Reconciling Supply and Demand: New Evidence on the Adjustment Mechanisms Between Actual and Potential Growth Rates

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Abstract: This paper is a contribution to the debate between supply-oriented and demand-oriented growth theories. By investigating the link between changes in the rate of capacity utilization, the volume of imports and the growth of productivity, it aims at providing a better understanding of the mechanisms that reconcile supply and demand in the long-term. The results point to a demand determination of economic growth, with the burden of adjustment falling over the potential rate of growth. Increases in the rate of capacity utilization seem to have a positive effect on productivity and no effect on the volume of imports. However, the existence of unexplored mechanisms that would make demand adjust to supply cannot be rejected.

Key-words: Supply-oriented growth; Demand-oriented growth; Capacity utilization; Potential growth; Natural growth.

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1. Introduction

The study of economic growth is far from being a unified field. Since Roy Harrod published his *Essay in Dynamic Theory* (1939), the first systematic attempt to model long-run growth, many theories have sought to explain the primary sources of growth and chart the way to economic development.

Growth theories can be classified into two categories: supply-oriented or demand-oriented. Supply-oriented growth theories conceive the development of supply-side factors as the primary source of economic growth. They focus on explaining the expansion of the economy's productive factors, such as capital, labor and technology, assuming that demand would automatically adjust to an increase in supply, i.e. demand is infinitely elastic in the long-run. On the contrary, demand-oriented growth theories postulate that growth is led by demand. This alternative approach assumes that supply is infinitely elastic in the long-run, meaning that it will spontaneously adjust to any change in demand. Hence, demand constraints, such as market uncertainty, credit rationing and balance of payments disequilibrium, are the main obstruction to economic growth.

If neither supply nor demand were infinitely elastic in the long-run, the economy would face a disequilibrium. If the growth rate of supply, a.k.a. the potential rate of growth, was permanently higher than the growth rate of demand, there would be a tendency for an ever-increasing excess capacity and unemployment. On the other hand, if demand grew faster than supply, the rate of capacity utilization would continuously increase. Since none of these scenarios are verified in reality, there must be some mechanism to reconcile the growth rates of demand and supply (Palley, 2003; Setterfield, 2006; 2012).

The reconciliation of actual and potential growth rates can be achieved via two possible mechanisms. On the one hand, the adjustment mechanism between the two growth rates could work through changes in the income elasticity of demand for imports in response to movements in the rate of capacity utilization. In this framework, if the rate of growth of demand is higher than potential output growth, the increasing trend in the rate of capacity utilization would lead to an increase in the income elasticity of demand for imports. Consequently, the rate of growth consistent with balance of payments equilibrium would fall and demand growth would be reduced until it equalizes with potential growth (Palley, 2003). On the other hand, the adjustment mechanism could also operate through changes in the Verdoorn Coefficient, which captures the magnitude of the effect of demand growth on productivity growth. In this case, if the rate of capacity utilization is increasing, there would be an increase in the Verdoorn Coefficient and, consequently, on the growth of productivity. Hence, the potential rate of growth would rise until it meets the actual rate of growth (Setterfield, 2006).

Depending on which of these two mechanisms takes place, growth will be supply-oriented or demand-oriented. If the income elasticity of demand for imports is endogenous in relation to capacity utilization, the burden of adjustment would fall on the growth of demand, which would adjust to supply. Alternatively, if the Verdoorn Coefficient is endogenous, supply would carry the burden of adjustment and growth would be determined by demand. However, it is important to note that both mechanisms could also work simultaneously, so that the steady state growth rate can be determined by supply and demand at the same time.

The objective of this paper is to test for the endogeneity of the income elasticity of demand for imports and of the Verdoorn Coeficient relative to the rate of capacity utilization. In doing so, it will contribute to determine whether economic growth is supply-oriented, demand-oriented or some middle ground between the two.

The remaining of the paper is divided in four sections. Section 2 reviews the literature on the topic, setting the theoretical background for the discussions that follow. Section 3 presents a formal model to reconcile the actual and potential rates of growth. Section 4 describes the econometric strategy and the empirical results. Section 5 briefly concludes.

2. Actual and Potential Growth in the Literature of Economic Growth

2.1. From Harrod to Solow: Growth Theory Arriving to the Mainstream

Economic growth hasn't always been central to macroeconomics. Through the first half of the 20th century, short-term crises dictated the research agenda and economists were almost too worried with inflation and unemployment to care about the long-run.

It was only in the fifties that Robert Solow (1956) published his famous model and gave birth to what would become the standard neoclassical theory of growth. However, few people notice today that Solow's article was actually a response to a previous conjecture on growth: the Harrod-Domar model.

Harrod's (1939) theory, later refined by Domar (1946), stated that there are two basic growth rates in the economy, the warranted and the natural rates of growth. The warranted rate of growth describes the growth of the capital stock. It is equal to the ratio between the saving rate and the capital-output ratio, which is assumed to be constant. The natural rate of growth is equal to the growth of the effective labor force and reflects both increases in population size and in productivity. Formally:[1]

$$y_k = \frac{\dot{K}}{K} = \frac{s}{v} \tag{1}$$

$$y_n = \frac{\dot{L}}{L} + \frac{(\dot{Y/L})}{(Y/L)} = n + a \tag{2}$$

where K is the capital stock, s is the saving rate, Y is output, y_k is the warranted rate of growth (i.e. the growth rate of the capital stock) and $v = K/Y$ is the required incremental capital-output ratio given techniques of production and the interest rate. Moreover, y_n is the natural rate of growth, L is the number of workers, n is the growth rate of the number of workers, and a is the variation of labor productivity. A dot over the variable indicates derivative with respect to time.

In Harrod's model, the only situation where the economy is stable is when both rates are equal. Consequently, the steady state condition of the model is given by:

$$n + a = {}^{s}/_{v} \tag{3}$$

However, since all the variables in equation (3) are exogenous, there is no mechanism to bring those two rates of growth together. Hence, the economy would either face growing excess of capital or growing unemployment.

Solow's (1956) article was an attempt to solve this problem. He claimed that the failure in the Harrod-Domar model was not accounting for substitutability between labor and capital, i.e. the capital-output ratio is not necessarily constant. If these two inputs were substitutes in the production process, the steady state would be reached automatically. For instance, suppose the warranted rate of growth is higher than the natural rate. The capital stock would grow faster than effective labor and inputs' prices would adjust to a relatively higher supply of capital. If labor and capital are substitutes, the economy would start using more capital per unit of labor increasing the capital-output ratio and reducing the warranted rate of growth. Hence, the warranted rate of growth would fall until it equals the natural rate, bringing the economy to equilibrium.

Formally, the fundamental equation of the Solow-Swan model shows the variation of the capital stock over time.[2] Assuming a neoclassical production function, Solow (1956) finds the following equation for the variation of the capital stock:[3]

$$\dot{K} = sF(K, AL) - \delta K \tag{4}$$

where A denotes technology, δ is the depreciation rate and the rest is defined as in previous equations.

Setting variables in intensive form and assuming labor augmenting technological progress, equation (4) can be written as follows:[4]

$$\dot{\kappa} = sF(\kappa) - (n + \delta + a)\kappa \tag{5}$$

where $\kappa = \frac{K}{AL}$ is capital per unit of effective labor, and $F(\kappa) = \frac{Y}{AL}$ is output per unit of effective labor. Once technological progress is labor augmenting, the rate of technological progress (a) is equal to the growth rate of labor productivity in equation (2).

By definition:

$$K = AL\left(\frac{K}{AL}\right) = \kappa(AL) \tag{6}$$

Taking logarithms and differentiating equation (6) with respect to time one finds the growth rate of the stock of capital:

$$y_K = \frac{\dot{K}}{K} = a + n + \frac{\dot{\kappa}}{\kappa} \tag{7}$$

Nonetheless, since the model's steady state condition is $\frac{\dot{\kappa}}{\kappa} = 0$, equation (7) reverts back to the stability condition of the Harrod-Domar model, expressed in equation (3). Hence, according to Solow (1956), by allowing for substitutability between labor and capital, the neoclassical model of growth solves the stability problem in Harrod's conjecture on growth.

2.2. An Alternative Approach: Demand-Oriented Growth Theory

The warranted rate of growth stands for the growth of capital stock. The natural rate, in turn, corresponds to the growth of effective labor. According to the neoclassical model, both rates are equal.[5] Hence, these rates are also equal to the growth rate of productive factors in the economy, which is called *potential rate of growth* (y_p)[6] and reflects the development of the supply, i.e. the economy's capacity to produce goods and services.

$$y_p = y_n = n + a \tag{8}$$

However, even after guaranteeing for the equilibrium between the warranted and the natural rates of growth, there is still a problem to be observed: the actual rate of growth can be constrained by the growth of demand. This idea reflects an attempt to apply the Keynesian principle of effective demand to the long-run (Keynes, 1936; Hein, 2014). From this perspective, economic growth is demand-oriented and demand constraints are the main barriers to long-term economic growth (McCombie and Thirlwall, 1994).

Following this approach, Kaldor (1966, 1970) argues that exports are the most important component of autonomous demand, since it depends largely on external income. Most importantly, exports generate the foreign currency necessary to finance growing imports, allowing other components of demand to grow without generating external imbalances (Thirlwall, 2002).

Thirlwall (1979) contributes to this approach by highlighting that countries cannot continuously expand imports without a counterpart in exports, given that balance of payments deficits cannot be financed indefinitely. To highlight the importance of this constraint, he formulated a demand-oriented growth model in which the balance of payments equilibrium condition plays a central role. The model is composed of three simples equations: an export and an import demand functions, and a balance of payments equilibrium condition.

$$x = \eta(p_d - p_f - e) - \varepsilon z \qquad (9)$$

$$m = \psi(p_f - p_d + e) + \pi y \qquad (10)$$

$$m + p_f + e = p_d + x \qquad (11)$$

where y is the growth rate of output, x is the growth rate of exports, m is the growth rate of imports, p_d and p_f are the growth rates of domestic and foreign prices, respectively, e is the growth rate of the nominal exchange rate, z is the growth rate of world income, ε is the income elasticity of demand for exports, η is price elasticity of demand for exports, ψ is the price elasticity of demand for imports, π is the income elasticity of demand for imports.

The solution of the model is found substituting equations (9) and (10) into (11) and rearranging to find:

$$y_{BP} = \frac{[(1+\pi+\psi)(p_d - p_f - e) + \varepsilon z]}{\pi} \qquad (12)$$

where y_{BP} is the growth of output consistent with balance-of-payments equilibrium.

Assuming that relative prices in trade are stable in the long run, Thirlwall (1979) states that the growth rate of domestic output is equal to the growth rate of external income times the ratio between the income elasticities of demand for exports and imports. This relation has been named "Thirlwall's Law":

$$y_{BP} = \frac{\varepsilon z}{\pi} \tag{13}$$

Thirlwall's (1979) seminal model, later called Balance of Payments Constraint Growth (BPCG) model, has become one of the canonical models in demand-oriented analyzes of growth. It shows how a country's growth rate is ultimately constrained by the growth of demand, and, more specifically, by the constraint imposed by the requirement of long-term current account balance.

Several studies show that Thirlwall's Law is performs extremely well in predicting countries long-term actual rate of growth (McCombie and Thirlwall, 2004). Hence, evidence suggests that it is possible to establish a correspondence between the actual rate of growth and the growth rate consistent with balance of payments equilibrium:

$$y_a = y_{BP} \tag{14}$$

where y_a is the actual rate of growth.

It is crucial to note, however, that Thirlwall's Law assumes that supply constraints are not binding, so that the growth of productive factors is infinitely elastic.

2.3. Endogenizing the Potential Rate of Growth

The neoclassical tradition postulates that the potential rate of growth is exogenous, i.e. it is not affected by short-run fluctuations or by economic policy.

It was only in the late 1980's, with the emergence of *New Growth Theory*, that some critics to this view started to emerge inside the mainstream (Romer, 1990; Lucas, 1988; Aghion and Howitt 1992; 1998).[7] Proponents of the new growth theory argued that short-run dynamics can impact long-run output, by affecting firms' innovative decisions. However, they focused almost exclusively on supply-side factors.

Yet, a few decades before the emergence of new growth theory, Kaldor (1966) called attention to the evidence of a positive effect of actual output growth on the growth of productivity. Inspired by the seminal empirical evidence found by Verdoorn (1949) and by the importance of dynamic increasing returns to scale highlighted by Young (1928), Kaldor (1966) argued that an expansion in current production generates technical progress and an increase in productivity. This effect is caused by the existence of both static and dynamic increasing returns, especially in manufacturing activities, generated by learning by doing and economies of scale.

The positive effect of output growth on productivity growth is captured by the so-called Verdoorn Coefficient in the following equation, named Kaldor-Verdoorn Law:

$$a = a_0 + \lambda y_a \quad (15)$$

where a_0 is the autonomous growth of productivity and λ is the Verdoorn Coefficient. The rest is defined as in previous sections.

The Verdoorn Law makes the potential rate of growth endogenous in relation to the actual rate of growth. If an increase in the actual growth rate generates an increase in productivity growth, it will also have a positive impact on the growth of effective labor and in the potential rate of growth. Hence, substituting equation (15) into equation (8) yields:

$$y_p = n + a_0 + \lambda y_a \quad (16)$$

Nonetheless, since the actual rate of growth can be described by Thirlwall's Law and by the growth of demand, substituting (14) into equation (16) yields:

$$y_p = n + a_0 + \lambda y_{BP} \quad (17)$$

Moreover, substituting equation (13) into equation (17) one finds:

$$y_p = n + a_0 + \lambda \frac{\varepsilon z}{\pi} \quad (18)$$

The endogeneity of the potential rate of growth relative to the actual rate of growth, as expressed in equation (18), has been extensively tested in the literature (Léon-Ledesma and Thirlwall, 2002; Libânio, 2009; Dray and Thirlwall, 2011; Lanzafame, 2013).[8] The first attempt to test for this relation was carried out by Léon-Ledesma and Thirlwall (2002) for a sample of 15 OECD countries. They found that the potential rate of growth tends to increase when the economy is booming (when the actual rate of growth is higher than the estimated potential rate) and to decrease in periods of slump. The same procedure was adopted by Libânio (2009) for a sample of Latin-American countries, and by Dray and Thirlwall (2011) for Asian countries. Both studies found results that corroborate the endogeneity of the potential growth rate. However, the direction of causality is still under dispute. While Léon-Ledesma and Thirlwall (2002) found mutual causality between the two growth rates, with both rates influencing each other's trajectory, Lanzafame (2013) found unidirectional causality running from the actual growth to the potential growth.

Moreover, it is worth noting that the Verdoorn Coefficient is not the only possible channel through which the endogeneity hypothesis can work. A rise in the actual rate of growth can also increase the labor force through positive variations in the participation rate or in working hours (Libânio 2009; McCombie 2011). However, as highlighted by Palley (2003), both effects are bounded from below by zero, and from above by 100 and 24, respectively.

3. Reconciling the Potential and the Actual Rate of Growth

As explained in previous sections, the Solow-Swan model provided an apparently successful mechanism for reconciling the warranted and the natural rates of growth. However, the actual growth rate could still be different from its potential value since it is guided by Thirlwall's law and by the dynamics of demand.

Nevertheless, in the long-run, the potential growth rate and the actual growth rate are expected to be equal. If the level of productive factors grows faster than demand, the economy would face a rising trend in excess capacity and a secular fall in the rate of capacity utilization. This situation could be reflected in the labor market, where unemployment would rise continuously. On the other hand, if demand grows faster than the amount of productive factors, the economy would face unceasing increases in the capacity utilization rate, as excess capacity falls. This, in turn, would be reflected as a progressive fall in unemployment. Yet, none of these scenarios is verified empirically (Palley, 2003; Setterfield, 2006, 2012). Hence, the following steady state condition must apply:

$$y_a = y_p = y \tag{19}$$

where y is the equilibrium growth rate.

Substituting equation (16) into equation (19) and rearranging its terms yields:

$$y = \frac{n+a_0}{1-\lambda} \tag{20}$$

Then, substituting equation (13) into equation (20) and rearranging:

$$z = \frac{\pi}{\varepsilon}\left(\frac{n+a_0}{1-\lambda}\right) \tag{21}$$

Equation (21) stresses that, in order to obtain long-run equilibrium between the actual and potential rates of growth, the growth of world income must be equal to $\frac{\pi}{\varepsilon}\left(\frac{n+a_0}{1-\lambda}\right)$, which is an arrangement of exogenous parameters internal to a specific economy. Since z is obviously also exogenous, nothing guarantees that the steady state condition will hold, and if it does hold, it will be the result of an unlikely coincidence.

It is more likely, however, that the economy will be either in a situation where the actual growth rate is higher than the potential growth rate:

$$z > \frac{\pi}{\varepsilon}\left(\frac{n+a_0}{1-\lambda}\right) \tag{22}$$

or in a situation where the actual growth rate is lower than its potential value:

$$z < \frac{\pi}{\varepsilon}\left(\frac{n+a_0}{1-\lambda}\right) \tag{23}$$

Therefore, there is also a need for a reconciling mechanism that makes the steady state condition hold in the long-run when the potential growth rate is endogenous in relation to the actual growth rate.

Aware of this requirement, Palley (2003) proposed two channels through which the potential and the actual rates could be equalized. The first one, which he emphasized the most, is the endogenization of the income elasticity of demand for imports (π) in relation to the rate of capacity utilization. The other one, which was endorsed by Setterfield (2006, 2012), is the endogenization of the Verdoorn Coefficient (λ) also in relation to capacity utilization.

3.1. Endogenizing the Income Elasticity of Demand for Imports

Assume the following definitions:

$$C = \frac{Y_a}{Y_p} \tag{24}$$

$$c = \frac{\dot{C}}{C} = y_a - y_p \tag{25}$$

where C is the rate of capacity utilization, Y_a is the level of actual output, Y_p is the level of potential output, and c is the growth rate of capacity utilization.

In the steady state, where actual growth is equal to potential growth, the rate of capacity utilization is constant. Therefore, the following condition for a steady state must hold:

$$c = y_a - y_p = 0 \tag{26}$$

Assuming now that π is endogenous in relation to C:

$$\pi = \pi(C) \tag{27}$$

$$\frac{d\pi}{dC} = \pi' > 0 \tag{28}$$

According to (28), a rise in capacity utilization will lead to an increase in the income elasticity of demand for imports. This assumption is based on Tobin's (1972) idea that imports are driven by bottlenecks. Tobin (1972) argued that the economy has heterogenous sectors. Hence, some sectors can have excess capacity while others operate at full capacity. In such an economy, if the actual rate of growth is higher than the potential rate of growth, there would be an increase in the number of sectors operating at full capacity, causing the emergence of more bottlenecks. This, in turn, would lead to a higher share of income increments spent in imports, i.e. an increase in π. The same logic would explain a fall in π if potential growth was higher than actual growth (Palley, 2003).

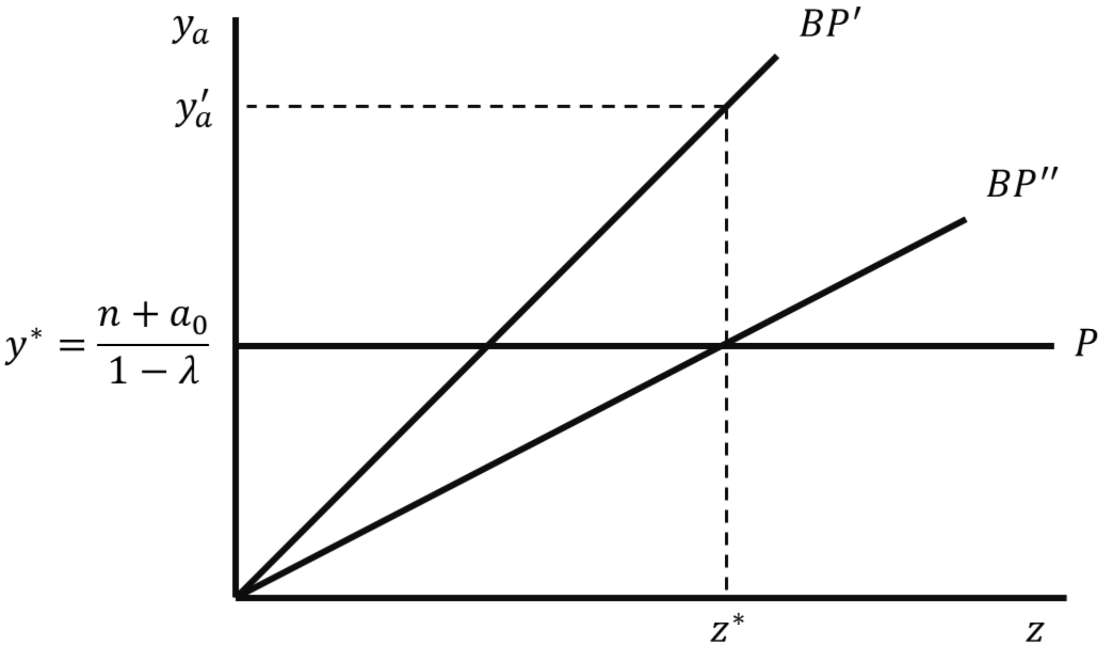
Substituting (28) into (13) and into the steady state condition (21) yields:

$$z = \frac{\pi(C)}{\varepsilon}\left(\frac{n+a_0}{1-\lambda}\right) \quad (29)$$

The adjustment mechanism is illustrated in Figure 1. If the initial actual rate of growth y_a', determined by z^*, is higher than the potential rate of growth, there would be rising excess capacity, as described by (22). As C increases, the income elasticity of demand for imports falls, as shown in (28). However, according to (29), decreases in $\pi(C)$ will lead to smaller actual rates, in order to maintain the balance of payments equilibrium. Therefore, the actual rate of growth would fall continuously, as represented by the changing slope of the actual growth function from BP' to BP'', until it equalizes with the potential rate, ending the movements on the capacity utilization rate.

The main consequence of the endogenization of the income elasticity of demand for imports relative to the rate of capacity utilization is that it places the burden of adjustment on the balance of payments constrained growth rate. Hence, apart from Verdoorn's Law, growth would be determined exclusively by supply-side factors. For this reason, McCombie (2011) has called Palley's (2003) proposal of endogenizing π a "demand-constrained growth model without a constraint" (McCombie, 2011, p. 372).

Figure 1. Reconciling actual and potential growth rates through adjustments in π



Source: Authors' elaboration based on Setterfield (2006).

3.2.Endogenizing the Verdoorn Coefficient

An alternative solution to reconcile the actual and the potential rates of growth is to endogenize the Verdoorn Coefficient in relation to the rate of capacity utilization. This mechanism was first proposed by Palley (2003) and endorsed by Setterfield (2006, 2012). Formally, this means:

$$\lambda = \lambda(C) \tag{30}$$

$$\frac{d\lambda}{dC} = \lambda' > 0 \tag{31}$$

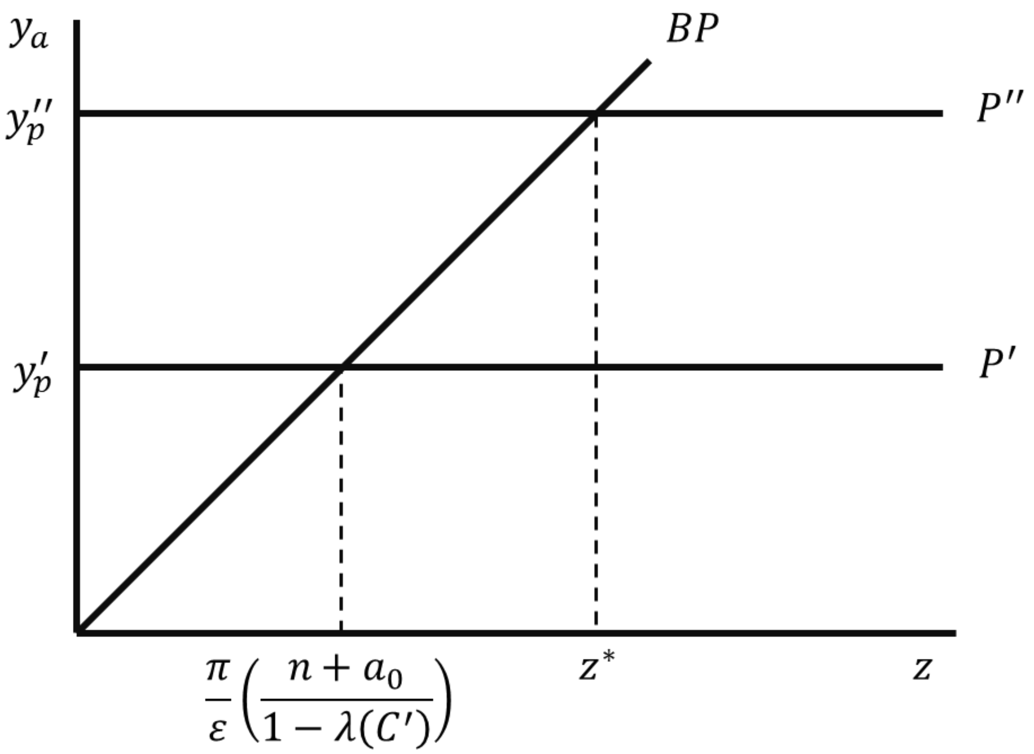
Equation (31) states that a rise in the rate of capacity utilization leads to an increase in the Verdoorn Coefficient. Hence, the extent to which an increase in actual output rises productivity is a direct function of capacity utilization. As argued by Setterfield (2006), this effect is the result of the behavior of firms and investors. When there is high excess capacity, i.e. a low value of C, investment spending is reduced. Moreover, if the level of production is low and there is excess capacity in the economy, there will be less incentives for firms to engage in innovative activity.

Substituting equation (30) into (16) and into the steady state condition (21) yields:

$$z = \frac{\pi}{\varepsilon}\left(\frac{n+a_0}{1-\lambda(C)}\right) \tag{32}$$

Assuming a situation when the actual rate of growth is higher than the potential rate of growth, capacity utilization would be rising, as stated by (22). This would lead to more investment and more innovative activity and a consequential increase in the Verdoorn Coefficient, shown by (31). A higher λ will continuously raise the growth rate of potential output until it equalizes with the actual rate of growth. This is represented by an upward shift in the potential growth line, P, in Figure 2.

Figure 2. Reconciling actual and potential growth rates through adjustments in λ



Source: Authors' elaboration based on Setterfield (2006).

Unlike the first mechanism, the endogenization of the Verdoorn Coefficient places the burden of adjustment on the supply side of the economy, i.e. on the potential rate of growth. In this scenario, changes in the actual rate of growth would be automatically followed by changes in the potential rate, restoring the equilibrium. Hence, growth would be fully demand-oriented.

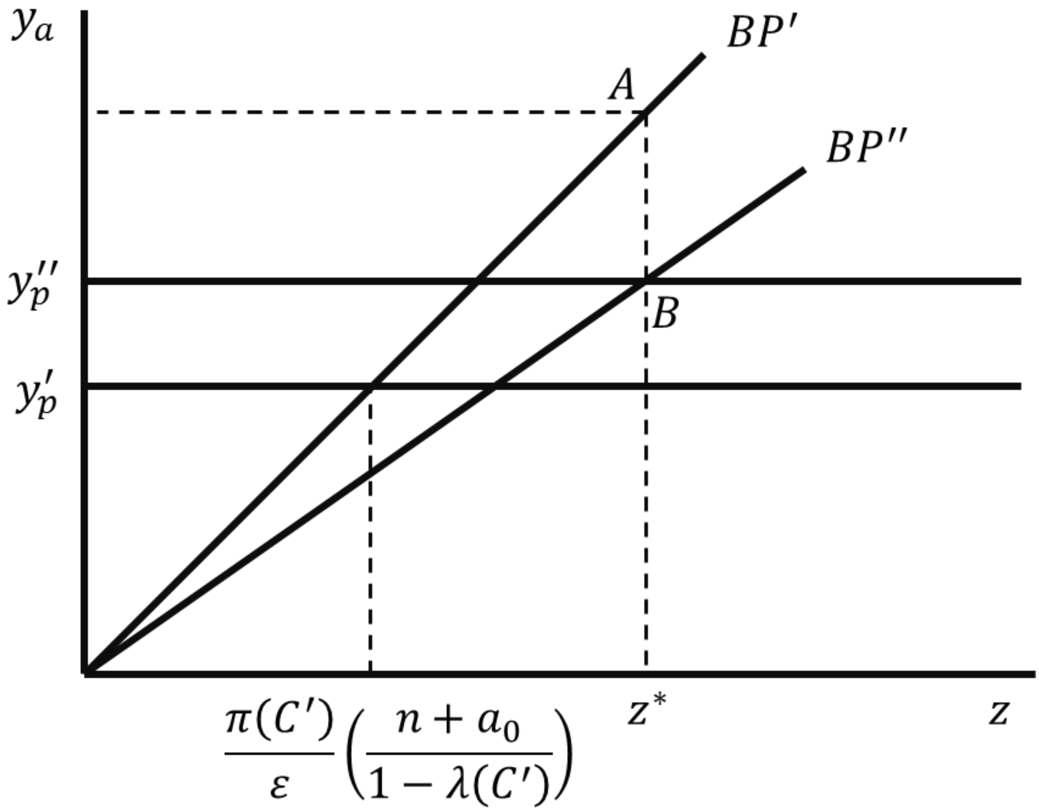
3.3. The Middle-Ground Case: Both Mechanisms Acting Together

The two reconciling mechanisms presented above are not mutually exclusive. Hence, the income elasticity of demand for imports and the Verdoorn Coefficient can be endogenous to the rate of capacity utilization at the same time. If this is the case, long run growth would be determined both by supply and demand factors and the steady state position would be a middle-ground between Figures 1 and 2.

This situation is described in Figure 3. The economy starts at point A, where the actual rate of growth, y_a', is higher than the potential rate of growth, y_p'. This unbalance will lead to increases in the rate of capacity utilization. As C rises, both the income elasticity of demand for imports and the Verdoorn Coefficient will increase. Consequently, the actual growth rate will fall and the potential growth will rise. Hence, both rates will adjust until the equilibrium is restored at point B, where $y_p = y_a$ and balance of payments is equalized.

The exact equilibrium position will depend on the relative impacts of capacity utilization on π and λ. If the income elasticity of demand for imports is more sensitive to changes in C than the Verdoorn Coefficient, growth would be more supply-led and demand would play a minor role in determining the steady state. Alternatively, if λ is more sensitive than π to changes in C, demand-side factors would be more relevant than supply-side factors to long-term growth.

Figure 3. Simultaneous adjustments in actual and in potential rates of growth



Source: Authors' elaboration.

4. Empirical Analysis

The empirical analyses to be presented in the following sections were based on data from several different sources. Table 1 presents a summary of all the variables, variables' codes, and sources. The final database used in this paper's tests covers a range of 38 countries, selected following data availability, over the period 1992 to 2014.

Table 1. Summary of data, codes and sources

Code	Variable's description	Source
	Estimating Capacity Utilization	
Code	Variable's description	Source
rgdpg	Real GDP growth (annual %)	World Bank national accounts data, and OECD National Accounts data files.
v_unempl	Percental Variation in Unemployment, total (% of total labor force)	International Labour Organization, ILOSTAT database.
prg	Potential Rate of Growth	Estimated as explained in section 4.0
v_rcu	Variation in the Rate of Capacity Utilization	Estimated as explained in section 4.1
	Estimating Elasticity of Demand	
rgdp	GDP (constant 2010 US$)	World Bank national accounts data, and OECD National Accounts data files.
rimport	Imports of goods and services (constant 2010 US$)	World Bank national accounts data, and OECD National Accounts data files.
ppp	PPP conversion factor, GDP (LCU per international $)	World Bank, International Comparison Program database.
	Estimating the Verdoorn Coefficient	
emp	Number of persons engaged (in millions)	Penn World Table 9.0
avh	Average annual hours worked by persons engaged	Penn World Table 9.0
lp	Labor Productivity, in mil. 2011US$	Defined as rgdp/(emp*avh)
twhg	Growth rate of total working hours	Defined as the growth rate of emp*avh

Source: Authors' elaboration.

4.1. Estimating Changes in the Rate of Capacity Utilization

To test for the endogeneity of λ and π relative to the rate of capacity utilization, C, it is first necessary to estimate the changes in C. Equation (25) states that such changes are equal to the difference between the actual rate of growth and the potential rate of growth. Therefore, to find c, it is necessary to estimate the potential rate of growth.

Léon-Ledesma and Thirlwall (2002) have proposed a simple method to estimate the potential rate of growth. They argue that, since the potential rate of growth is equal to the growth rate of the labor force plus advances in productivity (given by equation (8)), if the actual rate of growth is higher than the potential rate, there will be a fall in the unemployment rate. Analogously, if the potential rate of growth is higher, there will be an increase in unemployment. Hence, following Okun (1962), the potential rate of growth would be the growth rate that keeps unemployment constant.

This relation can be summarized by the following linear equation, called Okun’s Law:

$$\Delta\%U = \beta_0 - \beta_1 y \quad (33)$$

where U is the unemployment rate.

If unemployment is constant, i.e. $\Delta\%U = 0$, the economy will grow at its potential rate. Hence, the potential rate of growth will be equal to the ratio between the parameters, i.e. $y = y_p = {}^{\beta_0}/_{\beta_1}$.

Nonetheless, Léon-Ledesma and Thirlwall (2002) also stress the possibility of downward bias in β_1, caused by labor hoarding, leading to an overestimation of the potential output growth rate. On the other hand, β_0 could also be biased downward because of drop-outs from the labor force during periods of no growth. Hence, it is not possible to know for certain the extension and the direction of the bias in y_p.

The authors propose an alternative approach that deals with these particular problems by reversing the dependent and independent variables in equation (33):

$$y = \beta_0 - \beta_1(\Delta\%U) \quad (34)$$

In this equation, the potential rate of growth is equal to the coefficient β_0. However, since $\Delta\%U$ is not exogenous, the coefficients in equation (34) will also be statistically biased (Léon-Ledesma and Thirlwall, 2002).

The OLS estimations of equations (33) and (34) are presented in Tables 2 and 3 respectively. Most coefficients are significant at least at the 95% confidence level. However, significance results are better for Thirlwall’s reversal than for Okun’s Law. Thirlwall’s reversal also has the advantage of directly estimating the potential rate of growth. Furthermore, the average absolute difference between both estimates of the potential rate of growth is only 0,38%. Hence, as in Léon-Ledesma and Thirlwall (2002) and Libânio (2009), the comparison of these results suggests that the estimates found using Thirlwall's reversal are reliable estimates of the growth rate of potential output.

Table 2. Estimation of the potential rate of growth using Okun's Law

Country	Constant	Coefficient on GDP growth	R^2	DW	Potential Rate
Argentina[1]	0,0502 (0,6631)	-2,106 (−4,416)***	0,5629	24,954	0,0238
Australia	0,1879 (3,560)***	-6,208 (−4,036)***	0,4368	22,328	0,0303
Austria	0,0983 (2,358)**	-3,648 (−2,125)**	0,1770	26,800	0,0270
Brazil	0,0634 (2,199)**	-2,491 (−3,240)***	0,3333	18,729	0,0255
Bulgaria	0,0444 (0,894)	-2,064 (−1,886)*	0,1449	18,502	0,0215
Canada	0,1164 (6,039)***	-5,018 (−7,974)***	0,7517	16,327	0,0232
Chile	0,2138 (3,194)***	-3,835 (−3,256)***	0,3355	18,995	0,0557
China, Hong Kong SAR	0,3548 (5,440)***	-7,562 (−5,905)***	0,6241	17,391	0,0469
Colombia	0,1229 (2,502)**	-3,168 (−2,843)***	0,2780	18,458	0,0388
Costa Rica	0,3269 (5,656)***	-6,314 (−5,502)***	0,5904	17,014	0,0518
Czech Republic[1]	0,1533 (2,528)**	-4,977 (−4,179)***	0,5284	16,275	0,0308
Denmark	0,1379 (4,142)***	-8,295 (−6,384)***	0,6600	17,240	0,0166
Finland[1]	0,0310 (1,101)	-2,443 (−4,664)***	0,7111	29,272	0,0127
France	0,0618 (2,763)**	-3,386 (−3,230)***	0,3319	18,313	0,0183
Greece[1]	0,0903 (3,836)***	-2,823 (−5,586)***	0,7146	18,548	0,0320
India	0,1091 (-1,976)*	-1,640 (0,0477)**	0,1739	26,723	0,0665
Ireland[1]	0,2082 (3,525)***	-4,096 (−4,787)***	0,6256	19,433	0,0508
Israel	0,0820 (1,783)*	-2,565 (−2,702)**	0,2580	16,683	0,0320
Italy[1]	0,0390 (-1,649)	-2,897 (−3,659)***	0,5287	20,799	0,0135
Japan[1]	0,0419 (1,041)	-2,698 (−3,739)***	0,5350	19,352	0,0155
Malaysia[1]	0,1169 (4,255)***	-2,365 (−7,875)***	0,7445	21,870	0,0494
Mexico	0,1569 (3,701)***	-4,417 (−4,233)***	0,4604	18,256	0,0355
Netherlands[2]	0,0946 (2,201)**	-4,015 (−3,024)***	0,7378	18,893	0,0236
New Zealand	0,1448 (3,796)***	-5,584 (−5,067)***	0,5500	24,308	0,0259
Norway	0,0686 (1,502)	-3,233 (−2,078)*	0,1705	16,813	0,0212
Philippines	0,0507 (1,045)	-1,335 (−1,337)	0,0784	24,717	0,0380
Portugal[1]	0,1251 (3,124)***	-5,062 (−4,290)***	0,5368	18,400	0,0247
Republic of Korea[1]	0,4949 (3,584)***	-9,088 (−9,075)***	0,7487	18,475	0,0545
Russian Federation[1]	0,0555 (2,416)**	-2,138 (−6,130)***	0,6616	22,415	0,0260
Singapore	0,1870 (2,240)**	-2,355 (−2,099)**	0,1735	15,813	0,0794
Spain[1]	0,1465 (2,877)***	-6,324 (−4,982)***	0,6838	19,523	0,0232
Sweden[1]	0,0856 (1,582)	-3,717 (−4,270)***	0,6846	17,288	0,0230
Switzerland[1]	0,1199 (2,647)**	-5,376 (−3,133)***	0,4497	19,952	0,0223
Thailand	0,5077 (3,451)***	-11,32 (−4,354)***	0,4744	26,731	0,0448
Turkey	0,0934 (2,827)**	-1,640 (−3,335)***	0,3462	17,474	0,0570
United Kingdom[1]	0,0925 (3,098)***	-5,011 (−5,185)***	0,6204	18,189	0,0185
United States[1]	0,2072 (4,112)***	-8,786 (−6,713)***	0,7559	15,790	0,0236
Uruguay[1]	0,0357 (1,232)	-1,406 (−2,939)***	0,4627	20,133	0,0254

Notes: [1] Estimated Using Cochrane-Orcutt AR(1) interative procedure since evidence of autocorrelation was found.[2] Estimated using AR(2) errors. T statistic in parenthesis. Significance: * p<0.10, ** p<0.05, *** p<0.01.

Source: authors' elaboration.

Table 3. Estimation of the potential rate of growth using Thirlwall's reversal

Country	Constant	Coefficient on %U variation	R^2	DW	Potential Rate
Argentina[1]	0,0249 (1,23)	−0,2250 (−4,195)***	0,4424	22,863	0,0249
Australia	0,0316 (18,56)***	−0,0703 (−4,036)***	0,4368	18,574	0,0317
Austria	0,0199 (6,201)***	−0,0485 (−2,125)**	0,1770	16,275	0,0199
Brazil	0,0290 (7,563)***	−0,1337 (−3,240)***	-0,3333	22,592	0,0290
Bulgaria[1]	0,0268 (3,905)***	−0,0920 (−3,092)***	0,3604	17,495	0,0268
Canada	0,0240 (9,651)***	−0,1457 (−7,612)***	0,7587	20,047	0,0240
Chile[1]	0,0463 (6,070)***	−0,0812 (−4,669)***	0,5068	20,766	0,0464
China, Hong Kong SAR	0,0436 (9,543)***	−0,0825 (−5,905)***	0,6241	14,737	0,0437
Colombia	0,0376 (8,563)***	−0,0877 (−2,843)***	0,2780	18,656	0,0376
Costa Rica	0,0492 (15,91)***	−0,0935 (−5,502)***	0,5904	16,123	0,0492
Czech Republic[1]	0,0277 (3,308)***	−0,0939 (−4,277)***	0,5718	16,025	0,0277
Denmark	0,0165 (6,566)***	−0,0795 (−6,384)***	0,6600	15,426	0,0165
Finland[1]	0,0182 (2,495)**	−0,2127 (−4,659)***	0,5864	25,279	0,0183
France	0,0165 (6,345)***	−0,0980 (−3,230)***	0,3319	16,995	0,0165
Greece[1]	0,0177 (1,274)	−0,1498 (−3,605)***	0,7775	23,056	0,0177
India[1]	0,0688 (12,20)***	−0,1105 (−2,754)**	0,2726	18,347	0,0689
Ireland[1]	0,0512 (4,320)***	−0,1036 (−3,658)***	0,6823	18,531	0,0513
Israel	0,0403 (9,486)***	−0,1005 (−2,702)**	0,2580	16,324	0,0404
Italy	0,0082 (2,585)**	−0,1332 (−4,135)***	0,4488	17,061	0,0082
Japan	0,0118 (3,363)***	−0,0996 (−3,051)***	0,3071	19,720	0,0118
Malaysia[1]	0,0510 (6,599)***	−0,3182 (−7,790)***	0,7316	24,023	0,0510
Mexico	0,0309 (6,238)***	−0,1042 (−4,233)***	0,4604	23,853	0,0309
Netherlands[1]	0,0224 (5,769)***	−0,0706 (−4,052)***	0,5407	18,373	0,0225
New Zealand	0,0276 (10,48)***	−0,0984 (−5,067)***	0,5500	24,062	0,0276
Norway[1]	0,0223 (3,697)***	−0,0381 (−1,821)*	0,4237	21,559	0,0223
Philippines	0,0433 (9,793)***	−0,0587 −1,337	0,0784	17,694	0,0434
Portugal[1]	0,0168 (2,212)**	−0,0902 (−4,314)***	0,6337	20,566	0,0169
Republic of Korea[1]	0,0532 (4,396)***	−0,0882 (−8,982)***	0,7350	21,221	0,0533
Russian Federation[1]	0,0261 (2,754)**	−0,2672 (−5,627)***	0,7165	24,085	0,0262
Singapore	0,0651 (7,910)***	−0,0736 (−2,099)**	0,1735	18,370	0,0651
Spain[1]	0,0207 (2,306)**	−0,0805 (−4,899)***	0,7879	21,294	0,0208
Sweden	0,0262 (5,954)***	−0,0699 (−3,849)***	0,4137	17,824	0,0263
Switzerland	0,0195 (7,273)***	−0,0512 (−3,689)***	0,3932	18,826	0,0196
Thailand	0,0429 (6,976)***	−0,0418 (−4,354)***	0,4744	18,467	0,0429
Turkey	0,0502 (5,852)***	−0,2109 (−3,335)***	0,3462	20,853	0,0503
United Kingdom[1]	0,0201 (5,797)***	−0,1130 (−5,116)***	0,6385	17,113	0,0202
United States[1]	0,0236 (5,903)***	−0,0787 (−6,736)***	0,7764	20,596	0,0236
Uruguay	0,0324 (4,581)***	−0,2477 (−3,738)***	0,3996	16,211	0,0324

Notes: [1] Estimated Using Cochrane-Orcutt AR(1) interative procedure since evidence of autocorrelation was found.[2] Estimated using AR(2) errors. T statistic in parenthesis. Significance: * p<0.10, ** p<0.05, *** p<0.01.
Source: authors' elaboration.

Having estimated the potential rate of growth for each country in the sample, it is possible to calculate the value of the changes in the rate of capacity utilization (c) following equation (22).

4.2. Testing for the Endogeneity of the Income Elasticity of Demand for Imports

The income elasticity of demand for imports can be obtained from a standard import demand function as equation (10).[9] Hence, the income elasticity of demand for imports can be estimated through the following model:

$$ln(M) = \beta_{01} + \beta_{11} ln\left(\frac{P_f E}{P_d}\right) + \beta_{21}\ln(Y) + u_1 \tag{35}$$

where M is the total volume of imports, E is the level of the nominal exchange rate, Y is the level of domestic income, and P_f and P_d are the foreign and domestic price levels, respectively. Thus, the estimated value of β_{21} will be the estimate of π.

To estimate equation (35), the Purchasing Power Parity (PPP), defined as the number of units of a country's currency required to buy the same amounts of goods and services in the domestic market as a foreign currency would buy in foreign markets, was used to measure relative prices.

The hypothesis of endogeneity of the income elasticity of demand for import postulates that π is a positive function of C, as stated by equation (27). Hence, if $c > 0$, i.e. if the actual growth rate is higher than the potential growth rate, π will be increasing. As proposed by Romero and Britto (2017), who tested the endogeneity of the Verdoorn coefficient in relation to research intensity, the endogeneity of a given parameter can be tested considering an auxiliary relationship with the determinants of the endogenous parameter. In the case of the endogenous income elasticity of demand, this is formalized as follows:

$$\beta_{21} = \beta_{31} + \beta_{41} D \tag{36}$$

where D is a dummy variable that equals 1 if $y_a > y_p$ and equals 0 otherwise.

Therefore, substituting equation (36) into equation (35) yields:

$$ln(M) = \beta_{01} + \beta_{11} ln(PPP) + \beta_{31} \ln(Y) + \beta_{41} \ln(Y) D + u_1 \quad (37)$$

Finally, the possibility of misspecification should also be tested for. Even if changes in the rate of capacity utilization do not affect the income elasticity of demand, it can have a direct impact on imports through an unknown mechanism. For this reason, the final estimated model is:

$$ln(M) = \beta_{01} + \beta_{11} ln(PPP) + \beta_{31} \ln(Y) + \beta_{41} \ln(Y) D + \beta_{51} D + u_1 \quad (38)$$

4.3. Testing for the Endogeneity of the Verdoorn Coefficient

As represented in equation (15), the Verdoorn Law states that output growth has a positive impact on productivity growth. Nevertheless, since labor productivity is defined as real economic output per labor hour, labor productivity growth is equal to the growth of output minus the growth of the labor force:[10]

$$a \equiv y_a - l \quad (39)$$

where l is equal to the growth of employment.[11]

However, as highlighted by McCombie (2011), the combination of equations (15) and (39) reveals a problem in estimating equation (15): the possibility of spurious correlation caused by the presence of y_a in both sides of the equation. To solve this problem, the Verdoorn Law is often represented as:

$$l = -a_0 + (1 - \lambda) y_a \quad (40)$$

Hence, the Verdoorn coefficient can be estimated through the following model:

$$l = \beta_{02} + \beta_{12} y_a + u_2 \quad (41)$$

where the estimative of β_{12} will be equal to $(1 - \lambda)$.

The hypothesis of endogeneity of the Verdoorn Coefficient states that λ is a positive function of C, as shown in equation (30). Hence, if $c > 0$, i.e. if the actual growth rate is higher than the potential growth rate, then λ will be increasing. This hypothesis can be expressed as:

$$\lambda = \beta_{22} + \beta_{32} D \tag{42}$$

where D is a dummy variable that equals 1 if $y_a > y_p$, and equals 0 otherwise.

Combining equations (41) and (42) yields:

$$l = \beta_{02} + (1 - \beta_{22}) y_a - \beta_{32} y_a D = \beta_{02} + \beta_{42} y_a + \beta_{52} y_a D + u_2 \tag{43}$$

where $\beta_{42} = (1 - \beta_{22})$.

Just as in the case of the endogenization of π, the possibility of a specification error should be tested for. Hence, the final model to test for the endogeneity of the Verdoorn Coefficient is:

$$l = \beta_{02} + \beta_{42} y_a + \beta_{52} y_a D + \beta_{62} D + u_2 \tag{44}$$

In this model $(1 - \lambda) = (\beta_{42} + \beta_{52} D)$, which can be rearranged to find the Verdoorn coefficient, which is given by $\lambda = (1 - \beta_{42} - \beta_{52} D)$. Therefore, if β_{52} is negative and statistically significant, the Verdoorn Coefficient will be higher in periods of rising capacity utilization, i.e. when $D = 1$. If this is the case, one can say that λ is a positive function of C. Hence, λ is endogenous in relation to C.

4.4. Econometric Strategy

In estimating equations (38) and (44), one should be aware of the possibility of country specific fixed effects (a_i), which could lead to correlations between the regressors and the composite error term $u_{it} = a_i + e_{it}$. This problem is easily solved using a Fixed Effect (FE) OLS estimator, which allows the intercept to change across countries.

Nonetheless, estimates might still be biased if there is simultaneity between some explanatory variables and the dependent variables. In the import demand function, i.e. equation (38), there might be simultaneity between import growth and changes in relative prices. In the Kaldor-Verdoorn Law, i.e. equation (44), there might be simultaneity between demand growth and productivity growth. To deal with this issue, one option is to use the System Generalized

Method of Moments (SYS-GMM), a variation of the GMM developed by Arellano and Bover (1995) and Blundell and Bond (1998).

The SYS-GMM builds a system of two equations in levels and in first differences with distinct instruments to deal with the problem of correlation between the regressors and the error term (Roodman, 2009). Since external instruments are not always available, it uses lags of the independent variables as instruments. To test for the validity of the instruments, one can use either the Sargan or the Hansen statistics, with the null hypothesis of jointly validity (Roodman, 2009). Nonetheless, the identification of the parameters using the SYS-GMM estimator not only requires overidentification, tested using Sargan's and Hansen's tests, but it also requires no autocorrelation, which is tested using Arellano and Bond's (1991) Autoregressive (AR) test.

Finally, estimated coefficients could also be biased if the coefficients of the explanatory variables are in fact heterogenous across countries. This likely issue can be accounted for by employing the Pooled Mean Group (PMG) estimator proposed by Pesaran, Shin and Smith (1997,1999). To deal with slope heterogeneity, the Mean Group (MG) estimator, proposed by Pesaran and Smith (1995), estimates separate time-series models for each group and then take the arithmetic average of the individual coefficients. A combination of the FE approach and the MG estimator is the Pooled Mean Group (PMG) estimator proposed by Pesaran, Shin and Smith (1997,1999). As highlighted by Blackburne and Frank (2007), the PMG estimator assumes an autoregressive distributive lag (ARDL) panel that allows for intercept, short-run coefficients and error variances to differ across groups. However, the long-run coefficients should be equal across groups while imposing equal long-term coefficients across groups.

In sum, while the SYS-GMM ideally suited for panels with small number of time periods (T) and large number of cross-sectional units (N), the PMG is designed for panels with large T and large N. Thus, since this paper's dataset is somewhat between those scenarios, with N=38 and T=23, the results of both models are reported and compared.

4.5.Results

The estimations of equation (38) are presented in Table 4. As expected, the OLS estimations were more statistically significant, since they do not control for heterogeneity and endogeneity. Nonetheless, its results seem to be supported by the SYS-GMM and the PMG estimations. As expected, the coefficients for real GDP and for the Purchasing Power Parity were all significant at least at the 10% level, reaching the 1% confidence level for the OLS and the PMG estimators. On the other hand, the coefficients for the dummy and the interaction terms were not significant in any of the econometric models tested. The results of the SYS-GMM presented in Table 4 must be interpreted carefully, since the value of the Sargan Chi Statistic points to the non-validity of the instruments. However, despite not being weakened by many instruments, this test is not robust. In comparison, the value of the Hansen (1982) test (Chi = 2.07), which is robust but weakened by many instruments, supports the validity of the results. These caveats notwithstanding, the results of the SYS-GMM seems valid when compared with the PMG estimation.

These results reveal that changes in the rate of capacity utilization do not have any effect on real imports. The low level of significance of the interaction terms suggests that the income elasticity of demand for imports is not endogenous in relation to the rate of capacity utilization, going against Palley's (2003) original hypothesis. Moreover, the dummy variable alone was also non-significant, showing that not only π is not endogenous, but there is no other channel through which changes in C can impact the real value of imports. Hence, the automatic adjustment between the actual and the potential rates of growth would not occur via changes in imports.

Table 4. Testing for the Endogeneity of the Income Elasticity of Demand for Imports

Independent Variable: Log of Real Imports	OLS		SYS-GMM		PMG	
Log Real GDP	1.750***	(0.078)	1.245***	(0.207)	0.813***	(0.074)
Log PPP	0.050**	(0.020)	0.568	(0.364)	0.068***	(0.018)
Interaction GDP(Dummy)	-0.012	(0.007)	-0.020	(0.046)	0.025	(0.076)
Dummy	0.334*	(0.195)	0.564	(1.281)	-1099.8	(.)
Constant	-21.358***	(2.085)	-8.672	(6.142)	-	
Error Correcting Term	-		-		-0.096***	(0.027)
Nº of Observations	871		871		833	
Nº of Instruments	-		11		-	
Hansen J Statistic	-		0.084		-	
Arellano-Bond AR(2) Test	-		0.464		-	

Note: Standard errors in parenthesis. Significance: * p<0.10, ** p<0.05, *** p<0.01. The figures reported for the tests are *p*-values. The Hansen J Statistic tests for the validity of overidentifying restrictions under the null of joint-validity. The Arellano-Bond AR(2) Test has a null hypothesis of no serial correlation in the idiosyncratic disturbance term.
Source: Authors' elaboration.

McCombie (2011) presents a possible explanation for the non-validity of Palley's endogenous elasticity hypothesis. He argues that only the short-run elasticities are driven by sectoral bottlenecks, causing the short-run balance of payments growth rate to move anti-cyclically to the actual growth rate. In the long-run, however, the cyclical movements of the actual and short-run growth rates would compensate each other, and these rates would converge towards the long-run balance of payments equilibrium growth rate. This long-run rate is determined by the long-run income elasticity of demand for imports, which is driven not by sectoral bottlenecks, but by technological differences and non-price competitivity.

The estimations of equation (44) are presented in Table 5. Unsurprisingly, the coefficients for GDP growth were significant in each model estimated at least at the 5% confidence level. However, there were some differences between the estimations with respect to the remaining variables.

Table 5. Testing for the Endogeneity of the Verdoorn Coefficient

Independent Variable: Total working hours growth	OLS		SYS-GMM		PMG	
GDP Growth	0.540***	(0.078)	0.692***	(0.164)	0.723***	(0.042)
Interaction GDPg(Dummy)	-0.189***	(0.061)	-0.085	(0.233)	-0.348***	(0.069)
Dummy	0.004	(0.003)	0.015*	(0.009)	-3.419***	(0.503)
Constant	-0.002	(0.001)	-0.002	(0.002)	-	
Error Correcting Term	-		-		-0.856***	(0.045)
Nº of Observations	874		874		836	
Nº of Instruments	-		16		-	
Hansen J Statistic	-		0.496		-	
Arellano-Bond AR(2) Test	-		0.094		-	

Note: Standard errors in parenthesis. Significance: * p<0.10, ** p<0.05, *** p<0.01. The figures reported for the tests are *p*-values. The Hansen J Statistic tests for the validity of overidentifying restrictions under the null of joint-validity. The Arellano-Bond AR(2) Test has a null hypothesis of no serial correlation in the idiosyncratic disturbance term.

Source: Authors' elaboration.

The interaction variable presented a negative sign and was highly significant in the OLS and PMG models. These results support the hypothesis that the Verdoorn Coefficient is a positive function of the rate of capacity utilization, i.e. changes in the rate of capacity utilization impact on the growth of productivity. Hence, when actual growth is higher than potential growth, there will be a positive change on λ. This change increases the potential growth rate until it equalizes with the actual growth rate. However, these results must be taken with caution, since the interaction variable was not significant in the SYS-GMM estimations. Similar results are found when productivity growth is used as the dependent variable.

Moreover, the fact that the coefficient of the dummy variable alone is significant and positive at least at the 10% confidence level for both the PMG and SYS-GMM models indicates that the endogeneity of the Verdoorn Coefficient is not the only channel through which the potential growth rate can adjust to the actual growth rate. Since our dependent variable is total working hours per year, it is possible to speculate that positive changes in the rate of capacity utilization have a positive impact in the growth of the labor force as well. This can come from increases in daily working hours or in the participation rate (Palley; 2003; Setterfield, 2006; McCombie, 2011). Another possibility is that the Verdoorn Coefficient might be endogenous to other economic variables, such as the economy's research intensity (Romero and Britto, 2017).

The results presented in Tables 4 and 5 suggest that, at least inside our model's framework, growth is demand-led. Since changes in the rate of capacity utilization have no impact on absolute imports, the hypothesis that demand growth would adjust to supply growth is not supported. On the other hand, changes in capacity utilization have positive impacts on the Verdoorn Coefficient and, consequently, on productivity growth. Furthermore, based on the positive and significant value of the dummy in Table 5, it is possible to speculate that the growth of the labor force will also increase. Hence, in face of disequilibrium between the actual and potential rates of growth, the later would increase until equilibrium is restored.[12]

5. Concluding Remarks

This paper sought to contirbute to the debate between supply-oriented and demand-oriented growth theories. By testing for the endogeneity of the income elasticity of demand for imports and of the Verdoorn Coefficient, both relative to the rate of capacity utilization, it sought to contribute for a better understanding of whether demand adjusts to supply, or of supply adjusts to demand in the long-term.

The results point to a demand determination of long-run growth. While the endogeneity of the income elasticity of demand was not significant in neither of the econometric models used in the estimation, the Verdoorn Coefficient responded positively for changes in the rate of capacity utilization.

Moreover, the results also point to the existence of other adjustment mechanisms falling on the potential rate of growth. One of the possibilities is the adjustment in the growth of the labor force, through changes in participation rates and daily working hours (Palley, 2003; McCombie, 2011; Setterfield, 2012). Also, other economic factors, such as research intensity, can have positive effect on the Verdoorn Coefficient (Romero and Britto, 2017).

The fact that supply adjusts to demand in the long-run has a major implication for economic policy. If growth is led by demand, then constraints on demand such as market uncertainty, credit rationing and balance of payments disequilibrium are the main barriers to economic development. Hence, governmental policies should focus on easing those constraints.

In spite of this paper's findings, it is worth to mention that the existence of other mechanisms that would make demand adjust to supply cannot be completely rejected. The results provided in this study only suggest that this adjustment does not happen through changes in the level of imports. Therefore, economic policies which aim at directly increasing the potential rate of growth can still have a positive long-run effect.

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Footnotes

[1] A complete derivation of Harrod-Domar's warranted rate of growth would be:

$$\dot{K} = I = sY \rightarrow \dot{K}/K = sY/K = {s(Y/Y)}/{(K/Y)} = s/v.$$

[2] Trevor Swan (1956) has developed independently a model almost identical to Solow's (1956).

[3] A production function is called *neoclassical* if it satisfies the properties of constant returns to scale, positive and diminishing returns to private inputs and the so-called *Inada conditions* (Inada, 1963).

[4] A function is said to be in intensive form when it is expressed in *per capita* or *per worker* terms. Technological progress is *labor-augmenting* when it raises output in the same way as an increase in the stock of labor (Barro and Sala-i-Martin, 2004).

[5] The Neoclassical Model is not the only solution to the inconsistence on the Harrod-Domar model. Kaldor (1961) built a model where the equilibrium between the warranted and the natural rates of growth is reached through changes in the distribution of income.

[6] There are two basic productive factors in the economy: capital and labor. According to the neoclassical model, these two factors grow at the same rate.

[7] The first supply-oriented models of endogenous growth were in fact developed by Arrow (1962) and Frankel (1962). These conjectures have become known as the AK Model (Aghion and Howitt, 2009).

[8] Most of these articles refer to the potential rate of growth as the natural rate of growth.

[9] Time and Cross-Sectional subscripts were omitted for simplicity.

[10] Labor productivity can also be defined as real economic output per worker.

[11] Here, total employment is equal to total hours of work, i.e. the number of persons engaged times the average annual hours worked by person engaged.

[12] To test for asymmetric adjustments, the value of the dummy variable was inverted to check if the estimated coefficients change. Regression results using the inverted dummy (D=1 if $y_p > y_a$) revealed the endogenous parameters do not respond asymmetrically to positive and negative changes in capacity utilization. Results are available from the authors.