is possible to estimate the equation using the OLS model corrected by the HAC matrix and an AR (1), since there is evidence of serial correlation and autocorrelation.[5] The coefficient σ_π is significant at the 1% level. The capitalist propensity to save is σ_π=0.42. However, the coefficient $(\sigma_\omega - \sigma_\pi)\omega$ is not significantly different from zero. From the results it is possible to suggest that workers do not save, as suggested by classical economists and Kalecki. Naastepad and Storm (2007) estimate a similar saving equation for advanced economies. The parameter σ_w is 0.10 for France, 0.09 for Germany, 0.17 for Italy, 0.12 for Japan and 0.15 for the Netherlands, while the parameter $(\sigma_\pi - \sigma_\pi)\ \pi$ is 0.30 for France, 0.39 for Germany, 0.35 for Italy, 0.38 for Japan and 0.57 for the Netherlands. These results

[5] The autocorrelation test is shown in the appendix of this research.

are in line with the classical economic and Kaleckian theory, in which capitalists' propensity to save is bigger than workers' propensity.

Investment estimation

As pointed out by Hamilton (1994), whether the time series are co-integrated or integrated of order one, the OLS method is a super-consistent estimator. In addition, the independent variables are taken with lags to avoid simultaneity. The profit share parameter is negative and non-significant, whereas the output growth parameter is positive and significant at the 5% level. Investment appears to respond more to output growth than the profit share, which suggests a demand growth regime of accumulation. The relation between the real exchange rate and investment is negative and significant at the 5% level. Nonlinearity is tested; however, the real exchange rate squared parameter is not significant.

The coefficient related to the profit share is -0.83, and it is not significant, which means that an increase in the profit share does not raise investment in the Brazilian case. In comparison with advanced economies, the parameter is 0.29 for France, 0.60 for Japan, 0.47 for the Netherlands, 0.56 for Germany, 0.50 for Italy, 0.54 for the UK and 0.48 for the US[i] (Storm and Naastepad, 2007). Oreiro and Araújo (2013) estimate a similar equation with quarterly data from 1994 to 2008, but instead of using the income variable to study the relationship between investment and demand, they use capacity utilization. In the present research, the income is used given that it fits the theoretical model better.

Furthermore, Oreiro and Araujo (2013) study nonlinearity in the real exchange rate using the variables in level. The outcome of their work for the profit share coefficient is 0.66, which is quite close to the coefficient estimated in this research. Gala and Araujo (2002) estimate a similar equation using quarterly data from 2002 to 2008, but instead of using the profit share, they use the profit rate, and they use capacity utilization for the aggregate demand; however, the authors estimate the investment equation in level, whereas in this study the investment equation is estimated in first difference. Bhaduri and Marglin (1990, p. 379) argue that "Given the accountants' book value of capital in the short period, the average rate of profit [...] depends [...], on both the profit margin/share and the degree of capacity utilization".

The demand coefficient for Brazil is 0.53. Again, in contrast to advanced economies, considering only the results that are significant, the coefficient is 0.30 for the UK, -0.11 for

France, 0.16 for Spain and 0.12 for the US. In Brazil the elasticity to invest in relation to the aggregate demand is higher than that in advanced economies, meaning that investment responds more effectively to the aggregate demand in Brazil than it does in advanced economies.

The real exchange rate coefficient (-0.14) is significant. The real exchange rate is negatively related to investment growth. This result, however, does not disagree with Rodrik (2008), Rapetti *et al.* (2012) and Missio *et al.* (2015). In their work, the focus is on the real exchange rate misalignment. In the present research, the focus is in the real exchange rate as such. It is possible that, in the case in which the real exchange rate policy considers the issue highlighted by these authors, the real exchange rate would be positively related to investment growth.

Export estimation

Since the series saving and wage share are stationary, the LS method can be applied. The result for the export equation (4.15) shows that the coefficient related to the real unit labour cost has the expected sign (negative), although it is not significantly different from zero. Nevertheless, the coefficient of world trade ($\hat{z}$) has the expected signal and is significantly different from zero. Therefore, this result rejects the possibility that reducing the real wage would increase the export growth rate. For advanced economies, such as France, Germany, Italy, Japan, the Netherlands, Spain, the UK and the US, as shown by Naastepad and Storm (2007), the world trade is highly significant, and the unit labour cost is significant for all countries. The exception is Japan, for which these parameters are not significant. For the advanced countries, besides world trade, the unit labour cost is important in explaining exports. For Brazil reducing the real unit labour costs does not boost exports, as can be seen in the econometric experiment.

Wage-led or profit-led?

Given that the productivity, investment, saving and export equations are estimated, it is possible to evaluate whether the regime is profit- or wage-led by using equation (4.20) and calculating the outcome. The result is given below:

$$\frac{d\hat{y}}{d\hat{w}} = C = \frac{[\xi(\sigma_\pi - \sigma_\omega) - \psi_x \epsilon_1 - \psi_i \phi_1 \alpha]}{[1 - \psi_i \phi_2]} = 0.189 \qquad (4.20')$$

The result suggests that the Brazilian economy, considering the period between 1960 and 2011, operated under a wage-led regime. In contrast to Naastepad and Storm (2007), France, Germany, Italy, the Netherlands, Spain and the UK were wage-led, whereas the US and Japan were profit-led. The outcome of this research is different from the result obtained by Bruno (2003)[6], Gala and Araujo (2012), Oreiro and Araújo (2013), Camara *et al.* (2014) and Oreiro *et al.* (2013). The present model takes into consideration not only the real exchange rate's effect on investment and productivity but also the possibility of the labour unit cost being related to export growth. As a consequence, different results are to be expected.

Using the estimations from the productivity equation and the result of the demand regime (C =0.189), which is obtained from equation (4.20'), it is possible to calculate equation (4.28) in the following way:

$$\frac{d\hat{y}}{d\hat{w}} = \bar{\gamma} = \frac{(1-\beta_2)C}{1+\beta_1 C} = 0.15 \qquad (4.28')$$

The total impact of a 1-percentage-point decline in real wage growth on output growth is -0.15 percentage points. The Kaldor–Verdoorn effect is important in increasing the profit share given that a rise in output growth has a significant impact on productivity growth (β_1). However, a reduction in real wage growth has a negative impact on productivity growth (β_2), which makes the economy less wage-led, even though, for the Brazilian economy, the β_2 coefficient is smaller than β_1. The outcome for equation (4.28) for EU countries is 0.16, as can be found in Storm and Naastepad (2012).

Using the estimated parameters, the relationship between the demand regime and the real exchange rate is:

$$\frac{d\hat{y}}{d\hat{\theta}} = \bar{\delta} = -\frac{\beta_3 C}{1+\beta_1 C} = 0.013 \qquad (4.29')$$

The overall sign is positive, which means that exchange rate devaluation will increase the aggregate demand. This outcome agrees with Rodrik (2008), Rapetti *et al.* (2012) and

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[6] However, this author divides the Brazilian economy into two periods: i) the first period from 1970 to 1990; and ii) the second period from 1991 to 2001. Based on some econometric evidence, the author argues that the Brazilian economy operates under a profit-led regime in the first period and under a wage-led regime in the second period.

Missio *et al.* (2015). The purpose of their work is to study a real exchange rate index that takes into account the difference between the prices in the tradable and non-tradable goods sectors. There is a tendency to reduce the prices of tradable goods, because it is assumed that the productivity growth is faster in this sector than in the non-tradable goods sector. The results presented here are related to a structuralist model in the sense that the income distribution and aggregate demand are related to the real exchange rate.

The relationship between the demand regime and productivity is:

$$\frac{d\hat{\lambda}}{d\hat{w}} = \frac{\beta_2+\beta_1 C}{1+\beta_1 C} = 0.20 \qquad (4.30')$$

A decline in real wage growth has a negative impact on output due to the magnitude of the parameters β_1 and β_2. The Kaldor–Verdoorn effect is stronger than real wage growth. For EU countries the result of equation (4.30) is 0.46, which means that the decline in real wage growth and its impact in EU countries is much larger than it is in Brazil.

The total effect on productivity growth of real exchange rate devaluation is:

$$\frac{d\hat{\lambda}}{d\hat{\theta}} = \beta_3 + \beta_1 \frac{-(\beta_3 C)}{1+\beta_1 C} = 0.07 \qquad (4.31')$$

This result suggests that real exchange rate devaluation has a positive impact on productivity. This outcome agrees with Missio and Jayme Jr's (2013) finding that the real exchange rate increases the effort to achieve innovation.

In the case of the present research, the model is constructed taking into consideration the features related to the post-Kaleckian model and the real exchange rate as such. In fact, the discussion in this research opens the door to discussing the real exchange rate index. Razmi *et al.* (2012) propose a model that considers income distribution and the price differences between non-tradable and tradable goods sectors. However, it is a theoretical approach. Future research can address this issue from an empirical point of view.

The relationship between the demand regime and the employment level is:

$$\frac{d\hat{l}}{d\hat{w}} = \frac{(1-\beta_1-\beta_2)C-\beta_2}{1+\beta_1 C} = -0.17 \quad (4.34')$$

A 1-percentage-point decline in real wage growth raises employment growth by 0.17 points. This result reinforces the wage-led regime. The outcome of equation (4.34) for the Dutch economy is -0.29; in this case a decline in real wage growth increases employment growth (Strom and Naastepad, 2012).

It is possible to analyse the impact of real exchange rate variation on employment as follows:

$$\frac{d\hat{l}}{d\hat{\theta}} = \left[-\frac{\beta_3 C}{1+\beta_1 C}\right] - \left[\beta_3 + \beta_1 \frac{-(\beta_3 C)}{1+\beta_1 C}\right] = -0.001 \quad (4.33')$$

Therefore, devaluation of the real exchange rate has a negative impact on employment, which is not surprising if it is compared with the previous outcomes.

4.5 Conclusions

This research analysed the relationship among the demand regime, productivity growth and the real exchange rate. Even if the aggregate demand regime is wage-led, exchange rate devaluation can exert a positive impact on productivity. The opposite can also occur, even if the demand regime is profit-led. In this case exchange rate devaluation can have a negative impact on productivity and thus on economic growth. Furthermore, there are lacks in theoretical and empirical studies regarding the relationship between the macroeconomic indicator and the demand regimes.

An empirical exercise is performed for Brazil between 1960 and 2011, showing a wage-led regime. Based on the results of the export equation, the possibility that reducing real wages would increase the export growth rate is rejected. The results of the investment equation indicate that the profit share is not significant, meaning that the profit share does not explain investment; whereas the aggregate demand explains investment growth, the real exchange rate is negatively related to investment, and this negative relation with the real exchange rate is also shown in an econometric exercise performed by Araujo and Gala (2012). The outcomes of the productivity equation show that the Kaldor–Verdoorn effect is considerable compared with real wage growth. The impact of real wage growth on productivity growth is positive, indicating a wage-led regime. Furthermore, a decline in real wage growth has a negative impact on output growth. A reduction in real wage growth has a negative impact on productivity growth, which makes the economy wage-led. Therefore, the interaction between the demand regime and the real exchange rate shows that devaluation will have an ambiguous impact on the economy. Real exchange rate devaluation has a negative relationship with investment but a positive impact on productivity. From the results found in this research, the Brazilian economy operates in a wage-led demand regime.

CHAPTER 5. A POST-KALECKIAN MODEL CONSIDERING THE EXTERNAL EQUILIBRIUM APPLIED TO BRAZIL: 1960-2011

5.1 Introduction

The Balance of Payment Constrained Growth (BPGC) model first developed by Thirlwall (1979, 2011) is important to explain the developing economies experience (Jayme Jr, 2003; Britto; McCombie, 2009; Alencar; Strachman, 2014). However, as indicated by Seguino (2010), Ribeiro *et al.* (2016) and Ribeiro (2016) there is an understanding lack about the relationship between the Post-Kaleckian approach and BPCG theory. This research novelty is to integrate in a simple model the Post-Kaleckian and BPCG features.

The purpose of this chapter is to analyse whether the Brazilian economy operates under a wage-led or profit-led regime between 1960 and 2011, considering a model that integrates features of the Post-Kaleckian and BPGC approaches. The time period is limited by the data availability, especially; the series related to unit labour cost were collected on the Brazilian Institute of Geography and Statistics (IBGE), which is available until 2011.

To answer the question whether the Brazilian economy function under a wage-led or profit-led regime, it is proposed a simple model that integrates Post-Kaleckian features with the BPCG model. The proposed model suggests that a profit-led regime is more likely, if compared with Naastepad (2006), when Post-Kaleckian and BPCG features are combined. Moreover, for the Brazilian case, it is achieved a wage-led regime when a BP constrained growth is taken in consideration; however the real exchange rate has a positive impact on economic growth, through the export channel. This result is a novelty in the recent literature about the relationship between real exchange rate and economic growth within a Post-Kaleckian model. The Brazilian economy was chosen for being one of biggest economies in Latin America.

To achieve the purposed objective, in the second section the basic Thirlwall's model is discussed and some attempts to integrate the Post-Kaleckian approach to the BPGC model are discussed. In the sequence, the interaction among BPCG, income distribution and real exchange rate in a formal model is discussed. In section five an econometric exercise based on the model presented in this chapter is performed. Conclusions are discussed in the last section.

5.2 The Thirlwall's approach

The balance of payments approach was originally developed by Thirlwall (1979, 2011). Assuming that net flows of foreign capital are zero and the terms of trade remain constant, Thirlwall concludes that a country's long-term income growth rate is conditioned by the export growth rate in relation to demand income elasticity for imports, and in models that include capital flows, the long-term net balance of the capital account (Thirlwall; Hussain, 1982; Moreno-Brid, 1998-99, 2003; Barbosa Filho, 2002, 2004).

Thirlwall's Law can be represented by $y = x/\varphi$, which means that in the long run the domestic income rate growth corresponds to the export growth rate divided by the income elasticity of demand for imports. This dynamic is equivalent to Harrod trade multiplier (Harrod, 1933), as improved by Kaldor (1966, 1975) and by Kennedy and Thirlwall (1979, 2011).

In the Thirlwall's original model, the growth rate compatible with balance of payments equilibrium is a direct relation between the income elasticity of external demand for its exports and the income elasticity of demand for imports. In equilibrium:

$$\frac{Y_d}{Y_w} = \frac{\eta}{\varphi} \quad (5.1)$$

where:

Y_d = domestic income growth rate; Y_f = foreign income growth rate; η = income elasticity of demand for exports; φ = income elasticity of demand for imports. The external equilibrium condition is as follows:

$$\mathrm{P_d X = P_f M E} \quad (5.2)$$

where X is export volume, $\mathrm{P_d}$ is the domestic price of exports, M is import volume, $\mathrm{P_f}$ is the foreign price of imports, and E is the nominal exchange rate. Equation (5.2) expressed in terms of growth rates is:

$$p_d + x = p_f + m + e \qquad (5.3)$$

External demand for exports, likewise internal demand for imports, depends on relative prices, price and income elasticities, domestic and foreign income (Y and Z respectively), it follows that:

$$M = a\left(\frac{P_f E}{P_d}\right)^{\vartheta} Y^{\varphi} \qquad (5.4)$$

$$X = b\left(\frac{P_d}{P_f E}\right)^{\eta} Z^{\varepsilon} \qquad (5.5)$$

where "a" and "b" are constant, ϑ is the price elasticity of imports, φ is the income elasticity of demand for imports, η is the price elasticity of exports, and ε is the income elasticity of demand for exports. Equations (4) and (5) expressed in terms of growth rates are as follows:

$$\hat{x} = \eta\,(p_d - e - p_f) + \varepsilon\hat{z} \qquad (5.6)$$

$$\hat{m} = \vartheta\,(p_f + e - p_d) + \varphi\hat{y} \qquad (5.7)$$

Substituting (6) and (7) into (3) and solving for y gives the solution for the economic growth rate consistent with balance of payments growth:

$$Y_{BP} = \frac{(1 + \eta + \vartheta)\,(p_d - p_f - e) + \varepsilon z}{\varphi} \qquad (5.8)$$

Considering that the real exchange rate is constant (*e=0*), and assuming that external inflation is equal to domestic inflation (*pd-pf=0*), then equation (8) is simplified to the expression known as Thirlwall's Law:[7]

$$Y_{BP} = \frac{x}{\varphi} \qquad (5.9)$$

In the long-run expansion of a country's real domestic income is given by the ratio of export growth to the income elasticity of imports (Moreno-Brid; Pérez, 2003; Britto; McCombie, 2009; Alencar; Strachman, 2014). Since the basic features of the BPCG model

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[7] In which x = εz , by definition.

has been presented, the discussion of the attempts to integrate the Post-Kaleckian and BPCG model is introduced next.

Seguino (2010) explores the relationship between the BPCG theory with gender inequality, and thus income distribution. The model is based in stylized characteristics of semi-industrialized economies. Such economies produce manufactured goods that require low technological know-how, imported intermediate inputs and capital goods that are used in the domestic production, which makes the price elasticity of imports inelastic. The export is based on the Verdoorn-Kaldor approach, already discussed in chapter (3), notably, the argument that income growth increases productivity growth. In this model, export growth plays an important role in increasing productivity growth, as emphasised by Kaldor (1956). Although the author bases part of his model on export, in the formal model, he normalizes the exchange rate to 1, which means that he ignores changes in real exchange rate. The gender inequality is considered in the model through the ratio of nominal female-to-male wages, hence it is possible to differentiate the wage share of female and male in the income, that leads to differences on propensity to save based on gender. In the model, these differences will impact on the BPCG through export and investment. Thus, increase in gender inequality leads to decrease in investment and export, which can hurt economic growth through the BPCG. The author argues that gender inequality impact is unlikely to be transitory, and this inequality can change the long run economic growth path of the economy.

Ribeiro *et al.* (2015) combines the BPCG with Post-Kaleckian approach. In their model, the variable price is substituted by unit labour costs, as suggested in most models based on Kalecki's work. Therefore, the income distribution is incorporated in the BPCG. Further, the authors introduce the unit labour costs in relation to productivity growth, which opens the door for the Verdoorn-Kaldor's law. One emphasised supposition made by the authors is that in the long run, the wage share converges to labour productivity growth, which is, of course, unlikely for developing economies, as it was argued in chapter two. In addition, the income elasticity of export and import ratio $(\frac{\varepsilon}{\varphi})$ is endogenized. The elasticities ratio depends on wage share and technological process. In sequence, it is argued that technological progress depends on technological gap and profit share. Finally all the model aspects were combined, the authors argue that a currency devaluation net effect on the long run economic growth is ambiguous, since it depends on the size of change in the endogenous variables, i.e., technological gap, wage share, and technological process regime or, in other words, whether the regime is wage-led or profit-led. In fact, exchange rate devaluation would have effect on income elasticity of export and import. And it would have positive impact on non-price competitiveness through changes on income distribution and on technological change. This argument is interesting, since it would be possible to advise exchange rate devaluation to improve competitiveness. Furthermore, the authors conclude that the impact of exchange rate devaluation on growth is ambiguous and depends on several previews conditions, as it was already mentioned.

5.3 The model

The main objective of this section is to integrate the Balance of Payment Constrained Growth with aggregate demand, productivity and real Exchange rate in a simple model. The aggregate demand, as it was discussed in the last chapter can be expressed as follows:

$$y = c + i + x - m \tag{5.10}$$

where y is the output, c the aggregate consumption; i the aggregate investment; x the exports; and m the import goods. These variables are measured at constant prices. This aggregate demand definition is a standard one. Further, this aggregate demand is integrated in a Post-Kaleckian approach, as it was argued in the introduction. In the Post-Kaleckian model, an important feature is the distinction between the wage share and profit share. The wage share can be defined as:

$$\omega = (W/P)\lambda^{-1} = w\lambda^{-1} \tag{5.11}$$

in which ω as real cost of labour per unit of output, where ω is defined as the wage share, W the nominal wage, P the price, and finally λ the productivity. Since the wage share has been defined, the profit share is straightforward:

$$\pi = 1 - \omega \tag{5.12}$$

Taking equation (5.12) in growth rate, the following is reached:

$$\hat{\pi} = \frac{\Delta\pi}{\pi} = -\frac{\omega\Delta\omega}{\pi\omega} = -\alpha\hat{\omega} \tag{5.13}$$

Since it was already defined the wage and profit share, another important feature in the Post-Kaleckian model is introduced, namely the propensity to save. Marginal propensity to save as suggested by Bowles and Boyer (1995) is denoted by σ, which is different for workers (σ_w) and capitalists (σ_π). Therefore $(1-\sigma)$ is the consumption, where $(\sigma_w < \sigma_\pi)$ means propensity to save of the workers is lower than the capitalists. Naastepad (2006) and Naastepad and Storn (2007) follow Bowles and Boyer (1995) in the definition of the propensity. Then, the consumption function is expressed as:

$$c = (1-\sigma_\omega)\omega y + (1-\sigma_\pi)\pi y = [(1-\sigma_\omega)\omega + (1-\sigma_\pi)(1-\omega)]y;\ \sigma_\pi > \sigma_\omega \quad (5.14)$$

Bowles and Boyer (1995), Naastepad (2006) and Naastepad and Storn (2007) estimate the marginal propensity to save as follows:

$$\sigma = \frac{s}{y} = \sigma_\pi + (\sigma_\omega - \sigma_\pi)\omega \quad (5.15)$$

In this research, the estimation is performed with a minor difference, as it can be seen further in this chapter. Substituting (5.14) into (5.10) and rearranging the terms, it is reached:

$$y = \frac{i+x-m}{[1-(1-\sigma_\omega)\omega+(1-\sigma_\pi)(1-\omega))]} = \mu^{-1}[i+x-m] \quad (5.16)$$

or

$$y = \mu^{-1}[i+x-m] \quad (5.17)$$

Note that $\mu^{-1} = 1/[1-(1-\sigma_\omega)\omega + (1-\sigma_\pi)(1-\omega))]$ is the Keynesian multiplier, as defined by Naastepad (2006). The magnitude of the multiplier depends on ω. As usual, taking the total differentiating of equation (5.17), dividing by "y" and rearranging the terms, it is obtained the following expression for demand-led output growth:

$$\hat{y} = -\hat{\mu} + \frac{\mu^{-1}i}{y}\hat{\imath} + \frac{\mu^{-1}x}{y}\hat{x} - \frac{\mu^{-1}m}{y}\widehat{m} = -\hat{\mu} + \psi_i\hat{\imath} + \psi_x\hat{x} - \psi_m\widehat{m} \quad (5.18)$$

where ψ_i, ψ_x and ψ_m are the (adjusted multiplier) share of product in the investment, exports and imports, respectively. Note that in this model, the multiplier is also adjusted by the import share. As it was observed in chapter four, the multiplier is endogenous. Any change in the wage share is reflected in μ. Using the following expression for μ,$[\sigma_\pi +$

$(\sigma_\pi - \sigma_\omega)\omega = \mu]$, it is possible to differentiate the output growth rate as a function of growth rate of wage share, the outcome is shown below:

$$\hat{\mu} = -\frac{\omega}{\mu}(\sigma_\pi - \sigma_\omega)\omega = -\xi(\sigma_\pi - \sigma_\omega)\hat{\omega} \tag{5.19}$$

where ξ is a positive fraction of ω/μ. Following Bhaduri and Marglin (1990), the multiplier and the wage share determine the growth rate of investment, wherein i is positively related to the profit share π, output y and real exchange rate θ.

The real exchange rate can be a separate argument in the investment function. Several authors made this suggestion, among them Lima and Porcile (2013), Oreiro and Araujo (2013) and Missio and Jayme Jr (2013). Because the relationship between the real exchange rate and investment growth is an important feature in this model, it is necessary some discussion about the theme.

Campos and Rezende (2009) highlights transmission channels in which the real exchange rate devaluation would have impact on economic growth. The first transmission channel is related with the argument that if the real exchange rate is overvalued, there is a tendency to deficits in the trade balance. As an upshot, it leads to Balance of Payment crises, hurting growth. There is robust evidence that real exchange rate overvalued leads to Balance of Payment crises, notably for developing countries. Among authors that show this relationship are Aurelio (1997), Batista Jr (2002), Bresser-Pereira and Gala (2007), Carcanholo (2002), Alencar and Scarano (2010), Porcile *et al.* (2011), Munhoz and Libânio (2013) and Alencar and Strachman (2014b). Balance of Payment crises is still an issue for developing countries, however, such countries have difficulties to maintain a real exchange rate in a level that would even the trade balance, since it seems that these countries use the real exchange rate as a tool to control inflation. The next transmission channel is related to exchange rate misalignment. As this argument has been discussed in the chapter four, only the main key points are mentioned in this chapter.

In relation to real exchange rate misalignment, there are three main forms to consider exchange rate misalignment: i) the Balassa-Samuelson effect; ii) PPP effect, and; iii) the industrial disequilibrium effect. For all this exchange rate misalignment there is robust empirical evidence, as it was discussed in chapter four. In relation to exchange rate policy derived from these theories, the exchange rate misalignment correction would lead to economic growth.

Rodrick (2008) argues that real exchange rate devaluation boosts economic growth. The transmission channel is through the industrial sector, notably the tradable sector. This author proposes a real exchange index to analyse the effect of real exchange rate devaluation on growth. The argument is related with the non-tradable and tradable sector. For this author, there is a tendency to decrease prices in the tradable sector, since in this sector the productivity growth is higher. Then, the real exchange rate has a tendency to be overvalued. Besides the Balassa-Samuelson effect, as highlighted by Missio, Jayme Jr, Oreiro and Britto (2015b), the real exchange rate devaluation can change the relationship between the elasticities of export and import within BPCG model. Moreover the real exchange rate devaluation can have a nonlinear relation with economic growth as pointed out by Rapetti et al. (2012), Oreiro and Araujo (2013), Missio, Jayme Jr, Oreiro and Britto (2015b). There is strong empirical evidence for this real exchange rate misalignment that can be found in Bragança and Libânio (2008), Araujo (2009), Rapetti *et al.* (2012), Oreiro and Araujo (2013), Nassif *et al.* (2015), Missio, Jayme Jr, Oreiro and Britto (2015b). Besides the exchange rate misalignment considering the Balassa-Samuelson effect, there is the PPP effect that is discussed next.

Other researches relate overvalued currency with low per capita income growth rate. The empirical evidence for this relationship can be found in Cavallo *et al.* (1990), Dollar (1992), Razin and Collins (1997), Benaroya and Janci (1999), Acemoglu *et al.* (2002) and Fajnzylber *et al.* (2002). Since such corrections are not taken place, it is possible to find a negative relationship between the real exchange rate and investment growth. In a similar argument line, Gala (2008) studied the relationship between economic growth and a real exchange rate corrected by the Balassa-Samuelson effect and Purchase Power Parity (PPP) effect (i.e., another index for the real exchange rate). The PPP takes under consideration several aspects of different economies, such as subsidies applied by the government, costs of transport, customs duties, and so on. The author finds robust empirical evidence in favour to real exchange levels relevance to explain per capita income growth rates for several countries in different continents. The upshot is that the real exchange rate devaluation boosts economic growth, which means that the correction of real exchange rate raises per capita income rate. Once more, it is confirmed that exchange rate misalignment hurts growth. These finds are consistent and robust from a theoretical and empirical view point, however, it seems difficult to be implemented as exchange rate policy.

Barbosa-Filho (2006), Missio and Jayme Jr (2013), Campos, Jayme Jr and Britto (2013) and Missio, Jayme Jr, Oreiro and Britto (2015b) argue that the real exchange rate level can change the ratio relationship between import and export income elasticities within a BPCG model. The main argument is that if the real exchange rate were in the correct level, it would boost the industrial sector, which would be direct towards the sector with higher technological production. The most import evidence for this theory is provided by Campos, Jayme Jr and Britto (2013) and Missio, Jayme Jr, Oreiro and Britto (2015b).

Following Oreiro and Araujo (2013), Missio and Jayme Jr (2013) and Lima and Porcile (2013), the exchange rate should be a separate component in the investment function. This is due to the fact that exchange devaluations increase profits, and, also investment. However, following Missio and Jayme Jr, Rapetti et al (2012) and Oreiro and Araujo (2013), the relationship between real exchange rate and investment growth can be either positive or negative. On one hand, real exchange rate devaluation can boost export and trigger investment growth, thus, the relationship is positive. On the other hand, after some level, real exchange rate devaluation might increase the import cost of imported physical capital, which leads to decrease investment. Including the real exchange rate in the investment function, it is reached the following expression:

$$i = a_i b^{\phi_0} \pi^{\phi_1} y^{\phi_2} \theta^{\phi_3} \quad \phi_0, \phi_1, \phi_2 > 0\ ;\ \phi_3 \gtrless 0 \tag{5.20}$$

where a_i is a positive constant and b represents the '*animal spirits*' of entrepreneurs. Taking the above equation in terms of growth rates:

$$\hat{\imath} = \phi_0 \hat{b} + \phi_1 \hat{\pi} + \phi_2 \hat{y} + \phi_3 \hat{\theta} \tag{5.21}$$

the coefficient ϕ_1 is the elasticity of investment in relation to profit share, ϕ_2 is the elasticity of investment in relation to demand (output), and ϕ_3 is the elasticity of investment in relation to real exchange rate.

Substituting equations, (5.6), (5.7), (5.13), (5.19), (5.21) into (5.18), it is obtained the following equation:

$$\hat{y} = \frac{[\psi_i \phi_0 \hat{b} + \psi_x \varepsilon \hat{z}]}{[1+\psi_m \varphi - \psi_i \phi_2]} + \frac{[\xi(\sigma_\pi - \sigma_w) - \psi_i \phi_1 \alpha]}{[1+\psi_m \varphi - \psi_i \phi_2]} \widehat{w} + \frac{[\psi_i \phi_3 + \psi_x \eta - \psi_m \vartheta]}{[1+\psi_m \varphi - \psi_i \phi_2]} \hat{\theta} \tag{5.22}$$

The output grows with:

1) In order to the autonomous components being meaningful, it is required that $[1 + \psi_m \varphi - \psi_i \phi_2] > 0$, since $(0 < \psi_i < 1)$, elasticity of investment related to income should fall with: $0 \leq \phi_2 < (1/\psi_i)$; also the elasticity of imports related to income should fall with: $0 \leq \varphi < (1/\psi_m)$.
2) In relation to growth rate of wage share $[\widehat{\omega} = (\widehat{w} - \hat{\lambda})]$, the impact of increased wage share is ambiguous. If the real wage growth exceeds productivity growth $(\widehat{w} > \hat{\lambda})$, which means $(\widehat{\omega} > 0)$, it has two effects on output growth. It will reduce export and investment growth, and therefore the output. Or, it will increase the Keynesian multiplier, which means it will reduce the marginal propensity to save, to distribute income from profits to wages. This result is quite similar with the outcome in chapter four; however, it is not the same, since the equation denominator is different.
3) The real exchange rate relationship with income growth can be seen in the numerator $[\psi_i \phi_3 + \psi_x \eta - \psi_m \vartheta]$ of the equation (5.22). The economy growth rate is positively related to the income elasticity of investment and export. However the economic growth is negatively related with income elasticity of imports. In this model, the effects of the elasticities are moderated by the share of each of variables on income. Real exchange rate devaluation will have a positive or negative impact on investment, and a positive impact on export growth, but it will have a negative impact on imports.

Assuming that $(1 + \psi_m \varphi - \psi_i \phi_2) > 0$ and if the equation (5.22) is differentiated to respected with $\widehat{w}$, the demand regime is wage-led if:

$$\frac{d\hat{y}}{d\widehat{w}} = (\sigma_\pi - \sigma_w) > \left(\frac{i}{\pi y}\right) \phi_1 \tag{5.23}$$

If investment elasticity, based on profit share is relatively smaller than propensity to save (supposing that saving propensity by capitalists is greater than save propensity by workers) then the demand regime is wage-led. In this scenario increases in wage share will boost aggregate demand. It is important to notice that when the regime demand is analysed taking in consideration the theory of BPCG, the possibility of wage led demand is decreased. The present model is different from the approach presented by Naastepad (2006) and Storn and Naastepad (2007). In their model, they defined the export function as dependent on labour cost and world income. In the model present in this research, the export function depends on real exchange rate and world income. Conversely, if the investment demand elasticity is higher than propensity to save, the demand regime will be profit-led. This means that an increase in real wages will reduce economic growth.

Substituting [$\hat{\omega} = (\hat{w} - \hat{\lambda})$] in equation (5.22), the interaction between productivity and demand regime, in a profit-led economy is represented in the following expression:

$$\frac{d\hat{y}}{d\hat{\lambda}} > 0 \text{ if } (\sigma_\pi - \sigma_w) < \left(\frac{i}{\pi x}\right)\phi_1 \quad (5.24)$$

The reverse situation occurs (in comparison to $d\hat{y}/d\hat{w}$) when the derivative of equation is taken in (5.22) relation to $\hat{\lambda}$.

If the demand regime is wage-led, this is shown by the next equation:

$$\frac{d\hat{y}}{d\hat{\lambda}} < 0 \text{ if } (\sigma_\pi - \sigma_w) > \left(\frac{i}{\pi x}\right)\phi_1 \quad (5.25)$$

the negative impact on output growth of income redistribution implies that the growth rate of productivity is greater than the effects of an increase in investments (via profit share).

The derivative of equation (5.22) taken in relation to [$\hat{\omega} = (\hat{w} - \hat{\lambda})$] shows the demand led growth model:

$$\frac{d\hat{y}}{d\hat{w}} = C = \frac{[\xi(\sigma_\pi - \sigma_w) - \psi_i \phi_1 \alpha]}{[1 - \psi_i \phi_2]} \quad (5.26)$$

5.4 Interaction between productivity and aggregate demand

A simple formulation of endogenous productivity growth can be expressed as follows:

$$\hat{\lambda} = \beta_0 + \beta_1 \hat{y} + \beta_2 \hat{w} + \beta_3 \hat{\theta};\ \beta_0, \beta_{1,} > 0; 0 < \beta_2 < 1;\ \beta_3 \lesseqgtr 0 \quad (5.27)$$

Where $\hat{\lambda}$ is the growth rate of labor productivity, $\hat{y}$ the growth rate of real output, $\hat{w}$ the growth rate of the real wage, and $\hat{\theta}$ the real exchange rate. All the implications of this equation were discussed in chapter 3 of this research.

Substituting equations (5.26) into equation (5.19), assuming that $[\widehat{\omega} = (\widehat{w} - \hat{\lambda})]$, and equation (5.6), (5.7), (5.13), (5.21) into (5.18), it is obtained the interaction of aggregate demand and productivity:

$$\hat{y} = \frac{[-\xi(\sigma_\pi - \sigma_w)\beta_0 + \psi_i \phi_0 \hat{b} + \psi_x \varepsilon \hat{z}]}{[1 + \xi(\sigma_\pi - \sigma_w)\beta_1 + \psi_m \varphi - \psi_i \phi_2]} + \frac{[\xi(\sigma_\pi - \sigma_w)(1 - \beta_2) - \psi_i \phi_1 \alpha]}{[1 + \xi(\sigma_\pi - \sigma_w)\beta_1 + \psi_m \varphi - \psi_i \phi_2]}\widehat{w} + \frac{[-\xi(\sigma_\pi - \sigma_w)\beta_3 + \psi_i \phi_3 + \psi_x \eta - \psi_m \vartheta]}{[1 + \xi(\sigma_\pi - \sigma_w)\beta_1 + \psi_m \varphi - \psi_i \phi_2]}\widehat{\theta} \quad (5.28)$$

To the components being meaningful it is required that$[1 + \xi(\sigma_\pi - \sigma_w)\beta_1 + \psi_m \varphi - \psi_i \phi_2] > 0$, since, $\xi(\sigma_\pi - \sigma_w)\beta_1 > 0$ because the propensity to save out of profit is bigger than propensity to save out of wages. In addition $\beta_1 > 0$, by definition. Moreover, due to the fact that the term ξ is also positive. $(0 < \psi_i < 1)$ is the elasticity of investment related to income, and should fall with: $0 \leq \phi_2 < (1/\psi_i)$. Also the elasticity of imports related to income should fall with: $0 \leq \varphi < (1/\psi_m)$.

Differentiating the equation (5.28) with respect to $\widehat{\omega}$, it is reached:

$$\frac{d\hat{y}}{d\widehat{w}} = C = \frac{[\xi(\sigma_\pi - \sigma_w)(1 - \beta_2) - \psi_i \phi_1 \alpha]}{[1 + \xi(\sigma_\pi - \sigma_w)\beta_1 + \psi_m \varphi - \psi_i \phi_2]} \quad (5.29)$$

If:

$$\frac{d\hat{y}}{d\widehat{w}} = (\sigma_\pi - \sigma_\omega)(1 - \beta_2) > \left(\frac{i}{\pi y}\right)\phi_1 \quad (5.30)$$

Considering the above equation, the first term is $(\sigma_\pi - \sigma_\omega)(1 - \beta_2)$. Comparing this term with the equation (5.22), the term $(\sigma_\pi - \sigma_\omega)$ will be smaller, since $0 < \beta_2 < 1$. If the investment elasticity, based on profit share, is relatively smaller than propensity to save, supposing that saving propensity by capitalists is greater than save propensity by workers, multiplied by the term $(1 - \beta_2)$, then the demand regime is wage-led. In this scenario increases in wage share will increase aggregate demand. Conversely, if the investment demand elasticity is higher than propensity to save, considering the coefficient (β_2), the demand regime will be profit-led. This means that an increase in real wages will reduce economic growth. Differentiating equation (5.28) to respected with $\widehat{\theta}$, it is obtained:

$$\frac{d\hat{y}}{d\widehat{\theta}} = D = \frac{[-\xi(\sigma_\pi - \sigma_w)\beta_3 + \psi_i \phi_3 + \psi_x \eta - \psi_m \vartheta]}{[1 + \xi(\sigma_\pi - \sigma_w)\beta_1 + \psi_m \varphi - \psi_i \phi_2]} \quad (5.31)$$

The numerator in equation (5.31) can be positive or negative. In the case where it is negative, the valuation of the real exchange rate boosts economic growth. On the other hand, if the numerator is positive, real exchange rate devaluation is recommended to increase economic growth. From equation (5.31), in the case where the term $-[\xi(\sigma_\pi - \sigma_w)\beta_3]$ is positive, indicating that real exchange rate devaluation has positive effect on productivity growth, and the sum of this term plus $\psi_i\phi_3 + \psi_x\eta$ is bigger than $\psi_m\vartheta$, a real exchange devaluation growth is achieve, in this case, the overall numerator will be positive. In other words, if the relationship between real exchange rate and productivity growth plus the elasticity of real exchange rate and investment plus the price elasticity to export are (all together) bigger than the price elasticity to import, the real exchange rate devaluation leads to economic growth. Conversely, the overall outcome is negative, and it is achieved a real exchange rate valuation led economic growth.

The autonomous part of the equation (5.31) can be also positive or negative. Since there is no macroeconomic policy related to the autonomous part of the equation (5.31), this part of the equation is not discussed. Although it is possible to consider that the real exchange rate would affect the income elasticity to export, as it is discussed in Missio, Jayme Jr, Oreiro and Britto (2015b) and Ribeiro *et al.* (2016). Even though it could occur, this possibility is not the main focus of this research.

5.5 Econometric exercise

The data for Brazilian Gross Domestic Product (GDP) or (y), export (x), import (m) and World Income (z) can be found on World Development Indicators (WDI), World Bank, from 1960 to 2011. The real exchange rate was calculated in the usual manner: $\theta = \frac{P^*}{P}E$, where P^* is U.S. producer prices base 100 in 2005, the source was IMF. P is the consumer prices in Brazil base 100 in 2005, from 1960 to 1979, the source was IPEADA; E is the end-of-period nominal BRL/USD market exchange rate (buy); and θ is the real exchange rate. From 1980 to 2011 the real effective exchange rate was found in the WDI-World Banck.

The empirical analysis consists on estimate the imports and exports equation:

$$log\, M = constant + \varphi log\, Y + \vartheta\, log(p_f + e - p_d) \quad (5.32)$$

To estimate the exports equation, the same procedure is applied:

$$\log X = constant + \varepsilon log\ z + \eta\ log(p_d - e - p_f) \quad (5.33)$$

Since both equations are integrated of order (1), by the KPSS test, it is possible to estimate the equations (5.31) and (5.33) by applying the cointegration methodology. Based on the criteria for lag selection, it was chosen a VAR (1), it corresponds to a VEC (0). Considering that the Maximum Eigenvalue trace statistics accept the hypothesis of at least one cointegration vector, which means that the variables involved in the test have a long-term relationship. All these tests can be checked in the appendix of this chapter.

Exports estimation

Table 5.1: Exports equation – 1960-2011

	Vector Error Correction Estimates				
Long run equation	Constant	$ln\ x$ (-1)	$ln\ z$ (-1)	$ln\ \theta$ (-1)	@TREND(60)
	10.21	1.00000	1.098974	0.009663	-0.031491
			(0.36948)	(0.00287)	
			[2.97438]	[3.37204]	
Short run equation		D$ln\ x$ (-1)	D$ln\ z$ (-1)	D$ln\ \theta$ (-1)	
		(0.10958)	-0.006244	0.970290	
		(0.00214)	(0.02025)	(5.77600)	
		[4.16753]	[-0.30843]	[0.16799]	

Note: Standard errors in ( ) & t-statistics in [ ]

World income elasticity of export and the price elasticity are highly significant; although both present the expected sign. Usually, authors calculated the growth rate of export in the Balance of Payment constraint growth. Because of that, there is scarce work with estimation of the export equation.

Imports estimation

Table 5.2: Imports equation – 1960-2011

	Vector Error Correction Estimates				
Long run equation	Constant	$ln\ m$ (-1)	$ln\ y$ (-1)	$ln\ \theta$ (-1)	@TREND(60)
	26.64	1.00000	1.771369	- 0.110648	-0.084959
			(0.88543)	(0.01949)	
			[2.00058]	[-5.67800]	
Short run equation		D$ln\ m$ (-1)	D$ln\ y$ (-1)	D$ln\ \theta$ (-1)	
		0.051750	0.027378	1.906900	
		(0.02687)	(0.00678)	(0.82086)	
		[1.92571]	[4.03793]	[2.32304]	

Note: Standard errors in ( ) & t-statistics in [ ]

The income elasticity of imports presents the expected sign and it is significant. The price elasticity of imports presents the expected sign and is also significant. Lopez and Cruz (2000), Bértola, Higachi and Porcile (2002), and Lima e Carvalho (2009) found that the real exchange rate is not significant and with the opposite expected sign. Alencar and Strachman (2014) found the price elasticity of import significant but with the sign with opposite expected sign. Besides Brazil, these elasticities have been estimated for several countries with robust findings[8].

Given the outcomes for the productivity, saving and investment estimation from chapter four, table (4.4), and the results from tables (5.1) and (5.2), it is possible to calculate equation (5.29).

$$\frac{d\hat{y}}{d\hat{w}} = C = \frac{[\xi(\sigma_\pi - \sigma_w)(1-\beta_2) - \psi_i \phi_1 \alpha]}{[1+\xi(\sigma_\pi - \sigma_w)\beta_1 + \psi_m \varphi - \psi_i \phi_2]} = 0{,}22 \qquad (5.29')$$

In this case, the regime is wage-led, since the outcome of the equation (5.29') is positive. Comparing with equation (4.20) from chapter four, where the result was $C = 0{,}189$, the equation (5.29) outcome is stronger wage-led. Thus, when it is considered the BOPC in the model, increases the possibility of a wage-led regime, for the Brazilian case. Also, comparing with equation (4.28') from chapter four, where the regime growth was related with productivity growth, the result of $\frac{d\hat{y}}{d\hat{w}} = 0.15$. The results presented in this chapter are also wage-led, however, its outcome is bigger. Again, the result obtained in this work is different from the result reached by Bruno (2003), Araujo and Gala (2012), Oreiro and Araujo (2013), Camara *et al.* (2013), Oreiro *et al.* (2013). It can be due to the size of the database and how the model was built. In the present model, it is taken in consideration the real exchange rate effect on investment and productivity. Also, the BPCG aspect is considered in the model, notably, the price and income elasticity of export and import, as a

[8] Hansen and Kvedaras (2004) analyses the elasticities for the Baltics countries such as Estonia, Latvia and Lithuania, by using times series econometrics methods the authors estimated the price elasticity of import, that was -0.27, -0.44 and -0.26 respectively, and the income elasticity of import was 0.82, 1.51 and 0.72. Jeon (2009) analyses the import equation to China. The price elasticity of import was -0.58 and income elasticity to import 1.77. Thirlwall (2011) estimated the income elasticity to import to several countries, and the coefficient value is between 0.85 and 2.25. Moreno-Brid and Pérez (1999) estimated the income elasticity of import to countries in Central America, and found the coefficient between 1.10 and 3.70, the price elasticity of import between -0.44 and -1.63. Holland *et al.* (2004) estimated the income elasticity of import for several Latin American Countries, among these Brazil. The mentioned estimated elasticity was 2.16, for the period between 1951-2000.

result, it is expected to find different outcomes, since it is used a different model, with more variables. Again, by using the estimation results, it is possible to calculate equation (5.31).

$$\frac{d\hat{y}}{d\hat{\theta}} = D = \frac{[-\xi(\sigma_\pi - \sigma_w)\beta_3 + \psi_i\phi_3 + \psi_x\eta - \psi_m\vartheta]}{[1 + \xi(\sigma_\pi - \sigma_w)\beta_1 + \psi_m\varphi - \psi_i\phi_2]} = -0{,}04 \qquad (5.31')$$

For the relationship between economic growth and the real exchange rate, it is achieved a negative relation. Comparing with the result obtained in the last chapter, specifically with equation (4.29'), where the result was $\frac{d\hat{y}}{d\hat{\theta}} = 0{,}013$, the outcome of equation (5.31´) is negative, due to the fact that it was included the BPCG in the model. For the Brazilian case, although it is achieved a wage-led regime, when the BOP constraint growth model is taken in consideration, the real exchange rate has a negative impact on economic growth.

In relation to the real exchange rate misalignment discussion, it was argued that there is robust empirical evidence that the real exchange rate index boosts economic growth. It was seen that this index could be the Balassa-Samuelson effect, PPP effect, the industrial disequilibrium effect. The evidence for the Balassa-Samuelson effect can be found in Rodrik (2008), Bragança and Libânio (2008), Araújo (2009), Rapetti *et al.* (2012), Oreiro and Araujo (2013), Nassif *et al.* (2015), Missio *et al.* (2015b). Whereas, the evidence for the PPP effect can be found in Cavallo *et al.* (1990), Dollar (1992), Razin and Collins (1997), Benaroya and Janci (1999), Acemoglu *et al.* (2002) and Fajnzylber *et al.* (2002) and Gala (2008). It is interesting to notice that these authors found a positive relationship between real exchange rate devaluation through some kind of real exchange rate misalignment. In this research, by applying a Post-Kaleckian model that incorporates productivity growth and BPCG feature, it was reached opposite result. Although the real exchange rate devaluation can hurt investment, and aggregate demand, it can have a positive impact on productivity growth.

Krugman and Taylor (1978) present arguments to explain the reasons what aggregate demand falls when the exchange rate is undervalued. First, the devaluation raises prices of exports and imports. If the trade is in balance, and the terms of trade do not change, the price change is compensated. But if the increase in import prices overcomes the variation in exports, the net result will be a reduction of the country's income. Second, the depreciation of the real exchange rate redistributes income from wages to profits. This happens for two reasons: i) the monetary wages in the short term is rigid, then the depreciation of the exchange rate reduces the real wage; ii) exports increase the volume of income of exporters. Third, if the government budget is not in balance, it will have a compatible effect with impact on the income of the trade deficit. If the taxes are progressive, due to the devaluation, it will have a distribution of income from wages to profits, and greater participation on the economy of the collection tax. The devaluation transfers income from the private to the public, since, assuming ad valorem taxes, depreciation increases the price of imports, causing a positive impact on the collection of public sector.

5.6 Conclusion

The aim of this chapter was to combine productivity, real exchange rate and aggregate demand and BPCG in a formal model. Several authors, including Seguino (2010), Ribeiro et al. (2016) and Ribeiro (2016) argue that there is a lack of understanding about the relationship between the Balance of Payment Constrain Growth (BPCG) theory and the functional income distribution. In this chapter was advance in the understanding of this the subject.

Some aspects of the model can be highlight: i) in the model present in this chapter, when the income distribution is combine with BPCG, the possibility of wage-led regime is increased; ii) it is possible that even if an economy is profit-led, real exchange rate can boost economic growth, and, even if an economy is wage-led, real exchange rate devaluation can improve economic growth. This last result is possible because the investment and productivity equation are dependent of real exchange rate, as the import and export equations. Therefore, the real exchange rate devaluation can be positively or negatively related to investment and productivity.

An empirical exercise was performed for the Brazilian economy to the period between 1960 and 2011. For this country case, although the regime is wage-led regime, when a BOP constraint growth is taken in consideration, the real exchange rate has a positivity impact on economic growth. In relation to a whole literature on exchange rate misalignment such as Rodrik (2008), Bragança and Libânio (2008), Araújo (2009), Rapetti et al. (2012), Oreiro and Araujo (2013), Nassif et al. (2015), Missio et al. (2015b), Cavallo et al. (1990), Dollar (1992), Razin and Collins (1997), Benaroya and Janci (1999), Acemoglu et al. (2002) and Fajnzylber et al. (2002) and Gala (2008), it was reached in the model suggested in this chapter a positive relationship between real exchange rate devaluation and growth In fact, by using a Post-Kaleckian model which combines features of BPCG, it was obtained a similar result if it is compared with the exchange rate misalignment literature. The innovation in this research is that although the real exchange rate devaluation can hurt investment and productivity growth, as it can be seen in the estimative provided in this chapter, the overall outcome suggests that real exchange rate devaluation boost economic growth through the export channel.

Chapter 6: Conclusion

This research followed the Post-Kaleckian approach, in the sense that the capital accumulation and economic growth are driven by the growth of the demand (SETTERFIELD, 2003; Sawyer, 2012; Schoder, 2014).

In chapter two, the productivity approach within the Post-Kaleckian model was discussed, and it is applied to some Latin American countries. The purpose of this chapter was to analyse whether productivity growth is affected by income growth and employment growth for some selected Latin American countries. This chapter showed that the employment push coefficient was not significant for the majority of the countries. The exception is made to Uruguay, which shows a positive coefficient and highly significant, indicating a wage-led regime and Mexico, in which the parameter is negative indicating a profit-led regime. Nevertheless, for the other countries, these parameters were not significant. It is argued that this result confirms the Latin American Structuralist hypothesis. In fact, for the Latin American countries the productivity does not spread through the economy as the way it does in the advanced economies. Therefore, a rise in real wage growth (or employment growth) does not have a positive impact on productivity growth.

In chapter three, a Post-Kaleckian model with productivity growth and real exchange rate was discussed. Other secondary objective was to study the relationship between economic growth (through the so call Verdoorn coefficient) and the interaction between productivity growth and real wage growth. In this case, the real exchange rate is also related to the investment function, since the productivity growth is a separate argument in this mentioned function. The second novelty in this chapter was to perform empirical experiments, it is a novelty because there are few papers written on this subject, besides, there are less empirical experiments that include Latin American countries, such as Argentina, Brazil, Bolivia, Chile, Colombia, Mexico, Uruguay and Venezuela. The overall outcome is that the Kaldor-Verdoorn coefficient is significant for all analysed countries. Nevertheless, the estimated coefficients in this chapter are bigger than the parameters estimated to Latin American countries for other authors. Such studies include Acevedo et al. (2009), Borgoglio and Odisio (2015), Britto and McCombie (2015), Carton (2009), Destefanis (2002), Libanio (2006) and others. The reason for this discrepancy is related to the econometric method. Most of the studies applied to Latin American countries are performed by using panel data analysis, whereas in this research it is applied the LS method. Furthermore, the source of data is different, since in this research the dataset was collected on WDI – World Bank.

The wage-push variable presents the employment rate (L_{ne}). The parameter is significant for Brazil, Bolivia and Chile, and the parameters values are (0.39), (-0.10) and (1.08) respectively. Following Lavoie and Stockhammer (2012), Brazil and Chile can be considered wage-led regime, whereas Bolivia can be considered profit-led regime. In the case of Argentina, Colombia, Mexico, Uruguay and Venezuela the parameter is not significant. In relation to these last countries, the Latin American Structuralist School can explain this result. The point is that the way productivity growth is spread in Latin American countries is different than in advanced economies. For such countries, there are sectors with high and low productivity coexisting at the same time in the same economy. This heterogeneity in the productive sector slows down the productivity transmission. Therefore, real wage growth (employment growth) is not statistically significant. The parameter which expresses the relationship between the real exchange rate and productivity is also negative and significant for Brazil (-0.04), Bolivia (-0.05), Uruguay (-0.23) and Venezuela (-0.09). In this case, devaluation on the real exchange rate has a negative impact on productivity. This result means, for the analysed period, that the real exchange rate devaluation increases the cost of imported capital, reducing productivity growth. In addition, this parameter is not significant for Argentina and Mexico.

In chapter four, the Post-Kaleckian model as presented by Naastepad (2006) was applied. The purpose of this chapter four was to analyse the interaction between productivity growth, labour unit cost, real exchange rate and real wages growth for the Brazilian economy, between 1960 and 2011. An empirical exercise was performed for Brazil between 1960 and 2011, showing a wage-led regime. Based on the results of the export equation, the possibility of reducing real wage would increase the export growth rate is rejected. The results of investment equation indicate that profit share is statistically different from zero, which means that profit share does explain investment, whereas aggregate demand explains investment growth real exchange rate is negatively related to investment, this negative relation between real exchange rate is also shown in an econometric exercise performed by Araujo and Gala (2012). The outcomes of the productivity equation show that the Kaldor-Verdoorn effect is considerable compared to real wage growth. The impact of real exchange rate on productivity growth is negative but small; which might be due to the prolonged transmission mechanism. Furthermore, a decline in real wage growth has a negative impact on output growth. A reduction in real wage growth has a negative impact on productivity growth, which makes the economy wage-led. Therefore, the interaction between demand regime and real exchange rate shows that devaluation will have an ambiguous impact on the economy. The real exchange rate devaluation has a negative relationship with investment and productivity. From the results found in this research, the Brazilian economy operates in a wage-led demand regime.

In chapter five, it is analysed whether the Brazilian economy operates under a wage-led or profit-led regime between 1960 and 2011, considering a model that integrates features of the Post-Kaleckian and BPGC approaches. This chapter advanced in the understanding of this the subject. Some aspects of the model can be highlighted: i) in the model present in chapter 5, when the income distribution is combined with BPCG, the possibility of wage-led regime is reduced, since the income elasticity of import makes the economy more profit-led; ii) it is possible that even if an economy is profit-led, real exchange rate can boost economic growth, and, even if an economy is wage-led, real exchange rate devaluation can improve economic growth. This last result is possible because the investment and productivity equation are dependent of real exchange rate, as the import and export equations. Therefore, the real exchange rate devaluation can be positively or negatively related to investment and productivity. An empirical exercise was performed for the Brazilian economy to the period between 1960 and 2011. For this country case, although it is achieved a wage-led regime, when a BOP constraint growth is taken into consideration, the real exchange rate has a positive impact on economic growth. In relation to a whole literature on exchange rate misalignment such as Rodrik (2008), Bragança and Libânio (2008), Araújo (2009), Rapetti *et al.* (2012), Oreiro and Araujo (2013), Nassif *et al.* (2015), Missio *et al.* (2015b), Cavallo *et al.* (1990), Dollar (1992), Razin and Collins (1997), Benaroya and Janci (1999), Acemoglu *et al.* (2002) and Fajnzylber *et al.* (2002) and Gala (2008), it was reached in the model suggested in this chapter a positive relationship between real exchange rate devaluation and growth. In fact, by using a Post-Kaleckian model which combines features of BPCG, it was obtained a similar result if it is compared with the exchange rate misalignment literature. The innovation in this research is that although the real exchange rate devaluation can hurt investment and productivity growth, as it can be seen in the estimative provided in this chapter, the overall outcome suggests that real exchange rate devaluation boosts economic growth through the export channel

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APPENDIX

A2 – APPENDIX CHAPTER 2

Table A2.1: KPSS test for the Latin America selected countries

Variables	Argentina t-test	Brazil t-test	Bolivia t-test	Chile t-test	Colombia t-test	Mexico t-test	Uruguay t-test	Venezuela t-test	Critical value			Argentina Result	Brazil Result	Bolivia Result	Chile Result	Colombia Result	Mexico Result	Uruguay Result	Venezuela Result
									1% level	5% level	10% level								
Lnpr	0.615	0.630	0.593	0.653	0.673	0.600	0.704	0.189	0.739	0.463	0.347	Stationary	Stationary	Stationary	stationary	Stationary	Stationary	stationary	stationary
Lny	0.646	0.688	0.633	0.661	0.693	0.666	0.717	0.650	0.739	0.463	0.347	Stationary	Stationary	Stationary	stationary	Stationary	Stationary	stationary	stationary
Lne	0.282	0.410	0.448	0.235	0.153	0.150	0.153	0.117	0.739	0.463	0.347	Stationary	Stationary	Stationary	stationary	Stationary	Stationary	stationary	stationary
dLnpr	0.181	0.453	0.473	0.128	0.302	0.260	0.138	0.177	0.739	0.463	0.347	Stationary	Stationary	Stationary	stationary	Stationary	Stationary	stationary	stationary
dLny	0.232	0.178	0.446	0.128	0.142	0.185	0.116	0.124	0.739	0.463	0.347	Stationary	Stationary	Stationary	stationary	Stationary	Stationary	stationary	stationary
dLne	0.264	0.358	0.141	0.068	0.126	0.101	0.114	0.165	0.739	0.463	0.347	Stationary	Stationary	Stationary	stationary	Stationary	Stationary	stationary	stationary

Table A2.2: Breusch-Godfrey Serial Correlation LM Test for Latin America selected countries

Equation Productivity	Argentina	Brazil	Bolivia	Chile	Colombia	Mexico	Uruguay	Venezuela
$RESID(-1)$	-0.17 (-0.87)	0.81 (4.55)	0.64 (3.84)	0.78 (4.24)	0.83 (4.90)	1.11 (7.00)	0.78 (5.28)	0.87 (5.02)
$RESID(-2)$	0.14 (0.73)	0.18 (1.00)	0.35 (2.01)	0.25 (1.28)	0.18 (1.03)	-0.12 (-0.76)	0.23 (1.50)	0.11 (0.63)
F-statistic	0.838733	57.96642	27.31700	264.2558	119.3640	153.5934	70.65133	116.2427
Obs*R-squared	1.859144	27.19685	21.41617	31.33966	30.31716	30.24333	26.18238	30.22924
Prob. F(2,29)	0.4425							
Prob. F(2,29)		0.0000						
Prob. F(2,27)			0.0000					
Prob. F(2,28)				0.0000				
Prob. F(2,26)					0.0000			
Prob. F(2,21)						0.0000		
Prob. F(2,26)							0.0000	
Prob. F(2,29)								0.0000
Prob. Chi-Square(2)	0.3947	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Adj. R	-0.07	0.77	0.62	0.94	0.87	0.90	0.82	0.87
Durbin-Watson stat	1.98	1.30	1.55	1.05	1.17	1.28	1.13	1.01
Period	1980-2014	1980-2014	1980- 2012	1980- 2012	1980-2014	1988-2014	1983-2014	1980-2014

Table A2.3: Heteroskedasticity Test ARCH for Latin America selected countries

Equation Productivity	Argentina	Brazil	Bolivia	Chile	Colombia	Mexico	Uruguay	Venezuela
RESID^2(-1)	0.05 (0.29)	0.78 (5.68)	0.58 (3.87)	0.71 (5.53)	0.87 (10.51)	0.78 (7.06)	0.45 (2.88)	0.86 (10.29)
F-statistic	0.084635	32.36361	14.99882	30.60653	110.5955	49.94683	8.303480	106.0377
Obs*R-squared	0.089850	16.85509	10.56764	16.16012	25.77519	19.99202	6.861722	25.53490
Prob. F(1,31)	0.7730							
Prob. F(1,32)		0.0000						
Prob. F(1,29)			0.0006					
Prob. F(1,31)				0.0000				
Prob. F(1,31)					0.0000			
Prob. F(1,23)						0.0000		
Prob. F(1,29)							0.0000	
Prob. F(2,31)								0.0000
Prob. Chi-Square(2)	0.7644	0.0000	0.0012	0.0001	0.0000	0.0000	0.0000	0.0000
Adj. R	-0.029448	0.49	0.031	0.48	0.77	0.61	0.20	0.76
Durbin-Watson stat	1.99	2.11	1.40	1.59	2.00	1.10	1.99	1.57
Period	1980-2014	1980-2014	1980- 2012	1980- 2012	1980-2014	1988-2014	1983-2014	1980-2014

Table A2.4: Autocorrelation tests for Latin America selected countries

Argentina
Sample: 1980 2014
Included observations: 34

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.17...	-0.17...	1.1755	0.278
		2	0.161	0.134	2.1667	0.338
		3	0.242	0.305	4.4752	0.215
		4	-0.08...	-0.01...	4.7778	0.311
		5	0.267	0.180	7.7965	0.168
		6	-0.02...	-0.00...	7.8273	0.251
		7	-0.07...	-0.14...	8.0515	0.328
		8	-0.03...	-0.21...	8.0956	0.424
		9	-0.03...	-0.03...	8.1424	0.520
		1...	-0.07...	-0.06...	8.4453	0.585
		1...	-0.04...	-0.01...	8.5653	0.662
		1...	-0.04...	0.041	8.6669	0.731
		1...	-0.04...	0.084	8.7626	0.791
		1...	-0.08...	-0.07...	9.2248	0.816
		1...	-0.04...	-0.07...	9.3539	0.858
		1...	-0.07...	-0.09...	9.7028	0.882

Brazil
Sample: 1980 2014
Included observations: 34

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.819	0.819	24.849	0.000
		2	0.705	0.106	43.860	0.000
		3	0.615	0.037	58.789	0.000
		4	0.516	-0.05...	69.638	0.000
		5	0.399	-0.11...	76.368	0.000
		6	0.253	-0.19...	79.168	0.000
		7	0.194	0.121	80.881	0.000
		8	0.115	-0.05...	81.506	0.000
		9	0.061	0.042	81.690	0.000
		1...	0.008	-0.03...	81.693	0.000
		1...	0.025	0.168	81.727	0.000
		1...	-0.00...	-0.13...	81.727	0.000
		1...	-0.02...	0.004	81.766	0.000
		1...	-0.01...	0.004	81.786	0.000
		1...	0.004	0.082	81.787	0.000
		1...	-0.01...	-0.16...	81.807	0.000

Bolivia
Sample: 1 33
Included observations: 32

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.703	0.703	17.366	0.000
		2	0.604	0.216	30.592	0.000
		3	0.548	0.130	41.847	0.000
		4	0.378	-0.18...	47.400	0.000
		5	0.272	-0.07...	50.380	0.000
		6	0.265	0.127	53.321	0.000
		7	0.168	-0.04...	54.554	0.000
		8	0.153	0.061	55.613	0.000
		9	0.067	-0.17...	55.828	0.000
		1...	-0.07...	-0.22...	56.084	0.000
		1...	-0.17...	-0.15...	57.613	0.000
		1...	-0.25...	-0.06...	61.043	0.000
		1...	-0.26...	0.161	65.012	0.000
		1...	-0.33...	-0.15...	71.843	0.000
		1...	-0.31...	0.022	78.100	0.000
		1...	-0.27...	0.003	83.153	0.000

Chile
Sample: 1980 2013
Included observations: 33

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.928	0.928	31.071	0.000
		2	0.841	-0.14...	57.396	0.000
		3	0.778	0.144	80.695	0.000
		4	0.708	-0.13...	100.64	0.000
		5	0.632	-0.02...	117.14	0.000
		6	0.533	-0.25...	129.30	0.000
		7	0.432	-0.02...	137.60	0.000
		8	0.332	-0.15...	142.69	0.000
		9	0.212	-0.19...	144.85	0.000
		1...	0.099	-0.04...	145.34	0.000
		1...	0.010	0.061	145.35	0.000
		1...	-0.08...	-0.10...	145.70	0.000
		1...	-0.17...	-0.05...	147.41	0.000
		1...	-0.25...	0.024	151.25	0.000
		1...	-0.29...	0.150	156.93	0.000
		1...	-0.34...	-0.13...	164.83	0.000

Colombia
Sample: 1980 2014
Included observations: 34

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.894	0.894	29.628	0.000
		2	0.814	0.076	54.982	0.000
		3	0.733	-0.03...	76.214	0.000
		4	0.642	-0.10...	93.015	0.000
		5	0.555	-0.04...	106.03	0.000
		6	0.454	-0.12...	115.05	0.000
		7	0.357	-0.06...	120.84	0.000
		8	0.289	0.078	124.78	0.000
		9	0.221	-0.01...	127.17	0.000
		1...	0.157	-0.03...	128.43	0.000
		1...	0.097	-0.04...	128.94	0.000
		1...	0.022	-0.13...	128.96	0.000
		1...	-0.03...	-0.01...	129.03	0.000
		1...	-0.10...	-0.11...	129.69	0.000
		1...	-0.15...	0.016	131.26	0.000
		1...	-0.22...	-0.13...	134.68	0.000

Mexico
Sample: 1981 2014
Included observations: 33

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.911	0.911	29.962	0.000
		2	0.810	-0.11...	54.412	0.000
		3	0.693	-0.14...	72.897	0.000
		4	0.577	-0.05...	86.146	0.000
		5	0.488	0.101	95.981	0.000
		6	0.406	-0.04...	103.02	0.000
		7	0.349	0.062	108.42	0.000
		8	0.292	-0.06...	112.36	0.000
		9	0.228	-0.09...	114.85	0.000
		1...	0.143	-0.17...	115.88	0.000
		1...	0.043	-0.11...	115.98	0.000
		1...	-0.06...	-0.09...	116.18	0.000
		1...	-0.17...	-0.11...	117.84	0.000
		1...	-0.24...	0.084	121.44	0.000
		1...	-0.31...	-0.16...	127.98	0.000
		1...	-0.38...	-0.10...	137.97	0.000

Uruguay
Sample: 1983 2014
Included observations: 31

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.844	0.844	24.291	0.000
		2	0.753	0.141	44.290	0.000
		3	0.632	-0.11...	58.882	0.000
		4	0.535	-0.01...	69.710	0.000
		5	0.417	-0.10...	76.547	0.000
		6	0.304	-0.09...	80.321	0.000
		7	0.221	0.036	82.409	0.000
		8	0.144	-0.01...	83.336	0.000
		9	0.113	0.096	83.927	0.000
		1...	-0.01...	-0.34...	83.941	0.000
		1...	-0.08...	-0.01...	84.298	0.000
		1...	-0.21...	-0.25...	86.780	0.000
		1...	-0.24...	0.200	90.056	0.000
		1...	-0.29...	-0.04...	95.412	0.000
		1...	-0.38...	-0.25...	104.87	0.000
		1...	-0.40...	0.096	116.29	0.000

Venezuela
Sample: 1980 2014
Included observations: 34

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.907	0.907	30.511	0.000
		2	0.815	-0.04...	55.947	0.000
		3	0.743	0.059	77.764	0.000
		4	0.665	-0.07...	95.831	0.000
		5	0.580	-0.07...	110.05	0.000
		6	0.473	-0.18...	119.85	0.000
		7	0.368	-0.07...	125.98	0.000
		8	0.274	-0.03...	129.50	0.000
		9	0.195	0.027	131.36	0.000
		1...	0.144	0.118	132.41	0.000
		1...	0.077	-0.10...	132.72	0.000
		1...	0.010	-0.03...	132.73	0.000
		1...	-0.07...	-0.21...	133.03	0.000
		1...	-0.12...	0.073	133.95	0.000
		1...	-0.15...	-0.02...	135.52	0.000
		1...	-0.20...	-0.08...	138.43	0.000

Table A2.5: Multiple breakpoint tests for Latin America selected countries

Brazil

Sequential F-statistic determined breaks:			2
Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	2.547.826	7.643.477	13.98
1 vs. 2 *	2.577.619	7.732.857	15.72
2 vs. 3	4.232.293	1.269.688	16.83
Break dates:			
	Sequential	Repartition	
1	2004	1998	
2	1988	2005	

Chile

Sequential F-statistic determined breaks:			3
Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	5.920.593	1.776.178	13.98
1 vs. 2 *	1.108.839	3.326.516	15.72
2 vs. 3	3.336.609	1.000.983	16.83
Break dates:			
	Sequential	Repartition	
1	1996	1995	
2	2004	2004	

Colombia

Sequential F-statistic determined breaks:			4
Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	4.130.584	1.239.175	13.98
1 vs. 2 *	7.291.999	2.187.600	15.72
2 vs. 3 *	1.157.926	3.473.779	16.83
3 vs. 4 *	2.178.877	6.536.631	17.61
Break dates:			
	Sequential	Repartition	
1	1994	1989	
2	1989	1994	
3	2002	2002	
4	2009	2009	

Uruguay

Sequential F-statistic determined breaks:			2
Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	1.050.914	3.152.743	13.98
1 vs. 2 *	6.141.848	1.842.555	15.72
2 vs. 3 *	3.911.080	1.173.324	16.83
Break dates:			
	Sequential	Repartition	
1	2000	2000	
2	2006	2006	

Venezuela

Sequential F-statistic determined breaks:			3
Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	3.838.828	1.151.648	13.98
1 vs. 2 *	1.773.704	5.321.111	15.72
2 vs. 3	1.259.407	3.778.222	16.83
3 vs. 4	4.755.610	1.426.683	17.61
Break dates:			
	Sequential	Repartition	
1	1997	1988	
2	1988	1997	

Argentina

Sequential F-statistic determined breaks:			3
Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	5.001.868	1.500.560	13.98
1 vs. 2 *	1.778.415	5.335.245	15.72
Break dates:			
	Sequential	Repartition	
1	2008	2008	

Bolivia

Sequential F-statistic determined breaks:			3
Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	4.959.375	1.487.812	13.98
1 vs. 2 *	8.640.235	2.592.070	15.72
2 vs. 3 *	1.265.799	3.797.397	16.83
3 vs. 4	3.688.484	1.106.545	17.61
Break dates:			
	Sequential	Repartition	
1	2000	1985	
2	2010	2000	
3	1985	2010	

Mexico

Sequential F-statistic determined breaks:			1
Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	5.143.959	1.543.188	13.98
1 vs. 2 *	5.207.331	1.562.199	15.72
Break dates:			
	Sequential	Repartition	
1	1999	1999	

Bai-Perron tests of L+1 vs. L sequentially determined breaks; Sample: 1960 2011; Break test options: Trimming 0.15, Max. breaks 5, Sig. level 0.05; Test statistics employ HAC covariances (Bartlett kernel, Newey-West fixed bandwidth) assuming common data distribution; * Significant at the 0.05 level;

** Bai-Perron (Econometric Journal, 2003) critical values.

A3 – APPENDIX CHAPTER 3

Table A3.1: KPSS test for selected countries – chapter 3

Variables	Argentina t-test	Brazil t-test	Bolivia t-test	Chile t-test	Colombia t-test	Mexico t-test	Uruguay t-test	Venezuela t-test	Critical value			Argentina Result	Brazil Result	Bolivia Result	Chile Result	Colombia Result	Mexico Result	Uruguay Result	Venezuela Result
									1% level	5% level	10% level								
Lnpr	0.615	0.630	0.593	0.653	0.673	0.600	0.704	0.189	0.739	0.463	0.347	Stationary	Stationary	Stationary	stationary	Stationary	stationary	stationary	Stationary
Lny	0.646	0.688	0.633	0.661	0.693	0.782	0.717	0.650	0.739	0.463	0.347	Stationary	Stationary	Stationary	Stationary	Stationary	no stationary	stationary	Stationary
Lne	0.282	0.410	0.448	0.235	0.153	0.229	0.153	0.1177	0.739	0.463	0.347	Stationary	Stationary	Stationary	Stationary	Stationary	stationary	stationary	no stationary
Lnrer	0.261	0.133	0.468	0.259	0.206	0.249	0.585	0.2445	0.739	0.463	0.347	Stationary	Stationary	Stationary	Stationary	Stationary	No stationary	Stationary	Stationary
Lni_av	0.610	0.657	0.5951	0.652	0.665	0.759	0.626	0.579	0.739	0.463	0.347	Stationary	Stationary	Stationary	Stationary	Stationary	no stationary	Stationary	Stationary
dLnpr	0.181	0.453	0.473	0.128	0.302	0.260	0.138	0.177	0.739	0.463	0.347	Stationary	Stationary	Stationary	stationary	Stationary	stationary	stationary	Stationary
dLny	0.232	0.178	0.446	0.128	0.142	0.347	0.116	0.124	0.739	0.463	0.347	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary
dLne	0.264	0.358	0.141	0.068	0.126	0.060	0.114	0.165	0.739	0.463	0.347	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary
dLnrer	0.151	0.056	0.093	0.231	0.158	0.158	0.100	0.273	0.739	0.463	0.347	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary
dLni_av	0.157	0.128	0.411	0.133	0.089	0.287	0.114	0.106	0.739	0.463	0.347	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary

Table A3.2: Breusch-Godfrey Serial Correlation LM Test

Equation Productivity	Argentina	Brazil	Bolivia	Chile	Colombia	Mexico	Uruguay	Venezuela
$RESID(-1)$	-0.18 (-0.93)	0.83 (4.56)	0.65 (3.68)	0.63 (3.43)	0.68 (4.66)	0.70 (4.54)	0.70 (4.19)	0.68 (4.75)
$RESID(-2)$	0.08 (0.44)	0.15 (0.81)	0.37 (2.01)	0.22 (1.11)	0.42 (2.58)	0.44 (3.24)	0.29 (1.75)	0.37 (2.45)
F-statistic	0.658682	49.95193	30.49009	10.50767	68.38435	39.96812	48.35764	81.75049
Obs*R-squared	1.581728	26.76618	22.69553	14.75063	28.39453	24.90079	24.83674	29.18113
Prob. F(2,29)	0.5257							
Prob. F(2,27)		0.0000						
Prob. F(2,25)			0.0000					
Prob. F(2,26)				0.0005				
Prob. F(2,29)					0.0000			
Prob. F(2,26)						0.0000		
Prob. F(2,26)							0.0000	
Prob. F(2,28)								0.0000
Prob. Chi-Square(2)	0.4535	0.0000	0.000	0.0006	0.0000	0.0000	0.0000	0.0000
Adj. R	-0.16	0.73	0.63	0.31	0.79	0.69	0.75	0.82
Durbin-Watson stat	2.33	1.29	1.55	1.51	1.29	0.99	1.26	0.72
Period	1980-2014	1980-2014	1980- 2012	1980-2014	1980-2014	1981-2014	1983-2014	1983-2014

The t–statistics are the numbers in parentheses below each coefficient.

Table A3.3: Heteroskedasticity Test ARCH

Equation Productivity	Argentina	Brazil	Bolivia	Chile	Colombia	Mexico	Uruguay	Venezuela
RESID^2(-1)	0.04 (0.26)	0.75 (5.59)	0.63 (4.25)	0.14 (0.82)	0.65 (5.20)	-0.04 (-0.24)	0.15 (0.88)	0.45 (3.00)
F-statistic	0.070513	31.35923	18.10531	0.682968	27.09381	0.061184	0.776533	9.018228
Obs*R-squared	0.074892	16.59505	11.91510	0.712284	17.82038	0.065130	0.809548	7.436649
Prob. F(1,32)	0.7923							
Prob. F(1,31)		0.0000						
Prob. F(1,29)			0.0002					
Prob. F(1,30)				0.4151				
Prob. F(1,32)					0.0000			
Prob. F(2,31)						0.8063		
Prob. F(1,28)							0.3857	
Prob. F(1,31)								0.0052
Prob. Chi-Square(2)	0.7843	0.0000	0.0006	0.3987	0.0001	0.7986	0.3683	0.0064
Adj. R	-0.02	0.48	0.36	-0.01	0.44	-0.03	-0.07	0.20
Durbin-Watson stat	2.01	2.19	1.54	2.06	1.96	1.48	2.05	2.16
Period	1980-2014	1980-2014	1980- 2012	1980-2014	1980-2014	1981-2014	1983-2014	1983-2014

The t–statistics are the numbers in parentheses below each coefficient.

Table A3.4: autocorrelation test for selected countries

Argentina
Sample: 1980 2014
Included observations: 34

	AC	PAC	Q-Stat	Prob
1	-0.19...	-0.19...	1.3889	0.239
2	0.120	0.086	1.9431	0.378
3	0.213	0.263	3.7348	0.292
4	-0.07...	0.002	3.9699	0.410
5	0.133	0.065	4.7149	0.452
6	0.010	0.002	4.7195	0.580
7	-0.10...	-0.12...	5.2075	0.635
8	-0.01...	-0.12...	5.2243	0.733
9	-0.05...	-0.06...	5.3648	0.801
1...	-0.06...	-0.03...	5.6043	0.847
1...	-0.03...	-0.01...	5.6541	0.895
1...	-0.04...	0.005	5.7734	0.927
1...	-0.00...	0.048	5.7735	0.954
1...	-0.07...	-0.05...	6.1465	0.963
1...	-0.03...	-0.06...	6.2156	0.976
1...	-0.07...	-0.11...	6.6203	0.980

Brazil
Sample: 1980 2014
Included observations: 34

	AC	PAC	Q-Stat	Prob
1	0.814	0.814	24.594	0.000
2	0.692	0.086	42.919	0.000
3	0.611	0.076	57.637	0.000
4	0.506	-0.08...	68.075	0.000
5	0.373	-0.15...	73.935	0.000
6	0.250	-0.10...	76.674	0.000
7	0.197	0.101	78.431	0.000
8	0.118	-0.05...	79.088	0.000
9	0.079	0.084	79.390	0.000
1...	0.023	-0.09...	79.416	0.000
1...	0.019	0.089	79.436	0.000
1...	0.001	-0.05...	79.436	0.000
1...	-0.02...	-0.02...	79.474	0.000
1...	-0.01...	0.043	79.487	0.000
1...	0.009	0.076	79.492	0.000
1...	-0.03...	-0.19...	79.558	0.000

Bolivia
Sample: 1 33
Included observations: 32

	AC	PAC	Q-Stat	Prob
1	0.727	0.727	18.566	0.000
2	0.628	0.210	32.854	0.000
3	0.561	0.107	44.673	0.000
4	0.372	-0.24...	50.041	0.000
5	0.297	0.010	53.584	0.000
6	0.260	0.085	56.419	0.000
7	0.186	0.012	57.918	0.000
8	0.167	0.015	59.188	0.000
9	0.083	-0.16...	59.512	0.000
1...	-0.06...	-0.25...	59.712	0.000
1...	-0.17...	-0.18...	61.282	0.000
1...	-0.25...	-0.01...	64.935	0.000
1...	-0.30...	0.092	70.242	0.000
1...	-0.35...	-0.09...	77.916	0.000
1...	-0.34...	-0.01...	85.308	0.000
1...	-0.29...	0.043	91.159	0.000

Chile
Sample: 1980 2013
Included observations: 33

	AC	PAC	Q-Stat	Prob
1	0.576	0.576	11.955	0.001
2	0.357	0.038	16.695	0.000
3	0.307	0.131	20.325	0.000
4	0.340	0.166	24.943	0.000
5	0.267	-0.02...	27.894	0.000
6	0.244	0.076	30.449	0.000
7	0.267	0.092	33.614	0.000
8	0.119	-0.19...	34.270	0.000
9	0.082	0.035	34.591	0.000
1...	0.032	-0.09...	34.644	0.000
1...	-0.01...	-0.09...	34.652	0.000
1...	-0.10...	-0.09...	35.226	0.000
1...	-0.26...	-0.30...	39.321	0.000
1...	-0.20...	0.080	41.985	0.000
1...	-0.18...	-0.01...	44.153	0.000
1...	-0.16...	-0.00...	45.935	0.000

Colombia
Sample: 1980 2014
Included observations: 34

	AC	PAC	Q-Stat	Prob
1	0.797	0.797	23.561	0.000
2	0.676	0.111	41.027	0.000
3	0.590	0.063	54.767	0.000
4	0.521	0.033	65.833	0.000
5	0.446	-0.02...	74.234	0.000
6	0.409	0.067	81.546	0.000
7	0.332	-0.09...	86.551	0.000
8	0.273	-0.01...	90.049	0.000
9	0.218	-0.02...	92.373	0.000
1...	0.183	0.013	94.074	0.000
1...	0.127	-0.06...	94.927	0.000
1...	0.053	-0.11...	95.084	0.000
1...	0.033	0.074	95.147	0.000
1...	-0.07...	-0.24...	95.448	0.000
1...	-0.13...	-0.03...	96.658	0.000
1...	-0.23...	-0.20...	100.42	0.000

Mexico
Sample: 1981 2014
Included observations: 33

	AC	PAC	Q-Stat	Prob
1	0.648	0.648	15.174	0.000
2	0.676	0.441	32.202	0.000
3	0.450	-0.17...	39.990	0.000
4	0.451	0.055	48.073	0.000
5	0.319	0.002	52.279	0.000
6	0.281	-0.05...	55.656	0.000
7	0.345	0.316	60.948	0.000
8	0.209	-0.22...	62.958	0.000
9	0.236	-0.06...	65.636	0.000
1...	0.053	-0.12...	65.775	0.000
1...	0.030	-0.19...	65.823	0.000
1...	-0.16...	-0.14...	67.403	0.000
1...	-0.16...	0.012	69.034	0.000
1...	-0.20...	0.051	71.596	0.000
1...	-0.19...	0.039	74.023	0.000
1...	-0.25...	-0.22...	78.397	0.000

Uruguay
Sample: 1983 2014
Included observations: 31

	AC	PAC	Q-Stat	Prob
1	0.824	0.824	23.127	0.000
2	0.746	0.211	42.760	0.000
3	0.664	0.016	58.844	0.000
4	0.585	-0.02...	71.804	0.000
5	0.512	-0.02...	82.120	0.000
6	0.365	-0.27...	87.574	0.000
7	0.234	-0.18...	89.911	0.000
8	0.204	0.222	91.759	0.000
9	0.108	-0.09...	92.299	0.000
1...	0.002	-0.19...	92.299	0.000
1...	-0.11...	-0.10...	92.920	0.000
1...	-0.20...	-0.07...	95.219	0.000
1...	-0.23...	0.013	98.356	0.000
1...	-0.31...	-0.11...	104.35	0.000
1...	-0.40...	-0.06...	114.63	0.000
1...	-0.43...	-0.00...	127.70	0.000

Venezuela
Sample: 1980 2014
Included observations: 34

	AC	PAC	Q-Stat	Prob
1	0.838	0.838	26.023	0.000
2	0.754	0.174	47.744	0.000
3	0.679	0.039	65.924	0.000
4	0.593	-0.05...	80.264	0.000
5	0.528	0.011	92.024	0.000
6	0.467	-0.00...	101.55	0.000
7	0.399	-0.04...	108.75	0.000
8	0.283	-0.22...	112.52	0.000
9	0.249	0.135	115.56	0.000
1...	0.175	-0.09...	117.12	0.000
1...	0.091	-0.10...	117.56	0.000
1...	0.009	-0.13...	117.57	0.000
1...	-0.10...	-0.17...	118.18	0.000
1...	-0.15...	0.090	119.59	0.000
1...	-0.19...	0.032	122.01	0.000
1...	-0.22...	-0.03...	125.38	0.000

Table A3.5: Multiple breakpoint tests

Brazil

Sequential F-statistic determined breaks: 2

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	2.547.826	7.643.477	13.98
1 vs. 2 *	2.577.619	7.732.857	15.72
2 vs. 3	4.232.293	1.269.688	16.83

Break dates:

	Sequential	Repartition
1	2004	1998
2	1988	2005

Chile

Sequential F-statistic determined breaks: 3

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	5.920.593	1.776.178	13.98
1 vs. 2 *	1.108.839	3.326.516	15.72
2 vs. 3	3.336.609	1.000.983	16.83

Break dates:

	Sequential	Repartition
1	1996	1995
2	2004	2004

Colombia

Sequential F-statistic determined breaks: 4

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	4.130.584	1.239.175	13.98
1 vs. 2 *	7.291.999	2.187.600	15.72
2 vs. 3 *	1.157.926	3.473.779	16.83
3 vs. 4 *	2.178.877	6.536.631	17.61

Break dates:

	Sequential	Repartition
1	1994	1989
2	1989	1994
3	2002	2002
4	2009	2009

Uruguay

Sequential F-statistic determined breaks: 2

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	1.050.914	3.152.743	13.98
1 vs. 2 *	6.141.848	1.842.555	15.72
2 vs. 3 *	3.911.080	1.173.324	16.83

Break dates:

	Sequential	Repartition
1	2000	2000
2	2006	2006

Venezuela

Sequential F-statistic determined breaks: 3

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	3.838.828	1.151.648	13.98
1 vs. 2 *	1.773.704	5.321.111	15.72
2 vs. 3	1.259.407	3.778.222	16.83
3 vs. 4	4.755.610	1.426.683	17.61

Break dates:

	Sequential	Repartition
1	1997	1988
2	1988	1997

Argentina

Sequential F-statistic determined breaks: 3

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	5.001.868	1.500.560	13.98
1 vs. 2 *	1.778.415	5.335.245	15.72

Break dates:

	Sequential	Repartition
1	2008	2008

Bolivia

Sequential F-statistic determined breaks: 3

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	4.959.375	1.487.812	13.98
1 vs. 2 *	8.640.235	2.592.070	15.72
2 vs. 3 *	1.265.799	3.797.397	16.83
3 vs. 4	3.688.484	1.106.545	17.61

Break dates:

	Sequential	Repartition
1	2000	1985
2	2010	2000
3	1985	2010

Mexico

Sequential F-statistic determined breaks: 1

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	5.143.959	1.543.188	13.98
1 vs. 2 *	5.207.331	1.562.199	15.72

Break dates:

	Sequential	Repartition
1	1999	1999

A4 – APPENDIX CHAPTER 4

Table A4.1: The KPSS for the productivity, saving, investment and export equations.

			Productivity equation			
Variables	t test	Critical value			H0	Result
		1% level	5% level	10% level		
$ln\ \lambda$	0.84	0.74	0.46	0.35	Reject	no stationary
$ln\ y$	0.91	0.74	0.46	0.35	Reject	no stationary
$ln\ w$	0.82	0.74	0.46	0.35	Reject	no stationary
$ln\ \theta$	0.79	0.74	0.46	0.35	Reject	no stationary
$Dln\ \lambda$	0.22	0.74	0.46	0.35	no reject	Stationary
$Dln\ y$	0.39	0.74	0.46	0.35	no reject	Stationary
$Dln\ w$	0.18	0.74	0.46	0.35	no reject	Stationary
$Dln\ \theta$	0.12	0.74	0.46	0.35	no reject	Stationary
			Saving equation			
Variables	t test	Critical value			H0	Result
		1% level	5% level	10% level		
σ	0.42	0.74	0.46	0.35	No reject	Stationary
ω	0.08	0.74	0.46	0.35	No reject	Stationary
			Investment equation			
$ln\ i$	0.91	0.74	0.46	0.35	Reject	No stationary
$ln\ \pi$	0.08	0.74	0.46	0.35	No reject	Stationary
$ln\ y$	0.92	0.74	0.46	0.35	Reject	No stationary
$ln\ \theta$	0.79	0.74	0.46	0.35	Reject	no stationary
$Dln\ i$	0.10	0.74	0.46	0.35	No reject	Stationary
$Dln\ \pi$	0.08	0.74	0.46	0.35	No reject	Stationary
$Dln\ y$	0.39	0.74	0.46	0.35	no reject	Stationary
$Dln\ \theta$	0.12	0.74	0.46	0.35	no reject	Stationary
			Export equation			
x	0.19	0.74	0.46	0.35	No reject	Stationary
z	0.69	0.74	0.46	0.35	No reject	Stationary
v	0.08	0.74	0.46	0.35	No reject	Stationary

Table A4.2: Breusch-Godfrey Serial Correlation LM Test for the productivity, saving, investment and export equations.

Equation	Productivity	Saving	Investment	Export
$RESID(-1)$	0.60 (5.01)	0.83 (5.75)	0.03 (0.22)	-0.38 (-2.62)
$RESID(-2)$	0.47 (3.77)	-0.02 (-0.12)	-0.15 (-0.98)	-0.05 (0.14)
F-statistic	38.66149	25.39208	0.514612	3.641505
Obs*R-squared	32.23819	26.73279	1.165697	6.850273
Prob. F(2,45)	0.0000			
Prob. F(2,48)		0.0000		
Prob. F(2,44)			0.6013	
Prob. F(2,48)				0.0337
Prob. Chi-Square(2)	0.0000	0.0000	0.5583	0.0325
Adj. R	0.59	0.51	-0.11	0.13
Durbin-Watson stat	1.24	1.93	1.99	1.96
Period	1960-2011	1960-2011	1960-2011	1960-2011

Table A4.3: Heteroskedasticity Test ARCH for productivity, saving, investment and export equations.

Equation	Productivity	Saving	Investment	Export
RESID^2(-1)	0.29 (2.40)	-0.01 (-0.13)	-0.05 (-0.41)	0.23 (1.70)
F-statistic	5.765265	0.017246	0.170700	2.922009
Obs*R-squared	5.361514	0.017958	0.177182	2.870121
Prob. F(1,49)	0.0000			
Prob. F(1,48)		0.8961		
Prob. F(1,48)			0.6813	
Prob. F(1,49)				0.0902
Prob. Chi-Square(2)	0.0000	0.8934	0.6738	0.0325
Adj. R	0.08	0.000359	-0.01	0.05
Durbin-Watson stat	2.26	2.00	1.97	1.96
Period	1960-2011	1960-2011	1960-2011	1960-2011

Table A4.4: Multiple breakpoint tests for productivity, investment, saving and export equations.

Productivity equation

Sequential F-statistic determined breaks: 3

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	43.64199	174.5679	16.19
1 vs. 2 *	13.15916	52.63666	18.11
2 vs. 3 *	9.493310	37.97324	18.93
3 vs. 4 *	3.299627	13.19851	19.73

Break dates:

	Sequential	Repartition
1	1988	1969
2	1969	1989
3	1999	1999

Investment equation

Sequential F-statistic determined breaks: 0

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	2.918635	14.59317	18.23

Break dates:

	Sequential	Repartition

Saving equation

Sequential F-statistic determined breaks: 1

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	2.544.078	5.088.156	11.47
1 vs. 2	2.306.901	4.613.802	12.95

Break dates:

	Sequential	Repartition
1	1997	1997

Export equation

Sequential F-statistic determined breaks: 1

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	8.473.131	1.694.626	11.47
1 vs. 2	0.634702	1.269.405	12.95

Break dates:

	Sequential	Repartition
1	1968	1968

Bai-Perron tests of L+1 vs. L sequentially determined breaks; Sample: 1960 2011; Break test options: Trimming 0.15, Max. breaks 5, Sig. level 0.05; Test statistics employ HAC covariances (Bartlett kernel, Newey-West fixed bandwidth) assuming common data distribution; * Significant at the 0.05 level;
** Bai-Perron (Econometric Journal, 2003) critical values.

Table A4.5: Autocorrelation test – Saving equation – 1960-2011

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.624	0.624	21.460	0.000
		2	0.308	-0.13...	26.792	0.000
		3	0.035	-0.16...	26.863	0.000
		4	0.018	0.175	26.881	0.000
		5	-0.04...	-0.14...	27.025	0.000
		6	-0.04...	0.018	27.133	0.000
		7	-0.01...	0.082	27.149	0.000
		8	0.038	-0.00...	27.243	0.001
		9	0.055	0.020	27.443	0.001
		1...	0.102	0.101	28.141	0.002
		1...	0.127	0.025	29.237	0.002
		1...	0.167	0.084	31.197	0.002
		1...	0.160	0.043	33.045	0.002
		1...	0.128	-0.01...	34.260	0.002
		1...	0.081	0.029	34.756	0.003
		1...	0.072	0.053	35.155	0.004
		1...	0.001	-0.11...	35.155	0.006
		1...	0.029	0.137	35.224	0.009
		1...	0.047	0.022	35.411	0.012
		2...	-0.11...	-0.40...	36.488	0.013
		2...	-0.24...	0.022	41.882	0.004
		2...	-0.30...	-0.08...	50.777	0.000
		2...	-0.18...	-0.03...	53.999	0.000
		2...	-0.14...	-0.05...	55.981	0.000

Table A4.6: Autocorrelation test – Productivity and Investment equation – 1960-2011

Productivity equation
Sample: 1960 2011
Included observations: 51

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.615	0.615	20.468	0.000
		2	0.544	0.266	36.774	0.000
		3	0.492	0.144	50.415	0.000
		4	0.427	0.046	60.911	0.000
		5	0.466	0.181	73.696	0.000
		6	0.299	-0.18...	79.077	0.000
		7	0.282	0.007	83.971	0.000
		8	0.242	-0.01...	87.654	0.000
		9	0.209	0.015	90.464	0.000
		1...	0.186	-0.03...	92.739	0.000
		1...	0.115	-0.01...	93.638	0.000
		1...	0.127	0.028	94.761	0.000
		1...	0.080	-0.03...	95.221	0.000
		1...	0.075	0.012	95.636	0.000
		1...	0.129	0.131	96.879	0.000
		1...	0.072	-0.04...	97.275	0.000
		1...	0.071	-0.02...	97.677	0.000
		1...	0.016	-0.07...	97.696	0.000
		1...	0.044	0.054	97.864	0.000
		2...	0.042	-0.04...	98.017	0.000
		2...	-0.02...	-0.07...	98.092	0.000
		2...	-0.05...	-0.07...	98.389	0.000
		2...	-0.20...	-0.24...	102.31	0.000
		2...	-0.16...	-0.00...	104.94	0.000

Investment equation
Sample: 1960 2011
Included observations: 51

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.032	0.032	0.0538	0.817
		2	-0.14...	-0.14...	1.1783	0.555
		3	-0.04...	-0.03...	1.2675	0.737
		4	0.164	0.150	2.8205	0.588
		5	-0.04...	-0.07...	2.9485	0.708
		6	0.211	0.269	5.6190	0.467
		7	0.057	0.031	5.8160	0.561
		8	-0.18...	-0.17...	8.0353	0.430
		9	-0.02...	0.058	8.0758	0.527
		1...	0.046	-0.10...	8.2138	0.608
		1...	-0.09...	-0.11...	8.8336	0.637
		1...	0.007	0.054	8.8374	0.717
		1...	0.098	0.014	9.5226	0.732
		1...	-0.06...	0.013	9.8333	0.774
		1...	-0.19...	-0.12...	12.564	0.636
		1...	0.123	0.110	13.724	0.619
		1...	-0.03...	-0.08...	13.842	0.678
		1...	-0.08...	-0.07...	14.487	0.697
		1...	0.098	0.141	15.294	0.704
		2...	0.076	-0.02...	15.801	0.729
		2...	-0.06...	0.090	16.187	0.759
		2...	0.010	0.012	16.196	0.806
		2...	0.191	0.133	19.727	0.658
		2...	-0.07...	-0.02...	20.329	0.678

Table A4.7: Cointegration Test – Productivity equation – 1960-2011

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	5	2	2	2	3
Max-Eig	2	0	0	1	1

Note: Selected (0.05 level*) Number of Cointegrating Relations by Model. *Critical values based on MacKinnon-Haug-Michelis (1999).

Table A4.8: Cointegration Test – Productivity equation – 1960-2011

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	3	3	4	3	4
Max-Eig	3	2	2	2	4

Note: Selected (0.05 level*) Number of Cointegrating Relations by Model. *Critical values based on MacKinnon-Haug-Michelis (1999).

A5 – APPENDIX CHAPTER 5

Table A5.1 chapter 5 KPSS test

Imports and exports equation						
$ln\, m$	0.90	0.74	0.46	0.35	Reject	No stationary
$ln\, y$	0.91	0.74	0.46	0.35	Reject	No stationary
$ln\, \theta$	0.79	0.74	0.46	0.35	Reject	No stationary
$ln\, x$	0.79	0.74	0.46	0.35	Reject	No stationary
$ln\, z$	0.96	0.74	0.46	0.35	Reject	No stationary
D$ln\, m$	0.07	0.74	0.46	0.35	No reject	Stationary
D$ln\, y$	0.39	0.74	0.46	0.35	No reject	Stationary
D$ln\, \theta$	0.12	0.74	0.46	0.35	No reject	Stationary
D$ln\, x$	0.15	0.74	0.46	0.35	No reject	Stationary
D$ln\, z$	0.68	0.74	0.46	0.35	No reject	Stationary

Table A5.2: VAR Lag Order Selection Criteria- Imports equation

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2.051.708	NA	1.173.712	8.673.784	8.790.734	8.717.980
1	1.186.866	397.9057*	0.000202*	0.005472*	0.473273*	0.182255*
2	2.044.238	1.464.676	0.000207	0.023234	0.841885	0.332603
3	2.588.044	8.610.268	0.000243	0.171648	1.341.149	0.613604
4	3.491.551	1.317.615	0.000248	0.170187	1.690.538	0.744730

Note: * indicates lag order selected by the criterion, LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion and HQ: Hannan-Quinn information criterion.

Table A5.3: Cointegration test – Imports equation

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	1	1	1	1	0
Max-Eig	1	1	1	1	0

Note: Selected (0.05 level*) Number of Cointegrating Relations by Model. *Critical values based on MacKinnon-Haug-Michelis (1999).

Table A5.4: VAR Lag Order Selection Criteria- Exports equation

Lag	LogL	LR	FPE	AIC	SC	HQ
1	5.953.167	NA	2.45e-05*	-2.105486*	-1.754636*	-1.972900*
2	6.382.511	7.513.512	2.99e-05	-1.909.380	-1.207.679	-1.644.206
3	7.312.042	1.510.487	2.98e-05	-1.921.684	-0.869133	-1.523.924
4	7.455.647	2.154.080	4.16e-05	-1.606.520	-0.203119	-1.076.172

Note: * indicates lag order selected by the criterion, LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion and HQ: Hannan-Quinn information criterion.

Table A5.5: Cointegration test – Exports equation

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	1	2	1	1	0
Max-Eig	1	2	1	1	0

Note: Selected (0.05 level*) Number of Cointegrating Relations by Model. *Critical values based on MacKinnon-Haug-Michelis (1999).