

**Economic Growth under Alternative Monetary Regimes:
Inflation Targeting vs. Real Exchange Rate Targeting**

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ABSTRACT

As a result of a recent shift towards inflation targeting in several developing countries, a formal model is presented to examine the main features and consequences of this monetary regime and compare it to another based on real exchange rate targeting. Inflation targeting is shown to hurt growth and employment performance, and to cause long-run instability. Under real exchange rate targeting, the economy may be placed on a higher growth path, but the “trilemma” hurts inflation performance. This problem may be mitigated by adjustments in the legal reserve requirement rate or capital controls.

1. Introduction

Several models of growth have been developed within the structuralist tradition in order to analyze growth and distribution in open economies. These works, however, do not always include the monetary sector, and when they do, they rarely establish the interaction between the latter and the balance of payments; they are not designed to examine the association between the monetary regime, and the foreign exchange rate system. This article attempts to fill that void by means of a framework that allows comparing two alternative monetary regimes: one resulting from inflation targeting, and another resulting from real exchange rate targeting.

The topic becomes relevant as several developing nations are deciding to adopt inflation targeting regimes, combined with very flexible foreign exchange systems. This move has been encouraged by the IMF, and especially recommended to those economies with difficulties to bring their inflation rates down to the level of the more advanced countries. In various nations, however, this shift has been shown to cause unemployment, real exchange rate appreciation, lower output growth, and vulnerability to external shocks.

This article develops a formal model to compare the main features of two alternative settings for monetary policy. In section 2, the Central Bank adjusts the nominal exchange rate to hit a real exchange rate target, with inflation control playing an important but secondary role. In this case the growth and employment performance are favorable but the economy suffers the difficulties arising from the “trilemma.”

The model in section 3 presents a monetary system in which the nominal interest rate is chosen to hit an inflation target, and the nominal exchange rate floats freely to equilibrate the balance of payments. Under this inflation targeting scheme, price stability becomes the only goal of monetary policy. We show that this arrangement is very effective in bringing inflation down, but overdetermination hurts both the employment and growth potential of the economy.

For each of the models developed in sections 2 and 3, the dynamic properties of the long-run equilibrium are also analyzed. Section 4 presents some concluding remarks.

2. A small-open economy with a real exchange rate target

In this economy a real exchange rate target is set by the Central Bank at a level that is just the one required to maintain the competitiveness of exports. Maintaining exports will help employment so that, in a way, a real exchange rate target is analogous to an employment target.

The economy operates in the following way. The foreign exchange rate system is better defined as one in which the nominal rate is adjusted (crawling peg) by the Central Bank to bring the actual real rate to the specified target. This framework analyzes the difficulties the central bank faces when attempting to control both the money supply and the foreign exchange rate under an open capital account. This is the well known problem of the “trilemma” of monetary policy: with a rigid nominal exchange rate, attempts to reduce the money supply (and therefore inflation) by raising the interest rate cause an increase in international monetary reserves which, in turn, offsets the reduction in money supply (and thus, inflation) that authorities were originally looking for.

This situation leads to inflation rates that are higher than internationally accepted levels. But it also allows the Central Bank to make the adjustments that are needed to maintain the competitiveness of exports and the rate of economic growth.

2.1 Assumptions of the model

Some assumptions below are rather general, but others reveal the structuralist approach that is followed in building the model.¹

1. The country produces a consumption good “Q”, which could be exported or consumed domestically.
2. The country imports a composite good that may be used for consumption or investment purposes. All capital used in the country is imported.
3. The small economy cannot affect the international price of its imports P^M , but it determines domestically the price of local production P^Q , part of which is exported. This assumption, in relation to the price of local production, allows analyzing the effect that internal prices have on the competitiveness of exports.
4. The price of imports, in terms of foreign currency is P^M , assumed exogenous for the small economy. In terms of local currency, the price of imports is: eP^M where “e” represents the nominal exchange rate (number of units of local currency that have to be paid for one unit of foreign currency).
5. There are two social classes: producers and workers. Workers spend all their wage income on consumption of both the local good and the imported good, while producers save a fixed portion “s” of their profit income and the rest they spend on consumption of both the domestic and imported goods.
6. Good Q is produced by means of a fixed-coefficient production function:

$$Q = \text{Min} \left[\frac{L}{a}, uK \right]$$

where L represents the labor input, “a” is a technical coefficient, K is capital and “u” represents the output/capital ratio. Capital does not depreciate, and firms are assumed to hold excess capacity so that “u” is a variable that moves up (down) when capacity utilization increases (decreases).

7. The interest rate is a policy variable fixed by the Central Bank for stabilization purposes.

¹ The structuralist approach is described in Taylor (1991) and in Dutt (1992).

8. The capital stock K and the labor force N are given in the short- and medium-run, but they may change in the long-run.

9. The nominal exchange rate “ e ” is a policy variable that remains fixed in the short- and medium-run, but is adjusted in the long-run by the Central Bank. The adjustment process follows a rule that allows hitting a real exchange target.

10. The real exchange rate, which determines the competitiveness of exports, is defined as:

$$h = \frac{eP^M}{P^Q}.$$

11. The wage share is assumed given in the short- and medium-run, and is defined as $A = \frac{Wa}{P^Q}$. In the short-run W and the technical coefficient a are also fixed, but they adjust in the long-run. The domestic price level P^Q is given in the short-run but may vary in the medium-run.

12. The analysis is conducted in three stages: in the short-run, output adjusts while prices, the real exchange rate, and the distribution of income remain given; in the medium run inflation will move to clear the monetary market; and in the long-run the wage share and the real exchange rate are allowed to vary.

2.2 General overview

In this section we present the goods market, and define the conditions for macroeconomic equilibrium in the short-run (equality between the investment and savings rates). With the previous assumptions we may find equilibrium values for the rate of growth, the rate of profit, the output/capital ratio, and the employment rate; inflation only adjusts in the medium run, as seen below.

Within foreign sector, in the short run, the given levels of the interest rate and real exchange rate help us determine the increase in international monetary reserves; this then enters into the determination of money supply growth. With the short-run variables already determined, the monetary sector clears in the medium-run through adjustments in the inflation rate.

Once the whole model is solved we examine the impact that open market operations have on inflation and economic growth. It is at this point that the “trilemma” arises and the real exchange rate emerges as a leading character in the story. The relevance of this variable stems also from the fact that it is, along with the interest rate, the only one capable of stimulating the level of economic activity.²

² In other structuralist models (Dutt, 1983; Taylor, 1985, for example), income distribution plays a critical role in the determination of economic growth. Blecker (1989) then extends those models to examine how income distribution affects growth in an open economy. In this article, however, the investment function (our equation 2) looks more like the Neokeynesian version used by Marglin (1984), and the output/capital ratio has been taken out of the desired accumulation function. This modification prevents the wage share from having an effect on the rate of growth.

Equations of the model

Goods market

$$(1) \quad g^s = sr + B$$

$$(2) \quad g^d = b_0 + b_1 r - b_2 i$$

$$(3) \quad r = \frac{u}{h}(1 - A)$$

$$(4) \quad P^Q = \bar{P}^Q$$

$$(5) \quad g^d = g^s$$

$$(6) \quad \frac{L}{N} = \frac{L}{Q} \frac{Q}{K} \frac{K}{N} = l = auk$$

Monetary market

$$(7) \quad \hat{M}^d = \eta_1 \pi + \eta_2 u - \eta_3 i - \eta_4 \pi^E$$

$$(8) \quad \hat{M}^s = R + \tau_0 - \tau_1 i$$

$$(9) \quad \hat{M}^s = \hat{M}^d$$

$$(10) \quad i = i_0$$

Foreign sector

$$(11) \quad B = F - R$$

$$(12) \quad B = B(h); \quad B_h < 0$$

$$(13) \quad F = F(i); \quad F_i > 0$$

$$(14) \quad \hat{e} = \Omega[h_T - h]$$

In following the structuralist tradition, several variables are measured as ratios over the value of the capital stock $eP^M K$: desired investment (g^d), total saving (g^s), the current account deficit (B), capital flows (F), the increase in international monetary reserves (R), and output (u). The interest rate (i), the actual inflation rate (π), the expected inflation rate (π^E), and the rates of growth of money supply and money demand (\hat{M}^s, \hat{M}^d) are written in percentage terms. The real exchange rate and the wage share are denoted by h and A , respectively, and the symbols $\eta_1, \eta_2, \eta_3, \eta_4, \tau_0, \tau_1, b_0, b_1, b_2$ all represent positive parameters.

Equation (1) makes the total rate of saving g^s equal to domestic saving “ sr ”, plus the rate of foreign saving “ B ”. In (2) desired investment depends on the rate of profit and the interest rate. Expression (3) shows the rate of profit in terms of the output/capital ratio, the real exchange rate, and the wage share, and (4) tells us that prices remain fixed in the short-run. In (5) the goods market equilibrium condition is provided, while (6) shows the employment rate (l) as a function of the output/capital ratio (given k). This equation is derived from the production function.

In the monetary market, equilibrium is attained when the rates of growth of money supply and money demand (in nominal terms) are equal. Equation (7) suggests that the money demand side is determined by inflation, the output/capital ratio, the interest rate and an exogenous expected inflation term. Inflation increases the demand for money as the public will attempt to replenish the value of their real balances whenever inflation goes up. But also people will try to get rid of (i.e. spend) their holdings of money if they expect inflation: basically the public will attempt to win the race against inflation.

Equation (8), on the other hand, tells us that money supply grows with the accumulation of foreign exchange reserves, but decreases with the exogenous interest rate. This latter component attempts to formalize Central Bank policy-making: in order to reduce money growth, the Bank conducts open market operations and drives interest rates up, and the opposite would happen if policy makers wished to increase money growth. The constant parameter τ_0 captures the effect of monetary policy that is not related to open market operations. For example, an increase in the legal reserve ratio causes a decline in this parameter and thus a reduction in the money supply.

Equation (9) presents an equilibrium condition for the money market, and (10) describes the nominal interest rate as an exogenous variable. Inflation is seen as a monetary phenomenon: excess money supply leads to excess spending, and hence to higher inflation. But on the other hand, the lack of money supply results from high interest rates, which hurt employment and output growth. Thus, even with our monetarist formulation, effective demand continues as a relevant determinant of the level of economic activity. Here, of course, money is not neutral, so, unlike several versions of the “new consensus” macroeconomics (Meyer, 2001), money does matter. Our approach also differs from the Post Keynesian view of inflation as resulting from cost-push and social conflict (as presented for example in Arestis and Sawyer (2006)).

One final warning on the monetary sector: *ceteris paribus*, the use of the interest rate to control inflation, will only lead to a stable adjustment process if money supply is more sensitive to changes in the interest rate than money demand (i.e. τ_1 is bigger than η_3). Only in this case will the higher interest rate lead to a reduction in the excess money supply, and to a lower inflation rate.³

Equations (11) through (14) describe the foreign sector of the economy. In (11) the current account deficit is financed by capital inflows and depletion of international monetary reserves. The current account deficit depends negatively on the real exchange rate and net capital inflows depend positively on the interest rate. In (14) we see how, in the long-run, the monetary authority devalues the nominal exchange rate to bring the real rate to its target (h_T); Ω is a positive parameter.

³ The adjustment mechanism may be described by: $\frac{\partial i}{\partial t} = \varphi(M^s - M^d)$, $\varphi > 0$; and this will be stable only if

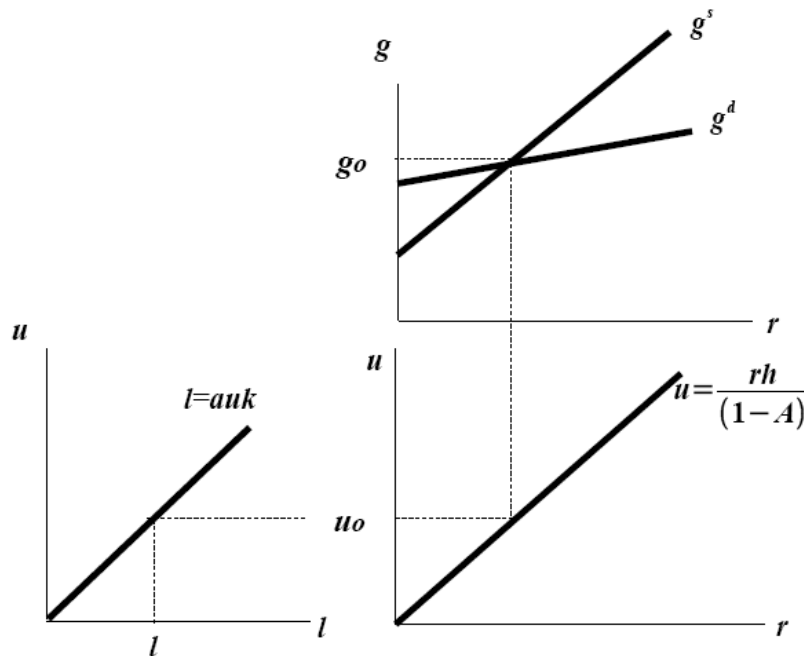
$$\varphi(-\tau_1 + \eta_3) < 0.$$

2.3 Formal solution of the model

The process starts when the Central Bank defines the nominal interest rate and the target for the real exchange rate. These two policy variables are utilized, respectively, to control the money supply, and to maintain the competitiveness of net exports. The current account deficit and net capital inflows can then be determined, and with this we can solve for R in (11).

In the goods sector equations (1), (2), (12) and (5) determine the profit rate. In (3), given A and h , we find the output/capital ratio, and (6) then leads to the employment rate (l). Again in Keynesian fashion, employment is determined in the goods market (not in the labor market as monetarist and new classical approaches would suggest). The short-run solution for the goods sector is shown in figure 1.

Figure No. 1

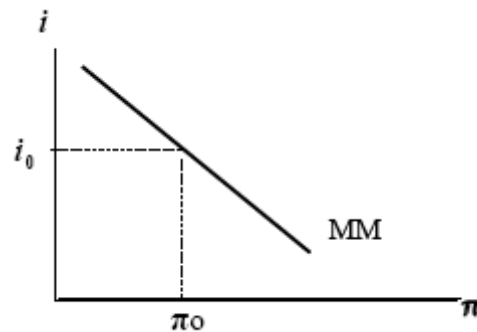


We may now move into the medium run and use (7), (8), (9) and (10) in the monetary sector to solve for inflation, as shown below:

$$(15) \quad \pi_0 = \frac{R_0 + \tau_0 + (-\tau_1 + \eta_3)i_0 - \eta_2 u_0 + \eta_4 \pi^E}{\eta_1}$$

where u_0 represents the level of the output/capital ratio found in the goods market, and i_0 denotes the interest rate fixed by the Central Bank. The relationship between the interest rate and inflation is shown in figure 2.

Figure 2



The money market equilibrium schedule (MM line) in figure 2 has a negative slope when the conditions specified in footnote 3 hold. This schedule provides the combinations of inflation and interest rate that are consistent with equilibrium in the monetary market. Here π_0 is the inflation rate that clears the money market when the Central Bank fixes the interest rate at i_0 . In order to bring inflation down, the Central Bank raises the interest rate to reduce money supply growth; as the availability of money declines, aggregate spending decreases and inflation goes down (the economy moves to the left along the MM line).

But the story is more complicated. First, in the foreign sector, a higher “ i ” will attract more capital flows, making international monetary reserves go up. The money supply will then increase (the MM line shifts out), compensating (at least partially) the initial attempt to reduce inflation pressure. Thus, the monetary authorities cannot control both the exchange rate and interest rate (and the money supply) under an open capital account: the well known problem of the “trilemma.”

Second, in the goods market, as “ i ” goes up (to reduce inflation), investment demand goes down; the g^d line shifts down and the rate of growth, the rate of profit, the output/capital ratio and the employment rate decrease. Stabilization is successful but only at the expense of economic activity.

Fortunately, the Central Bank can decide to increase the target level for h , which will cause foreign savings (the current account deficit) to go down. The g^s line in figure 1 will shift to the right (down) leading to faster growth, higher profit rate, and higher output/capital ratio and employment rate.

We have thus confirmed the double edged character of the real exchange rate: it is to blame for the difficulties the Central Bank faces in controlling inflation; had it had more flexibility in the short-run, there would have been no accumulation of international reserves and we would not have lost ground in the fight against inflation. But on the other hand, it is the ability of the Central Bank to move the real exchange rate to a targeted level, which provides the economy with the possibility to reach faster growth and higher employment rates. Arguments and evidence in favor of targeting the real exchange rate may be found in Frenkel (2004) and in Frenkel and Ros (2005).

Now a final comment on monetary policy: there is no reason for the Central Bank to only use open market operations to control the money supply. Other policy instruments, like the legal reserve requirement, could play an important control role without a direct impact on interest rates.⁴ A

⁴ This point was analyzed with a formal model in Cordero (2005).

higher reserve requirement ratio may be seen in our model as a reduction in the term τ_0 in equation (15). In figure 2 this will show as a downward shift of the MM schedule, indicating that there will now be a lower level of inflation at every level of the interest rate. The Central Bank may thus be able to curve down price growth, but without changes in international monetary reserves, breaking in this way the “trilemma.” The alternative presented here is also in line with the arguments in Frenkel (2004), who goes even further to point out that capital controls are feasible; a similar argument on the convenience of capital controls is provided by Ffrench Davis (2003).

Many Central Banks, however, would not like to use the legal reserve requirement, or capital controls as instruments for monetary policy: they prefer open market operations because they are, well, more market oriented.⁵ Policy makers are thus opting for more flexible exchange rate arrangements, combined with inflation targeting regimes, as will be explained in section 3.

2.4 Long run dynamics

In this section we follow Cordero (1995) in analyzing the interaction between the wage share and the real exchange rate, which we assumed given in the short- and medium-run. We proceed by assuming that, in the long run, the variables which adjusted in the short- run to clear the goods market (u, g, r, l), and in the medium-run to clear the monetary sector (π), remain at their equilibrium levels.

The motion of A is given by

$$(16) \quad \hat{A} = \hat{W} + \hat{a} - \pi$$

where the hats denote rate of growth. The coefficient a was defined as $\frac{L}{Q}$ so we can write that

$$y = \frac{Q}{L} = \frac{1}{a} \quad \text{where “}y\text{” represents average labor productivity.}$$

Following Arrow (1962) it is argued that labor productivity depends on learning, which is assumed to be positively related to production. We also follow Dutt (1994) in assuming that production is associated to the investment rate “ g ”:

$$(17) \quad \hat{y} = -\hat{a} = Y(g - \gamma), \quad Y_g > 0$$

with Y_g the partial derivative of productivity growth with respect to the investment rate, and γ is an arbitrary constant number.

The specification of wage growth assumes that workers try to increase their nominal wage whenever the actual wage share falls below an exogenous level A^W desired by workers as indicated in the following equation:

⁵ The mainstream view argues that higher levels of the legal reserve requirement cause higher administrative costs, and thus may lead to higher spreads and margins for financial intermediation. But this is not necessarily true: in the case of Costa Rica, for example, the reserve requirement fell from 15% in 1999 to 5% in 2002, but in the same period the spread between active and passive interest rates declined only half a percentage point. Then, in 2003, when the reserve requirement jumped from 5% to 10%, the spread went up by only 1.5% (Cordero, 2005).

$$(18) \hat{W} = \theta[A^w - A]$$

Finally, the inflation rate that clears the monetary market depends on the real exchange rate and the wage share:

$$(19) \pi_0 = \pi(h, A); \pi_h < 0; \pi_A < 0$$

where, again, the sub-indexes denote the variable we are taking the partial derivative of π with respect to. The dependency of π_0 on “ h ” and “ A ” comes from the presence of the output/capital ratio in equation (15); and from the fact that the equilibrium level of “ u ” was determined in the goods market (through the interaction between g^d and g^s for given h and A).

We may now put equations (17) through (19) in (16) to get a differential equation in h and A :

$$(20) \hat{A} = \theta[A^w - A] - Y[g(h) - \gamma] - \pi[h, A]$$

The dynamic behavior of the real exchange rate is described by:

$$(21) \hat{h} = \hat{e} - \pi$$

According to (14), reproduced below, the nominal exchange rate moves up when the actual level of the real exchange rate falls below the target chosen by the Central Bank:

$$(14) \hat{e} = \Omega[h_T - h]$$

Next, use (19) and (14) in (21) to get:

$$(22) \hat{h} = \Omega[h_T - h] - \pi[h, A]$$

Equations (20) and (22) form a system of two differential equations in two state variables: h, A ; the stability of the system is analyzed by means of the Jacobian matrix:

$$Det(J) = \begin{bmatrix} \frac{\partial \hat{A}}{\partial A} & \frac{\partial \hat{A}}{\partial h} \\ \frac{\partial \hat{h}}{\partial A} & \frac{\partial \hat{h}}{\partial h} \end{bmatrix} = \begin{bmatrix} (-\theta - \pi_A) & (-Y_g g_h - \pi_h) \\ -\pi_A & (-\Omega - \pi_A) \end{bmatrix}$$

The determinant of the Jacobian is:

$$Det(J) = (\theta + \pi_A)(\Omega + \pi_h) - \pi_A(Y_g g_h - \pi_h) = \theta[\Omega + \pi_h] + \pi_A[\Omega - Y_g g_h]$$

which will be positive if $\Omega > \pi_h$ and $\Omega > Y_g g_h$. In other words, $Det(J)$ will be positive if Ω is large.

The trace is given by $Tr(J) = -\theta - \pi_A - \Omega - \pi_h$, which will be negative if θ , and Ω are large. So the long-run equilibrium will be stable if wages are flexible and the Central Bank is very committed to maintaining the real exchange rate close to the chosen target; this is possible when $\Omega = 1$. Only in this case will the nominal exchange rate be adjusted in the proportion required to make $h = h_T$.⁶

3. The small economy under an inflation targeting regime

3.1 The inflation targeting regime

In the previous section we saw the problems that may arise if, with a fixed real exchange rate, the Central Bank attempts to control inflation by using open market operations. Although, as we saw, there are several ways in which the “trilemma” could be faced successfully, there is a strong tendency to move to an inflation targeting regime and turn the exchange rate system into a flexible one. This bias, according to Epstein (2005), is part of a global change in the practice of central banking, promoted mostly by institutions like the International Monetary Fund. In this view, central banking practices must be based on independence, inflation as the goal of policy (including application of inflation targeting regimes), and the use of indirect methods of monetary policy (mostly open market operations). Arestis and Sawyer (2003), on the other hand, relate this bias to the “new consensus” macroeconomics in which inflation targets become the focus of monetary policy. In this section of the article, we want to emphasize that, once this approach is adopted, everything in the economy will be tied to the inflation target; the result is great success in bringing inflation down, but a rather disappointing performance in terms of growth and employment.

According to Galindo and Ros (2005) this monetary regime leads to possible appreciation of the real exchange rate, and increased vulnerability to monetary shocks coming from the external sector. In the case of Mexico, these authors show that inflation targeting has led to an appreciation of the real exchange rate, which has had a negative impact on output growth.

Epstein (2002) reports that the utilization of this monetary system in South Africa led to high interest rates, accompanied by low employment and investment rates. His recommendation is that South Africa move to a scheme in which employment is targeted, but subject to an inflation goal. He also recommends the use of capital controls in order to better control the effect of the world economy on South Africa. Setterfield (2006) also argues that governments should pursue output and employment targets, in addition to inflation goals.

Other, more general cross-country studies have found that there is no reason to keep inflation below the 3 to 5 percent range, especially because in middle income economies higher single digit rates of inflation could stimulate economic growth (Pollin and Zhu, 2005). Another study conducted by Ball and Sheridan (2003), concludes that inflation targeting has generated no major benefits in economic

⁶ The long-run motion of k is given by: $\hat{k} = g - \hat{N}$. The short-run equilibrium level of g depends on h : $g_0 = \bar{g}(h)$, $\bar{g}_h > 0$. Assume that $\hat{N} = n(k)$ with $n_k > 0$, and we get $\hat{k} = \bar{g}(h) - n(k)$. The system formed by (20) and (22) provides a solution for h , which we use to find the level of k required for $\hat{k} = 0$. The equilibrium is stable if $n_k > 0$.

performance (other than a decline in inflation rates).

In this section we develop a model to examine the effects of inflation targeting on growth and employment.

3.2 Revised equations

Money market

$$(23) \quad i = \Gamma(\pi); \quad \Gamma_{\pi} < 0; \quad \pi = p(i), \quad p_i < 0$$

$$(24) \quad \hat{M}^s = \tau_0 - \tau_1 i$$

$$(25) \quad \hat{M}^d = \eta_1 \pi + \eta_2 u - \eta_3 i$$

$$(26) \quad \pi = \pi_T$$

$$(27) \quad \hat{M}^s = \hat{M}^d$$

Foreign sector

$$(28) \quad B = F$$

$$(29) \quad B = B(h); \quad B_h < 0$$

$$(30) \quad F = F(i); \quad F_i > 0$$

Goods sector

$$(31) \quad g^d = g^d(r, i), \quad g_r^d > 0, \quad g_i^d < 0$$

$$(32) \quad G = g^d(r, i) - B(h)$$

$$(33) \quad S = sr$$

$$(34) \quad G = S$$

$$(4) \quad P^Q = \bar{P}^Q$$

$$(3) \quad r = \frac{u}{h}(1 - A)$$

$$(6) \quad l = auk$$

In equation (23), the interest rate is the mechanism the Central Bank uses to control inflation. Once a target is defined in (26), open market operations allow bringing the interest rate to the level that is exactly needed to hit the chosen inflation target. As for money demand (equation 25), we use a formulation that is similar to the one in section 2. Finally, and in accordance to this monetary system, we assume that the Central Bank announces an inflation target in the understanding that this goal is prior to any other objective the bank might have. The priority assigned to hitting this level will be clear as the model is explained in more detail.

Next, we turn to the foreign sector where we start by getting rid of the accumulation of international monetary reserves. As equation (28) shows, the current account deficit has to be financed by net capital inflows. This is made possible by allowing the real exchange rate to fluctuate as required to satisfy expression (28).⁷

In the goods sector, the specification looks a bit different from section 2, but it still holds the same meaning: equation (32) defines demand injections, while (33) defines domestic savings. Equations (3), (4) and (6) are borrowed from the previous section to describe prices, the rate of profit, and the employment rate.

3.3 Solution of the model

Price rigidities are an important feature of this model: in the short-run, prices remain fixed by equation (4), and will adjust only in the medium-run (the growth of prices in the medium-run is determined by the inflation target chosen by the Central Bank). In the short-run, the burden of adjustment falls on the output/capital ratio and the real exchange rate.

Once the inflation target π_T is announced, equations (26) and (23) allow defining the nominal interest rate. In the foreign sector the real exchange rate adjusts to equilibrate the balance of payments and we have:

$$(35) \quad h = h[i], \quad h_i < 0$$

Next, with i and h known we move to the monetary sector: equations (24), (25) and (27) provide an expression for money market equilibrium:

$$(36) \quad \tau_0 - \tau_1 i - \eta_1 p(i) - \eta_2 u + \eta_3 i = 0$$

This equation describes a relationship between the interest rate and the output/capital ratio, and the slope is given by

$$\frac{\partial u}{\partial i} = \frac{[-\tau_1 - \eta_1 p_i + \eta_3]}{\eta_2} < 0$$

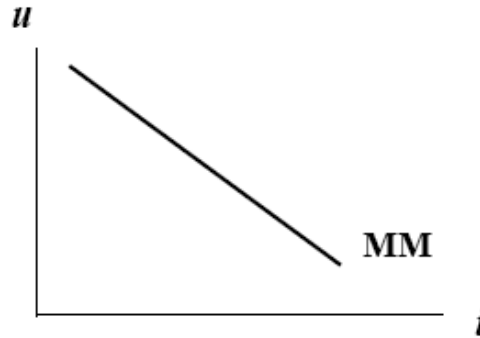
As before, the sign of this slope results from the conditions in footnote 3 (figure 3 presents the corresponding graph) and we write that:

$$(37) \quad u = u[i], \quad u_i < 0$$

⁷ With prices fixed in equation (4), h adjusts as a result of variations in the nominal exchange rate e .

Once we know the inflation target we can plug the known interest rate i_0 in (36) to find the output/capital ratio (u) that clears the money market. This implies that, in order to derive u , it is not necessary that savings and investment be equal: the model is overdetermined.

Figure 3



In the next step we go to the goods sector, and examine the behavior of the rate of profit. From (3), and also using (35) and (37) we may write the following expression:

$$(38) \quad r = \frac{[u(i)]}{[h(i)]}(1 - A)$$

and the response of the rate of profit to changes in the interest rate is given by:

$$(39) \quad \frac{\partial r}{\partial i} = r_i = \frac{(1 - A)}{[h(i)]^2} [u_i h - u h_i]$$

We do not have information to define the sign of the term $[u_i h - u h_i]$, so we can just examine two possible cases:

$$(40a) \quad r = r[i, (1 - A)], \quad r_i < 0, \quad r_A < 0$$

or

$$(40b) \quad r = r[i, (1 - A)], \quad r_i > 0, \quad r_A < 0$$

Signing the derivatives of r with respect to “ i ” is very important as that will allow to also sign the derivatives of demand injections (G) and domestic saving (S) with respect to “ i ”.

Case 1:

$$r_i < 0, \quad r_A < 0$$

From (32) and from (40a) we get:

$$(41) \quad G = g^d \{r[i, (1 - A)], i\} - B[h(i)]$$

and the slope of this line is

$$(42) \quad \frac{\partial G}{\partial i} = g_r^d r_i + g_i^d - B_h h_i < 0$$

Next, from (33) and (40a) obtain:

$$(43) \quad S = sr[i, (1 - A)]$$

and the slope of the savings function is

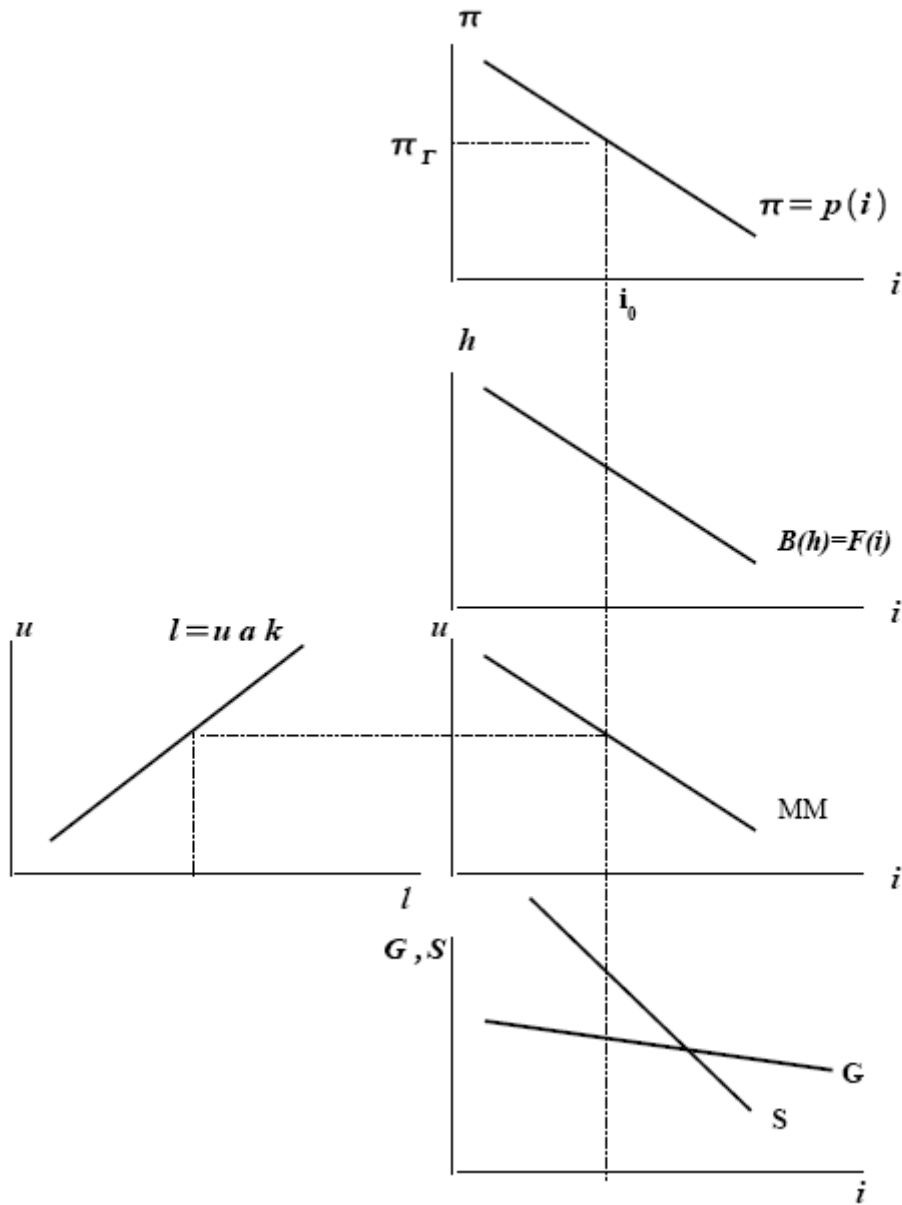
$$(44) \quad \frac{\partial S}{\partial i} = sr_i < 0$$

Just as in other keynesian models, the slope of the S line has to be steeper than that of the G line in order to secure stability of equilibrium in the short run:

$$(45) \quad \left| \frac{\partial G}{\partial i} \right| < \left| \frac{\partial S}{\partial i} \right|$$

The graphical solution appears in figure 4. In the first panel, choosing an inflation target fixes the interest rate by means of equation (23). The foreign sector appears in the second panel, where the known interest rate leads to the real exchange rate that clears the balance of payments. The monetary sector in the third panel shows that, given the interest rate, the “MM” schedule helps us determine the output/capital ratio. Then we examine the behavior of demand injections (G) and domestic saving (S), and overdetermination becomes clear. If the interest rate is below the one that brings G and S to equality, then the economy will be at a point on the G line. Any reduction in the inflation target (and thus increase in the interest rate) will lead to real appreciation, higher unemployment, and a lower rate of economic growth. A reduction of the inflation target will reduce the level of activity even if the interest rate is to the right of the one that makes G and S equal. As the nominal exchange rate is no longer a policy variable, the Central Bank cannot stimulate economic activity and reduce the inflation rate at the same time.

Figure 4

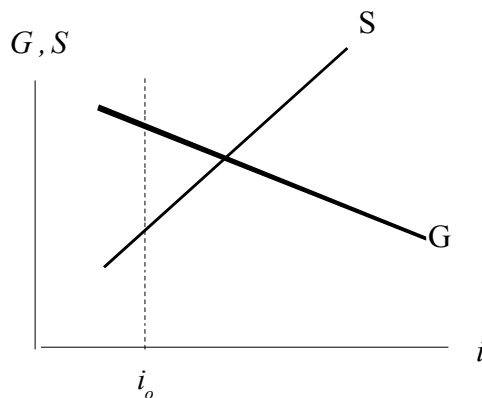


Case 2:

$$r_i > 0, r_A < 0$$

Here the G function keeps the negative slope, but the S function will definitely have a positive slope in the S versus i plane, as shown in figure 5.

Figure 5



With the interest rate at the given level i_0 (which is, again, lower than the one that brings G and S to equality), the economy must be at a point on the S schedule (investors cannot satisfy their desires). A reduction in the inflation target will require a rightward movement of the interest rate, with the economy moving along the domestic saving line towards the right and to a higher rate of growth. But notice that investment desires will suffer a downward movement along the G schedule. So what we are observing here is that, as inflation is brought down, the investment drive also declines. Thus, in this case we see that within the inflation targeting regime, overdetermination causes a gap between actual and desired investment. When the given interest rate lies to the right of the level that brings domestic savings and demand injections to equality, the economy is positioned at a point on the G schedule; in this case stabilization policies lead to a lower rate of growth.

3.4 Long run dynamics

In the long run we analyze two state variables: A and k , where k represents the capital (K) to labor force (N) ratio. The analysis here is based on Cordero (2002), which was further developed in Cordero (2004).

The motion of A is described by equation (16) reproduced below:

$$(16) \quad \hat{A} = \hat{W} + \hat{a} - \pi$$

and for the technical coefficient “ a ” we use equation (17) also reproduced below:

$$(17) \quad \hat{y} = -\hat{a} = Y(g - \gamma), \quad Y_g > 0$$

The growth of nominal wages is again depicted by (18)

$$(18) \quad \hat{W} = \theta[A^W - A]$$

but the desired wage share is now endogenized and made dependent on the employment rate:

$$(46) \quad A^W = \alpha_0 + \alpha_1 \left(\frac{L}{N} \right) = \alpha_0 + \alpha_1 \left(\frac{L}{Q} \frac{Q}{K} \frac{K}{N} \right) = \alpha_0 + \alpha_1 (auk)$$

Finally, we recall that the local inflation rate was set by a target defined by the Central Bank, according to equation (26):

$$(26) \quad \pi = \pi_T$$

The use of (17), (18), (46), (37) and (26) in (16) leads to a differential equation for the evolution of A :

$$(47) \quad \hat{A} = \theta\alpha_0 + \theta\alpha_1 au[i]k - \theta A - Y[g - \gamma] - \pi_T$$

The motion of k is described by:

$$\hat{k} = \hat{K} - \hat{N}$$

where \hat{K} is the investment rate (g), and \hat{N} is assumed fixed at a level denoted by “ n ”:

$$(48) \quad \hat{k} = g - n$$

In order to finish writing (47) and (48) in terms of A and k , we have to replace g with its short-run equilibrium value.⁸ Before we proceed we must generate expressions for the desired investment rate and total savings. The first of these is provided by equation (31) which, after using (40a) becomes:

$$(49) \quad g^d = g^d \{r[i, (1 - A)], i\}, \quad g_r^d > 0, g_i^d < 0, r_i < 0, r_A < 0$$

Total savings, on the other hand, is defined as domestic savings (sr) plus foreign savings [$B(h)$]. From (33), (40a) and our definition of foreign savings, we get

$$(50) \quad g^s = s\{r[i, (1 - A)]\} + B[h], \quad s > 0, r_i < 0, r_A < 0$$

For the case depicted in figure 4 the g level is determined by the corresponding value of g^d in equation (49).⁹

The system formed by (47) and (48) may be re-written as:

$$(51) \quad \hat{A} = \theta\alpha_0 + \theta\alpha_1 au[i]k - \theta A - Y[g^d \{r[i, (1 - A)], i\} - \gamma] - \pi_T$$

$$(52) \quad \hat{k} = g^d \{r[i, (1 - A)], i\} - n$$

⁸ Of course we also analyzed a second case which here would require that we plug (40b) in (31) for the g^d expression, and in (33) for the g^s equation. The long-run dynamics will be analogous to that of the first case, but will not be presented in the paper.

⁹ If the interest rate that is consistent with the inflation target falls to the right of the level making G equal to S , then the g level is determined by the corresponding value of g^s in equation (50). Again, the dynamics of this case is analogous to the one resulting from figure 4 and will not be analyzed here in detail.

The stability of the system is analyzed by means of the Jacobian matrix:

$$Det(J) = \begin{bmatrix} \frac{\partial \hat{A}}{\partial A} & \frac{\partial \hat{A}}{\partial k} \\ \frac{\partial \hat{k}}{\partial A} & \frac{\partial \hat{k}}{\partial k} \end{bmatrix} = \begin{bmatrix} (-\theta - Y_g g_r^d r_A) & \theta \alpha_1 au [i] \\ g_r^d r_A & 0 \end{bmatrix}$$

We have:

$$Det(J) = -[g_r^d r_A][\theta \alpha_1 au [i]] > 0$$

and

$$Tr(J) = (-\theta - Y_g g_r^d r_A)$$

Since $r_A < 0$, the long-run equilibrium will be stable when nominal wage flexibility is important (θ large) compared to learning effects (Y_g). This does not mean that the economy has to stay away from productivity gains; it means instead that wage flexibility is necessary to accommodate productivity growth.

4. Concluding remarks

This paper compares the effects of different monetary regimes on the growth and inflation performance of the economy. With a real exchange rate target the decisions of the Central Bank are affected by the “trilemma” of monetary policy, but the real exchange rate can still be utilized to push employment and economic growth. Thus, although stabilization based on open market operations has a tendency to lower economic activity, the Central Bank can always target a level of the real exchange rate which compensates, at least partially, the contractionary effects of stabilization. The use of monetary instruments like the legal reserve requirement may help bring inflation down without the problems associated to the “trilemma.” The long-run equilibrium is stable if nominal wages are flexible, and the Central Bank maintains a competitive real exchange rate.

When inflation targeting is introduced, the problems of the “trilemma” disappear and inflation is more easily controlled. In this setting all economic results depend on monetary policy. This situation causes overdetermination as there is no level of the rate of profit which is capable (except by accident) of bringing saving and investment to equality. Stabilization policy is harmful to growth and employment and, even if when savings increased, investment desires remain unsatisfied. The inflation targeting regime leads to a stable long-run equilibrium if nominal wages are flexible enough to accommodate the productivity gains resulting from learning.

The most important result in this article is the recognition of the critical importance that the real exchange rate has on the determination of the rates of accumulation and employment of the small open economy. Thus, countries which have already decided to embark on inflation targeting

regimes, should allow themselves to tolerate higher inflation goals to avoid excessive appreciation of the real exchange rate.

For countries which still find themselves battling the difficulties of the “trilemma” the recommendation would be to combine the use of open market operations with the legal reserve requirement or even with some control over the capital account of the balance of payments.

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