THE EXCHANGE AND INTEREST RATE TERM STRUCTURE UNDER RISK AVERSION AND RATIONAL EXPECTATIONS

by

Charles A. WYPLOSZ

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Directeur de la Publication :

Jean-Claude THOENIG
Associate Dean: Research and Development
INSEAD

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THE EXCHANGE AND INTEREST RATE TERM STRUCTURE UNDER RISK AVERSION AND RATIONAL EXPECTATIONS*

Charles A. Wyplosz**
INSEAD, Fontainebleau, France

Abstract

Recent portfolio balance models of exchange rate determination under rational expectations are extended to determine jointly the exchange rates, both spot and forward, the interest rate and the current account. With risk aversion, domestic and foreign bonds are not perfect substitutes, despite capital mobility, so that the domestic and foreign interest rates diverge by more than the expected rate of depreciation or, equivalently, the forward rate is a biased predictor of the spot rate. The resulting model is used to explore the responses to a current account disturbance, distinguishing whether this disturbance is permanent or transitory and whether it has been anticipated or not.

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** Address: INSEAD, Boulevard de Constance, 77305 Fontainebleau, France.

1 - INTRODUCTION

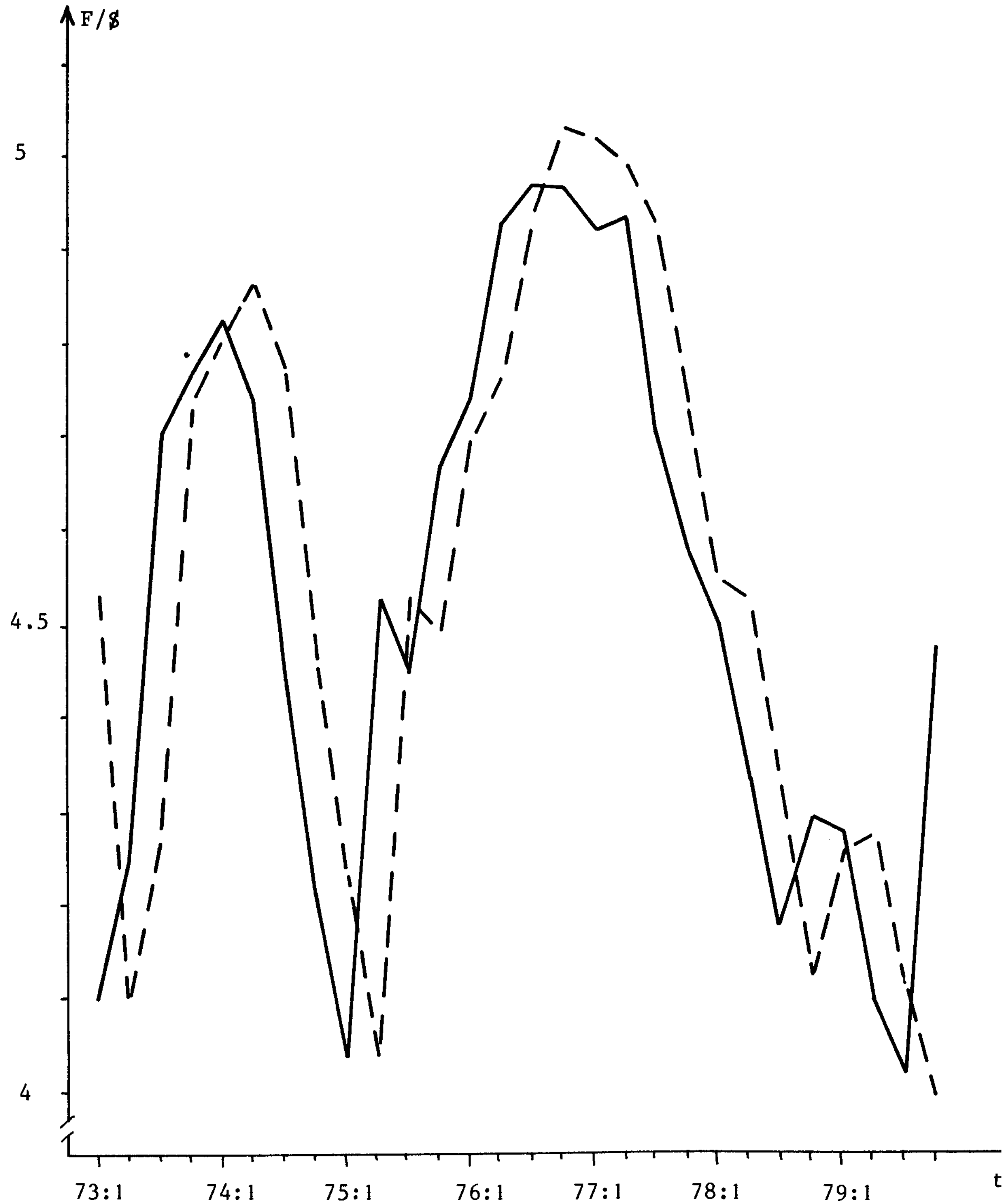
This paper presents an extension of the models by Rodriguez (1978) and Dornbusch and Fischer (1980), such that we can study the joint behavior of the spot and forward exchange rates, the interest rate and their term structure under rational expectations, as well as the current account. The notion that these variables should be properly understood as jointly endogenously determined is not new. The monetary approach, and particularly the portfolio balance models, have made it clear that interest and exchange rates follow from portfolio general equilibrium conditions. Further developments included explicitely the formation of expectations and the role of the current account.[1] Finally, it has been obvious for a long time that the forward exchange rate should be explained together with the exchange and interest rates.[2]

Yet, surprisingly, few models have been devoted to explore the joint behavior of these variables. On the contrary, as noted by Kohlhagen and Willett (1980), a great deal of attention has been recently devoted to simple key relationships: purchasing power parity, Irving Fisher's expectations, the interest rate parity conditions, the future spot-forward exchange rate relationship, etc... Unfortunately this does not go without some confusion in the empirical literature. For example, it is customary to make the validity of certain models depend on the sign of the estimated coefficients of some (endogenous) variable appearing on the right hand side of a given regression.[3]

One purpose of this paper is to once again caution against drawing sanguine conclusions from models which are inherently partial equilibrium. Through a series of experiments, it will be shown that the observable relationships between the above-mentioned endogenous variables are likely to be strongly dependent upon the sample period.

A second purpose is to deal explicitely with the forward exchange rate. The pattern apparent on figure 1 is general and can be reproduced for other currencies over different periods, and has been reported by many authors (e.g. Isard (1978)). It appears that the discrepancy between the spot and the lagged exchange rate exhibits some degree of persistence and systematicity[4]: the forward rate is usually above the spot rate when the latter appreciates, and conversely, but turning points are always missed. The usual explanation, as spelled out for example in Mussa (1979), is that apart from trend movements, both rates react instantaneously to the acquisition of new information, and that most of the variability is attributable to such news. To make this argument rigorous then, one must deal explicitely with uncertainty. In particular, unless it is assumed that risk neutrality prevails, it is no longer possible to assume perfect substituability between assets denominated in different currencies. Accordingly, the model developed here allows for domestic and foreign interest to differ not only by the expected rate of depreciation but also by a risk premium. Equivalently, the forward rate is shown to be a systematically biased predictor of the expected future spot exchange rate.[5]

The next section builds up a pure small country portfolio balance model with three assets and a forward market.[6] A general solution of this discrete time model under rational expectations is given in section 3. In section 4, the model is used to describe the dynamic adjustment of exchange and interest rates following a shift in the current account. The disturbance is allowed to be temporary or permanent, anticipated or unanticipated. The results are discussed in the last concluding section.



<u>FIGURE 1</u>

The French Franc: Lagged Spot (E_{t-1}) and Three Month Forward Rate (F_t). Quarterly Data. Source: IFS (Tape of June 1980).

2 - THE MODEL

The structure of this discrete time model heavily draws on Rodriguez (1978). It is assumed that the domestic economy is small enough not to affect the interest rate in the foreign country, taken to represent the rest of the world. The domestic portfolio includes three assets: 1) domestic money, not traded internationally, with a constant (zero) nominal yield; 2) a domestic non traded bond, with a nominal return r_t; 3) a foreign bond, the only one which traded, with a nominal return r_t^*, so that its expected yield for domestic holders is $r_t^* + ({}_tE_{t+1} - E_t)/E_t$, where $\dot{E}_t$ is the exchange rate at time t, and ${}_tE_{t+1}$ its expected next period value. However, because there exists a forward exchange market, domestic holders can obtain a non stockastic return of $r_t^* + ({}_tF_{t+1} - E_t)/E_t$ by selling their next period receipts at the rate ${}_tF_{t+1}$, agreed at period t for delivery at period t+1. Thus, the present setup differs from Rodriguez by the addition of a domestic non traded asset as well as by the existence of a forward market. The model then can be interpreted as consisting of four assets: money, domestic bonds, foreign bonds uncovered, and foreign bonds covered. With Walras law, we will have three independent equations determining r_t, E_t and ${}_tF_{t+1}$.

Since there is no added uncertainty resulting from the holding of foreign bonds as compared to the holding of domestic bonds, perfect capital mobility renders these two assets perfect substitutes, so that the covered interest parity condition holds[7]:

$$(1) \qquad r_t = r_t^* + ({}_tf_{t+1} - e_t)$$

where $e_t = \log E_t$ and ${}_tf_{t+1} = \log {}_tF_{t+1}$.[8]

The remaining assets are imperfect substitutes. The following equation follows from standard portfolio balance conditions and is similar to the one used by Rodriguez:

$$\frac{M_t}{E_t A_t} = K\left(r_t, r_t^* + \frac{{}_tE_{t+1} - E_t}{E_t}\right)$$

where A_t represents the foreign currency value of domestically held foreign assets.[9] Taking logarithms and linearizing this condition becomes:

$$(2) \qquad m_t - e_t - a_t = h'_0 - h_1 r_t^* - h_2 r_t - h_1({}_te_{t+1} - e_t) + u_t$$

where $m_t = \log M_t$, $a_t = \log A_t$ and ${}_te_{t+1} = \log {}_tE_{t+1}$ and with a random disturbance term u_t added to reflect demand shifts.[10]

The last equation describes the forward market equilibrium condition. Under risk aversion, a premium separates out the forward rate from the corresponding expected future spot rate:

$$(3) \qquad {}_te_{t+1} - {}_tf_{t+1} = \alpha . H_t + \beta . {}_tB_{t+1}$$

with H_t a hedging pressure term to be defined shortly and ${}_tB_{t+1}$ the next period expected current account. This particular specification of the premium is derived from Wyplosz (1980), a simplified version of which is presented in Appendix 2. It acknowledges two sources of risk premia. First the role of foreign assets in the domestic portfolio has been studied in the Finance Theory literature (see Solnik (1974) or Frankel (1979)), and leads to the hedging term. This is a complicated expression involving the value of domestically held traded assets a_t and the covariance terms customarily obtained from mean-variance utility maximization. These expressions have little macroeconomic content so that it is proposed here to simply describe the hedging pressure term as a linear function of a_t[11]:

(4) $H_t = a_t - \bar{a}$

The second source of a risk premium in (3) attempts to capture the important role of trade related forward market operations, very much in line with the explicit treatment of the current account in the determination of the spot exchange rate. The presence of ${}_tB_{t+1}$ reflects the fact that traders would normally cover on the forward exchange market part of next period payments (assuming that trade deals agreed upon during period t are paid for in period t+1). Consequently, traders will have to offer a risk premium to induce risk averse investors to carry part of the exchange risk which they cannot fully diversify among themselves as long as expected trade is not in balance.

The coefficients α, β and $\bar{a}$ are derived from optimizing behavior and presumed to be positive, although not time-invariant. Their values depend, among others, upon the level of exchange rate uncertainty and the total amount of risk aversion existing among forward exchange market participants.[12] In what follows these coefficients are taken to be constant.

The instantaneous portfolio equilibrium conditions having been specified, we now proceed to describe the dynamics. With the supply of domestic money and bonds normally held constant, this is given by the accumulation or decumulation of foreign assets through the current account. Following Rodriguez, we define the Normalized Current Account i.e. the ratio of the current account to domestic holdings of foreign assets:[13]

(5) $B_t = \dfrac{CA_t}{A_t} = \dfrac{\Delta A_t}{A_t} = a_{t+1} - a_t$

The accumulation of foreign assets is described by a Metzler-type aggregate savings function negatively related to domestic wealth expressed in foreign currency units:

(6) $$a_{t+1} - a_t = k'_{0,t} - k_1 a_t - k_2(m_t - e_t) + v_{t+1}$$

where v_{t+1} is a random disturbance. The term $k'_{0,t}$ is a "structural parameter" which can change over time. Since the right-hand side is a log-linear version of a wealth-saving relationship, the coefficient k_1 and k_2 are not necessarily equal and the value of domestic bonds is assumed to be constant.

Finally, we assume that expectations are formed rationally, i.e. for any variable X_t:

(7) $${}_tX_{t+1} = E(X_{t+1}/I_t)$$

where E( ) is the expectations operator and I_t is information available at time t.

3 - GENERAL SOLUTION

It will be computationally easier to deal with the hedging pressure term $H_t = a_t - \bar{a}$ rather than a_t. Accordingly, the model to be solved is rewritten as:

(1) $$r_t = r^{\star}_t + {}_tf_{t+1} - e_t$$

(2') $$m_t - e_t - H_t = h_0 - h_1 r^{\star}_t - h_2 r_t - h_1({}_te_{t+1} - e_t) + u_t$$

(3') $${}_te_{t+1} - {}_tf_{t+1} = \alpha . H_t + \beta . ({}_tH_{t+1} - H_t)$$

(6') $$H_{t+1} - H_t = k_{0,t} - k_1 H_t - k_2(m_t - e_t) + v_{t+1}$$

with $h_0 = h'_0 + \bar{a}$ and $k_{0,t} = k'_{0,t} - k_1\bar{a}$.

It turns out that the model is block-recursive since it can be solved first for e_t and H_t, and then, through (1) and (3') for ${}_t f_{t+1}$ and r_t. This is shown by substituting (1) and (3') in (2') and (6') which are rewritten as:

$$(8) \qquad H_{t+1} = (1 - k_1)H_t + k_2 e_t + k_{0,t} - k_2 m_t + v_{t+1}$$

$$(9) \qquad {}_t e_{t+1} = A_1 H_t + A_2 e_t + A_3 + A_4 k_{0,t} - r_t^* - (A_2 - 1)m_t + A_5 u_t + A_4 \cdot {}_t v_{t+1}$$

with $A_1 = (1 + \alpha h_2 - \beta h_2 k_1)/h, \quad A_2 = (1 + h + \beta h_2 k_2)/h$

$A_3 = h_0/h, \quad A_4 = \beta h_2/h, \quad A_5 = 1/h, \quad h = h_1 + h_2.$

Before proceeding to solving these equations, we briefly examine the stationary state implications of the model. The stationary state is achieved with $r_t^* = \bar{r}$, $k_{0,t} = \bar{k}_0$, $m_t = \bar{m}$, and $v_t = {}_t v_{t+1} = u_t = 0$. Then (8) and (9) imply:

$$(10) \qquad \bar{H} = \frac{\bar{k}_0 - h_0 k_2 + k_2 h \bar{r}^*}{k_1 + k_2 + \alpha h_2 k_2}$$

$$(11) \qquad \bar{e} = \bar{m} - \frac{(1 - \alpha h_2)\bar{k}_0 + h_0 k_1 - k_1 h \bar{r}^*}{k_1 + k_2 + \alpha h_2 k_2}$$

Quite clearly, the model's stationary state characteristics are identical to those of Rodriguez or Dornbusch and Fischer. We first observe the homogeneity property: an increase in the money supply is entirely absorbed by an equiproportionate depreciation with no change in foreign asset holdings. Second, an increase in the foreign exchange rate leads to a higher demand for foreign assets: this is met both by an exchange rate depreciation which increases the domestic value of these assets and by a higher volume of domestic holdings. Finally, a structural improvement in the current account (an increase in $\bar{k}_0$) will lead to an increased stock of foreign assets and an exchange rate appreciation[14] implied by the requirement of portfolio equilibrium (equation (2')).

More novel are the stationary state characteristics of the interest and forward exchange rates:

(12) $\quad \bar{f} = \bar{e} - \alpha\bar{H}$

(13) $\quad \bar{r} = \bar{r}^{*} - \alpha\bar{H}$

In the presence of uncertainty there will be a need for forward cover on foreign assets. If $\bar{H}>0$, with the stationarity state current account in balance, this implies a net supply of foreign currency forward and $\bar{f}<\bar{e}$. Consequently, foreign covered bonds being a perfect substitute to domestic ones, $\bar{r}$ will be lower than $\bar{r}^{*}$ as dictated by the interest parity condition.

These results should not be taken too literally. It has been noted that $\bar{a}$ is not really a constant and it is likely that in the long run $\bar{a}$ would eventually assume whatever value is needed to have $\bar{H}=0$. This does not preclude the possibility of observing for quite a long time divergences between r and r^{*} as well as a risk premium on the forward exchange rate. In what follows it will be assumed that $\bar{H}=0$ is zero in the original stationary state, but may differ from zero in the new one that follows the disturbance.

To solve the model, we use the method derived in Blanchard and Kahn (1980). The essential feature of this method consists in distinguishing between variables according to whether they are predetermined or not. Non-predetermined variables in a rational expectations model are those variables which react instantaneously and freely to news: interest rates, exchange rates play such a role. Predetermined variables on the other side, although responding to changes in expectations, cannot vary overnight. This is the case of stock variables, here foreign asset holdings. In solving models including both types of variables, one may want to obtain for the non-predetermined variables solutions which are forward looking, i.e. independent of past expectations, while predetermined variables depend upon both past and present expectations of the future values of the exogeneous variables.

Equations (8) and (9) are rewritten in matrix form with $K = 1 - k_1$:

$$(14)\qquad \begin{bmatrix} H_{t+1} \\ {}_te_{t+1} \end{bmatrix} = A \begin{bmatrix} H_t \\ e_t \end{bmatrix} + \begin{bmatrix} \gamma_1 \\ \gamma_2 \end{bmatrix} \begin{bmatrix} Z_t \end{bmatrix} \quad \text{and } A = \begin{bmatrix} K & k_1 \\ A_1 & A_2 \end{bmatrix}$$

where $Z_t' = 1, k_{0,t}, r_t^*, m_t, u_t, v_{t+1}, {}_tv_{t+1}$ collects the exogenous driving variables. Blanchard and Kahn show that for (14) to be (saddle-point) stable, the matrix A must have one root outside and one root inside the unit circle. This is the case here when $A_2K>A_1k_2$. Thereafter it will be assumed that this condition is satisfied and, in order to avoid oscillatory solutions, that the two roots λ_1 and λ_2 are positive:

$$0<\lambda_1<1 \quad \text{and} \quad \lambda_2>1.$$

We can now write the rational expectations solutions to (14):

$$(15)\qquad H_t = \lambda_1 H_{t-1} + \gamma_1 Z_{t-1} - \sum_{i=0}^{\infty} \lambda_2^{-i-1} \left[(K-\lambda)\gamma_1 + k_2\gamma_2\right] {}_{t-1}Z_{t+i-1}$$

$$(16)\qquad e_t = -(K-\lambda_1)k_2^{-1} H_t - \sum_{i=0}^{\infty} \lambda_2^{-i-1} \left[(K-\lambda_1)k_2^{-1}\gamma_1 + \gamma_2\right] {}_tZ_{t+i}$$

These equations can be used to study the system under any expected behavior of the variables collected in Z_t. We will consider next one simple case.[15]

4 - A CURRENT ACCOUNT DISTURBANCE

It will be assumed now that $m_t = \bar{m}$, $r_t = \bar{r}^*$, $\forall t$, and that u_t and v_t are independent white noise disturbances. The experiment will start at period t=0. Up to t=-1, the system was resting in the stationary state described by (10) to (13) with $k_{0,t} = \bar{k}_0$ and the additional assumption that $\bar{H}=0$ so that $\bar{e}=\bar{f}$ and $\bar{r}=\bar{r}^*$. At time t=0, a disturbance in $k_{0,t}$ will be discovered and we are interested in describing the paths of expected ${}_0a_t$, ${}_0e_t$, ${}_0r_t$, as well as the term structure of ${}_0f_t$, for all $t \geq 0$. The zero subscript being unambiguous will be dropped to simplify notations but it is important to keep in mind that we are looking at (rational) expectations as off period zero.

With these assumptions, the expected vector Z_t reduces to $Z'_t = \left[1, k_{0,t}, \bar{r}^*, \bar{m}, 0, 0, 0\right]$. Several experiments will be conducted with $k_{0,t}$ increasing from $\bar{k}_0$ to $\bar{k}'_0$, depending upon whether this disturbance is permanent or temporary, anticipated or not.

4.1 Stationary States

The initial stationary state is characterized by $\bar{H}=0$, $\bar{e} = m - \bar{k}_0/k_2$, $\bar{r}=\bar{r}^*$ and $\bar{f}=\bar{e}$. If $k_{0,t}$ is permanently increased from $\bar{k}_0$ to $\bar{k}'_0$ the new stationary state is:

$$\bar{e}' = \bar{e} - (1 + \alpha h_2)(k_1 + k_2 + \alpha h_2 k_2)^{-1}(\bar{k}'_0 - \bar{k}_0)$$

$$\bar{H}' = (k_1 + k_2 + \alpha h_2 k_2)^{-1}(\bar{k}'_0 - \bar{k}_0)$$

so that there will be an accumulation of foreign assets and an exchange rate appreciation. From (6') it is clear that when the new stationary state is achieved:

$$k_1(\bar{H}' - \bar{H}) - k_2(\bar{e}' - \bar{e}) = (\bar{k}'_0 - \bar{k}_0)$$

because the requirement of a balanced current account imposes that the exogenous gain in competitiveness be matched by an increase in H and a decrease in e, both changes leading to a higher aggregate spending through wealth effects. The breakdown between these two adjustments is dictated by the portfolio balance condition. Finally note that with $\bar{H}'>0$, we have $\bar{f}'<\bar{e}'$ and $\bar{r}<r^*$.

4.2 An Unanticipated Permanent Change

At time zero, it is discovered that $k_{0,t}$ has increased permanently from $\bar{k}_0$ to $\bar{k}'_0$. The rational expectations paths are derived from (15) and (16):

$$(17) \qquad H_t = \bar{H}'(1 - \lambda_1^t)$$

$$(18) \qquad e_t = \bar{e}' + (K - \lambda_1)k_2^{-1}.\bar{H}'.\lambda_1^t$$

The behavior of the endogenous variables is depicted on figure 2 at the end of the section. It appears that the current account becomes positive as the economy starts accumulating foreign assets. Portfolio equilibrium requires a corresponding exchange rate appreciation maintaining the domestic value of foreign assets compatible with a fixed money supply. Furthermore, the expectation of appreciations as off t=0 implies an immediate increase in the demand for money which has to be offset by a discrete initial drop in e_t.[16]

The forward rate term structure is given by (3'). With a current account surplus and H_t becoming positive, there is a net supply of foreign currency forward which pushes f_{t+1} below e_{t+1}: the forward rate persistently underestimates the future spot rate, despite rational expectations and perfect capital mobility. Consequently, the domestic interest rate decreases below the world level.

4.3 An Anticipated Permanent Gain

In this experiment $k_{0,t} = \bar{k}_0$ for $t<T$ and $k_{0,t} = \bar{k}'_0 > \bar{k}_0$ for $t \geq T$, the disturbance being announced at time zero. One can think of the discovery of oil in the North Sea and the expectation that it will start flowing at some known later date. The laws of motion, derived from (15) and (16) are given below and the graphical description is on figure 3:

$$(19)\quad \begin{aligned} H_{T-n} &= -\frac{K-\lambda_1}{\lambda_2 - 1} \cdot \frac{\lambda_2^{T-n} - \lambda_1^{T-n}}{\lambda_2 - \lambda_1} \cdot \frac{\bar{k}'_0 - \bar{k}_0}{\lambda_2^T} \quad , \forall n \geq 0 \\ H_{T+n} &= \lambda_1^n H_T + \bar{H}'(1 - \lambda_1^n) \quad , \forall n > 0 \end{aligned}$$

$$(20)\quad \begin{aligned} e_{T-n} &= \bar{e} - \frac{K-\lambda_1}{k_2(\lambda_2 - 1)} \cdot \frac{\Phi(T-n)}{\lambda_2^T} \cdot (\bar{k}'_0 - \bar{k}_0) \quad , \forall n > 0 \\ e_{T+n} &= \bar{e}' + \frac{K-\lambda_1}{k_2} \cdot (\bar{H}' - H_T) \cdot \lambda_1^n \quad , \forall n \geq 0 \end{aligned}$$

with $\Phi(t) = \lambda_2^t - (K - \lambda_1)(\lambda_2^t - \lambda_1^t)(\lambda_2 - \lambda_1)^{-1}$.

Obviously, H_{T-n} is negative and decreasing from $H_0=0$ to H_T. Then H_{T+n} is a weighted average of H_T and its long run value $\bar{H}'$. The function $\Phi(t)$ is positive and increasing (except maybe initially, but with no clear economic interpretation).[17]

As the exchange rate is expected to appreciate in the long run, the demand for money increases immediately in period t=0: there must be an initial offsetting discrete appreciation to reduce the domestic value of foreign bonds $(e_t + H_t)$.[18] As a consequence of this appreciation, the current account turns into a deficit until period T when the gain in k_0 materializes. Thereafter, foreign assets are accumulated beyond proportion with the exchange rate appreciation so that in the steady state $(\bar{e}' + \bar{H}')$ is above $(\bar{e} + \bar{H})$ with the wealth effect on expenditure compensating the increase in k_0 and ensuring a balanced current account.

Regarding the forward exchange rate, between periods zero and T, with both H_t and B_t negative, f_t is unambiguously at a discount (see (3')). After period T, we eventually have both H_t and B_t positive so that f_t will drop below e_t. For a while, however, immediately after T, we still have H_t negative but increasing so that B_t is positive and the sign of $e_t - f_t$ is ambiguous, depending upon the relative magnitudes of coefficients α and β. On figure 3, we represent the case where β is larger so that the current account term dominates the hedging pressure effect.

The relationship between the domestic and foreign interest ratès is given by (1) which is rewritten here as:

$$(1') \qquad r_t - r_t^* = (f_{t+1} - e_{t+1}) + (e_{t+1} - e_t)$$

After period T, both terms on the right hand side are negative so that the domestic interest rate is below the world level. Before period T (and maybe somewhat later as discussed above), the first bracket is positive, the second negative. The relative absolute values of these two terms depend upon the sizes of coefficients α and β. When α and β are small, the depreciation effect dominates and this is the case described by Dornbusch and Fischer.

On the contrary, when α and β are large, it is the risk premium effect that matters. In Appendix 1, we give the observed means and standard deviations of $({}_tf_{t+1} - e_{t+1})$ and $(e_{t+1} - e_t)$ for several currencies over the floating rate period (1973:2 - 1980:1, quarterly data). There is no presumption as to which effect should dominate in (1'). To bring out more sharply the distinctive feature of this paper, it is assumed in the graphical description that β is larger than α and large enough for the risk premium effect to dominate. Thus on figure 3, r_t is shown above r^* between periods 0 and T.

It is interesting to note that before period T, we observe a current account <u>deficit</u> together with an exchange rate <u>appreciation</u>. Such a behavior during the transition to a new stable path has been previously described, e.g. in Rodriguez and in Dornbusch and Fischer. Of interest also is that, while the exchange rate always appreciates, the interest rate first increases then decreases, thus violating the uncovered interest parity condition. Finally, we note that the forward rate is constantly a biased predictor of the future spot rate, but it first overestimates it, then moves to underestimate it, with no noticeable change in the smooth behavior of the spot rate.

4.4 An Unanticipated Temporary Gain

What happens when it turns out that this year's crop has been exceptionally good? That is one way of interpreting the present experiment where $k_{0,t}$ jumps to $\bar{k}'_0$ from period zero to period T-1, and then gets back to its initial level $\bar{k}_0$. It can be shown formally, but it is intuitively clear, that this experiment is the sum of an unanticipated increase and of an anticipated decrease of k_0, both changes being permanent and of the same magnitude. The graphical description of figure 4 is therefore derived from the results obtained in sections 4.2 and 4.3. Of course, the stationary state remains unchanged following a temporary disturbance.

Because k_0 increases, the economy immediately starts accumulating foreign assets. This increase in wealth leads to a higher demand for money which has to be offset by an exchange rate appreciation (to reduce $e_t + H_t$), or by the expectation of a depreciation, or both. As a result, the exchange rate immediately appreciates upon announcement of the good crop.[19] If the disturbance is known to be short-lived (T is small), the jump is small, there will be a modest increase in foreign assets holdings until T and after period zero the exchange depreciates back to its long run value. If T is large, more foreign bonds will be accumulated, the initial appreciation in e_t is larger and followed for a while by a further gradual depreciation. Before period T, however, the exchange rate turns around and embarks on a depreciation path toward its equilibrium value. The latter case only is reported in figure 4.

After period T, the current account turns into a deficit because the wealth effect of accumulated foreign bonds is not matched anymore by the good crop effect. The forward rate is unambiguously below the corresponding spot rate until period T since in (3') both H_t and the current account are positive. After period T, however, the sign of $e_t - f_t$ is ambiguous since the current account turns into a deficit. On figure 4, it is assumed that β is large so that the latter effect dominates. The same assumption is made in drawing the behavior of the interest rate just before T when the exchange rate is depreciating thus pushing the interest rate up. Elsewhere, however, there is no ambiguity concerning the sign of $(r_t - r_t^*)$.

4.5 An Anticipated Temporary Gain

The good crop of section 4.4 could have been anticipated (or else, it is realized that the North Sea oil will eventually be depleted). This case is understood as the sum of two anticipated permanent changes of opposite signs and identical sizes and is described on figure 5. At period zero, it is announced that from T_1 up to period $T_2 - 1$, $k_{0,t}$ will increase from $\bar{k}_0$ to $\bar{k}'_0$, and that after T_2 it will revert to $\bar{k}_0$.

Upon announcement, the exchange rate immediately appreciates. This is because it is realized that when k_0 increases, foreign bonds will be accumulated and there will be the need for an exchange rate appreciation to keep the demand for money in line. This appreciation being expected as off period zero, the ensuing increased demand for money requires an immediate matching appreciation. Because of that appreciation, the current account is in deficit between periods 0 and T_1. With a_t decreasing now, the demand for money is maintained through a further (expected) appreciation. At time T_1, the good crop brings the current account to a surplus: foreign bonds are accumulated, increasing domestic wealth and prompting a depreciation in order to maintain portfolio balance. With increased wealth, when at T_2 $k_{0,t}$ drops back to $\bar{k}_0$, the current account deficit leads to a decumulation of foreign bonds until the stationary state is reached.

The forward rate initially overpredicts the corresponding spot rate. For a while after T_1, H_t remains negative while B_t is positive, so that there is some ambiguity, but eventually there needs to be a switch to under-prediction. After T_2, the sign of $(e_t - f_t)$ is unclear and, as before, figure 5 assumes that the current effect dominates. The sign of $(r_t - r^*)$ is always ambiguous in this experiment. The figure displays but one possibility, corresponding

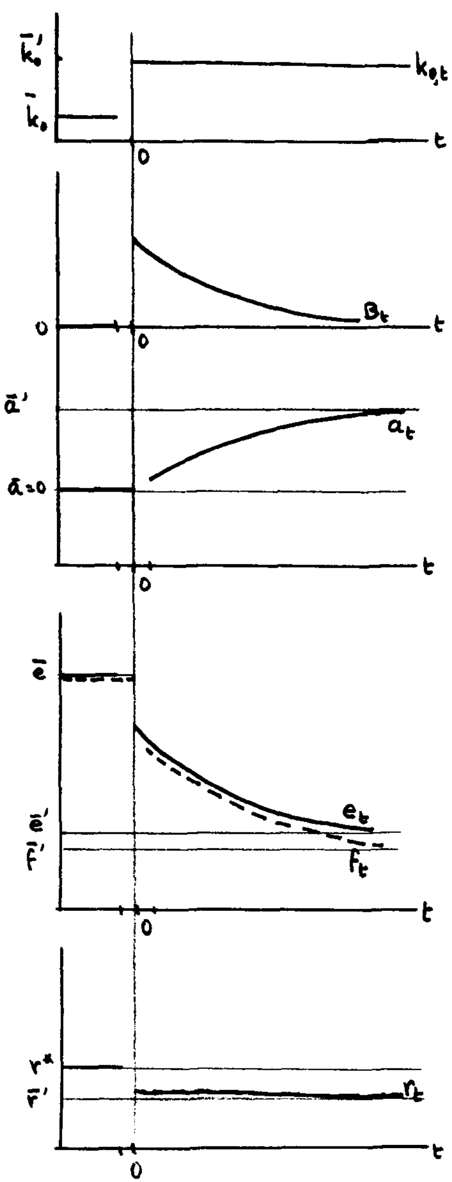


FIGURE 2 UNANTICIPATED PERMANENT

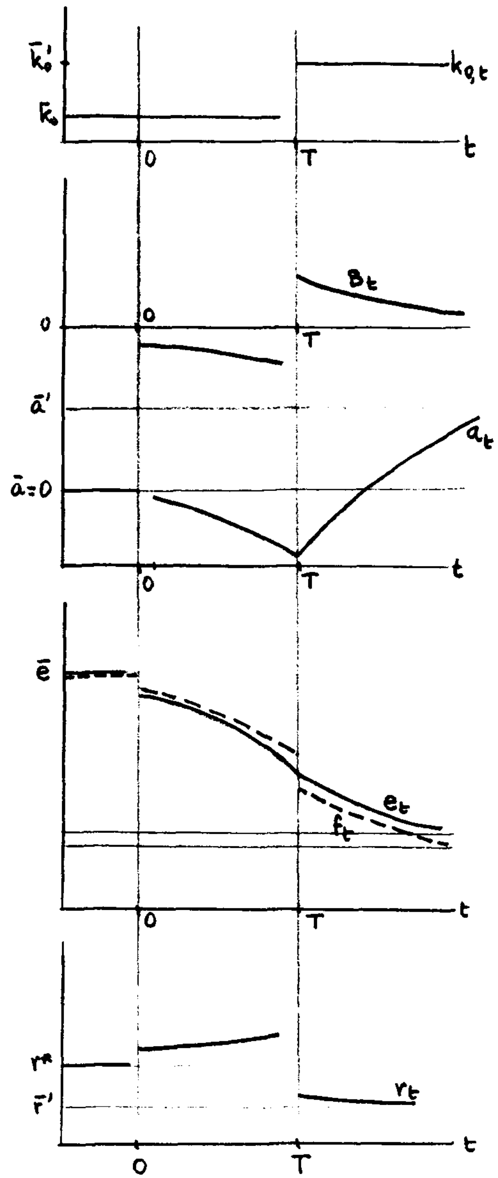


FIGURE 3: ANTICIPATED PERMANENT

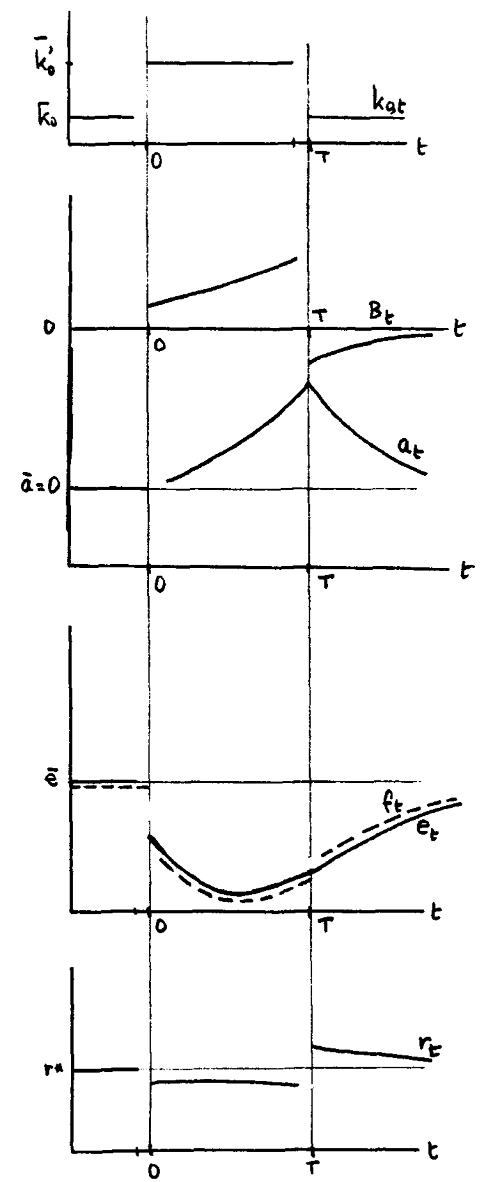


FIGURE 4: UNANTICIPATED TEMPORARY

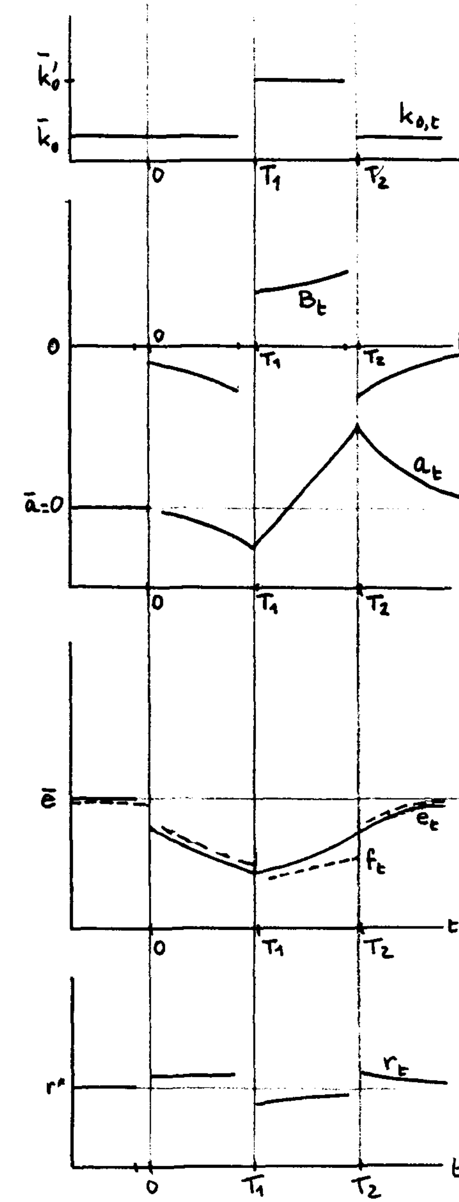


FIGURE 5: ANTICIPATED TEMPORARY

to the case where β is so large as to dominate in (3') and (1'). While this ambiguity may sound deceptive, it is, in and by itself, an important result in view of the recent empirical works attempting to establish a link between the exchange and interest rates.

5 - CONCLUDING REMARKS

The experiments with current account disturbances reported in this paper are indicative of the pattern of responses that can be generated by other disturbances in this class of models.

One feature that emerges from the results is the instability of some well popularized contemporaneous relationships. For example, we can observe an increased money supply together with a higher interest rate. It is also equally possible to obtain a current account deficit first accompanied by an appreciating exchange rate, and then by a depreciation.[20]

The implication is that in empirical works, unless we are certain to have isolated a structural equation and its truly exogenous instruments, we should not be surprised to obtain qualitatively different results depending upon which disturbance has been dominating the sample period. This applies particularly to tests of hypotheses made to depend on the sign of the contemporaneous relationship between two variables that are obviously endogenous. As a fitting example, consider the many tests of exchange market efficiency[21] which focus on the existence of a bias between ${}_t f_{t+1}$ and ${}_t e_{t+1}$. From figures 2 to 5 it appears that such a bias is both systematic and unstable.[22] It depends on the nature of the disturbance and varies over time for a given disturbance.

Finally, it may be interesting to compare the actual behavior of the spot and forward exchange rates depicted on figure 1 and the simulation results on figures 2 to 5. If anything, these results tend to support Mussa's (1979) contention that anticipated events, mostly temporary ones, dominate the behavior of these rates.

FOOTNOTES

1. Useful references for the portfolio balance approach stressing the endogeneity of the spot exchange rate and of the interest rate are Black (1973), Branson et al. (1977) and Dornbusch (1975). For the role of expectations, see for example Mussa (1976), Kouri (1976) and Dornbusch (1976). Recent works on the current account include Niehans (1977), Rodriguez (1978) and Dornbusch and Fischer (1980).

2. This follows from the so-called "Modern Theory" (see Grubel (1966)) or from the Finance Theory (see Solnik (1974) and Grauer et al. (1976)).

3. This is apparent in Frankel's (1979b) assessment of the Dornbusch model, or in Hooper and Morton's (1980) test of the portfolio balance approach, to quote some of the best and most influential recent empirical works.

4. There is a considerable amount of empirical work on this issue, with a growing number of authors rejecting the no-bias assumption. For a survey see Levich (1979). For a sample of recent results see Hakkio (1980), Bilson (1980), Meese and Singleton (1980).

5. For a recent work very similar in spirit see Stein (1980). Dooley and Isard (1979) also introduce a risk premium.

6. As in the Rodriguez model, there is no attempt to describe the real side of the economy, and therefore the price and output levels are left out. Dornbusch and Fischer have an LS-LM link between the real and financial sectors of their model and describe the behavior prices under the assumption of fixed output. Giavazzi (1980) provides an interesting extension of their work by introducing a supply equation which enables him to describe jointly the output, the price level and the exchange rate.

7. Admittedly then, the domestic bonds are redundant assets. For the reader uncomfortable with the existence of redundant assets it is possible to consider (1) as an equation defining the implicit return on (the only existing) foreign assets.

8. Obviously, (1) is an approximation of the exact formula:

$$(1 + r_t)/(1 + r_t^*) = {}_tF_{t+1}/E_t .$$

9. This equation is the ratio of the two following equilibrium conditions:

$$M_t = L\left(r_t,\ r^* + \frac{{}_tE_{t+1} - E_t}{E_t}\right) .\ W_t, \text{ for domestic money}$$

$$E_tA_t = A\left(r_t,\ r^* + \frac{{}_tE_{t+1} - E_t}{E_t}\right) .\ W_t, \text{ for foreign bonds uncovered}$$

where W_t is total domestic wealth.

10. While the sign of h_1 is unambiguously positive, h_2 is <u>assumed</u> to be positive.

11. For a similar development, but with no specific role for trade, see Dornbusch (1980) where $\bar{a}$ is shown to be the minimum variance portfolio.

12. It is worthwhile noting that if there exists only one risk neutral investor with unlimited access to funds, then there is no bias ($\alpha=\beta=0$). If all traders are risk neutral, then there is no current account effect on the bias ($\beta=0$).

13. There is no compelling reason to have $CA_t = a_{t+1} - a_t$ rather than $CA_t = a_t - a_{t-1}$.

14. For the exchange rate to appreciate we need $1 - \alpha h_2 > 0$. We expect h_2 to be significantly smaller than 1 (see footnote 10). Regarding α, it will be assumed later on to be small. There remains however the possibility that with α large, the exchange rate depreciates because with H increasing, the foreign currency is at a forward discount (see e.g. (12)) and through the interest parity condition this pushes $\bar{r}$ way below $\bar{r}^*$ (e.g. (13)), thus bringing a substitution away from domestic assets and toward foreign ones.

15. The cases of a money supply disturbance (a change in m_t) and of a portfolio balance disturbance (a change in r^*_t), be it anticipated or not, temporary or permanent, are available from the author upon request.

16. We note in (18) that $K - \lambda_1 > 0$ since

$$\lambda_1 = 1/2.\left[A_2 + K - ((A_2 - K)^2 + 4A_1k_2)^{1/2}\right].$$ Also, it can be shown

that $e_0 = \bar{e} - (\lambda_2 - 1)^{-1}k_2^{-1}(A_4k_2 + K - \lambda_1) < \bar{e}$.

17. $\phi(t)$ can be rewritten as $\phi(t) = \left[(\lambda_2 - K)\lambda_2^{\,t} + (K - \lambda_1)\lambda_1^{\,t}\right](\lambda_2 - \lambda_1)^{-1}$. We have $0<\lambda_1<1<\lambda_2$, $K - \lambda_1 > 0$ (see footnote 16) and $\lambda_2 - K > 0$ (because $K<1$). So $\Phi(t)$ is the sum of two positive terms: the first one is increasing, the second one decreasing. Eventually it must be increasing but, depending upon the respective values of $(\lambda_2 - K)$ and $(K - \lambda_1)$ it may be initially decreasing.

18. From (20) we have $e_0 = \bar{e} - (K - \lambda_1)k_2^{-1}(\lambda_2 - 1)^{-1}\lambda_2^{-T}(\bar{k}'_0 - \bar{k}_0)$, so that $e_0 < \bar{e}$ unambiguously. Also the larger T, the smaller the initial jump.

19. As the sum of two changes of opposite signs this might be ambiguous. With (16), it can be shown that

$$e_0 = \bar{e} - (K - \lambda_1)k_1^{-1}(\lambda_2 - 1)^{-1}(1 - \lambda_2^{-T})(\bar{k}'_0 - \bar{k}_0) < \bar{e},$$ and also that

the longer the disturbance lasts (i.e. the larger T) the larger this initial drop.

20. These examples are derived explicitely in Rodriguez and Dornbusch and Fischer. Also see footnote 15.

21. For some references, see footnote 4.

22. The model even exaggerates the stability of the bias by assuming the constancy of the parameters α, β and $\bar{a}$ in equations (3) and (4).

APPENDIX 1

Summary Statistics for $(e_{t+1} - e_t)$ and $({}_tf_{t+1} - e_{t+1})$

(Quarterly Data: 1973:1 - 1980:1)

	$e_{t+1} - e_t$		${}_tf_{t+1} - e_{t+1}$	
	Mean	Standard Deviation	Mean	Standard Deviation
Deutsch Mark	-0.013	0.059	0.005	0.058
French Franc	0.000	0.049	0.003	0.050
Sterling Pound	0.005	0.043	0.005	0.042
Yen	-0.002	0.045	0.003	0.051
Swiss Franc	-0.020	0.072	0.008	0.074

All data are end of quarter. $e_t = \log E_t$ and ${}_tf_{t+1} = \log {}_tF_{t+1}$ with E_t and ${}_tF_{t+1}$ in currency units per dollar.

Source: IFS, June 1980 tape.

APPENDIX 2

A Simplified Derivation of the Risk Premium

This appendix presents a simplified version of the argument developed in Wyplosz (1980).

We consider a small economy consisting of international traders who export a volume X_t and import a volume Z_t. The price of these goods is assumed to be P^*_t, fixed in foreign currency. The deals arranged during period t will be paid for in period t+1. A proportion α_t (respectively, β_t) of exports (respectively imports) are not covered on the forward exchange market, and the amount paid will depend on the unknown value of the exchange rate $\tilde{E}_{t+1}$.

We also have investors, with an initial wealth W_t. They hold domestic money M_t, domestic bonds (value = B_t), foreign bonds without cover (value = $B_{u,t}$). The interest factor (interest rate +1) on domestic bonds is $\tilde{R}_t$, on foreign bonds it is $\tilde{R}^*_t$. Randomness arises for $\tilde{E}_{t+1}$, $\tilde{R}_t$ and $\tilde{R}^*_t$.

The economy chooses α_t, β_t, M_t, B_t, $B_{c,t}$, $B_{u,t}$ in order to maximise the sum Ω_t of returns from trade and wealth. By Walras law $M_t = W_t - B_t - B_{c,t} - B_{u,t}$. Dropping the subscript t we have:

$$\text{(A2-1)} \quad \Omega = \alpha\tilde{E}_{+1}P^*X + (1-\alpha)FP^*X - \beta\tilde{E}_{+1}P^*Z - (1-\beta)FP^*Z + W - B - B_u - B_c$$
$$+ B\tilde{R} + B_u\tilde{R}^*(\tilde{E}_{+1}/E_0) + B_c\overline{R^*}(F/E_0) + B^*_c(\tilde{R}^* - \overline{R^*})\tilde{E}_{+1}/E_0$$

where $\overline{R^*} = E(\tilde{R}^*)$. We can re-arrange (A2-1) to obtain:

$$\text{(A2-2)} \quad \Omega = A + B\tilde{R} + C\tilde{\lambda} + D\tilde{\psi}$$

where $\tilde{\lambda} = (\tilde{E}_{+1} - F)/E_0$, $\tilde{\psi} = \tilde{R}^*\tilde{E}_{+1}$

and $A = FP^*(X - M) + W - B - B_u - B_c$

$C = FP^*(\alpha X - \beta Z) - B_c\overline{R^*}F/E_0$

$D = (B_u + B_c)/E_0$

The economy has a mean variance utility function:

$$\text{(A2-3)} \quad E[u(\Omega)] = U[E(\Omega), V(\Omega)] \quad \text{with } U_1>0,\ U_2<0.$$

The net supply of foreign currency forward is:

$$\text{(A2-4)} \quad S = (t\alpha)FP^{*}X - (1-\beta)FP^{*}Z + B_c\overline{R}^{*}F/E_0 = FP^{*}(X - M) - C$$

Maximising $E[u(\Omega)]$ with respect to α, β, B, B_u, B_c we obtain the corresponding first order conditions. We are interested in establishing the forward market equilibrium condition S=0, so we need only to know the optimal value $\hat{C}$ of C. This value is given as a function of optimal values $\hat{B}$ and $\hat{D}$ of B and D in (A2-2):

$$\text{(A2-5)} \quad \hat{C} = \frac{1}{\rho}.\frac{E(\tilde{\lambda})}{V(\tilde{\lambda})} + \frac{\hat{B}\ \mathrm{cov}(\tilde{R},\tilde{\lambda}) + \hat{D}\ \mathrm{cov}(\tilde{\lambda},\tilde{\psi})}{V(\tilde{\lambda})}$$

where $\rho = -U_1/2U_2$ the degree of risk aversion. With (A2-4) and (A2-5), the forward market equilibrium condition gives:

$$\text{(A2-6)} \quad E(\tilde{\lambda}) = \rho.V(\tilde{\lambda}).FP^{*}.(X - M) + \rho\left[\hat{B}\ \mathrm{cov}(\tilde{R},\tilde{\lambda}) + \hat{D}\ \mathrm{cov}(\tilde{\lambda},\tilde{\psi})\right]$$

which is used as (3) in the text. Also note that this set-up could be used to derive the portfolio balance condition (2) by solving for B, B_c and B_u.

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