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

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

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SUMÁRIO

RESUMO

O objetivo desse trabalho é discutir a teoria do crescimento da produtividade e suas aplicações empíricas. Inúmeros autores enfatizam o impacto da desvalorização da taxa de câmbio real sobre a produtividade. A principal questão de pesquisa desse trabalho é: a taxa de câmbio real tem impacto positivo ou negativo sobre o crescimento da produtividade? O primeiro passo para responder esta questão é discutir o crescimento da produtividade no contexto dos regimes de demanda. O segundo passo consiste em um experimento empírico que estima a equação de crescimento da produtividade para uma amostra de países latino-americanos. O resultado é que o coeficiente de Kaldor-Verdoorn é significativo para todos os países analisados, Argentina, Brasil, Bolívia, Chile, Colômbia, México, Uruguai e Venezuela. A variável *wage-push* é significativa para apenas dois países, Bolívia e Chile, indicando que, na Bolívia, o regime é liderado por lucros, enquanto que no Chile o regime de crescimento é liderado pelos salários. Em relação à taxa de câmbio real e a esta mesma variável ao quadrado, os parâmetros são negativos para todos os países, indicando que a desvalorização da taxa de câmbio real não aumenta o crescimento da produtividade.

Palavras-chave: Modelo pós-kaleckiano, demanda agregada, taxa de câmbio real, produtividade, salário real.

ABSTRACT

This paper aims to discuss the theory of productivity growth and its empirical applications, several authors emphasize the impact of 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? 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 Kaldor–Verdoorn coefficient is significant for all the analysed countries, Argentina, Brazil, Bolivia, Chile, Colombia, Mexico, Uruguay and Venezuela. 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 it 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.

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

JEL: O11, O15, O41.

1. INTRODUCTION

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

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

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

2. PRODUCTIVITY GROWTH

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

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

Since there is the possibility of a wage-led or a profit-led demand regime, it is interesting to consider external constraints. Basilio and Oreiro (2015) argue that for developing economies, if the demand regime is wage-led, the economic growth in the short term might be slow due to differences in the income elasticity of imports and exports. In a developing country, in general, the income elasticity of imports is higher than the income elasticity of exports. Therefore, increasing wage shares raise imports more than proportionally, thus generating an external constraint on economic growth, along the lines of Thirlwall's law. The authors, however, do not consider the fact that the increasing wage share can have a positive impact on productivity growth. In any case, it is important to investigate the external constraints when studying the wage-led/profit-led approach.

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

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

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

2.1. Verdoorn effect

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

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

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

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

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

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 (λ) and income growth ($\hat{y}$). Since $\lambda = \hat{y} - \hat{e}$, it is possible to overcome the bias using the specification in which the employment growth rate is the dependent variable and the income growth is the independent variable. The problem arises from the fact that both the employment growth rate and the income rate are endogenous. Other alternatives involve using the capital stock, labour share and capital as the independent variable; however, the empirical evidence is poor.

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

2.2. 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, 2009, p. 735).

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

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

2.3. Productivity and the 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 why the aggregate demand falls when the exchange rate is undervalued. The devaluation leads to increasing export and import prices. If the increase in import prices overcomes the variation in exports, the net result will be a reduction of the country's income. Additionally, if the import prices increase, imported machines and equipment will become more expensive, and this will have a negative impact on productivity growth.

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

3. THE MODEL

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

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

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

where π is the profit share.

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

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

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:

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

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:

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

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

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

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

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

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

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

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

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:

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

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

[1] The supply elasticity tends to infinity.

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

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

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

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 bigger than the reduction in consumption ($(\sigma_\pi-\sigma_\omega)\frac{u}{b}$). In this case a profit-led demand is reached. Otherwise, a wage-led demand is achieved.

Taking the partial derivative of capital accumulation in relation to saving profits and wages, $\frac{\partial g^*}{\partial \sigma_\pi} < 0$, $\frac{\partial g^*}{\partial \sigma_\omega} < 0$ are obtained. An increasing propensity to save wages and profits reduces capital accumulation. The partial derivative of capital accumulation in an open economy makes it less likely for the economy's accumulation and growth to be a wage-led growth regime. The overall outcome of equation (16) depends on the direct effect of the improvement in the profit ($\tau\{[\sigma_\omega+(\sigma_\pi-\sigma_\omega)\pi]\left(\frac{1}{b}\right)-\beta+\varsigma_2\}$), the indirect effect of distribution ($\beta(\sigma_\pi-\sigma_\omega)\frac{u}{b}$) and finally the indirect effect of international competitiveness through net exports and domestic capacity utilization ($\beta\varsigma_1\frac{\partial\theta}{\partial\pi}$).

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

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

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

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

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), the long-run equilibrium rates for capacity utilization and productivity growth are achieved as follows:

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

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

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 bigger than the slope of the productivity equation. It is possible to make this condition explicit as follows:

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

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

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

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

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

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

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

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

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

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 $(\beta_2\{[\sigma_\omega+(\sigma_\pi-\sigma_\omega)\pi]\left(\frac{1}{b}\right)-\beta+\varsigma_2\})$, 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 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 Verdoorn's law. An extensive review of this matter can be found in the study by McCombie *et al*. (2002). In this subsection some empirical applications of Verdoorn's law will be discussed.

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

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

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

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

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

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

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

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

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

4. ECONOMETRIC EXERCISE

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

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

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

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

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

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

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

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

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

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

Table (2) shows the results of the estimated productivity equations. The regressions are performed using the least squares, robust least squares and least squares correcting the autocorrelation and heteroskedasticity with the HAC matrix. The overall outcome is that the Kaldor–Verdoorn coefficient is significant for all the countries: Argentina (0.52), Brazil (0.70), Bolivia (0.63), Chile (0.28), Colombia (0.80), Mexico (0.55), Uruguay (0.86) and Venezuela (0.86).

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

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

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

5. CONCLUSION

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

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

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

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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 1% level	Critical value 5% level	Critical value 10% level	Argentina Result	Brazil Result	Bolivia Result	Chile Result	Colombia Result	Mexico Result	Uruguay Result	Venezuela Result
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

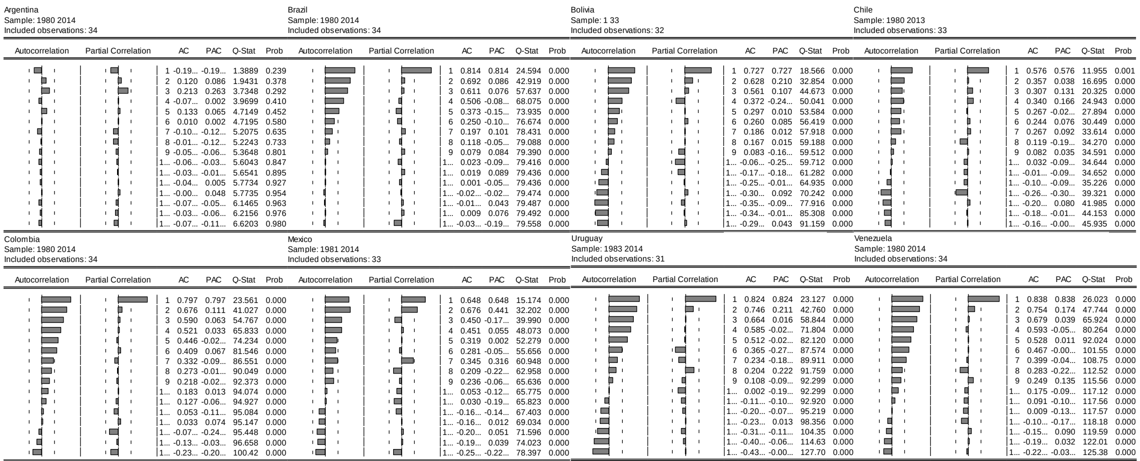
The t–-statistics are the numbers in parentheses below each coefficient.

TABLE A.3
Heteroskedasticity ARCH Test

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	