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Tight Money and Central Bank Intervention

(A selective analytical survey)

by

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ABSTRACT

This paper reviews some models of central bank intervention in the foreign exchange market in the context of tight monetary policy. It is shown that in a small open economy with capital mobility it is still possible to raise the domestic interest rate, at least temporarily, above the international one if the domestic price level exhibits some rigidity (the “overshooting hypothesis”) or if domestic and foreign bonds are imperfect substitutes. The increase in the domestic interest rate in the context of tight money often involves an increase in the risk premium as a result of the change in the asset portfolio of the public. The risk premium can be derived by using the capital asset pricing model of finance theory. Some illustrations of the change in portfolio are presented using the Israeli experience. The paper concludes with a discussion of diffusing the risk premium in a successful disinflation.

1. Introduction.

According to textbook models the central bank cannot affect the interest rate under perfect capital mobility, so that tight monetary policy is ineffective. Yet, as is well known, central banks implement quite often tight monetary policies with some degree of success. This is usually explained by some kind of rigidity or market imperfection. Thus the Dornbusch "Overshooting exchange rate model" shows that under domestic price rigidity tight money can raise the real interest rate temporarily. The other view is that the effectiveness of tight money is due to the fact that capital mobility is imperfect because of inherent reasons (underdeveloped capital markets) or deliberate policies of "throwing sand in the wheels" (controls on capital flows or a "Tobin tax" on inflows).

A somewhat related view focuses on imperfect substitutability between domestic and foreign bonds, which opens the possibility of raising the real interest rate through the risk premium via the "portfolio effect". In this case the real interest rate can be raised presumably not only for the short run but for the medium run as well. Yet, maintaining the interest rate spread for a long time creates additional problems, especially on the fiscal side.

In this note I shall review selectively models that were used in the literature to formalize some of the above approaches, and illustrate some of their implications using Israeli data.

2. Tight money under price rigidity (the "overshooting model")[1].

This model assumes domestic price (P) rigidity, but DP is flexible, where D the time derivative. The model assumes a floating exchange rate (ER) and the expected

[1] Dornbusch (1980) ch. 11.

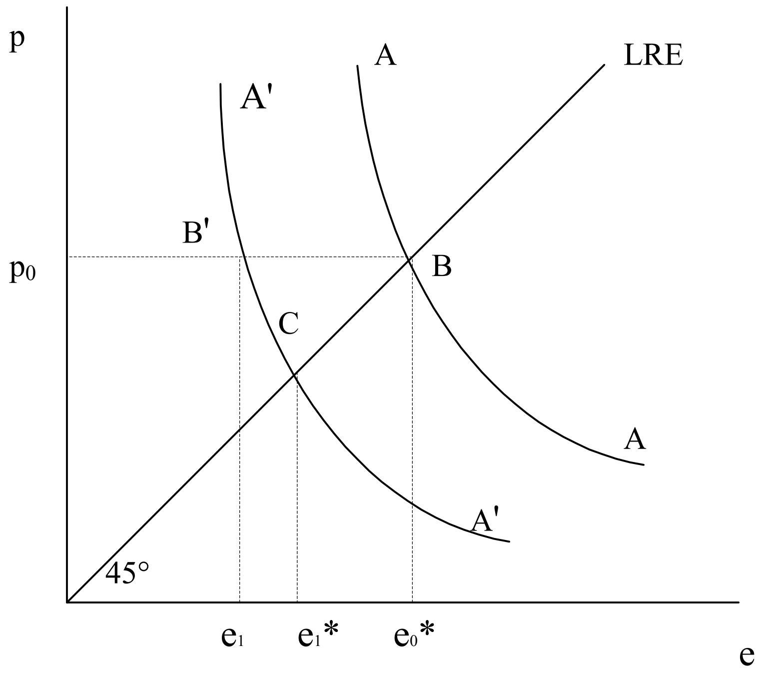
(and actual) devaluation is given by $De=\theta(e^*-e)$ where e is the log of the nominal ER (E) and e* is the long run equilibrium ($\theta>0$). The nominal interest rate i, under rational expectations is given by $i=i^*+De$. When the central bank reduces the money stock h (=ln H) it will lead to a larger reduction in e than in e* (“overshooting”) so that i will increase. This is described in Figure 1 in the p (=ln P) and e plane, where AA is the asset equilibrium curve.

The reason that this curve is downward sloping is as follows. An increase in p will reduce real balances and thus cause an increase in i, which in turn requires an increase in De. But the latter requires that e should fall.

The nominal homogeneity of the system requires that e*, p* and the exogenous h move together on a 1:1 basis along the long run equilibrium curve LRE. As h is reduced the AA curve shifts to the left with the LRE shifting to C, while the short run equilibrium shifts to B’ as a result of price rigidity. These changes produce the overshooting and the increase in i. The dynamic movement is along A’A’ from B’ to C where Dp is negative, so that the real interest rate i-Dp increases on impact. However this increase is temporary and i is back at i* in the long run.

An undesirable side effect of the tight money experiment is the initial real appreciation. If the central bank wishes to raise the i without the appreciation it is tempted to offset the appreciation by intervention in the Forex market, but this will be ineffective if domestic and foreign bonds are perfect substitutes. The problem is that we have only one policy instrument (h) to deal with two variables (i and e). This leads us to consider the model of imperfect asset substitution.

Fig 1:Dornbusch Overshooting Model



e=log ER , p=log price level , LRE=long run equilibrium

AA=asset market equilibrium

3. The Krugman-Obstfeld model of sterilized intervention[2].

Figure 2 describes the Krugman-Obstfeld model which shows how E and i are determined in the short run for a given real money stock (M/P). The AA curve in the upper panel is the arbitrage (or uncovered interest parity) condition $i=i^*+(E^e-E)/E$ where E^e is the expected E for the next period. Suppose that starting initially at Q , the central bank (CB) tightens monetary conditions by reducing M in the lower panel

[2] Krugman and Obstfeld (1994) ch. 18.

Fig 2a:Bonds Perfect substitutes

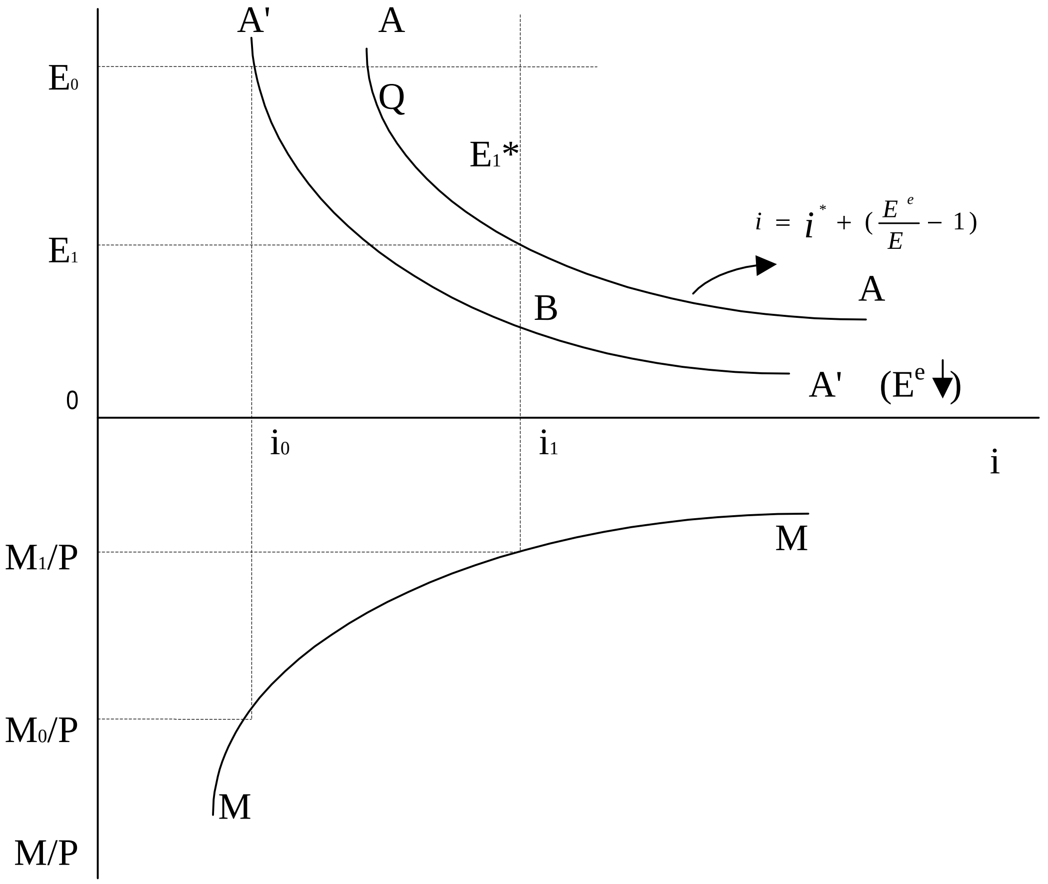
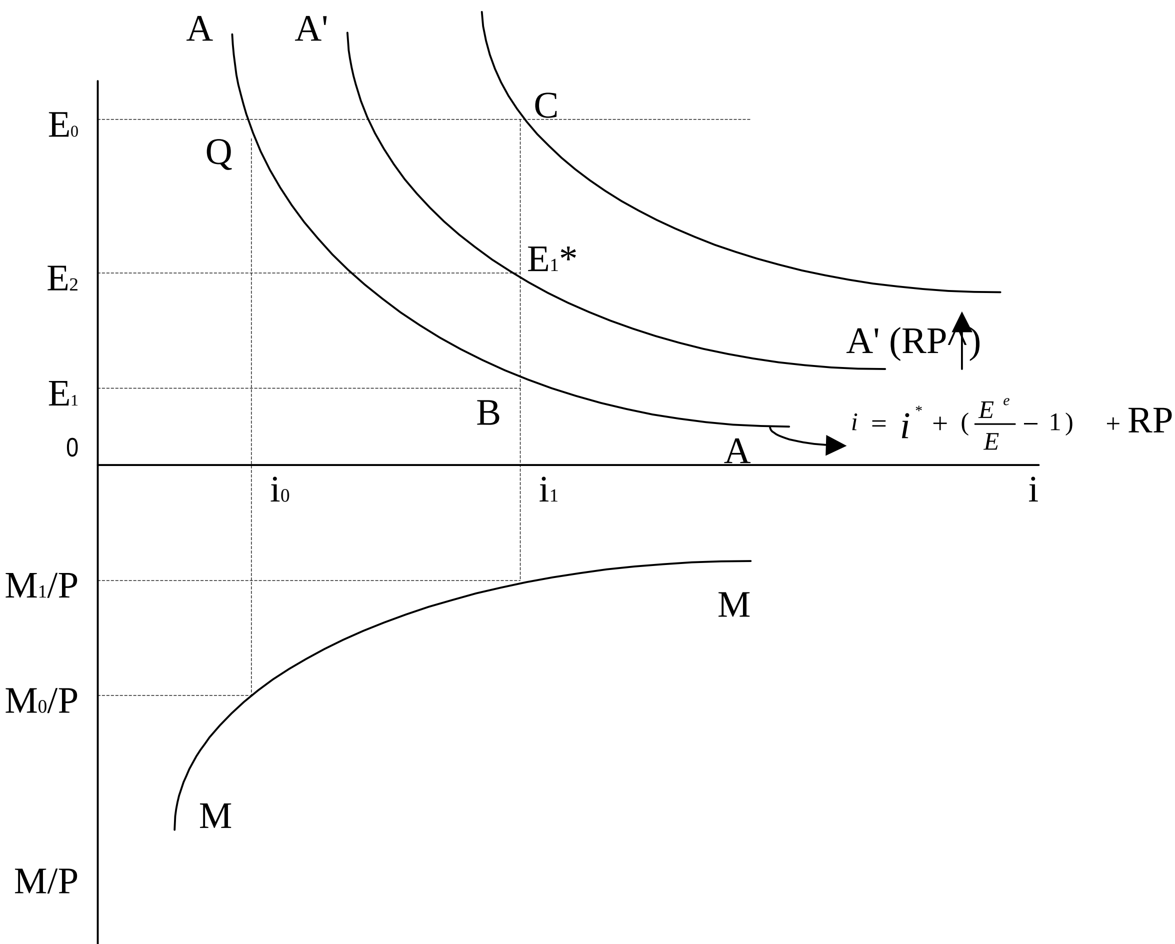


Fig 2b:Bonds imperfect substitutes



permanently to M_1 . By rational expectations people may infer that the long term ER will decline proportionately (indicated by E^*_1) so that E^e must also decrease, which will shift the AA curve downward to A'A' in Figure 2a. The new equilibrium is then at B where i increases but E appreciates. Note, however, that E appreciates more than E* which reflects again the overshooting property.

The CB can mitigate the appreciation by engaging in an open market purchase of foreign exchange bonds. But if this is unsterilized, then M in the hands of the public will increase and thus nullify the increase in i. However, assuming that domestic and foreign bonds are imperfect substitutes the CB can wipe out the excess liquidity by selling bonds to the public (i.e. decrease its domestic credit DC) while maintaining i at i_1 and at the same time enabling the ER to depreciate as a result of the increase in the risk premium. This is because the public will be willing to exchange foreign bonds for domestic ones only if the CB compensates it for the increased risk by raising the interest rate on the latter bonds.

The interest rate equation now becomes

$$i=i^*+[(E^e-E)/E]+k(G-DC),$$

where G is the total stock of government bonds outside the treasury while DC are the government bonds held by the CB. G-DC=K are then the bonds in the hands of the public which affect positively the risk premium (RP) on these securities through the function k(.), k'>0, say in the form of a product RP=(k)(G-DC). Sterilized intervention means that the CB reduces DC in order to purchase foreign bonds while keeping M and i constant, which implies that E increases in the above formula. In terms of Figure 2b the interest curve is shifted upward by the increased RP from AA to A'A' so that E is equated with E^*_1, while i is maintained at the high rate i_1. It is also possible to raise the AA curve so as to maintain the ER at its original level E_0 (at C).

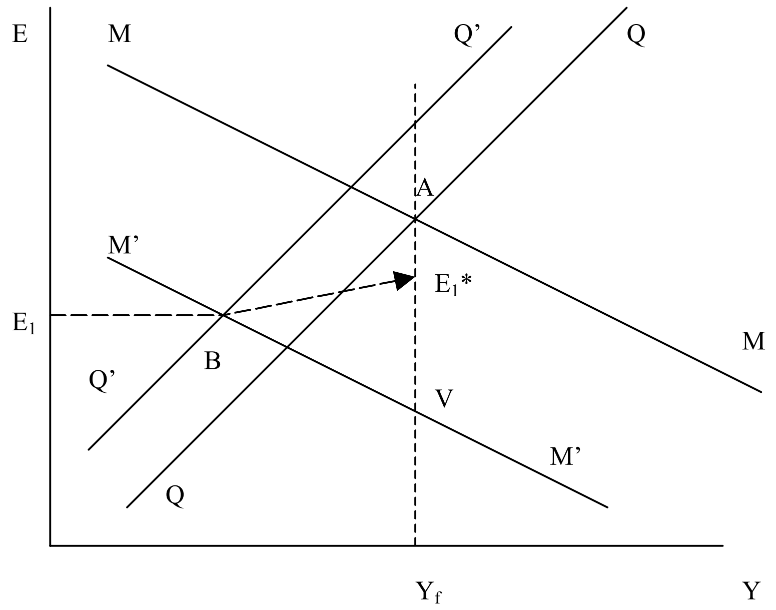
There are two important aspects to the above policy. First, with sterilized intervention the arbitrage condition under tight money may be maintained by an increase in RP rather than by expected devaluation. Secondly, we have now two policy instruments- M and DC- which enable the CB to manipulate independently i and E (this was not possible when bonds were perfect substitutes).

So far we have kept output (Y) constant, but we can relax this assumption in order to study the effect of tight money on economic activity. Consider first the implementation of tight money without sterilized intervention. Note that in Figure 2 the MM curve at the lower panel is based on a given Y; from this we can derive a negative relation between equilibrium E and Y which is depicted by MM in Figure 3 which assumes perfect substitution of bonds (this curve has M, P and E^e as parameters). In addition we have a positive relation between E and Y from the IS-LM model (i.e. devaluation is expansionary) which is depicted by QQ (again this curve has M and P as parameters). The effect of tight money (a reduction in M) is to shift the two curves to the left to an intersection at B, where output is smaller and the ER is appreciated (the latter follows from the arbitrage condition where a rise in i, as a result of tight money, requires a decline in E)[3]. Note that the recession modifies the appreciation of the ER compared with the case where Y is constant, in which case E is at the point V.

[3] Suppose to the contrary that E rises or stays unchanged. Then the IS/LM analysis implies that the interest rate rises. However, by the arbitrage condition the interest rate can rise only if E declines, which entails a contradiction. Hence the only admissible case is that E falls and the interest rate increases.

In the longer term E^e and P will fall proportionately with M which implies that the intersection between the two curves will converge gradually from B to the point E^*_1 in Figure 3. (E^e is located between current E and E^*_1).

Fig.3. Variable output (y) . bonds perfect substitutes



QQ : IS/LM

MM : $L(M/P, Y) = i = i^* + [(E^e/E) - 1]$

Let us return now to sterilized intervention in figure 2. Suppose that the CB purchases foreign bonds up to the point where the ER returns to its original level (E_0) along with a contraction of DC so as to wipe out the additional liquidity. This will shift AA curve to the right, to the intersection at C. Since the effect of sterilized intervention is associated with depreciation, we may infer that the recessionary effect of the original tight money policy will be mitigated. This is because in the IS-LM model the devaluation associated with the movement from B to C will increase output along with an increase in the interest rate.

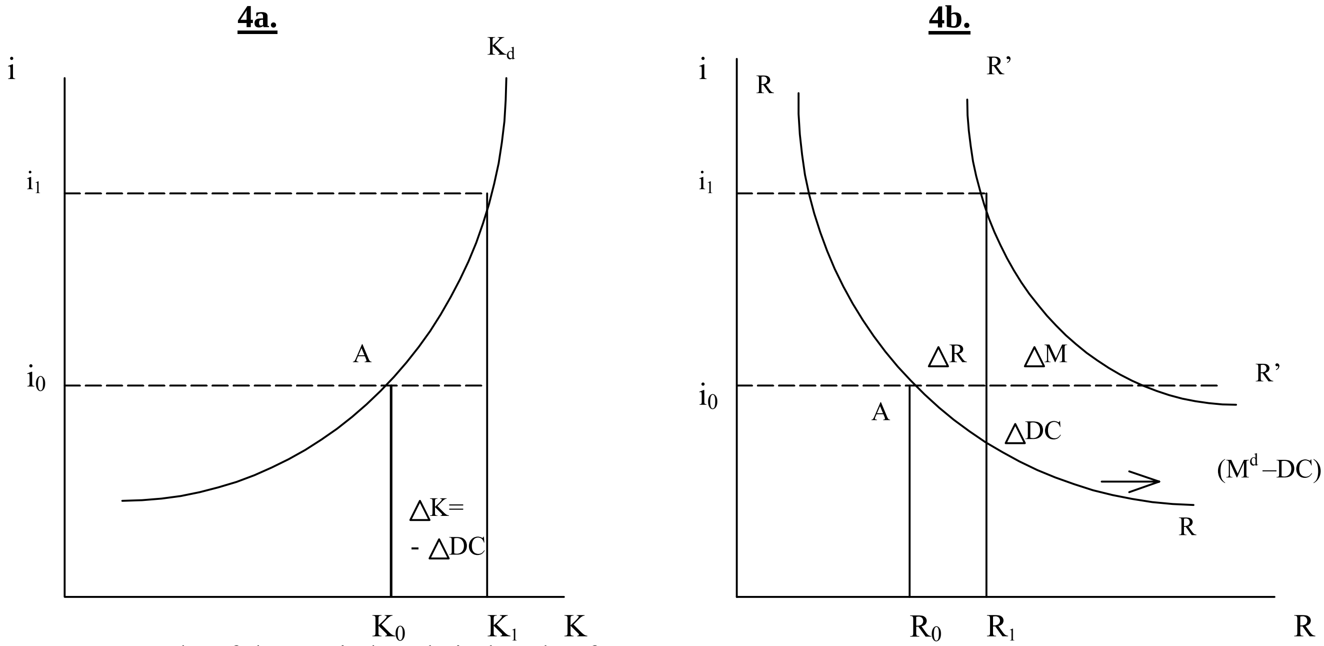
Tight money with a fixed ER.

As long as we assume imperfect substitution between domestic and foreign bonds, it is possible to use tight money effectively in spite of capital mobility even under a fixed ER regime. Thus imperfect substitutability implies that the offset coefficient is less that one, which enables the CB to raise the domestic interest rate by a contraction of DC. In this case money is endogenous so our two policy instruments are the (fixed) ER and DC.

The working of this model is described in Figure 4 (adapted from Dornbusch 1980). The interest rate is determined in 4_a by the intersection of the stock of domestic bonds in the hands of the public, denoted by K (=G-DC), and the demand for these bonds (K^d). In 4_b the foreign reserves R are drawn as a function of i, using the demand function for money (M^d) and the balance sheet identity of the CB which states that M=R+DC (we treat M as base money). A contraction of DC will raise the equilibrium i in the left hand panel and shift the RR curve to the right so that in equilibrium R will rise and M will fall (for details see Dornbusch 1980). The results are basically similar to the case of a flexible ER regime where tight money is implemented with sterilized intervention.

Fig .4. Tight money ($\Delta DC < 0$) under fixed ER and imperfect substitution between bonds .

(Dornbusch 1980)



K = Supply of domestic bonds in hands of public.

K^d = Demand.

DC = Domestic credit. $\Delta DC<0$

R = Foreign reserves.

$\left|\frac{\Delta R}{\Delta DC}\right| < 1$ (Offset coefficient)

4. Ricardian equivalence.

The above models can be criticized on the ground that they do not take into account the future fiscal implications of the changes in the public's asset portfolio. It is well known that in a complete Ricardian model, a change in the portfolio can have no real effects. As Obstfeld (1980) shows, in the present context it must mean that the public internalizes the implications of the changes in the central bank's reserves on the future income streams to the private sector. Thus suppose that the CB purchases foreign bonds from the public. This clearly reduces the private income stream from these bonds, but it also increases the income stream of the consolidated public sector which enables it to increase by an equal amount the transfer payments to the private sector in Forex or to reduce taxes. The same is true for the bonds that the CB sells to the public in the framework of sterilized intervention. This implies that we have to think of the underlying model as being non-Ricardian, like a model of overlapping generations with no bequests.

5. Explicit derivation of the risk premium (RP).

The CAPM of finance theory provides a natural framework to derive the RP explicitly. More specifically, we may use for this purpose the mean-variance model [as in Frankel (1982) or Dornbusch (1988)]. In the latter work, which is the one we shall follow, the author considers a portfolio consisting of two assets-domestic and foreign- with random real returns: r and r* respectively. The RP is defined[4] as the excess of the expected value of r over that of r*, i.e. RP=Er-Er*. Let x denote the proportion of financial wealth (W) invested in the domestic bond (B). The optimal x can then be expressed as a positive linear function of RP with a constant term representing the x (denoted x_{min}), which yields the minimum variance portfolio (see Figure 5). From a macro perspective, we may invert the above relationship and consider RP as function of B/W as in Figure 5. This establishes the basic feature of the portfolio balance approach, namely that the RP is a function of the portfolio composition. If the CB engages in sterilized intervention then it increases the share of

[4] Note that we are dealing here with a differential risk premium associated with two risky assets, and not with the risk premium relative to a risk free asset, as is usually the case in CAPM. It can be shown that the latter is larger if domestic and foreign inflations are positively correlated.

B at the expense of foreign bonds (B*) in the portfolio W (which equals B+EB*, where E denotes the ER)[5]. This will increase the RP, which will be positive if $x>x_{min}$.

The previous analysis was carried out in terms of real returns. Let us now relate it to the nominal variables under alternative ER regimes. In line with Dornbusch (1988) we define the following variables:

$\pi' = a\pi + (1-a)(\pi^* + d)$; $d = \pi - \pi^* + u$; $r = i - \pi' = i - \pi - (1-a)u$; $r^* = (i^* + d) - \pi' = i^* - \pi^* + au$.

It is assumed that π and π* are the inflation rates in terms of the domestic and foreign goods respectably (both are tradable), and 'a' is the share of domestic goods in the price index of the home country. Then π' is the weighted inflation index in terms of the domestic currency and d is the rate of devaluation of the ER (domestic price of foreign currency). The deviations from PPP are denoted by u (in fact u is the change in the real ER so that $u = (d/dt)\ln(EP^*/P)$).

Denoting the variance of x by V(x) we can express the RP as:

$RP = Er - Er^* = nV(d)\{(B/W) - 1 + [V(\pi)/V(d)] + (1-a)[V(u)/V(d)]\}$

where n is a measure of risk aversion and where u, π and π* are assumed (for simplicity) to be uncorrelated (note that under statistical independence V(d) is the sum of the variances of the three variables). The important implication from the above formula is that the RP depends not only on B/W but also on the relative variance of inflation. Thus when the variance of home-good inflation V(π) declines, which usually goes with the reduction of the level of inflation, then the RP is expected to fall. Under the above assumptions it also follows that the RP is positively related to V(u) if B/W is larger than 'a', i.e. if the importance of domestic bonds in the asset market exceeds the importance of the domestic good in the price index. Thus when

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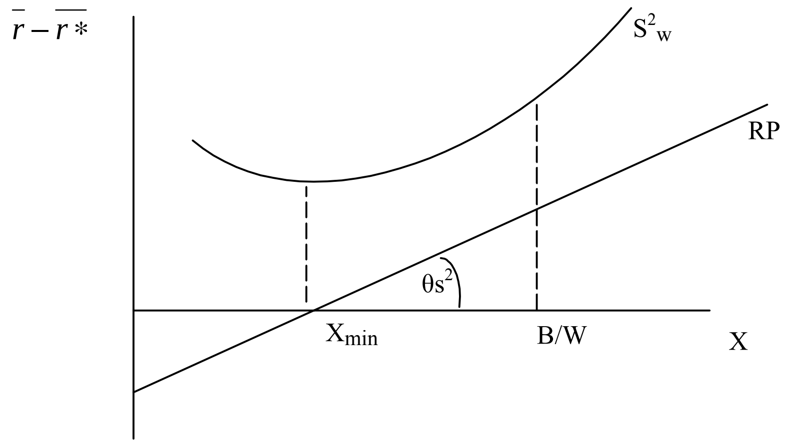
[5] This result holds essentially when there exists a third, risk-free, asset provided the covariance of domestic and foreign inflation is small.

internal and external conditions lead to a reduction in the variance of the real ER we may expect a reduction in the RP.

The above analysis poses a problem for the fixed ER regime. If the regime is credible then V(d)=0[6], which implies that the RP is independent of the composition of the portfolio. However the portfolio balance factor may be applicable under a fixed ER if the regime is not credible, in which case the expected variance of d is positive.

Fig .5. Risk premium (RP) and portfolio composition (Dornbusch)



$\bar{r} - \overline{r*} = \theta s^2[\,(B/w) - X_{min}\,)] = Er - Er*.$

$S^2 = Var\,(r - r*)$

θ = Parameter of risk aversion

S^2_w = Variance of the portfolio

7. Country risk and the RP.

How is the country risk related to the above RP measure? Suppose that the country risk reflects a risk of default of domestic bonds. Then we may regard the domestic interest rate i as containing a random component x so that the effective interest rate is now i-x. Under this assumption the variance of the real return on domestic bonds increases and it increases the RP precisely in the same way as an increase in the

[6] In this case we cannot have independent variation of π, π* and u.

variance of domestic inflation V(π). In fact in the expression of the RP the variances of π and x appear in the form of a sum V(π)+V(x). This shows that the (foregoing version of) country risk is fully reflected in RP measured by Er-Er*. Since, however, the country risk is only one component of the RP we should not confuse the two when we consider the policies of interest rate reductions.

8. Empirical studies and the Israeli experience.

It is somewhat surprising that in spite of the logical plausibility to the portfolio balance effect on the RP, there is at most only a weak support for this approach in econometric studies. Edison (1993), who summarizes the available international experience concludes that although there is growing evidence that the RP is not negligible, and that bonds are not perfect substitutes, there is only a weak link between the RP and the asset portfolio. The same is also true of the ability of sterilized intervention to influence the ER. At the same time many central banks continue to implement sterilized intervention, at least for limited time periods.

The Israeli experience with tight monetary policy took place in the context of disinflationary policy. Monetary tightening since 1994 pushed the ER close to the floor (i.e. the appreciated limit) of the ER band, a process which was fortified by exogenous inflows. This led to sterilized intervention on a massive scale. The foreign reserves of the CB increased from around five billion USD to around twenty billion over a period of five years, though part of it was due to exogenous inflows. The counterpart of this was an increase in short term sheqel denominated assets and an increase in the foreign loans of the private sector. On the balance sheet of the CB the increase in the foreign exchange reserves was associated with a sharp cut in domestic credit with little effect on the monetary base (all in dollar terms), thus almost all the increase in reserves was sterilized . This enabled the CB create a substantial wedge between domestic and foreign interest rates over most of the period (even after allowing for depreciation). If we consider the post 1994 period as a whole we can see that all the expected features of tight money cum sterilized intervention have been realized in the Israeli experience (Liviatan and Sussman 1999).

9. Long term implications of sterilized intervention.

An obvious difficulty with pursuing sterilized intervention for a long time is the fiscal burden arising from the excess of interest on domestic bonds over foreign rates which increase the CB losses (creating a "quasi-fiscal" deficit). The increase in the deficit feeds into the public debt which creates a problem of "unpleasant monetarist arithmetic" a la Sargent-Wallace (1981). The creation of a fiscal burden by the CB who pleads for fiscal discipline by the treasury is embarrassing for the image of the CB, which impedes the continuation of this policy, unless there is a general consensus about the disinflationary policies.

10. Diffusing the risk premium.

If the risk premium is created in the course of a disinflation program then one may suppose that when inflation is brought down the above process may be reversed. This means that the CB will reduce the interest rate through monetary expansion and at the same time sell reserves and sterilize the latter operation by an open market purchase of domestic bonds. In this package the reduction in the rate of interest tends to raise the ER, while the sale of reserves tends to reduce it. However since the latter reduces the money supply (which tends to raise the interest rate) the CB has to offset this effect by a purchase of domestic bonds. According to the Krugman-Obstfeld model the reduction in the ratio of B/EB* will reduce the RP so that the sterilized intervention will enable to maintain the interest rate at its reduces level without a devaluation of the currency.

The objection to this policy in real life is that the reduction in the interest rate may undermine the credibility of the CB and trigger a run on the currency. This can be supported by two arguments. First, note that when the uncovered interest parity is brought to balance by the RP, we are dealing with an underlying stock equilibrium. If this equilibrium is not attained instantaneously then the stock adjustment may involve large capital outflows which may trigger a run. Secondly, in a framework of multiple equilibria, the pessimistic expectations regarding devaluation, which may develop in view of large outflows, may be too costly to resist by the policymakers, which may lead to a self-justifying crisis. These considerations may carry more weight when the policymakers are not fully convinced that inflation has indeed been conquered on a permanent basis.

Apart from these difficulties there are some automatic forces which tend to reduce the RP in a successful disinflation process. We have noted earlier that when inflation is brought down its variance falls too, and as we have seen this tends to reduce the RP in the portfolio balance model. There is an additional consideration which is related to the disinflation process. The increase in the real interest rate in this process tends to create a recession, which in turn may entail a real depreciation. However the real depreciation tends to reduce the proportion of domestic bonds relative to foreign ones, which according to the portfolio-balance model should lead to a reduction in the RP.

Another important channel are the capital inflows that may increase as a result of stabilization of the economy following a successful disinflation. These flows will decrease the ratio of domestic to foreign bonds and consequently the RP will decline.

This is the most desirable scenario of diffusing the RP, and it seems to have taken place recently in Israel.

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