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

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ABSTRACT: The aim of this research is to discuss the theory on productivity growth as well as its empirical applications. It emphasized the impact of the real exchange rate devaluation on productivity. The main research question is: does the real exchange rate have a positive or negative impact on productivity growth? Besides define a productivity equation that considers the relationship between productivity growth and real exchange rate an empirical experiment that estimates the productivity growth equation for a sample of Latin American countries was performed. Regarding to the real exchange rate and this variable taken in squared, the parameters are negative for all countries, indicating that real exchange rate devaluation does not increase productivity growth.

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

JEL: O11, O15, O41.

ÁREA TEMÁTICA

Área 6 - Crescimento, Desenvolvimento Econômico e Instituições

1. Introduction

The aim of this research is to discuss the theory on 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 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 particularly relevant for 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?

In order to answer this question, the first step is to define a productivity equation that considers the relationship between productivity growth and real exchange rate. Then, the real exchange rate is added to the equation proposed by Naastepad (2006) and Hein and Tarassow (2010). A second step is to discuss productivity growth in the context of demand regimes. The third step consists in 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 the Latin America (*WDI*, 2013).

Besides this short introduction, the research is divided 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 on empirical studies on productivity growth. The fifth section is dedicated to the empirical experiment. Finally, the last section brings final considerations.

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 increasing spending on R&D, investment and capital intensity in production. Naastepad (2006), Storm and Naastepad (2012), and Hein and Tarassow (2010) show empirical evidence for this relationship to 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, whose economies differ greatly from those of European countries. Secondly, 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 on profit share can be induced by a change in the mark-up in the ratio of imported materials to unit labour costs. An increase in profit share is created by a rising mark-up, domestic prices tend to increase and the real exchange rate and hence international competitiveness will decline. Nevertheless, if an increase profit share is originated by an increasing unit imported material costs ratio to unit labour costs, the real exchange rate will also raise and international competitiveness will improve. The depreciation of the domestic currency in nominal terms, which means, increasing in the nominal exchange rate, or decreasing nominal wages will raise unit material costs ratio to unit labour costs, and will hence increase profit share along with improved competitiveness. Although raising 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 wage-led or 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, economic growth in the short term might be slow, due to differences in 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 raises imports more than proportionally, thus generating an external constraint to economic growth, along the lines of the Thirlwall's law. The authors, however, do not consider the fact that the increasing wage share can have positive impact on productivity growth. In any case, it is important the study of external constrain when wage-led/profit-led approach is studied.

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

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

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. Since the equation has been defined, the next step is to discuss the equation arguments.

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; 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 was Dixon and Thirlwall (1975). The authors present a model to explain differences on 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), Hein and Tarassow (2010) bring strong econometric evidence on this approach. This theory is especially important for development of countries economic growth, because this approach has the potential to clarify the role of the modern sectors and aggregate demand on productive growth. This theory is critical for economic policy, since managing aggregate demand is one relevant economic policy tool.

Originally, the Verdoorn-Kaldor coefficient was expressed as:

$$\lambda = \beta_0 + \beta_1 g \qquad (2)$$

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 related to this approach. The first is related to problems in the productivity equation, specifically the Verdoorn- Kaldor coefficient. The equation which relates the productivity growth with income growth can be expressed as:

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

Following McCombie *et al*. (2002), the controversy is associated with the equation specification, which can display bias caused by 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 employment growth rate is the dependent variable and the income growth is the independent variable. The problem arises by the fact that both (employment growth rate and income rate) are endogenous. Other alternatives involve using capital stock, labour share and capital as independent variable, however, have poor empirical evidence.

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 Naastepad (2006), Storm and Naastepad (2012), Hein and Tarassow (2010), usually work with lags on the independent variables to avoid simultaneity between the dependent and independent variables, e.g., 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 estimate the coefficient is to study the means the literature solves the problem.

2.2 Productivity and real wage

The coefficient β_2 in equation (1) reflects a positive relationship between real wages growth and productivity growth. Supposing high employment rate, which possibly raises the workers bargain power will quicken 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 economy income, thus causing a reduction in the profit share. Firms and capitalist, 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 are empirical evidences for this relationship. Naastepad (2006), and Hein and Tarassow (2010) confirm this relationship for European countries. It is important to note that the economic structure of Europeans countries is different from the Latin American countries. Because Latin American countries are less industrialized when compared to Europeans countries, the workers will have less bargain powers. Moreover, supposing that the workers have bargaining powers, it can be the case that the firms will have difficulties to enhance productivity growth in face of real wage growth. Hence, increasing real wage growth above productivity growth will reduce the firms' profitability, and if the investment decisions depend on profits, firms will reduce investment and the productivity growth will fall. Whether this relationship is positive or negative, it is a question for empirical experiment, which will be undertaken further in this research.

Thus, increasing real wages lead to improvement in technical progress and innovation. Moreover, an increase in real wages can also eliminate inefficient firms, favouring structural changes and raising skilled workers proportion in the economy. In this research is argued that this positive effect is only possible when enterprises can innovate in the face of increasing real wages. For underdevelopment 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 reverse of that found elsewhere. It might be possible that the level of economic development can interfere with the dynamics of productivity growth through time.

2.3 Productivity and real exchange rate

The coefficient β_3 in equation (1) reflects the indirect impact of the real exchange rate on productivity growth. Krugman and Taylor (1978) explain the reasons 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. Also, if the imports prices increase, imported machines and equipment become more expensive, which 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 funds availability necessary to finance investment and innovative activity (Missio and Jayme Jr, 2013). In this case, a devaluation of the real exchange rate increases profits, which increases investment, and thus aggregate demand. Implicitly, the authors are considering that the aggregate demand regime is profit-led.

3. The model

Hein and Tarassow (2010) introduce the discussion 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 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 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; Stockhammer, p. 15, 2012)". It is 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. The parameter "u" is capacity utilization rate given by the capital stock. The labour-output ratio is ($a = L/Y$), both "a" and "b" are assumed to be constant. The ($w = W/p$) is real wage, (r) rate of profit and (u) capacity utilization rate.

Following the Kaleckian tradition, the model is built upon 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.

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

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

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:

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

in which σ_ω is the propensity to save out of 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 total savings, pI the total nominal investment, pX the total nominal export, $Ep_f M$ the total nominal imports and NX the net exports. Dividing the above equation by nominal capital stock (pK), it is obtained: i) $S/pK = \sigma$; ii) $I/K = g$ and iii) $NX/pK = nx$.

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

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

$$nx = \varsigma_1 \theta(\pi) - \varsigma_2 u + \varsigma_3 u_f, \;\; \varsigma_1, \varsigma_2, \varsigma_3 > 0 \quad (11)$$

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 the elasticity of investment and net export.

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

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

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

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

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

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

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

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[1] The supply elasticity tends to infinity.

[2] Unfortunately, the variable real wage of the total worker's compensation was not found. Actually, it was found the Unemployment, total (% of total labour force) (national estimate). In order to obtain the employment rate, it was made the following account for each period: 100-Unemployment.

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

From the equation (15), a positive result of this equation 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 demand is reached. Otherwise, a wage-led demand is achieved.

Taking the partial derivative of capital accumulation in relation to saving out profits and wages it is obtained $\frac{\partial g^*}{\partial \sigma_\pi} < 0$, $\frac{\partial g^*}{\partial \sigma_\omega} < 0$. Increasing propensity to save out 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 for equation (16) depends on the direct effect of the improvement in the profit ($\tau\{[\sigma_\omega +$ *σπ−σωπ1b−β+ς2}*), the indirect effect of distribution (*βσπ−σωub*), and finally the indirect effect of international competitiveness through net export 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 profit rate is the same as in a closed economy and the analysis applied for the profit share can be easily reproduced.

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

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

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

or

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

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 with productivity growth.

Merging equation (13) and (17), it is achieved the long-run equilibrium rates for capacity utilization and productivity growth as follows:

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

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

Substituting equation (19) and (20) into (12), it is obtained the long-run capital accumulation rate, as follows:

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

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

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

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

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 profit share, it is achieved the following expression:

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

The result is quite close to the result for an open economy model. If the overall result of equation (24) is positive, which means that the positive effect related with investment demand (τ) and with 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 $\vartheta\mathrm{\beta}_2$, the last term related if productivity growth equation. In this case the demand is profit-led. Otherwise, it is wage-led.

Taking the partial derivative of capital accumulation rate in the long-run equilibrium (21) in relation to the profit share, it is obtained the follow equation:

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

From the expression (25), wage-led accumulation and 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 for equation (25) depends on the direct effect of the improving in profits (($\tau - \vartheta\beta 2\sigma\omega + \sigma\pi - \sigma\omega\pi 1b + \varsigma 2$), which in this case the parameters related to productivity ($\vartheta\beta 2$) can decrease this whole term. The indirect effect of distribution ($(\mathrm{\beta} + \vartheta\beta_1)(\sigma_\pi - \sigma_\omega)\frac{u}{b}$), which in this model, the productivity term can make this term even bigger, when compared with the model related to open economy.

Finally, the indirect effect of international competitiveness, net export and domestic capacity utilization ($(\beta + \vartheta)\varsigma_1 \frac{\partial \theta}{\partial \pi} + \beta_3 \frac{\partial \theta}{\partial \pi}$), it is obtained in this model a positive feedback effect through international competitiveness on productivity (ϑ). 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 the profit-led accumulation more likely. As it was discussed for the model with open economy, if the income redistribution favours wages, and this is associated with a decrease in the mark-up pricing, competitiveness will improve, thus raising the net exports, which might reinforce a wage-led demand.

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

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

Changes on profit share have two effects on productivity growth rate in the long-run equilibrium. The first effect is through the goods market expressed by the term ($\beta_1 \left[\tau - (\sigma_\pi - \sigma_\omega)\frac{u}{b} + \varsigma_1 \frac{\partial \theta}{\partial \pi} + \right.$ $\beta 3 \partial \theta \partial \pi$). This term might be positive or negative. It depends on the demand regime, which can be profit-led or wage-led. The second effect is through the term ($\beta_2\{[\sigma_\omega + (\sigma_\pi - \sigma_\omega)\pi]\left(\frac{1}{b}\right) - \beta + \varsigma_2\}$), which is, by assumption, positive. This term is related with the negative effect of profit share on productivity (β_2). The overall result can be positive or negative; it will depend on the relationship of increase profit share on productivity growth.

The demand regime can be profit-led or wage-led, as it has been 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 ($\frac{\partial u^{**}}{\partial \pi}; \frac{\partial g^{**}}{\partial \pi} > 0$), increase on 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 (26).

4. Empirical studies

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

León-Ledesma (2002) estimated the Verdoorn coefficient for OECD countries and the Verdoorn coefficient, finding a highly significant coefficient (0,672). Besides the productivity equation, the author tested the relationship between output growth and export growth. The estimated parameter was also significant.

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

Naastepad (2006), Storn and Naastepad (2007), and Naastepad and Storm (2012), tested equation (26) below for a large sample of OCDE and Latin American countries, for different periods, given the lack of data for many countries. In order to study the regime demand from the empirical point of view, the authors estimated the follow equation:

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

in which $\hat{\lambda}$ is productivity growth, $\hat{y}$ income growth and $\hat{w}$ real wage growth.

The results showed that the Verdoorn coefficient is significant. In addition to this, the parameter related to real wages (β_2) is positive and significant.

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

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

In which $\hat{y}$ is the labour productivity, *Y* is the GPD, *w* real wage, *sh* is the share of manufacturing sector, GAP is *gap* related with US labour's productivity. Furthermore, the authors assessed the possibility of structural breaks using *dummies variables*. The statistical methodology used in the paper was the Autoregressive Vectors (VEC).

This study found that Germany, UK and USA's economies were wage-led, which was reinforced by the productivity regime. Thus, increases in profit share have negative effects on the demand, and hence on economic growth. In France, despite the demand regime being wage-led, the authors found no significant effect of the profit share on the productivity regime, i.e., 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 productivity regime.

5. Econometric exercise

Besides the theoretical model, the real exchange rate squared is tested as indicated by Missio, Jayme Jr, Britto and Oreiro (2015) in order to test non-linearity in the real exchange rate, as follows:

$$\hat{\lambda} = \beta_0 + \beta_1 \hat{y} + \beta_2 \hat{w} + \beta_3 \hat{\theta} + \beta_3 \hat{\theta}^2 \quad (1)$$

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

The estimation of equation (1) followed the traditional steps: i) stationary tests; ii) cointegration test; iii) regressions.

Table 1: Variables for the productivity equation

Variable	Abbreviation	Period	Source
Productivity = variable was 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

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

The estimation strategy used is the same applied in the previous subsection. The first step is to analyse in which case the variables are stationary for each variable and country. Hence, Kwiatkowski-Phillips-Schmidt-Shin (KPSS), (1992) tests were applied. In the KPSS tests, the null hypothesis is that the time series are stationary was verified for most countries (Mexico and Venezuela were exceptions when variables were taken in levels), that the series are stationary in levels as well as in first differences. Hence, in a conservative strategy, all series are integrated of order one, *I*(1).

The next step was to carry out the Multiple Breakpoint test (or Bai-Perron (2003) tests). For this test was found breakpoints to the following countries: Argentina, Brazil, Chile, Colombia and Venezuela. As breakpoints were found in the series, dummy variables were included in order correct the problem. The Multiple breakpoint tests for the countries that present structural breaks are reported in the appendix.

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

[2] Unfortunately, the variable real wage of the total worker's compensation was not found. Actually, it was found the Unemployment, total (% of total labour force) (national estimate). In order to obtain the employment rate, it was made the following account for each period: 100-Unemployment.

Table 2: Estimates of productivity equation (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: First difference is applied for all variables. The estimation method was Least Squares corrected by HAC standard errors & 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 Durbin–Watson statistic. F is the F-statistic and prob > F is the probability associated with observing an F-statistic. Furthermore, Dummies variables were applied when needed. All the tests that justify applying these methodologies are reported in the Appendix.

In order to chose the best model, for instance AR(1), or ARMA(1,1) and etc, the strategy was to combine i) the F is the probability associated with observing an F-statistic close to zero; and ii) the Durbin–Watson statistic as close as possible to 2.00.

Table (2) shows the results of the estimated productivity equations. The regressions were made using the Least Squared, Robust Least Squared, Least Squared correcting the autocorrelation and heteroskedasticity by the HAC matrix. The overall outcome is that the Kaldor-Verdoorn coefficient is significant for all countries. The coefficient for Argentina is (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 with those estimated for Latin American countries by other authors (the exception is made for Chile, in which the parameter is smaller than the findings in the literature). Such studies in this topic for Latin American countries include Acevedo *et al*. (2009), Borgoglio and Odisio (2015), Britto and McCombie (2015), Carton (2009), Destefanis (2002), Libanio (2006), Oliveira, Jayme Jr. and Lemos (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 America 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, real wage growth (employment growth) is not statically significant.

Regarding the real exchange rate parameter, the real exchange rate was tested and the real exchange rate squared, in order to test for non-linearities. For all countries, except Colombia, the parameter ($Dln\, rer\,(-1)$), $Dln\, rer2(-1)$ or both is/are significant, however negative. In the case of Colombia either the parameters are significant. Given the theoretical discussion presented before, these results may mean that the 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 impacted negatively 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 Araujo (2013), Nassif *et al*. (2015), Missio, Jayme Jr., Oreiro and Britto (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). However, most of the work on the theme focuses on exchange rate misalignments. In this research, the focus is on real exchange rate change and level. This difference is important because the result reach 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, real exchange rate has a positive impact on productivity growth.

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 call Verdoorn coefficient) and the interaction between productivity growth and real wage growth. These relationships (productivity growth, real wage growth and income growth) have been explored on several papers (for instance Naastepad (2006) and Hein and Tarassow (2010).

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

The empirical experiment performed to Argentina, Brazil, Bolivia, Chile, Colombia, Mexico, Uruguay and Venezuela has as an overall outcome that the Kaldor-Verdoorn coefficient is significant for all analysed countries. Nevertheless, the estimated coefficients in this research are bigger than the parameters estimated to 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 to the real exchange rate and this variable taken in squared, the parameters are negative for all countries, indicating that real exchange rate devaluation does not increase productivity growth. However, future studies should take in consideration exchange rate misalignments for these countries, but using panel data analysis. It could alter the result found in this study.

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A – APPENDIX

Table A.1: KPSS test for 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	0.782	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 A.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 A.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 A.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 A.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

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

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