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EXCHANGE RATE MANAGEMENT AND THE RISK PREMIUM

by

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I am grateful for useful comments and suggestions by Paul de Grauwe and Francesco Giavazzi. The usual disclaimer applies.

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ABSTRACT

This article uses a standard small country portfolio balance model of exchange rates under the assumption of perfect foresight to examine the differing effects of foreign exchange market operations (sterilised and non sterilised) and domestic money market operations on the exchange rate and domestic interest rate. It is shown that the operations have differing effects because of their different impacts on the risk premium. An expression for the change in the risk premium is endogenously derived from the model structure. A distinction is made between the direct effect of an operation on the risk premium due to the change in relative asset supplies and the indirect effect due to the change in the exchange rate induced by the change in relative asset supplies. The net effect on the risk premium in the case of all three operations is shown to be ambiguous.

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Exchange Rate Management and the Risk Premium

1. Introduction

Exchange rate management involves the conscious use of policy instruments by the authorities to influence the exchange rate in their desired direction. The problem facing the authorities is that they have a number of alternative policy instruments with which to attempt to manage the exchange rate. More specifically, there are three commonly employed instruments that a country can use to influence its exchange rate: An Open Market Operation (OMO) defined as an increase or decrease in the domestic monetary base brought about via a purchase or sale of domestic bonds. A Foreign Exchange Operation (FXO) defined as an increase or decrease in the domestic monetary base brought about via a purchase or sale of foreign currency denominated assets. A Sterilised Foreign Exchange Operation (SFXO) which involves the authorities offsetting the monetary base implications of a purchase or sale of foreign assets via a sale or purchase of domestic bonds. Distinguishing between OMO's FXO's and SFXO's is clearly important for policy makers who have available these three alternative instruments for managing the exchange rate.

In the monetary models of exchange rate determination be they of the "sticky price" Dornbusch (1976), Frankel (1979) type or the all prices "fully flexible" Frenkel (1976), Mussa (1976), Bilson (1978) type, the authorities can only influence the exchange rate by altering the supply of money in relation to the demand for money. In the monetary models domestic and foreign bonds are assumed to be perfect substitutes, hence, there is no difference in the exchange rate effects between an OMO and FXO that change the money stock by equivalent amounts. The monetary models by assuming perfect substitutability invoke the assumption of uncovered interest rate parity, that is:

$$r - rf = E\dot{s}$$

Where: r = nominal domestic interest rate.
rf = nominal foreign interest rate.
$E\dot{s}$ = expected rate of depreciation of the domestic currency

In the monetary models of exchange rate determination since a SFXO does not alter the relative money stocks it cannot have any exchange rate effects. A SFXO is an exchange of domestic for foreign bonds which are assumed by the monetary models to be perfect substitutes it follows that a SFXO cannot exert any exchange rate effects.

The portfolio balance model of exchange rate determination was originally developed by Branson (1976) and Kouri (1976) and later extended by Girton and Henderson (1977), Obstfeld (1980), Allen and Kenen (1980), Branson (1977, 1984), Kouri (1983) and Frankel (1983 and 1984). In the portfolio balance approach the authorities can break up the uncovered interest parity condition by influencing a so called risk premium:

$$r - rf = E\dot{s} + RP$$

Where the risk premium depends for its existence upon the fulfillment of all three of the following conditions (see Frankel 1979b and 1986) Firstly, there are differences in the perceived risks between domestic and foreign bonds - the essence of a risky asset being that its expected real rate of return is uncertain. If there are no perceived differences in risks then with perfect capital mobility they must be perfect substitutes. Secondly, there has to be risk aversion on the part of economic agents to the perceived differences in risk - the principle of risk aversion is that investors will only be prepared to take on increased risk if there is a sufficient increase in expected real returns to compensate. Finally, there must be a difference between the risk minimizing portfolio and the actual portfolio forced at market clearing prices into the investors portfolios. If all three of these conditions are fulfilled then the uncovered interest parity condition will not hold due to the existence of a risk premium which represents the compensation required by private agents for accepting risk exposure above the minimum possible.

The attractiveness of the portfolio balance approach is threefold: (i) it allows for different relative asset supplies other than money to influence the exchange rate and hence OMO's, FXO's and SFXO's which alter relative asset supplies in different ways have differing exchange rate and interest rate effects (ii) it introduces a role for the current account to influence the exchange rate because a current account surplus represents an accumulation of foreign assets by domestic residents (iii) it can admit the monetary model as a special case of perfect substitutability between domestic and foreign bonds.

In this paper, a standard small country portfolio balance model under the assumption of perfect foresight is used to examine the differing exchange rate and interest rate implications of FXO's, OMO's and SFXO's. The model outlined follows the portfolio balance specification as developed by William Branson (1976, 1977 and 1984). The contribution of the paper is that it is shown that the different exchange rate and interest effects of the three operations are due to the risk premium an expression for which is endogenously derived from the model structure. The only other paper to derive such an expression for the risk premium from the portfolio balance model is contained in Dooley and Isard (1983) but they derive their expression with static exchange rate expectations so that the expected exchange rate component of the risk premium is not explicitly dealt with. This paper deals explicitly with both the interest rate and exchange rate component of the risk premium. The incorporation of the exchange rate effect on the risk premium is shown to be important when evaluating the impact of the operations on the risk premium.

The paper is set out as follows: Section two sketches the model, derives the two schedules crucial to the dynamics of the model and examines the conditions necessary for stability. Section three analyses the differing exchange rate effects of the operations. Section four examines the effects of the three operations on the risk premium. The final section points to the limitations of the portfolio balance model and extensions for future research.

2. The Model

There are assumed to be three assets that are held in the portfolios of the private agents and the authorities: Domestic monetary base, M. Domestic bonds denominated only in the domestic currency, B. Foreign bonds denominated only in the foreign currency, F.

Domestic bonds may be held by either domestic agents or the authorities. Thus, we may denote the net supply of domestic bonds which is assumed to be fixed [1] as:

$$\bar{B} = Bp + Ba \quad (1)$$

Where: $\bar{B}$ is the fixed net supply of domestic bonds
Bp is the domestic bond holdings of private agents
Ba is the domestic bond holdings of the authorities

Similarly, the country's net holding of foreign bonds is held by private agents and the authorities which we assume in our analysis to be positive in both cases and equal to the summation of previous current account surpluses [2]. Unlike the stock of domestic bonds the holdings of foreign assets may be increased or decreased over time via a current account surplus or deficit. Thus, we have:

$$F = Fp + Fa \quad (2)$$

Where: F is the net holdings of foreign bonds by the country
Fp is the foreign bond holdings of private agents
Fa is the stock of foreign bonds held by the authorities

The domestic monetary base liability of the authorities is equivalent to their assets so that:

$$M = Ba + sFa \quad (3)$$

Where s is the exchange rate defined as domestic currency units per unit of foreign currency.

For simplicity it is assumed that capital gains or losses to the authorities as a result of exchange rate changes do not affect the monetary base.

Total private financial wealth [3] at any point in time is given by the identity:

$$W = M + Bp + sFp \quad (4)$$

The demand to hold money by the private sector is inversely related to the domestic interest rate, inversely related to the expected rate of return on foreign bonds and positively to domestic income. This yields:

$$M = m(r, rf+\dot{s}, Y, W) \qquad m_r<0,\ m_{\dot{s}}<0,\ m_Y>0 \text{ and } m_W>0 \qquad (5)$$

Where: r = domestic nominal interest rate
rf = fixed foreign interest rate
$\dot{s}$ = expected/actual rate of depreciation of the domestic currency
Y = domestic nominal income
$m_r, m_{\dot{s}}, m_Y$ and m_W are partial derivatives

The demand to hold domestic bonds as a proportion of private wealth is positively related to the domestic interest rate, inversely related to the expected rate of return on foreign assets and inversely related to domestic nominal income. This yields:

$$Bp = b(r, rf+\dot{s}, Y, W) \qquad b_r>0,\ b_{\dot{s}}<0,\ b_Y<0 \text{ and } b_W>0 \qquad (6)$$

Where: b_r, $b_{\dot{s}}$, b_Y and b_W are partial derivatives.

The demand to hold foreign bonds as a proportion of total wealth is inversely related to the domestic interest rate, positively related to the expected rate of return from holding foreign bonds and inversely related to domestic nominal income. This yields:

$$sFp = f(r, rf+\dot{s}, Y, W) \quad f_r<0,\ f_{\dot{s}}>0,\ f_y<0 \text{ and } f_w>0 \qquad (7)$$

Where: f_r, $f_{\dot{s}}$, f_y and f_w are partial derivatives.

The balance sheet constraint is given by the identity:

$m_w + b_w + f_w = 1$ Balance Sheet Constraint

The balance sheet identity is coupled with the assumption that assets are gross substitutes implying the following constraints on the partial derivatives:

$$m_r + b_r + f_r = 0$$

$$m_{\dot{s}} + b_{\dot{s}} + f_{\dot{s}} = 0$$

The current account balance is crucial to the dynamics of the system because the current account surplus gives the rate of accumulation of foreign assets. That is:

$$C = \frac{dFp}{dt} = \dot{F}p = T + rf\,(Fp + Fa) \qquad (8)$$

Where: C = current account surplus
T = the trade balance in foreign currency

The current account is made up of two components: the revenue from net exports (the trade balance) and interest rate receipts from net holdings of foreign assets. One of the long run stationary state equilibrium conditions in this zero growth model is that the current account balance is zero.

Net exports are assumed to be a positive function of the real exchange rate

$T = T(s/Pd)$ $Ts>0$ (9)

Where: Pd is the domestic price level
Ts is the partial derivative

The assumption that net exports are a positive function of the real exchange rate is quite strong because it rules out the well known possibility that there may be an initial J-curve effect on the trade balance, the assumption implies that the Marshall-Lerner condition always holds.

It is assumed that foreign exchange market participants form their expectations rationally and in fact possess perfect foresight with respect to the exchange rate. This assumption means that we can interchange the expected rate of depreciation with the actual rate (ie $E\dot{s} = \dot{s}$).

We can by taking two equations from (5) to (7) and substituting the wealth definition from equation (4) and utilising the assumption of perfect foresight derive $\dot{s} = 0$ and $\dot{F}p = 0$ schedules as functions of M, B and sFp. The resulting $\dot{s}=0$ and $\dot{F}p=0$ equations can then be represented on a phase diagram in the s, Fp plane.

The $\dot{s}$ = 0 Schedule

In appendix 1 it is shown that by simultaneously solving the domestic money market equation (5) with the foreign asset market equation (7) the $\dot{s} = 0$ schedule has a negative slope in the s, Fp plane given by the expression:

$$\left.\frac{ds}{dFp}\right|_{\dot{s}=0} = \frac{-s}{Fp}$$

Since the elasticity of the $\dot{s}=0$ schedule is given by the expression Fpds/sdFp = -1, the $\dot{s}=0$ schedule must be a rectangular hyperbola in the s, Fp plane.

The $\dot{F}p$ = 0 Schedule

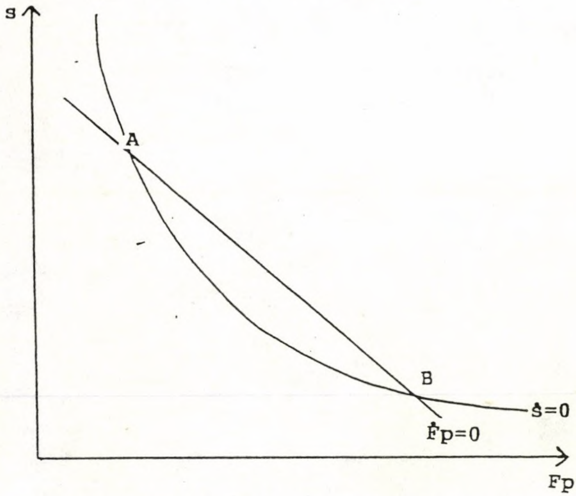
In appendix 1, it is shown that by taking equation (8) the $\dot{F}p = 0$ schedule has a negative slope in the s, Fp plane given by:

$$\left.\frac{ds}{dFp}\right|_{\dot{F}p=0} = \frac{-rf}{Ts}$$

Equilibrium and Stability of the Model

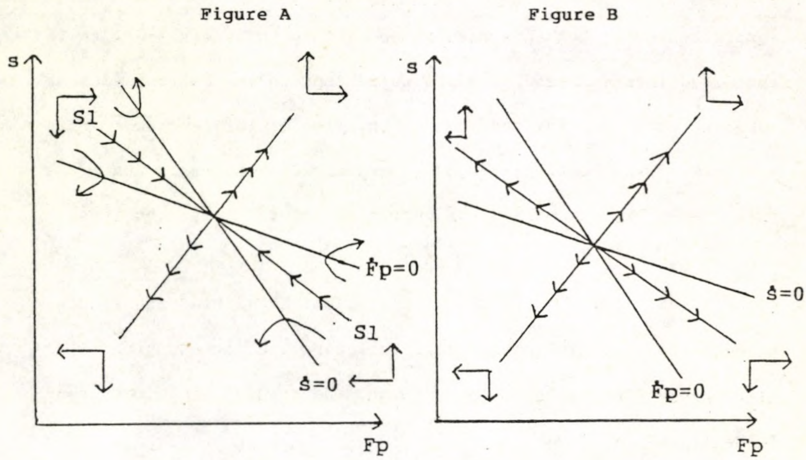
The model is in equilibrium when the $\dot{F}p = 0$ schedule intersects the $\dot{s} = 0$ schedule. Since the $\dot{s} = 0$ schedule is a rectangular hyperbola and the $\dot{F}p = 0$ schedule has a negative slope the model has two possible equilibrium solutions as depicted below:

Figure 1: Equilibrium of the Model



The fact that the model has two possible equilibrium solution is disturbing because as we see below only the linear approximation around point A has a unique saddle path leading to equilibrium.

Figure 2: Linear Approximation of the Model



As we can see from the phase diagrams only around point A is there a unique saddle path S1S1 leading to equilibrium under the assumption of perfect foresight, at point B all paths lead away from equilibrium [4]. The condition for the model to exhibit a unique saddle path leading to equilibrium is that the $\dot{s}$ schedule is steeper than the $\dot{F}p$ schedule. The slope of the $\dot{s}$ schedule is given by -s/Fp and the slope of the $\dot{F}p$ schedule is given by the term -rf/Ts, thus the condition for a saddle path equilibrium is that s Ts > rf Fp. This condition is assumed to hold in what follows to ensure an economic analysis that tends to equilibrium. This stability condition is formally proven in appendix two.

The economic reasoning behind the necessary stability condition is easy to follow: When there is a current account surplus there will be an appreciation of the exchange rate and with it a fall in net exports. However, the current account surplus also implies an accumulation of foreign assets and with it increased interest rate receipts which improve the current account surplus. Consequently, for the appreciation of the exchange rate to reduce the current account surplus it is necessary that the fall in net exports exceed the increased interest rate receipts.

In addition, since there is only a unique saddle path leading to equilibrium it is assumed that following the introduction of a disturbance the economy jumps onto the unique saddle path that leads to equilibrium.

3. The Effects of FXO's OMO's and SFXO's.

With an expansionary FXO, the authorities purchase foreign bonds from the private sector with newly created monetary base, that is, dM = -sdFp = sdFa. There will be an upward shift of the $\dot{s} = 0$ schedule given by the expression:

$$\left.\frac{ds}{dM}\right|_{\dot{s}=0} = \frac{[f_r + m_r]}{[f_r m_w + m_r - m_r f_w]Fp}$$

With an expansionary OMO, the authorities increase the private sectors holdings of money and decrease their holdings of domestic bonds by an equivalent amount, that is, dM = - dBp = dBa. In this case, there is again an upwards shift of the $\dot{s}$ schedule given by the expression:

$$\left.\frac{ds}{dM}\right|_{\dot{s}=0} = \frac{f_r}{[f_r m_w + m_r - m_r f_w]Fp}$$

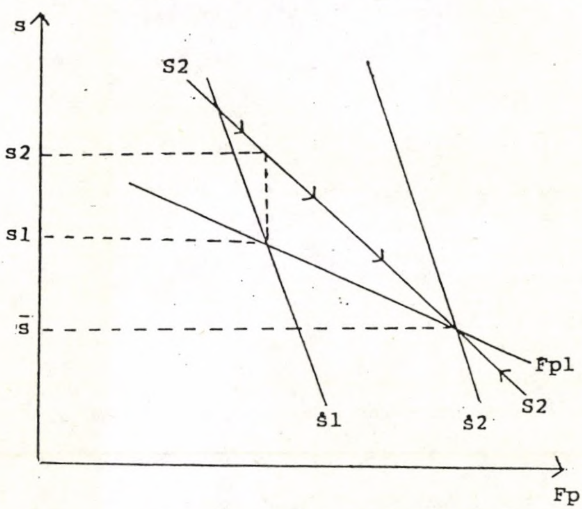
With a sterilised intervention in the foreign exchange market there is a purchase of foreign assets with domestic money base and the an equivalent sale of domestic bonds so as to leave the money base unchanged that is, $-sdFp = dBp$, it is tantermount to the authorities altering the currency composition of bonds held in private portfolios. In this case there will be an upward shift of the $\dot{s}$ schedule given by the expression:

$$\left.\frac{ds}{dBp}\right|_{\dot{s}=0} = \frac{m_r}{[f_r m_w + m_r - m_r f_w]Fp}$$

Which upon observation is seen to be simply the expression for an FXO less an OMO.

The effect of the upward shift of the $\dot{s}$ schedule is illustrated below:

Figure 3: The Effects of a Shift in the $\dot{s}$ Schedule.



Following an operation of whatever sort, there is an upward shift of the $\dot{s}$ schedule. There is a jump depreciation of the exchange rate onto the new saddle path S2S2 from s1 to s2. The jump depreciation is required to restore instantaneous asset market equilibrium to asset holders portfolios since an operation of whatever sort creates an excess demand for foreign assets that can only be satisfied in the short run by a depreciation of the domestic currency.

The initial depreciation implies that there is a depreciation of the real exchange rate. The result is that the current account moves into surplus, the surplus leads to increased private sector holdings of foreign assets which in turn results in an increased demand for domestic assets with a resulting appreciation of the domestic currency. The economy thus moves along the saddle path S2S2 until new long run equilibrium is reached at exchange rate $\bar{s}$. During the transition to long run equilibrium the economy experiences a current account surplus and an appreciating currency, Kouri (1983) labels such a link between the current account and the exchange rate as the "acceleration hypothesis."

One of the features of the model is that it is long run non neutral with respect to the real exchange rate. This is because the current account surplus that follows an operation results in an accumulation of foreign assets and an accompanying increase in the contribution of interest rate receipts from the holding of foreign assets on the service component of the current account. As such, it is necessary for the real exchange rate to have appreciated in the long run equilibrium so that there is a deterioration of the trade account to offset the improvement in the service account to ensure that the current account is restored to balance in the long run [5].

From the expressions for the upward shift of the $\dot{s}$ schedule we can see that the shift is greater in the case of an FXO, this implies that the saddle path following an FXO lies above that following an OMO so that the initial jump in the exchange rate is greater following an FXO than in the case of an OMO. The economic reasoning for this result is that an FXO leads to a initial fall in private agents holdings of foreign assets while an OMO does not, consequently an FXO creates an even greater excess demand for foreign bonds than an OMO, requiring that the initial jump in the exchange rate has to be greater than for an OMO. Only when domestic and foreign bonds are perfect substitutes so that $-f_r \rightarrow \infty$ do the effects of an OMO and FXO on the initial jump in the exchange rate become identical.

In the case of a SFXO, it is seen that the operation has a relatively weaker effect on the nominal exchange rate than a FXO because the shift of the $\dot{s}$ schedule is less than in the case of an FXO. This ensures that the new saddle path following a SFXO must lie below that of a FXO which guarantees that the initial jump in the exchange rate is less than that which follows a FXO. As such, a SFXO is a relatively ineffective means of influencing the exchange rate. In the limiting case where domestic and foreign bonds are perfect substitutes ($b_r = -f_r \rightarrow \infty$) a SFXO will have no exchange rate effects.

4. Analysing the Effects on the Risk Premium

The essential difference between the monetarist approach to exchange rate determination and the portfolio balance approach is that the latter breaks up the uncovered interest rate parity condition by introducing a risk premium. That is:

$$r - rf = E\dot{s} + RP$$

Where: RP is the risk premium on the domestic currency assets.

It therefore follows that under the assumption of perfect foresight ($E\dot{s} = \dot{s}$) that:

$$dr - drf = d\dot{s} + dRP$$

Since in the model the foreign interest rate is assumed to be fixed (drf=0), I can rearrange the above to yield:

$$dRP = dr - d\dot{s}$$

Around the neighbourhood of the stationary equilibrium $d\dot{s} = \dot{s}$ and appendix one derives an expression for dr. This means that it is possible to derive from the structure of the portfolio balance model itself an expression for the change in the risk premium which is reported below:

$$dRP = \frac{\begin{aligned} &[-m_{\dot{s}} b_w - b_{\dot{s}} + b_{\dot{s}} m_w] \, dM \\ &+ [m_{\dot{s}} - m_{\dot{s}} b_w + b_{\dot{s}} m_w] \, dB \\ &+ [-m_{\dot{s}} b_w + b_{\dot{s}} m_w] s \, dFp \\ &+ [-m_{\dot{s}} b_w + b_{\dot{s}} m_w] Fp \, ds \end{aligned}}{[m_{\dot{s}} b_r - b_{\dot{s}} m_r]} + \frac{\begin{aligned} &[f_r - f_r m_w + m_r f_w] \, dM \\ &+ [-f_r m_w + m_r f_w] \, dB \\ &+ [-f_r m_w - m_r + m_r f_w] e \, dFp \\ &+ [-f_r m_w - m_r + m_r f_w] Fp \, ds \end{aligned}}{[f_{\dot{s}} m_r - f_r m_{\dot{s}}]}$$

Following an OMO the effect on the risk premium is given by:

$$dRPomo = \frac{[- b_{\dot{s}} - m_{\dot{s}}]\ dM + [-m_{\dot{s}}\ b_w + b_{\dot{s}}\ m_w]Fp\ ds}{[m_{\dot{s}}\ b_r - b_{\dot{s}}\ m_r]} + \frac{[f_r]\ dM + [-f_r\ m_w - m_r + m_r\ f_w]Fp\ ds}{[f_{\dot{s}}\ m_r - f_r\ m_{\dot{s}}]}$$

Following an FXO the effect on the risk premium is given by:

$$dRPfxo = \frac{[-b_{\dot{s}}]\ dM + [-m_{\dot{s}}\ b_w + b_{\dot{s}}\ m_w]Fp\ ds}{[m_{\dot{s}}\ b_r - b_{\dot{s}}\ m_r]} + \frac{[f_r + m_r]\ dM + [-f_r\ m_r - m_r + m_r\ f_w]Fp\ ds}{[f_{\dot{s}}\ m_r - f_r\ m_{\dot{s}}]}$$

Following an SFXO the effect on the risk premium is given by:

$$dRPsfxo = \frac{[m_{\dot{s}}]\ dB + [-m_{\dot{s}}\ b_w + b_{\dot{s}}\ m_r]Fp\ ds}{[m_{\dot{s}}\ b_r - b_{\dot{s}}\ m_r]} + \frac{[m_r]\ dB + [-f_r\ m_w - m_r + m_r\ f_w]Fp\ ds}{[f_{\dot{s}}\ m_r - f_r\ m_{\dot{s}}]}$$

These results for the various operations are summarised in the table below. In so doing, I distinguish between the direct effect of the operation on the risk premium and the indirect effect. The direct effect results from the change in relative asset supplies and the indirect effect results from the change in the exchange rate induced by the change in relative asset supplies. Both the domestic interest rate and change in the expected depreciation of the currency may be divided up into direct and indirect effects.

Effects on the Risk Premium

Type of operation	dr D	dr I	dr N	$-d\dot{s}$ D	$-d\dot{s}$ I	$-d\dot{s}$ N	dRP D	dRP I	dRP N
OMO dM = - dBp	-	-	-	+	-	+	?	-	?
FXO dM = -sdFp	-	-	-	+	-	+	?	-	?
SFXO dBp= -sdFp	+	-	?	+	-	+	+	-	?

D - direct effect [dM, dB, dFp] I - indirect effect [Fp ds] N - net effect (D+I)

Some explanation of the results reported above is necessary: In the case of an OMO and FXO the direct effect of the increase in the money supply is to depress the domestic interest rate, this effect is more pronounced in the case of an OMO because the operation reduces private agents holdings of domestic bonds. In the case of an SFXO, however, the direct effect is to raise the domestic interest rate, this is because the operation increases private agents holdings of domestic bonds relative to the other two assets. In all three cases, the indirect effect on the domestic interest rate is negative as the depreciation increases private agents wealth leading to an increased demand for domestic bonds [6].

With regard to the exchange rate effect, the direct effect of the operations is to lead to an expected appreciation of the currency as the operations increase the relative holdings of domestic assets or in the case of an OMO the proportion of non interest earning money to bonds. The indirect effect of the depreciation, however, works in the opposite direction because the depreciation has the effect of of increasing relative holdings of foreign assets requiring an expected depreciation of the domestic currency. We know, however, that if the economy jumps onto the unique stable saddle path the former effect outweighs the latter so that there is an expected appreciation of the domestic currency.

As can be seen, unless we impose constraints upon the various parameters, it is not possible to evaluate the net effect on the risk premium of the various operations. The source of the ambiguity derives from the fact that the depreciation following an operation of whatever sort revalues private holdings of foreign bonds and with it raises domestic wealth which leaves it unclear whether or not the stock of domestic bonds and money rise or fall as a proportion of wealth. That is:

$$RP = RP\ (M/W,\ Bp/W) \quad RP1>0 \quad RP2>0.$$

In the case of an OMO it is clear the ratio Bp/W declines, however, it is unclear what happens to the M/W ratio. With an FXO while the ratio Bp/W falls it is unclear whether the ratio M/W rises or falls. While in the case of an SFXO it is unclear whether the ratio Bp/W rises or falls while the M/W ratio falls.

The above explanation may help account for the difficulty that some authors such as Frankel (1982) and Rogoff (1984) have had in explaining the empirical behaviour of the risk premium in terms of only relative asset supplies. This is because the risk premium may rise or fall following an operation of whatever sort to manage the exchange rate due to the exchange rate effect induced by the change in relative asset supplies.

5. Conclusions

In this paper, I have argued that the distinguishing feature of the portfolio balance model is that it breaks up the uncovered interest rate parity condition by the introduction of a risk premium. I have derived from the model structure itself an equation for the change in the risk premium. This contribution is of significance for two reasons: Firstly, the change in the risk premium is affected by changes in all the asset supplies depicted in the model including the domestic money supply, this suggests that existing research which typically analyses the risk premium in relation to only two assets - domestic and foreign bonds, needs to be extended to explicitly include changes in the money stock. Secondly, due to the wealth effects resulting from a change in the exchange rate induced by changes in relative asset supplies, it is not possible to identify unambiguous effects on the risk premium. Whatever, one cannot analyse exchange rate management without analysing the risk premium.

One fairly strong conclusion that emerges from the portfolio balance model is that a given change in the money stock has a more powerful effect on the exchange rate when carried out by a purchase of foreign assets than when achieved via a purchase of domestic assets. It is only in the limiting case when domestic and foreign bonds are perfect substitutes that the effects become identical. This is an important result because it at least provides a rationale for the observed interventions of authorities in foreign exchange markets. Another clear result that follows is that it is only by assuming that domestic and foreign bonds are imperfect substitutes that a SFXO can exert exchange rate effects through a portfolio balance channel. It has been shown that a SFXO will have a relatively weaker effect on the exchange rate than an FXO.

Since the risk premium is a function of perceived risks the portfolio balance model may be subject to the Lucas critique. The portfolio balance model as we have seen assumes that the domestic authorities can manipulate the risk premium by changing relative asset supplies and that this gives them the scope to pursue an SFXO. However, it may be the case that the operation itself alters the level of perceived risks in an unpredictable fashion so that an operation that was intended to reduce the risk premium ends up increasing it leading to a reversal of the results of the model. Clearly, how the various operations affect risk perceptions is an area that merits closer attention.

Footnotes

[1] In order to assume that the supply is fixed it is necessary to assume in the following analysis that the budget is continuously balanced. For an excellent analysis of the Portfolio balance model with budget deficits see Penati (1986).

[2] It has been suggested by some authors that a negative net foreign asset position may imply instability in portfolio balance models. However, as Branson and Henderson (1985) demonstrate this is not the case if one utilises the assumption of rational expectations in the foreign exchange market. The instability problem can arise only if one assumes non rational expectations such as static or regressive expectation mechanisms.

[3] The portfolio balance model makes the assumption that both domestic and foreign bonds are regarded as net wealth by private agents. However, Barro (1974) argues that since private agents realise that a government financed bond deficit will mean increased future tax liabilities then private agents do not regard bonds as net wealth.

[4] The fact that there is is only a single saddle path that leads to equilibrium is a typical feature of rational expectations models.

[5] Claassen (1983) derives a similar result in a quantity theoretical two country comparative static model. Following a monetary expansion the current account of the expanding country goes into surplus due to the real depreciation of its currency. In the final equilibrium it is necessary for there to be a deterioration of the trade account of the country so as to offset the improved interest rate receipts from the holdings of foreign assets. This deterioration is brought about via a real appreciation of the domestic currency and the wealth effect of the accumulation of foreign assets on import expenditure.

[6] The effect of an increase in private agents wealth is shown in appendix one to be ambiguous. The ambiguity arises from the fact that an increase in foreign bond holdings leads to an increased demand for both domestic money and bonds and the domestic interest rate will have to adjust to satisfy the relative demands in these two markets. In the analysis the domestic interest rate is assumed to fall as agents demand relatively more bonds than money in response to the increase in wealth.

Appendix 1: Solving for $\dot{s} = 0$, $\dot{F}p = 0$ and dr.

The $\dot{s} = 0$ schedule

Taking the total differential of equation (5) and using the fact that in the neighbourhood of the stationary state $d\dot{s}=\dot{s}$ (Branson and Henderson 1985 p.760) yields:

$$dM = m_r \, dr + m_{\dot{s}} \, \dot{s} + m_w \, dW \quad (10)$$

Taking the total differential of equation (7) yields:

$$dsFp = f_r \, dr + f_{\dot{s}} \, \dot{s} + f_w \, dW \quad (11)$$

From equation (10) $dr = \dfrac{dM - m_{\dot{s}} \, \dot{s} - m_w \, dW}{m_r}$

From equation (11) $dr = \dfrac{dsFp - f_{\dot{s}} \, \dot{s} - f_w \, dW}{f_r}$

So that $\dfrac{dM - m_{\dot{s}} \, \dot{s} - m_w \, dW}{m_r} = \dfrac{dsFp - f_{\dot{s}} \, \dot{s} - f_w \, dW}{f_r}$

Multiplying through both sides by $(f_r \, m_r)$, and using the fact that

$dW = dM + dB + dsFp$ and $dsFp = Fp \, ds + s \, dFp$ and rearranging, I

obtain:

$$\dot{s} = \frac{\begin{aligned} &[-f_r + f_r m_w - m_r f_w] \; dM \\ + &[f_r m_w - m_r f_w] \; dB \\ + &[f_r m_w + m_r - m_r f_w]s \; dFp \\ + &[f_r m_w + m_r - m_r f_w]Fp \; ds \end{aligned}}{[f_{\dot{s}} m_r - f_r m_{\dot{s}}]} \quad (12)$$

The $\dot{F}p$ = 0 Schedule

In the analysis it is assumed that $\dot{F}a = 0$ so by taking the total differential of equation (8) and using the fact that in the neighbourhood of the stationary state $d\dot{F}p = \dot{F}p$, I obtain:

$$\dot{F}p = Ts\, ds + rf\, dFp \qquad (13)$$

Solving for the Domestic Interest Rate

The domestic interest rate has to adjust to clear the domestic money and bonds market. Taking the total differential of equation (5) yields:

$$dM = m_r\, dr + m_{\dot{s}}\, \dot{s} + m_w\, dW$$

Taking the total differential of equation (6) yields

$$dB = b_r\, dr + b_{\dot{s}}\, \dot{s} + b_w\, dW$$

Thus

$$\frac{dM - m_r\, dr - m_w\, dW}{m_{\dot{s}}} = \dot{s} \quad \text{and} \quad \frac{dB - b_r\, dr - m_w\, dW}{b_{\dot{s}}} = \dot{s}$$

So that
$$\frac{dM - m_r\, dr - m_w\, dW}{m_{\dot{s}}} = \frac{dB - b_r\, dr - b_w\, dW}{b_{\dot{s}}}$$

Multiplying through by ($m_{\dot{s}}\, b_{\dot{s}}$), splitting up the expression dW and rearranging yields:

$$dr = \frac{\begin{aligned} &[-m_{\dot{s}}\, b_w - b_{\dot{s}} + b_{\dot{s}}\, m_w] \quad dM \\ + &[m_{\dot{s}} - m_{\dot{s}}\, b_w + b_{\dot{s}}\, m_w] \quad dB \\ + &[-m_{\dot{s}}\, b_w + b_{\dot{s}}\, m_w]s \quad dFp \\ + &[-m_{\dot{s}}\, b_w + b_{\dot{s}}\, m_w]Fp\ ds \end{aligned}}{[m_{\dot{s}}\, b_r - b_{\dot{s}}\, m_r]}$$

From the above expression, it is evident that an increase in the money stock depresses the domestic interest rate and an increase in the supply of domestic bonds held by private agents requires a rise in the domestic interest rate. The wealth effect of an increase in wealth either via an increased private holdings of foreign bonds or a depreciation of the exchange rate is ambiguous, In the analysis, I assume that $|-m_{\dot{s}} \; b_w|>|b_{\dot{s}} \; m_w|$, so that an increase in wealth by raising the demand for domestic bonds depresses the domestic interest rate.

Appendix Two:

Eigenvalues, Stability, Initial Conditions and Rates of Change

In this appendix, I derive the eigenvalues of the system, conditions necessary for stability, the initial conditions and expressions for the expected rates of change of the exchange rate and rate of accumulation of foreign assets during the transition to the steady state.

The two dynamic variables linearised around the steady state are expressed in matrix form as:

$$\begin{bmatrix} \dot{s} \\ \dot{F}p \end{bmatrix} \quad \begin{bmatrix} \dfrac{[f_r m_w + m_r - m_r f_w]Fp}{[f_{\dot{s}} m_r - f_r m_{\dot{s}}]} & \dfrac{[f_r m_w + m_r - m_r f_w]s}{[f_{\dot{s}} m_r - f_r m_{\dot{s}}]} \\ Ts & rf \end{bmatrix} \begin{bmatrix} s - \bar{s} \\ Fp - \bar{F}p \end{bmatrix}$$

As is well known, the roots of the above matrix can be found by using the trace and determinant. The two roots are given by:

$$\lambda_1, \lambda_2 = \frac{Fp\ X + rf \pm \sqrt{[Fp\ X + rf]^2 - 4[Fp\ X\ rf - s\ X\ Ts]}}{2}$$

Where: $X = \dfrac{[f_r m_w + m_r - m_r f_w]}{[f_{\dot{s}} m_r - f_r m_{\dot{s}}]} > 0$

Thus, providing that s Ts > rf Fp the above system will produce a saddle point equilibrium with one negative and one positive characteristic root given by λ_1 and λ_2 respectively.

Time Paths

The general solution for the time path of the two variables is given by:

$$s(t) = c_o A e^{\lambda_1 t} + c_1 B e^{\lambda_2 t} + \bar{s}.$$

$$Fp(t) = c_o e^{\lambda_1 t} + c_1 e^{\lambda_2 t} + \bar{Fp}.$$

Where: e is the natural number 2.718...
c_o and c_1 are determined by the initial conditions.
$\begin{bmatrix} A \\ 1 \end{bmatrix}$ and $\begin{bmatrix} B \\ 1 \end{bmatrix}$ are the eigenvectors.
λ_1 and λ_2 are the negative and positive characteristic roots respectively.

Initial Conditions

At time t = 0

$$(s - \bar{s}) = c_o A$$

$$(Fp - \bar{Fp}) = c_o$$

Therefore A gives the slope of the saddle path.

At the steady state, we know $\dot{s} = \dot{Fp} = 0$. Only the negative characteristic root produces a unique path leading to equilibrium so we have to set $c_1=0$. Next, we find the value of the eigenvalue A.

$$\begin{bmatrix} Fp\,X - \lambda_1 & s\,X \\ Ts & rf - \lambda_1 \end{bmatrix} \begin{bmatrix} A \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

Therefore $A = \dfrac{\lambda_1 - rf}{Ts} < 0$ the saddle path has a negative slope.

$Fp(0) = c_o + \bar{F}p$ so that $c_o = Fp(0) - \bar{F}p$

Hence:

$$s(0) - \bar{s} = [Fp(0) - Fp] \frac{[\lambda_1 - rf]}{Ts}$$

Rates of Change

$\dot{s} = c_o \lambda_1 A e^{\lambda_1 t}$ and $\dot{F}p = c_o \lambda_1 e^{\lambda_1 t}$

The above is nothing more than a statement of the acceleration hypothesis, when there is an accumulation of foreign assets due to a current account surplus the exchange rate appreciates during the transition to equilibrium.

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