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## Article

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*Suggested Citation:* Summa, Ricardo (2016) : An alternative model to the open-economy "new consensus" for the analysis of inflation targeting, EconomiA, ISSN 1517-7580, Elsevier, Amsterdam, Vol. 17, Iss. 3, pp. 310-323,  
<https://doi.org/10.1016/j.econ.2016.09.007>

This Version is available at:

<https://hdl.handle.net/10419/179629>

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# An alternative model to the open-economy “new consensus” for the analysis of inflation targeting

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Received 25 November 2015; received in revised form 19 May 2016; accepted 9 September 2016

Available online 19 September 2016

## Abstract

In this paper we will discuss a demand-led growth model which is constrained by economic policy. In this way, we will incorporate an inflation targeting regime in the raffian supermultiplier model in order to analyze how economic policy can influence the growth rate of productive capacity. We will analyze an open-economy where inflation is a cost-push phenomenon and the monetary authority can manage the nominal exchange rate through changes in interest rate differentials. As functional income distribution will depend on the evolution of nominal wages, exchange rate and interest rate, we will show that inflation target system, in addition of not being neutral in terms of long run growth, also can lead to different outcomes in terms of functional income distribution.

*Keywords:* Demand-led growth; Functional income distribution; Inflation target

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## 1. Introduction

The new consensus or the “three equation” model was fully analyzed by [Carlin and Soskice \(2010\)](#), [Romer \(2000\)](#), [Taylor \(1997,2000\)](#) and now is becoming popular even in the undergraduate textbooks ([Mankiw, 2010](#)). The New Consensus model with inflation targeting is based on the following theoretical structure: (i) the effective output depends on the real interest rate (stimulating investment spending), (ii) the existence of an accelerationist Phillips curve and (iii) a Taylor rule, relating the Monetary Authority response via nominal interest rate to deviations of inflation from its target and output from its potential. The potential output is determined by the stocks of factors of production – capital and labor – and their productivity, according to the neoclassical theory of value and distribution.

In an open-economy context, the new consensus model postulates that the Real Interest Rate Parity holds ([Romer, 2006](#)). It is implicit on this assumption that the Uncovered Interest Rate Parity holds in the short run and that the individuals operating in the exchange rate market have Rational Expectations and believe that the Purchasing Power Parity holds in the long run ([Lavoie, 2000](#)).

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Peer review under responsibility of National Association of Postgraduate Centers in Economics, ANPEC.

The main results of this model are well known. The long-run core inflation is related with demand shocks and does not depend on the exchange rate (open-economy long run neutrality); the inflation control mechanism involves the impact of the real interest rate on aggregate demand, targeting a null output gap. There is no trade-off between inflation and productive capacity, since the latter is independent of the effective output<sup>1</sup>; and inflation target can always be achieved, because the Monetary Authority can always set the real interest rate in line with the natural rate of interest.<sup>2</sup>

There are, however, a considerable number of works that evaluate critically the new consensus model in a closed-economy context. They show that by changing some of the hypotheses of this model (such as the accelerationist Phillips Curve), different results can emerge regarding output, productive capacity and inflation dynamics (Setterfield, 2004; Lavoie and Kriesler, 2007; Lavoie, 2006; Atesoglu and Smithin, 2006; Serrano, 2006; Aspromourgos, 2007; Setterfield, 2015). For open economy, we have few examples of alternative models, such as Cordero (2008) and Vera (2014).

In this paper we present a heterodox open-economy macroeconomic model that seeks to establish an alternative view to the “New Consensus” model and analyze the determinants of long-run inflation, the transmission channels of monetary policy, the costs of such policy and its limitations. The structure of the model intends to be simple, in order to be comparable to the new consensus model. We will analyze an open-economy where inflation is a cost-push phenomenon and the monetary authority can manage the nominal exchange rate through changes in interest rate differentials. In this model we will incorporate an explicit inflation target regime in the Sraffian supermultiplier model<sup>3</sup> in order to analyze how economic policy can influence the growth rate of productive capacity and the Functional income distribution.

The structure of the paper is as follows. In the next section, the alternative model to the open-economy new consensus will be presented. In section 3, we will present the model closure and the analytical solution. In the fourth section, we will present some numerical simulations. Concluding remarks will be made on the last section.

## 2. An alternative model to the open-economy “new consensus”

The alternative model presented here follows the same simplified scheme of the New Consensus model, but alters significantly some theoretical assumptions: (i) First, the potential output or productive capacity of the economy follows the long-run expected effective demand; we use the Sraffian supermultiplier to model the demand led growth of productive capacity. (ii) The output growth rate depends on the real interest rate (through the effect on autonomous spending) and the real exchange rate (through the effect on exports). (iii) The Phillips curve is non accelerationist (partial inertia hypothesis) and depends on the role of nominal exchange rate, on imported inflation and on the degree of distributive conflict, (iv) the nominal exchange rate depends on the interest rate differential and is subject to speculation, and (v) the Monetary Authority seeks to achieve a pre-defined inflation target, through changes in nominal interest rate.

### 2.1. The Sraffian Supermultiplier and of the growth rate of the autonomous components of effective demand

The first assumption of our model is that the potential output or productive capacity of the economy ( $Y^*$ ) follows the long-run expected effective demand. We use the Sraffian supermultiplier (Serrano, 1995) to model the demand-led growth of productive capacity.

Following the tradition of Classical Political Economy, or the Surplus Approach, the potential output will be constrained by the scarcest factor, given the technical coefficients (Garegnani, 1962, 1990, 1992). Assuming that in a capitalist economy in general we have no labor scarcity, the productive capacity of this economy will be determined by the size of the capital stock and the technical capital-output ratio. This means that the potential output can be

<sup>1</sup> In fact, although not explicit, “new consensus” economists believe that there is a negative relationship between high inflation rates and productive capacity, in the sense that high inflation can create some inefficiencies, lowering the growth rates of potential output (See Taylor (1997) and Goodfriend (2004). Lavoie (2006) call this relationship “the hidden equation”).

<sup>2</sup> Except when the MA reach the zero bound on interest rate policy (Goodfriend, 2004).

<sup>3</sup> See Serrano (1995), Cesaratto et al. (2003), Lavoie (2014) and Allain (2015), Freitas and Serrano (2015), Serrano and Freitas (2015) and Pariboni (2015).

reached even with structural labor unemployment.<sup>4</sup> The equilibrium between aggregate demand and output and the determinants of aggregate demand components are shown in Eqs. (1)–(4):

$$Y = I + C + G + X - M \quad (1)$$

$$C = w(1 - t)Y + A \quad (2)$$

$$I = v(d + g_e)Y \quad (3)$$

$$M = mY \quad (4)$$

We use the standard notation. In Eq. (1)  $Y$  is the current level of effective demand and output. Eqs. (2) and (3) show the components of the aggregate demand. In (2) we suppose a simple Kaleckian consumption function, where aggregate consumption ( $C$ ) depends on the Wage Bill (wage share ( $W$ ) times disposable national income  $((1 - t)Y$ ) and an autonomous component ( $A$ ); The aggregate investment spending ( $I$ ) is fully induced by national income (3). This means that the investment will be expanded in order to replace the depreciated capital stock ( $d$ ) and to create productive capacity in order to meet the expected average rate of growth of normal effective demand (over the life of investment), ( $g_e$ ), and this also depend on the capital-output ratio ( $v$ ). Imports are induced by the level of current effective demand (4), where ( $m$ ) denotes the imported coefficient.

Denoting  $Z$  as the sum of the autonomous components of effective demand (Autonomous consumption ( $A$ ), Government expenditure ( $G$ ) and exports ( $X$ )), we can write short run equilibrium level of output as:

$$Y = \frac{Z}{1 + m - w(1 - t) - v(d + g_e)} \quad (5)$$

Eq. (5) shows the level of effective demand as a function of the autonomous components of aggregate demand and the output Supermultiplier (Cesaratto et al., 2003).

Denoting  $z$  as the growth rate of autonomous spending, we suppose that  $z$  grows at an exogenous rate  $\sigma$  but is also influenced by (ex post) real interest rate ( $r$ ).<sup>5</sup> This inverse relation reflects the negative effect of the real interest rate in the growth rate of autonomous consumption:

$$z = \sigma - \vartheta(i - \pi) \quad (6)$$

Moreover, we assume that in the process of accumulation “ $g_e$ ” is made endogenous and is gradually revised as a flexible accelerator process, and this gradual process with long lags is here modeled as small values of “ $x$ ” (Cesaratto et al., 2003).

$$g_{et} = g_{et-1} + x(g_{t-j} - g_{et-j}) \quad (7)$$

Therefore, the growth rate of effective demand and output,  $g$ , will depend on the growth rate of autonomous spendings,  $z$  (Serrano, 1995; Cesaratto et al., 2003).

$$g = z \quad (8)$$

Since the capital-output ratio is given, the growth rate of productive capacity,  $g^*$ , is determined by the growth rate of capital stock. As the productive capacity depends on investment, and the flexible accelerator process ensures that the

<sup>4</sup> As we assumed that the potential output level is restricted by the capital stock and technical coefficient, the growth rate of potential output also will be restricted by growth rate of capital stock (and changes in technical coefficient). So, growth rates of productive capacity will not be constrained by the ‘natural rate of growth’ since there are in the short run unemployed labor and in the long run, even if effective demand growth rates are high, several mechanisms (like immigration, changes in the participation rate, Verdoon’s law etc) that can adjust the natural rate in order to seek productive capacity growths rates.

<sup>5</sup> In general, the IS curve is written in terms of the level of output and the real interest rate, and not growth of output as we are assuming here. We are aware that this is a strong assumption. The idea behind this relation is that booms of durable consumption goods and residential investment can be generated or aborted depending on the real interest rate. The relation between households’ credit conditions (which include real interest rate but also other aspects) and the dynamics of autonomous spending is very complex and must be estimated empirically. However, if we replace Eq. (6) by a regular IS curve relating the level of autonomous components of effective demand and the real interest rate, the only change in our model results will be the trade-off between inflation target and output and productive capacity.

investment will be gradually adjusted to meet the growth rate of effective demand, in the long run the potential output level will converge to:

$$Y^* = \frac{Z}{1 + m - w(1 - t) - z} \quad (9)$$

So, the causality of the adjustment between productive capacity and long period effective demand will be from the former in direction to the latter. Consequently, in the long period the level of output will be the same as the productive capacity:

$$Y = Y^* \quad (10)$$

## 2.2. Cost-push inflation

Let's suppose a very simple economy which produces a basic commodity, using also labor and imported inputs.  $P$  is the price of this commodity,  $a$ ,  $m$  and  $l$  are respectively technical coefficients of domestic inputs, imported inputs and labor,  $W$  is nominal wage,  $P^*$  is the price of imported inputs in international currency and  $e$  is the nominal exchange rate. Let's suppose also that this economy produces and export a non-basic commodity. The price level of this economy will be:

$$P = (1 + i)aP_{-1} + lW + meP^* \quad (11)$$

In Eq. (11),  $i$  is the nominal interest rate. Here it is implicit that there is a process of equalization of the profit rate to the interest rate set by the monetary authority, a la [Pivetti \(1991\)](#). The competition among capitalists ensures this process of equalization from exogenous nominal interest rate to nominal profit rate, and it occurs through two channels: the opportunity cost of capital and the financial cost. In fact we are simplifying the original contribution of [Pivetti \(1991\)](#), which supposes that there is also a "Risk and trouble" factor that must be included in Eq. (11) (for more on this point, see also [Serrano \(1993\)](#), [Stirati \(2001\)](#) and [Lima and Setterfield \(2010\)](#)).

Inflation ( $\pi$ ), measured by  $\ln(P - P_{-1})$ , will be the result of rate of change of nominal wages ( $\hat{W}$ ), nominal interest rate ( $\hat{i}$ ), nominal exchange rate ( $\hat{e}$ ) and international inflation (measured in international currency),  $\pi^*$ , as shown in equation (12)<sup>6</sup>:

$$\pi = l^* \hat{W} + m^* (\hat{e} + \pi^*) + a^* \hat{i} \quad (12)$$

To obtain a reduced form of the Phillips curve, we must discuss the dynamics of nominal wage. Eq. (13) shows that nominal wage change depend on past overall inflation, output gap and an exogenous component ( $c$ ).

$$\hat{W} = \theta \pi_{-1} + \tau(Y - Y^*) + c \quad (13)$$

First of all, the parameter  $\theta$  represent the proportion of past inflation that workers can incorporate in their wage contracts. This parameter will depend on workers' bargaining power ([Ros \(1989\)](#)). In this way,  $\theta$  has nothing to do with the capacity of workers in forecast the future inflation.<sup>7</sup> Workers, for example, can forecast very well the inflation rate in the near future, but cannot be able to incorporate the whole forecasted inflation in their wage contracts, depending on their bargaining power ([Rowthorn, 1977](#)).

The output gap is a proxy to demand shocks. When current output is above potential output (a positive output gap), unit labor cost rises due to workers claims of higher wages.<sup>8</sup> Finally, nominal wage can change due to other institutional, cultural and political aspects that affect workers' bargaining power, and this is represented in Eq. (13) by "c" ([Kalecki, 1971](#); [Rowthorn, 1977](#); [Stirati, 1994, 2001](#)).

Substituting Eq. (13) into (12), the following reduced form of Phillips curve is obtained:

$$\pi = \alpha \pi_{-1} + \beta(Y - Y^*) + l^* c + m^* (\hat{e} + \pi^*) + a^* \hat{i} \quad (14)$$

<sup>6</sup> Notice that the parameters  $l^*$ ,  $m^*$  and  $a^*$  now reflect the weighted average of the cost components.

<sup>7</sup> We are supposing here that inflation expectations are revised accordingly to inflation levels in the recent past. In this way, recent past inflation is a good proxy to expected inflation, i.e., backward-looking expectations.

<sup>8</sup> See [Palumbo \(2015\)](#) for the relation between worker's bargaining power and the level of activity in the seminal [Phillips \(1958\)](#) work. See also [Kalecki \(1943,1971\)](#).

In Eq. (14), we suppose that inflation inertia (measured by the parameter  $\alpha = l^*\theta$ ) is not complete.<sup>9,10</sup> Also, we do not suppose open economy neutrality<sup>11</sup> and thus international inflation converted in domestic currency ( $\hat{e} + \pi^*$ ) can be different from domestic inflation, which means that real exchange rate can change over time.

Also, despite of the short period effects of output gap on inflation, in the long period, according to the sraffian supermultiplier results (10), the productive capacity responds to effective demand and the output gap gradually closes. In this case, demand-pull inflation pressures are temporary.

### 2.3. The multiplier and the functional income distribution

Also from Eq. (11) we can determine the level of real wage of the economy. Dividing Eq. (11) by  $P$  and re-arranging, we can determine the real wage level:

$$\frac{W}{P} = \frac{(1 - (1 + i)/(1 + \pi)a) - m(eP^*)/P}{l} \quad (15)$$

Supposing that the labor coefficient ( $l$ ) is not changing, the wage share will depend on real interest rate and real exchange rate. A rise in the real interest rate is expected to reduce the wage share, and real Exchange rate appreciation has the effect of cheapening imported inputs and thus improving the workers purchasing power. So, an exchange rate (depreciation) appreciation is related with a (fall) rise in wage share.

As the aggregate consumption function depend on the wage share ( $W$ ), changes in the real exchange rate and the real interest rate will alter the multiplier effect in equation (9). In attempting to close our model, we need only to discuss the nominal interest rate setting mechanism and the nominal exchange rate determination.

### 2.4. Nominal exchange rate determination

In order to analyze the nominal exchange rate determination we need to look at the economy's balance of payments. The balance of payments is obtained by summing the balance of current account (CC) with financial account. The financial account can be split into transactions that involve short run ( $F_{CP}$ ) and long run capital flows ( $F_{LP}$ ).

$$BP = CC + F_{LP} + F_{CP} \quad (16)$$

In a purely floating exchange rate regime, the balance of payments must sum to zero with no overall surplus or deficit. This means that the current account balance must equal the financial account balance:

$$F_{CP} = -CC - F_{LP} \quad (17)$$

Supposing that long run capital flows are exogenously determined, we must analyze the determinants of short run capital flows and current account balance. In our model, the short run capital flows depends on the interest rate differential between the domestic interest rate ( $i$ ) and international rate ( $i^W$ ) (plus the sovereign spread ( $\rho$ ) and expected exchange rate change ( $e_{+1}^e - e$ )). The parameter  $F$  is an autonomous component of short run capital flows and  $\delta$  is the sensivity of short run capital flows to interest rate differentials. We suppose that capital flows are not infinitely sensitive to interest rate differentials.<sup>12</sup>

$$F_{CP} = F + \delta(i - (i^W + \rho + (e_{+1}^e - e))) \quad (18)$$

<sup>9</sup> For a theoretical critique of the hypothesis of full persistence in the new consensus model, see Serrano (2006) Setterfield and Leblond (2003) and Setterfield (2004). The usual condition in the new consensus macroeconomic models that the sum of effects on current inflation of past and expected inflation is equal to one and the conclusion that follows that the effect of a single demand shock would be a permanent acceleration of inflation.

<sup>10</sup> Setterfield (2005), Setterfield and Lovejoy (2006) and Pollin (2002,2005) shows that when introducing explicitly some distributive conflict variable in US Phillips curve, estimations of "a" fall considerably.

<sup>11</sup> In an open economy new consensus model, the full pass-through from expected to actual inflation for the economy as a whole also requires the assumption that relative Purchasing Power Parity holds empirically, that is, that domestic inflation must be equal to tradable goods inflation in the local currency, and that the sum of  $a$  and  $m^*$  is equal to 1.

<sup>12</sup> See Summa (2015) and Serrano and Summa (2015) for this theoretical discussion. Even Blanchard (2016) now reached the same conclusion that capital flows have finite elasticity.

It is important to notice that the domestic interest rate does not necessarily adjust to the international rate (plus sovereign spread and Exchange rate change expectations). So the Monetary Authority can institutionally set the domestic interest rate, and thus stimulate capital inflows or outflows.<sup>13</sup>

Supposing also that the international rate ( $i^w$ ) and the spread<sup>14</sup> ( $\rho$ ) are exogenous variables, we just need to discuss the exchange rate expectations to solve the nominal exchange rate determination problem.

We assume that expected nominal exchange rate, ( $e_{+1}^e$ ), is at least in part endogenous and dependent on the evolution of the nominal exchange rate occurred in the near past. This is because the foreign currency can be seen as an asset, subject to speculation (Frenkel and Taylor, 2006). After a continuous process of nominal exchange appreciation, further appreciation could be expected in the future. Dealers speculating in the exchange rate market will thus avoid buying foreign currency expecting that its price will be lower in the near future. This will lead to another round of currency appreciation, because foreign currency sellers will have to lower its price and buyers will only buy it if the price is lower. As a consequence, a process of exchange rate appreciation can lead to expectations of appreciation (the same is valid with processes of exchange rate devaluation) (Serrano and Summa, 2015).

Exogenous shocks can also influence expectations, like good or bad news about the future path of some external variables that affect currency dealers' opinions about the exchange rate that will prevail in the future, reversing or aggravating the process described above.

In the model, the best way to formalize the process described above is supposing that the exchange rate expectations are adaptive, and subject to exogenous shocks ( $\varphi$ ) related to news about relevant variables that influences currency dealers' expectations:

$$e_{+1}^e = e^e + h(e_{-1} - e^e) + \varphi, \text{ com } b \leq 1 \quad (19)$$

If we assume, attempting to simplify the model, that  $h = 1$  and  $\varphi = 0$ , expectations about exchange rate will depend only on the exchange rate prevailing one period ago:

$$e_{+1}^e = e_{-1} \quad (20)$$

Replacing Eq. (17) in (16) we have:

$$-CC - F_{LP} = F + \delta(i - (i^w + \rho + (e_{+1}^e - e))) \quad (21)$$

Eq. (21) determines the balance of payments equilibrium. Denoting  $F'$  as the sum of the exogenous flows and the current account balance ( $F' = F + CC + F_{LP}$ ), rearranging (21) and substituting nominal exchange rate expectations (20) we have:

$$e = e_{-1} - (i - i^w - \rho) - \frac{F'}{\delta} \quad (22)$$

Nominal exchange rate will thus depend on the past exchange rate, interest rate differential (plus sovereign spread), exogenous capital flows and current account balance. And the change in nominal exchange rate ( $e - e_{-1}$ ) depends on the interest rate differential. This means that a positive and constant interest rate differential will lead to a process of nominal exchange rate appreciation through time.<sup>15</sup>

This results from the exchange rate expectation effect through current exchange rate. A positive interest rate differential with elastic expectations can lead to process of exchange rate appreciation, and this will bring expectations of other currency appreciation, reinforcing the process of Exchange rate appreciation again, and so on. The same unstable process can occur in the opposite direction if the monetary authority set permanently the domestic interest rate bellow international rate (plus sovereign spread).<sup>16</sup>

<sup>13</sup> See Pivetti (1991, 2007) for the exogenous interest rate approach. For the interest rate exogeneity even in open economies, see Lavoie (2000, 2001, 2002-2003), Pivetti (2001) and Serrano and Summa (2015).

<sup>14</sup> The assumption of exogenous sovereign spread is quite strong, but in section 4.6 we discuss the implications of relaxing this hypothesis.

<sup>15</sup> Notice that this result differs from uncovered interest parity model where a positive interest rate differential leads to a "once and for all" nominal exchange rate appreciation through time, while in our model a **process** of nominal exchange rate appreciation follows from a positive interest rate differential.

<sup>16</sup> In practice, monetary authorities are forced to manipulate interest rate differentials together with interventions in currency market, buying and selling foreign reserves, but we will not incorporate this into our model.

### 3. The model closure and analytical solution

To close our model we need to establish how the interest rate is determined. We suppose, as in the new consensus model, that the monetary authority set the nominal interest rate in order to achieve inflation target ( $\pi^T$ ). The Monetary Authority raises the nominal interest rate when inflation is above target, and lowers when it is below:

$$i = i_{-1} + \gamma(\pi - \pi^T) \quad (23)$$

In order to obtain the analytical solution, we depart from the Phillips curve (Equation 14). The long run inflation will depend on the permanent pressures on inflation. Demand shocks, as we discuss, are temporary as the productive capacity adjusts to the current output level. In the long run, this source of pressure disappears. Cost-push shocks such as changes in nominal interest rates ( $\Delta i$ ) are also temporary, since there is a nominal interest rate ( $i = i^T$ ) that is capable of achieving inflation target. So, in the long run we do not expect changes in the nominal interest rate.

Consequently, in the long run, inflation will depend on international inflation, changes in nominal exchange rate, on the degree of distributive conflict “ $c$ ” and on the inflation inertia degree:

$$\pi = \frac{l^*c + m^*(\hat{e} + \pi^*)}{1 - \alpha} \quad (24)$$

We have the following system to solve:

$$z = \sigma - \vartheta(i - \pi) \quad (6)$$

$$\hat{e} = -(i - i^w - \rho) - \frac{F'}{\delta} \quad (22)$$

$$i = i_{-1} + \gamma(\pi - \pi^T) \quad (23)$$

$$\pi = \frac{l^*c + m^*(\hat{e} + \pi^*)}{1 - \alpha} \quad (24)$$

From Eq. (24) we can deduce that, given international inflation, the share of imported inputs, inflation inertia degree and workers’ bargaining power  $c$ , there is a change in nominal exchange rate that can bring long run inflation to the target.

To achieve this exchange rate change, the monetary authority must set domestic interest rate above international rate. We will denote the domestic interest rate necessary to change nominal exchange rate and thus to bring long run inflation to the target as ( $i^T$ ). Replacing Eq. (24) in (22) and as if  $\pi = \pi^T \rightarrow i = i^T$ , we have:

$$\pi^T = \frac{l^*c + m^*(\pi^* - ((i^T - i^w - \rho) + F'/\delta))}{1 - \alpha} \quad (25)$$

Thus, the domestic interest rate necessary to change nominal exchange rate and thus to bring long run inflation to the target ( $i^T$ ) will be:

$$i^T = \pi^* + (i^w + \rho) - \frac{F'}{\delta} - \left( \frac{\pi^T(1 - \alpha) - l^*c}{m^*} \right) \quad (26)$$

As we can see, there is an inverse relation between nominal interest rates and the inflation target. The slope of this relation depends on the inflation inertia degree “ $\alpha$ ”,  $m^*$  and  $l^*c$ , while the position depends on international conditions ( $\pi^w$ ,  $(i^w + \rho)$ ,  $F'/\delta$ ).

Replacing  $i^T$  and  $\pi^T$  in Eq. (6) we find the growth rate of autonomous expenditures ( $z$ )

$$z = \sigma - \vartheta \left( \pi^* + (i^w + \rho) - \frac{F'}{\delta} \right) + \vartheta \left( \pi^T \left( \frac{(1 - \alpha) - l^*c}{m^*} + 1 \right) \right) \quad (27)$$

Eq. (27) shows us that there is a positive relation between the growth rate of autonomous spending ( $z$ ) and inflation target. So, the higher is inflation target, the higher will be growth rate of the growth rate of autonomous spending.

International inflation is inversely related with the growth rate of autonomous spending. This occurs because the higher international inflation is, the greater will be the nominal interest rate differential to control domestic inflation.



Given the inflation target, this means that we will have, as a by-product, a higher real interest rate, and consequently, a lower growth rate of autonomous expenditures.

The same results apply to the international interest rate and sovereign spread. A rise in these variables means that, if the government wishes to achieve the same inflation target, the domestic interest rate must rise to obtain the same nominal exchange rate appreciation. This will result in higher domestic real interest rates and lower growth rates of autonomous spending.

Finally, the growth rate of productive capacity will be the result of both autonomous spending and the multiplier, with the latter changing as a consequence of variations in functional income distribution, according to Eq. (9) and (15).

#### 4. Numerical simulations

Once we established an analytical solution to the model in its simplest version, we can run numerical simulations to assess the behavior of some selected variables. The purpose of this exercise is to: (1) evaluate if the analytical solution results are valid; (2) evaluate the dynamic path in direction (or not) to the equilibrium position; (3) compare different equilibrium positions when we change parameters, such as inflation target.

We will assess the path results of: 1. growth rates of productive capacity and Functional distribution of income when we have different (a) inflation target; (b) international inflation rate; (c) sovereign spread. We can also check the hypothesis that, if the monetary authority controls the nominal interest rate, it can control inflation rate in direction to the target when the core inflation is cost-push and related with imported inflation. And finally, it will be analyzed the dynamic path of real interest rate, real exchange rate and output gap related to different inflation targets.

In the numerical simulation exercise, the extreme hypothesis of  $h = 1$  in the adaptive exchange rate expectation (20) is abandoned and the exchange rate expectations now depend on an average weight of past exchange rate.

The initial condition, parameters and exogenous variables supposed are: (a) inflation starts at 6%; (b) First exchange rate expectations is 4,0 and the parameter  $h$  is 0,76; (c) International interest rate is 5% and sovereign spread is 2%; (d) initial domestic nominal interest rate is 20%; (e) Output and productive capacity initial levels are in equilibrium and are equal to 400; (f) Exogenous component of growth rate of autonomous expenditures,  $\sigma$  is 8%; (g) The monetary authority's rule parameter  $\gamma$  is 0,7; (h) a high value of  $\delta$ , denoting that short run capital flows are highly sensitive to interest rate differentials. All the simulations start with the same initial conditions.

##### 4.1. Alternative inflation target

In the first exercise, we change the monetary authority inflation target in order to analyze alternative paths of productive capacity growth rate, inflation rate, real interest rate, real exchange rate and output gap. Fig. 1 shows the growth rate of capacity paths to different inflation targets (2%, 5% and 7%). As it was expected, lower inflation targets will generate, as a by-product, lower growth rates of productive capacity. Inflation dynamics with different inflation

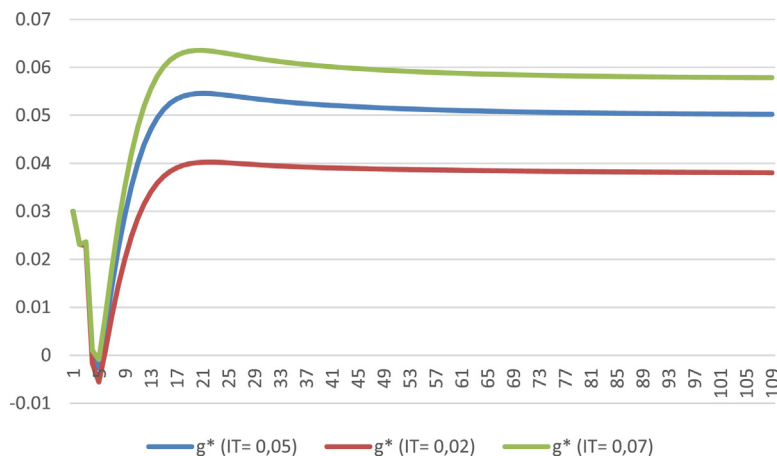


Fig. 1. Growth rates of productive capacity ( $g^*$ ) with different inflation targets.

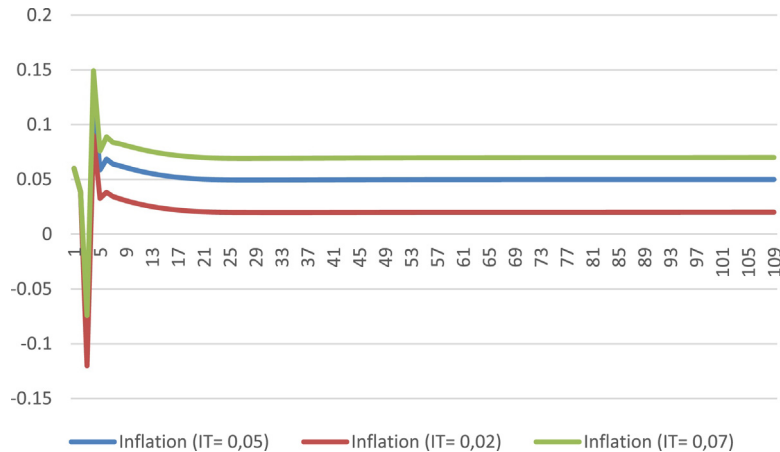


Fig. 2. Inflation rate dynamics with different inflation targets.

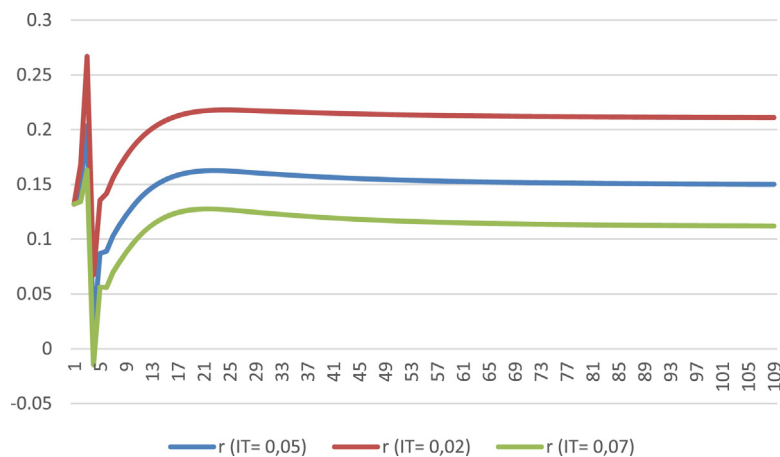


Fig. 3. Real interest rate ( $r$ ) with different inflation targets.

targets are showed in Fig. 2. It is interesting to note that Monetary Authority can achieve inflation rate target in the three cases. It means that, even in an economy where the core inflation is cost-pushed and related with imported inflation, it is possible to the Monetary Authority to control inflation rate using nominal interest as the only policy instrument.

Fig. 3 shows the dynamic paths of the real interest rate. Notice that this figure is related to Fig. 1 discussed above. It shows that when the inflation target is lower, the Monetary Authority must set a higher nominal interest rate, resulting in a higher *ex post* real interest rate (higher nominal rate plus lower inflation rate), and this will lead to lower growth rates of productive capacity.

Output gap behavior is showed in Fig. 4. We can see that output gap endogenously tends to close in all the three cases, although it will take longer time to converge when inflation target (and so growth rates of productive capacity) is higher. We can see in Fig. 5 the path of real exchange rate. The result shows that, given that this domestic economy face an international inflation and has an inflation target, the nominal exchange rate will appreciate more than inflation differential, resulting in real exchange rate appreciation too. Note that this occurs to the three different inflation targets. The higher is the inflation target, the higher will be inflation differential, and this will lead to a quicker process of real exchange rate appreciation.

The last point to notice is that all the results were obtained with the monetary policy rule parameter  $\gamma = 0.7$ . Even with these parameter, inflation converges to the target as the MA set domestic nominal interest rate. This result could be seen as puzzling to one that believes in the ‘new consensus model’ relations, since in this model the  $\gamma$  parameter must be greater than one, that is, the nominal interest rate must raise more than the difference between inflation and inflation target, in order to guarantee a real interest rate change in the right direction. The point is that in the ‘new consensus

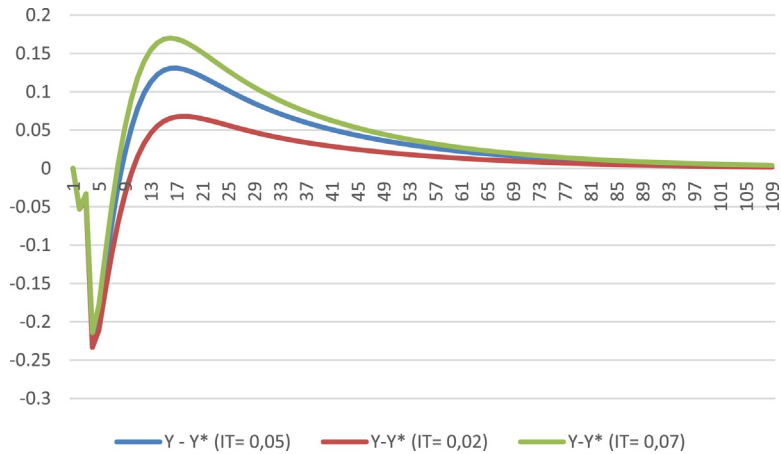


Fig. 4. Output gap with different inflation targets.

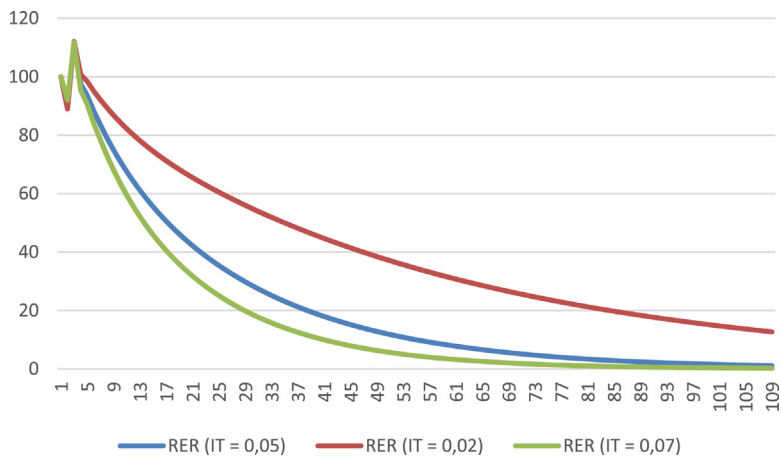


Fig. 5. Real exchange rate with different inflation targets.

model’, MA must change the real interest rate in order to affect output gap, and so to control demand-pulled inflation pressures.

In our model, the transmission mechanism is from the nominal interest rate – through nominal interest rate differential with nominal international interest rate plus sovereign spread – to the nominal exchange rate, which adaptive expectations can lead to a process of nominal exchange rate appreciation (or depreciation) and so to affect inflation through time. So, it is easy to understand that a change in the nominal interest rate, even if it coincides at first with a change in the real interest rate in the opposite direction, can control inflation.

#### 4.2. International inflation

Now, we run another exercise changing international inflation and observing the results in relation to different international inflation. The growth rates paths of productive capacity related to these different international inflation rates are illustrated in Fig. 6. If the economy faces a lower international inflation, given the inflation target, the growth rate of productive capacity will be higher than if it faces a higher international inflation. This happens because MA will need a lower effort in appreciating nominal exchange rate, and it requires a lower interest rate differential, resulting in lower levels of real interest rate and, consequently, higher rates of growth of productive capacity.

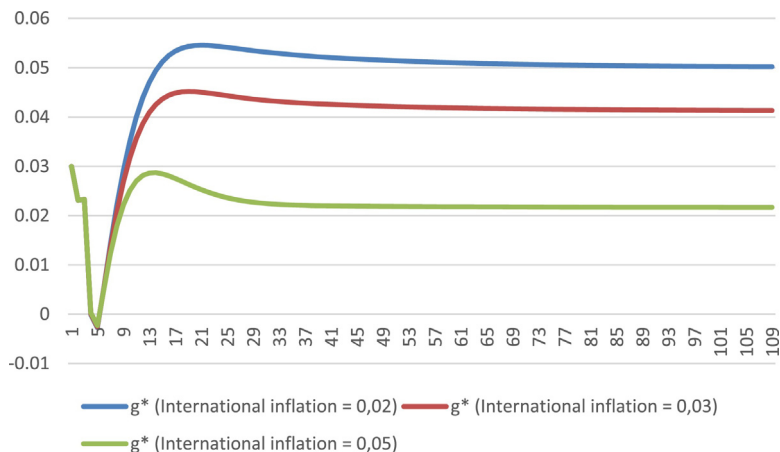


Fig. 6. Growth rates of productive capacity ( $g^*$ ) with different international inflation.

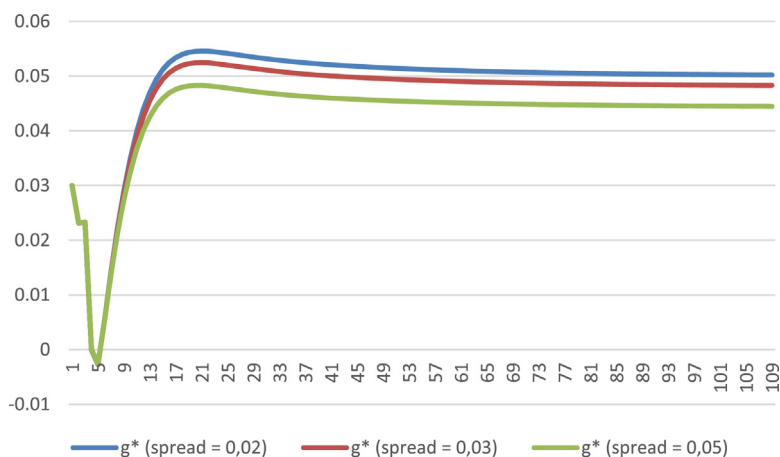


Fig. 7. Growth rates of productive capacity ( $g^*$ ) with different sovereign spread.

This result calls attention to another way of interpreting external constraint in demand-led growth models. This means that demand-led growth of productive capacity can be restricted by economic policy objectives (in this case, inflation target) depending on the external conditions (in this case, international inflation).

#### 4.3. International interest rate and sovereign spread

The same results are obtained when we alter international interest rate (or sovereign spread), indicating another sources of demand-led growth constraint due to external conditions when a country seeks some economic policy target. In this case, a rise in international interest rate due to, for example, autonomous changes in US monetary policy, or a rise in country's sovereign spread as consequence of a worsen in international liquidity conditions, will result in lower growth rates of productive capacity (see Fig. 7). This occurs because, in order to maintain the same interest rate differential, it is necessary that the MA must raise domestic interest rate, with consequences to growth rates of effective demand and productive capacity.

#### 4.4. Functional income distribution

In Fig. 8 we can see the functional income distribution results to different inflation targets. The conclusion is that the higher is inflation target, the higher will be the wage share on income. This occurs by two reasons: (1) The real interest rate will be lower when inflation target is higher, and this will lead to a lower profit rate in the long run; (2)

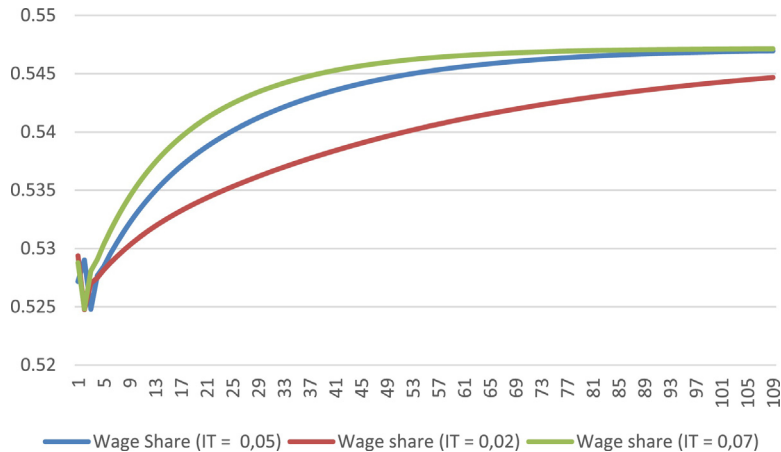


Fig. 8. Wage share ( $w$ ) with different inflation targets.

Real exchange rate appreciate quicker when inflation target is higher, and this lowers the price level and thus improve real wages.

#### 4.5. Some limits to inflation control in this framework

Until now we discussed external constraints to demand-led growth of productive capacity, that is, given some international inflation (or international interest rate levels) the growth rates of productive capacity will be lower, as a by-product of achieving a pre-established inflation target.

But we also need to consider the impossibility of a MA in attaining inflation target, depending on the external conditions of a country, or due to international conditions in general.

As discussed before, given an international inflation, the only way of a country to seek an inflation target when inflation is cost-pushed is by appreciating constantly the nominal exchange rate.

But the country sometimes can face rising sovereign spreads to finance current account deficits or even an international credit rationing (Serrano and Summa, 2015), for exogenous (worsening of international credit markets conditions and international credit rationing worldwide) or endogenous (increasing in short run external debt, for example) reasons. If it happens, MA can lose control in attracting short run capital flows and MA can be forced to abandon IT due to an unstable process of exchange rate depreciation.<sup>17</sup>

Other limits to inflation control can arise from political disputes over different groups. Some organized political groups which depend on competitive exchange rates (to export their goods and services, for example) can oppose to a process of real exchange rate appreciation, and if they are successful in stopping the appreciation process, the inflation will not converge to its target.

It is important to note that this impossibility of attaining IT can happen even if MA has ‘full credibility’. It is not a question of credibility, but of ‘structural’ external or political conditions. In sum, there are limitations in implementing such policy, which depends on the external, political and institutional factors.

## 5. Conclusion

A very important issue about demand-led growth macroeconomic models regards the possible constraints to this kind of growth. The sraffian supermultiplier states that, assuring the stability conditions,<sup>18</sup> capacity output growth respond to and is sufficient to meet effective demand. One possible constraint to demand-led growth could be

<sup>17</sup> In fact, MA can abandon the floating Exchange rate regime and try to stabilish ceilings to nominal exchange rate, but in practice this kind of policy depend for example on the size of stock of international reserves previously accumulated. So, the inflation target policy will last until MA still has foreign reserves and can control nominal exchange rate. When the stock of foreign reserves is depleted, the inflation target must be abandoned.

<sup>18</sup> See Freitas and Serrano (2015).

balance-of-payment long run sustainability, and there is a vast tradition of models following the Kaldor-Thirlwall approach that deals with this issue.

However, and this is an insight which can be obtained from the model presented here, even if there is external room for demand-led growth, some other constraints to the growth of autonomous components of effective demand could appear. The kind of constraint we explored in this paper is related to the imposition of macroeconomic policy targets (for example, inflation target or a target of primary surplus/GDP) by policy makers. This can influence the growth rate of autonomous spending, and thus of the productive capacity.

So, we can say that the demand-led growth model presented here is constrained by economic policy. Also, this constraint depends mainly on the evolution of country's external accounts, the international credit market conditions and international inflation.

The long-run costs of pursuing such policy were evaluated in terms of rate of growth of productive capacity and functional income distribution to different inflation targets. First, the policy of inflation control is not neutral in terms of growth rate of productive capacity, since controlling inflation through the nominal exchange rate appreciation needs a positive interest rate differential, and, as a result, it impacts on the real interest rate and output/capacity growth rates. Hence, a higher inflation targeting or a lower imported inflation ultimately leads to a higher growth rate of productive capacity. Finally, the anti-inflationary policy is not neutral in terms of functional income distribution. Since the distribution depends on the real interest rate and real exchange rate, a lower inflation target will lead to higher real interest rates and, consequently, the income distribution will change, reducing the wage share.

Thus, in the model presented here the international inflation has a role in influencing the long run growth rate of productive capacity. This occurs because when the economy experiences a raise in the international inflation, it impacts on the long run domestic inflation, and the Monetary Authority reacts raising the interest rate differential to appreciate the nominal exchange rate faster, in order to reach the inflation target. A higher real interest rate is a by-product of such policy, and has consequences on lowering the growth rate of current output and productive capacity. The external constraint thus can appear in the form of higher imported inflation.

It is important to notice that there can be limitations to operating such policies. This depends on a country political and external conditions and international conditions in general, since the policy of inflation control depends largely on a process of nominal exchange rate appreciation, and this depend on the capacity of MA to set nominal interest rate and attract short run financial flows. The success of this policy will ultimately depends on the country's external solvency and liquidity conditions and also on the international credit market conditions.

Finally, it is worth noticing that we are not proposing here a rule of thumb or a stable and well-defined set of choices between economic policy objectives (inflation target) and outcomes (growth rate of productive capacity and functional income distribution). What we want to call attention is that in an open-economy, in which growth rate of productive capacity is demand-led and MA follows some explicit economic policy objectives (like inflation target), there will be real costs in achieving policy targets, and these costs will depend on external conditions.

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