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EXCHANGE RATE RISK AND THE MACROECONOMICS OF EXCHANGE RATE DETERMINATION

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Exchange Rate Risk and the Macroeconomics of Exchange Rate Determination

ABSTRACT

This paper discusses the link between portfolio diversification models of exchange risk and the macroeconomics of exchange rate determination. A first part sets out the mean-variance model of portfolio choice for the case of two nominal assets with random real returns. From there the model is made "international" by a specification of the world inflation process. The concept of exchange risk is discussed in terms of the variability of the real exchange rate.

The paper shows that when all randomness in real returns derives from variability of the real exchange rate, rather than from inflation variability, full hedging is possible. Even for the case of no real exchange rate variability, it is shown, variability of the nominal rate of depreciation is a determinant of the portfolio composition.

The risk premium is derived and discussed in terms of the deviation of the anticipated rate of depreciation from the interest differential. The actual rate of depreciation may exceed the interest differential either because of news or because of a risk premium that depends on the relative asset supplies compared to their shares in a minimum variance portfolio. An appendix investigates the implications of tastes and differences and shows that there is an additional component of the premium due to differences in consumption patterns.

The portfolio model is integrated in a macro-model to show how the relative supplies of non-monetary assets, through yield and valuation effects, determine the impact and longrun consequences of real and nominal monetary disturbances. The integration of the portfolio and macro models relies crucially on the properties of the demand for money. A demand for money that depends on the average return on securities, rather than on the domestic interest rate, implies that portfolio considerations do not affect exchange rates.

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EXCHANGE RATE RISK AND THE MACROECONOMICS OF EXCHANGE RATE DETERMINATION

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This paper adresses the question of what contribution finance theory can make to an explanation of exchange rate movements. It is an attempt to integrate ideas of finance theory such as portfolio difersifi_cation, efficiency, rationality, use of information, in a reasonably eclectic macroeconomic model and to study in that broadened context the determination of exchange rates.

There have been traditionally two views of exchange rates. One holds that the exchange rate is the relative price of two monies, the other that it is the relative price of domestic and foreign goods. A third view, suggested by Fischer (1976) takes into account portfolio considerations to suggest that the exchange rate is the relative price of nominal assets. There is, of course, little sense in any of these partial equilibrium slogans and it becomes readily apparent that in most instances real, monetary and financial considerations interact in the determination of exchange rates. Real and monetary aspects of exchange rate determination have been extensively modelled, but this has not been the case for portfolio considerations until the very recent interest in current account oriented exchange rate theory. This paper attempts to contribute to the integration of the various approaches by providing an integrated statement of the various elements of portfolio theory that are relevant and by modelling these elements in a macroeconomic context.

The paper proceeds as follows: Part I develops the basic portfolio model for an abstract economy. In part II the model is made "international" by a specification of the interna-ional inflation process. In that context we discuss the role of exchange risk in portfolio selection and the determinants of the forward premium. Many of the ideas here are well-established and these

parts may be looked at primarily as an exposition.

In part III the portfolio demands are integrated in a macroeconomic model. The model is one with rational expectations and focusses on the determination of inflation, depreciation and the level of the exchange rate. In studying various real and financial disturbances we point out the role of portfolio considerations in a macro setting. The part concludes with a discussion of the critical role played by the particular formulation of money demand.

I. PORTFOLIO SELECTION, MARKET EQUILIBRIUM AND RISK PREMIA.

This section lays out, for review and integration, the basic analytical framework of portfolio selection, market equilibrium and risk premia. This field, in the finance literature, is of course already common place. The application to the open economy has been slow or late. Nevertheless, a relatively complete statement has now emerged from the writing of Solnik (1973), Kouri (1975,1978a, 1978b),Wihlborg (1978), Roll and Solnik (1977), Adler and Dumas(1976), Jeffrey Frankel (1979),Kouri and Macedo (1978), Stulz (1979) and Fama and Farber (1979).

1. Portfolio Selection

The model is one of two period expected utility maximisation for an individual faced with two securities with random real returns. (We lack the macho for n.). The random returns on these securities are characterized in terms of their mean and variance covariances. The portfolio composition, derived from expected utility maximization, can be stated in terms of the parameters of risk aversion and the structure of returns. We now briefly sketch the derivation. Let w, r, r* and x be the initial level of real wealth, the random returns on home and foreign securities and the portfolio share of foreign securities. End of period wealth then is random and equal to $\tilde{w} = w(1+r) + xw(r^*-r)$.

Utility is a function of the mean and variance of end of period wealth:

$$(1) \qquad U = U(\bar{w}, s^2_{\bar{w}})$$

The mean and variance of wealth are defined as:

$$(2) \qquad \bar{w}=w(1+\bar{r})+xw(\bar{r}^*-\bar{r}); \; s^2_{\bar{w}}= w^2((1-x)^2 s^2_r + x^2 s^2_{r^*} + 2x(1-x)s_{rr^*})$$

where a bar denotes a mean. Maximizing (1) with respect to x yields the optimal portfolio share:

$$(3)\quad x = \frac{(\bar{r}^* - \bar{r}) + \Theta(s_r^2 - s_{rr^*})}{\Theta s^2}; \quad s^2 \equiv (s_r^2 + s_{r^*}^2 - 2\, s_{rr^*})$$

and where $\Theta \equiv -U_2 w/U_1$ is the coefficient of risk aversion.

Equation (3) shows the conventional result that portfolio selection depends on yield differentials, risk aversion and the return structure. To gain some further understanding we can separate the portfolio share into two separate components. The first is a speculative component, the other share corresponds to a minimum variance portfolio, as pointed out in Kouri (1978a):

$$(3)'\quad x = \frac{(\bar{r}^* - \bar{r})}{\Theta s^2} + \alpha\,; \qquad \alpha \equiv (s_r^2 - s_{rr^*})/s^2$$

It is readily shown that α is the share of the foreign security in a portfolio chosen to minimize the variance of wealth. The minimum variance portfolio is independent of risk aversion, of course, and its composition depends only on the relative riskiness of the two bonds. The first term in (3)' represents the speculative portfolio share. This one depends on yield differentials, risk aversion and risk. It is readily recognized that speculative holdings of the other security are $-(\bar{r}^* - \bar{r})/\Theta s^2$ so that across assets the speculative portfolio sums to zero. Investors thus allocate their wealth to a minimum variance portfolio and issue one of the securities using the proceeds to hold another as a speculative portfolio.

2. Market Equilibrium:

The optimal portfolio share in (3)' is that for an individual investor. To proceed from here to the condition of market equilibrium we have to aggregate across investors, all of whom share the same information, but may differ in their wealth or risk aversion. Nominal demand for asterix-type bonds (there is no sense, as yet, in which they are foreign) of the typical investor is $x_j W_j$. Here x_j depends on the investor's risk aversion and W_j denotes her nominal, non-monetary wealth. Denoting the nominal

supply of asterix-type bonds V^*, the market equilibrium condition becomes: $V^* = \Sigma\, x_j W_j$. Using the definition of aggregate non-monetary wealth, $\bar{W} = \Sigma\, W_j$, the equilibrium condition can be expressed in the form:

$$(4) \qquad \left(\frac{r^*-r}{\theta s^2} + \alpha \right)\bar{W} = V^* \; ; \qquad \theta = \Sigma \frac{\theta_j}{W_j/\bar{W}}$$

In (4) θ now denotes the market coefficient of relative risk aversion, being a wealth weighted average of the individual coefficients.

Equation for can be solved for the market equilibrium real yield differential:

$$(5) \qquad \bar{r}^*-\bar{r} = \theta s^2 (V^*/W - \alpha)$$

The yield differential in (5) has three determinants. The higher risk aversion, θ, the larger the yield differential. In the same direction works an increase in relative yield variability, s^2. The third determinant is the relative asset supply. It takes the interesting form of a yield differential proportional to the difference between the actual relative supply, $V^*/\bar{W}$, and the share of the asset in the minimum variance portfolio, α. The yield differential is therefore positive or negative depending whether the relative supply of the security exceeds or falls short of its share in the minimum variance portfolio.[1]

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[1] Equation (5) can of course be directly derived using the conventional result that the yield differential over the risk-free rate is proportional to the covariance with the market. Forming the respective expressions we find that $\bar{r}^*-\bar{r} = \theta(s_{r^*R} - s_{rR})$ where $R = (1-x)r+xr^*$ is the return on the market portfolio. Calculating the expression and using $x=V^*/\bar{W}$ and the definition of α yields (5).

Figure 1 shows the equilibrium yield diffferential. The upper schedu represents the variance of wealth , achieving a minimum at $x=\alpha$. The lower schedule shows the yield differential as a function of the dis crepancy between actual relative supplies and the minimum variance portfolio. The slope of the schedule is the coefficient θs^2. For a relative security supply $V^*/\bar{W}$ we show at point A the equilibrium ris premium.

The result is intuitive since all market participants will want to the minimum variance portfolio and need compensation to bear more then the minimum risk. Relatively more risk averse market participants will hold more nearly the minimum variance portfolio than is available in the aggregate. The more risk neutral participants will issue the lacking securities and hold the excessive ones, charging a yield differential for bearing the speculative role.

Risk is thus defined in terms of divergences from the minimum variance portfolio. Given this interpretation it is clear that an increase in the relative supply of a security will change the yield differential ; the yield differential will rise or decline absolutely as $V^*/\bar{W}-\alpha \gtrless 0$.

So far the model is in no particular way "international". In the next section we apply it to a two-country context by specifying the sources of real yield variability.

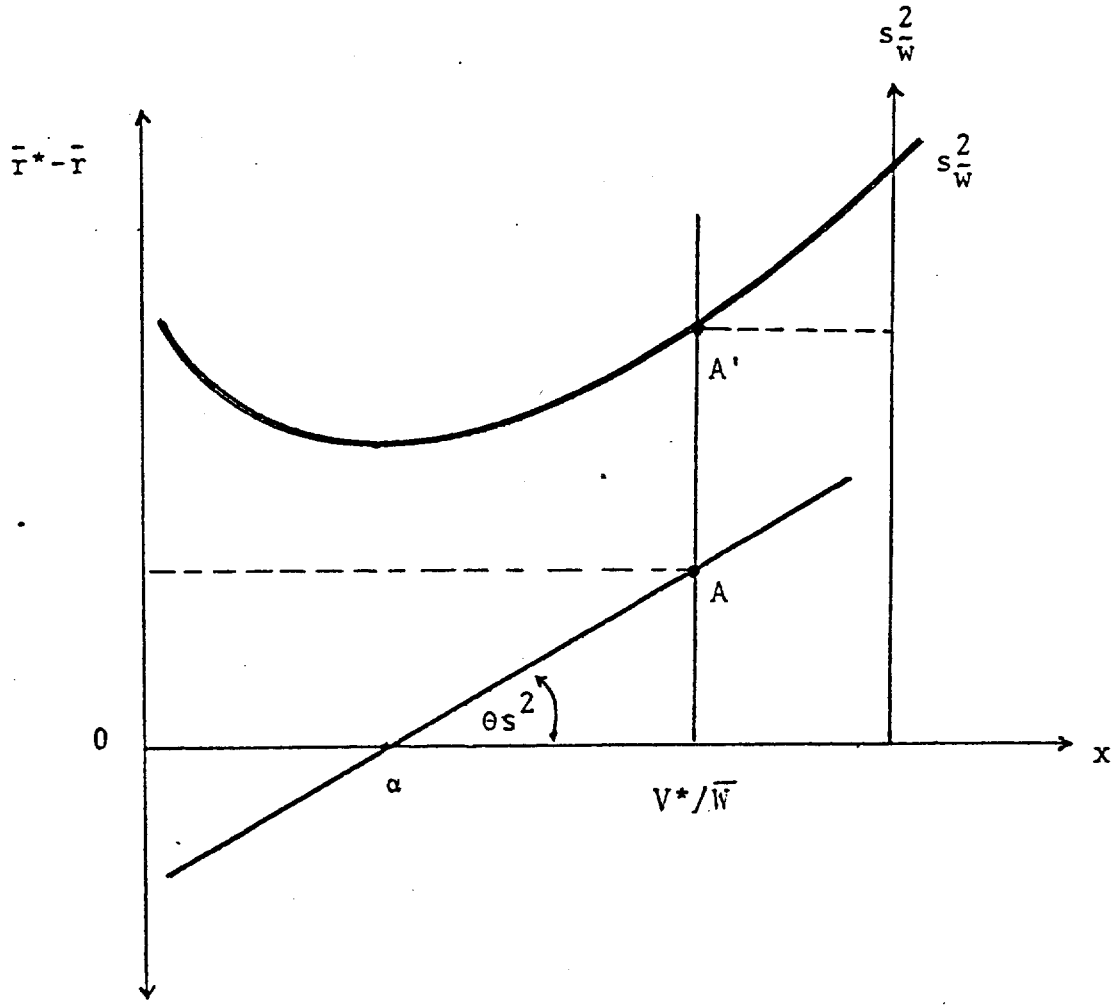


FIGURE 1

II. INFLATION, DEPRECIATION AND REAL RETURNS

In this part we develop a model of the process that generates real returns. With the model of real returns supplementing the equations of portfolio choice and yield differentials we can answer a number of questions. First, what is the role of exchange risk in portfolio selection and in risk premia? Second, what are the determinants of the forward premium for foreign exchange. Third, what role do distribution effects play in asset markets, or to what extent do differences in consumption patterns get reflected in asset markets?[1]

1. A Model of Real Returns

We assume that there are only two securities both are bonds with nominal pay-offs in the currencies of the home country and the foreign country. The nominal interest rate on these shortterm securities is known, but the real return is random because of uncertain inflation rates and uncertain exchange rate behavior. A first task now is to specify the rate of inflation of the consumption basket.

This is a two commodity world,each country being specialized in the production of one commodity. The rates of inflation of the local currency prices of the two commodities are π and π^*, respectively. All portfolio holders, domestic and foreign alike, consume the two commodities in the same proportions. This assumption of common tastes, maintained until the appendix, implies that all portfolio holders face a common dollar rate of inflation, $\tilde{\pi}$.

$$\tilde{\pi} = a\pi + (1-a)(\pi^*+d) \tag{6}$$

where d is the random rate of depreciation of the dollar relative to the foreign currency. The "world" rate of inflation relevant in assessing real security returns is thus simply a weighted average of the dollar inflation rates of the two commodities, the weights corresponding to the budget shares.

[1] This last question is addressed in the appendix.

The rate of depreciation is a random variable, assumed to follow purchasing power parity, but with a random component reflecting real exchange rate variability:

$$(7) \qquad d = \pi - \pi^* + u$$

where the real exchange rate variation u for the present has zero mean.

Equations (6) and (7) in combination with the nominal interest rates, i and i*, define the real returns:

$$(8) \qquad r = i - \bar{\pi} = i - \pi - (1-a)u; \quad r^* = (i^*+d) - \bar{\pi} = i^* - \pi^* + au$$

We note, once more, that the assumption of a common consumption basket across countries implies that investors face the same "real" return structure and therefore will chose the same portfolio composition. Equation (8) shows that real returns are affected not only by random variations in the inflation rates but also by real exchange rate variations or deviations of the exchange rate from purchasing power parity. For given inflation rates a positive u implies that the home currency depreciates beyond the PPP path, raising in home currency the price of foreign goods and thus lowering the real return to home currency bonds. The real return to foreign currency bonds, of course, rises since in foreign currency domestic goods prices decline.

We now define the variances and covariances of the real returns and the real return differentials:

$$(9) \qquad s_r^2 = s_\pi^2 + (1-a)^2 s_u^2 \; ; \; s_{r^*}^2 = s_{\pi^*}^2 + a^2 s_u^2 \; ;$$

$$s_{rr^*} = s_{\pi\pi^*} - a(1-a)s_u^2$$

and

$$s_d^2 = s_\pi^2 + s_{\pi^*}^2 - 2s_{\pi\pi^*} + s_u^2 = s^2$$

where we have assumed that deviations from PPP are uncorrelated with inflation rates. It is interesting to note from the expression for the covariance of real returns, s_{rr^*}, that real exchange rate

variability contributes a negative correlation to the real return structure, while raising the variance of real returns. In (9) we define the variance of real yield differential which, by (7) and (8), is also the variance of the rate of depreciation, s_d^2.

The variance of real returns in (9) shows that for dollar bonds the real return variability depends on the US inflation variability s_π^2, and on the variability of PPP deviations, s_u^2. The latter is more significant the larger the foreign country as measured by their share in world inflation, 1-a. Note that the foreign rate of inflation has no impact on the real return variability of dollar bonds since it is fully offset by exchange depreciation. Only deviations from PPP matter. For foreign currency bonds the real return variability depends on the variance of foreign currency inflation and again on the variability of deviations from PPP.

2. Portfolio Composition and Exchange Risk

Replacing the formula for return variance in (9) into equation (3) yields an interesting expression for the portfolio and in particular for its minimum variance component:

$$(10) \qquad x = \frac{(\bar{r}^*-\bar{r})}{\theta s_d^2} + \frac{s_\pi^2 - s_{\pi\pi^*} + (1-a)s_u^2}{s_d^2} \; ;$$

The hedging portfolio or minimum variance portfolio will now depend on the structure of the world inflation process. Suppose, first, that inflation rates are deterministic so that $s_d^2=s_u^2$. In that case the portfolio share reduces to:

$$(11) \qquad x = (\bar{r}^*-\bar{r})/\, \theta s_u^2 + (1-a)$$

The equation states that with exchange risk as the only source of real return variability hedging can be complete. Investors will allocate their wealth to the two securities in a proportion determined by the relative inflation shares (1-a)/a. With that allocation, because of the perfect negative correlation of real

returns the minimum variance portfolio is actually riskfree. The speculative portfolio, of course, still depends on risk, return, and risk aversion. The first striking result then is that, with deviations from PPP the only source of real return variability, the individual can fully hedge, although in the aggregate that may not be possible as we note below.

The alternative case assumes that there is no variability in the real exchange rate so that $s_u^2 = 0$ and the variance of exchange depreciation only depends on national inflation variance. Now the portfolio share is:

$$x = \frac{\bar{r}^* - \bar{r}}{\theta s_d^2} + \frac{s_\pi (s_\pi - \rho s_{\pi^*})}{s_d^2} \tag{11}$$

where ρ is the coefficient of correlation of inflation rates. Thus without real exchange rate variability the allocation of portfolios depends on the inflation variances and covariances. With inflation rates uncorrelated investors favor the securities of the country with the more stable inflation rate. The minimum variance portfolio share is inversely proportional to the ratio of inflation variance to the variance of exchange depreciation, s_π^2/s_d^2.

In the general case the portfolio share, as shown in (10) will depend on both exchange rate and inflation variability. Even here, though, it remains true that portfolio shares in the minimum variance portfolio are positively related to country size as measured by (1-a), although the coefficient on that size variable is the fraction which indicates the relative importance of exchange risk.

3. Yield Differentials and Risk Premia:

We return now to the yield differential in (5) and state it in terms of the more specific structure. Replacing by the minimum variance portfolio share in (10) we have:

$$(5)' \quad \bar{r}^*-\bar{r} = \Theta s^2 \left[V^*/\bar{W} - (s_\pi^2-\mathrm{cov}(\pi,\pi^*)/s^2-(1-a)s_u^2/s^2\right]$$

Consider first again the case where deviations from PPP are the only source of real rate variability. In that event (5)' reduces to:

$$(5)'' \quad \bar{r}^*-\bar{r} = \Theta s_u^2 \left[V^*/\bar{W} - (1-a)\right]$$

There will be a yield differential to induce the public to bear positive risk. The risk is proportional to the deviation of relative asset supplies from the zero variance portfolio share, 1-a. Again the price of that risk is higher than higher risk aversion and real exchange rate variability. We have thus established that in a world where exchange rate uncertainty is the only source of real return variability there is a yield differential or risk premium if asset supplies are out of line with minimum variance portfolios where the latter replicate the relative importance of countries in world inflation and thus, roughly, relative country size.

In the case of pure exchange risk, risk premia emerge therefore only if relative asset supplies are out of line with relative country size.

Consider now the more general case. What characterizes the risk premium and how does it respond to changes in the stochastic structure? From (5)' we can write the change in the risk premium induced by a change in the stochastic structure, $d\upsilon$:

$$(12) \quad d(\bar{r}^*-\bar{r})/d\upsilon = \Theta(V^*/\bar{W}-\alpha)\frac{ds^2}{d\upsilon} - \Theta s^2 \frac{V^*}{\bar{W}} \frac{d\alpha}{d\upsilon}$$

There are thus two channels. The first is a change in the premium due to a change in the variability of relative real yield differentials.

The second channel is the change in the minimum variance portfolio induced by a shift in the stochastic structure.

By the first channel a higher variability of yield differentials raises the risk premium. Variability would increase as a consequence of increased home inflation variance, if returns if inflation variances are negatively correlated. Increased correlation of inflation rates, by contrast reduces variability of relative returns and thus tends to reduce the premium due to this first channel. The second channel captures the effect on the risk premium due to changes in the minimum variance portfolio. The effects of changes in inflation variance or correlation are ambiguous here.

The implications of higher real exchange rate variability are particularly interesting. From (5)' we obtain the expression:

$$(12) \qquad \frac{d(\bar{r}^*-\bar{r})}{ds_u^2} = \Theta\left[\frac{V^*}{W} - (1-a)\right]$$

Accordingly the effect of increased real exchange rate variance depends only on the relative size of asset supplies and countries.

4. The Forward Premium and Excess Depreciation:

In this section we review several implications of the portfolio balnce model that are of interest from a macroeconomic perspective. They concern respectively the risk premium on forward foreign exchange, homogeity and the relation betwleen the level of exchange rates and the anticipated rate of depreciation.

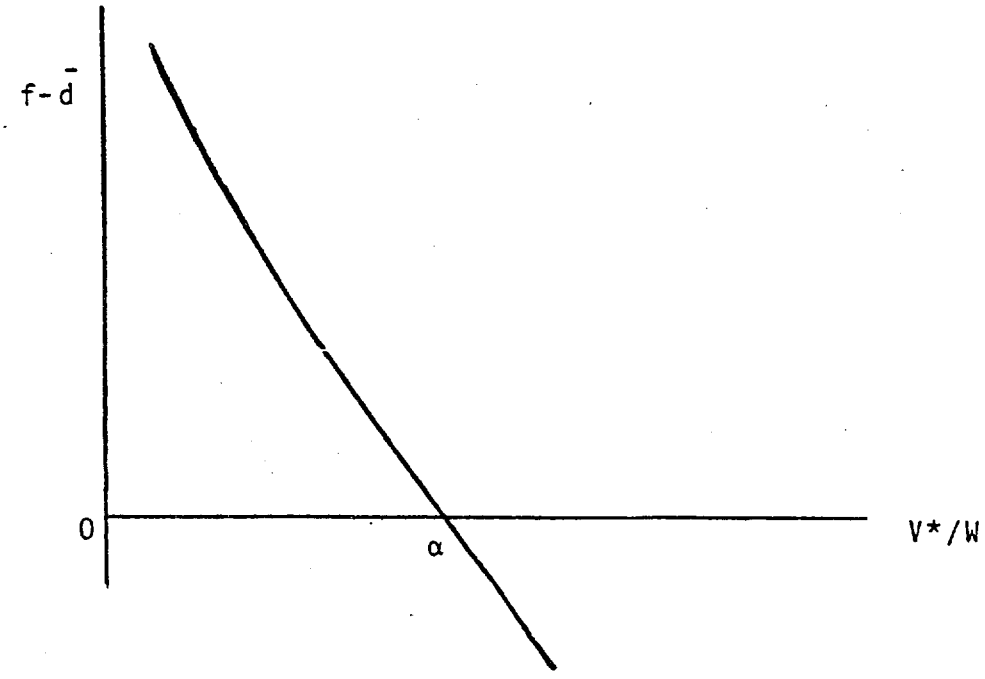
There is a direct link between the risk premium in (5)' and the risk premium in the foreign exchange market. Nominal interest differentials are equal to the forward premium, $i-i^*=f$, as has been amply documented. From (7) and (8) the mean or anticipated real yield differential is $\bar{r}^*-\bar{r} = i^*-i + \bar{d}$, where $\bar{d}$ is the anticipated rate of depreciation. Thus, $f-\bar{d} = -(\bar{r}^*-\bar{r})$ or

the difference between the anticipated rate of depreciation and the forward rate equals the equilibrium real yield differential. Using the substitution in (5)' yields:

$$(13) \quad f = \bar{d} - \Theta s^2(V^*/\bar{W} - \alpha)$$

Accordingly the forward premium exceeds the anticipated rate of depreciation if the relative supply of foreign securities falls short of their minimum variance portfolio share. The theory thus supports the view that there is a negative relationship between the foreign exchange risk premium and relative asset supplies as shown in figure 2. The interpretation of the forward exchange premium is simply that with excessive relative supplies of foreign assets some speculators will borrow in home currency , thus issuing domestic securities that are relatively scare, and hold foreign securities that are relatively plentiful. Their expected return must exceed the interest differential in order to warrant the above minimum risk position.

FIGURE 2



The forward exchange premium in (13) and Figure 2 warrants three observations. First we observe that its determinants are those of the real yield differentials and that accordingly our earlier analysis applies. Secondly, the slope of the premium schedule in respect to a change in relative asset supplies is determined by both the stochastic structure and risk aversion.

A third point has been particularly emphasized by Jeffrey Frankel (1979b). It is that the risk premium is a function of the relative supplies of outside assets, not a function of net foreign assets as has been suggested in earlier discussions. The point is particularly important because it implies that there is no direct link between the current account,and the related changes in net foreign assets, and the risk premium. We return to this point below when we discuss differences in national consumption patterns and the resulting portfolio preferences.[1]

The discussion of the relation between the forward premium and the expected rate of depreciation leads naturally to a second question: What is the relation between actual depreciation,d, and the forward premium? To answer that question we use the identity $d-f= d-\bar{d} + \bar{d}-f$ to write:

$$(14) \qquad d - f = d - \bar{d} + \theta s^2 (V^*/W - \alpha)$$

$$\text{excesss depreciation} = \text{"news"} + \text{risk premium}$$

The decomposition in (14) suggests that we can break up"excess depreciation"or depreciation in excess of the forward premium into two components. One is the risk premium the other is unanticipated depreciation or "news". How much of the actual excess depreciation, as defined by the lefthand side, do we believe to be due to "news" and how much can be attributed to the risk premium ?

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[1] Throughout this paper we abstract from differences in risk aversion as a source of distribution effects. Thus θ is assumed constant and independent of the distribution of wealth. We also assume away the possibility of default.

CHART 1 EXCESS DOLLAR-DM DEPRECIATION
(monthly, at annual rates)

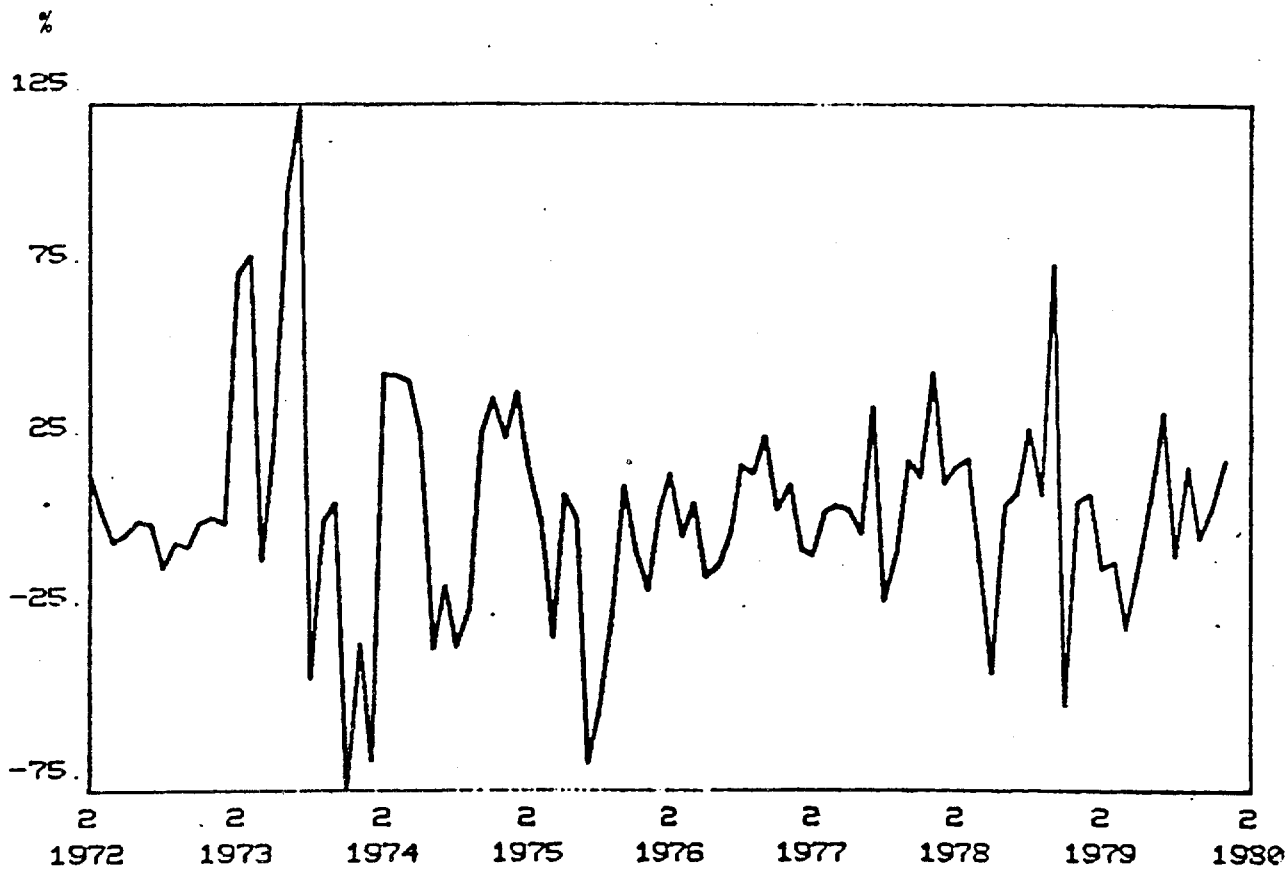

Chart 1 shows the excess depreciation of the dollar, monthly at annual rates. It is quite apparent that this excess depreciation displays a substantial randomness. The "news" component is therefore likely to be an important item in explaining the excess depreciation. In Dornbusch (1980) unanticipated current account and cyclical developments are shown to explain a large part of the excess depreciation. Cumby and Obstfeld (1979) have shown that on weekly data all major currencies show serial correlation in the excess depreciation, thus making a case that the risk component, in addition to news, is an important and systematic component of excess depreciation. This remains an active area of research as shown in the work of Frenkel (1980) or Isard (1980).

In the appendix we discuss a more general model that allows for differences in national consumption patterns. It is shown there that portfolio preferences will differ only to the extent that there is real exchange rate risk, $s_u^2 = 0$. With real exchange rate risk countries will tend to hold relatively more of their own currency securities, thus hedging against the impact of exchange rate deviations from PPP exerting adverse effects on their real returns. Interestingly, the quantative importance of these local habitat effects may be small. Indeed, the local habitat component of the risk premium is the product of three fractions.

5. Further Implications:

A further implication of the portfolio model is the homogeneity of degree zero of the risk premium, Patinkin-like, in nominal money, nominal outside bonds and the exchange rate. The point is immediately appreciated by writing the relative supplies of bonds in the form:

$$V^*/\bar{W} = \bar{V}^*E/(V + \bar{V}^*E)$$

where $\bar{W}=V+E\bar{V}^*$ is world nominal, non-monetary wealth measured in home currency and $\bar{V}^*$ is the foreign currency value of foreign currency bonds, E being the home currency price of foreign exchange. An exchange depreciation, accordingly, will change relative asset supplies and therefore the equilibrium real rate differential, unless it is accompanied by an equiproportionate rise in home currency bonds.

Another point, particularly stressed by Dooley and Isard (1979), is that the portfolio balance model is not a complete model of exchange rate determination. Indeed, it only establishes a relation between nominal interest differentials, anticipated depreciation and the level of the exchange rate. This is apparent from rewriting (13) in the form:

$$(15)\quad i-i^* = \bar{d} - \Theta s^2 \left(\frac{\bar{V}^*E}{\bar{V}^*E+V} - \alpha \right)$$

where we have substituted $V^*=E\bar{V}^*$ to show the domestic currency value of foreign assets as the product of the exchange rate and the given nominal stock of foreign currency denominated securities, $\bar{V}^*$. For given nominal interest rates the portfolio balance model thus implies a positive relation between the level of the exchange rate, E, and the rate of depreciation. To close the model we need further equations that determine the nominal interest differential and that restrict the exchange rate dynamics. Accordingly the portfolio model must be embedded in a broader macroeconomic model. This is the task of the next part.

I. PORTFOLIO BALANCE IN A MACRO MODEL

In this part we develop a rational expectations macroeconomic model in which the portfolio balance equation in (15) is one of the key equations. The macroeconomic model determines the nominal interest differential from conditions of monetary equilibrium and portfolio balance. Inflation is determined by trend money growth and the state of aggregate demand which in turn depends on the real exchange rate. In that setting there will be a unique path of the level and rate of depreciation of the exchange rate -- and thus rates of inflation and rates of change of the terms of trade -- so as to be consistent with expectations and assure convergence to the steady state. We first develop the macroeconomic model and then apply it to investigate the adjustment process to a variety of real and financial disturbances. The analysis will establish that the portfolio balance relation is central to determining the exchange rate implications of various shocks.

1. The Macro Model

In money markets we assume that real money demand is a function of real income and the expected nominal yields on domestic and foreign securities. For ease of manipulation we assume unit real income elasticities and a semilogarithnic functional form. With these assumptions, and imposing money market equilibrium at home and abroad, we have:

$$(16) \quad m-y = -bi -c(i^*+\bar{d}) \quad ; \quad m^*-y^* = -bi^* -c(i-d)$$

where m,y,m* denote home and foreign logs of nominal money and nominal income. Note in passing that each country's money demand depends on the alternative cost of holding that particular currency as measured by the nominal interest in home currency and the exchange depreciation-adjusted return on foreign securities. There is an explicit assumption here that the alternative to holding each currency is to hold securities,not other monies. Currency susbstitutuion, therefore, is not recognized as a possibility.

Now subtracting one quilibrium condition form the other, and collecting terms, yields an expression for the interest differential:

$$(17) \qquad i-i^* = -\frac{1}{b-c}(z+2cd) \quad ; \quad z \equiv m-y-(m^*-y^*), \quad b-c>0$$

where the term z denotes relative money income ratios and where we assume that b-c > 0. Money market equilibrium, as shown in (17), thus implies that a rise in domestic money relative to income will lower the interest differential, as will a rise in anticipated depreciation.

Both portfolio balance and money market equilibrium establish relations between interest differentials and anticipated depreciation. We combine these now by equating (15) and (17) to solve for the equilibrium rate of depreciation consistent with full asset market equilibrium:

$$(18) \qquad \bar{d} = \beta\left(\frac{v^*}{v^* + v/\sigma} - \alpha\right) - \gamma z.;$$

where we define the coefficients:

$$\beta \equiv \frac{b-c}{b+c}\,\Theta s^2 \geq 0 \quad \text{and} \quad \gamma \equiv \frac{1}{b+c} > 0$$

and use the definitions of the terms of trade and real security supplies:

$$\sigma \equiv EP^*/P \quad ; \quad v \equiv V/P \quad ; \quad v^* \equiv V^*/P^*$$

Equation (18) describes full equilibrium in the assets markets and will be used below in our diagrams as the asset market equilibrium schedule QQ. In asset market equilibrium the rate of depreciation is higher the higher the real supplies of foreign securities or the real exchange rate, σ, and the lower the real supply of home securities. There is thus clearly a link between the relative supplies of financial assets, the terms of trade and the rate of depreciation. Monetary factors enter in the term z that proxies relative money market conditions. Depreciation is higher the higher the ratio of money to income at home and the lower it is abroad.

We note that the relative substitutability of monies with home and foreign bonds affect the equilibrium rate of depreciation in (18). The closer the substitutability the more nearly b equals c so that β tends toward zero. This implies that security markets are relatively unimportant by comparison with monetary conditions in the determination of the rate of depreciation.

In the following analysis we assume that the home country is sufficiently small so that foreign repercussions can be ignored. Accordingly foreign inflation is taken as given, as are the real value of foreign securities, employment abroad and real balances. We concentrate thus on the home economy.

In the home goods market we assume that the rate of inflation is equal to the rate of trend money creation, $\dot{m}$, plus an increasing function of the terms of trade:[1]

$$\pi = g(\sigma) + \dot{m} \tag{19}$$

The price adjustment mechanism reflects the assumption that goods prices adjust only slowly to imbalance in the goods market and that goods demand is determined by relative prices. Output is assumed throughout at the full employment level. The model thus corresponds to that shown in Dornbusch (1976) although the asset market specification is, of course, different.

The expected rate of depreciation, $\bar{d}$, is determined by the inflation differential and the anticipated rate of adjustment in the terms of trade along the equilibrium path, $\dot{\sigma}$. We assume that along the rational expectations path the rate of adjustment in the terms of trade is proportional to the discrepancy between longrun equilibrium terms of trade and the current actual level:

$$\bar{d} = g(\sigma) + \dot{m} + h(\bar{\sigma} - \sigma) \quad ; \quad g' - h < 0 \; ; \quad g(\bar{\sigma}) = 0 \tag{20}$$

where we already impose a restriction on h required for the stability of the rational expectations path, as will become apparent below.

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[1] More extensively we can write (19) as $\pi = \psi(q-y) + \dot{m}$ where q and y are actual demand and fullemployment output. Actual demand is a function of output and the terms of trade: $q = \nu y + \mu\sigma$. Accordingly the equilibrium terms of trade are $\bar{\sigma} = y(1-\nu)/\mu$. Using that definition we can rewrite the inflation equation as $\pi = \mu\psi(\sigma - \bar{\sigma}) + \dot{m}$.

In Figure 3 we show the whole system in steady state equilibrium. The model is conveniently studied in terms of rates of depreciation and inflation relative to the growth rates of nominal assets, $\dot{m}$, and by reference to the terms of trade, or real exchange rate, σ. In steady state equilibrium at point A the real value of money and bonds are constant, inflation equals depreciation, actual and anticipated depreciation are equal. The Figure shows as upward sloping the schedule QQ that reflects the equilibrium in assets markets defined by (18). The schedule is flatter the lower is the term β. That implies that a low coefficient of

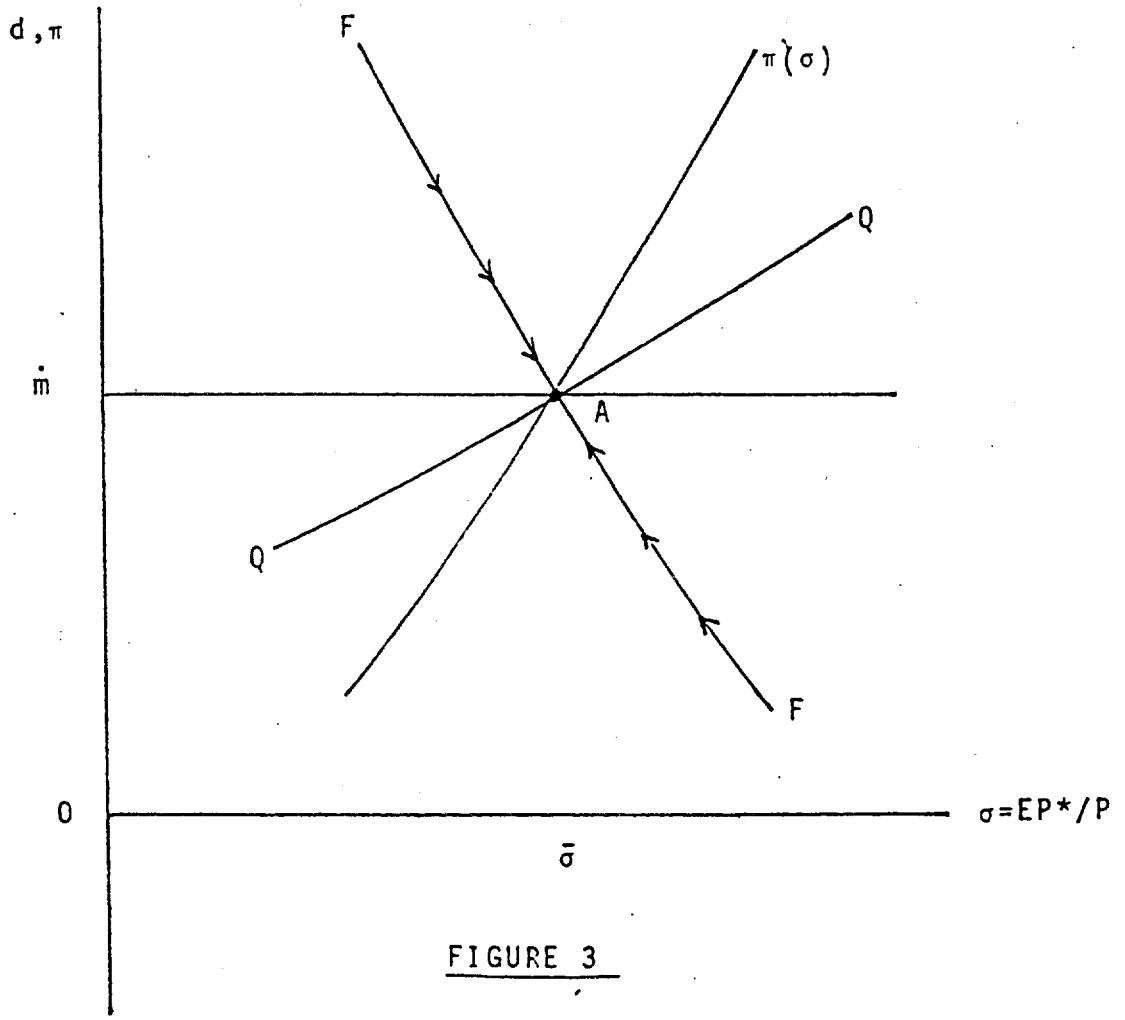

FIGURE 3

risk aversion or a low variability of relative asset returns tend to reduce the slope; if home and foreign securities tend to be equally close substitutes for monies this will tend to reduce the slope, as will a high level of substitutability between money and securities, b+c.

The inflation schedule corresponding to equation (19) is also shown upward sloping, by assumption steeper than the QQ schedule. The slope reflects the effect of changes in the real exchange rate on aggregate demand and the resulting effect of excess demand on the rate of inflation. The schedule thus represents a standard expectations augmented Phillips curve.

The rational expectations path is shown as FF and represents equation (20). The path shows the actual rate of depreciation as a function of money growth and the terms of trade. The coefficient h in (20) depends of course on the structural coefficients of the entire model.[1]

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(1) The saddle point properties of the model, as is conventional for rational expectations problems, can be seen by looking at the real balance and terms of trade space, plotting the schedules corresponding to constant real balances (and real bonds) and to constant terms of trade respectively.

2. Real and Financial Disturbances

Longrun equilibrium is shown at point A where inflation and depreciation equal the rates of expansion of nominal assets. At A real asset supplies and relative asset supplies are accordingly constant. Consider now how that economy is affected by real and financial disturbances. We start with the effects of a permanent fall in demand for domestic goods.

The current account worsening or fall in demand implies that the longrun equilibrium terms of trade will deteriorate to $\bar{\sigma}'$ in Figure 4. Accordingly the inflation schedule will shift out and to the right as does the schedule describing the depreciation rate along the perfect foresight path. The new shortrun equilibrium is determined by point A'. There is thus an immediate depreciation of the exchange rate and an immediate terms of trade deterioration. This is a result well in line with current account oriented models of the exchange rate. Associated with the terms of trade deterioration we have an increase in the rate of depreciation and a reduction in the rate of inflation.

At point A' the reduced rate of inflation implies that real balances are rising, thereby inducing a tendency for the rate of depreciation in (18) to decline. At the same time the rate of depreciation exceeds the rate of creation of bonds so that $v/\sigma = V/E$ declines thus tending to raise the rate of depreciation through the risk premium effect. We assume that money market effects dominates the risk premium effect so that the asset market equilibrium shifts down and to the right. The economy adjusts accordingly with a further deterioration in the terms of trade that raise competitiveness and thus narrow the gap between depreciation and inflation. The process continues until the new longrun equilibrium at A" is reached.

In Figure 5 we consider the effect of a once and for all, unanticipated, rise in the nominal money stock. From (18) to (20) it is apparent that only the asset market equilibrium schedule QQ will shift and that it shifts down and to the right. Longrun equilibrium terms of trade consistent with goods market equilibrium remain unchanged at $\bar{\sigma}$.

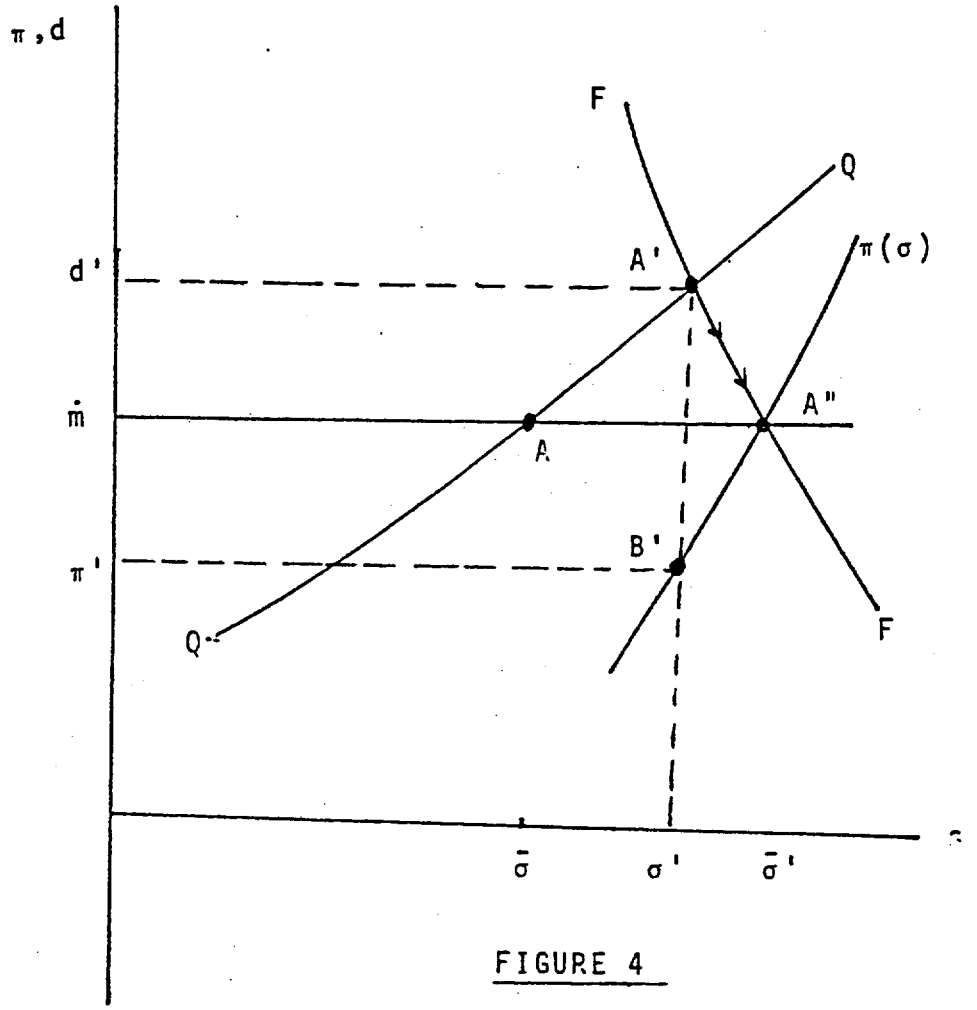

FIGURE 4

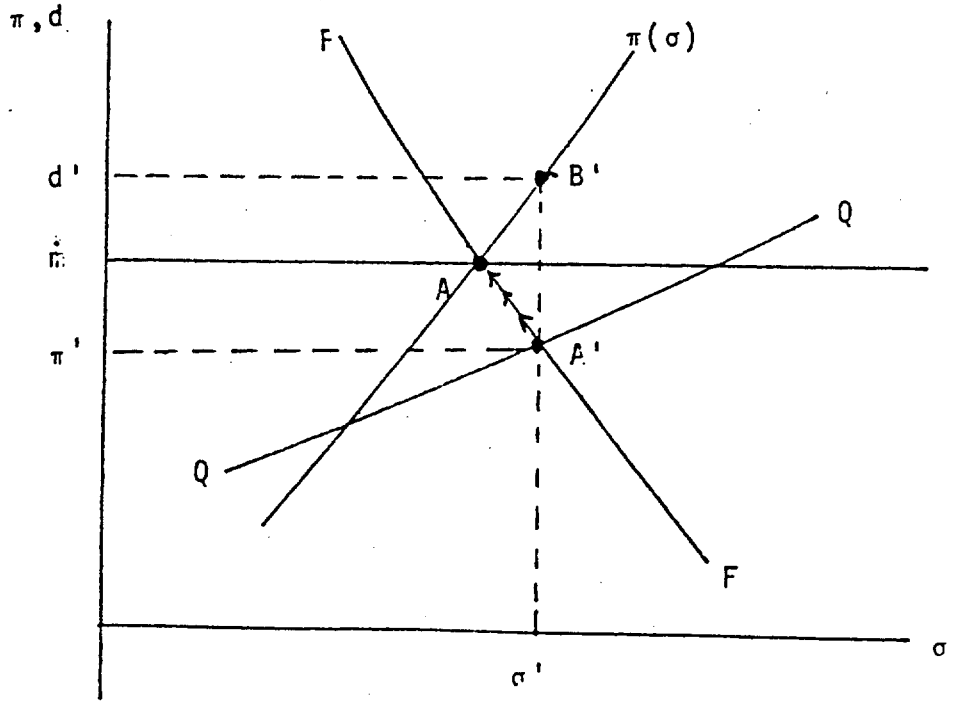

FIGURE 5

The shortrun effect of the money disturbance is a depreciation of the exchange rate and a deterioration in the terms of trade. At point A' the rate of depreciation has declined while the rate of inflation associated with the gain in competitiveness has risen. Accordingly the terms of trade are improving.

In shortrun equilibrium inflation exceeds money growth & creation of debt exceeds the rate of depreciation. Accordingly real balances are rising but the relative supply of foreign assets is declining. Again assuming that the monetary effect dominates we have an upward shifting asset market equilibrium schedule. The economy moves toward the steady state with continuing terms of trade improvement and a narrowing of the gap between inflation and depreciation.

What about the steady state? The longrun homogeneity in money prices, bonds and the exchange rate cannot be satisfied here because only money increased. Therefore money rises relative to debt, while exchange rates remain unchanged relative to prices.

Next we study a shift in asset demands. Suppose the public recognizes increased real exchange rate variability. Then by (12)' asset demand shifts will change the equilibrium risk premium. Particularly if initially foreign relative asset supplies fell short of the foreign size, $V^*/W - (1-a) < 0$ the risk on premium on foreign securities will fall. In terms of Figure 5 this implies a downward shift of the asset market equilibrium schedule. Accordingly the exchange rate will depreciate and we go through the adjustment process already described. An alternative is a market intervention. The appropriate policy here is to issue Carter bonds -- an issue of foreign currency denominate bonds with the proceeds serving to recover domestic securities. This is equivalent to a sterilized exchange market intervention in support of the home currency. The intervention policy would preserve the initial real equilibrium as the change in the relative supply of nominal assets is achieved by trading nominal assets rather than through valuation changes. The risk of the operation, of course, is that we do not know when we are facing portfolio shifts and when the source of the disturbance is a change in the equilibrium terms of trade.

A last application of the model is the effect of a currently anticipated future disturbance. In different models this question has been addressed by Wilson (1979), Rogoff (1979), Dornbusch and Fischer (1980) and others. We take here the case of a currently anticipated future increase in the nominal money stock. Suppose it becomes known that T years into the future there will be a once and for all increase in nominal money. How will that expectation effect the current exchange rate, inflation and rate of depreciation?

In Figure 5 we showed that an unanticipated increase in current money leads to a transitory depreciation, increased inflation and reduced rates of depreciation. The expectation of a future increase in money of course leads the public to contemplate that future course of events, leads to the expectation of a capital gain on foreign exchange holdings and thereby forces an immediate depreciation of the spot exchange rate.

In Figure 6 we show the impact effect of currently anticipated future money. The spot exchange rate immediately depreciates and leads to a terms of trade deterioration from $\bar{\sigma}$ to σ. In that shortrun equilibrium we have increased inflation and depreciation and thus falling real money and security holdings. Furthermore, with inflation in excess of depreciation the terms of trade are improving. This implies that there is an initial exchange rate overshooting. Over time now with falling real asset holdings the QQ schedule is shifting upward while the real exchange rate continues to appreciate. Only at the time where the money does actually arrive does the QQ schedule shift back down, as in Figure 5, and lead to an equilibrium at point A" on the perfect foresight path. From here the economy returns to the initial steady state.

3. A Let-Down ?

A central part of our macro model was the specification of the monetary sector in (16)where nominal yields on home and foreign currency securities had a differential effect on money demand. Suppose, alternatively, that money demand depends on the average

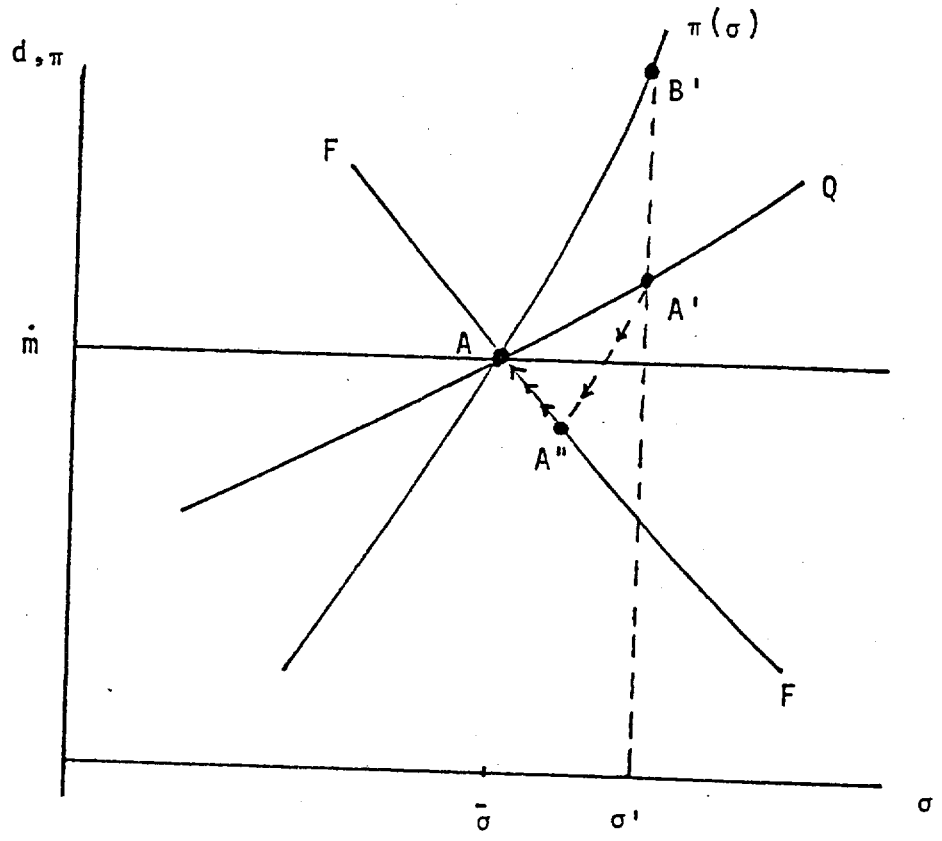

FIGURE 6

nominal return on the portfolio, measured in terms of the respective currencies. Then the money market equilibrium conditions become:

$$(16)' \quad m-p = -b'\lambda \; ; \quad m^*-p^* = -b'\lambda^*$$

where $\lambda = \omega i+(1-\omega)(i^*+d)$ and $\lambda^*=\omega(i-d)+(1-\omega)i^*$ are the alternative costs of holding home and foreign monies.

It is immediately apparent that this specification is equivalent, in terms of (18) to the case where b=c or $\beta=0$. The asset market equilibrium condition representing the QQ schedule reduces to:

$$(18)' \quad d = -\gamma z$$

The striking implication of this case is that security markets have no relevance now to the macroeconomics of exchange rate determination, inflation and depreciation. The relative supplies of securities only affect interest rate diffferentials, the rate of depreciation and the average level of interest rates are determined by the conditions of monetary equilibrium.

None of our earlier analysis is substantially affected--because we already assumed the dominance of monetary considerations in the QQ schedule--except in three respects. First, the QQ schedule now is flat and security markets have no role in determining the extent of exchange rate adjustment in response to a disturbance. Second, adjustment to a real disturbance such as a permanent terms of trade change, now is immediate and full rather than a drawn-out process. Finally, as already noted, the relative supplies of securities and sterilized intervention policy become irrelevant to exchange rates. Moreover, these observations remain true when a broader specification of the goods market allows the real interest rate to affect aggregate demand.

Whether portfolio considerations are relevant to the macroeconomics of exchange rate determination depends then critically on the precise way in which home and foreign interest rates enter the demand for money. This siggests, of course, that more attention must be paid to the derivation of money demand. In particular it may be quite frivolous to assume a money demand equation such as (16)' rather than derive it jointly with the portfolio equations from maximisation considerations. The force of that consideration is strengthened by an observation due to Kouri (1975,1978b). He notes that domestic money and home currency bonds have the same stochastic characteristics since they are both assets fixed in nominal terms. This implies an interdependence of money holdings and bond holdings since investors can effectively rent their money rather than own it. In Kouri's work the joint derivation of money and portfolio equations leads to a money demand equation that depends only on home interest rates and wealth, rather than income. In terms of our model that would imply that the term c=0 and that portfolio considerations do play a role in exchange rate determination. Clearly, then, money demand properties remain the key issue in integrating portfolio balance and exchange rate determination.

APENDIX: LOCAL HABITATS

Suppose that, unlike in part II, we assume different consumption patterns across countries. Then the relevant inflation rates will differ as the composition of consumption baskets varies across countries. Maintaining for the home country the definition of dollar inflation of the consumer price index as in (6) we have a parallel equation for the foreign consumer:

$$(6)' \qquad \tilde{\pi}^* = a^*\pi + (1-a^*)(\pi^*+d)$$

Accordingly the real rates of return faced by foreign consumers will be:

$$(8)' \qquad j = i-\pi-(1-a^*)u \quad , \quad j^* = i^*-\pi^*+a^*u$$

where j and j* are the real returns to foreign consumers on home and foreign securities respectively. It is immediately apparent from the real return equations that both variances and covariances of real returns will be different for home and foreign consumers, but that the variance of the rate of depreciation will be the same. This point is apparent from inspection of equations (9).

The foreign portfolio holders' share of foreign securities can now be written as:

$$(10)' \qquad x^* = \frac{\bar{r}^*-\bar{r}}{\Theta s_d^2} + \frac{s_\pi^2 - s_{\pi\pi^*} + (1-a^*)s_u^2}{s_d^2}$$

where we have used the fact that mean real yield differentials are equal across countries. The foreign portfolio share differs only in the minimum variance component and does so only to the extent that there is real exchange rate variability. In particular with real exchange rate variability foreigners will hold a larger share of their portfolio in terms of foreign securities if their expenditure share of foreign goods, 1-a*, exceeds our expenditure share for those commodities, 1-a. Differences in tastes do <u>not</u> affect the speculative portfolio.

The condition of market equilibrium is obtained from aggregation: $xW + x^*W^* = V^*$, or using (10) and (10)':

$$(5)'' \qquad \bar{r}^* - \bar{r} = \Theta s_d^2 \left[V^*/(V^*+V) - \alpha \right] + \Theta s_u^2 (a^*-a) \frac{W^*}{W+W^*}$$

where α was defined in (5)' and where W and W* are aggregate home and foreign, non-monetary nominal assets: $W+W^* \equiv \bar{W} \equiv V+V^*$.

Country specific consumption patterns thus introduce a real interest differential or risk premium. The extent of the premium depends on the difference in tastes, a*-a, the coefficient of risk aversion, the variance of the real exchange rate depreciation and wealth distribution $W^*/(W+W^*)$.

The role of differences in consumption patterns is to introduce distribution effects into the determination of the risk premium. An international redistribution of wealth toward the foreign country, with $a > a^*$, will lower the real yield differential on foreign securities. In terms of excess depreciation we now obtain the following relation:

$$(14)' \qquad d - f = (d-\bar{d}) + \Theta s_d^2 \left[\left(\frac{V^*}{V^*+V} - \alpha \right) + (a^*-a) \frac{s_u^2}{s_d^2} \frac{W^*}{W^*+W} \right]$$

Accordingly differences in consumption patterns induce an extra term in the risk premium that causes a divergence between the forward premium and the rate of depreciation. A redistribution of wealth toward the foreign country, through a cumulative current account deficit of the home country, would reduce the rate of excess depreciation, since $a^*-a < 0$.

Equation (5)" or (14)' are interesting in that they point to the difference in the quantitative importance of the relative supply and the relative walth effects. The latter has a coefficient $(a^*-a)s_u^2/s_d^2$ which is a fraction of the other coefficient. Thus empirically we would expect relative supply effects to be more important, unless current account imbalances dominate budget imbalances that give rise to the issue of outside debt. In much of the literature on the risk premium, in particular in the work

by Dooley and Isard (1979) the wealth distribution effect is singled out, and rejected, as an explanation for the large excess depreciation of exchange rates in the 1970's. For a further discussion see Dornbusch (1980).

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