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A post-Kaleckian model with productivity growth and real exchange rate applied to selected Latin American countries

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Abstract:

This paper aims to discuss the theory of productivity growth and its empirical applications, taking into consideration the impact of real exchange rate devaluation on productivity. The main question is: does the real exchange rate have a positive or a negative impact on productivity growth? The first step in answering this question is to discuss productivity growth in the context of demand regimes. The second step consists of an empirical experiment that estimates the productivity growth equation for a sample of Latin American countries. The overall outcome is that the Smith-Kaldor-Verdoorn coefficient is significant for all the analyzed countries: Argentina, Brazil, Bolivia, Chile, Colombia, Mexico, and Uruguay. 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.

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The aim of this paper is to discuss the theory of productivity regime as well as its empirical applications. It follows the work of Sylos-Labini (1984, 1985, 2004), Naastepad (2006), and Hein and Tarassow (2010). The research on demand regimes and productivity regime 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), Missio et al. (2015b), Oreiro et al. (2015) 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

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has been crucial to economic policy debates. The main question of the paper is to find if the real exchange rate has a positive or a negative impact on productivity growth. To the best of our knowledge, the literature based on the Kalecki and Sylos-Labini approach does not deal with the interactions between the real exchange rate and productivity growth. Besides, it lacks empirical studies for Latin American countries, the economies of which differ greatly from those of European countries. Marinho et al. (2002), as well as Pacheco-Lopez and Thirlwall (2013), for instance, present this subject empirically based on Kaldor's theory but using different theoretical shortcuts, since they do not include the real exchange rate and productivity. Cimoli and Porcile (2014) highlight the asymmetries in Latin American development and the role of balance-of-payments constraints; but they do not connect the real exchange rate and productivity.

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 Sylos-Labini (1984, 1985, 2004), 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, and Uruguay. Together these countries represent 86% of the GPD of Latin America (World Development Indicators, 2013).

The paper is organized 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 conclusions.

1. Productivity growth

According to Sylos-Labini (1984, 1985) and 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. Sylos-Labini (1984, 1985), Naastepad (2006), Storm and Naastepad (2012), Hein and Tarassow (2010) and Carnevali at al. (2020) provide empirical evidence for this relationship in several European countries[2]. The relationship between real wage growth and productivity growth is well established for European countries. As already mentioned in the introduction, we intend to fill the gap on the literature regarding this topic. First, by analyzing empirically for Latin American countries, which differ greatly from European countries. Second, by including the interactions between the real exchange rate and productivity growth.

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 labor costs, changes in the profit share can be induced by a change in the mark-up in the ratio of imported materials to unit labor

[2] Corsi and D'Ippoliti (2013) provide an empirical exercise of the relationship between wages and productivity in the public sector.

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 begins from an increasing ratio of unit imported material costs to unit labor 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 labor costs ratio and hence increase the profit share along with competitiveness. Although enlarging the profit share can have a positive or a 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 important 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. As largely discussed in the literature, developing countries have a greater income elasticity of imports than an income elasticity of exports.[3] 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:

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

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

1.1. Smith-Kaldor-Verdoorn effect

The coefficient β_1 in equation (1) is the Smith-Kaldor-Verdoorn coefficient. The relation between increasing productivity and demand growth can be expressed through the following channels: i) improvements in the division of labor; 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.

Sylos-Labini (1983, 1995) named the Smith effect, the relationship between output growth and productivity growth. The author argues that the productivity in manufacturing industries is positively related with the market size. For this author, in the short run the

[3] As highlighted by Prebisch (1962) and the Latin American Structuralist school. See also Missio et al. (2015a) and Bielschowsky (1998).

increase in output generates more employment and learning by doing. Moreover, in the long run, considering the implementation of machinery, it would lead to investment.

There is vast empirical evidence on this relationship. Sylos-Labini (1983), Naastepad (2006), Storm and Naastepad (2012), Hein and Tarassow (2010) and Carnevali at al. (2020) 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 aggregate demand is a relevant economic policy tool.

Originally, the Smith-Verdoorn-Kaldor coefficient is expressed as:[4]

$$\hat{\lambda} = \beta_0 + \beta_1 g \quad (2)$$

where $\hat{\lambda}$ is the productivity growth, β_0 is the autonomous component of productivity, β_1 is the Verdoorn coefficient, and g is the economic growth. Dixon and Thirlwall (1975) argue that the Verdoorn coefficient is the parameter that exaggerates the rate of growth across regions.

There are some issues related to the Smith-Verdoorn–Kaldor coefficient. McCombie et al. (2002) stress issues concerning this approach. The most important issue regards 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:

$$\hat{\lambda} = \beta_0 + \beta_1 \hat{y} \quad (3)$$

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 ($\hat{\lambda}$) and income growth ($\hat{y}$). Since $\hat{\lambda} = \hat{y} - \hat{e}$, it is possible to overcome the bias using the specification in which the employment growth rate, $\hat{e}$, is the dependent variable and the income growth is the independent variable. The concern arises from the fact that both the employment growth rate and the income rate are endogenous. Other alternatives involve using the capital stock, the labor 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 taken 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 Smith-Kaldor-Verdoorn 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.

Another way to deal with the endogeneity, but when working on panel data, is to use instrumental variables. Following Arellano and Bond (1991) we can assume the non-correlation of the errors with contemporaneous and future explanatory variables. In this case, the present values of the regressors can be correlated with past errors (Arellano and Bond, 1991; Wooldridge, 2000; Greene, 2003). The assumption of sequential exogeneity is consistent

[4] In the original version, productivity growth is only λ, but we included that in the variable in order to keep the same pattern in this paper.

with the presence of the lagged dependent variable among the regressors (dynamic models of panel data). These models control the existence of a correlation between past values of the dependent variable and the contemporaneous values of other explanatory variables, thus eliminating potential sources of bias of the estimators associated with this type of correlation (Blundell and Bond, 1998; Wooldridge, 2000). Although this technique can deal with the McCombie et al. (2002) warning, when working only with time series the lagged variables can avoid endogeneity.

In any case, working with econometrics, the researcher faces a trade-off. Should we use more or fewer variables in order to activate the best result? In fact, there are several techniques to solve the endogeneity problems. We could use instrumental variables, which is not an easy job when we are working with macroeconomics variables. On the other hand, we can use lags in independent variables, which makes the model simple and more parsimonious, as long as it deals with the problems McCombie et al. (2002) highlight.

1.2. Productivity and real wages

The coefficient β_2 in equation (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, 2010, p. 735).

Sylos-Labini (1983, p. 169) argues that "we have to broaden our analysis to take into account the fact that increases in productivity are, at the same time, cause and effect of the long-run increase in wages relative not only to the prices of machines but to all or almost all prices: cause, since the increase in productivity induces trade unions to demand higher wages and, at the same time, allows the firms to pay them (under certain circumstances firms may decide spontaneously to grant higher wages both to attract and keep the most efficient workers and to ensure social peace within the firm); effect, since firms try to offset wage increases by saving labor either in absolute terms by rationalizing the productive process, or in relative terms by introducing machines capable of increasing productivity". Carnevali at al. (2020), considering the work of Sylos-Labini (1983), named this the Ricardo-Sylos-Labini effect. The Ricardo effect has two components: i) the organization effect, which means that the increase of labor in production, through organization, increases productivity; and ii) the investment effect, the substitution of labor for machinery in order to save labor, which also increases productivity.

There is empirical evidence for this relationship. Naastepad (2006), Hein and Tarassow (2010) and Carnevali at al. (2020) 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 ones, it is sound to suppose 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 leads to improvements in technical progress and innovation. Besides, an increase in real wages can eliminate inefficient firms, favoring structural changes and enlarging the proportion of skilled workers in the economy. In this paper 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 labor level can squeeze profits and hence reduce investment. 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.

1.3. Productivity and the real exchange rate

The coefficient β_3 in equation (1) reflects the indirect impact of the real exchange rate level on productivity growth. Krugman and Taylor (1978) explain why 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 import prices increase, imported machines and equipment will become more expensive, and this will have a negative impact on productivity growth. The Krugman and Taylor (1978) paper as well as traditional literature on exchange rate and aggregate demand suppose that the Marshall-Lerner (M-L) condition holds, as has been empirically demonstrated in several works for developing countries.[5]

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 competitive 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. 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.

2. The model

Hein and Tarassow (2010) point out the effect of technical change and productivity on aggregate demand. Productivity will be profit-led if an increase in wages discourages productivity-enhancing capital investment and, as a consequence, the growth of labor productivity slows (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, either if firms 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 worker motivation or, in

[5] See Jayme Jr. (2003) and López and Cruz (2000), among others, about the validity of the M-L condition on Latin American countries.

developing countries, if their health and nutritional situation improves. This case is often referred to as the efficiency wage hypothesis in mainstream literature (Lavoie and Stockhammer, 2013). 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 and 'u' is the capacity utilization rate given by the capital stock. The labor-output ratio is $(a = L/Y)$, and both 'a' and 'b' are assumed to be constant. $(w = W/p)$ is the real wage, (r) the rate of profit, and (u) the capacity utilization rate.

Hein (2014) builds a model on the following equation:

$$r = \frac{\Pi}{K} = \frac{\Pi}{pY}\frac{Y}{Y^p}\frac{Y^p}{K} = \frac{pY - WL}{pY}\frac{Y}{Y^p}\frac{Y^p}{K} = \frac{Y - wL}{Y}\frac{Y}{Y^p}\frac{Y^p}{K} = (1 - wa)u\frac{1}{b} = \pi\frac{u}{b} \quad (4)$$

where π is the profit share, and Π is the gross profit.

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

$$p = (1 + m)\frac{W}{Y} = (1 + m)wa, m > 0 \quad (5)$$

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

$$w = \frac{W}{p} = \frac{1}{(1+m)a} \quad (6)$$

Therefore, the profit share can be defined as follows:

$$\pi = \frac{\Pi}{pY} = \frac{pY - W}{pY} = 1 - \frac{W}{(1+m)W} = 1 - \frac{1}{1+m} = \frac{m}{1+m} \quad (7)$$

The saving equation can be written in the following form:

$$\sigma = \frac{\sigma_\pi + \sigma_\omega}{pK} = \frac{\sigma_\pi \Pi \quad + \sigma_\omega (Y - \Pi \quad)}{pK} = [\sigma_\omega(1 - \pi) + \ \sigma_\pi \pi]\left(\frac{u}{b}\right) = [\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{u}{b}\right) \quad (8)$$

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:

$$S = pI + pX - Ep_f M = I + NX \quad (9)$$

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, and p_f the foreign prices. Dividing the above equation by the nominal capital stock (pK), the following are obtained: i) $S/pK = \sigma$; ii) $I/K = g$; and iii) $NX/pK = nx$.

$$\sigma = g + nx \quad (10)$$

Assuming that the Marshall-Lerner condition holds, which states that the sum of the absolute values of export and import elasticities exceeds 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:

$$nx = \varsigma_1 \theta(\pi) - \varsigma_2 u + \varsigma_3 u_f, \ \ \varsigma_1, \varsigma_2, \varsigma_3 > 0 \tag{11}$$

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

The elasticity of saving is greater 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 positively 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}).

$$g = \frac{I}{K} = \alpha + \beta u + \tau \pi + \vartheta \hat{\lambda}; \ \alpha, \beta, \tau, \vartheta > 0; \ g > 0 \text{ to } r > r_{min} \tag{12}$$

Assuming that the stability condition holds, plugging equations (8), (12) and (11) into equation (10) and solving for capacity utilization and capital accumulation, the following equations are achieved:

$$u^* = \frac{\alpha + \tau\pi + \varsigma_1\theta(\pi) + \vartheta\hat{\lambda} + \varsigma_3 u_f}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2} \tag{13}$$

$$g^* = \frac{(\alpha + \tau\pi + \vartheta\hat{\lambda})[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi + \varsigma_2] + \beta(\varsigma_1\theta(\pi))}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2} \tag{14}$$

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

$$\frac{\partial u^*}{\partial \pi} = \frac{\tau - (\sigma_\pi - \sigma_\omega)\frac{u}{b} + \varsigma_1 \frac{\partial \theta}{\partial \pi}}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2} \gtrless 0 \tag{15}$$

$$\frac{\partial g^*}{\partial \pi} = \frac{\tau\{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2\} - \beta(\sigma_\pi - \sigma_\omega)\frac{u}{b} + \beta\varsigma_1\frac{\partial \theta}{\partial \pi}}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2} \gtrless 0 \tag{16}$$

A positive result from equation (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 greater 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 that the economy's accumulation and growth will be a wage-led growth regime. The overall outcome of equation (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 above, the productivity equations can be defined as follows:

$$\hat{\lambda} = \beta_0 + \beta_1 u + \beta_2 \pi + \beta_3 \theta,\ 0 < \beta_1 < 1;\ \beta_{2,} \lesseqgtr 0;\ \beta_3 \lesseqgtr 0 \quad (17)$$

or

$$\hat{\lambda} = \beta_0 + \beta_4 y + \beta_2 \pi + \beta_3 \theta,\ 0 < \beta_1 < 1;\ \beta_{2,} \lesseqgtr 0;\ \beta_3 \lesseqgtr 0 \quad (18)$$

Assuming that equations (17) and (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 (13) and (17) achieves the long-run equilibrium rates for capacity utilization and productivity growth as follows:

$$u^{**} = \frac{\alpha + (\tau - \beta_2 \vartheta)\pi + \varsigma_1 \theta(\pi) + \vartheta(\beta_0 + \beta_3 \theta(\pi)) + \varsigma_3 u_f}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2 - \vartheta\beta_1} \quad (19)$$

$$\hat{\lambda}^{**} = \frac{(\beta_0 - \beta_2 \pi)\left\{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2\right\} + \beta_1[\alpha + \tau\pi + \varsigma_1 \theta(\pi) + \vartheta\beta_3 \theta(\pi) + \varsigma_3 u_f]}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2 - \vartheta\beta_1} \quad (20)$$

Substituting equations (19) and (20) into (12) obtains the long-run capital accumulation rate as follows:

$$g^{**} = \alpha + \tau\pi + \beta\left\{\frac{\alpha + (\tau - \beta_2 \vartheta)\pi + \varsigma_1 \theta(\pi) + \vartheta\beta_0 + \varsigma_3 u_f}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2 - \vartheta\beta_1}\right\} +$$
$$+\vartheta\left\{\frac{(\beta_0 - \beta_2 \pi)\left\{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2\right\} + \beta_1[\alpha + \tau\pi + \varsigma_1 \theta(\pi) + \vartheta\beta_3 \theta(\pi) + \varsigma_3 u_f]}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2 - \vartheta\beta_1}\right\} \quad (21)$$

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

$$[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2 - \vartheta\beta_1 > 0 \quad (22)$$

$$(1 - \vartheta\beta_2)\{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) + \varsigma_2\} - \beta > 0 \quad (23)$$

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 (19) in relation to the profit share, the following expression is achieved:

$$\frac{\partial u^{**}}{\partial \pi} = \frac{\tau - \vartheta\beta_2 - (\sigma_\pi - \sigma_\omega)\frac{u}{b} + \varsigma_1 \frac{\partial \theta}{\partial \pi} + \beta_3 \frac{\partial \theta}{\partial \pi}}{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2 - \vartheta\beta_1} \gtrless 0 \quad (24)$$

The result is quite close to the result of an open economy model. If the overall result of equation (24) is positive, the positive effect related to investment demand (τ) and to 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 greater than the reduction in consumption ($(\sigma_{\pi}-\sigma_{\omega})\frac{u}{b}$) and $\vartheta ϐ_2$, 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, equation (21), in relation to the profit share, the following equation is obtained:

$$\frac{\partial g^{**}}{\partial \pi}=\frac{(\tau-\vartheta\beta_2)\left\{[\sigma_{\omega}+(\sigma_{\pi}-\sigma_{\omega})\pi]\left(\frac{1}{b}\right)+\varsigma_2\right\}-(ϐ+\vartheta\beta_1)(\sigma_{\pi}-\sigma_{\omega})\frac{u}{b}+(ϐ+\vartheta)\varsigma_1\frac{\partial\theta}{\partial\pi}+\beta_3\frac{\partial\theta}{\partial\pi}}{[\sigma_{\omega}+(\sigma_{\pi}-\sigma_{\omega})\pi]\left(\frac{1}{b}\right)-ϐ+\varsigma_2-\vartheta\beta_1}\gtreqless 0 \tag{25}$$

From equation (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 (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 this case the parameters related to productivity ($\vartheta\beta_2$) can decrease this whole term. Regarding the indirect effect of distribution ($(ϐ+\vartheta\beta_1)(\sigma_{\pi}-\sigma_{\omega})\frac{u}{b}$), in this model the productivity term can make this term even greater than in the model related to an open economy.

For the indirect effect of international competitiveness, net exports and domestic capacity utilization ($(ϐ+\vartheta)\varsigma_1\frac{\partial\theta}{\partial\pi}+\beta_3\frac{\partial\theta}{\partial\pi}$), 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 $[(ϐ+\vartheta)\varsigma_1\frac{\partial\theta}{\partial\pi}+\beta_3\frac{\partial\theta}{\partial\pi})]$, which would make profit-led accumulation more likely. As discussed for the model with an open economy, if the income redistribution favors 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 analyze the relation between productivity growth and the profit share in the short term as follows:

$$\frac{\partial\hat{\lambda}^{**}}{\partial\pi}=\frac{\beta_1\left[\tau-(\sigma_{\pi}-\sigma_{\omega})\frac{u}{b}+\varsigma_1\frac{\partial\theta}{\partial\pi}+\beta_3\frac{\partial\theta}{\partial\pi}\right]-\beta_2\{[\sigma_{\omega}+(\sigma_{\pi}-\sigma_{\omega})\pi]\left(\frac{1}{b}\right)-ϐ+\varsigma_2\}}{[\sigma_{\omega}+(\sigma_{\pi}-\sigma_{\omega})\pi]\left(\frac{1}{b}\right)-ϐ+\varsigma_2-\vartheta\beta_1}\gtreqless 0 \tag{26}$$

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 ($\beta_2\{[\sigma_{\omega}+(\sigma_{\pi}-\sigma_{\omega})\pi]\left(\frac{1}{b}\right)-ϐ+\varsigma_2\}$), 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 (24), (25) and (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 a negative impact on $\frac{\partial \hat{\lambda}^{**}}{\partial \pi}$, depending on the sign of the parameters of equation (26).

3. Empirical studies

As explained by McCombie et al. (2002), there are several issues related to the specification of the Smith-Kaldor-Verdoorn effect. 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 Smith-Kaldor-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.

Sylos-Labini (1983) estimates the Smith-Kaldor-Verdoorn coefficient and the relationship between productivity and real wages for Italy and the United States, whereas Carnevali et al. (2020) estimate the Smith-Kaldor-Verdoorn and Ricardo-Sylos-Labini coefficients for a set of European countries. The authors used several different statistical methodologies for testing the coefficients. The main conclusion is that the Smith-Kaldor-Verdoorn and Ricardo-Sylos-Labini coefficients are significant to explain productivity growth in the sample of European countries. Also, the authors argue that the slowdown of productivity is due to the reduction of wage share in those economies. It is important to notice that Sylos-Labini (1983) estimates lagged investment explicitly, whereas we do not.

Angeriz et al. (2009) estimate the Smith-Kaldor-Verdoorn coefficient 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 for the period 1977-2005, using Verdoorn's law itself together with other contributing factors to explain labor productivity growth, such as manufacturing agglomeration and spatial interaction. The authors, based on the econometric findings, argue that there was a slowdown in labor 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:

$$\hat{\lambda} = \beta_0 + \beta_1 \hat{y} + \beta_2 \hat{w};\ \beta_0, \beta_1 > 0; 0 < \beta_2 < 1 \tag{26}$$

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 Smith-Kaldor-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 equation to analyze the demand regime:

$$\hat{\lambda} = f(\hat{Y}, \hat{w}, sh_m, GAP) \quad (27)$$

in which $\hat{\lambda}$ is the labor 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 US labor productivity. Furthermore, the authors assess the possibility of structural breaks using *dummy variables*. The estimation used an error-correction-model (ECM).

This study finds that the economies of Germany, the UK and the US 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.

4. Econometric exercise

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

$$\hat{\lambda} = \beta_0 + \beta_1\hat{y} + \beta_2\hat{w} + \beta_3\hat{\theta} + \beta_3\hat{\theta}^2 \quad (28)$$

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 (1) follows the traditional steps: i) stationarity tests; ii) a cointegration test; and iii) regressions.

Table 1 – *Variables for the productivity equation*

Variable	Abbreviation	Period	Source
Productivity = 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 1981-2014	World Bank national accounts data and OECD National Accounts data files
GDP = constant local currency	*Lny*		World Bank national accounts data and (National Accounts data files
Wage share	*Lw*		International Labour Organization, key indicators of the Labour Market database
The 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.[6]

The estimation strategy used is the same as that applied in the previous subsection. The first step is to determine in which case the variables are stationary for each variable and country. Hence, Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests are applied. In the KPSS tests, the null hypothesis that the time series are stationary is verified for all countries, and the series

[6] The wage share variable was obtained following the Tosoni (2014) methodology.

are stationary in first differences. Hence, following a conservative strategy, all the series are integrated of order one, $I(1)$. 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.

Table 2 – *Estimates of productivity equation (1) – selected countries*

	Argentina	**Brazil**	**Bolivia**	**Chile**	**Colombia**	**Mexico**	**Uruguay**
Constant	0.013	0.01	-0.0001	0.02	0.02	0.01	0.01
t-test	(2.46)	(5.49)	(-0.02)	(2.12)	(3.01)	(2.43)	(0.98)
p value	0.02	0.00	0.97	0.04	0.00	0.02	0.33
DlnY (-1)	0.35	0.41	0.89	0.41	0.37	0.34	0.69
t-test	(1.70)	(3.51)	(7.99)	(1.78)	(1.78)	(1.82)	(1.78)
p value	0.09	0.00	0.00	0.08	0.08	0.08	0.09
DlnW (-1)	0.25	0.33	-0.07	-0.38	0.10	-0.40	0.16
t-test	(2.40)	(2.29)	(-1.94)	(-1.78)	(1.66)	(-2.34)	(2.01)
p value	0.02	0.03	0.06	0.08	0.10	0.02	0.05
Dln rer (-1)	-0.08	-0.22	0.59	2.24	-3.23	3.58	0.21
t-test	(-0.98)	(-0.16)	(1.80)	(0.92)	(-1.83)	(2.35)	(0.09)
p value	0.33	0.87	0.08	0.36	0.07	0.02	0.92
Dln rer2 (-1)	0.13	0.013	-0.05	-25	0.36	-0.37	-0.05
t-test	(2.40)	(0.08)	(-1.73)	(-0.97)	(1.80)	(-2.16)	(0.84)
p value	0.02	0.93	0.09	0.33	0.08	0.04	0.84
AR (4)	No	No	No	No	No	Yes	No
MA (1)	No	No	Yes	Yes	Yes	Yes	Yes
MA (2)	Yes	No	No	Yes	No	Yes	Yes
MA (3)	Yes	No	No	Yes	Yes	Yes	
R2 Adj.	0.73	0.13	0.49	0.41	0.20	0.31	0.53
SE	0.02	0.02	0.02	0.04	0.008	0.01	0.02
D.W	1.96	1.73	1.88	1.72	1.83	2.03	2.30
F-stat.	15.66	2.25	6.99	4.69	2.69	408.6	7.80
prob>F	0.00	0.08	0.00	0.00	0.02	0.00	0.00
obs.	34	34	32	32	34	33	31
Period	1980-2014	1980-2014	1980-2012	1980-2012	1980-2014	1981-2014	1983-2014

Note: The first difference is applied to all the variables. The t-statistics are 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 2 shows the results of the estimated productivity equations. The regressions are performed using least squares, robust least squares and least squares correcting the autocorrelation and heteroskedasticity with the HAC matrix. The overall outcome is that the Smith-Kaldor-Verdoorn coefficient is significant for all the countries: Argentina (0.35), Brazil (0.41), Bolivia (0.89), Chile (0.41), Colombia (0.37), Mexico (0.41) and Uruguay (0.69).

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), and Oliveira et al. (2006). The Ricardo-Sylos-Labini coefficient is the ($Dlnw$). The parameter is significant for Argentina, Brazil, Bolivia, Chile, Mexico and Uruguay, and the parameters' values are 0.25, 0.33, -0.07, -0.38, -0.40 and 0.16, respectively, meaning that Argentina, Brazil and Uruguay are wage-led regimes, whereas Bolivia, Chile and Mexico are profit-led regimes. In the case of Colombia, the parameter is not 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 Argentina, Bolivia, Colombia and Mexico, the parameter $Dln\ rer\ (-1)$, $Dln\ rer2(-1)$ or both is/are significant. In the case of Brazil, Chile and Uruguay, both of the parameters are non-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. However, there is an extensive body of work on the relationship between the real exchange rate and growth, such as Rodrik (2008), Bragança and Libânio (2008), 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). Most of the work on this topic focuses on exchange rate misalignments, and in our research we focus on the real exchange rate change.

The mixed results for Brazil, Chile and Uruguay deserve further investigation. Indeed, the null effect of the changes in the real exchange rate on productivity, on the one hand, meets the role of non-price competitiveness, as McCombie and Thirlwall (1994) highlight. On the other hand, it shows the fact that the productive structure in those countries does not depend on the exchange rate. Gabriel et al. (2016) open a window to analyze this feature, although more research needs to be done.

5. Conclusions

The main goal of this paper was to assess the relationship between the real exchange rate and productivity growth. The secondary objectives were to study the relationship between economic growth and productivity growth (through the so-called Smith-Kaldor-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, Sylos-Labini (1983); Naastepad, 2006; Hein and Tarassow, 2010; and Carnevali et al., 2020).

The first novelty of our paper 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, and Uruguay is that the Kaldor-Verdoorn coefficient is significant for all the evaluated countries. Nevertheless, the estimated coefficients in this research are greater 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.

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Table A1 – *KPSS test for selected countries*

Variable	**Argentina t-test**	**Brazil t-test**	**Bolivia t-test**	**Chile t-test**	**Colombia t-test**	**Mexico t-test**	**Uruguay t-test**			**Critica l value**	**Argentina result**	**Brazil result**	**Bolivia result**	**Chile result**	**Colombia result**	**Mexico result**	**Uruguay result**
								1% level	5% level	10% level							
DLnpr	0.30	0.09	0.429	0.08	0.18	0.12	0.10	0.739	0.463	0.347	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary
DLny	0.23	0.17	0.446	0.12	0.14	0.12	0.11	0.739	0.463	0.347	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary
DLnw	0.12	0.20	0.263	0.10	0.50	0.08	0.12	0.739	0.463	0.347	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary
DLnrer	0.15	0.05	0.093	0.23	0.15	0.20	0.10	0.739	0.463	0.347	Stationary	Stationary	Stationary	Stationary	Stationary	Not stationary	Stationary
DLnrer2	0.20	0.05	0.10	0.23	015	0.21	0.10										

Table A2 – *Breusch-Godfrey Serial Correlation LM Test*

	Argentina	Brazil	Bolivia	Chile	Colombia	Mexico	Uruguay
$RESID(-1)$	0.37 (2.01)	0.17 (0.93)	0.01 (0.06)	0.12 (0.59)	-0.32 (-1.56)	-0.40 (-1.78)	0.17 (0.84)
$RESID(-2)$	-0.40 (-2.16)	0.25 (1.30)	0.09 (0.4)	0.04 (0.23)	0.19 (1.03)	-0.09 (-0.42)	-0.16 (-0.72)
F-statistic	3.786959	1.745099	0.083827	0.202994	2.276517	1.604751	0.541109
Obs*R-squared	7.448193	3.891963	0.213167	0.507369	4.906126	3.612211	1.337551
Prob. F(2,27)	0.0355						
Prob. F(2,27)		0.1938					
Prob. F(2,26)			0.9198				
Prob. F(2,27)				0.8176			
Prob. F(2,26)					0.1220		
Prob. F(2,21)						0.2195	
Prob. F(2,26)							0.5890
Prob. F(2,29)							
Prob. Chi-Square(2)	0.0241	0.1428	0.8989	0.7759	0.0860	0.1643	0.5123
Adj. R	0.04	0.11	0.006	-0.2	-0.04	-0.09	-0.19
Durbin-Watson stat	1.93	2.04	1.91	1.93	2.00	1.84	2.00

Note: t-statistics are in parentheses below each coefficient.

Table A3 – *Heteroskedasticity ARCH Test*

	Argentina	Brazil	Bolivia	Chile	Colombia	Mexico	Uruguay
RESID^2(-1)	0.24 (1.39)	0.30 (1.80)	-0.04 (-0.26)	-0.06 (-0.36)	0.63 (4.60)	-0.03 (-0.15)	-0.01 (0.07)
F-statistic	1.954446	3.244658	0.072318	0.131114	21.24476	0.023034	0.005511
Obs*R-squared	1.957148	3.126727	0.077114	0.139246	13.41909	0.024502	0.005904
Prob. F(1,31)	0.1720						
Prob. F(1,32)		0.0814					
Prob. F(1,29)			0.7899				
Prob. F(1,31)				0.7198			
Prob. F(1,31)					0.0001		
Prob. F(1,23)						0.8804	
Prob. F(1,29)							
Prob. F(2,31)							0.9413
Prob. Chi-Square(2)	0.1618	0.0770	0.7812	0.7090	0.0002	0.8756	0.9388
Adj. R	0.02	0.06	-0.03	-0.02	0.38	-0.03	-0.03
Durbin-Watson stat	2.00	2.06	2.00	2.00	1.83	1.76	1.98
Period	1980-2014	1980-2014	1980-2012	1980-2012	1980-2014	1988-2014	1983-2014

Note: t-statistics are in parentheses below each coefficient.

Table A4 – *Multiple breakpoint tests*

	Argentina	Brazil	Bolivia	Chile	Colombia	Mexico	Uruguay
Break test 0 vs 1 and F-Statistic	50.01868*	31.99319*	49.59375	18.57040	41.30584*	51.43959*	105.0914*
Break test 0 vs 2 and F-Statistic		5.608526*	8.640.235	56.70004	7.291999*	5.207331*	6.141848*
Break test 0 vs 3 and F-Statistic		2.638.395	12.65799	1.726374	11.57926*		3.911080*
Break test 0 vs 4 and F-Statistic			3.688.484		2.178877*		
Break test 0 vs 1 and Scaled F-Statistic	150.0560*	127.9728*	148.7812*	74.28160	123.9175*	154.3188*	315.2743*
Break test 0 vs 2 and Scaled F-Statistic		22.43411*	25.92070*	226.8001	21.87600*	15.62199*	18.42555*
Break test 0 vs 3 and Scaled F-Statistic		1.055.358	37.97397*	6.905498	34.73779*		11.73324*
Break test 0 vs 4 and Scaled F-Statistic			11.06545		6.536631*		
Break test 0 vs 1 and Critical value	13.98	16.19	13.98	16.19	13.98	13.98	13.98
Break test 0 vs 2 and Critical value		18.11	15.72	18.11	15.72	15.72	15.72
Break test 0 vs 3 and Critical value		18.93	16.83	18.93	16.83		16.83
Break test 0 vs 4 and Critical value			17.61		17.61		
Break dates 1 and Sequential - Repartition	1999 - 1999	1991 - 1991	2000-1985	2000-2000	1994-1989	1999-1999	2000-2006
Break dates 2 and Sequential - Repartition		2002 - 2002	2010-2000	2005-2005	1989-1994		2006-2006
Break dates 3 and Sequential - Repartition			1985-2010		2002-2002		
Break dates 4 and Sequential - Repartition					2009-2009		