Chapter 37

PUZZLES IN INTERNATIONAL FINANCIAL MARKETS

KAREN K. LEWIS*

University of Pennsylvania

Contents

*I am grateful for comments from Greg Bauer, Geert Bekaert, Charles Engel, Ken Froot, Bob Hodrick, Urban Jermann, Dick Marston, Maury Obstfeld, Ken Rogoff, Lars Svensson, Ingrid Werner, and participants at the Handbook of International Economics Conference at Princeton University. Any errors are mine alone.

Handbook of International Economics, vol. III, Edited by G. Grossman and K. Rogoff

0. Introduction

International financial markets have undergone tremendous growth over the last decade. During this period, foreign exchange and equity markets have attained record-breaking volumes. Furthermore, moves toward liberalizing capital markets around the world are likely to continue to fuel this growth in the future.

This growth experience has highlighted important issues concerning the function of international capital markets. At least two of these issues focus upon key ingredients of models used in the field of international macroeconomics and finance. First, an important building block to many models, including topics covered elsewhere in this book, is the assumption of uncovered interest parity. According to the Fisher (1930) interest parity condition, the expected returns in one country should be equalized through speculation to the returns in another country once converted to the same currency. Thus, the ex ante expected home currency returns on foreign deposits in excess of domestic deposits should be zero. Despite this theoretical prediction, the behavior of domestic relative to foreign returns has decisively rejected this assumption over the floating rate period.[1] This rejection clearly leads to the question: What can explain the behavior of domestic relative to foreign returns and can these explanations suggest ways in which models of the rest of the economy are either succeeding or failing?

A second issue raised by the growth in international financial trade corresponds to the decisions of domestic investors. An implicit assumption behind many economic models is that investors will take advantage of potential gains in returns and risk-sharing through integrated capital markets. At the same time, recent evidence shows that domestic investors continue to hold almost all of their wealth in domestic assets. This evidence leads to other important questions. Why do domestic investors appear to ignore potential gains to foreign investment opportunities and does the answer imply necessary modifications to our views about international capital market equilibrium?

In this chapter, I address each of these two general questions by evaluating the research surrounding them.[2] While the evidence to date has helped clarify the set of possible answers, complete explanations continue to be elusive. For this reason, the two questions could be restated as two puzzles in international finance.

The first puzzle concerns explanations for deviations from uncovered interest parity

[1]For early evidence of this rejection, see Cumby and Obstfeld (1981, 1984).

[2]As such, the intention of this investigation is not to comprehensively survey the literature in international finance, but to critically evaluate various explanations for these two outstanding puzzles. Comprehensive surveys on certain aspects of this chapter can be found elsewhere. In particular, Hodrick (1987) surveys the empirical methods in international finance, while Adler and Dumas (1983), Stulz (1994), and Dumas (1994) survey the literature on international portfolio choice.

or, equivalently, excess returns on foreign relative to domestic deposits. Explaining this puzzle has been made more difficult by an important observation made by Fama (1984). In a simple regression test, he showed that, not only are excess returns predictable ex ante, but the variance of these predictable returns is greater than the variance of the expected change in the exchange rate itself. Thus, theoretical models of the excess returns across countries must explain, not only their presence, but their high variation. This behavior I call the ''predictable excess return puzzle''.

In Section 1, I consider various explanations for the puzzle. First, under standard assumptions about rational expectations, *ex post* excess returns just equal the market's true expected excess returns plus a forecast error that is unpredictable ex ante. Under this assumption, predictable excess returns must be identically equal to the foreign exchange risk premium. I consider two standard risk premium models, one based upon a static capital-asset-pricing model (CAPM) and the other based upon a dynamic general equilibrium model. While these models can explain non-zero excess returns, they cannot explain the high degree of variation in returns. In essence, the factors that should theoretically determine the risk premium do not display sufficient variability to explain the puzzle.

I then consider explanations based upon forecast errors. Froot and Frankel (1989) have shown with survey measures of expected exchange rates that excess returns through the mid-1980s were largely driven by systematic forecast errors, not by risk premia. Explanations of this phenomenon can be broken into two groups. First, market forecasts are irrational. Second, the market is rational but the distribution of economic disturbances perceived by traders is different than the one measured by researchers. While no formal testable model of the former explanation has yet been proposed, evidence from the latter explanation provides some insights. Evans and Lewis (1995) provide evidence that systematic forecast errors can explain some of the predictable excess return puzzle. However, a substantial amount of variability in these returns remains unexplained. I conclude the section with conjectures about how this puzzle may be resolved in the future.

Section 1 also describes a related issue, central bank intervention. The presence of systematic deviations from uncovered interest parity has been used as an explanation for why central bank interventions may be able to affect the exchange rate. I summarize this argument and its relationship to the evidence on the foreign exchange risk premium.

Section 2 introduces the second puzzle called ''home bias'', the phenomenon that domestic investors hold too little of their portfolios in foreign assets. I consider this puzzle with the two models used to examine the foreign exchange risk premium. Both models suggest that domestic investors hold too little of their wealth in the form of foreign assets. The first type of model, based upon CAPM, implies that domestic investors should hold foreign assets in their portfolio in a fraction that depends upon their degree of risk aversion, among other variables. While plausible levels of risk aversion suggest that U.S. investors in the 1980s should have held over one half of their wealth in foreign equities, evidence suggests that they held less than 10 percent in these securities.

The second type of model, based upon complete markets, gives predictions about consumption risk-sharing. If investors have allocated their portfolios optimally, they will perfectly pool their risks and will hold the same international portfolio shares as do foreigners. As a result, consumption growth rates will be equal across countries except for measurement errors and taste shocks. Despite this prediction, the evidence implies that country-specific output risk is not diversified away.

Thus, whether from a partial or general equilibrium point of view, the ''home bias'' puzzle appears significant. I consider some potential explanations for this puzzle, such as the presence of non-traded goods. Even after accounting for these modifications, however, the puzzle seems to remain. I conclude by pointing to implied directions for future research.

1. The behavior of excess foreign exchange returns

The behavior of the excess return on foreign pure discount bonds relative to their domestic counterparts has been an important variable in the study of international financial markets. A higher expected return on foreign relative to domestic deposits with equivalent default risk and maturity implies that the currency composition of the deposits is significant in determining the relative returns. If so, then an important task is to understand why.

For this purpose, note that ''covered interest parity (CIP)'' is:[3]

$$i_t - i_t^* = f_t - s_t \,. \tag{1.1}$$

where i_t and i_t^* are the interest rates on domestic and foreign deposits, respectively, s_t is the logarithm of the domestic currency price of foreign currency at time t, and f_t is the logarithm of the forward rate, the time t domestic currency price of foreign currency delivered at time $t+1$.

Holding a foreign deposit will give the investor the foreign interest rate return plus the capital gain on foreign currency, $i_t^* + s_{t+1} - s_t$. If the investor borrowed in dollars to obtain the funds for this investment, the excess return on foreign currency would

[3]With continuous compounding, the cost of borrowing in domestic currency, $\exp(i_t)$, must through arbitrage be equal to the return from taking one unit of domestic currency and buying spot $1/S_t$ units of foreign currency, where S_t is the level of the exchange rate, investing it at the rate $\exp(i_t^*)$, and selling the returns forward at F_t, the level of the forward rate. Thus, CIP says: $\exp(i_t) = \exp(i_t^*)(F_t/S_t)$. Taking the logarithm of this expression and rearranging gives eq. (1.1). Alternatively, (1.1) can be derived as a logarithmic approximation when the interest rates are not continuously compounded. Following the same logic as above, CIP says: $(1 + i_t) = (1 + i_t^*)(F_t/S_t)$. Taking the logarithm and using the approximation that $\log(1 + i_t) \approx i_t$ gives eq. (1.1).

be:

$$er_{t+1} \equiv i_t^* + s_{t+1} - s_t - i_t \,. \tag{1.2}$$

Substituting covered interest parity (1.1) into (1.2) gives:

$$er_{t+1} \equiv s_{t+1} - f_t \,. \tag{1.3}$$

Both forms of excess returns will be used below.

Since the excess return is not known at the time of taking out the contract, t, analyzing any behavioral aspects of these returns depends upon measures of expected excess returns. One such measure is the statistically predicted value of the excess return based upon time t information:

$$per_t \equiv E_t(er_{t+1}) = E_t\,\Delta s_{t+1} - (f_t - s_t)\,, \tag{1.4}$$

where $E_t(\cdot)$ is the statistical expectations operator conditional on time t information. Thus,

$$er_{t+1} = per_t + \varepsilon_{t+1}\,, \tag{1.5}$$

where the last term is the statistical forecast error, $\varepsilon_{t+1} \equiv s_{t+1} - E_t s_{t+1}$.

1.1. Some empirical regularities

Much of the early research on excess returns asked whether the predictable component of these returns were equal to zero. Under the assumption that the market forms expectations by linear statistical prediction, then predicted excess returns will equal zero if uncovered interest parity holds. To see why, note that uncovered interest parity says:[4]

$$i_t - i_t^* = E_t^m s_{t+1} - s_t \tag{1.6}$$

where $E_t^m(\cdot)$ is the market's expectation conditional upon current information. Note that this expectation is not necessarily the statistical expectation, $E_t(\cdot)$. Below I will discuss some of the literature in which the market's expectation does not equal the statistical expectation conditional upon current information, so that $E_t(\cdot) \neq E_t^m(\cdot)$.

Thus, uncovered interest parity in (1.6) says that the returns on a unit of domestic currency invested in a domestic deposit equals the expected returns from converting the domestic currency into the foreign currency, investing it in a foreign deposit and then converting the proceeds back into domestic currency at the future realized exchange rate. If uncovered interest parity holds and furthermore the market's

[4]This expression can be derived in logarithmic form following similar steps to the covered interest parity condition in footnote 3.

expectation equals the statistical prediction of the exchange rate, then predictable excess returns must be equal to 0, since in this case, $per_t \equiv i_t^* + E_t^m s_{t+1} - s_t - i_t = 0$.

Figure 1.1 plots estimates of the predictable excess annualized monthly returns for the dollar/DM and dollar/yen rate from the beginning of 1975 to the end of 1989.[5] The figure graphs the predicted excess returns given current information as measured by the forward premium. These predicted returns are the actual returns regressed upon the forward premium, $f_t - s_t$, according to the linear projection equation given in Panel A of Table 1.1:[6,7]

$$er_{t+1} = b_0 + b_1(f_t - s_t) + u_{t+1}\,. \tag{1.7}$$

The dashed lines represent the two standard error confidence bands around the predicted values.

Three features of the predicted returns stand out from this analysis. First, the predicted returns are significantly different from zero over some periods in the sample. Second, the returns change sign during the sample. The predictable excess returns on holding DM or yen deposits was significantly negative during part of the early 1980s and was significantly positive in the late 1980s. Therefore, explanations of excess foreign bond returns must explain not only why these returns are not zero, but also why they are sometimes negative and at other times positive. Third, the predictable returns display considerable variability. The DM returns range from 20 percent to −30 percent per annum, while the yen returns vary from over 32 percent to −30 percent.

This last feature of predictable returns is the most difficult to reconcile with standard models. Fama (1984) emphasized it dramatically with the decomposition described next.

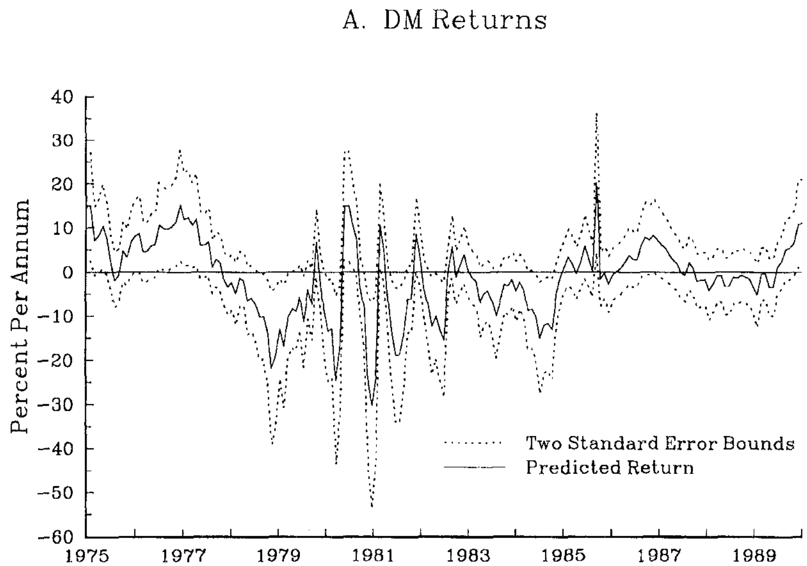
1.1.1. The Fama result

Fama (1984) illustrated the degree of predictable excess return variability using a simple regression test. This simple test has produced a challenge for researchers in international finance. I will therefore use this basic result as a benchmark for

[5]These data are from Citibase and were kindly provided by Geert Bekaert. In constructing the spot and forward rates, I took the average of the bid and ask rates. While averaging in this way introduces measurement error, Bekaert and Hodrick (1993) find that the biases introduced by the measurement error are small.

[6]Bilson (1981) estimated this regression and found that uncovered interest parity does not hold. A subsequent literature has verified this finding over other sample periods and currencies.

[7]In principle, this regression could be run on any variables that help explain excess returns. A number of authors have found that these returns can be explained by lagged excess returns [Hansen and Hodrick (1983)], lagged stock returns [Giovannini and Jorion (1987a)], the spread between long and short interest rates in different currencies [Campbell and Clarida (1987)], and industrial production [Cumby (1988)], to name a few. This regression was run for parsimony and because it relates to the Fama (1984) regression described below.



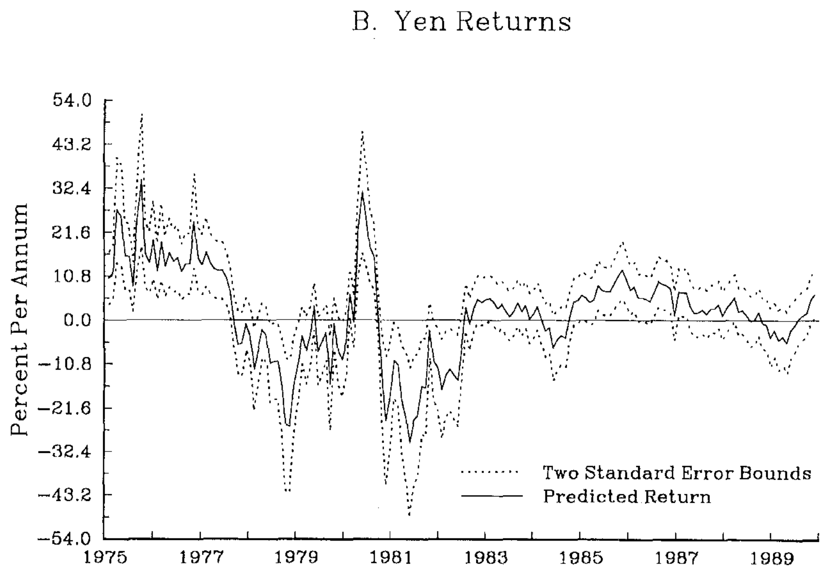


Figure 1.1. Predictable foreign returns in excess of dollar returns.

Table 1.1
The Fama regression and the foreign excess return puzzle

A. The Fama regression: full sample

$$\Delta s_{t+1} = \beta_0 + \beta_1 \ (f_t - s_t) + u_{t+1}$$

Exchange Rate	β_0 (St. Err)	β_1 (St. Err)	MSL Ho: $\beta_1 = 1/2$	MSL Ho: $\beta_1 = 1$
\$/DM	−13.70** (5.81)	−3.33** (1.60)	.004	.009
\$/£	7.95** (3.48)	−2.31** (0.79)	<.001	<.001
\$/¥	−12.87** (3.61)	−2.28** (0.83)	<.001	<.001

B. Summary statistics

Exchange Rate	Mean($s_{t+1} - f_t$) (St. Dev($s_{t+1} - f_t$))	Var($f_t - s_t$)	Var($E_t \Delta s_{t+1}$)	Var(per$_{t+1}$)
\$/DM	1.4 (41.3)	4.1	44.9	75.9
\$/£	0.1 (41.9)	11.3	60.0	123.4
\$/£	−1.6 (40.8)	12.0	62.3	128.9

C. Fama regression: Subsamples

Exchange Rate	1975–79 β_1 (St. Err) (MSL: $\beta_1 = 1/2$)	1980–84 β_1 (St. Err.) (MSL: $\beta_1 = 1/2$)	1984–89 β_1 (St. Err) (MSL: $\beta_1 = 1/2$)
\$/DM	1.06 (2.67) (.58)	−1.32 (2.34) (.22)	−12.05** (4.13) (.10)
\$/£	0.92 (1.50) (.61)	−2.91** (1.10) (.001)	−9.70* (4.90) (.02)
\$/¥	−1.33 (1.14) (.06)	−2.07 (1.51) (.05)	−11.39** (3.76) (.001)

Notes: β_1 is the estimates of the regression of the exchange rate change on the forward premium. Exchange rate changes are annualized monthly rates.
* indicates significantly different than zero at the 10 percent marginal significance level.
** indicates significantly different than zero at the 5 percent marginal significance level.

discussing various theoretical explanations for the behavior of predictable returns below.[8]

The test regresses the change in the exchange rate on the forward premium:

$$\Delta s_{t+1} = \beta_0 + \beta_1(f_t - s_t) + u_{t+1}\,, \tag{1.8}$$

where Δ is the backward difference operator and u_{t+1} is an error term. Note that this regression is equivalent to eq. (1.7) where $\beta_1 = 1 + b_1$ and $\beta_0 = b_0$. If predictable excess returns are zero, then $E_t s_{t+1} = f_t$ and $\beta_1 = 1$ or, equivalently, $b_1 = 0$ in (1.7).

Table 1.1, Panel A shows the results of this regression using the dollar exchange rates against the DM, British pound and Japanese yen over the period from 1975 to 1989. As the table shows, the estimate of β_1 are all significantly less than one. In fact, they are even significantly negative! This result is typical of many other studies examining the same relationship.[9]

When $\beta_1 < \frac{1}{2}$, this coefficient can convey information about the variability in the expected change in the exchange rate relative to the predictable component of excess returns.[10] To see why, note that the probability limit of the OLS coefficient β_1 is:

$$\begin{aligned}\beta_1 &= \mathrm{Cov}(\Delta s_{t+1}, f_t - s_t)/\mathrm{Var}(f_t - s_t)\\ &= [\mathrm{Cov}(E_t\,\Delta s_{t+1}, f_t - s_t) + \mathrm{Cov}(\varepsilon_{t+1}, f_t - s_t)]/\mathrm{Var}(f_t - s_t)\\ &= \mathrm{Cov}(E_t\,\Delta s_{t+1}, f_t - s_t)/\mathrm{Var}(f_t - s_t)\,,\end{aligned} \tag{1.9}$$

where the last equality follows because $\mathrm{Cov}(\varepsilon_{t+1}, f_t - s_t) = 0$ by construction.

In this case, a finding of $\beta_1 < \frac{1}{2}$ as in Table 1.1 implies that the variance of the predictable component of excess returns exceeds the variance of the linear prediction of the exchange rate change. In other words,

$$\mathrm{Var}(per_t) > \mathrm{Var}(E_t(\Delta s_{t+1}))\,. \tag{1.10}$$

To see why, note that the variance of (1.4) can be written:

$$\mathrm{Var}(per_t) = \mathrm{Var}(E_t\,\Delta s_{t+1}) - 2\,\mathrm{Cov}(f_t - s_t, E_t\,\Delta s_{t+1}) + \mathrm{Var}(f_t - s_t)\,. \tag{1.11}$$

Substituting (1.11) and then (1.9) for the left-hand side of (1.10) implies that the

[8]This regression test is only one of many tests that have been applied to excess foreign currency returns as described in Hodrick (1987). I emphasize the Fama result only as a useful discussion point for later analysis.

[9]This result is less apparent for some of the cross exchange rates within the European Monetary System. For example, Bossaerts and Hillion (1991) find positive estimates of β_1 for most currencies against the French franc. On the other hand, Bekaert and Hodrick (1993) have examined the same relationship using other non-dollar cross rates and found similar relationships to those against the dollar, as in Table 1.1.

[10]The following discussion modifies the Fama (1984) result more generally to describe predictable excess returns without making any assumption about expectations. Later, I will discuss the relationship actually described by Fama concerning the variance of the foreign exchange risk premium.

inequality will hold if:

$$\mathrm{Cov}(f_t - s_t, E_t\,\Delta s_{t+1})/\mathrm{Var}(f_t - s_t) = \beta_1 < \tfrac{1}{2}\,. \tag{1.12}$$

This relationship can also be seen using the estimates in Table 1.1. As shown in Panel B, the standard deviations of predicted excess returns are roughly twice the corresponding standard deviations of the predicted values from regressions of the change in the exchange rate on the forward premium.

Therefore, the striking conclusion from Table 1.1 is that, not only are excess returns non-zero and predictable given current information, their variance is quite large relative to expected exchange rate changes.

1.1.2. Potential explanations

What explains these results? This is an important issue that has been the focus of a great deal of research over the past decade. Generally, the explanations can be classified into two groups: (a) the foreign exchange risk premium, or (b) expectational errors. To see how explanations fall into these two groups, it is useful to decompose the Fama regression coefficient further.

For this purpose, define the risk premium on the position with the return in (1.3) as:

$$rp_t \equiv E_t^m s_{t+1} - f_t = E_t^m\,\Delta s_{t+1} - (f_t - s_t) \tag{1.13}$$

Equation (1.13) says that the market's expected return for holding foreign deposits is an equilibrium premium paid for taking more risk. The market's forecast error is:

$$\Delta s_{t+1} - E_t^m\,\Delta s_{t+1} = \eta_{t+1}\,. \tag{1.14}$$

Thus, the excess return can be written as:

$$er_{t+1} = rp_t + \eta_{t+1}\,. \tag{1.15}$$

Consider first the notion that the behavior of predictable returns found above was due to the risk premium, the interpretation given by Fama (1984). According to this view, expectations are rational and the statistical distribution of the economy is known to the market. In this case, $\varepsilon_{t+1} = \eta_{t+1}$ so that the predictable part of excess returns, per_t, is just equal to the risk premium, rp_t. The evidence in Table 1.1 then implies that the variance of the risk premium exceeds the variance of the market's expectations of exchange rate changes.

Consider next the opposite extreme. Suppose that the risk premium were constant and equal to rp_0 so that $er_{t+1} = rp_0 + \eta_{t+1}$. In this case, the high variation in predictable excess returns found in Table 1.1 must arise from variation in the component of the forecast error that is correlated with lagged information.

Of course, time-varying risk premia and systematic forecast errors are not mutually exclusive and the behavior of predictable excess returns could result from a combination of these two factors.

Below, I will describe explanations for the behavior of excess returns based upon these two broad classifications. First, the predicted returns may be the outcome of an equilibrium process. According to this explanation, the returns were positive to investors with an open position in non-dollar bonds during the late 1980s and negative during the early 1980s because the market as a whole was compensating investors for taking this position. Under this explanation, the predictable returns are a "foreign exchange risk premium".

Second, the predicted returns may result from systematic forecast errors. These systematic forecast errors could arise from two different types of sources. One source is the presence of some irrational traders in the market. For example, traders buying yen forward during the late 1980s may not have used all information efficiently, and expected to make profits even though they were systematically wrong.

A second source of systematic forecast errors arises from difficulties in measuring expectations of predictable returns. According to this explanation, the regression equations used to measure expectations as in Figure 1.1 may not accurately reflect the market's expectation of returns. For example, traders buying yen forward in the late 1980s may have placed some probability on the likelihood that the dollar would rebound significantly. This event would introduce a so-called "peso problem" in measuring the expected returns in the standard ways described above. I discuss each of these explanations below.

1.2. The foreign exchange risk premium

One explanation for predictable excess returns is that domestic investors who are willing to hold foreign bonds and then convert the returns back into domestic currency at the future prevailing exchange rate must be compensated for the foreign exchange risk. According to this explanation, expectations are rational so that $E_t = E_t^m$ always. Since this assumption applies to all of the risk premium models, I will simply write the market's expectations in this section as E_t.

Why might non-zero predictable excess returns be the result of an equilibrium process? I will describe two types of risk premium models. The first set of models is static in nature and treats the processes followed by exchange rates, interest rates, and inflation rates as exogenous. As such, the models in this group are partial equilibrium.

The second set of models I will present below focuses upon intertemporal investment decisions and also allows the exchange rate, interest rate, and inflation processes to emerge endogenously from underlying technology and monetary processes. According to these models, the foreign exchange risk premium is determined together with the other variables.

In the context of these models, a useful way to summarize the variability puzzle in excess returns found above is the Hansen and Jaganathan (1991) bound. This measure gives a lower bound to the risk premium implied by financial returns in general. Estimates of these lower bounds are quite difficult to reconcile with implied risk premia from the theoretical models, as will be demonstrated below.[11]

1.2.1. The risk premium based upon partial equilibrium CAPM

The first efforts toward understanding the foreign exchange risk premium followed as natural extensions of the static version of the "capital asset pricing model".[12] The international version of the model involves all wealth including equity.[13] However, to focus upon the foreign exchange risk premium as well as the implications for central bank intervention, I will delay incorporating equity into the analysis until Section 2.

I begin with the simplest version of this model. I treat this model in discrete time and use logarithmic approximations. While this simplification greatly streamlines the analysis, it ignores a potentially important component to the risk premium arising from Jensen's Inequality. I will return to introduce this component following the basic analysis below.

Suppose there are two representative agents in each of two countries. They each want to maximize end-of-period wealth. If real wealth for the home investor at the end of time t is defined as W_t, then his real wealth in the next period is defined as:

$$W_{t+1} = W_t(1 + r_{p,t+1}), \quad W^*_{t+1} = W^*_t(1 + r^*_{p,t+1}) \tag{1.16}$$

where $r_{p,t+1}$ is the real return on the home portfolio from t to $t+1$. To consider this portfolio return more carefully, suppose that the home and foreign investors can hold only a home and a foreign asset. I will first describe the portfolio decision on the part of the home investor. The portfolio decision for the foreign investor is completely symmetric.

The real return on the home portfolio is:

$$r_{p,t+1} = x_t r^*_{t+1} + (1 - x_t) r_{t+1} \tag{1.17}$$

where x_t is the share of W_t held in the foreign asset, r^*_{t+1} is the return on the foreign asset and r_{t+1} is the return on the domestic asset both realized at $t+1$.

To write these real returns in terms of observables, their nominal returns in each

[11]The puzzle posed by the high variability of the estimated H–J bounds implied by foreign exchange returns relative to theoretical models is similar to that posed by other markets such as equity returns. However, the degree of risk aversion required to reconcile theory with the empirical bounds appears to be exceptionally high for foreign exchange returns.

[12]See Sharpe (1964), Lintner (1965), and Mossin (1966).

[13]See the development of this model in Solnik (1974a).

currency are deflated by exchange rate and price level changes:

$$1 + r^*_{t+1} \equiv (1 + i^*_t)(S_{t+1}P_t/S_tP_{t+1}) \approx 1 + i^*_t + \Delta s_{t+1} - \pi_{t+1}\,,$$
$$1 + r_{t+1} \equiv (1 + i_t)(P_t/P_{t+1}) \approx 1 + i_t - \pi_{t+1}\,, \tag{1.18}$$

where P_t is the domestic price level at time t, i_t and i^*_t are the nominal returns on assets held from time t to $t+1$. For simplicity, this real return is approximated using the nominal rates less the domestic inflation rate defined as π_{t+1}. It is therefore convenient to rewrite the real return on the portfolio in terms of the nominal return:

$$i_{p,t+1} \equiv x_t(i^*_t + \Delta s_{t+1}) + (1 - x_t)i_t \tag{1.19}$$

so that $r_{p,t+1} = i_{p,t+1} - \pi_{t+1}$.

As with the domestic CAPM, the investor is assumed to choose x_t to maximize an objective function that is increasing in the mean but decreasing in the variance of end-of-period wealth, denoted $\mathrm{Var}_t(W_{t+1})$, where Var_t is the variance conditional upon information known at time t. Thus, the objective function is:

$$V = V(E_t(W_{t+1}), \mathrm{Var}_t(W_{t+1}))\,, \quad V_1 > 0, V_2 < 0\,. \tag{1.20}$$

Solving the model requires calculating the mean and variance of wealth in terms of the observables. The conditional mean and variance can be rewritten by substituting (1.18) into (1.17).

$$E_tW_{t+1} = W_t + W_tE_t(x_ter_{t+1} + r_{t+1})$$
$$\mathrm{Var}_tW_{t+1} = W_t^2\,\mathrm{Var}_t(x_ter_{t+1} + r_{t+1})\,. \tag{1.21}$$

Deriving the first-order conditions of (1.20) with respect to x_t, substituting (1.21) into the result and defining the measure of relative risk aversion as $\rho \equiv -2V_2W_t/V_1$ where V_i are the partial derivatives of V with respect to the ith argument, gives:[14]

$$per_{t+1} = \rho\,\mathrm{Cov}_t(er_{t+1}, i_{p,t+1}) - \rho\,\mathrm{Cov}_t(er_{t+1}, \pi_{t+1})\,. \tag{1.22}$$

This first-order condition is the basic CAPM relationship that holds if the home investor were (counterfactually) to comprise the entire market.

Adler and Dumas (1983) describe the intuition behind this model. The more risk averse are investors, the greater their aversion to variance and the higher is ρ. Furthermore, as (1.22) shows, given the price of risk, the expected excess return increases with the covariance between the excess return and the nominal return on wealth, $i_{p,t+1}$. If the excess return has a high covariance with the overall portfolio, the

[14]This measure of relative risk aversion is approximately the Arrow–Pratt measure: $-U''W/U'$, where $U(W)$ is the utility function. Taking a Taylor-series expansion of $E(U(W))$ and differentiating with respect to $E(W)$ and $\mathrm{Var}(W)$ shows that ρ as defined in the text is the same as the Arrow–Pratt measure.

predictable excess return must be correspondingly high to compensate the investor for risk.

The last term reflects the degree to which the foreign asset provides a hedge against inflation. Since the value of wealth falls with inflation, a higher covariance of returns with inflation increases the hedging properties of the foreign asset. Therefore, the required excess return decreases with this term.

This basic equation underlies the choice of equity as well as deposits across countries, as I will return to discuss more fully in Section 2. However, since I am focusing upon the foreign exchange risk premium in this section, I will now use the fact that the domestic and foreign assets are risk-free bonds in their respective currencies. Also, in order for aggregate outside bonds to be considered net wealth, Ricardian equivalence must not hold. In this case, the conditional covariance between excess returns arises solely from the conditional covariance between exchange rates.[15] Therefore, eq. (1.22) can be written as:

$$per_{t+1} = \rho x_t \operatorname{Var}_t(\Delta s_{t+1}) - \rho \operatorname{Cov}_t(\Delta s_{t+1}, \pi_{t+1}) . \tag{1.23}$$

Thus, the first-order conditions depend only upon the variability of exchange rates and inflation.

Determining (1.23) as a world market equilibrium requires solving the problem from the foreign investor's point of view and summing demand functions across domestic and foreign residents. Following the same steps as above for the foreign investor implies the equilibrium relationship,[16]

$$\begin{aligned} per_{t+1} = {} & \rho[x_t w_t - (1 - x_t^*)w_t^*] \operatorname{Var}_t(\Delta s) \\ & - \rho[w_t \operatorname{Cov}_t(\Delta s_{t+1}, \pi_{t+1}) + w_t^* \operatorname{Cov}_t(\Delta s_{t+1}, \pi^f_{t+1})] \end{aligned} \tag{1.24}$$

where x_t^* is the share of foreigner's wealth that they hold in their own assets, where ρ^f is the foreign inflation rate, and where w_t and w_t^* are the shares of the world wealth held by home and foreign residents, respectively, so that $w_t + w_t^* = 1$.

Equation (1.24) has an intuitive interpretation. Suppose first that inflation were perfectly forecastable. In this case, the covariance terms are zero and the sign of the risk premium would depend upon the difference between $x_t w_t$ and $(1 - x_t^*)w_t^*$, or the difference between domestic holdings of foreign bonds and foreign holdings of domestic bonds. When domestic residents are net creditors so that $x_t w_t > (1 - x_t^*)w_t^*$, then the overall effect on the risk premium is to compensate domestic investors for

[15] Using the definition of er and i_p in (1.19), $\operatorname{Cov}(er_{t+1}, i_{p,t+1}) = \operatorname{Var}(\Delta s_{t+1})x_t$ and $\operatorname{Cov}(er_{t+1}, \pi_{t+1}) = \operatorname{Cov}(\Delta s_{t+1}, \pi_{t+1})$.

[16] Following these steps, the first-order conditions for the foreign investor is: $per_{t+1} = \rho x_t^* \operatorname{Var}(\Delta s_{t+1}) + \rho \operatorname{Cov}(er_{t+1}, \pi^*_{t+1})$ where π^*_{t+1} is the foreign inflation measured in terms of the domestic currency. Solving this condition with respect to x^*, summing demand equations $x_t W_t + x_t^* W_t^*$, and setting the aggregated demand equal to the given supply of foreign bonds, the equilibrium expected excess return can be written as in eq. (1.24).

net holdings of foreign deposits. Next, consider the effects of uncertain inflation. In this case, holdings of deposits in the other country can provide a hedge against inflation depending upon the covariance between own inflation and the exchange rate.

Equation (1.24) examines only two risk-free bonds and two investors in order to demonstrate the intuition simply. More generally, the portfolio should include all possible assets available to the investor. Similarly, the inflation hedges should be aggregated over all countries in the world. Adler and Dumas (1983) show how this model generalizes allowing for many countries. In this case, the exchange rate variance in (1.24) becomes a variance-covariance matrix across currencies, and the inflation hedge component depends upon the covariance matrix of exchange rates and inflation rates across countries.

1.2.1.1. The Jensen's inequality term

In continuous time, the predictable excess returns also depend upon a term arising from Jensen's inequality.[17] Instead of eq. (1.22), the expression for predictable excess returns is:

$$per_t = \rho \operatorname{Cov}_t(er_{t+1}, i_{p,t+1}) + (1-\rho) \operatorname{Cov}_t(er_{t+1}, \pi_{t+1}) . \tag{1.25}$$

The presence of this term implies that (1.23) becomes:

$$per_t = \rho x_t \operatorname{Var}_t(\Delta s_{t+1}) + (1-\rho) \operatorname{Cov}_t(\Delta s_{t+1}, \pi_{t+1}) . \tag{1.26}$$

Thus, even when expectations are rational and investors are risk neutral so that $\rho = 0$, predictable excess returns are non-zero and equal to $\operatorname{Cov}_t(\Delta s_{t+1}, \pi_{t+1})$. For this reason, Frenkel and Razin (1980) and Engel (1984) pointed out that due to this Jensen's inequality term, predictable excess returns are not zero even when investors are risk averse and expectations are statistically unbiased. Since predictable excess returns are not zero even in the absence of risk aversion, it may be argued that these returns should not be called a "risk premium".

How important is this Jensen's inequality term? Clearly this depends upon the importance of the covariance between the exchange rate and inflation. Empirically, the covariance between exchange rates and inflation is quite small and near zero as will be shown in Section 2. In fact, a number of authors including Engel (1984) and Cumby (1988) have found that the behavior of excess returns measured in real terms and in nominal terms do not behave very differently. Therefore, it seems unlikely that this term can help explain an important fraction of excess return behavior.

1.2.1.2. Empirical evidence: What is wrong with the model?

A number of authors have examined the implied behavior of the foreign exchange risk premium based upon the model above. The general finding is that estimates of

[17] See the derivation in Adler and Dumas (1983), for example.

the parameter of risk aversion are large but insignificantly different than zero and that the restrictions of the model are rejected.[18]

Why doesn't this model seem to explain the foreign exchange risk premium? Recall the results found in the Fama regression in Table 1.1 and consider them in light of eq. (1.24). The Fama result implies that the model must explain a very high degree of variability in the risk premium, with a standard deviation of between 9 and 11 percent for the dollar against the DM, pound, and yen. Equation (1.24) shows that this variability must come from either the asset shares across countries, the wealth shares, or the conditional variances and covariances.

However, the standard deviation of measures of outside bonds and relative wealth positions, as measured by current account changes, is only about 1 to 3 percent per annum.[19] As for volatility arising from movements in conditional variances, Engel and Rodrigues (1989) found that the largest period of variation in conditional variances was in 1979. During this period, conditional variances moved over a range of about .3 percent per annum, with these ranges much lower over other periods.[20] Overall, these variables do not exhibit sufficient variation to be able to explain the variance in predictable returns.

Recall also that predictable excess returns change sign frequently, even over short periods, as depicted in Figure 1.1. However, the model predicts that these changes in sign will take place only when countries change from net debtor to creditor positions or when conditional variances change sufficiently. The infrequent shifts between net debtor to creditor positions and the lack of variability in conditional variances suggest that this model cannot explain the changes in sign in predictable returns either.

From a theoretical point of view, this model suffers from other problems as well. First, the optimization problem faced by the representative investor is a static one. Second, the model is partial equilibrium in nature. The exchange rate and interest rate processes are exogenous to the model so these variables cannot depend jointly upon the risk premium. These issues are directly addressed in the general equilibrium framework described next.

1.2.2. The risk premium in general equilibrium

1.2.2.1. A stylized model

Given the theoretical difficulties with the static CAPM risk premium model, much of the subsequent analysis of the foreign exchange risk premium has been developed

[18]Frankel (1982) used a version of this model to estimate the measure of risk aversion assuming purchasing power parity and constant variances of returns. Lewis (1988b) relaxed the assumption of purchasing power parity by estimating the model using direct measures of the covariance between inflation and exchange rates. Engel and Rodrigues (1989) allowed variances to be time-varying. Despite these and other refinements in the literature, the model is typically rejected.

[19]These variances were measured using historical data on outside bonds as constructed in Lewis (1988a).

[20]On the plausibility of the conditional variance explaining the risk premium, see the discussion among Frankel (1986), Pagan (1986), and Giovannini and Jorion (1987a,b).

using general equilibrium pricing conditions. Basic relationships among asset pricing variables were motivated by the two-country complete markets model of Lucas (1982). Although this model is too stylized to explain the empirical behavior of the exchange rate itself, the intuition from this model has motivated various tests of relationships that are more general than this model. For this reason, I will review the model briefly before considering these general relationships.

In the Lucas model, there are representative agents with identical preferences in each of two countries. They seek to maximize the expected infinite life-time utility function:

$$E_0\left\{\sum_{t=0}^{\infty} \beta^t U(C_t^i, C_t^{*i})\right\} \tag{1.27}$$

for residents of country i where C_t^i and C_t^{*i} are the domestic and foreign produced goods, respectively, consumed by the resident of country i at time t.

Consumers in each country can buy goods produced in the other country. To keep the production side of the economy simple, suppose that goods are produced exogenously with outputs each period defined as the vector: $\psi_t = (Y_t, Y_t^*)$. Every period, the home consumer receives the output of the home good, Y_t, and endowments of money, M_t, while the foreign consumer receives the current output of the foreign good, Y_t^*, as well as foreign money, M_t^*. To buy goods, however, each consumer must buy the domestic good with domestic money at price $P_{y,t}$, and the foreign good with the foreign money at price $P_{y^*,t}$. This restriction and the assumption that consumers know their current endowments before buying goods imply a cash-in-advance constraint,

$$P_{y,t} = M_t/2Y_t \quad \text{and} \quad P_{y^*,t} = M_t^*/2Y_t^* . \tag{1.28}$$

As Lucas (1978) has shown, it is possible to price any asset from a basic general equilibrium model with complete markets. Hodrick and Srivastava (1986), Domowitz and Hakkio (1985), and Engel (1992a) examine the implications of the foreign exchange risk premium in this model.[21] To find the risk premium, recall that: $rp_t \equiv s_{t+1} - f_t \approx (E_t(S_{t+1}) - F_t)/S_t$, where $F_t = \exp(f_t)$ and $S_t = \exp(s_t)$. Therefore, solving for the risk premium requires solving for the spot and forward exchange rates.

To solve for the spot exchange rate, notice first that the relative price of good Y^* in terms of good Y, defined as p, is given by:

$$p_t = U_{c^*}(\psi_t)/U_c(\psi_t) , \tag{1.29}$$

where U_c and U_{c^*} are the marginal utilities with respect to C and C^*, respectively.

[21]Engel (1992a) shows how the risk premium in this model requires dependence between monetary and real disturbances. He shows that the assumption of monetary and real independence in the applications by Hodrick and Srivastava (1986) and Domowitz and Hakkio (1985) imply that the risk premium would be zero.

According to the law of one price, the nominal exchange rate and this relative price are related according to:

$$p_t = S_t P_{y*,t} / P_{y,t} . \tag{1.30}$$

Using eqs. (1.28), (1.29), and (1.30), the nominal exchange rate can alternatively be rewritten:

$$\begin{aligned} S_t &= p_t P_{y,t} / P_{y*,t} = [U_{c*}(\psi_t) / U_c(\psi_t)] P_{y,t} / P_{y*,t} \\ &= [U_{c*}(\psi_t) / U_c(\psi_t)][M_t Y_t^* / M_t^* Y_t] . \end{aligned} \tag{1.31}$$

The nominal exchange rate is the contemporaneous marginal rate of substitution in utility between holdings of domestic money M and foreign money M^*.[22] Using this specification of the spot exchange rate together with covered interest parity, the model can be solved for the forward rate, and thus the risk premium, as will be shown below in general settings.

As eq. (1.31) shows, the Lucas model allows an exact calculation of the determinants of the spot exchange rate by defining the components of the nominal marginal rates of substitution in consumption in each country. However, the basic intuition obtained from the first-order conditions of this model holds in much more general settings described next.

1.2.2.2. First-order conditions and the risk premium

Consider now the foreign exchange risk premium in a more general setting in which the investor maximizes utility by choosing consumption and investments over time with a utility function such as in (1.27). The relationship between spot and forward rates is determined by domestic and foreign interest rates through covered interest parity. The price of a deposit paying one unit of each currency at time $t + 1$ is given by:

$$\begin{aligned} 1/R_{t+1}^{rf} &= E_t\{\beta U_c(\psi_{t+1}) P_{y,t} / U_c(\psi_t) P_{y,t+1}\} \equiv E_t(Q_{t+1}) \\ 1/R_{t+1}^{rf*} &= E_t\{\beta U_{c*}(\psi_{t+1}) P_{y*,t} / U_{c*}(\psi_t) P_{y*,t+1}\} \equiv E_t(Q_{t+1}^*) \end{aligned} \tag{1.32}$$

where R_{t+1}^{rf} and R_{t+1}^{rf*} are the nominal interest rates on a risk-free deposit paying one unit of M and M^*, respectively, in period $t + 1$.[23] Q_{t+1} is defined as the intertemporal marginal rate of substitution of one unit of domestic currency between period t and

[22]This model implies that the exchange rate depends only upon contemporaneous variables, and is therefore not forward-looking. Svensson (1985a,b) assumes a different timing to the cash-in-advance constraint which implies a precautionary motive for holding money, making the exchange rate depend upon expected future values. Engel (1992b) derives the risk premium implications of this model. Bekaert (1992) introduces a transactions technology for money holdings and provides a richer production economy.

[23]These rates are related to the earlier definition of interest rates according to: $R_{t+1}^{rf} \equiv (1 + i_t)$ and $R_{t+1}^{rf*} \equiv (1 + i_t^*)$.

period $t+1$, while Q^*_{t+1} is the counterpart in foreign currency. Below, I will call Q_{t+1} and Q^*_{t+1}, respectively, the domestic and foreign nominal intertemporal rates of substitution.

The relationship in eq. (1.32) holds for any economy in which no arbitrage opportunities are present.[24] As described by Telmer (1993), this relationship also holds in settings where investors cannot fully insure all possible states of the world because markets are incomplete.

The spot exchange rate is simply the contemporaneous ratio of nominal rates of substitution in consumption. Therefore, using the definitions for Q and Q^*, the ratio of future to current exchange rates can be written:

$$(S_{t+1}/S_t) = (Q^*_{t+1}/Q_{t+1}) . \tag{1.33}$$

Equation (1.29) from the Lucas model provides a specific example of this general relationship.

Covered interest parity and (1.32) imply:

$$F_t = S_t R^{rf}_{t+1}/R^{rf*}_{t+1} = S_t E_t(Q^*_{t+1})/E_t(Q_{t+1}) . \tag{1.34}$$

Note that the relationship between the forward rate and spot rate in (1.34) is quite general. To solve for the forward rate using the specific form of the Lucas model requires only substituting the solution for the spot rate in (1.31).

These relationships may now be stated in the form of the Fama result. Recall that Table 1.1 showed that $\mathrm{Var}(rp_t)$ is greater than $\mathrm{Var}(E_t\,\Delta s_{t+1})$, where $rp_t \equiv E_t s_{t+1} - f_t \approx (E_t S_{t+1} - F_t)/S_t$ and $E_t\,\Delta s_{t+1} \approx (E_t S_{t+1} - S_t)/S_t$. Using the expressions for the spot rate in (1.33) and the forward rate in (1.34), the Fama result says that: $\mathrm{Var}(rp_t) > \mathrm{Var}(E_t\,\Delta s_{t+1})$ or that,

$$\mathrm{Var}\{E_t(Q^*_{t+1}/Q_{t+1}) - [E_t(Q^*_{t+1})/E_t(Q_{t+1})]\} > \mathrm{Var}\{E_t(Q^*_{t+1}/Q_{t+1})\} . \tag{1.35}$$

In other words, the risk premium is the difference between the ratio of expected marginal rates of substitution in consumption and the expectation of this ratio. The variance of this difference exceeds the variance of the expected ratio of marginal rates of substitution alone.

The generality of the intertemporal relationships between the marginal rates of substitution and the interest rates in (1.32) suggests that testing these relationships are natural first steps.[25] Mark (1985) tests the intertemporal restrictions with consumption for a consumer with constant relative risk aversion utility. He estimates the parameter of risk aversion to be quite large, generally in a range of 12 to 50 for most sets of instrumental variables. As suggested by the large variability of the predictable excess

[24]The generality of this relationship has stimulated a large literature on consumption smoothing behavior. See for example Hall (1978) and papers in the survey in Hall (1989).

[25]Indeed, the relationships are so general that they must hold for domestic assets, as well as foreign currency returns as will be described in more detail below.

returns, large amounts of risk aversion are required to reconcile the variability of the predictable returns to the risk premium model. While Mark finds that the over-identifying restrictions of the model are not rejected for some instruments, the relative risk aversion parameter is estimated quite imprecisely, so that the hypothesis that the parameter of risk aversion is zero cannot be rejected.

Such parametric tests are useful for understanding how particular utility functions must behave to produce the behavior of excess returns given by the data. However, to relax the assumption of particular utility functions, more general tests have been developed to investigate the relationship across all asset returns. Below, I describe two types of these general tests: latent variable models and Hansen–Jaganathan bounds.

1.2.2.3. Latent variable model

The latent variable test was pioneered in foreign exchange studies by Hansen and Hodrick (1983) and was developed independently for application in a standard CAPM environment by Gibbons and Ferson (1985).

To understand the basic intuition behind this test, note that the first order condition of intertemporal maximization underlying (1.32) implies that the following relationship holds:[26]

$$E_t(Q_{t+1}R^j_{t+1}) = 1 \quad \forall j\,. \tag{1.36}$$

As before, Q_{t+1} is the intertemporal marginal rate of substitution in consumption and R^j_{t+1} is the gross rate of return on any asset j realized at time $t+1$. For now, I will treat consumption as a single domestic good, C, although this framework could be modified to include a composite good.[27] Since relation (1.36) holds for any asset with return j, it also holds for the risk-free rate.

$$E_t\{Q_{t+1}(R^j_{t+1} - R^{rf}_{t+1})\} = E_t\{Q_{t+1}er^j_{t+1}\} = 0 \tag{1.37}$$

where $er^j_{t+1} \equiv R^j_{t+1} - R^{rf}_{t+1}$ is the excess return on asset j over the risk free rate. Since the conditional expectation of the risk-free rate is known at time t, eq. (1.37) for this rate can be rewritten as in (1.32). Using the definition of covariances and (1.32), eq. (1.37) can be rewritten as:[28]

$$E_t(er^j_{t+1}) = -\mathrm{Cov}_t(R^j_{t+1}, Q_{t+1})R^{rf}_{t+1}\,. \tag{1.38}$$

Since (1.38) holds for any asset, we may substitute out the risk-free rate with any

[26]The intertemporal first order condition for an asset with any nominal payoff R^j_{t+1} is: $U_c(\psi_t)(1/P_{y,t}) = E_t(U_c(\psi_{t+1})(1/P_{y,t+1})R^j_{t+1})$. Dividing both sides by the left-hand side expression and using the definition of Q gives eq. (1.36).

[27]Adler and Dumas (1983) consider such an extension for the CAPM in their appendix.

[28]In other words, the fact that $E(XY) = E(X)E(Y) + \mathrm{Cov}(X, Y)$ for any X and Y.

asset b to get:

$$E_t(er^j_{t+1}) = [\mathrm{Cov}_t(R^j_{t+1}, Q_{t+1})/\mathrm{Cov}_t(R^b_{t+1}, Q_{t+1})]E_t(er^b_{t+1}) . \tag{1.39}$$

Since all returns depend upon their conditional covariances with the marginal rate of substitution in consumption, they must move in proportion to each other according to the ratios of these conditional covariances.

In order to test this restriction, Hansen and Hodrick (1983) as well as many subsequent researchers assume that the conditional covariances between returns and the marginal rate of substitution in consumption move in proportion across assets over time. Under this assumption, the ratios of covariances in (1.39) are constant. Generally, the studies find that the over-identifying restrictions implied by returns moving in proportion are not rejected for low frequencies such as quarterly returns, but are strongly rejected for high frequency data, such as weekly.[29]

Cumby (1988, 1990) and Lewis (1991) question whether the rejections come from the auxiliary assumption that covariances move in proportion to each other. Consistent with the pattern of rejection in the latent variable tests, Lewis (1991) finds that the ratios of covariances in (1.39) appear to move in proportion only over longer holding periods. However, the question remains whether this tendency not to reject over longer horizons is a matter of low power.

Bekaert and Hodrick (1992) indirectly consider this possibility by using the one step ahead information in a VAR of foreign exchange and equity returns to test the latent variable restrictions. They find that a single factor model as implied by (1.39) is rejected, although a two factor model appears to fit the data better.

The main contribution of this literature testing for latent variable relationships seems to be its characterization of the behavior of excess returns. This literature shows that some factors, or comovements, help explain returns. A single factor model could be the result of a general equilibrium pricing relationship, but it could also be due to any model that suggests a proportional relationship between returns. Therefore, the latent variable test appears too general to draw any implications for the validity of general equilibrium pricing models.

1.2.2.4. Hansen–Jaganathan bounds

A useful way to compare the variability of predictable excess returns with the implications of any one model has been provided in the pioneering work of Hansen

[29] Hansen and Hodrick (1983) tested these restrictions using monthly excess foreign returns across six currencies, rejecting this restriction with marginal significance levels near 5 percent. Hodrick and Srivastava (1984) expanded the sample period and rejected the model. Giovannini and Jorion (1987a) examined weekly returns and used returns from the stock market, finding the restrictions to be rejected. Campbell and Clarida (1987) used three month returns across the Eurocurrency term structure as well as the foreign exchange market. Lewis (1990) surveyed this literature and found that the rejection of the latent variable restrictions is sensitive only to the holding period, not the inclusion of term structure rather than equity returns. Considering a number of combinations of returns and holding periods, that study found that the shorter the holding period, the more likely the restrictions are to reject.

and Jaganathan (1991), originally applied to US T-Bill rates. Since the basic framework holds for *all* returns, it clearly has implications for the foreign exchange risk premium.

The Hansen–Jaganathan (H–J) bounds use combinations of excess returns to provide a lower bound on the volatility of the intertemporal marginal rate of substitution in consumption, Q_{t+1}. This lower bound is a powerful empirical tool since it must hold for any model and, as such, is free of parameters. To see how this relationship is derived, consider again eq. (1.37) using the Law of Iterated Expectations and subsuming the superscript j:

$$E(Q_{t+1}er_{t+1}) = 0\,. \tag{1.37'}$$

Suppose that the intertemporal marginal rate of substitution can be written as a linear projection on er_{t+1}.

$$Q_{t+1} = \delta_0 + \delta' er_{t+1} + e_{t+1}\,, \tag{1.40}$$

where e_{t+1} is the projection error. Then by OLS, the parameter vector δ can be written:

$$\begin{aligned}\delta &= \sum\nolimits^{-1} [E(Q_{t+1}er_{t+1}) - E(Q_{t+1})E(er_{t+1})] \\ &= -\sum\nolimits^{-1} E(Q_{t+1})E(er_{t+1})\,,\end{aligned} \tag{1.41}$$

where Σ is the variance of er_{t+1} (when er is a vector, Σ is the variance-covariance matrix) and where the second equality follows by eq. (1.37′). Substituting (1.41) into (1.40) above and noting that the variance of e_t is positive, we have:

$$\sigma^2(Q_{t+1}) > [E(Q_{t+1})]^2 E(er_{t+1})' \sum\nolimits^{-1} E(er_{t+1}) \tag{1.42}$$

or,

$$\sigma(Q_{t+1})/[E(Q_{t+1})] > \left[E(er_{t+1})' \sum\nolimits^{-1} E(er_{t+1})\right]^{1/2}. \tag{1.42'}$$

Bekaert and Hodrick (1992) estimate H–J bounds as in (1.42′) using different measures of returns. For a combination of equity and foreign exchange returns in the US, Japan, UK, and Germany, they find that the bounds are in the vicinity of 0.6 to 0.7. However, Bekaert (1994) calculated the ratio of the $\sigma(Q)/E(Q)$ for an extension of the Lucas (1982) model to be 0.01 assuming a relative risk aversion parameter of 2. To obtain bounds near the Bekaert and Hodrick (1992) estimates, this risk aversion coefficient must be over 140!

1.2.3. Foreign exchange intervention and the risk premium

The foreign exchange risk premium has also been used to explain the popularity of foreign exchange intervention by central bankers. To illustrate some recent foreign exchange activity, Figures 1.2 depict intervention by the US authorities during 1985 to 1990 against the DM/$ and ¥/$ exchange rates, respectively.[30] While the US went through periods such as 1986 in which no intervention was undertaken, other periods such as 1988 were marked by frequent intervention. Other major central banks such as the Bank of Japan and the Bundesbank, the German central bank, were even more actively involved in intervention during this period. Roughly speaking, interventions to sell dollars appeared to take place when the dollar was relatively strong such as in late 1985 and in 1989, while dollar purchases took place when the dollar was weaker such as in 1987 and early 1988.

Whether these interventions affect the exchange rate or not remains an issue of active empirical research.[31] Nevertheless, it is clear that central bankers continue to intervene. This obvious fact has led researchers to search for reasons why intervention may be effective in changing the exchange rate. One explanation depends upon the presence of a risk premium.

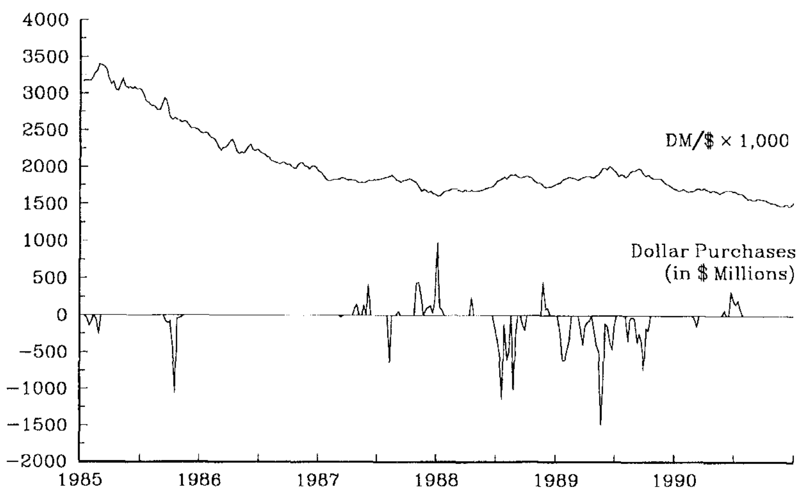
Before describing how a risk premium can provide a rationale for intervention, it is important to first understand why the effectiveness of intervention appears so puzzling to researchers. For this purpose, consider a typical foreign exchange intervention operation. Suppose that the U.S. authorities would like to support the dollar against the yen. In this case, they would conduct dollar purchasing operations. These operations can be understood as a two step procedure. First, they would buy dollars and sell yen reserves in the foreign exchange market. If the authorities took no further action, then the US high-powered money supply would decline by the amount of the dollar purchases. For this reason, they would then undertake a second step to "sterilize" the effects upon the money supply. That is, they would offset the decline in the money supply by buying T-Bills through open-market operations. This sterilization procedure is carried out through monetary policy targeting in the United States, Germany and other countries.

This sterilization practice produces a challenge for explaining how intervention can affect the exchange rate. Conventional demand and supply intuition suggests that a decline in the US money supply leads to an appreciation in the dollar since the exchange rate is the relative price of monies. However, the second step of "sterilization" implies that the money supplies are not affected. Therefore, how can

[30]The intervention series was supplied by the Federal Reserve Board of Governors and the exchange rate series is the Wednesday rate reported in the Federal Reserve Bulletin.

[31]For a recent survey, see Edison (1993).

A. Against the DM



B. Against the Yen

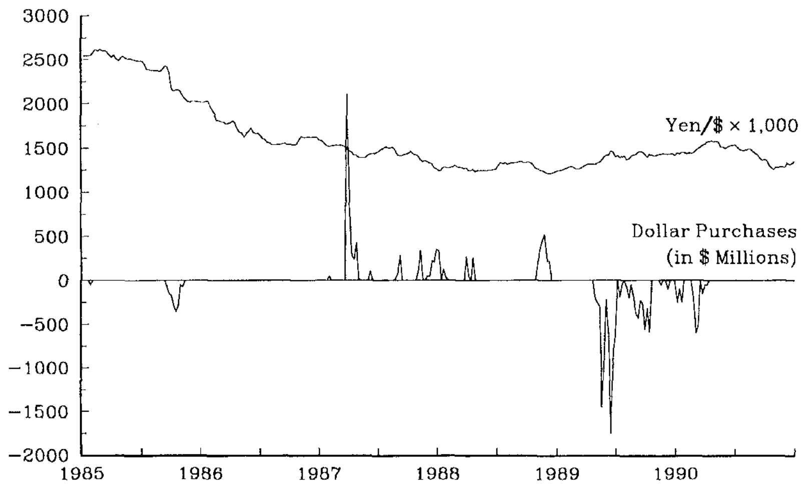


Figure 1.2. US foreign exchange intervention against the DM and yen.

the intervention process possibly affect the exchange rate? The proposed answer: the "portfolio balance" effect through a risk premium.[32]

The "portfolio balance" explanation is straightforward.[33] It is true that money supplies are not affected under sterilized intervention, it is argued, but relative supplies of interest-bearing assets are. After the sterilized intervention described above, the private sector is left holding less US T-Bills and more yen interest-bearing assets. Unless the private sector is indifferent to the currency denomination of its portfolio, the relative return on these assets must change. Specifically, the intervention creates an excess supply of yen bonds and an excess demand for dollar bonds at the previous relative rate of return. One way to attain this equilibrium is for the dollar to appreciate so that both the value of and rate of return on dollar bonds is now higher relative to yen bonds than before the intervention.

The strength of this channel therefore depends upon how much intervention affects the relative price of bonds. Consider this relative expected rate of return in the context of the partial equilibrium model described in Section 1.2. Recall that this return was written as:

$$i_t^* - i_t + E_t\,\Delta s_{t+1} = \rho x_t\,\mathrm{Var}(\Delta s) - \rho\,\mathrm{Cov}(\Delta s, \pi)\,. \qquad (1.23)$$

Now suppose central bankers intervene by purchasing dollars. In this case, x_t will increase since the private sector will be left holding relatively more foreign bonds and less dollar bonds. Therefore, the expected excess return on foreign bonds must increase.

Sterilization is intended to keep the money supply and, hence, the interest rates constant. For this reason, the interest rates, i_t and i_t^*, are typically assumed to be constant following the intervention. An increase in x_t then requires an increase in $E_t\,\Delta s_{t+1}$ in order to clear the financial market.[34] The expected future exchange rate is assumed to be constant so that the intervention requires that the spot rate, s_t, declines and the dollar appreciates.[35]

The plausibility of this channel clearly depends upon how much the exchange rate must respond in order to maintain portfolio balance. If investors are relatively

[32]An alternative explanation is the "signalling" story. This story, articulated by Mussa (1981), suggests that current sterilized intervention is correlated with future changes in the money supply. Therefore, even though current money supplies are not altered through intervention, traders believe that future money will change, inducing an immediate response in exchange rates. For a discussion of this literature, see the chapter by Frankel and Rose (1995) in this volume.

[33]The portfolio balance approach was developed by Kouri (1976), Branson (1977), and Girton and Henderson (1977), among others. For a discussion, see Branson and Henderson (1984).

[34]Changes in the current spot rate can also offset the increase in foreign bond portfolio shares directly since these shares are measured in units of domestic currency. For more on this relationship, see Branson and Henderson (1984).

[35]This assumption is stronger than needed. As long as the expected future exchange rate does not increase sufficiently so that the current spot rate increases, the basic argument of the portfolio balance model will hold.

risk-neutral so that $\rho \approx 0$, they will consider bonds close substitutes and the expected relative rate of return will be close to zero. In this case, large changes in intervention through asset shares x will have little effect upon the exchange rate. While the specifics of the CAPM model provide the motivation for these effects, it is also clear that any portfolio model in which investors consider bonds denominated in different currencies to be highly substitutable will yield the same prediction that intervention is relatively ineffective. Thus, the plausibility of the portfolio balance channel hinges upon whether changes in the currency denomination of the portfolio affect the equilibrium relative returns of assets.

The empirical studies that examine this issue fall into two basic groups. The first set of studies estimate portfolios of bond demand equations that are not restricted to follow the CAPM restrictions in (1.23′). Rogoff (1984) and Lewis (1988a) find no evidence that bond demands are sufficiently inelastic that intervention would affect expected real rates of return. A second set of studies uses the CAPM restrictions to examine this relationship. Clearly, this set includes all studies of the static international CAPM, considered in Section 1.2, even though intervention may not have been the focus of the study. As described there, this literature has been summarily unsuccessful in relating bond supplies to a measure of the foreign exchange risk premium. However, Dominguez and Frankel (1993) use survey data as a measure of expectations as well as intervention as a measure of bonds. They find some support for the hypothesis that intervention affects the expected relative rates of return. Since the forecasts captured in survey measures are irrational, as will be described below, more research must be done to understand how intervention affects expectations before monetary authorities could potentially use intervention policy in a predictable fashion.

The portfolio balance story typically ignores the effects of expectations in the general equilibrium of the economy. Backus and Kehoe (1989) show that this omission can be quite important. They show that government debt instruments can be manipulated as in a sterilized intervention without affecting exchange rates at all. Furthermore, sterilized interventions to support the dollar may be correlated with dollar appreciations, depreciations, or not at all.

1.2.4. Empirical conclusions

Whether from a partial or general equilibrium point of view, explaining the foreign exchange risk premium requires a high degree of implied variability in predictable excess returns. Observable ingredients in the risk premium models do not vary sufficiently to explain this behavior on their own. In the static CAPM, bond supplies and conditional variances do not fluctuate sufficiently. In general equilibrium, the relatively low degree of variability in consumption is inconsistent with the high degree of variability in asset returns. Thus, unless risk aversion is extremely high, neither the static CAPM nor the general equilibrium relationships can explain the risk premium.

The high variability in excess returns relative to predictions of theoretical models is a problem that plagues other markets as well.[36] One direction that has been pursued to explain risk premia in markets such as equity is to depart from the standard time-separable iso-elastic utility function. Backus, Gregory and Telmer (1993) examine the theoretical implications of risk premia based upon non-standard utility preferences, particularly habit-persistence.[37] They find that habit-persistence raises the variability of the intertemporal marginal rate of substitution, but does not explain other features of the model. Bekaert, Hodrick, and Marshall (1994) consider utility functions that allow for first-order risk aversion as opposed to the second-order risk aversion implied by standard utility functions. Based upon a class of utility functions related to Epstein and Zin (1990), they find that the variability of the risk premium increases. However, they are not able to match the risk premium on the foreign exchange, equity and bond markets of the US and Japan. While these seem important directions to pursue, there appears to remain a discrepancy between the actual and theoretical variability in excess returns.

This discrepancy has led some to argue that the anomalous behavior of predictable returns may be due to systematic expectational errors. In this case, expectational errors may contribute to the high degree of variability in predictable excess returns.

There are two basic groups of explanations for these expectational errors. First, forecast errors may be systematic because some agents in the market are not rational. The "market's forecast" is really a composite of a heterogeneous group of traders. Since some of these traders are irrational, measures of the market's expectations will not be rational. The second explanation for systematic expectational errors arises from statistical problems with measuring expectations. I next describe each of these two explanations.

1.3. Market inefficiencies and rational expectations

Understanding the behavior of predictable excess returns requires an identifying decomposition between the forecast error component and the risk premium component. The analysis above used the standard decomposition that forecast errors are conditionally uncorrelated with past information so that all predictable excess returns must equal the foreign exchange risk premia. If this assumption is violated, however, then predictable excess returns confound risk premia and forecast errors.

Froot and Frankel (1989) provide a decomposition of each component of

[36]For example, Mehra and Prescott (1985) show that the US equity premium, the return on stocks in excess of the risk free rate, requires high variability in the marginal rate of substitution in consumption, implying an implausibly high risk aversion parameter.

[37]For more on habit-persistence utility functions, see Constantanides (1990) and Abel (1990).

predictable excess returns. The behavior of these returns can be conveniently summarized in the Fama (1984) regression of excess returns on forward premia described previously in Section 1.1.1. Since the change in the exchange rate equals the market's expected future exchange rate plus a forecast error, $\Delta s_{t+1} = E_t^m \Delta s_{t+1} + \eta_{t+1}$, the regression coefficient can also be written as:

$$\beta_1 = [\mathrm{Cov}(E_t^m \Delta s_{t+1}, f_t + s_t) + \mathrm{Cov}(\eta_{t+1}, f_t - s_t)] / \mathrm{Var}(f_t - s_t)\,. \tag{1.43}$$

Rewriting the forward premium, $f - s$, in (1.43) in terms of its identity with the risk premium in (1.13), the probability limit of β_1 is:

$$\beta_1 = 1 - \beta_{rp} - \beta_{re}$$

where

$$\begin{aligned} \beta_{rp} &= [\mathrm{Var}(rp_t) - \mathrm{Cov}(E_t^m \Delta s_{t+1}, rp_t)] / \mathrm{Var}(f_t - s_t)\,, \\ \beta_{re} &= -\mathrm{Cov}(\eta_{t+1}, f_t - s_t) / \mathrm{Var}(f_t - s_t)\,. \end{aligned} \tag{1.44}$$

This equation shows that if $\beta_1 \neq 1$, then either (a) the risk premium is time-varying, or else (b) the market's forecast error is correlated with the forward premium, or (c) some combination of the two.

Fama interpreted the finding of $\beta_1 \neq 1$ as the result of a risk premium, since under standard rational expectations assumptions $E_t s_{t+1} = E_t^m s_{t+1}$ and $\mathrm{Cov}(\eta_{t+1}, f_t - s_t) = 0$. In this case, $\beta_{re} = 0$ and $\beta_1 = 1 - \beta_{rp}$. Under this assumption, the variance of the risk premium exceeds the variance of the market's expectations of exchange rate changes, an implication difficult to explain with conventional risk premium models.

If instead, the risk premium were constant, then $\beta_1 = 1 - \beta_{re}$. A finding that $\beta_1 < 1$ implies that $\mathrm{Cov}(\eta_{t+1}, f_t - s_t) < 0$, or that the forecast error is negatively correlated with the forward premium. In this case, the forward rate systematically predicts exchange rate movements in the opposite direction from their subsequent movement.

Determining which component, β_{re} or β_{rp}, is most important requires some measure of expectations. Froot and Frankel (1989) examine this decomposition using exchange rate forecasts from surveys conducted by financial firms.[38] They identify the median forecast across traders surveyed at each period t as a measure of the market's expected future spot rate, $E_t^m s_{t+1}$. They combine this measure of expectations with the forward rate to identify the risk premium.

With this identification, Froot and Frankel (1989) decompose the Fama coefficient into the component due to the risk premium, rp_t, and the component due to the forecast error, η_{t+1}. Table 1.2 shows the results of calculating β_1, β_{rp}, and β_{re} using

[38]They combine surveys from three different sources: the MMS, the Economist, and the AMEX. The sample periods as well as sampling procedures differ across these surveys. See Frankel and Froot (1987) and Froot and Frankel (1989) for a more detailed description.

Table 1.2
Components of the Fama regression coefficient

Date set	Dates	(1) β_1	(2) β_{rp}	(3) β_{re}
Economist	6/81–12/85	−0.57	0.08	1.49
3 month	"	−1.21	−0.30	2.51
6 month	"	−1.98	−0.00	2.99
12 month	"	0.29	0.19	0.52
MMS 1 month	11/82–1/88	−1.74	−2.07	4.81
MMS 3 month	1/83–10/84	−6.25	1.18	6.07
AMEX	1/76–7/85	−2.21	−0.03	3.25
6 month	"	−2.42	−0.22	3.63
12 month	1/76–7/84	−2.14	0.03	3.11

Notes: From Froot and Frankel (1989).

their data set. Over the different time periods of the various survey measures, the coefficient estimates in the column labeled β_1 are typically negative, similar to the results found in Table 1.1.

The contribution of the risk premium is given in column (2). From eq. (1.44), note that for time-varying risk premia to explain the negative estimates of β_1, it must be true that $\beta_{rp} > 1$. However, column (2) shows that all but one of the estimates of β_{rp} are less than one. Only the MMS 3 month survey gives an estimate of $\beta_{rp} > 1$, but in this case the estimate of β_1 exceeds -6! Thus, even in this case, the risk premium does not explain an important fraction of the variation of the predictable excess return. For the other samples, the estimates of β_{rp} are frequently close to zero, implying that the variance of the risk premium is small compared to that of the forecast error.

On the other hand, the contribution of the forecast error is considerable as shown in column (3) of Table 1.2. Recall that for the correlation between forecast errors and forward premia to explain the negative estimates of β_1, it must be true that $\beta_{re} > 1$. For every case in which $\beta_1 < 0$, column (3) shows that $\beta_{re} > 1$. Thus, the important component in the variability of predictable returns appears to be the forecast error, and not the risk premium.

1.3.1. Interpretation

The results in Table 1.2 clearly contradict the standard interpretation of rational expectations. Forecast errors appear to be significantly correlated with the lagged forward premium, a variable readily observable to traders. Where does this correlation come from?

There are two general ways in which this question has been answered. First, the aggregated expectations of the market may be irrational. Frankel and Froot (1987) use the same survey measure of expectations to determine how expectations depend upon lagged information. Consistent with the evidence in Table 1.2 they find that these expectations are significantly different from the *ex post* realized exchange rate, so that expectations appear irrational. They also find that exchange rate expectations take the form of a distributed lag of past exchange rates, that these expectations are stabilizing and that they are not driven by destabilizing bandwagon effects.

This irrationality may arise from the presence of heterogeneous traders in the market. Though not specifically related to the foreign exchange market, De Long, Shleifer, Summers, and Waldmann (1990) show that the presence of irrational traders can affect prices and that these traders can even earn higher expected returns than their rational counterparts. Intuitively, the unpredictability of irrational traders' beliefs creates a risk in asset prices that deters rational traders from aggressively betting against them. Bearing a disproportionate amount of risk, the irrational traders can earn a higher expected return and therefore rational agents do not necessarily compete them out of the market.

Models of heterogeneous agents have been developed to evaluate the foreign exchange market more directly, as well. Frankel and Froot (1988) present a model of two types of traders, "chartists" and "fundamentalists" who have different horizons for holding assets. They show that this model is capable of explaining some of the myopic expectations apparent from survey data. Froot and Thaler (1990) argue that the Fama result is consistent with the market waiting one period before reacting to new information. To date, however, heterogeneous agent models have yet to be developed in a testable way to provide evidence of their effects upon excess foreign exchange returns.[39]

A second general answer to the question posed above comes from statistical difficulties with measuring the market's forecasts under rational expectations that depend upon the sample. These difficulties arise when the distribution of shocks that affect the economy undergo infrequent shifts.[40] Examples of these types of shifts may be as obvious as monetary policy regime changes, oil price shocks, and natural disasters, or they may be more subtle such as a shift in the trend of the exchange rate. In any case, when rational economic agents incorporate into their forecasts uncertainty about shifts in the distribution of economic shocks, the forecast errors may be serially correlated for periods of time. The length of this time period depends upon the infrequency and therefore the likelihood of the shift occurring. I describe these issues next.

[39]An important step in this direction is the recent work by Lyons (1993). He develops a market microstructure model of the behavior of traders. Based upon trade-by-trade data from an individual trader, he is able to test some implications of his model. The relationship between this microstructure model and the equilibrium behavior of returns remains an important direction for future research.

[40]Strictly speaking, the issue arises whenever the number of shifts in the sample is unrepresentative of the underlying distribution. Therefore, the shifts may in fact be too frequent in the sample. Since the examples considered below and in the literature involve too few rather than too many shifts in the sample, I will discuss only this case in the text.

1.4. Rational systematic forecast errors

The problem that shifts in a given sample may be unrepresentative of the underlying distribution is clearly a problem endemic to all measurements of expectations. This problem can therefore affect all areas of economics in which expectations are important. However, the problem in international finance has been understood for some time in the context of infrequent exchange rate realignments.[41] This intuition has natural extensions for floating exchange rates.

The problem can be loosely grouped into two categories: learning about a possible past shift in the economic distribution; and expectations about a future shift in the economic distribution. For simplicity, I will discuss each case separately. I will then finish the section by discussing how both features are likely to be present in excess return behavior.

1.4.1. Learning

To understand the effects of rational learning, consider an extreme case when there is a potential once-and-for-all shift in the underlying distribution of the economy. Examples of such shifts could be a change in monetary operating procedures, a shift from an expansionary to contractionary monetary policy regime, or a change in fiscal policy such as a change in taxes with unknown future effects.

To help fix ideas, suppose that the shift would imply a stronger value of the domestic currency, such as a tightening in domestic monetary policy, for example. Define the expected future exchange rate conditional upon the old regime as $E_t(s_{t+1} \mid \mathrm{O})$ and the expectation conditional upon the new regime as $E_t(s_{t+1} \mid N)$, where $E_t(s_{t+1} \mid \mathrm{O}) > E_t(s_{t+1} \mid \mathrm{N})$. This inequality can also be written as $E_t(\Delta s_{t+1} \mid \mathrm{O}) > E_t(\Delta s_{t+1} \mid \mathrm{N})$ since the current spot rate is in the time t information set. The expected future exchange rate at time t will be a probability-weighted average of the two expected values:

$$E_t s_{t+1} = (1 - \lambda_t) E_t(s_{t+1} \mid N) + \lambda_t E_t(s_{t+1} \mid O) \tag{1.45}$$

where λ_t is the market's assessed probability at time t that monetary policy is based upon the old regime.

The evolution of the market's probability of the old regime is based upon a rational learning process. In particular, suppose that traders know that if a change in policy occurred, it happened a time $\tau < t$. Then, traders will update their probabilities that the regime is new by subsequent observations of the exchange rate according to

[41] Rogoff (1980) first wrote about this problem in the Mexican peso futures market. Krasker (1980) developed a parametric hyperinflation example to quantify the potential size distortions in market efficiency tests arising from the peso problem.

Bayes' law:

$$\lambda_t = \frac{\lambda_{t-1}L(\Delta s_t, \Delta s_{t-1}, \ldots, \Delta s_{\tau+1} \mid O)}{(1-\lambda_{t-1})L(\Delta s_t, \Delta s_{t-1}, \ldots, \Delta s_{\tau+1} \mid N) + \lambda_{t-1}L(\Delta s_t, \Delta s_{t-1}, \ldots, \Delta s_{\tau+1} \mid O)} \tag{1.46}$$

where $L(\cdot \mid \mathrm{O})$ and $L(\cdot \mid \mathrm{N})$ is the likelihood of the observation given the regime is old and new, respectively. Suppose that the regime actually changed at time τ.[42] Then since $E_t(\Delta s_{t+1} \mid \mathrm{N}) < E_t(\Delta s_{t+1} \mid \mathrm{O})$, the actual observations of the exchange rate will tend to decrease over time, thereby increasing the likelihood of the New regime, relative to the old regime so that λ_t will decrease over time. As the number of observations grows large,

$$\operatorname*{plim}_{t\to\infty} \lambda_t = 0 . \tag{1.47}$$

Thus, as the number of observations increases, the market learns about the new regime.

Consider the behavior of forecast errors during this learning period, however. For expositional simplicity, suppose that the process is in fact "new". Subtracting the realized exchange rate from the expectation in eq. (1.45) gives:

$$\begin{aligned} s^N_{t+1} - E_t s_{t+1} \equiv \eta_{t+1} &= [s^N_{t+1} - E_t(s_{t+1} \mid N)] - \lambda_t[E_t(s_{t+1} \mid O) - E_t(s_{t+1} \mid N)] , \\ &= \eta^N_{t+1} - \lambda_t \nabla s_{t+1} \end{aligned} \tag{1.48}$$

where s^N_{t+1} indicates a realization of the exchange rate from process N, $\eta^N_{t+1} \equiv s^N_{t+1} - E_t(s_{t+1} \mid \mathrm{N})$ and $\nabla s \equiv E_t(\Delta s_{t+1} \mid \mathrm{O}) - E_t(\Delta s_{t+1} \mid \mathrm{N})$, the difference between the expected future exchange rate changes conditional upon each regime. Note that η^N_{t+1} is the forecast error conditional upon the true regime and is therefore uncorrelated with time t information. However, as long as the market believes the old regime is possible so that $\lambda_t \neq 0$, then the difference between expected exchange rates in each regime, ∇s, will introduce a potential for the mean to be non-zero.

To see how learning may affect the behavior of predictable excess returns described in Table 1.1 and Figure 1.1, recall the definition of excess returns: $er_{t+1} = rp_t + (s_{t+1} - E_t s_{t+1})$. Suppose now that the variability of the risk premium is small, as suggested by the survey data. In order to focus upon the behavior of forecast errors in this discussion, I will assume for now that the risk premium is zero but will reintroduce it below. In this extreme assumption, the behavior of forecast errors can be identified solely with the behavior of excess returns.

Consider first the mean of excess returns. The mean of excess returns in a sample

[42] Even if the change did not occur, learning implies that the forecast errors will be serially correlated with a non-zero mean as well as other features to be described below. [See Lewis (1989a,b)].

of size T is the sample mean of the forecast errors:

$$\text{Mean}(er_t) = \frac{\sum_{t=\tau}^{T}(s_{t+1} - E_t s_{t+1})}{T} = -\frac{\sum_{t=\tau}^{T} \lambda_t \nabla s_{t+1}}{T} \tag{1.49}$$

where the last equality follows since $E(\sum_{t=\tau}^{T} \eta_t^N / T) = 0$.

Now notice the systematic tendency of forecast errors during learning. If $E_t(s_{t+1} \mid N) < E_t(s_{t+1} \mid O)$ so that $\nabla s > 0$, then the mean of η_t will be negative as long as $\lambda_t > 0$. The intuition behind this result is straightforward. As long as the market is not sure if a shift has occurred, by (1.45) they will place a probability weight of λ_t on the possibility that the old regime is in place. However, since the domestic currency is expected to be weaker in this regime, the market will be systematically surprised at the strength of the domestic currency. Over time, however, $\lambda \rightarrow 0$ and the mean of excess returns in (1.49) equals zero.

Now consider the Fama regression of excess returns on the forward premium during learning. In the extreme case when the risk premium is zero, the coefficient on the forward premium is $\beta_1 = 1 - \beta_{re}$, where:

$$\beta_{re} = -\frac{\text{Cov}(\eta_{t+1}, f_t - s_t)}{\text{Var}(f_t - s_t)} = -\frac{\text{Cov}(\eta_{t+1}, E_t s_{t+1} - s_t)}{\text{Var}(E_t s_{t+1} - s_t)} . \tag{1.50}$$

Since $\beta_1 < 1$, the covariance between the forecast error and the expected exchange rate change must be negative in order for learning to explain the Fama result.

While β_{re} must go to zero as the sample size gets large, the covariance between the forecast error and the forward premium can be negative if the market places a sufficient amount of probability on the old regime. To illustrate this possibility, I will assume that the forecasts conditional upon each regime are uncorrelated. In this case, the numerator of (1.50) is:

$$\text{Cov}(\eta_{t+1}, E_t\, \Delta s_{t+1}) = \lambda_t[(1 - \lambda_t)\, \text{Var}(E_t\, \Delta s_{t+1}^N) - \lambda_t\, \text{Var}(E_t\, \Delta s_{t+1}^O)] . \tag{1.51}$$

The covariance between forecast errors and the expected change in the exchange rate can thus be negative when the probability-weighted variance of the exchange rate in the old regime exceeds its counterpart in the new regime. If the probability of the old regime is sufficiently large, the covariance will be negative. As λ goes to zero over time, this covariance also goes to zero.

To emphasize the role played by the probability, suppose that the variance of the exchange rate in the two regimes were the same. In this case, the covariance in (1.51) can be rewritten:

$$\text{Cov}(\eta_{t+1}, E_t\, \Delta s_{t+1}) = \lambda_t(1 - 2\lambda_t)\, \text{Var}(E_t\, \Delta s_{t+1}^i) , \quad \text{for } i = O, N . \tag{1.52}$$

In this simple case, the covariance is negative whenever the probability of the old regime exceeds one-half. During such a period, $\beta_{re} > 0$ contributing to the finding that $\beta_1 < 1$.

The intuition behind this result is straightforward. During learning, the market expects a weaker domestic currency than is realized *ex post*. The forward premium reflects the expected change in the exchange rate that in turn depends upon the probability of the old regime in which the exchange rate depreciates. However, since the regime is in fact new, the forecast errors tend to reflect unexpected systematic appreciations in the domestic currency. This interaction generates a negative covariation between the forecast error and the forward premium when the probability of the old regime is considered high by the market. As the market believes the old regime less likely, the negative covariance between forecast errors and forward premium disappears.

Lewis (1989b) uses a model in which the exchange rate depends upon US monetary policy to examine the potential effects of learning about contractionary shifts in the US money market during the early 1980s. Based upon conservative parameter values, this paper finds that learning explained about half of the behavior of excess returns. As shown in Figure 1.1, the mean of excess returns on holding open dollar positions during this period were substantially larger than for the entire sample period. Thus, learning about shifts in policies may have important effects upon exchange rate forecast errors.

On the other hand, Panel C of Table 1.1 points to a difficulty with explaining the Fama result entirely with learning. As the market learns, the probability of the old regime must go to zero and, with no risk premium, the Fama coefficient should converge to one. If learning about tight US monetary policy during the early 1980s were driving all of the Fama result, subsample estimates should therefore find that β_1 is closer to one by the late 1980s. Panel C reports estimates of the Fama regression breaking the sample into thirds. While the coefficients tend to be closer to one during the 1970s, the estimates are significantly negative with larger absolute values in the late 1980s.[43] Clearly, the Fama finding is not the result of a particular period in history for dollar exchange rates.

Of course, the market may have believed that they were learning about a different shift in the late 1980s. In other words, the distribution of economic shocks could potentially be subject to multiple shifts. If so, then rational traders should incorporate the possibility that the exchange rate process may shift in the future. I discuss this possibility next.

1.4.2. Peso problems

A "peso problem" arises when market participants anticipate a future discrete shift in policy that is not materialized within the sample period examined. Milton Friedman

[43] Additional evidence is provided in Bekaert and Hodrick (1993) who find significant negative coefficients for the Fama regression using cross exchange rates that do not include the dollar.

allegedly first used this term to explain why Mexican peso deposit rates during the early 1970s remained substantially higher than U.S. dollar interest rates even though the exchange rate had been fixed for a decade. As Friedman argued, the market expected a devaluation of the peso, so that higher Mexican peso interest rates reflected a weaker peso at the forward rate implied through covered interest parity. This conjecture was subsequently justified when the Mexican peso was devalued in the late 1970s.[44]

The first written discussion of the "peso problem" appears in Rogoff (1980). He considers a regression of the Mexican peso/US dollar exchange rate on the futures rate. He argues that a reason for rejecting the hypothesis that the coefficient equals one may have been the market's anticipation of a devaluation in the peso.

Under floating exchange rates, Evans and Lewis (1995) examine potential "peso problem" effects upon various features of excess return behavior, including the Fama result. This investigation was motivated by the observation in Engel and Hamilton (1990) and Kaminsky (1993) that the dollar exchange rate appears to have undergone appreciating and then depreciating regimes. Additional evidence of the markets beliefs about jumps in the exchange rate resulting from these shifts come from option pricing. Bates (1994) finds that the risk of a significant change in the dollar exchange rate was priced into foreign exchange options during the period.

To see the potential effects of anticipated future changes in exchange rate regimes, consider the expected future exchange rate based upon the current regime, C, and an alternative regime, A, that may be realized in the future:

$$E_t s_{t+1} = (1 - \ell_t) E_t(s_{t+1} \mid C) + \ell_t E_t(s_{t+1} \mid A) \tag{1.53}$$

where ℓ_t is the probability that the exchange rate regime will shift from the current regime to an alternative regime, A. In contrast to eq. (1.45), note that eq. (1.53) depends only upon the expected *future* change in regime, not learning about a past change.

As long as the shift in regime does not materialize, then the exchange rate will be generated by the current regime, C. Therefore, the forecast error will be:

$$\begin{aligned} s^C_{t+1} - E_t s_{t+1} \equiv \eta_{t+1} &= (s^C_{t+1} - E_t(s_{t+1} \mid C)) + \ell_t(E_t(s_{t+1} \mid C) - E_t(s_{t+1} \mid A)) \\ &= \eta^C_{t+1} + \ell_t \nabla s_{t+1} \end{aligned} \tag{1.54}$$

where now η^C_{t+1} is the forecast error conditional upon C, and $\nabla s_{t+1} \equiv E_t(s_{t+1} \mid C) - E_t(s_{t+1} \mid A)$.

Substituting this definition for η_t into the sample mean in (1.48) and (1.49) into the regression coefficient in (1.50) shows that, by replacing λ with ℓ, the same relationships hold for the peso problem as they do for learning.

[44]Lizondo (1983) provides a discussion and a theoretical model of the Mexican peso futures market in anticipation of a devaluation.

The difference between future anticipated shifts in the exchange rate process and learning about a past change is that a shift will eventually materialize if the market is rational. Thus, the appropriate measure of β_1 should be based upon the number of shifts in regime that take place in a typical sample. Evans and Lewis (1995) consider this possibility by first estimating a model of regime switching in the dollar–yen, dollar–DM and dollar–pound exchange rates during the floating rate sample. Based upon rational expectations of a shift in regimes, they then generate the empirical distributions of the Fama regression coefficient.

Table 1.3 shows how the standard Fama results are affected when traders expect the exchange rate to switch regimes. Panels A and B report the effects upon estimates based upon, respectively, monthly and quarterly returns using the same data as in Table 1.1. Column (1) gives the marginal significance levels based upon standard distribution theory for the hypothesis that the estimate equals one. The hypothesis is rejected with marginal significance levels less than one percent in all cases, as found in Table 1.1.

Columns (2) and (3) demonstrate the effects of peso problems. Column (2) reports the mean bias given by the difference between the estimated β_1 and the true β_1^* from the switching model in Evans and Lewis (1995). In all cases, the Fama coefficient is biased downward as a result of the peso problem. Column (3) gives the ratio of the estimated standard deviation of the risk premium over the true standard deviation of the risk premium. For all currencies and both frequencies, the standard deviation of the measured risk premium exceeds that of the true risk premium from the model. For

Table 1.3
The Fama result and the peso problem

Exchange Rate	(1) Asymptotic p-value for Ho: $\beta_1 = 1$	(2) Bias in coefficient	(3) Bias in variance
	A. Monthly returns		
\$/BP	<.001	−0.726	1.222
\$/DM	.001	−1.068	1.237
\$/¥	<.001	−0.107	1.035
	B. Quarterly returns		
\$/BP	.001	−0.724	1.216
\$/DM	.0045	−0.720	1.162
\$/¥	<.001	−0.124	1.031

Notes: Column (1) gives the p-values based upon standard asymptotics of the hypothesis that the coefficient (β_1) in regressions of exchange rate changes on the forward premium are equal to one. Estimates are based upon data used in Table 1.1. Columns (2) and (3) are based upon the exchange rate switching model in Evans and Lewis (1995) using the same data. Column (2) reports the mean bias in the coefficient due to the peso problem when traders anticipate shifts in the exchange rate. Column (3) gives the mean of the estimate of the standard deviation in the risk premium based upon standard inferences divided by the true standard deviation from the model.

the pound and the DM, the standard deviations of the measured risk premium are about 20 percent higher than the actual standard deviation. This evidence suggests that standard inference techniques based upon assuming zero covariance between the forecast error and the forward premium can be misleading in the Fama regression. Potentially, an important component of the deviations from one may be introduced by peso problems.

At the same time, the evidence in Table 1.3 shows that peso problems alone cannot explain all of the behavior of predictable excess returns. Even after adjusting for the peso problem bias in coefficients and variances, the remaining component of predictable returns remains sizeable. Similarly, when Bates (1994) tests for whether expected jumps can fully explain the deviations from uncovered interest parity, he finds that the test is rejected. However, Table 1.3 also indicates that the bias introduced by peso problems can be economically significant.

This discussion suggests that, when the economic environment changes discretely, forecast errors are likely to be serially correlated in small samples. Whether a sample is small or not depends upon the infrequency of shifts in the distribution. For example, Engel and Hamilton (1990) and Evans and Lewis (1995) find that the dollar appeared to go through roughly 3 appreciating and 2 depreciating regimes against the DM from 1975 to 1989. If traders are making their forecasts on the potential for these regimes to change, then it would take many such shifts to give mean zero, serially correlated forecast errors.

1.5. Risk premia, market inefficiencies, learning, or peso problems?

To this point, I have described research investigating the source of foreign currency excess returns. Researchers who believe that forecast errors must be uncorrelated with everything in the lagged information set are forced to accept the view that these predictable excess returns are the result of an equilibrium risk premium model. However, no risk premium model with believable measures of risk aversion has yet been able to generate the variability in predictable excess returns that are observed in the data.

On the other hand, survey measures of expectations suggest that most of the action in predictable excess returns comes from forecast errors that are correlated with lagged information. While considering heterogeneous trader models appears to be an important direction for future research, no such model has yet been provided to explain the behavior of excess returns.

In the meantime, I have shown that discrete changes in the economic environment can help explain serially correlated forecast errors as well as the high variance of predictable excess returns, even within the context of a representative agent framework. When once-and-for-all shifts in the economic distribution occur, forecast errors are likely to covary in the opposite direction from the forward premium, potentially generating a downward bias in the Fama coefficient. However, learning about a single past change in the economic environment can only explain particular time periods such as the early 1980s and cannot explain the persistence of the high variation in predictable excess returns.

I also showed that anticipated future changes in the exchange rate regime could produce behavior similar to that of learning. While serially correlated errors disappear in sample sizes that include many regime shifts, the average length of a cycle of appreciation and then depreciation in the dollar/DM rate found in Evans and Lewis (1995) has been about $7\frac{1}{2}$ years. At this rate, it would be about 225 years before a sample of 30 of these events would be observed.

Examining each of these explanations in isolation might lead to the conclusion that predictable excess returns remain a complete mystery. However, each of these explanations have ignored the other explanations. It seems likely that if there are shifts in regimes, then anticipations of these shifts will affect the market's assessment of risk and therefore the foreign exchange risk premium. Heterogeneous views toward this risk may be compounded into an aggregate measure of the risk premium that exceeds the measures in conventional studies. Thus, a difficult but important direction for future research will be to integrate the various explanations for the behavior of excess returns.

2. International portfolio allocation

Another empirical puzzle that has attracted the attention of international finance researchers concerns the choice of international assets by domestic investors. Domestic residents tend to hold a very large proportion of their wealth in domestic assets alone. The magnitude of this investment in domestic relative to foreign equities is difficult to reconcile with standard portfolio arguments.[45]

This issue has recently been emphasized by French and Poterba (1991) and Tesar and Werner (1992). Table 2.1, Panel A gives the measure of the U.S. equity portfolio shares decomposed into source of equity by country using numbers taken from French and Poterba (1991).[46] As the column under "actual share" shows, about 94 percent of the US investor's wealth was held in domestic equity.

To evaluate whether this large proportion of holdings in domestic assets is surprising requires an international investment model. For this purpose, I will use the same models described in Section 2. Therefore, I will only briefly review them in this section. Section 2.1 reviews the partial equilibrium CAPM model. This model suggests that the optimal holding of domestic US assets is less than 50 percent. From

[45]The relatively low degree of domestic relative to foreign holdings of equities has been recognized at least since Levy and Sarnat (1970).

[46]These data are adjusted from the U.S. Treasury Bulletin and Howell and Cozini (1990) and correspond to June 1990 values. French and Poterba (1991) also consider British equities.

Table 2.1
The "home bias" puzzle for the US

A. Multilateral

Country	Actual share	Implied model share $\rho = 1$	$\rho = 2$	$\rho = 3$	$\rho = 6$	$\rho = 10$
US	.936	.465	.464	.463	.458	.453
Japan	.032	.442	.440	.438	.432	.425
Germany	.005	.092	.096	.099	.109	.123

B. Summary statistics for excess equity returns

Country	Mean(i)	Std. dev(i)	Cov(i, π)*
US	9.96	52.90	–
Japan	17.15	74.80	−0.01
Germany	11.46	81.89	0.10

Note: Optimal shares calculated as: (2.5) $\underline{\chi}_t = \rho^{-1} E_t \underline{r}_{t+1} \operatorname{Var}(\underline{r}_{t+1})^{-1}$ derived in text.
* Covariance estimates calculated as the covariance between exchange rate changes and U.S. inflation.

this perspective, the evidence in Table 2.1 that more than 90 percent of US holdings are in domestic assets is indeed surprising.

Section 2.2 considers the portfolio holdings suggested by a general equilibrium model. If preferences are iso-elastic and goods are tradeable, then countries should share equally in each other's stockmarkets. This implication is also clearly inconsistent with the numbers in Table 2.1. Since this result depends upon the utility function, I also examine a more general framework that provides predictions for consumption in the presence of risk-sharing under complete markets. These predictions give similar implications for the home bias puzzle. In particular, domestic consumption is significantly correlated with idiosyncratic income shocks, in contrast to the implications of optimal international risk-sharing.[47]

The pervasiveness of the home bias puzzle both in terms of foreign equity holdings and international consumption patterns suggests that investors are either prevented from arbitraging differences or that the gains from doing so may not be large enough. In Section 2.3, I will consider these possibilities.

2.1. "Home bias" based upon partial equilibrium

What pattern of equity holdings should we expect to find from a partial equilibrium point of view? To see the basic intuition, it is useful to contrast the implied behavior of returns with the CAPM model based upon deposits discussed in Section 1.2. That model gave the following general relationship for returns on foreign relative to

[47]The implications of international risk sharing were pointed out in Scheinkman (1984) and Leme (1984).

domestic deposits:

$$per_{t+1} = \rho \operatorname{Cov}_t(er_{t+1}, i_{p,t+1}) - \rho \operatorname{Cov}_t(er_{t+1}, \pi_{t+1}) . \tag{1.22}$$

Required returns on foreign relative to domestic deposits depend positively upon the measure of relative risk-aversion, ρ, and the variability of returns captured by the covariance between excess returns and the return on the portfolio. The returns depend negatively upon the covariance between returns and inflation.

2.1.1. Optimal portfolio shares of foreign assets

I will now focus upon equity holdings at home and abroad, but will show that the expected returns on these assets take a similar form as those of foreign currency deposits. Suppose first that there are only two assets, domestic equity and foreign equity. Define the vector of portfolio weights, $\chi_t = (\chi_t^h, \chi_t^f)'$, where χ_t^h is the share in the home stock and χ_t^f is the share in the foreign stock, respectively. Furthermore, define the vector of real returns as $\underline{r}_{t+1} = (r_{t+1}^h, r_{t+1}^f)'$. Now consider the investor's decision. He chooses the vector of portfolio weights, χ, to maximize an objective function that is increasing in expected wealth, but decreasing in the variance of wealth, as in eq. (1.20). Expected wealth can now be written:

$$E_t W_{t+1} = W_t + W_t \chi_t' E_t \underline{r}_{t+1} . \tag{2.1}$$

And the variance of wealth becomes:

$$\operatorname{Var}_t(W_{t+1}) = W_t^2 \operatorname{Var}_t(\chi_t' \underline{r}_{t+1}) = W_t^2 \chi_t' \operatorname{Var}_t(\underline{r}_{t+1}) \chi_t \tag{2.2}$$

where $\operatorname{Var}_t(\underline{r})$ is the conditional variance-covariance matrix of the vector $\underline{r}$.

Substituting (2.1) and (2.2) into (1.20) and maximizing with respect to χ gives the first-order conditions:

$$E_t \underline{r}_{t+1}' = \rho \chi_t' \operatorname{Var}_t(\underline{r}_{t+1}) . \tag{2.3}$$

Note that by decomposing the equity portfolio in terms of nominal returns, $\underline{r}_{t+1} \equiv \underline{i}_{t+1} - \pi_{t+1} \iota$ where ι is a 2×1 vector of ones, and noting that the portfolio return is $r_{p,t+1} = \chi_t' \underline{r}_{t+1}$, the first order conditions can be rewritten:

$$E_t \underline{r}_{t+1} = \rho \operatorname{Cov}_t(\underline{r}_{t+1}, i_{p,t+1}) - \rho \operatorname{Cov}_t(\underline{r}_{t+1}, \pi_{t+1}) . \tag{2.4}$$

Note that these equilibrium returns have the same form and, hence, intuition as the foreign exchange returns in (1.23). As the covariance of returns with the portfolio increases, the required return of each asset increases according to the portfolio weights of the asset. The required return also increases with the covariance between the domestic and foreign assets since a higher covariance increases the over-all risk of the portfolio. Finally, required returns decrease with the covariance between returns and inflation since the higher this covariance, the better the hedge of equity returns against inflation. The returns depend upon these variances and covariances according to the risk aversion parameter, ρ.

To see what this model implies about portfolio holdings, solve (2.3) in terms of the domestic asset demand equations.[48]

$$\underline{\chi}_t = \rho^{-1} E_t \underline{r}_{t+1} \operatorname{Var}_t(\underline{r}_{t+1})^{-1} . \tag{2.5}$$

Thus, the share of holdings in each asset depends inversely upon the measure of relative risk aversion, ρ, and the variability of returns. However, it depends positively upon the expected returns.[49] To examine returns in a multiple country setting, it is straightforward to extend (2.5) to the case of N different countries. In this case, $\underline{r}$ is the $N \times 1$ vector of equity returns in each of N countries and $\underline{\chi}$ is the vector of portfolio shares in each country.

This framework can be used to evaluate how closely the model's implied portfolio shares match the actual shares in Table 2.1. For this purpose, Panel A of Table 2.1 reports the implied portfolio shares using (2.5) based upon unconditional variances and data from monthly observations of country stock indexes and exchange rates from the *London Financial Times* over the period from January 1976 to February 1992. The covariance between returns and inflation is proxied by the covariance between exchange rates and inflation.

As this analysis shows, US investors have a much stronger preference for domestic equity holdings than is suggested by the CAPM model. This behavior is not particular to Americans. French and Poterba (1991) show that this behavior also holds for Japanese, German, British, and French residents. Therefore, "home bias" appears to be a general phenomenon.

2.1.2. Empirical tests: How good is the model?

One explanation for the evidence might simply be that the CAPM model is not a very good description of the world. I described evidence above showing that this model did not help describe the foreign exchange risk premium very well, but how does it do as an empirical characterization of stock returns?

Early empirical research on the international CAPM such as Solnik (1974b) and Stehle (1977) looked at the relationship in (2.4) based upon unconditional returns,

[48] Solnik (1974a) was the first to derive international equilibrium rates of return where consumers differ in their consumption prices. Stulz (1981a) shows how the consumption-based CAPM with i.i.d. shocks can be analyzed in a multi-country setting without assuming PPP. In this case, the equilibrium returns depend upon asset demand functions similar to (2.5) that are aggregated over investors of all countries. [See also Hodrick (1981)].

[49] As explained in Adler and Dumas (1983), the second term depends upon the minimum variance portfolio. Thus, even a risk-neutral investor with $\rho = 0$ would hold this portfolio since it provides an optimal hedge against inflation, in the absence of a real risk-free bond.

finding mixed results. These studies tested for the pricing relationship between returns rather than using measures of asset shares. More recently, Dumas and Solnik (1993) have estimated a conditional version of the model using returns in both equities and deposits allowing for time-varying covariances.[50] They find that the hypothesis of zero price on exchange rate risk is rejected, so that exchange rate variability appears to have explanatory power for equity returns. They also find that the international partial equilibrium CAPM is not rejected by the data.

Engel (1993), Engel and Rodrigues (1993), and Thomas and Wickens (1993) use asset share data to estimate models similar to (2.4). These studies reject the over-identifying restrictions of the model. Similar to Dumas and Solnik (1993), however, Engel (1993) finds that the model helps explain excess returns.

Other studies have used the CAPM as a benchmark to examine the factor relationships between equity returns in different countries. Harvey (1991) considers whether the behavior of equity returns for seventeen markets can be explained according to their covariance with the world equity return, consistent with the CAPM model. Assuming purchasing power parity, he finds that for most countries except Japan the model appears to explain country returns relatively well. Ferson and Harvey (1993) examine the predictability of a single beta asset pricing model for equity returns in eighteen countries also assuming purchasing power parity and no exchange rate risk. As in Harvey (1991), they find that the model has explanatory power for returns. However, they also find that these returns are better explained by multiple beta models that incorporate factors intended to capture exchange rate and other local sources of risk. Despite these other risk sources, the greatest source of risk priced in their model appears to be a global equity market risk component. Campbell and Hamao (1992) test a single factor latent variable restrictions across the US and Japan and find that they are rejected, although domestic equity returns and interest rates appear to be important predictors of foreign equity returns. They interpret their findings as evidence for market integration.

Overall, the evidence appears to be mixed. Tests of the international CAPM based upon asset share data tend to reject the model, while tests based upon relationships among returns tend to find more support in the form of explanatory power, particularly when account is taken of exchange rate risk. Whether the restrictions of the model are rejected or not, it appears to have some predictive content for international equity returns.

2.1.3. Is the international risk diversifiable with domestic assets?

Since the evidence suggests that the international CAPM relationships cannot be completely dismissed and therefore the home bias puzzle remains open, the next step

[50] They use the method described in Harvey (1991). This framework assumes that conditional variances are a linear function of a set of information variables.

is to consider possible explanations within these relationships. The analysis described above focuses upon the risk associated with international equity and, potentially, bond returns. However, it seems possible that the risk measured by the returns on international assets might be captured by returns on some domestic assets. If so, then, domestic residents may hold a disproportionately large component of domestic assets simply because they can gain the same diversification benefits with particular domestic securities as foreign assets.

One possible group of domestic returns that may be correlated with foreign returns corresponds to the equity of domestic multinational corporations. Since much of their earnings come from abroad, it might seem that their returns more closely match the returns on foreign stock markets than do other domestic companies. Jacquillat and Solnik (1978) ask whether the stocks of domestic multi-national firms have this diversification potential by regressing the returns of their stocks on the returns of stock indexes for a set of countries. They find that the coefficients on their own domestic stock index (the traditional market "betas") are close to one. Therefore, domestic multinational stocks are not much different in their diversification benefits than holding the domestic market portfolio.

Another approach would be to argue that the benefits of diversification come from industry-specific risk and not country-specific risk. Roll (1992) argued that industry-specific sources of risk explain international stock market indexes. However, Heston and Rouwenhoerst (forthcoming) and Solnik and de Freitas (1988) find that the primary sources of risk are in fact country-specific.[51]

This evidence suggests that the home bias puzzle is not explainable by the fact that domestic sources of risk can substitute perfectly for foreign risk factors.

2.2. "Home bias" based upon general equilibrium

The partial equilibrium nature of the CAPM treats equity returns as exogenous to the model and focuses upon the investor's static portfolio decision. On the other hand, general equilibrium pricing models simultaneously solve for the equity returns together with the intertemporal asset allocation decision. To illustrate this joint solution, I will return to the general equilibrium framework examined in Section 1.2 to show how international equity returns are determined in this context.

The implications of this model for the "home bias" puzzle are not as straightforward as in the static CAPM described above. In general, it is not possible to determine what should be the optimal portfolio holdings. Under additional assumptions, however, there are at least two basic implications of the model that may be compared with empirical observations on home bias. First, if the utility function is

[51]These papers use an arbitrage pricing theory (APT) approach to finding the factors of risk that determine stock prices. On the APT, see also Solnik (1983), and Bansal, Hsieh, and Viswanathan (1993).

iso-elastic, then portfolio holdings should be identical for all countries. This assumption is clearly at variance with the evidence in Table 2.1. Second, even if the utility function is not iso-elastic but markets are complete, then the intertemporal marginal rates of substitution in consumption should be equalized across countries. If, further, utility is iso-elastic, then complete markets imply that consumption growth rates should also be equalized across countries. As will be shown below, this prediction is also contrary to the evidence in the data.

2.2.1. International equity markets

To see the implications of general equilibrium for the absence of "home bias", consider again the framework described in Section 1.2. As there, it is expositionally useful to consider an endowment economy with one tradeable, non-durable good. Suppose there are j countries, each producing endowments of the good in the amount of Y_t^j for country j at time t. The stream of payments of these endowments can be purchased by buying a share of equity in country j at price z_t^j. This equity pays out endowments as dividends.

2.2.1.1. The closed economy prices

For later discussion, it is useful to first consider the price of these stocks in the absence of trade in world markets. For country j, the domestic investor's decision is restricted to buying shares in domestic equity or other domestic assets. Maximizing the expected present value of utility,

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t^j)$$

with respect to consumption of the good, defined as C, and the share of domestic equity gives the first-order condition:[52]

$$U'(C_t^j)z_t^j = \beta E_t\{U'(C_{t+1}^j)[Y_{t+1}^j + z_{t+1}^j]\} \tag{2.6}$$

or, solving (2.6) in terms of z, the domestic equity price is:

$$z_t^j = E_t \sum_{\tau=1}^{\infty} q_{t+\tau} Y_{t+\tau}^j \tag{2.7}$$

where $q_{t+1} \equiv \{\beta U'(C_{t+1}^j)/U'(C_t^j)\}$. Note that q_t is the real intertemporal marginal rate of substitution in consumption while Q_t, defined in Section 1.2, is the nominal marginal rate of substitution.

The first order condition given in (2.6) is quite general and does not depend upon the specific assumptions of this model. The real stock price is the sum of the expected

[52]This first-order condition can be found by maximizing the lifetime utility over the shares of domestic equities, θ_t, subject to the constraint that $C_t^j + \theta_t z_t^j \le \theta_{t-1} Y_t^j + \theta_{t-1} z_t^j$.

intertemporal marginal rates of substitution in consumption arising from the future dividend payments. Due to the generality of this first-order condition, this stock price formulation underlies many studies of equity markets.[53]

Under the specific assumptions of the endowment economy, the price can be further solved in terms of the production state. In equilibrium, the quantity of shares must equal one and, in the absence of investment, consumption equals production: $C^j_t = Y^j_t$. Therefore, in equilibrium, $q_{t+1} = \{\beta U'(Y^j_{t+1})/U'(Y^j_t)\}$. In the absence of trade in international equity markets, each country will hold all of the stock of its own country and will consume its own output.

2.2.1.2. The integrated world market equilibrium

Now consider the price determined by perfectly integrated world capital markets. In this case, investors in country j may choose among foreign assets, determining a portfolio share for equity holdings in countries $i = 1, \ldots, N$. The stock of each country i has a price in the world stock market of $\underline{z}^i_t$. In this case, as long as countries have the same iso-elastic utility function, then they will all hold the same portfolio.[54] This result is general and does not depend upon the completeness of markets nor the endowment nature of the economy. The common portfolio can be characterized as a world mutual fund.

Determining the actual portfolio holdings as well as the consumption levels requires solving for the wealth levels and, hence, the stock prices of each country. First, defining the price of the world mutual fund as $\underline{z}_t$ and its dividend stream as $\underline{Y}_t = \sum_{j=1}^{N} Y^j_t$, the same steps may be followed as for the closed economy case to yield the mutual fund price:

$$\underline{z}_t = E_t \sum\nolimits_{\tau=1}^{\infty} \underline{q}_{t+\tau} \underline{Y}_{t+\tau} \tag{2.8}$$

where now $\underline{q}_{t+1} = \{\beta U'(\underline{Y}^j_{t+1})/U'(\underline{Y}^j_t)\}$. Similarly, the price of each country's stock on world markets is:

$$\underline{z}^i_t = E_t \sum\nolimits_{\tau=1}^{\infty} \underline{q}_{t+\tau} Y^j_{t+\tau} \, . \tag{2.9}$$

Each country j will sell its endowment stream on world markets and receive $\underline{z}^j$. Country j will in turn buy shares $\underline{\theta}^j$ in the mutual fund at price $\underline{z}$. Therefore, country j will hold shares equal to $\underline{\theta}^j = (z^j/\underline{z})$. Consumption for country j will correspondingly be given by: $C^j_t = \theta^j \underline{Y}_t$. Each country shares in world consumption according to its share of wealth as valued according to the world stock market.

This result leads to a second implication for integrated stock markets under

[53]For example, Hansen and Singleton (1983) and Shiller (1981) test restrictions implied by this pricing relationship using US stock returns.

[54]See the discussion in Ingersoll (1987) and the references therein.

iso-elastic utility: countries share in the world consumption growth rate and therefore have the same consumption growth rates. As described in the chapter by Baxter (1995), this result depends only upon complete asset markets and does not depend upon the endowment assumptions in this discussion.[55]

2.2.1.3. Theoretical implications of no "home bias" relative to the evidence

Above, we showed that in the absence of "home bias", general equilibrium relationships based upon iso-elastic utility and complete markets would imply that two variables would be the same for all countries in the world: first, portfolio shares; and second, consumption growth rates.

As shown above, US as well as German, British, Japanese and French residents hold most of their equity holdings in their own countries. Therefore, they clearly do not hold the same portfolio shares. Furthermore, Tesar and Werner (1992) show that around the world foreigners hold a small fraction of the domestic stock markets. It is clear that this implication of the general equilibrium framework is rejected by casual data.

As for the implied common movement in consumption growth rates, this implication requires that no country-specific component should explain domestic consumption growth.[56] Since consumption data are often plagued by measurement error, one way to examine this issue is to run a cross-sectional regression of consumption growth on output growth and a constant to capture the common component across countries. This regression may be written as:

$$\ln(C^j_{t+1}/C^j_t) = b_0 + b_1 \ln(Y^j_{t+1}/Y^j_t) + \zeta^j_{t+1} \tag{2.10}$$

where $b_0 \equiv \ln(\underline{C}_{t+1}/\underline{C}_t)$, the aggregate consumption growth rate, is a constant across countries at each point in time, Y^j_t is the output level in country j at time t, b_i are parameters, and ζ^j_{t+1} is a residual including the measurement error.

Complete markets and optimal risk-sharing imply that $b_1 = 0$. In other words, consumption should vary with the common component of international consumption captured by the constant and should be independent of any country specific disturbances. In particular, it should be independent of output.

Table 2.2 reports the results of estimates of eq. (2.10) for 72 countries in the Penn World Tables over five year intervals. As the numbers show, the coefficient b_1 is significantly positive in all cases. This result implies that countries consume more in

[55]In business cycle models with complete markets, intertemporal marginal rates of substitution in consumption are equalized across countries. To see that markets are complete in the example above, note that the only sources of uncertainty are the endowment realizations across countries. As a result, the set of possible states is spanned by holdings of equities so that markets are complete.

[56]This implication derives from the implicit assumption above that consumption is separable in the utility function from other goods such as leisure. If this assumption does not hold, then the following test may be amended with similar conclusions. See Lewis (1993).

Table 2.2
Home bias puzzle and international consumption patterns

A. Cross-sectional regressions of consumption growth on income growth

Growth rate year pairs	Coeff. b_1 (Std. error)
1951–50	0.87** (.09)
1956–55	1.07** (.09)
1961–60	1.26** (.11)
1966–65	0.92** (.16)
1971–70	1.40** (.11)
1976–75	1.04** (.19)
1981–80	0.83** (.11)
1986–85	1.06** (.16)

B. Domestic relative to foreign turnover of stock ownership

Country	Domestic ratio	Foreign equity held by dom. res.	Domestic equity held by for. res.
Canada	0.61	7.7	2.2
UK	0.77	NA	1.4
US	1.07	2.5	1.6

Notes: Cross-sectional regression in Panel A use top 72 countries in Penn World Tables by data quality. Panel B from Tesar and Werner (1992).

response to country-specific increases in income than the aggregated world consumption growth rate.[57] These findings are consistent with the view that domestic residents hold a suboptimally high proportion of their wealth in domestic equities, as we have found to be true above.

2.2.2. Empirical evidence: How good are the pricing relationships?

Note that the first-order conditions for equity pricing in eq. (2.6) can be written in the general form $E_t(q_{t+1}r^j_{t+1}) = 1$, where $r^j_{t+1} \equiv [Y^j_{t+1} + z^j_{t+1}]/z^j_t$. When prices and dividends are in nominal terms, then this first-order condition can be written as the product of the nominal intertemporal marginal rate of substitution in consumption and

[57]Lewis (1994) considers a related regression using panel estimation. Obstfeld (1989, 1994c) finds similar results in time series regressions of the industrialized countries. See Baxter (1995) for more discussion.

the stock returns given in (1.36): $E_t(Q_{t+1}R^j_{t+1}) = 1$.[58] Therefore, all of the evidence on latent variable models and Hansen–Jagannathan bounds described for excess foreign exchange returns are equally applicable to equity returns as well.

Cumby (1990) tested for a single latent variable among stock returns across a set of countries and found that the restrictions were rejected. Campbell and Hamao (1992) found that the US and Japanese stocks helped forecast each other. A single latent variable model was rejected for the 1970s, but not the 1980s. Other studies have tested the relationship using both foreign exchange returns and stock returns, generally rejecting the restrictions.[59] Bekaert and Hodrick (1992) also calculate the Hansen–Jagannathan bounds using both stock and foreign exchange returns, finding that these lower bounds on the intertemporal marginal rate of substitution in consumption are much larger than could be derived from standard theoretical models.

Essentially, the evidence based upon first-order conditions in general equilibrium equity pricing relationships across countries provide the same inconsistencies as do foreign exchange returns. First, latent variable comovements do not necessarily provide evidence for general equilibrium pricing relationships, even if they exist. A number of studies have found common transmission effects among stock markets without reference to general equilibrium pricing effects.[60]

The variability of the equity premium implied by the data is much larger than the variability implied by theory. As before, this discrepancy leaves open the question of whether other utility functions or modifications of the model's assumptions will ultimately provide more evidence for the model. Therefore, other studies have asked whether modifications of the basic model might help explain "home bias".

2.2.3. *Are non-traded goods responsible for the "home bias"?*

The basic model considered above assumes that residents of all countries consume a single tradeable good. Stockman and Dellas (1989) point out that if investors consume non-traded goods in addition to traded goods, then domestic investors will hold all of the equities with payouts in domestic non-traded goods and will share equally in the world equity market in traded goods when their wealth levels are equal. Since domestic residents hold all of the non-traded goods equities, the domestic

[58]That is, defining Z as the nominal stock price and e as the nominal endowment,

$$Z^j_t = E_t \sum_{\tau=1}^{\infty} Q_{t+\tau} e^j_{t+\tau} .$$

[59]See, for example, Bekaert and Hodrick (1992), Giovannini and Jorion (1987a) and Lewis (1990).

[60]For example, see Eun and Shim (1989). King and Wadhwani (1990) find international transmission effects between equity markets following the October 1987 crash and argue that these effects result from traders with imperfect information rationally trying to learn the true equity values.

residents' total holdings of traded and non-traded equities will be biased toward home equities.[61]

Stockman and Dellas (1989) assume that non-traded goods are separable from tradeable goods in utility. However, Baxter, Jermann, and King (1994) show that the Stockman-Dellas result is sensitive to the assumption that utility is separable between traded and non-traded goods. Depending upon the degree of substitutability between tradeables and non-tradeables and the level of risk aversion, domestic residents may want to hold less than 100 percent of domestic non-traded good equities and may even want to short it.[62]

Non-traded goods can also help explain the bias in consumption growth rates toward domestic country disturbances, as found in Table 2.2. Tesar (1993) and Stockman and Tesar (1995) show theoretically and empirically that the presence of non-traded goods can lower the implied correlation between consumption growth rates. For a panel data set of 72 countries, Lewis (1993) shows that non-traded goods can explain less than one percent of the variance in idiosyncratic component of consumption growth rates, leaving much of the idiosyncratic movements unexplained.[63]

In sum, the presence of non-traded goods may theoretically explain the home bias puzzle as reflected in portfolio holdings as well as consumption comovements. However, a clear relationship between portfolio holdings and non-traded goods depends upon particular values to parameters in the utility function. It has yet to be determined whether these values are plausible enough to explain the home bias puzzle. In terms of consumption co-movements, non-tradeables alone do not appear to be able to explain empirically the idiosyncratic movements in consumption growth rates across countries. Overall, the presence of non-traded goods moves in the direction of explaining the home bias puzzle, but leaves open the question of whether it can explain the puzzle.

[61]This explanation is related to an argument in several earlier papers based upon partial equilibrium analysis. Hedging domestic price uncertainty could result in home bias, it was argued, when domestic residents consume a higher share of domestic goods than foreigners. Branson and Henderson (1984) survey this literature and show that the relationship is ambiguous. Eldor, Pines, and Schwartz (1988) present sufficient conditions for home bias based upon this relationship using a general equilibrium model.

[62]The effects of non-separabilities in utility are also considered in Pesenti and van Wincoop (1994) and Tesar (forthcoming). These papers assume that domestic residents are restricted from holding foreign non-traded goods equities, and derive conditions under which an investor would find it optimal to be biased toward domestic traded goods equities. Baxter, Jermann, and King (1994) show that as long as investors are able to hold foreign non-traded goods equities, domestic investors will never choose to bias their portfolio holdings toward domestic traded goods equities.

[63]Baxter (1995) provides a discussion of the larger literature in this area as well as the related issue of non-traded factors in production.

2.3. Restrictions and frictions in international equity market transactions

The low degree of risk-sharing whether viewed from a partial equilibrium or a general equilibrium point of view currently remains a puzzle in international finance. Since home bias does not seem readily explainable by modifications to the standard models described above, the search for an explanation leads naturally to questions about basic underlying assumptions of the models. Both the partial and general equilibrium frameworks assume that markets are perfectly integrated without any government restrictions or other impediments. They also assume that investors are rationally informed about the potential gains of diversifying into foreign stock markets and, implicitly, that these gains are large enough to offset any transactions costs from acquiring foreign equities.[64] Any of these assumptions may be invalidated and, if so, may help explain the puzzle. I describe evidence concerning these explanations next.

2.3.1. Segmented equity markets and government restrictions

One explanation for the puzzle may be that domestic investors face barriers to acquiring foreign equities. The inability to obtain or hold foreign equities at the same cost as foreign residents may be the result of government restrictions such as taxes or may reflect more subtle constraints. In the extreme case of complete capital market immobility, countries may be forced to hold only their own equities as in the example described in Section 2.2. More realistically, countries are likely to face some restrictions that potentially impede capital flows, with the likely outcome that portfolios of domestic residents are biased toward domestic equities.

General recognition that international capital market restrictions exist has led to studies concerning the theoretical effects and empirical evidence of segmented markets. Stulz (1981b) analyzes the effects of taxes on gross holdings of foreign assets, finding that some foreign assets will not be held by domestic residents in equilibrium.[65] Errunza and Losq (1985) develop and test a restricted version of the Stulz (1981b) model in which domestic investors cannot hold foreign equities but foreign investors can hold both domestic and foreign equities. They apply this model to U.S. (domestic) relative to developing country (foreign) markets and find that parameter restrictions implied by the hypothesis of mild segmentation are not rejected. Errunza and Losq (1989) theoretically consider the effects of capital flow restrictions on the holdings of equity positions and their welfare implications.

Since market segmentation seems most likely to exist between the developed

[64] Obstfeld (1994a) provides a useful survey of the issues behind capital market movements as well as measures of capital immobility.

[65] Black (1974) examines the effects of proportional taxes on net holdings of risky foreign assets. In this model, sufficiently high barriers to investment induce large short holdings of foreign assets but not an equilibrium in which foreign assets are not held at all by domestic residents.

countries and developing or emerging markets, recent research has examined the behavior of equities in these markets. Bonser-Neal, Brauer, Neal, and Wheatley (1990) analyze the effects of government liberalizations on the pricing of ''country funds'', mutual funds comprised of the assets in specific countries. For five developing countries with foreign investment restrictions, they consider the ratios between the price of the funds in the international market relative to the net asset values (NAVs) of their underlying component equities within the country. Bonser-Neal, et al. find that the price–NAV ratios fall significantly either in anticipation or following liberalizations of investment restrictions. They interpret this evidence as demonstrating that government-imposed barriers have been effective in segmenting international capital markets. Hardouvelis, La Porta, and Wizman (1993) also find that cross-border investment restrictions are significant in explaining the difference between prices and NAVs of country funds.

Harvey (1993) provides a broad empirical examination of returns in twenty emerging markets. He finds that standard international asset pricing models based upon integrated capital markets fail to explain the returns and predictability of country returns, concluding that models based upon market segmentation seem more likely to explain these returns. Similarly, Claessens and Rhee (1993) investigate the stock performance in emerging markets in relation to their accessibility by foreign investors, finding that they reject market integration.

As described in Section 2.2 above, home bias in portfolio holdings is linked in general equilibrium models to country-specific effects on domestic consumption. Using a panel data set of capital market restrictions for 72 countries, Lewis (1993) finds that the country-specific bias in domestic consumption is significantly larger for countries with capital market restrictions than those without any restrictions.

Taken together, the evidence suggests that government restrictions can be important for explaining why the portfolios of domestic residents in developing, relatively unrestricted countries may be biased away from holdings of equities in emerging markets. On the other hand, this argument is more difficult to make for the developed countries that do not face these restrictions. As we have seen, the US demonstrates a strong ''home bias'' in equity holdings with developed countries yet it does not impose significant restrictions of capital account movements.

Additional evidence of this implausibility is provided in Tesar and Werner (1992). They calculate the turnover rate on foreign equity held by domestic residents as well as the turnover rate on domestic equity held by foreign residents. Panel B of Table 2.2 reports their results together with the total turnover. While the total turnover rate averages less than one, the turnover rates for international equity flows is *higher*. Therefore, the flows of capital on international equity transactions tend to be higher than those on domestic flows. Significant restrictions on international transactions would suggest the opposite pattern. Although this evidence does not provide any standard errors and therefore should be interpreted with caution, it suggests that international equity transactions are not significantly impeded among these countries.

2.3.2. *Market frictions: How big are the gains?*

Behind the home bias puzzle is the presumption that investors would benefit sufficiently from acquiring foreign equities in order to offset any transactions costs. However, acquisition of foreign securities is not costless, even in ideal circumstances. With fully integrated capital markets, there are at least brokerage costs and perhaps the costs of getting information about foreign countries and companies. While these costs may be arguably small, they must be compared with the potential gains from diversifying. On this issue, studies based upon the partial equilibrium CAPM and the general equilibrium approach appear to give quite different answers.

Based upon the partial equilibrium CAPM, the portfolio improvement from diversifying into foreign securities has been recognized since at least Levy and Sarnat (1970). More recently, Grauer and Hakansson (1987) show that the gains to a US investor from diversifying into 14 non-US equity and bond markets is quite large. For example, relative to the US S&P 500 index with a mean of 10 percent and a standard deviation of 17.3 percent, portfolios including foreign assets could dominate with means of 13 percent or more and standard deviations of 16 percent or less.

On the other hand, general equilibrium models suggest that gains to international diversification can be quite small.[66] Cole and Obstfeld (1991) calculated the gains from diversifying in a two-country general equilibrium model without growth. They found that the gains from moving from an autarkic equilibrium without trade in financial markets to one in which investors optimally hold foreign securities are miniscule, between 0.1 percent to 0.2 percent of annual consumption. On the other hand, Obstfeld (1994b) finds that the gains from diversification can be much larger when growth is incorporated into the analysis.

The distinct approaches used in these two literatures obscure an important empirical difference that may help explain the striking contrasts between their implied gains to risk sharing. That is, general equilibrium models tend to base their calculations of welfare gains on consumption data while the partial equilibrium calculations come from equity return data. As described above with respect to Hansen–Jagannathan bounds, consumption-based models have been unsuccessful in generating sufficient variability in theoretical returns to be able to explain equity and foreign exchange premia. Lewis (1994) shows that this discrepancy is important. When the variability in equity returns from a general equilibrium approach is matched with the actual equity return volatility instead of consumption volatility, then general equilibrium models also generate significant welfare costs, even in the absence of growth.

While this evidence is preliminary, it suggests that the same problems in explaining risk premia volatility may also plague unified attempts to calculate welfare costs of insufficient risk sharing.

[66]Tesar (forthcoming) surveys this literature.

2.3.3. Market inefficiencies

Another explanation for home bias is simply that the market is inefficient and investors do not recognize the potential gains to their portfolio performance. In this vein, French and Poterba (1991) have argued that the home bias in portfolio holdings can be explained by the fact that domestic investors are overly optimistic about the returns in the home market. Using the model in Section 2.1, they calculate the degree to which domestic expected returns would have to exceed actual returns in order to justify the large share of domestic wealth held in domestic assets. They find that the "optimism" on U.S. equity was about 4 percent. Also, the expected returns on foreign stocks should have been 1 percent to 7 percent lower than they actually were.

Baxter and Jermann (1993) take this argument a step farther by considering human capital as part of wealth. They argue that domestic wealth is comprised of, not only financial wealth, but also human capital. Since their measured U.S. returns on human capital are positively correlated with U.S. equities, and since human capital is non-tradeable, the domestic investor should take short positions in the domestic financial market. They calculate the degree of "optimism" as in French and Poterba and find results similar to theirs.

Therefore, one answer to the home bias puzzle is that domestic investors are simply uninformed or irrational about foreign relative to domestic returns. If so, this answer leads to questions similar to those raised about irrational forecast errors in Section 1. Where does the irrational domestic optimism or foreign pessimism come from? Can it be explained by heterogeneous agent models? Are there testable implications of this explanation? So far, theoretical models and tests based upon this explanation have yet to be produced.

2.4. The future of the "home bias" puzzle

This section has reviewed arguments to explain the bias by domestic residents toward holdings of domestic assets in their portfolios. I have showed the presence of this bias based upon both partial and general equilibrium models, as well as attempts to modify the standard models to explain the results. While modifications, such as the presence of non-traded goods, move in the direction of lessening the puzzle, the evidence so far suggests that these modifications are unlikely to fully resolve the issue.

Other evidence suggests that restrictions in capital markets might help explain the home bias by developed countries away from developing country equities. Among the well integrated markets of many developed countries, this explanation seems unlikely to be an important explanation, however. Whether the potential gains to investors are large enough to warrant international diversification remains an open question – calculations based upon stock returns tend to find that the gains are large, while those based upon consumption find that the gains are tiny. Although unpalatable to most economists, a final possibility is simply that investors are uninformed about foreign diversification, although testable models based upon this argument have not been provided.

An important development in the last decade has been the increased accessibility of domestic residents to foreign markets through international mutual funds as well as more open capital markets. While acquiring individual foreign stocks may be costly through either informational difficulties arising from different languages, accounting systems, or legal risks, mutual funds that hold foreign securities readily provide the domestic investor with the gains of international diversification. These mutual funds typically do not cost much more than the domestic funds. Anecdotal evidence during the early 1990s from newspapers suggested that American investors were acquiring foreign securities and mutual funds in record numbers. Therefore, it remains to be seen whether the home bias puzzle will disappear as foreign securities become easier to purchase by domestic residents.

References

Abel, A. (1990), "Asset prices under habit formation and catching up with the Joneses", American Economic Review 80:38–42.

Adler, M. and B. Dumas (1983), "International portfolio choice and corporate finance: A synthesis", Journal of Finance 38:925–984.

Backus, D.K., A.W. Gregory, and C.I. Telmer (1993), "Accounting for forward rates in markets for foreign currency", Journal of Finance 48:1887–1908.

Backus, D.K. and P.J. Kehoe (1989), "On the denomination of government debt: A critique of the portfolio balance approach", Journal of Monetary Economics 23:359–376.

Bansal, R., D.A. Hsieh, and S. Viswanathan (1993), "A new approach to international arbitrage pricing", Journal of Finance 48:1719–1747.

Bates, D.S. (1994), "Dollar jump fears: 1984–1992", working paper, University of Pennsylvania.

Baxter, M. (1995), "International business cycles", in: G. Grossman and K. Rogoff, eds., Handbook of international economics, vol. 3 (North-Holland, Amsterdam).

Baxter, M. and U.J. Jermann (1993), "The international diversification puzzle is worse than you think", Rochester Center for Economic Research Working Paper No. 350.

Baxter, M., U.J. Jermann, and R.G. King (1994), "Non-traded goods, non-traded factors, and international non-diversification", working paper, University of Virginia.

Bekaert, G. (1992), "The time-variation in risk and return in foreign exchange markets: A general equilibrium approach", Stanford University Working Paper Series, No. 1276.

Bekaert, G. (1994), "Exchange rate volatility and deviations from unbiasedness in a cash-in-advance model", Journal of International Economics 36:29–52.

Bekaert, G. and R.J. Hodrick (1992), "Characterizing predictable components in excess returns on equity and foreign exchange markets", Journal of Finance 47:467–510.

Bekaert, G. and R.J. Hodrick (1993), "On biases in the measurement of foreign exchange risk premiums", Journal of International Money and Finance 12:115–138.

Bekaert, G., R.J. Hodrick, and D. Marshall (1994), "The implications of first-order risk aversion for asset market premiums", National Bureau of Economic Research Working Paper No. 4624.

Black, F. (1974), "International capital market equilibrium with investment barriers", Journal of Financial Economics 1:337–352.

Bilson, J.F.O. (1981), "The 'speculative efficiency' hypothesis", Journal of Business 54:435–452.

Bonser-Neal, C., G. Brauer, R. Neal, and S. Wheatley (1990), ''International investment restrictions and closed-end country fund prices'', Journal of Finance 45:523–548.
Bossearts, P. and P. Hillion (1991), ''Market microstructure effects of government intervention in the foreign exchange market'', Review of Financial Studies 4:513–541.
Branson, W. (1977), ''Asset markets and relative prices in exchange rate determination'', Sozialwissenschaftliche Annalen 1:69–89.
Branson, W. and D. Henderson (1984), ''The specification and influence of asset markets'', in: R.W. Jones and P.B. Kenen, eds., Handbook of international economics, vol. 1 (North-Holland, Amsterdam).
Campbell, J.Y. and R.H. Clarida (1987), ''The term structure of Euromarket interest rates: An empirical investigation'', Journal of Monetary Economics 19:25–44.
Campbell, J.Y. and Y. Hamao (1992), ''Predictable stock returns in the United States and Japan: A study of long-term capital market integration'', Journal of Finance 47:43–70.
Claessens, S. and M. Rhee (1993), ''The effects of equity barriers on foreign investment in developing countries'', National Bureau of Economic Research Working Paper No. 4579.
Cole, H.L., and M. Obstfeld, (1991), ''Commodity trade and international risk sharing: How much do financial markets matter?'', Journal of Monetary Economics 28:3–24.
Constantinides, G. (1990), ''Habit formation: A resolution of the equity premium puzzle'', Journal of Political Economy 98:519–543.
Cumby, R.E. (1988), ''Is it risk? Explaining deviations from uncovered interest parity'', Journal of Monetary Economics 22:279–300.
Cumby, R.E. (1990), ''Consumption risk and international equity returns: Some empirical evidence'', Journal of International Money and Finance 9:181–192.
Cumby, R.E. and M. Obstfeld (1981), ''A note on exchange-rate expectations and nominal interest differentials: A test of the Fisher hypothesis'', Journal of Finance 36:697–703.
Cumby, R.E. and M. Obstfeld (1984), ''International interest rate and price level linkages under flexible exchange rates: A review of recent evidence'', in: J.F.O. Bilson and R.C. Marston, eds., Exchange rate theory and practice (University of Chicago Press, Chicago).
De Long, J.B., A. Shleifer, L.H. Summers, and R.J. Waldmann (1990), ''Noise trader risk in financial markets'', Journal of Political Economy 98:703–738.
Dominguez, K. and J. Frankel (1993), ''Does foreign exchange intervention matter? The portfolio effect'', American Economic Review 83:1356–1369.
Domowitz, I. and C. Hakkio (1985), ''Conditional variance and the risk premium in the foreign exchange market'', Journal of International Economics 19:47–66.
Dumas, B. (1994), ''Partial-equilibrium vs general-equilibrium models of international capital market equilibrium'', in: R. van der Ploeg, ed., Handbook of international macroeconomics (Basil Blackwell, Oxford).
Dumas, B. and B. Solnik (1993), ''The world price of exchange rate risk, working paper'', Hautes Etudes Commerciales School of Management.
Edison, H.J. (1993), ''The effectiveness of central-bank intervention: A survey of the literature after 1982'', Special Papers in International Economics No. 18, Princeton University Printing Services, Princeton, NJ.
Eldor, R., D. Pines, and A. Schwartz (1988), ''Home asset preferences and productivity shocks'', Journal of International Economics 25:165–176.
Engel, C.M. (1984), ''Testing for the absence of expected real profits from forward market speculation'', Journal of International Economics 17:299–308.
Engel, C.M. (1992a), ''On the foreign exchange risk premium in a general equilibrium model'', Journal of International Economics 32:305–319.
Engel, C.M. (1992b), ''The risk premium and the liquidity premium in foreign exchange markets'', International Economic Review 33:871–879.
Engel, C.M. (1993), ''Tests of CAPM on an international portfolio of bonds and stocks'', National Bureau of Economic Research Working Paper No. 4598.
Engel, C.M. and J.D. Hamilton (1990), ''Long swings in the dollar: Are they in the data and do the markets know it?'', American Economic Review 80:689–713.
Engel, C.M. and A.P. Rodrigues (1989), ''Tests of international CAPM with time-varying covariances'', Journal of Applied Econometrics 4:119–138.

Engel, C.M. and A.P. Rodrigues (1993), "Tests of mean-variance efficiency of international equity markets", Oxford Economic Papers 45:403–421.

Epstein, L. and S. Zin (1990), "'First order' risk aversion and the equity premium puzzle", Journal of Monetary Economics 26:387–407.

Errunza, V. and E. Losq (1985), "International asset pricing under mild segmentation: Theory and evidence", Journal of Finance 40:105–124.

Errunza, V. and E. Losq (1989), "Capital flow controls, international asset pricing, and investor's welfare: A multi-country framework", Journal of Finance 44:1025–1037.

Eun, C.S. and S. Shim (1989), "International transmission of stock market movements", Journal of Financial and Quantitative Analysis 24:241–256.

Evans, M.D.D. and K.K. Lewis (1995), "Do long-term swings in the dollar affect estimates of the risk premium?", Review of Financial Studies, forthcoming.

Fama, E. (1984), "Forward and spot exchange rates", Journal of Monetary Economics 14:319–338.

Ferson, W.E. and C.R. Harvey (1993), "The risk and predictability of international equity returns", Review of Financial Studies 6:527–566.

Fisher, I. (1930), The theory of interest (Macmillan, New York).

Frankel, J.A. (1982), "In search of the exchange risk premium: A six-currency test assuming mean-variance optimization", Journal of International Money and Finance 1:255–274.

Frankel, J.A. (1986), "The implications of mean-variance optimization for four questions in international macroeconomics", Journal of International Money and Finance 5 (Supplement):S53–S75.

Frankel, J.A. and K.A. Froot (1987), "Using survey data to test standard propositions regarding exchange rate expectations", American Economic Review 77:133–153.

Frankel, J.A. and K.A. Froot (1988), "Explaining the demand for dollars: International rates of return and the expectations of chartists and fundamentalists", in: R. Chambers and P. Paarlberg, eds., Agriculture, macroeconomics and the exchange rate (Westview Press, Boulder, CO).

Frankel, J.A. and A. Rose (1995), "An empirical characterization of nominal exchange rates", in: K. Rogoff and G. Grossman, eds., Handbook of international economics (North Holland, Amsterdam).

French, K. and J. Poterba (1991), "International diversification and international equity markets", American Economic Review 81:222–226.

Frenkel, J.A. and A. Razin (1980), "Stochastic prices and tests of efficiency of foreign exchange markets", Economic Letters 6:165–170.

Froot, K.A. and J.A. Frankel (1989), "Forward discount bias: Is it an exchange risk premium?", The Quarterly Journal of Economics 104:139–161.

Froot, K.A. and R. Thaler (1990), "Anomalies: Foreign exchange", Journal of Economic Perspectives 4:179–192.

Gibbons, M. and W.E. Ferson (1985), "Testing asset pricing models with changing expectations and an unobservable market portfolio", Journal of Financial Economics 14:217–236.

Giovannini, A. and P. Jorion (1987a), "Interest rates and risk premia in the stock market and in the foreign exchange market", Journal of International Money and Finance 6:107–124.

Giovannini, A. and P. Jorion (1987b), "Foreign-exchange risk premia volatility once again", Journal of International Money and Finance 7:111–114.

Girton, A. and D. Henderson (1977), "Central bank operations in foreign and domestic assets under fixed and flexible exchange rates", in: P. Clark, D. Logue, and R. Sweeney, eds., The effects of exchange rate adjustment (US Treasury, Washington, DC).

Grauer, R.R. and N.H. Hakansson (1987), "Gains from international diversification: 1968–85 returns on portfolios of stocks and bonds", Journal of Finance 42:721–739.

Hall, R.E. (1978), "Stochastic implications of the life cycle-permanent income hypothesis: Theory and evidence", Journal of Political Economy 86:971–987.

Hall, R.E. (1989), "Consumption", in: R.J. Barro, ed., Modern business cycle theory (Harvard University Press, Cambridge, MA).

Hansen, L.P. and R.J. Hodrick (1983), "Risk averse speculation in the forward foreign exchange market: An econometric analysis of linear models", in: J.A. Frenkel, ed., Exchange rates and international macroeconomics (University of Chicago Press, Chicago).

Hansen, L.P. and R. Jagannathan (1991), "Implications of security market data for models of dynamic economies", Journal of Political Economy 99:225–262.

Hansen, L.P. and K.J. Singleton (1983), "Stochastic consumption, risk aversion, and the temporal behavior of asset returns", Journal of Political Economy 91': 249–265.

Hardouvelis, G.A., R. La Porta, and T.A. Wizman (1993), "What moves the discount on country equity funds"? National Bureau of Economic Research Working Paper No. 4571.

Harvey, C. (1991), "The world price of covariance risk", Journal of Finance 46:111–158.

Harvey, C. (1993), "Predictable risk and returns in emerging markets, working paper", Duke University.

Heston, S.L. and K.G. Roewenhorst (1994), "Industrial structure explains the benefits of international diversification?", Journal of Financial Economics 36:3–27.

Hodrick, R.J. (1981), "International asset pricing with time-varying risk premia", Journal of International Economics 11:573–587.

Hodrick, R.J. (1987), The empirical evidence on the efficiency of forward and futures foreign exchange markets (Harwood Academic Publishers, Chur, Switzerland).

Hodrick, R.J. and S. Srivastava (1984), "An investigation of risk and return in forward foreign exchange", Journal of International Money and Finance 3:5–29.

Hodrick, R.J. and S. Srivastava (1986), "The covariation of risk premiums and expected future spot exchange rates", Journal of International Money and Finance 5 (Supplement):S5–S21.

Howell, M. and A. Cozzini (1990), International equity flows – 1990 edition (Salomon Brothers European Equity Research, London, UK).

Ingersoll, J.E., Jr. (1987), "Portfolio Separation Theorems", in: Theory of financial decision making (Rowman and Littlefield, Savage, MD).

Jacquillat, B. and B. Solnik (1978), "Multinationals are poor tools for diversification", Journal of Portfolio Management 4:3–12.

Kaminsky, G.L. (1993), "Is there a peso-problem? Evidence from the dollar/pound exchange rate 1976–1987", American Economic Review 83:450–472.

King, M.A. and S. Wadhwani (1990), "Transmission of volatility between stock markets", Review of Financial Studies 3:5–33.

Kouri, P. (1976), "The exchange rate and the balance of payments in the short run and in the long run: A monetary approach", Scandinavian Journal of Economics 78:280–308.

Krasker, W. (1980), "The 'peso problem' in testing the efficiency of forward exchange markets", Journal of Monetary Economics 6:269–276.

Leme, P. (1984), "Integration of international capital markets", working paper, University of Chicago.

Levy, H. and M. Sarnat (1970), "International diversification of investment portfolios", American Economic Review 60:668–675.

Lewis, K.K. (1988a), "Testing the portfolio balance model: A multi-lateral approach", Journal of International Economics 24:109–127.

Lewis, K.K. (1988b), "Inflation risk and asset market disturbances: The mean-variance model revisited", Journal of International Money and Finance 7:273–288.

Lewis, K.K. (1989a), "Can learning affect exchange rate behavior? The case of the dollar in the early 1980's", Journal of Monetary Economics 23:79–100.

Lewis, K.K. (1989b), "Changing beliefs and systematic rational forecast errors with evidence from foreign exchange", American Economic Review 79:621–636.

Lewis, K.K. (1990), "The behavior of Eurocurrency returns across different holding periods and monetary regimes", Journal of Finance 45:1211–1236.

Lewis, K.K. (1991), "Should the holding period matter for the intertemporal consumption-based CAPM?", Journal of Monetary Economics 28:365–389.

Lewis, K.K. (1993), "What can explain the apparent lack of international consumption risk-sharing?", working paper, University of Pennsylvania.

Lewis, K.K. (1994), "Why do consumption and stock returns suggest such different costs of imperfect risk-sharing?", working paper, University of Pennsylvania.

Lintner, J. (1965), "The valuation of risky assets and the selection of risky investment in stock portfolios and capital budgets", Review of Economics and Statistics 47:13–37.

Lizondo, J.S. (1983), "Foreign exchange futures prices under fixed exchange rates", Journal of International Economics 14:69–84.

Lucas, R.E., Jr. (1978), "Asset prices in an exchange economy", Econometrica 46:1429–1445.

Lucas, R.E., Jr. (1982), "Interest rates and currency prices in a two-country world", Journal of Monetary Economics 10:336–360.

Lyons, R.K. (1993), "Tests of microstructural hypotheses in the foreign exchange market", National Bureau of Economic Research Working Paper No. 4471.
Mark, N. (1985), "On time-varying risk premia in the foreign exchange market", Journal of Monetary Economics 16:3–18.
Mehra, R. and E.C. Prescott (1985), "The equity premium: A puzzle", Journal of Monetary Economics 15:145–162.
Mossin, J. (1966), "Equilibrium in a capital asset market", Econometrica 34:768–783.
Mussa, M. (1981), "The role of official intervention", Group of Thirty Occasional Papers, No. 6, Group of Thirty, New York.
Obstfeld, M. (1989), "How integrated are world capital markets? Some new tests", in: G. Calvo, R. Findlay, J. de Macedo, eds., Debt, stabilization and development: Essays in memory of Carlos Diaz-Alejandro (Basil Blackwell, Oxford).
Obstfeld, M. (1994a), "International capital market mobility in the 1990s", in: P.B. Kenen, ed., Understanding interdependence: The macroeconomics of the open economy (Princeton University Press, Princeton, NJ).
Obstfeld, M. (1994b), "Risk-taking, global diversification, and growth", American Economic Review 84:1310–1329.
Obstfeld, M. (1994c), "Are industrial-country consumption risks globally diversified?", in: L. Liederman and A. Razin, eds., Capital mobility: The impact on consumption, investment, and growth (Cambridge University Press, Cambridge).
Pagan, A. (1986), "A note on the magnitude of risk premia", Journal of International Money and Finance 7:109–110.
Pesenti, P. and E. van Wincoop (1994), "International portfolio diversification and non-traded goods", working paper, Princeton University.
Rogoff, K. (1980), "Tests of the martingale model for foreign exchange futures markets", in Essays on expectations and exchange rate volatility, Ph.D. dissertation, Massachusetts Institute of Technology, Cambridge, MA.
Rogoff, K. (1984), "On the effects of sterilized intervention: An analysis of weekly data", Journal of Monetary Economics 14:133–159.
Roll, R. (1992), "Industrial structure and the comparative behavior of international stock market indexes", Journal of Finance 47:3–41.
Scheinkman, J.A. (1984), "General equilibrium models of economic fluctuations: A survey of theory", working paper, University of Chicago.
Sharpe, W. (1964), "Capital asset prices: A theory of market equilibrium under conditions of risk", Journal of Finance 19:425–442.
Shiller, R.J. (1981), "Do stock prices move too much to be justified by subsequent changes in dividends?", American Economic Review 71:421–436.
Solnik, B. (1974a), "An equilibrium model of the international capital market", Journal of Economic Theory 8:500–524.
Solnik, B. (1974b), "The international pricing of risk: An empirical investigation of the world capital market structure", Journal of Finance 29:365–378.
Solnik, B. (1983), "International arbitrage pricing theory", Journal of Finance 38:449–457.
Solnik, B. and A. de Freitas (1988), "International factors of stock price behaviour", in: S. Khoury and A. Ghosh, eds., Recent developments in international finance and banking (Lexington Books, Lexington, MA).
Stehle, R. (1977), "An empirical test of the alternative hypotheses of national and international pricing of risky assets", Journal of Finance 32:493–502.
Stockman, A.C. and H. Dellas (1989), "International portfolio nondiversification and exchange rate variability", Journal of International Economics 26:271–290.
Stockman, A.C. and L. Tesar (1995), "Tastes and technology in a two-country models of the business-cycle: Explaining international comovements", American Economic Review, 85:168–185.
Stulz, R.M. (1981a), "A model of international asset pricing", Journal of Financial Economics 9:383–406.
Stulz, R.M. (1981b), "On the effects of barriers to international investment", Journal of Finance 36:923–934.
Stulz, R.M. (1994), "International portfolio choice and asset pricing: An integrative survey", in: R.

Jarrow, V. Maksimovic, and W.T. Ziemba, eds., Finance, in: Series of handbooks in operations research and management science (North-Holland, Amsterdam).
Svensson, L.E.O. (1985a), "Currency prices, terms of trade and interest rates: A general equilibrium asset-pricing cash-in-advance approach", Journal of International Economics 18:17–42.
Svensson, L.E.O. (1985b), "Money and asset prices in a cash-in-advance economy", Journal of Political Economy 93:919–944.
Telmer, C.I. (1993), "Asset pricing puzzles and incomplete markets", Journal of Finance 48:1803–1832.
Tesar, L. (1993), "International risk sharing and non-traded goods", Journal of International Economics 35:69–89.
Tesar, L. (1995), "Evaluating the gains from international risk-sharing", in: A. Meltzer and C. Plosser, eds., Carnegie-Rochester conference series on public policy, forthcoming.
Tesar, L.L. and I.M. Werner (1992), "Home bias and the globalization of securities markets", National Bureau of Economic Research Working Paper No. 4218.
Thomas, S.H. and M.R. Wickens (1993), "An international CAPM for bonds and equities", Journal of International Money and Finance 12:390–412.