

KEYWORDS

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The sustainability of monetary sterilization policies

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The focus of this paper is on policies that set out simultaneously to control the exchange rate and monetary conditions (an instrument interest rate, for example) in situations where capital mobility is unrestricted, there is an excess supply of international currency and the central bank sets targets for the exchange rate and interest rate. The paper calculates how high the local interest rate can go at any time without rendering monetary sterilization policy unsustainable, defines the degree of monetary autonomy as the difference between this rate on the one hand and the sum of the international interest rate and the rate of increase in the exchange rate on the other, and analyses how the degree of autonomy evolves. Numerical examples using data from Argentina and elsewhere suggest that sterilization policy is sustainable and that a considerable degree of monetary autonomy exists in contexts that are by no means unusual in many developing economies.

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I

Introduction

In a context of free capital mobility, the central bank can simultaneously control the exchange rate and the interest rate. This runs directly counter to what is claimed by the so-called “trilemma” of an economy open to capital movements. Here we argue that this trilemma is false in certain circumstances and, consequently, is false as a general theorem.

The condition for combining control of the exchange rate with the preservation of monetary autonomy is the existence of an excess supply of international currency at the exchange rate targeted by the central bank. That is, the conditions in the current account and capital account are such that the local currency would appreciate if the bank did not intervene to hold down the exchange rate. In this context, the monetary authority can set the exchange rate by purchasing the excess supply in the currency market and can control the interest rate by sterilizing the monetary effects of this intervention, which it does by issuing treasury or central bank bonds in the money market. The central bank has two instruments for achieving its two goals: intervention in the foreign currency market to set the exchange rate and intervention in the money market to determine the interest rate.

An excess supply of currency, at the exchange rate targeted by the central bank and at the current interest rate, implies an excess demand for local assets. Fully sterilized intervention can be seen as a policy that is implemented in two stages. In the first, central bank intervention in the currency market leads to an increase in the monetary base. As a result there is a larger monetary base, an unaltered stock of local assets and an interest rate lower than the initial one. In the second stage, full sterilization completely offsets the change in the private-sector portfolio that occurred in the first stage. The central bank absorbs the increase in the monetary base and issues an amount of local assets equivalent to the initial excess demand for these assets (the excess supply of currency), returning the local interest rate to its previous level (Bofinger and Wollmershäuser, 2003).

An excess supply of international currency at the exchange rate targeted by the central bank is what invalidates the “trilemma” and empowers that bank to set the exchange rate and the interest rate. We believe that this idea is unfamiliar because the specialized literature dealing with monetary autonomy and with currency regimes and policies rarely addresses conditions in which there is an excess supply of international currency, mainly concentrating instead on situations of balance-of-payments deficit.

In situations of deficit, the “trilemma” does indeed usually hold true. In conditions of excess demand in the currency market, the ability even of powerful central banks to intervene in that market is ultimately limited by the available amount of reserves. In situations of excess demand for international currency, therefore, not even these central banks can adopt an exchange-rate target without affecting the interest rate. But there is no symmetry between situations of deficit and surplus in the balance of payments, however. The “trilemma” is valid in one case but not in the other (Frenkel, 2007).

Sterilized buying operations can be carried out at any time. But can this policy be applied continuously? Not in every circumstance. The sustainability of the policy depends on the interest rate earned by the international reserves, on the local interest rate, on the exchange-rate trend and on the evolution of the variables determining the supply of and demand for the monetary base. The main conclusion of this paper is that there is a maximum local interest rate above which the policy of sterilization becomes unsustainable. In conditions of excess supply of international currency at the targeted exchange rate, the central bank can set the exchange rate and is free to set a local interest rate no higher than that maximum without giving rise to an unsustainable trend. We set forth this conclusion in a previous paper (Frenkel, 2007). Here we present a formal model to justify it.

The paper is presented as follows. Following this introduction, section II describes the problem and defines the degree of monetary autonomy. Section III presents the model and defines and derives the sustainability condition; it also shows that this condition is equivalent to the central bank having non-negative financial results. Section IV discusses the dynamic of the sustainability condition. Section V defines and derives the condition

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for the permanence of the degree of monetary autonomy; both this section and section III include numerical examples with data similar to those observed in Argentina in late 2006. Lastly, section VI presents two interesting

applications of the results obtained. Both are illustrated using numerical examples to show that the conditions for sustainability and permanence exist in situations that are by no means unusual.

II

The cost of sterilization and the degree of monetary autonomy

At any point in time, the unit cost of sterilization is $s = i - r - e$, where s is the cost of sterilization, i the local interest rate, r the international interest rate and $e = dE/E$ ($E = \text{pesos / US\$}$) the rate of increase in the price of the international currency. The sterilization cost s is nil if $i = r + e$, i.e., if the local interest rate is equal to the sum of the international interest rate and the rate of increase in the exchange rate. Or (which comes to the same thing) if the uncovered interest parity (uip) condition is strictly met (Bofinger and Wollmershäuser, 2003).

A policy of sterilization is obviously sustainable if the cost of sterilization is nil or negative. If this were the sustainability condition, the policy of sterilization would only be sustainable if $i \leq r + e$, i.e., $r + e$ would be the maximum value of the interest rate needed to keep the policy of sterilization sustainable.¹ Rates higher than this would make the policy unsustainable.

In what follows we show that the condition referred to is not necessary for sustainability. We

demonstrate that the policy can be sustainable with local interest rates higher than $r + e$ and we calculate the maximum rate at which sterilization remains sustainable. For this we formulate a simple model which takes account of the fact that, in addition to interest-bearing financial assets, the public demands and the central bank issues a monetary base which is not interest-bearing.

The above considerations suggest that the degree of monetary autonomy should be defined as the difference between the maximum local interest rate at which the policy of sterilization is sustainable and $r + e$. If this maximum rate is termed i_{max} and the degree of monetary autonomy g , we get: $g = i_{max} - (r + e)$.

Given the international interest rate and the rate of increase in the exchange rate, then the higher the local interest rate that can be set without rendering the policy of sterilization unsustainable, the greater the degree of autonomy.

¹ It may happen that $i \leq r + e$ (a) and there is still excess supply on the currency market. This can arise because capital flows are a function of $i - (r + E(e))$ (b), where $E(e)$ is the expected rate of increase in the exchange rate. It can happen that $E(e) < e$ for fairly long periods, so that expression b is positive even when expression a subsequently proves to hold true. For example, this situation has been present in recent years in China, where the local interest rate is lower than the sum of the United States Federal Reserve interest rate and the rate of increase in the exchange rate (see McKinnon and Schnabl, 2006).

III

The sustainability condition

The central bank has international reserves as its only asset. In addition, it issues two liabilities, monetary base and sterilization bills yielding the local interest rate i . Thus, $P = B + L$, where P is the total stock of central bank liabilities, B the outstanding monetary base and L the stock of interest-bearing liabilities.

At interest rate i and exchange rate E there is an excess supply of international currency C in the currency market, which the central bank purchases. The increase in the bank's total liabilities is

$$dP = dB + dL = CE + iL \quad (1)$$

where CE is the peso value of flow C , while iL is the flow of interest the central bank has to pay on stock L of interest-bearing liabilities.

Let us suppose that $dP > dB$, so that $dL > 0$.

The increase in monetary base demand is

$$dB = B\beta(p + y) \quad (2)$$

where p is the inflation rate, y is the real GDP growth rate and β is the demand-elasticity of the monetary base to nominal GDP.

R is the central bank's stock of international reserves (in international currency) and $d(RE)$ is the increase in the peso value of these reserves. The international reserves yield r , the international interest rate. Therefore,

$$\begin{aligned} d(RE) &= R dE + E dR = \\ &= R dE + E(C + rR) = \\ &= R dE + EC + ErR \end{aligned} \quad (3)$$

The sustainability condition for the sterilization policy is defined as $dP \leq d(RE)$. This condition means that the sterilization policy is sustainable if the ratio between the central bank's total liabilities and the peso value of the international reserves $P/(RE)$ does not increase.

Substituting (1) and (3) into the sustainability condition gives:

$$\begin{aligned} CE + iL &\leq R dE + EC + ErR \\ iL &\leq R dE + ErR \end{aligned} \quad (4)$$

Dividing expression (4) by RE gives:

$$\begin{aligned} iL/RE &\leq e + ry \\ i &\leq (e + r) / (L/RE) \end{aligned} \quad (5)$$

The sterilization policy is sustainable when local interest rates are no higher than the second term of expression (5). We use the term $l_R = L/RE$ for the ratio between the stock of interest-bearing central bank liabilities and the local-currency value of the international reserves, and formulate the sustainability condition as

$$i \leq (e + r) / l_R \quad (6)$$

If $l_R < 1$, then the level of local interest rates at which the sterilization policy remains sustainable can be higher than $e + r$, and the lower the l_R ratio then the higher they can be. As was pointed out earlier, the operations of the central bank determine the local interest rate and the exchange rate at all times. The sustainability of these operations depends on the local and international rates, on l_R and on the trend of the exchange rate over time.

The maximum local interest rate at which the sterilization policy remains sustainable is $i_{max} = (r + e) / l_R$. Consequently, the degree of monetary autonomy is:

$$\begin{aligned} g &= i_{max} - (r + e) = \\ &= (r + e) (1 - l_R) / l_R \end{aligned}$$

The degree of monetary autonomy, i.e., the difference between the highest sustainable local rate and $r + e$, is thus expressed as a proportion of $r + e$. The lower l_R is, the higher the degree of autonomy.

The central bank's financial (quasi-fiscal) result²

The central bank financial result is $Cf \approx RE(r + e) - iL$. The condition of a non-negative financial result is

$$Cf \approx RE(r + e) - iL \geq 0 \quad (7)$$

Dividing by RE gives $Cf/RE \approx r + e - il_R \geq 0$, whence

² This point was suggested by Javier Okseniuk.

$$i \leq (e + r) / l_R = i_{max} \tag{8}$$

Expression (8) is the same as the sustainability condition (6) we derived earlier. That condition equates to the central bank having a non-negative financial result.

A numerical example using approximate data from Argentina in late

To illustrate the results presented, we shall now calculate the indicators using approximate data from the Argentine economy in late 2006.

Let us suppose that $r = 4\%$, $e = 3\%$, $i = 10\%$ and $l_R = 43\%$. In that case the highest rate consistent with

sustainability was: $i_{max} = (r + e) / l_R = 16.3\%$. What that means is that the sterilization policy was sustainable at interest rates of up to 16.3%. The actual rate was 10%, which was below the highest sustainable rate, so that the sterilization policy met the sustainability condition.

The degree of monetary autonomy with the parameters referred to is $g = i_{max} - (r + e) = 9.3\%$. The interest rate could exceed the sum of the international interest rate and the rate of increase in the exchange rate by 9.3 percentage points without rendering the sterilization policy unsustainable. With the parameters described, there is a wide margin of monetary autonomy.

IV

The dynamics of the sustainability condition

Given r and e , the sustainability condition (6) establishes at each point in time the range of interest rates that preserve the sustainability of sterilization as a function of l_R . The relationship can be seen in figure 1.

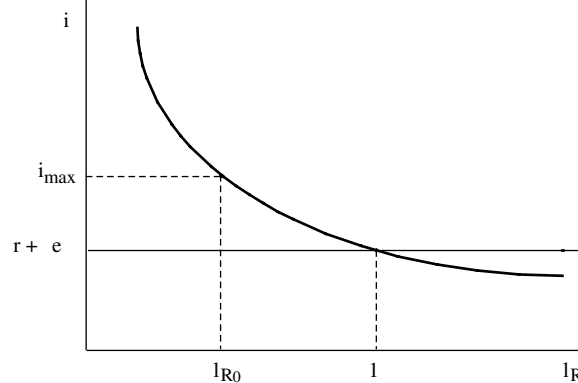
The curve illustrates the relationship between i_{max} and l_R . At time 0, the relationship between the stock of interest-bearing central bank liabilities and the value of reserves is l_{R0} and interest rates that preserve sustainability are those lower than i_{max} . The degree of monetary autonomy g at that time is measured by the distance between i_{max} and $r + e$ on the vertical axis.

The l_R ratio varies over time, altering the range of sustainable interest rates and the degree of monetary

autonomy. As l_R moves along the horizontal axis over time, the curve determines the movement of the maximum interest rate, of the range of sustainable rates and of the degree of autonomy on the vertical axis.

These considerations indicate that it would be advisable to analyse the trend of the sustainability condition to establish whether the highest interest rate consistent with a sustainable policy of sterilization tends to rise or fall over time. Or, what comes to the same thing, whether developments in the monetary variables and the currency market tend to increase or reduce the degree of monetary autonomy.

FIGURE 1



V

The permanence condition

For the purpose described, we define the permanence condition of the degree of monetary autonomy as:

$$d(L/R E) = dl_R \leq 0 \quad (9)$$

If the monetary and currency market variables meet condition (9), the highest sustainable interest rate and the degree of autonomy tend to remain stable or increase. If condition (9) is not met, the degree of autonomy tends to fall. We shall now express the permanence condition as a function of the monetary and currency market variables.

Equation (9) gives

$$d(L/R E) = [dL R E - L d(R E)] / (R E)^2 \leq 0 \quad (10)$$

Considering that $dL = dP - dB$ and substituting (1), (2) and (3) into (10), after some simplifications we get $C E + i L - B \beta (p + y) - L (C/R + r + e) \leq 0$.

It is convenient to regroup the terms so as to leave on the left-hand side of the expression only those that include C , which is the flow of central bank foreign-currency purchases: $C/(L/E) - C/R \leq r + e - i + (B/L) \beta (p + y)$. Considering that $l_R = (L/E)/R$ and regrouping, we get:

$$C/R \leq [l_R / (1 - l_R)] \{ (B/L) \beta (p + y) - [i - (r + e)] \} \quad (11)$$

Given the interest rate and the exchange-rate trend, both of which it determines, the central bank does not control the excess supply of international currency in the exchange market. The degree of autonomy remains if the variables referred to meet condition (11). In this expression, the permanence condition is formulated as a restriction on the ratio between the flow of foreign currency purchased by the central bank and the stock of international reserves. If the sustainability condition is to remain stable or the degree of monetary autonomy increase, the C/R ratio must not be higher than the right-hand term of expression (11). A larger flow of purchases means that the degree of autonomy tends to fall.

The right-hand side of expression (11) includes all variables relating to the monetary structure and dynamic of the economy. The restriction depends positively on

l_R , on the ratio between the outstanding monetary base and the stock of interest-bearing liabilities and on the rate of monetary base demand growth. The higher these variables, the more foreign exchange the central bank can purchase in the currency market without affecting the permanence of the sustainability condition. At the same time, the restriction depends negatively on the difference between the current local interest rate and $r + e$.

A further numerical example using approximate data from Argentina in late 2006

Let us suppose that in late 2006 $B/L = 1.75$, elasticity $\beta = 1$, $i = 10\%$, $r = 4\%$, $e = 3\%$, $l_R = 43\%$, international reserves $R = \text{US\$ } 31$ billion and the projected 2007 rate of growth in nominal GDP $(p + y) = 19\%$. The term $[l_R / (1 - l_R)] = 0.75$.

With these inputs, expression (11) yields the following permanence condition: $C/R \leq 22.7\%$.

The permanence of the degree of monetary autonomy in late 2006 required that the flow of dollar purchases not exceed 22.7% of reserves, i.e., some US\$ 7 billion a year. A larger flow of purchases would tend to reduce the maximum sustainable rate and the degree of monetary autonomy.

In fact, 2007 projections were for a flow of international currency purchases exceeding the maximum level that would preserve the degree of monetary autonomy. This is not too alarming as, given the other parameters, the consequent rise in l_R has a relatively small effect on the maximum sustainable interest rate and the degree of autonomy. In fact, dl_R can be calculated directly from equation (10) and the values of the parameters given. If it is assumed, for example, that $C/R = 40\%$, then l_R rises by 10 percentage points in a year (from 43% to 53%) and, given the other parameters, the maximum sustainable rate falls by 0.7% (from 16.3% to 15.6%).

At the same time, it is worth stressing the sensitivity of the maximum sustainable rate and the degree of autonomy to the trend of the exchange rate. For example, when $l_R = 43\%$, every percentage point increase (decrease) in the exchange rate increases (reduces) the maximum sustainable interest rate by $1\% / 0.43 = 2.33\%$. If the rate of increase in e is zero instead of 3% a year, the maximum interest rate falls by seven percentage points, from 16.3% to 9.3%.

VI

Two interesting cases

We shall now look at two interesting applications of the sustainability and permanence conditions derived above, illustrating the degree of monetary autonomy in different circumstances. In both cases monetary policy keeps the real exchange rate constant. In both, consequently, $e = p - p^*$, where p^* is the international inflation rate.

Case 1

In this case, the local inflation rate is the same as the international one, $p = p^*$, so that $e = 0$. Substituting into (6), the sustainability condition in this case comes out as: $i \leq r / l_R = i_{max}$. If $l_R < 1$, there is some degree of monetary autonomy even if the rate of variation in the exchange rate is nil.

The permanence condition in this case is:

$$C/R \leq [l_R / (1 - l_R)] [(B/L) \beta (p + y) - (i - r)] \quad (12)$$

The central bank can purchase international currency and retain its degree of monetary autonomy as long as the flow of purchases meets condition (12) and the expression is positive. That is: $(B/L) \beta (p + y) > (i - r)$. The condition states that the increase in monetary base demand (function of the inflation rate and the growth rate), in proportion to the stock of interest-bearing liabilities, must be greater than the difference between the local interest rate and the international rate.

There is nothing remarkable about this condition. To illustrate the point quantitatively, we assign arbitrary but plausible values to the parameters, in order to simplify the calculations. Let $l_R = 0.5$; $(B/L) = 1$ and $\beta = 1$. With the value of l_R referred to, the maximum sustainable rate is twice the international rate. With these parameters, the permanence condition is: $C/R \leq p + y - (i - r)$. Or to put it another way, $i - r \leq p + y - C/R$.

Let us suppose, for example, that the inflation rate is $p = p^* = 3\%$, the growth rate $y = 6\%$ and the international interest rate $r = 5\%$. With these figures the degree of autonomy is permanent, for example, when i exceeds r by no more than two percentage points while annual purchases by the central bank do not represent more than 7% of reserves. In this example, the maximum sustainable rate is $i_{max} = 10\%$. Larger purchases will

gradually reduce it but will not render the sterilization policy unsustainable in the short term.

Case 2

In this case, the inflation rate in the economy is higher than the international rate, $p > p^*$, so that $e = p - p^* > 0$. The central bank, meanwhile, applies an inflation targeting policy, using a truncated Taylor rule (not taking account of the gap between actual and potential output):

$$i = \gamma p \quad (13)$$

where $\gamma > 1$ is the parameter of the rule. Now we wish to determine the highest sustainable value of the policy parameter.

Substituting the exchange rate into expression (6), the sustainability condition of the sterilization policy is: $i \leq (r + p - p^*) / l_R = i_{max}$. Substituting (13) into this expression, we get: $\gamma p \leq (r + p - p^*) / l_R$, whence:

$$\gamma \leq [1 + (r - p^*) / p] / l_R \quad (14)$$

The right-hand term of expression (14) is the maximum value of the policy rule parameter that preserves the sustainability of the sterilization policy. The term in square brackets is 1 plus the ratio between the real international interest rate and the local inflation rate. If $l_R < 1$, values of γ well in excess of 1 are clearly sustainable.

Substituting the exchange rate into (11), the permanence condition comes out as: $C/R \leq [l_R / (1 - l_R)] \{ (B/L) \beta (p + y) - [i - (r + p - p^*)] \}$, and substituting the policy rule (13) and grouping gives:

$$C/R \leq [l_R / (1 - l_R)] \{ (B/L) \beta (p + y) - [(\gamma - 1) p - (r - p^*)] \} \quad (15)$$

The permanence of the sustainability condition holds provided that international currency purchases meet condition (15) and the expression is positive. In other words, $(B/L) \beta (p + y) > (\gamma - 1) p - (r - p^*)$. The condition states that the increase in monetary base demand as a proportion of the stock of interest-bearing liabilities must be greater than the difference between

the real local interest rate $(\gamma - 1)p$ and the real international interest rate.

As in the previous case, we attributed arbitrary but plausible values to the parameters to provide a simple quantitative illustration of the results. Let $l_R = 0.5$, $(B/L) = 1$ and $\beta = 1$. The permanence condition (15) then comes out as: $C/R \leq (p + y) - [(\gamma - 1)p - (r - p^*)]$.

Let us suppose, for example, that the international inflation rate is $p^* = 3\%$, the international interest rate $r = 5\%$, the local inflation rate $p = 10\%$, the growth rate $y = 6\%$ and the policy parameter $\gamma = 1.5$ (consequently, interest rate $i = 15\%$).

With these data, the maximum sustainable γ parameter is 2.4 and the permanence of the sustainability condition holds if annual purchases of international currency do not represent more than 13% of reserves. As can be seen, there is a high degree of autonomy and this is preserved in conditions that are by no means out of the ordinary.

It might be interesting to consider a numerical example with a lower growth rate (implying a lower

rate of growth in monetary base demand) and a severer anti-inflation policy (implying a greater financial cost for sterilization), similar to those seen in Brazil in recent years. Suppose the growth rate $y = 3\%$ and the policy parameter $\gamma = 2$. In this numerical example the sterilization policy is also sustainable, but the degree of autonomy is preserved only when annual purchases by the central bank do not exceed 5% of reserves. It must be emphasized once again, however, that larger purchases do not mean that the sterilization policy is rendered rapidly unsustainable, but that the degree of autonomy is reduced gradually. If annual purchases by the central bank are higher than the figures given, once the expansion of the bank's interest-bearing liabilities cancels out the difference between the maximum sustainable parameter and the parameter actually applied, the central bank must opt either to abandon the policy rule, which is becoming unsustainable, or to leave the real exchange rate to appreciate. In this example, the problem of sustainability arises because the growth rate is very low and the interest rate very high.

(Original Spanish)

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