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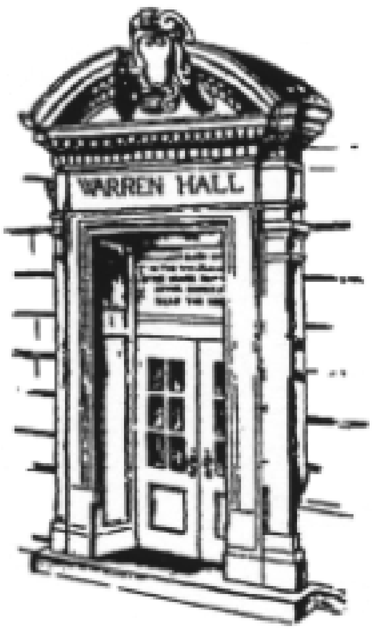

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The International CAPM When Expected Returns Are Time-Varying

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Abstract

This paper derives a dynamic version of the international CAPM. The exchange-rate risk factors and intertemporal hedging factors are derived endogenously in a model that builds upon Campbell (1993). We provide a theoretical foundation for empirical risk factors often used in international asset pricing, including dividend yields, forward premia and, especially, exchange-rate indices. The model nests the standard CAPM, the international CAPM and the dynamic CAPM. Empirically, the model performs quite well in explaining average foreign-exchange and stock market returns in the US, Japan, Germany and the UK, and exchange-risk and intertemporal hedging factors play some role in pricing these assets. However, while derived in a theoretically sound fashion, these new factors are proportional to covariances with the world market portfolio. Hence, for practical purpose, the model does not perform better than the standard CAPM model. We apply the model to explain returns on portfolios of high book-to-market stocks across countries, and find that the exchange rate and intertemporal hedging factors do not help to predict these returns. Hence, they cannot account for the two-factor model proposed in Fama and French (1998).

JEL Classification Numbers: G12, G15

Keywords: International CAPM; dynamic asset pricing; exchange rate risk; intertemporal hedging

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1 Introduction

When returns are predictable, investors would want to hedge against changes in future investment opportunities in a multi-period model.[1] Recently Campbell (1993, 1996) developed a tractable way to explicitly introduce intertemporal hedging into a CAPM. The basic result is that a factor that predicts the expected return on the market portfolio becomes a hedging factor for the cross section of assets' returns. This methodology is a breakthrough in empirically linking the time-series predictability to cross-sectional asset pricing in a domestic setting.

The international CAPM literature shows that when purchasing power parity (PPP) does not hold, the asset pricing model must also include exchange risk factors.[2] However, the existing international CAPM does not allow for predictability of asset returns. In this paper, we develop a dynamic international CAPM by generalizing Campbell's model to the international environment. This model includes five risk factors: the market and hedging factors as in Campbell, an inflation factor due to the nominal nature of the model, the exchange rate risk factor as in an international CAPM, and a hedging factor due to predictability of future real exchange rates.[3]

This paper makes three main contributions. First, the model nests the standard CAPM, the international CAPM, and the dynamic CAPM. This allows one to assess the significance of exchange rates or the intertemporal hedging factors in explaining expected asset returns in a model where the other factors are controlled. Second, many recent studies have used empirical factors such as inflation, dividend yield and forward premium to explain international stock returns. It is important to provide a theoretical foundation for using these factors in a model. In our model, these factors are present either because of the existence of purchasing power parity (PPP) deviations or because their time series behaviors show that they help to forecast future investment opportunities. As other empirical studies have done, we aggregate different exchange-rate risks into a single exchange-rate index to facilitate empirical estimation.[4] But we state the necessary assumptions to bundle different countries' exchange-rate risks into the aggregate exchange-rate index. Third, this is the first paper that explicitly identifies and investigates the importance of intertemporal hedging of future real exchange rate risk.

The model is formulated to be tractable in order to accomplish empirical analysis. The

[1] Merton (1973) first derived the intertemporal asset pricing model.

[2] Adler and Dumas (1983) and Solnik (1974)

[3] The real version of the model does not include the inflation factor.

[4] See among others, Ferson and Harvey (1993), Bansal, Hsieh, and Viswanathan (1993), and O'Brien and Dole (1999).

model is estimated and tested using data on equity and foreign exchange market returns for the four largest industrial economies: the United States, Japan, Germany, and the United Kingdom. Using a Vector Autoregression (VAR) approach, we use state variables widely documented in the literature to summarize the predictability of asset returns in one-period and in multi-period settings. This time-series predictability is then used in the cross-section asset pricing. We use the generalized method of moments to simultaneously estimate the time-series equations and asset pricing equations. This paper derives a dynamic version of the international CAPM. The exchange-rate risk factors and intertemporal hedging factors are derived endogenously in a model that builds upon Campbell (1993). We provide a theoretical foundation for empirical risk factors often used in international asset pricing, including dividend yields, forward premia and, especially, exchange-rate indices. The model nests the standard CAPM, the international CAPM and the dynamic CAPM. Empirically, the model performs quite well in explaining average foreign-exchange and stock market returns in the US, Japan, Germany and the UK. Exchange-risk and intertemporal hedging factors play some role in pricing these assets. However, while derived in a theoretically sound fashion, these new factors are proportional to covariances with the world market portfolio. Hence, for practical purpose, the model does not perform better than the standard CAPM model. We also apply the model to explain returns on portfolios of high book-to-market stocks across countries, and find that the exchange rate and intertemporal hedging factors do not help to predict these returns. Hence, they cannot account for the two-factor model proposed in Fama and French (1998).

2 Literature Review

The starting point of the international CAPM literature is the observation that PPP does not hold. Deviation from PPP says that exchange-rate changes are not offset by changes in the price levels of the countries. As a result, investors from different countries evaluate returns on the same asset differently. This violates the standard CAPM assumption that investors have homogeneous expectations of returns, and it presents difficulties for the aggregation of individual portfolios into a general asset pricing equation. Solnik (1974) and Adler and Dumas (1983) derive the international asset pricing models that modify CAPM to incorporate exchange-rate risk. In their models, in addition to the market risk factor, the international CAPM involves other risk factors that include covariances with exchange-rate changes of different countries. The international CAPM assumes that interest rate stays constant over time, essentially reducing the model to a static one. This paper develops an intertemporal, international asset pricing model in which the state variables may be priced.

Previous empirical literature has recognized the importance of addressing both exchange rate risk and intertemporal hedging, but has not considered them simultaneously.[5] DeSantis and Gerard (1998) develop tests of a conditional version of the Adler-Dumas model but face a similar problem: "when analyzing the conditional version of the ICAPM, the intertemporal nature of the problem should also be taken into consideration. ... Unfortunately, this would significantly complicate the empirical analysis." Dumas and Solnik (1995) assume that the time-varying world prices of foreign exchange risk depend on conditioning information and examine the unconditional implications of the conditional model. Harvey (1991), Bekaert and Hodrick (1992), and Ferson and Harvey (1993) all characterize the predictability of country returns and develop tests of conditional CAPMs.[6] In this paper we take a step back from these studies and derive the relevant empirical state variables from a theoretical model. We then proceed by empirically assessing the importance of the intertemporal hedging and exchange-risk factors implied by these state variables.

The framework in this paper is an alternative to the consumption CAPM framework in international asset pricing.[7] Empirical evidence using consumption data does not seem to support the model. The problem may be due to measurement errors in consumption data, which are likely to be even more severe for an international study.[8] It is, therefore, useful to explore alternative approaches to examine intertemporal hedging.

Hodrick, Ng, and Sengmueller (1999), also, explore the importance of intertemporal hedging for international equity returns.[9] They apply Campbell's (1993) two-factor (market and hedging) model to examine the ability of the intertemporal model to explain the cross-section of returns of the G7 country stock indices. However, they assume that PPP holds and consequently do not consider exchange rate risk, which is, instead, addressed in the current paper.[10]

This paper is organized as follows. Section 3 develops the international asset pricing model.

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[5]Dumas and Solnik (1995).

[6]Other important studies include Jorion (1991), who studies the pricing of exchange rate risk in the US stock market, and Vassalou (1999).

[7]Stulz (1981) derives an international version of consumption CAPM which allows for both changes in investment opportunity sets and consumption opportunity sets. See Stulz (1994) for a survey on the recent development of the theoretical literature.

[8]See, for example, Evans and Hasan (1998).

[9]Chang and Hung (1999) also examine a conditional version of the Campbell (1993) model on international equity returns without considering foreign exchange risk.

[10]In a recent working paper, Chang, et al. (2002) independently develop an international version of the dynamic CAPM which allows for time-varying conditional second moments.

Section 4 describes the data. Section 5 discusses the econometric methodology. Section 6 discusses the estimation results of the model and comparisons among different asset pricing models. Section 7 discusses the estimation of applying the model on high book-to-market portfolios. Section 8 concludes.

3 The Model

In this section, we derive an international asset pricing model with intertemporal hedging based on Campbell's (1993) log-linearized method. Campbell's dynamic CAPM involves a single representative agent maximizing over his intertemporal utility. In contrast, this model involves multiple country investors maximizing their utilities while taking into account their future consumption.

There are J countries in the world each with its own currency. Investors are able to buy assets in any country in the freely floating foreign exchange market. In each country j there exists a nominally riskless asset and a risky asset. While all goods are available in all countries, residents of a country have to pay for the goods at the prices available in their own countries. The real return on an asset, thus, depends on the country's price level where the asset's return is evaluated. Deviations in PPP drive a wedge between real returns in two countries. Deviations in PPP may occur, for instance, from deviations from the law of one price of individual goods due to shipping cost, friction, or taste differences among countries.[11] It is simply taken for granted that PPP deviations exist and asset pricing implications are explored.

In the model each country investor's log-linearized budget constraint is denominated into the reference currency of a numeraire country (country 1). Because PPP deviations exist, the differences in inflation of the consumption bundles for different countries are not offset by exchange rate changes. The real exchange rate, therefore, becomes a factor affecting the return of an investor when the return is denominated in the reference currency. The consumption in each country investor's Euler condition is substituted away using the investor's current and future asset returns. This expected return implies asset demands which can, then, be aggregated. The aggregate expected returns that result contain five factors, which are covariances with the world stock market returns, with changes in a weighted real exchange-rate index vis-a-vis

[11] Within a country, an aggregate price index is specified so that utility of the representative consumer depends only on the aggregate consumption bundle and aggregate price index. Different tastes for consumption goods in different countries could lead to PPP deviations. The model also does not explain why money is needed, and it takes the distributions of asset returns as given.

the reference currency, with reference currency inflation, with news about future world stock market returns, and news about the future changes in the real exchange-rate index.

Unlike previous international asset pricing models which involves many countries' exchange-rate risk factors, in the present study the aggregation bundles different countries' exchange-rate risk factors into a single exchange-rate index. This makes the empirical asset pricing model significantly simpler. The multiple hedging factors of multiple future exchange-rate risks are now reduced to a hedging factor involving the future movement of the exchange-rate index. To achieve this parsimonious setup, it is necessary to make some simplifying assumptions: First, different countries' investors have the same risk aversions and discount parameters. Second, over time, different investors expect future country wealth weights and portfolio weights to equal the current ones. These assumptions will be discussed later.

The model is developed in five steps. First, individual country consumer-investor's budget constraint is approximated using log-linearization. Second, returns are adjusted into a single reference currency. Third, the consumer maximizes the intertemporal utility function, and the Euler condition is, then, denominated in the reference currency. Fourth, consumption is substituted by present and future returns using the intertemporal budget constraint. Fifth, the asset demands of different investors in different countries are aggregated and an aggregate expected return formulation is derived.

3.1 Approximating the Budget Constraint

Define W_t as real wealth and C_t as real consumption of a representative investor in country j at the beginning of time t. Define $R^r_{p,t+1}$ as the real gross return on aggregate wealth for investor j, which is the real return on the portfolio p chosen by the investor. Investor j's market portfolio can include assets in other countries. Define P_t as the price level at time t in country j, and define Q_t as the real exchange rate (good 1/good j) at time t. The budget constraint of the investor is

$$W_{t+1} = R^r_{p,t+1}(W_t - C_t) \tag{1}$$

As in Campbell (1996), we divide equation (1) by W_t and log-linearize the resulting expression in a first-order Taylor approximation around the mean log consumption-wealth ratio $c - w$.

The result is

$$\Delta w_{t+1} = r^r_{p,t+1} + k_w + (1 - 1/\rho)(c_t - w_t) \tag{2}$$

where lowercase letters are natural logarithms of their uppercase counterparts, $\rho = 1 - exp(c - w)$, and k_w is a constant.[12] When the log consumption-wealth ratio is stationary, equation (2) implies that the innovation in the logarithm of consumption can be written as the innovation in the discounted present value of the return on the market minus the innovation in the discounted present value of consumption growth. Formally,

$$c_{t+1} - E_t(c_{t+1}) = (E_{t+1} - E_t)\left(\sum_{k=0}^{\infty} \rho^k r^r_{p,t+k+1}\right) - (E_{t+1} - E_t)\left(\sum_{k=1}^{\infty} \rho^k \Delta c_{t+k+1}\right) \tag{3}$$

Equation (3) indicates that an unanticipated increase in consumption today must be due to an innovation in the return on wealth, either today or an expected increase in the future, or it must coincide with a planned reduction in the growth rate of consumption in the future.

3.2 Using a Common Reference Currency

Because different countries' asset returns are involved, a reference currency is needed as numeraire. Without loss of generality, country 1's currency is chosen as the reference currency. The real return for country j's investor can be expressed as

$$R^r_{pt+1} = R^1_{p,t+1} \frac{P^1_t}{P^1_{t+1}} \frac{Q_t}{Q_{t+1}} \tag{4}$$

where $R^1_{p,t+1}$ is the nominal return of country j investor's portfolio expressed in country 1's currency, P^1_t is the time t price level in currency 1, and Q_t is the time t real exchange rate (good 1/good j). The expected real return is the nominal return in the reference currency deflated by the reference currency inflation and translated into real terms for country j through real exchange-rate changes. Equation (4) is derived directly from the definition of the real exchange rate.

In logs, equation (4) is

$$r^r_{p,t+1} = r^1_{p,t+1} - \pi^1_{t+1} - \Delta q_{t+1} \tag{5}$$

If purchasing power parity holds, then $\Delta q_{t+1} = 0$. In this case, the real return for the same asset from any country investor's perspective is the same. The real return to investor j is simply the nominal return in currency 1 deflated by currency 1 inflation. But when PPP

[12] $k_w = \log(1 - \exp(c - w)) - (1 - \frac{1}{\rho})(c - w)$

does not hold, then the real return in country j would differ by an amount equal to the real exchange rate change from the real return in country 1.

3.3 Consumer's Maximization Problem

Country j consumer preferences are modeled as in Epstein and Zin (1989) and Weil (1989), with separate parameters for the coefficient of relative risk aversion γ and for the elasticity of intertemporal substitution σ. The objective function is defined recursively by

$$U_t = \left((1-\beta)C_t^{(1-\gamma)/\theta} + \beta(E_t U_{t+1}^{1-\gamma})^{1/\theta}\right)^{\theta/(1-\gamma)} \tag{6}$$

where $\theta = (1-\gamma)/(1-1/\sigma)$. Campbell (1996) notes that θ can have either sign, $\theta \to 0$ as $\gamma \to 1$, $\theta \to \infty$ as $\sigma \to 1$, and $\theta \to 1$ as $\gamma \to 1/\sigma$.

Epstein and Zin (1989) solve for the Euler equations associated with maximizing equation (6) subject to the budget constraint given in (3). The Euler equation for asset i is:

$$1 = E_t\left(\left(\beta\left(\frac{C_{t+1}}{C_t}\right)^{-\frac{1}{\sigma}}\right)^{\theta}\left(\frac{1}{R^r_{p,t+1}}\right)^{1-\theta} R^r_{i,t+1}\right) \tag{7}$$

Using (4), we can express the returns in reference currency:

$$1 = E_t\left(\left(\beta\left(\frac{C_{t+1}}{C_t}\right)^{-\frac{1}{\sigma}}\right)^{\theta}\left(\frac{1}{R^1_{p,t+1}\frac{P^1_t}{P^1_{t+1}}\frac{Q_t}{Q_{t+1}}}\right)^{1-\theta} R^1_{i,t+1}\frac{P^1_t}{P^1_{t+1}}\frac{Q_t}{Q_{t+1}}\right) \tag{8}$$

Assuming that returns, consumption growth, inflations and real exchange rate changes are jointly log-normal and homoskedastic, this equation implies the following two equations, with detailed steps in Appendix A.

$$E_t(\Delta c_{t+1}) = \mu_p + \sigma E_t(r^1_{p,t+1} - \pi^1_{t+1} - \Delta q_{t+1}) \tag{9}$$

and

$$E_t(r^1_{i,t+1} - r^1_{f,t+1}) + \frac{V_{ii}}{2} = \frac{\theta}{\sigma}V_{ic} + (1-\theta)V_{ip} + \theta(V_{i\pi^1} + V_{iq}) \tag{10}$$

where μ_p is a variance term that measures the uncertainty of consumption relative to the real market return.[13] This variance is assumed to be constant. In equation (10), $r^1_{f,t+1}$ is the riskless nominal interest rate in the reference currency; V_{ii} =var$(\tilde{r}^1_{i,t+1})$ is the variance of asset

[13] $\mu_p = \sigma \log\beta + \frac{1}{2}(\frac{\theta}{\sigma})var_t(\Delta c_{t+1} - \sigma r_{m,t+1})$

i's returns relative to the conditional mean and $\widetilde{r}^1_{i,t+1} = r^1_{i,t+1} - E_t r^1_{i,t+1}$ V_{ic} =cov$(\widetilde{r}^1_{i,t+1}, \widetilde{c}_{t+1})$ is the covariance of asset i's return with country j's consumption. Also, V_{ip} =cov$(\widetilde{r}^1_{i,t+1}, \widetilde{r}^1_{p,t+1})$, where $r^1_p = \sum_n w_{nj} r^1_n$ is the return of the optimal portfolio for country j's investor in the reference currency, r_n is the asset return n, and w_{nj} represents the portfolio weight of investor j on asset n. Finally, $V_{i\pi}$ =cov$(\widetilde{r}^1_{i,t+1}, \widetilde{\pi}^1_{t+1})$, and V_{iq} =cov$(\widetilde{r}^1_{i,t+1}, \widetilde{\Delta q}_{t+1})$.

Equation (10) indicates that the continuously compounded risk premium on an asset plus one-half of the asset's variance is determined by the covariances of the asset's return with consumption, with the return on investor j's market portfolio, and with the inflation and real exchange rate change. The equation would reduce to Campbell's (1993, 1996) dynamic CAPM, if PPP holds exactly (i.e. $\Delta q_{t+1} = 0$).[14] In turn, the dynamic CAPM would reduce to CCAPM under time-separable power utility function, when θ equals one, and to static CAPM under log utility, when $\theta = 0$ and $\gamma = 1$.

3.4 Substituting Away Consumption

Equation (9) indicates that consumption growth is linearly related to the expected real return on the market portfolio of investor j. This fact is used in conjunction with the linearized budget constraint to eliminate consumption from the asset pricing model. Substituting the first Euler equation (9) into the dynamic budget constraint (3) yields

$$\begin{aligned} c_{t+1} - E_t c_{t+1} &= (E_{t+1} - E_t)(r^1_{p,t+1} - \pi^1_{t+1} - \Delta q_{t+1}) \\ &\quad + (1-\sigma)(E_{t+1} - E_t)\left(\sum_{k=1}^{\infty} \rho^k (r^1_{p,t+k+1} - \pi^1_{t+k+1} - \Delta q_{t+k+1})\right) \end{aligned} \tag{11}$$

Equation (11) indicates that the innovation in consumption, which enters the asset pricing equation (10), equals the innovations in the real returns and in the discounted expected future real returns. This expression (11) can be used to substitute away the covariance of surprises in asset returns with consumption in the second Euler equation (10). Using the definition of θ, the asset pricing equation (10) becomes

$$E_t(r^1_{i,t+1} - r^1_{f,t+1}) + \frac{V_{ii}}{2} = \gamma V_{i,p^1} + (1-\gamma)(V_{i,q} + V_{i,\pi}) + (\gamma - 1)(V_{ihp^1} - V_{i,h\pi} - V_{i,hq}) \tag{12}$$

Equation (12) demonstrates that in nominal reference currency terms, an asset's risk premium (adjusted for one-half its own variance) depends on the asset's covariance with the

[14] Without PPP deviations, the equation will reduce to a nominal version of Campbell (1996). It will be exactly equal to Campbell when there is also no inflation risk.

market portfolio's return with weight γ, with the real depreciation adjusted for reference currency inflation with weight $1-\gamma$, and with the innovation in discounted expected future market returns minus future inflation and real depreciation with weight $\gamma - 1$.

Thus, the expected return of asset i for country investor j is affected by the covariance with different factors. The first factor is the innovation in the own country portfolio returns. The second and third factors are covariances with reference currency inflation and nominal exchange rate change.[15] The remaining three factors are the innovation in future country portfolio returns, news on future inflation, and news regarding future exchange rate changes.

Equation (12) can be rewritten in a five factor form:[16]

$$E_t(r^1_{i,t+1} - r^1_{f,t+1}) + \frac{V_{ii}}{2} = \gamma_j V_{i,pj^r} + (1-\gamma_j)V_{i,qj} + V_{i,\pi} + (\gamma_j - 1)(V_{ihpj^r} - V_{i,hqj}) \qquad (13)$$

where we insert country subscript j. $V_{i,pj^r} = V_{i,pj} - V_{i,\pi}$ is the covariance of return i with the real return of portfolio p of country j's investor, deflated using the reference currency price index; and $V_{i,hpj^r} = V_{i,hpj} - V_{i,h\pi}$ is the covariance with the future real returns of portfolio p of country j's investor, deflated using the reference currency price index. Equation (12) differs from Campbell's (1993) domestic asset pricing model in that it is international and nominal. The model can be expressed using domestic currency in real terms instead of the reference currency 1, in which case the variance of inflation will also appear.[17]

3.5 Aggregation Across Countries

Equation (13) is the asset pricing equation for the representative investor in country j. But it is not useful for obtaining the required rates of return on the various securities since individual portfolio holdings cannot be observed. An equilibrium asset pricing equation is needed. For the sake of parsimony in the empirical work, many previous authors have used an exchange rate index as opposed to individual countries' exchange rates as factor in explaining international stock returns (see for example Bansal, Hsieh, and Viswanathan (1993), Ferson and Harvey (1993), and O'Brien and Dolde (1999)). However, they have not stated the necessary

[15]These two factors come from the real exchange rate change between country j and country 1.

[16]The future inflation term does not appear explicitly but is used to convert the future returns into real returns.

[17]The premium that applies to inflation and exchange-rate risk has a coefficient that equals 1 minus the coefficient of the market premium in equation (12). This prevents "money illusion," meaning that the equation can be expressed in real terms in country j goods. This premium exists even if the investor is risk neutral when $\gamma = 0$ (Dumas (1994)).

assumptions for using the exchange-rate indices. The aggregation here derives a set of sufficient conditions for exchange-rate indices to be used instead of individual countries' exchange rates.[18]

To aggregate the equations, the asset demands for different securities by investors are deduced from their Euler equations (13). Each country's investor has a choice of investing in assets from other countries. The demands are summed for each security. The aggregate expected return comes from the aggregate asset demand equation. The demands for assets are then aggregated and set equal to the world supplies of assets to form the equilibrium. The equilibrium asset demands imply the fundamental asset pricing equations. Appendix B provides the detailed steps in a two-country example, but the n-country extension is straightforward. The following assumptions are made:

$$\gamma_n = \gamma \tag{14}$$

$$\rho_n = \rho \tag{15}$$

$$w_{n,t+j} = w_{n,t} \tag{16}$$

$$W_{n,t+j} = W_{n,t} \tag{17}$$

for all n and j > 0 , where γ_n is the coefficient of risk aversion in country n, ρ_n is the discount parameter for future return in that country, $w_{n,t}$ is country n investor's portfolio weights in time t, and $W_{n,t}$ is country n's stock market capitalization as a ratio of the world's stock market capitalization in time t.

(14) says that the coefficients of relative risk aversion (CRRA) of different countries are the same, as assumed in Adler and Dumas (1983). Empirically it is difficult to conclude whether or not CRRA differ across countries; even in a domestic setting, there are widespread disagreements on the level of CRRA (as seen in the equity premium puzzle literature). It is useful to note that while there may be heterogeneity of relative risk aversion across individuals within a nation, as long as the distribution of risk aversion is similar among countries, the aggregate relative risk aversion would still be similar across those countries. (see Gokey (1991))

(15) says that the discount parameters for future returns ρ (which is a function of the mean consumption/wealth ratio) are the same across countries. This assumption preserves stationarity of wealth among countries. If (15) is violated, then the country with the lowest discount parameter will accumulate infinite wealth.

[18] In an independently developed theoretical working paper, Gokey (1991) also aggregates different exchange-risk factors into an exchange-rate index in a static model. When he considers a dynamic model along the line of Merton (1973), the model becomes too abstract and too general for any empirical investigation.

Both (14) and (15) maintain that investors are homogeneous. Relaxing these assumption is non-trivial and beyond the scope of the current paper. Wang (1996) and Chan and Kogan (2002) examine possible ways in which investors can be treated as heterogeneous.

(16) states that the expected values of different country investors' future portfolio weights are assumed to be the same as the current portfolio weights. (17) states that different countries' future stock market capitalization as a ratio of the world's are assumed to be the same as the current ratios. Together with the first two assumptions, assumptions (16) and (17) allow us to condense the effect of future exchange-rate changes of multiple countries into the effect of the future changes in an exchange-rate index.

There are some empirical evidence related to (16) and (17). Tesar and Werner (1996) show that the evidence on (16) is mixed in different countries. For US and Canada, between 1980 to 1990, international portfolio investment as a percentage of domestic market capitalization change moderately from 2.2 to 2.7% and from 3.6% to 4.2%. For UK, however, the percentage has gone up from 11.4% to 31.9%. A look at the data on individual stock market shares relative to the world stock market shares show that there are also some variations in countries' stock market capitalization weights in the world. US stock market capitalization as a ratio of the G7 countries' stock market capitalization went from 56% in 1980 to 46% in 1995, while Japan changed from 22.2% to 30.1% in the same period. When these two assumptions are violated, additional hedging terms related to hedging against future changes in market capitalization and portfolio weights would appear. While these additional hedging effects may also be important, including them would drastically increase the number of parameters that need to be estimated. This will be left for future research. For the current study, we will focus on the impact of intertemporal hedging due to the future exchange rate movements as captured through the exchange rate index.

After the aggregation, the resulting fundamental asset pricing equation is as follows:

$$E_t(r_{i,t+1} - r_{f,t+1}) + \frac{V_{ii}}{2} = \gamma V_{i,m} + (1-\gamma)V_{i,q} + V_{i,\pi} + (\gamma - 1)(V_{ihm} - V_{i,hq}) \tag{18}$$

where $V_{i,m}$ =cov$(\tilde{r}^1_{i,t+1}, \widetilde{r_{m,t+1} - \pi^1_{t+1}})$ is the covariance of asset returns with innovation in real market returns; $\Delta q_{t+1} = \sum_{j=1}^{J} (\frac{w_j}{W})\, \Delta q_{j,t+1}$ is the change of a real exchange rate index weighted by the stock markets' wealth relative to the world's; $V_{i,q}$ =cov$(\tilde{r}^1_{i,t+1}, \widetilde{\Delta q}_{t+1})$, $V_{i,hm}$ =cov$(\tilde{r}^1_{i,t+1}, (E_{t+1} - E_t) \sum_{k=1}^{\infty} \rho^k \sum_{j=1}^{J} (\frac{w_j}{W})\, (r^1_{m,t+k+1} - \pi^1_{t+k+1}))$, covariance with news on future real market returns and $V_{i,hq}$ =cov$(\tilde{r}^1_{i,t+1}, (E_{t+1} - E_t) \sum_{k=1}^{\infty} \rho^k \Delta q_{t+k+1})$, covariance with news on future real exchange rate changes.

Equation (18) is the dynamic international CAPM (DICAPM).[19] It explains an asset's risk premium by the covariances of the asset's return with the real market returns, with the reference currency inflation, with change in the real exchange-rate index (exchange-rate risk), and with expected future real market returns and future real currency depreciations (the intertemporal hedging components). The current and future real exchange rate terms appear because of PPP deviations. In addition to the standard international CAPM where investment opportunities stay constant, predictable changes in investment opportunities now induce an effect of intertemporal hedging against future real exchange rate changes. Similar to the domestic version of the dynamic CAPM, the intertemporal hedging against future stock return changes becomes another factor.

The model imposes restrictions on the risk prices of the factors in a multifactor model. The risk prices of these factors are determined by the coefficients of relative risk aversion and also by their ability to forecast future returns. Three factors come directly from the derivation of the model, namely, innovations in market return, real exchange-rate change, and inflation. The other two factors are important only because they may help to forecast future market returns and real exchange-rate changes. This model justifies why dividend yield and forward premium are included in previous empirical international asset pricing literature as in Bekaert and Hodrick (1992) and Ferson and Harvey (1993). The variables should be included as factors in the cross-sectional asset pricing because they forecast future investment opportunities. We will examine the prices of risk in the empirical section in more details.

3.6 Comparison with Other Asset Pricing Models

The dynamic international CAPM (18) nests the international CAPM, the dynamic CAPM, and the static CAPM as special cases. When future returns and real exchange-rate changes are not predictable, the intertemporal hedging terms V_{ihm} and $V_{i,hq}$ in (18) become 0. In this case, expected returns are determined by covariances with market returns, with real exchange rate change, and with inflation. This is the same as the static international CAPM as developed in Adler and Dumas (1983), when $\gamma's$ are equal across different countries. When PPP holds, real

[19] While the derivation of equation (18) is similar to Campbell (1996) in assuming conditional homoskedasticity, Campbell (1993) discusses several conditions under which the asset pricing equation can be derived in a more realistic environment of conditional heteroskedasticity. The most straightforward approach is to assume that the elasticity of substitution, γ, equals one. In this case, equation (18) holds in terms of conditional expected returns with all second moments replaced by conditional second moments. In this paper, we derive and test the unconditional implications of such a specification that allows for heteroskedasticity. Chang et al. (2001) discusses another way to extend the framework of Campbell (1996) to handle heteroskedasticity.

exchange rate change equals to 0. As a result, covariances with real exchange rate changes $V_{i,q}$ and $V_{i,hq}$ in (18) equal 0, and the model reduces into Campbell's dynamic CAPM. This special case is investigated in Hodrick, Ng, and Sengmueller (1999), where PPP is assumed, and the dynamic CAPM is used to assess the stock returns in the G7 countries using the world stock market return as the market portfolio. When PPP holds and returns are unpredictable, then static CAPM holds.

Another case where the static CAPM holds is when γ is 1. The coefficient of relative risk aversion γ determines the compensation that investors demand for covariance risks. When $\gamma = 1$, the model's predictions coincide with those of the static CAPM. Notice that the coefficient for the intertemporal hedging term of future stock return is $\gamma - 1$. Hence, when $\gamma > (<) \ 1$, investors require higher (lower) expected returns on assets that covary positively with innovations in discounted expected future returns. Just as in Campbell's (1996) setup, a positive covariance carries a mixed blessing. On one hand, investors like assets that have good payoffs when expected future returns are high. But, on the other hand, investors dislike the fact that such assets provide poor hedging against deterioration in future investment opportunities. When γ is greater than 1, the latter effect dominates the former.

The factors included in the asset pricing model are common in the empirical international finance literature. Ferson and Harvey (1993), for example, use market returns, real exchange-rate index, and G7 inflation, in addition to interest rates and oil prices, as the global economic risk factors. While Ferson and Harvey (1993) motivate these factors very well, the present model provides a tighter explanation for these factors in the international asset returns.

Like the original CAPM and international CAPM, the DICAPM is a partial-equilibrium model which does not fully specify the list of state variables. There is another important set of literature that builds general-equilibrium, international asset pricing models.[20] The advantage of the current model is that it is highly tractable, and it provides good guidance to empirical investigation. Equation (18) becomes the fundamental asset pricing formula in our empirical investigation.

4 Data and Construction of Factors

Table 1 presents summary statistics, all in logs, for the dataset used in this paper. Monthly data from July 1978 to April 1998 are used. The first two variables, world real equity return

[20] Apte, Sercu, and Uppal (1996), Dumas (1992), and Stulz (1987), among many others. See Dumas (1994) for a survey.

and real exchange-rate index change, are the risk factors implied by the asset pricing model. The next three variables, U.S. inflation, MSCI world market dividend yield, and G7 average forward premiums, are the forecasting variables that are frequently found in the literature to be important in predicting future stock and foreign exchange returns. The next seven variables are the local equity returns in the U.S., Japan, Germany and U.K., and the returns from investment of a U.S. investor on the money markets of Japan, Germany and U.K.

The first variable is the logarithm of real world returns (RRET_W) with the units being percent per month. The Morgan Stanley Capital Index (MSCI) world market index, deflated by the U.S. Consumer Price Index (CPI), is the measure for the real world returns. The second variable is the weighted sum of the log of changes in real exchange rates (ΔRER) of the United States versus those of the other six G7 countries. Change in the real exchange rate for one particular country j is defined as the change in log of spot rates (in U.S. $/currency j), adjusted by the difference in the two countries' inflations: $\Delta q_{j,t+1} = \pi^j_{t+1} + \Delta s_{j,t+1} - \pi^1_{t+1}$. The real exchange-rate changes for G7 countries are summed with weights to construct the real exchange-rate index change. The stock market capitalization (in U.S. $) of each country relative to the world market capitalization is used as its wealth weight.[21] Changes in foreign exchange rates are then added together with the wealth weights.[22] The inflation rates for the seven countries are calculated from their consumer price index (CPI) series for all items calculated by the Organization for Economic Cooperation and Development (OECD), and obtained through DRI. The third variable is the logarithmic inflation rate of the United States (USINF), and the fourth is the logarithm of dividend yield (LOGDP) of the MSCI world market. The fifth, LOGFP, is the weighted sum of the logarithm of the forward premium $\ln(F_{jt}/S_{jt})$ in the G7 countries, where F_{jt} and S_{jt} are the 1-month forward and spot exchange-rates of currency 1 relative to currency j, respectively.[23]

The empirical analysis for this paper involves forecasting the foreign exchange returns and equity returns of different countries using world common forecasting variables. The four countries whose asset returns are investigated are the United States (US), Japan (JP), Germany (GE), and the United Kingdom (UK), jointly referred to as the G4. U.S. currency is used as

[21] Because obtaining the stock market capitalization data from MSCI are prohibitively expensive, we use the stock market capitalization figures from Datastream Global Index.

[22] The bid and ask foreign exchange data are from Data Resources Inc. (DRI). They reflect the London closing price on the last day of the month.

[23] To obtain parsimony in the VAR system, some important forecasting variables are not used, i.e. dividend-earning payout ratio and default spread, whose predictive power is much reduced once the dividend yield is included. See Campbell (1996)

the reference currency and j=1 for the U.S. stocks. $r^{j}_{fj,t+1}$ is the 1-month nominal interest rate in country j (subscript) denominated in country j's currency (superscript) which is set at time t for delivery at time t+1. Eurocurrency 1-month bill rates are used; $r^{j}_{j,t+1}$ is the continuously compounded one-month rate of return in country j's equity market (subscript) denominated in currency j (superscript).

The sixth to ninth variables in Table 1 are the local currency returns on the MSCI country indices for US, JP, GE, and UK in excess of the respective countries' Eurocurrency 1-month bill rates $r^{j}_{j,t+1} - r^{j}_{f,j,t+1}$. The difference of the log rate of return of the security from the log of the Eurocurrency bill rate in the respective currency is taken. All Eurocurrency rates are obtained from DRI. The next three variables are excess dollar rates of returns in Japan's, Germany's and the United Kingdom's money market investments above the U.S. Eurocurrency 1-month rates $\Delta s_{jt+1} + r^{j}_{f,j,t+1} - r^{1}_{f,1,t+1}$. Transaction costs in the foreign exchange market are incorporated where a currency is bought at the bank's ask price and sold at its bid price for foreign exchange. The excess return of the uncovered investment in country j's equity market equals the sum of the local currency stock excess returns and the foreign exchange excess returns. All the rates of return are measured as percent per month in table 1.

The joint predictability of stock returns and foreign currency returns is investigated in a common VAR in Bekaert and Hodrick (1992), who use instruments from different pairs of countries and document large, predictable components. The methodology here requires one set of instruments for all assets, and hence the degree of predictability may be lower.

5 Econometric Methodology

5.1 State Variables Time Series Behavior

To develop testable restrictions from equation (18), the future real return on the world equity market portfolio and real exchange-rate depreciation must be forecastable. Since the theoretical model requires multiperiod forecasts of the world real stock return and real exchange-rate change, it is useful to stack these variables as the first two elements of a five-dimensional vector of state variables z_t and to use a vector autoregression (VAR) as in the following:

$$z_{t+1} = Az_t + \epsilon_{t+1} \tag{19}$$

The representation of the VAR as a first-order system is not restrictive, as the variables can always be stacked into a first-order companion form. We report the results of the first-order specification because this is the order chosen by the Schwarz (1978) criterion.

We use a five-variable, first-order vector autoregression:

$$z_t = \left[r_t, \Delta q_t, \pi_t^1, (d_t - p_t), (f_t - s_t)\right]' \tag{20}$$

where r_t is the value-weighted real return of the world stock markets deflated by the U.S. CPI; Δq_t is the change of a wealth-weighted real exchange-rate index relative to the U.S. dollar, weighted by the individual country's stock market wealth; π_t^1 is the U.S. inflation rate; $d_t - p_t$ is the wealth-weighted dividend yield of different countries' stock markets; and $f_t - s_t$ is the wealth-weighted forward premium.

Both the expected local currency equity premium and the expected foreign exchange excess return can be forecasted using the state variables. The forecasting equations for various assets' excess returns are the following:

$$er_{i,t+1} = \mu_i + M_i' z_t + \eta_{i,t+1} \tag{21}$$

where $er_{i,t+1}$ is the excess return of asset i, with $i = 1 \ldots 7$.[24]

Table 2 shows the results of these equations. For the equity return forecasting equation, the value of the χ^2 statistic with 5 degrees of freedom is 9.12, which indicates that the local equity returns are predictable at a statistical significance of 10%. The adjusted R^2 for the real return equation is a 5.2%, which is in the typical range of R^2 for the monthly forecasting equation. (Bekaert and Hodrick (1992) and Campbell (1996). The dividend yield ratio enters with a significant positive coefficient, while U.S. inflation has a negative coefficient that is significant. This pattern of strong statistical significance with low percentage predictability is to be expected in monthly data. In efficient markets, most of the observed return will be unexpected, unless economic agents are extremely risk averse. The adjusted R^2 for the real exchange-rate index change is 2.5%, which is also typical in this literature, although the joint predictability test shows that the real exchange rate depreciation is predictable at a 10% significance level. (Bekaert and Hodrick (1992) and Mark (1995)) The forward premium enters with a significant negative coefficient.

The most important features of the other forecasting equations are the coefficients of the variables on their own lags. Dividend yield and forward premium are highly serially correlated with coefficients of 0.976 and 0.940. There are also important off-diagonal terms indicating significant dynamics among inflation, dividend yield, and the forward premium.

[24] When $i = 1, 2, 3,$ and 4, $er_{i,t+1}$are the local equity excess returns. When $i = 5, 6,$ and 7, $er_{i,t+1}$ represents the excess foreign exchange returns on the Japan, Germany, and the U.K. money markets from the U.S. point of view.

Panel A of Table 2 reports the Cumby-Huizinga (1992) L tests for residual serial correlation of the first four and eight lags in each equation. For the first four lags, there is some sign of residual serial correlation for the log forward premium equation. Other than that, first order VAR seems to be adequate as a data-generating process.

Panel B of Table 2 reports excess return forecasting equations for the G4 countries. Aside from the U.K. excess stock return, all the asset returns are predictable at a 10% or lower significance level. The evidence for predictability of excess returns for the foreign exchange market investment is stronger than that for the excess returns on local equity markets.

Investors' surprises in expectation of future changes in world real returns and real exchange rates are proxied by the innovations in the forecasts of these variables. Table 3 shows the covariances and correlations of the innovations in the VAR. The correlations are in bold above the diagonal. There are large differences in innovation variances among variables. The innovation variance of the real stock return is about six times that of the innovation variance of the real exchange-rate change. Inflation variance is about one-fifth of the real exchange-rate index. The other innovation variances are much smaller. The innovations across different variables are also correlated. The innovation of the real stock return is negatively correlated to the U.S. local inflation, log dividend yield, and forward premium.

5.2 Innovations in Forecasts of Future Stock Returns and Real Exchange-Rate Depreciation

The remaining factors in the asset pricing framework are the innovation in the discounted expected future stock returns and real exchange-rate changes. To generate these innovations from the VAR, we define the five-dimensional indicator vector e1, whose first element is 1 and whose other elements are 0. Similarly, e2 generates the innovation in present value of the real exchange-rate components. Thus, the surprises on discounted expected future values of real market returns and on discounted expected future real currency depreciations are

$$
\begin{aligned}
& (E_{t+1} - E_t)\left(\sum_{k=1}^{\infty} \rho^k (r_{m,t+k+1} - \pi^1_{t+k+1})\right) \qquad (22) \\
= \; & e1' \sum_{k=1}^{\infty} \rho^k A^k \varepsilon_{t+k+1} \\
= \; & e1' \rho A (I - \rho A)^{-1} \varepsilon_{t+1} \\
= \; & \lambda'_{hm} \varepsilon_{t+1}
\end{aligned}
$$

Similarly, $(E_{t+1} - E_t)\left(\sum_{k=1}^{\infty} \rho^k \Delta q_{t+k+1}\right) = e2'\rho A(I - \rho A)^{-1}\varepsilon_{t+1} = \lambda'_{hq}\varepsilon_{t+1}$ The vectors λ'_{hm} and λ'_{hq} are defined in the last equality signs. Subscript h is used to identify this coefficient with the hedging demands of investors. The first component is a five-element vector λ'_{hm} that measures the forecasting power of each state variable toward future real market returns. When an element in λ'_{hm} is positive, it means that a positive shock to the state variable presents good news about future returns. The second component λ'_{hq} measures the forecasting power of each state variable toward future real exchange-rate changes. When an element in λ'_{hq} is positive, it means that a positive shock to the state variable implies future real depreciation of the U.S. dollar.

The asset pricing model (18) says that the expected return of an asset depends on the news of future real returns minus future real exchange-rate changes. Thus, $\lambda_h = \lambda_{hm} - \lambda_{hq}$ captures the total contribution of the forecasting ability of the state variables to explain required rates of return.

The difference in the variances of the innovations and the correlations among innovations make it difficult to interpret the estimation results for a VAR factor model unless the factors are orthogonalized and scaled in some way. To deal with this problem, Campbell (1996) employs Sims's (1980) triangular orthogonalization of the innovations. He also scales the innovations such that they have the same variance as the innovation to the real return. We adopt the same procedure.

The orthogonalized innovation in the equity return is unaffected, while the orthogonalized innovation in the real exchange-rate change is the component of real exchange-rate change that is orthogonal to the equity return. The orthogonalized innovation in inflation is the component that is orthogonal to both equity return and real exchange change. The orthogonalized innovation in the dividend yield is orthogonal to the three previous factors. The innovation to forward premium is the part of the risk that is orthogonal to the four previous factors. It is important to note that only part of the results in table 4 and the constrained prices of risk in Panel C of Table 5 depend on this orthogonalization. The rest of the results in the paper do not depend on this assumption.

Panel A of Table 4 shows the coefficients of the vector λ_h for the raw innovations and for the orthogonalized innovations, using $\rho = 0.9949$. Asymptotic standard errors are reported. Shocks to equity returns, inflation, and forward premium have negative effects on the innovation in discounted expected future returns, but the innovations in the real exchange-rate and dividend yield have positive effects. We then break up the future predictable component into its future stock component λ_{hm} and future real exchange depreciation component λ_{hq}. The joint predictability test rejects the hypothesis that the coefficients of λ_{hm} are jointly 0 with a p-value of 0.002, while the p-value for the coefficients of λ_{hq} is 0.829. Hence, the future stock returns are much more predictable than the future real exchange rate changes.

In Panel B, the coefficient of the orthogonalized innovation to returns is the percentage of an innovation in returns that is expected to be reversed in the long run. Campbell (1996) finds the coefficient for postwar stock returns to be -0.92, which is significant mean reversion. Hodrick, Ng, and Sengmueller (1999) find the coefficient for world real return to be -0.23. Here the coefficient for world real return is found to be a similar -0.21. Shocks to the real exchange-rate change have almost no autocorrelation with the shocks to the long-term real exchange-rate change. Interestingly, while the one-period real exchange-rate change and world stock return have a modest 0.34 positive correlation, shocks to the long-term stock return and real exchange-rate are highly correlated, with a coefficient of 0.82.

6 Estimation of the Asset Pricing Model

6.1 Simultaneous Estimation of VAR, Forecasting, and Asset Pricing Equations

To estimate the model with the correct standard errors, the state variable VAR equations, the forecasting equations, and the pricing equations are estimated simultaneously using GMM.

The state variable VAR equations are the following:

$$z_{t+1} = \alpha + Az_t + \varepsilon_{t+1} \tag{23}$$

with orthogonality conditions $E\left(\varepsilon_{t+1} \quad (1, z_t')'\right) = 0$.

The forecasting equations for various assets' excess returns are the following:

$$er_{t+1} = \mu + M'z_t + \eta_{t+1} \tag{24}$$

with orthogonality conditions $E\left(\eta_{t+1} \quad (1, z_t')'\right) = 0$.

The excess returns that the asset pricing equations seek to explain (as defined in (21)) are the U.S. excess equity return, the returns of foreign equity in excess of the U.S. interest rate, and the excess returns of foreign exchange.

The third block of equations comes from the fundamental asset pricing equations (18):

$$u_{i,t+1} = E_t(r_{i,t+1} - r_{f,t+1}) + \frac{V_{ii}}{2} - \gamma V_{im} - (1-\gamma)V_{iq} - V_{i\pi} - (\gamma - 1)(V_{ih} - V_{i,hq})$$

where $u_{i,t+1}$ represents the pricing errors.[25]

The orthogonality conditions for the asset pricing equations are

$$E(u_{t+1} \quad 1) = 0 \tag{25}$$

The five-variable VAR implies 30 orthogonality conditions, while the forecasting equation has 42 orthogonality conditions. The pricing equation implies the last seven, making a total of 79 orthogonality conditions.[26] In the first set of results, the unconditional implications of the conditional model are tested. We do not impose additional restrictions because all the orthogonality conditions are estimated simultaneously.

The conditional implications of the model can be tested using $E(u_{t+1} \quad (1, z_t')') = 0$. This would mean another 42 orthogonality conditions and would make the system too large to estimate simultaneously.

6.2 Coefficient of Relative Risk Aversion

Table 5 reports the 73 parameter estimates of the model associated with the VAR forecasting equations, the G4 stock market, foreign exchange market excess return forecasting equations,

[25]The empirical counterparts of the pricing equations can be expressed generally as

$$\begin{aligned} u_{i,t+1} \;=\; & (eL' + ef')Mz_t + \frac{1}{2}(eL'\eta_{t+1})^2 + \frac{1}{2}(ef'\eta_{t+1})^2 \\ & + eL'\eta_{t+1}ef'\eta_{t+1} - \gamma[(eL' + ef')\eta_{t+1}e1'\varepsilon_{t+1}] \\ & -(1-\gamma)\left((eL' + ef')\eta_{t+1}e2'\varepsilon_{t+1}) - ((eL' + ef')\eta_{t+1}e3'\varepsilon_{t+1}\right) \\ & -(\gamma - 1)((eL' + ef')\eta_{t+1}\lambda'_{hm}\varepsilon_{t+1}) - ((eL' + ef')\eta_{t+1}\lambda'_{hq}\varepsilon_{t+1})) \end{aligned}$$

where eL' refers to the row corresponding to the local equity return of country j, and ef' refers to the row corresponding to the foreign exchange-rate return of country i. Japan, for example, has $eL' = e2'$ which selects the local equity premium for Japan and $ef' = e5'$ which selects the foreign exchange excess return for Japan. The foreign exchange returns correspond to the case when $eL' = 0$ and $ef' = e5'$.

[26]For efficiency, the entire system of 79 orthogonality conditions was estimated simultaneously. To investigate whether or not this procedure has introduced noise, I also estimate the system in two stages. The state variables and forecasting equations are estimated in the first stage as a just identified system. The innovations to the state variables and to the assets are then used in the pricing equations. The standard errors are then corrected as outlined in Ogaki (1993). The result is essentially the same.

and the asset pricing equations, as well as the constrained prices of risks. The coefficients on the VAR forecasting equations and excess return forecasting equations are not significantly different from the estimates in Table 1. The important parameter is the coefficient of relative risk aversion γ, estimated to be 5.99 with a standard error of 3.62. The estimate is quite similar to Hodrick, Ng, and Sengmueller's (1999) finding of 5.06 for G7 equity returns.

The overidentifying restictions of the model are not rejected at any standard level of significance, with a $\chi^2(6)$ statistic of 2.26. It cannot be rejected that the international dynamic asset pricing model thus explains the cross-section of the G4 equity and foreign exchange returns.

6.3 Estimated Prices of Risks

Equation (18) can be rewritten in terms of a constrained multi-factor asset pricing model:

$$\begin{aligned} E_t(r_{i,t+1} - r_{f,t+1}) + \frac{V_{ii}}{2} &= (\gamma + (\gamma - 1)\lambda_{h1})\, V_{i1} + \\ &\quad ((1-\gamma) - (\gamma - 1)\lambda_{h2})\, V_{i,2} + (1 + (\gamma - 1)\lambda_{h3})V_{i,3} \\ &\quad + \sum_{k=4}^{5} (\gamma - 1)\lambda_{hk} V_{ik} \end{aligned} \tag{26}$$

The price of risk of a factor depends on the factor's covariance with the current market returns or real exchange returns, and with expected returns in the future. The price of risk that arises from the traditional covariance of an asset's return with the market return is $\gamma + (\gamma - 1)\lambda_{h1}$, where λ_{hk} represents the kth element of λ_h. The other prices of risk are evident from equation (26). Thus, this model provides a clear link between the coefficient of relative risk aversion γ and the prices of risks that arise from covariances between asset returns and various factors.

The prices of risks are given in Panel C of Table 5 for the orthogonalized innovations. The covariance of a return with the return on the market portfolio has a large positive and significant coefficient, which justifies the important role of this variable in the traditional CAPM. The change in real exchange-rate index has a large and negative coefficient, although it is not quite statistically significant. The negative coefficient means that the asset that hedges against real exchange-rate depreciation commands a lower required rate of return. Like Jorion (1991), who finds that exchange rate risk is not priced in the U.S. stock market, we also do not find important cross-sectional real-exchange risk effect in these international assets. This finding is also consistent with Dumas and Solnik (1995), who cannot reject that the unconditional CAPM perform just as well as international CAPM. The prices of other covariance risks are an order of magnitude smaller than these coefficients and have standard errors larger than the coefficients.

6.4 Tests of Restricted Models

There are several conditions that allow the predictions of the dynamic international CAPM to collapse to the predictions of the CAPM, DCAPM, and ICAPM. This section investigates whether we can reject these restrictions or not.

6.4.1 Can the DICAPM be reduced to the ICAPM?

The dynamic, international model reduces to Adler and Dumas's (1983) static, international CAPM, when the covariances with intertemporal hedging factors equal 0. When market returns and exchange-rate changes are not predictable, or when they are not correlated with the assets to be priced, then the intertemporal hedging components drop out of the asset pricing equation. A GMM likelihood ratio test of the hypothesis $V_{ihm} - V_{ihq} = 0$ involves estimation of the model under this restriction with the same weighting matrix as is used without the restriction. The difference in the values of the criterion function is a $\chi^2(7) = 98.904$, with a p-value less than 0.0001, indicating strong evidence that the covariances with the hedge portfolios are important in pricing the cross-section of asset returns.

When there are perfect cross-sectional correlations between some factors, the dynamic international CAPM would also reduce into other CAPMs. The international CAPM holds when each intertemporal hedging component of expected return $\gamma(V_{ihm} - V_{ihq})$ is proportional to the international CAPM component $\gamma V_{im} + (1-\gamma)V_{iq} + V_{i\pi}$ with the same factor of proportionality. The test of this restriction is a $\chi^2(6) = 4.099$, implying a p-value of 0.663. Thus, the international CAPM would provide a valid proxy for the risks involved.

6.4.2 Can the DICAPM be reduced to the DCAPM?

The dynamic, international model becomes a dynamic CAPM if there is no PPP deviation presently or in the future. This means that $V_{iq} + V_{ihq} = 0$. The test of this restriction yields a $\chi^2(7) = 105.253$, implying a p-value less than 0.0001. This implies that one should not apply Campbell's (1996) dynamic CAPM to international asset returns without taking PPP deviations into account. A proportionality test of DICAPM vs. the dynamic CAPM yields a $\chi^2(6) = 3.750$,with a p-value of 0.710, which implies that the Dynamic CAPM cannot be rejected either.

6.4.3 Can the DICAPM be reduced to the CAPM?

The dynamic international model reduces to the static CAPM if PPP holds and the covariances with the intertemporal hedging factors equal 0. This is clearly rejected because each case has previously been rejected. An alternative way for the model to collapse into CAPM is if $\gamma = 1$. The expected returns are then determined only by the covariance of the asset with the market portfolio. A GMM likelihood ratio test of the hypothesis that $\gamma = 1$ involves estimation of the model under this restriction with the same weighting matrix as is used without the restriction. The difference in the values of the criterion function is a $\chi^2(1) = 2.803$, which implies a p-value of 0.0941, indicating it is unlikely that $\gamma = 1$.

The static CAPM would describe the data well when $\alpha(\gamma V_{im})$ is equal to $(1-\gamma)V_{iq} + V_{i\pi} + \gamma(V_{ihm} - V_{ihq})$. The test of this restriction yields a $\chi^2(6) = 3.507$, with a p-value of 0.743, indicating that CAPM is not a bad proxy either. Hence we are unable to reject the hypothesis that for these seven stock and foreign exchange investments, the DICAPM collapses into these other models, in particular CAPM, because these assets have close cross-sectional correlations.

6.5 Additional CAPM Test

Our inability to reject the restrictions of the CAPM suggest that the traditional CAPM may be an adequate representation of expected returns in the cross section of stock and foreign exchange portfolios in the sense of having comparable pricing errors. To investigate this conjecture, we set up the following system of equations:

$$\begin{aligned} r_{m,t+1} &= \mu_m + \varepsilon_{m,t+1} \\ r_{i,t+1} - r_{f,t+1} &= \mu_i + \eta_{i,t+1} \\ u_{it+1} &= E_t(r_{i,t+1} - r_{f,t+1}) + \frac{V_{ii}}{2} - \gamma V_{im} \end{aligned} \tag{27}$$

for i = 1,..., 7.[27] The system is estimated by making each of the error terms orthogonal to a constant. Since there are nine parameters in the system of equations and fifteen orthogonality conditions, the test of the overidentifying restrictions is a $\chi^2(6)$.

This version of the CAPM is estimated in Panel A of Table 6 for the stock and foreign exchange assets in two samples. The first, in Panel A1, is our base sample of 1978:07 to 1998:04.

[27]The empirical counterparts of the pricing equations are

$$\begin{aligned} u_{i,t+1} &= (eL' + ef')Mz_t + \frac{1}{2}(eL'\eta_{t+1})^2 + \frac{1}{2}(ef'\eta_{t+1})^2 \\ &\quad + eL'\eta_{t+1}ef'\eta_{t+1} - \gamma[(eL' + ef')\eta_{t+1}e1'\varepsilon_{t+1}] \end{aligned}$$

The second, in Panel A2, is a sub-sample from 1978:07 to 1995:12, which is the overlapping time period between our sample and Fama and French (1998) sample of 1975:01 to 1995:12. The estimated value of γ for the full sample is 3.295, with a standard error of 1.758. The $\chi^2(6)$ statistic that tests the overidentifying restrictions of the model is 3.779, which corresponds to a p-value of 0.707. Hence, the CAPM is not rejected by the data. The pricing errors of the CAPM are given in Panel B of Table 6. The largest pricing error is only 0.035 percent per month. In the sub-sample, the average returns are slightly lower for the stocks and slightly higher for the foreign exchange assets, but the inference is similar.

The CAPM seems, thus, to capture the cross-section of asset returns very well. Figure 1 provides some intuition by plotting the expected returns of assets (from Column 2, Panel B1, Table 6) against the covariances with the world market returns (from Column 3 of the same panel). Foreign exchange assets provide lower average returns than the stock portfolios, and they also have lower covariances with the market returns than the stocks. As a result, the stock market factor explains a good part of the broad cross-section of returns for these assets. Combined with the statistical evidence documented earlier that V_{im} is proportional to the rest of the factors, this suggests that in a cross-sectional sense the market portfolio is a relatively good proxy for the other risk factors.

However, predictability of returns is generally inconsistent with the static CAPM. Only if γ=1, or if V_{ih} is proportional to V_{im}, does Campbell's (1996) theory collapse to a conditional CAPM. If the static CAPM is true, the pricing errors should not be predictable with conditioning information. We test this predictability restriction by examining the additional orthogonality conditions that the asset-pricing errors from the CAPM model should be orthogonal to z_t. Since there are seven assets, five elements in z_t, and no additional parameters to estimate, we can calculate a $\chi^2(35)$ statistic directly from the value of the GMM objective function for these 35 orthogonality conditions. The value of this statistic is 73.256, with a p-value of 0.0002. This indicates considerable evidence against a static CAPM.

We did not require the pricing errors of the dynamic international model to be orthogonal to the z_t information set. When we calculate the analogous $\chi^2(35)$ statistic for these restrictions on the dynamic model, we find a test statistic of 150.72, with a p-value smaller than 0.0000. Thus, the dynamic international model also fails this test of dynamic asset pricing.

6.6 Explaining the Cross-section of Asset Returns

In this subsection, we analyze the cross-section of asset returns of the Dynamic International CAPM. Table 7 analyzes the sources of risks and the pricing errors. The average adjusted excess rates of return for the G4 equity and foreign exchange assets are listed. The average adjusted return is the average return of the equity or foreign exchange assets, adjusted by half the conditional variances because log returns instead of gross returns are used. For the full sample, the first column in panel A1 of Table 7 show the average risk premium. Since the local equity excess returns and foreign exchange excess returns are forecasted independently, it is possible to separate excess equity returns from the U.S. perspective into three components: equity, foreign exchange, and their covariance.[28] The next three columns in panel A break down the average adjusted returns into different components. The second column gives the adjusted excess returns due to market risk due to market risk (i.e., time average of local returns minus local risk-free rate plus half the variances). The third column shows the adjusted excess returns due to the foreign exchange market (i.e., time average of foreign exchange returns minus risk-free rates plus half the variances). The fourth column lists the covariance between the local equity and foreign exchange returns.

The breakdown of average returns shows that average stock excess returns are orders of magnitude larger than average excess returns in the foreign exchange market. Foreign exchange returns in Germany, for example, are almost forty times less than average stock returns.[29] The subsample in panel A2 shows similar pattern. The dynamic pricing model predicts that the average adjusted excess return contains covariance risk with the world market portfolio $\gamma V_{i,m}$, covariance risk with real currency depreciation $(1-\gamma)V_{i,q}$, covariance risk with inflation $V_{i,\pi}$, and covariance risk with discounted expected future real returns $(\gamma - 1)V_{ihm}$ and future real exchange-rate changes $(1-\gamma)V_{i,hq}$. This breakdown is shown in panels B1 and B2 of Table 7.

While the foreign exchange assets have average returns of almost 0, it is not because there is no market or exchange-rate risk premiums. On the contrary, the market and exchange-rate risk premiums are equally substantial, but carry opposite signs and cancel each other. The market risk premiums are positive, but are counteracted by the negative risk premium from the exchange-rate risk. Since $\gamma - 1$ is found to be negative, those assets whose dollar returns are higher when the dollar depreciates would provide hedging values. The result implies that the foreign exchange assets command risk premia due to covariance with the real market return, but they hedge against exchange-rate risk and hence carry a lower risk premium. Because the inflation and intertemporal hedging risk premiums are orders of magnitude smaller, the two

[28] Average adjusted returns for assets= $\frac{1}{T-1}\sum_{t=1}^{T-1}\left((r^j_{j,t+1} - r^j_{fj,t+1}) + \frac{1}{2}(eL'\eta_{i,t+1})^2\right)$ $+\frac{1}{T-1}\sum_{t=1}^{T-1}\left(\left(\Delta s_{jt+1} + r^j_{f,j,t+1} - r^1_{f,1,t+1}\right) + \frac{1}{2}(ef'\eta_{i,t+1})^2\right) + \frac{1}{T-1}\sum_{t=1}^{T-1}\left(eL'\eta_{i,t+1}ef'\eta_{i,t+1}\right)$

[29] The covariances between the stock returns and the foreign exchange returns are also much less than the stock market returns.

counteracting effects result in small observed average returns on the foreign exchange market. A German foreign exchange asset, for example, has a risk premium of 0.180% per month coming from its covariance with the world market returns. However, because of its covariance with real depreciation of the U.S. dollar, the German foreign exchange risk premium is reduced by 0.198% per month, leading to an observed return of 0.015%.

In general, for all assets, the pricing errors are quite small in both samples. In the full sample, the pricing errors vary from -0.03% per month for the Japanese equity market to -0.002% for the UK foreign exchange market. In the subsample, the pricing errors range from -0.016 for the German equity market to 0.003 for the Japenese foreign exchange market.

For stocks, the market risk components are uniformly larger in magnitude than the other components and account for large part of the observed average adjusted returns. This justifies the important roles that market covariance risks play in the CAPM. At the same time, V_{iq} is negative for all assets except the U.S. equity market, which shows that all foreign assets have lower required rates of return since they hedge against U.S. currency real depreciation. In the U.S. case, covariances with exchange rates account for a very small part of the expected returns. For other countries, however, covariances with exchange rates are quite important. For example, in the full sample, the covariance with exchange-rate risk helps lower the Japanese stock expected return by 0.291 to 0.571% per month.

The intertemporal hedging components are important for stock returns. In the United States, for example, the intertemporal hedging for stock return is considerable, lowering the expected returns from 0.755 to 0.624%. The intertemporal hedging consideration is even larger than the exchange-rate consideration. In Japan, the intertemporal hedging component for future stock returns is also important, lowering the expected return by 0.282 to 0.571%. The United Kingdom and Germany also experience a sizeable lowering of the expected return for the intertemporal hedging component.

In particular, the intertemporal hedging effects are of the same order of magnitude as the exchange-rate risk. This suggests that Dumas and Solnik's (1995) conjecture that exchange-risk factors adequately proxy for the intertemporal hedging factors is not supported by the data. These findings are similar in the sub-sample.

For the foreign exchange assets, the intertemporal hedging demand components are much smaller in magnitude than the market risk and exchange-rate risk components. In both samples, the intertemporal hedging components for future market returns are positive for the three foreign exchange assets and negative for the foreign stocks. The hedging components for the discounted sum of future real exchange-rate changes are much less than other components.

Except for the Japanese market, they are slightly negative.

Finally, there is a strong cross-sectional correlation between $\gamma V_{i,m}$ and the remaining factors $(1-\gamma)V_{iq} + V_{i\pi} + (\gamma-1)(V_{ih} - V_{i,hq})$. Out of these seven assets, large positive covariance with the market tends to associate with large negative covariance with the other risk factors. Figure 2 illustrates this by plotting Column 3, Panel B1 in table 7 against the sum of the remaining factors. The cross-sectional relationship provides intuition for the earlier result that we cannot reject the exchange-rate and that intertemporal factors are proportional to the market factor.

7 High Book-to-Market Returns

Fama and French (1996) argue that the static CAPM is insufficient. In domestic U.S. asset pricing, they show that expected returns depend on sensitivities of returns to three factors. In international asset pricing, Fama and French (1998) use two factors: the excess return on the world market portfolio and the difference in returns between the world high and low book-to-market portfolios (i.e. the high-minus-low factor).

The way in which Fama and French (1998) demonstrate the inadequacy of the static CAPM is by constructing portfolios of stocks for each country based on book-to-market ratios. They find that portfolios with high book-to-market (HBM) ratios are particularly troublesome for the CAPM to price. The average returns on high book-to-market firms are significantly higher than those predicted by the CAPM. Our version of these results is presented in Table 8, which excludes Canada because of data availability. The sample period for this estimation is from 1978:07 to 1995:12. Note that the average adjusted returns on the HBM portfolios are considerably higher than the returns on the value-weighted MSCI market portfolios, except in the case of Italy. Table 8 indicates the pricing errors from the CAPM for the HBM portfolios are much larger than for the country portfolios. The pricing errors range from 0.111 for Italian HBM portfolio to 0.577 for French portfolio. The estimation uses the estimated value of γ from the analogous sample for the CAPM estimation with the country market portfolios, and the mean parameters for the HBM return equations are estimated prior to examining the pricing equations.

Table 9 examines whether the dynamic model can successfully price the HBM country portfolios. The answer here, too, is negative. The pricing errors from the dynamic model are comparable to the pricing errors from the CAPM. They range from 0.093 for Italian HBM portfolio to 0.609 for French HBM portfolio.

8 Conclusion

This paper develops the implications of stock and foreign exchange return predictability for cross-sectional international asset pricing. Until now, the literature has addressed the foreign exchange risk and intertemporal hedging separately. The dynamic international model derived in this paper nests the standard CAPM, the international CAPM, and the dynamic CAPM. As a result, we can examine the roles of the exchange risk factors and the intertemporal hedging factors in explaining the cross sections of stock and foreign-exchange returns. The model explains the dollar-denominated excess returns on the stock and foreign exchange assets of the G4 countries quite well, but the static CAPM does also. The exchange risk and intertemporal hedging terms are non-zero, yet we are unable to reject that they are proportional to covariances with the market portfolio, in which case they have no direct role in the cross-sectional international asset pricing.[30] Because the static CAPM is inconsistent with return predictability in the data, our specification tests demonstrate that instrumental variables can predict the asset-pricing errors from the static CAPM. Unfortunately, these same specification tests reveal that the dynamic international model fails along the same dimensions. Neither model can price the high book-to-market country portfolios that Fama and French (1998) construct.

Empirical researchers have tried to provide the missing theoretical link between the intertemporal predictability of international equity and foreign exchange returns and the cross-section of asset returns. Ferson and Harvey (1993) develop an eclectic, empirical approach. They develop conditional beta-pricing models in which expected returns equal the sum of several betas times their associated prices of risks. They allow the betas to vary over time depending on local information, but they require the prices of risks to vary only with global information. They motivate using a trade-weighted exchange-rate index as a global economic factor. The problem with this approach is that it is not tightly linked to theory.

Our model serves to provide a theoretical basis for using various empirical factors. These factors are present either because of the existence of purchasing power parity (PPP) deviation or because their time series behaviors show that they help to forecast future investment opportunities. Also, based on the model, we can state the necessary assumptions to bundle different countries' exchange-rate risks into the aggregate exchange-rate index. The assumptions are quite restrictive and that may be part of the reason why the model does not perform better.

Fama and French (1998) present evidence that the static CAPM is insufficient, and they

[30] Hodrick, Ng and Sengmueller (2000) and Campbell (1996) reach similar conclusions with the intertemporal hedging of stock returns.

present a two-factor model that successfully prices the problematic returns on high book-to-market country portfolios. It is plausible that a risk-based theoretical explanation for the presence of the second risk factor exists. As Fama and French (1998) note, their tests do not cleanly identify the consumption-investment state variables that would link their analysis to intertemporal asset-pricing theories. Campbell (1996) provides such a framework. Implementing Campbell's model internationally, Hodrick, Ng and Sengmueller (2000) report that the dynamic model does not explain the high book-to-market country portfolios any better than the CAPM. As Hodrick, Ng and Sengmueller (2000) suggest, the failure of the model in explaining international equity returns may potentially be due to omission of exchange rate risk factors. Here, we find that adding exchange-rate risk and intertemporal hedging factor does not improve the explanatory power over the static CAPM, and hence does not substitute for the second factor proposed in Fama and French (1998).

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Appendix A: Deriving the Euler equations

We suppress the country j superscript (except for the returns and real exchange rates) for this appendix. It should be noted that all the parameters β, θ, σ and γ are country-j specific, and that real consumption is also specific to country j. For this appendix, we use the notations $v(X_{t+1}) = E(X_{t+1} - E_t(X_{t+1}))^2$ and $c(X_{t+1}, Y_{t+1}) = E(X_{t+1} - E_t(X_{t+1}))(Y_{t+1} - E_t(Y_{t+1}))$

The Euler equation (7), as applied to the market portfolio p, yields

$$1 = E_t \left(\left(\beta \left(\frac{C_{t+1}}{C_t} \right)^{-\frac{1}{\sigma}} \right)^{\theta} \left(\frac{1}{\frac{P_t^1}{P_{t+1}^1} \frac{Q_t}{Q_{t+1}} R_{p,t+1}^1} \right)^{-\theta} \right) \tag{28}$$

Take the log of (28), assuming that asset returns, inflation, exchange rates, and consumption are jointly conditionally homoskedastic and log normally distributed,

$$\begin{aligned} 0 \;=\; & \theta \log \beta - \frac{\theta}{\sigma} E_t \Delta c_{t+1} + \theta E_t (r_{p,t+1}^1 - \pi_{t+1}^1 - \Delta q_{t+1}) \\ & + \frac{1}{2} \left(\left(\frac{\theta}{\sigma} \right)^2 v(\Delta c_{t+1}) + \theta^2 v(r_{p,t+1}^1 - \pi_{t+1}^1 - \Delta q_{t+1}) \right) \\ & - (\frac{\theta^2}{\sigma}) c(\Delta c_{t+1}, r_{p,t+1} - \pi_{t+1}^1 - \Delta q_{t+1}) \end{aligned} \tag{29}$$

Since asset returns are conditionally homoskedastic and log normally distributed, equation (29) may be written as (9):

$$E_t(\Delta c_{t+1}) = \mu_p + \sigma E_t (r_{p,t+1}^1 - \pi_{t+1}^1 - \Delta q_{t+1})$$

where $\mu_p = \sigma \log \beta + \frac{1}{2} \left(\frac{\theta}{\sigma} \right) v \left(\Delta c_{t+1} - \sigma (r_{p,t+1}^1 - \pi_{t+1}^1 - \Delta q_{t+1}) \right)$ is a variance term that measures the uncertainty of consumption relative to the real market returns.

Again assuming joint lognormality, the log version of the Euler equation (7) looks like this:

$$\begin{aligned} 0 &= \theta \log \beta - \frac{\theta}{\sigma} E_t \Delta c_{t+1} + (\theta - 1) E_t (r^1_{p,t+1} - \pi^1_{t+1} - \Delta q_{t+1}) \\ &\quad + E_t (r^1_{p,t+1} - \pi^1_{t+1} - \Delta q_{t+1}) + \frac{1}{2} \left(\frac{\theta}{\sigma}\right)^2 v(\Delta c_{t+1}) + \frac{1}{2} (\theta - 1)^2 v(r^1_{p,t+1} - \pi^1_{t+1} - \Delta q_{t+1}) \\ &\quad + \frac{1}{2} v(r^1_{p,t+1} - \pi^1_{t+1} - \Delta q_{t+1}) - \left(\frac{\theta(\theta-1)}{\sigma}\right) c(\Delta c_{t+1}, r^1_{p,t+1} - \pi^1_{t+1} - \Delta q_{t+1}) \\ &\quad - \frac{\theta}{\sigma} c(\Delta c_{t+1}, r^1_{p,t+1} - \pi^1_{t+1} - \Delta q_{t+1}) + (\theta - 1) c(r_{i,t+1} - \pi^1_{t+1}, r^1_{p,t+1} - \pi^1_{t+1} - \Delta q_{t+1}) \end{aligned} \tag{30}$$

Subtracting the nominally risk-free rate version of (30) from equation (30) yields the Euler equation:

$$\begin{aligned} 0 &= E_t (r^1_{i,t+1} - r^1_{f1,t+1}) + \frac{1}{2} v(r^1_{i,t+1}) - c(r^1_{i,t+1} - r^1_{f1,t+1}, \pi^1_{t+1} + \Delta q_{t+1}) \\ &\quad - \frac{\theta}{\sigma} c(\Delta c_{t+1}, r^1_{i,t+1} - r^1_{f1,t+1}) \\ &\quad + (\theta - 1) c(r^1_{i,t+1} - r^1_{f1,t+1}, r^1_{p,t+1} - \pi^1_{t+1} - \Delta q_{t+1}) \end{aligned} \tag{31}$$

which reduces to (10).

Appendix B: Aggregating Across Different Countries

The aggregation procedures are summarized in several steps. First, investors' asset demands for different securities are deduced from the Euler equation (13). Then these demands for the securities are summed. The aggregate expected return comes from the aggregate demand. This appendix illustrates the procedure with a two-country (countries 1 and 2) example and two assets, but the G-country, N-asset extension is straightforward. The assumptions are listed in (14), (15), (16), and (17). For this appendix, we use the notations $v(X_{t+1}) = E(X_{t+1} - E_t(X_{t+1}))^2$ and $c(X_{t+1}, Y_{t+1}) = E(X_{t+1} - E_t(X_{t+1}))(Y_{t+1} - E_t(Y_{t+1}))$.

Country 2's investor has the following Euler equation, in reference currency 1:

$$E_{t,2}(r^1_{i,t+1} - r^1_{f,t+1}) + \frac{V_{ii,2}}{2} = \gamma V_{ip2} + (1-\gamma) V_{i,q2} + V_{i\pi^1} + (\gamma - 1)(V_{ihp2} - V_{i,hq2}) \tag{32}$$

where $V_{i,p2}$ is $c(r^1_{i,t+1}, r^1_{p2,t+1} - \pi^1_{t+1})$, the covariance of return i with real returns on country 2's portfolio, expressed in the reference currency in real terms; $V_{i,q2}$ is $c(r^1_{i,t+1}, \Delta q_{2,t+1})$, the covariance of return i with change in the real exchange rate; V_{i,π^1} is $c(r^1_{i,t+1}, \pi^1_{t+1})$; $\Delta q_{2,t+1}$ is the change in real exchange rate of country 2 versus the reference currency; and $V_{i,hp2} - V_{i,hq2}$ is $c\left(r^1_{i,t+1}, (E_{t+1} - E_t) \sum_{k=1}^{\infty} \rho^k \left(r^1_{p2,t+k+1} - \pi^1_{t+k+1} - \Delta q_{2,t+k+1}\right)\right)$, covariance of return i with future real returns where real returns depend on the future nominal returns, inflation, and real exchange-rate changes.

Country 1's investor has the Euler equation for security i, in reference currency 1:

$$E_{t,1}(r^1_{i,t+1} - r^1_{f,t+1}) + \frac{V_{ii,1}}{2} = \gamma V_{ip1} + (1-\gamma)V_{i,q1} + V_{i\pi^1} + (\gamma - 1)(V_{ihp1} - V_{i,hq1}) \qquad (33)$$

where the definitions are similar to country 2's except that Δq_1 is 0 because in this case the investor's country coincides with the reference currency country and $V_{i,q_1} = V_{i,hq1} = 0$.

Equation (32) can be expressed as:

$$\begin{aligned} & E_{t,2}(r^1_{i,t+1} - r^1_{f,t+1}) + \frac{V_{ii,2}}{2} && (34) \\ = \; & \gamma c(r^1_{i,t+1}, \sum_{n=1}^{N} w_{n2,t+1} r_{n2,t+1}) + (1-\gamma)(V_{i,q_2} + V_{i\pi^1}) \\ & +(\gamma-1)c(r^1_{i,t+1}, \sum_{k=1}^{\infty} \rho^k \sum_{n=1}^{N} w_{n2,t+1} r_{n2,t+k+1}) + (\gamma-1)(V_{ih\pi^1} - V_{i,hq_2}) \end{aligned}$$

where the country 2 investor's portfolio return $r_{p2,t+1}$ is substituted by $\sum_{n=1}^{2} w_{n2} r_{n2,t+1}$, the portfolio weights times asset returns, and $V_{i,h\pi^1}$ is $c\left(r^1_{i,t+1}, \sum_{k=1}^{\infty} \rho^k \pi^1_{t+k+1}\right)$. Note that assumptions (14) and (15) allow γ and ρ to be the same across different countries.

By law of iterated expectation,

$$\begin{aligned} & E_{t,2}(r_{i,t+1} - r_{f,t+1}) + \frac{V_{ii,2}}{2} && (35) \\ & -(1-\gamma)(V_{i,q_2} + V_{i\pi^1} - V_{ih\pi^1} + V_{i,hq_2}) \\ = \; & c\left(r_{i,t+1} - r_{f,t+1}, \gamma \sum_{n=1}^{2} w_{n2,t} r_{n2,t+1} + (\gamma-1) \sum_{k=1}^{\infty} \rho^k \sum_{n=1}^{2} w_{n2,t+k} r_{n2,t+k+1}\right) \\ = \; & c\left(r_{i,t+1} - r_{f,t+1}, \gamma \sum_{n=1}^{2} w_{n2,t} r_{n2,t+1} + (\gamma-1) \sum_{k=1}^{\infty} \rho^k E_t\left(\sum_{n=1}^{2} w_{n2,t+k}\left(E_{t+k} r_{n2,t+k+1}\right)\right)\right) \end{aligned}$$

Assumption (16) says future portfolio weights stay the same. Hence,

$$\begin{aligned} & E_{t,2}(r_{i,t+1} - r_{f,t+1}) + \frac{V_{ii,2}}{2} && (36) \\ & -(1-\gamma)(V_{i,q_2} + V_{i\pi^1} - V_{ih\pi^1} + V_{i,hq_2}) \end{aligned}$$

$$
\begin{aligned}
&= \sum_{n=1}^{2} w_{n2} c(r_{i,t+1} - r_{f,t+1}, \gamma r_{n2,t+1} + (\gamma - 1)\sum_{k=1}^{\infty} \rho^k r_{n2,t+k+1}) \\
&= (\gamma(\sigma_{i1}\sigma_{i2}) + (\gamma - 1)(\sigma_{i1h}\sigma_{i2h}))\,(w_{12}w_{22})'
\end{aligned}
$$

where $\sigma_{in} = c(r_i, r_n)$, the covariance of asset i's excess return with asset n's returns;

$- = [\sigma_{in}]$, is the covariance matrix of the assets' returns;

$\sigma_{inh} = c(r_i, \sum_{k=1}^{\infty} \rho^k r_{n,t+k+1})$, the covariance of asset i's returns with future asset n's returns;

$\tilde{-} = [\sigma_{inh}]$ is the covariance matrix of assets' returns with the future returns. Both $-$ and $\tilde{-}$ are assumed to be time-invarying and invertible.

Note that in the case of static international CAPM, the intertemporal hedging terms do not exist, and hence the (16) is not needed.

Country 2's investor portfolio weights for various assets are as follows:

$$
\begin{aligned}
&\begin{pmatrix} w_{12,t} \\ w_{22,t} \end{pmatrix} \qquad (37) \\
&= \begin{pmatrix} v_{11} & v_{12} \\ v_{21} & v_{22} \end{pmatrix} \begin{pmatrix} E_{t,2}(r_{1,t+1} - r_{f,t+1}) + \frac{V_{11,2}}{2} - (1-\gamma)(V_{1,q_2} + V_{1\pi^1} - V_{1h\pi^1} + V_{1,hq_2}) \\ E_{t,2}(r_{2,t+1} - r_{f,t+1}) + \frac{V_{22,2}}{2} - (1-\gamma)(V_{2,q_2} + V_{2\pi^1} - V_{2h\pi^1} + V_{2,hq_2}) \end{pmatrix}
\end{aligned}
$$

where $V = \begin{pmatrix} v_{11} & v_{12} \\ v_{21} & v_{22} \end{pmatrix} = \left(\gamma - + (\gamma - 1)\tilde{-}\right)^{-1}$. The conditional covariance of the portfolio weights and expected returns is a constant V, which verifies the conjecture earlier.

The world's demand for security 1 equals the sum of investor n's portfolio weight times investor n's wealth, $W_{1,t}$. The world demand thus equals $w_{11,t}W_{1,t} + w_{12,t}W_{2,t}$.

The world's supply for security 1 equals the share of world wealth on security 1 times the total world wealth $w_{1,t}^w W_t$ where $W_t = W_{1,t} + W_{2,t}$. Assuming that equilibrium is attained at all times, demand equals supply, that is, $w_{11,t}W_{1,t} + w_{12,t}W_{2,t} = w_{1,t}^w W_t$. If we multiply (32) by the weight $W_{1,t}$, and (33) by its weight $W_{2,t}$, we can sum up the demand for the two securities:

$$
\begin{aligned}
&\begin{pmatrix} w_{1,t}^w \\ w_{2,t}^w \end{pmatrix} W_t \qquad (38) \\
&= \begin{pmatrix} v_{11} & v_{12} \\ v_{21} & v_{22} \end{pmatrix} *
\end{aligned}
$$

$$\begin{pmatrix} \sum_{j=1}^{2} W_{j,t} \left(E_{t,j}(r_{1,t+1} - r_{f,t+1}) + \frac{V_{11,j}}{2} \right) - (1-\gamma) \left(\sum_{j=1}^{2} W_{j,t}(V_{1\pi^1} - V_{1h\pi^1} + V_{1,q_j} + V_{1,hqj}) \right) \\ \sum_{j=1}^{2} W_{j,t} \left(E_{t,j}(r_{2,t+1} - r_{f,t+1}) + \frac{V_{22,j}}{2} \right) - (1-\gamma) \left(\sum_{j=1}^{2} W_{j,t}(V_{2\pi^1} - V_{2h\pi^1} + V_{2,qj} + V_{2,hqj}) \right) \end{pmatrix}$$

This defines the world aggregate demand for security 1 and 2.

Multiplying both sides by V and regrouping terms,

$$\begin{pmatrix} \sum_{j=1}^{2} \left(\frac{W_j}{W}\right)_t \left(E_{t,j}(r_{1,t+1} - r_{f,t+1}) + \frac{V_{11,j}}{2} \right) \\ \sum_{j=1}^{2} \left(\frac{W_j}{W}\right)_t \left(E_{t,j}(r_{2,t+1} - r_{f,t+1}) + \frac{V_{22,j}}{2} \right) \end{pmatrix} \tag{39}$$

$$= \left(\gamma\text{-} \;+ (\gamma-1)\text{-}^{\sim}\right) \begin{pmatrix} w_{1t}^{w} \\ w_{2t}^{w} \end{pmatrix} + \begin{pmatrix} (1-\gamma)(V_{1\pi^1} - V_{1h\pi^1}) + (1-\gamma) \sum_{j=1}^{2} \left(\frac{W_j}{W}\right)_t (V_{1,qj} + V_{1,hqj}) \\ (1-\gamma)(V_{2\pi^1} - V_{2h\pi^1}) + (1-\gamma) \sum_{j=1}^{2} \left(\frac{W_j}{W}\right)_t (V_{2,qj} + V_{2,hqj}) \end{pmatrix}$$

These are the aggregate required rates of return for assets 1 and 2.

$$\begin{pmatrix} E_t(r_{1,t+1} - r_{f,t+1}) + \frac{V_{11}}{2} \\ E_t(r_{2,t+1} - r_{f,t+1}) + \frac{V_{22}}{2} \end{pmatrix} \tag{40}$$

$$= \left(\gamma\text{-} \;+ (\gamma-1)\text{-}^{\sim}\right) \begin{pmatrix} w_{1t}^{w} \\ w_{2t}^{w} \end{pmatrix} + \begin{pmatrix} (1-\gamma)(V_{1\pi^1} - V_{1h\pi^1}) + (1-\gamma) \sum_{j=1}^{2} \left(\frac{W_j}{W}\right)_t (V_{1,qj} + V_{1,hqj}) \\ (1-\gamma)(V_{2\pi^1} - V_{2h\pi^1}) + (1-\gamma) \sum_{j=1}^{2} \left(\frac{W_j}{W}\right)_t (V_{2,qj} + V_{2,hqj}) \end{pmatrix}$$

$$= \begin{pmatrix} \gamma c(r_1, w_{1t}^{w} r_1 + w_{2t}^{w} r_2) + (\gamma-1) c(r_1, \sum_{n=1}^{2} w_{nt}^{w} \sum_{k=1}^{\infty} \rho^k r_{n,t+k+1}) \\ \gamma c(r_2, w_{1t}^{w} r_1 + w_{2t}^{w} r_2) + (\gamma-1) c(r_2, \sum_{n=1}^{2} w_{nt}^{w} \sum_{k=1}^{\infty} \rho^k r_{n,t+k+1}) \end{pmatrix}$$

$$+ \begin{pmatrix} (1-\gamma)(V_{1\pi^1} - V_{1h\pi^1}) + (1-\gamma) \sum_{j=1}^{2} \left(\frac{W_j}{W}\right)_t (V_{1,qj} + V_{1,hqj}) \\ (1-\gamma)(V_{2\pi^1} - V_{2h\pi^1}) + (1-\gamma) \sum_{j=1}^{2} \left(\frac{W_j}{W}\right)_t (V_{2,qj} + V_{2,hqj}) \end{pmatrix}$$

In the next few steps, we will show that the terms on the right hand side of the current expression reduce into the terms $V_{i,h}, V_{i,q}$ and $V_{i,hq}$ as defined in the text and the following. The return of the value-weighted world market portfolio is, by definition, $w_{1t}^{w} r_{1t} + w_{2t}^{w} r_{2t} = r_{mt}$. (17) states that individual country's weight in the value-weighted market portfolio stays the same. The return of the future world market portfolio is therefore:

$$\sum_{n=1}^{2} w_n^w \sum_{k=1}^{\infty} \rho^k r_{n,t+k+1} = \sum_{k=1}^{\infty} \rho^k \left(\sum_{n=1}^{2} w_n^w r_{n,t+k+1} \right) = \sum_{k=1}^{\infty} \rho^k r_{m,t+k+1} \tag{41}$$

A real exchange-rate index Δq is constructed where $\Delta q \equiv \sum_{j=1}^{2} \left(\frac{W_j}{W}\right)_t \Delta q_j$, and hence, $\sum_{j=1}^{2} \left(\frac{W_j}{W}\right)_t V_{1,q_j} = V_{1,q}$. $V_{1,hq}$ is the expected future real exchange-rate depreciation.

Now, we are ready to see that the required rates of return of the two assets equal

$$\begin{aligned} & \begin{pmatrix} E_t(r_{1,t+1} - r_{f,t+1}) + \frac{V_{11}}{2} \\ E_t(r_{2,t+1} - r_{f,t+1}) + \frac{V_{22}}{2} \end{pmatrix} \\ = & \begin{pmatrix} \gamma V_{1,m} + (\gamma - 1)V_{1,hm} + V_{1\pi^1} + (1-\gamma)V_{1,q} + (1-\gamma)V_{1,hq_j}) \\ \gamma V_{2,m} + (\gamma - 1)V_{2,hm} + V_{2h\pi^1} + (1-\gamma)V_{2,q} + (1-\gamma)V_{2,hq_j}) \end{pmatrix} \end{aligned} \tag{42}$$

where the last equality uses the definitions $V_{1,m} = V_{1,m^1} - V_{1\pi^1}$ and $V_{1,hm} = V_{1,hm^1} - V_{1h\pi^1}$.

These are the fundamental asset pricing equations for the two assets in the two-country case.

Extension to N assets and J countries' case is straightforward: - and $\tilde{-}$ become N by N in dimension, and the world stock return and real exchange-rate index are aggregated with J countries. The fundamental asset pricing equation is equation (18):

$$E_t(r_{i,t+1} - r_{f,t+1}) + \frac{V_{ii}}{2} = \gamma V_{i,m} + (1-\gamma)V_{i,q} + V_{i,\pi^1} + (\gamma - 1)(V_{ihm} - V_{i,hq})$$

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Table 1: Summary Statistics

The first five variables are the world real equity return (RRET_W), G7 real exchange-rate change (ΔRER), the logarithm of U.S. inflation (USINF), the logarithm of the dividend yield (LOGDP), and logarithm of forward premium (LOGFP). The next four variables are excess returns on U.S. stocks, on Japanese stocks, on German stocks, on U.K. stocks, all in local currencies. The last three variables are excess returns in Japanese foreign exchange, in German foreign exchange and in U.K. foreign exchange. The sample period is 1978:07 to 1998:04.

	Mean	Standard Deviation	Minimum	Maximum
RRET_W	0.791	4.095	-18.849	10.492
ΔRER	-0.065	1.599	-5.069	4.686
USINF	0.382	0.333	-0.455	1.496
LOGDP	-6.032	0.361	-6.641	-5.366
LOGFP	0.067	0.107	-0.177	0.344
EXRET-US	0.627	4.221	-24.493	11.924
EXRET-JP-L	0.214	5.461	-22.480	17.728
EXRET-GE-L	0.498	5.484	-26.068	15.293
EXRET-UK-L	0.549	5.023	-30.857	12.646
EXRET-JP-FX	-0.211	3.605	-12.540	10.513
EXRET-GE-FX	-0.163	3.462	-11.121	7.862
EXRET-UK-FX	0.065	3.428	-12.418	13.573

Table 2: Fundamental VAR and Forecasting Equations

Panel A contains a five-variable VAR. The five variables are the world real equity return (RRET_W), G7 real exchange-rate change (ΔRER), the logarithm of US inflation (USINF), the logarithm of the dividend yield (LOGDP) and the logarithm of forward premium (LOGFP). Regressions in Panel B project excess dollar returns on the G4 countries' stock excess returns and foreign exchange excess market onto the same information set as the VAR. The joint predictability test examines the predictive power of the five lagged variables. The Cumby-Huizinga (1992) L-test test jointly the hypothesis that the first four or eight autocorrelations of the residuals are all zero. The sample period is 1978:07 to 1998:04.

Dependent Variable	Coefficients of Regressors							Joint p	L-test	
	RRET_W (std.err.)	ΔRER (std.err.)	USINF (std.err.)	LOGDP (std.err.)	LOGFP (std.err.)	CONST (std.err.)	R^2	$\chi^2(5)$ p-value	$\chi^2(4)$ p-val	$\chi^2(8)$ p-val
Panel A: Fundamental VAR										
RRET_W	-0.057	0.137	-3.631	1.696	-2.218	12.602	0.052	9.12	2.66	15.43
	(0.081)	(0.163)	(1.022)	(0.851)	(2.517)	(5.278)		0.10	0.62	0.05
ΔRER	-0.044	0.026	-0.095	0.033	-2.934	0.407	0.025	10.86	3.11	10.13
	(0.032)	(0.085)	(0.394)	(0.322)	(1.170)	(2.029)		0.05	0.54	0.26
USINF	0.010	-0.007	0.611	0.153	0.332	1.041	0.524	195.91	1.20	13.53
	(0.004)	(0.009)	(0.069)	(0.053)	(0.173)	(0.343)		0.00	0.88	0.09
LOGDP	0.000	-0.001	0.038	0.976	0.020	-0.166	0.987	16833	5.75	12.68
	(0.001)	(0.002)	(0.010)	(0.009)	(0.024)	(0.053)		0.00	0.22	0.12
LOGFP	0.001	-0.002	0.000	0.000	0.940	0.004	0.881	1574	8.29	14.50
	(0.001)	(0.002)	(0.011)	(0.008)	(0.025)	0.052		0.00	0.08	0.07
Panel B: Forecasting equations										
EXRET-US	-0.082	0.130	-2.699	0.737	-1.848	6.294	0.021	9.65	2.46	8.31
	(0.102)	(0.195)	(1.023)	(0.953)	(2.385)	(5.903)		0.09	0.65	0.40
EXRET-JP-L	0.060	0.121	-3.800	2.807	5.029	18.226	0.034	10.77	0.77	2.70
	(0.117)	(0.242)	(1.252)	(0.997)	(3.789)	(6.210)		0.06	0.94	0.95
EXRET-GE-L	0.107	-0.440	-3.590	1.037	1.441	7.911	0.034	15.75	1.35	5.81
	(0.139)	(0.294)	(1.235)	(1.142)	(3.148)	(7.069)		0.01	0.85	0.67
EXRET-UK-L	0.027	0.140	-2.763	1.742	0.071	12.091	0.010	6.68	7.96	16.97
	(0.112)	(0.226)	(1.243)	(1.092)	(3.239)	(6.743)		0.25	0.09	0.03
EXRET-JP-FX	-0.034	0.041	-0.494	0.488	-9.229	3.572	0.057	20.32	0.59	14.10
	(0.071)	(0.171)	(0.931)	(0.785)	(2.401)	(4.947)		0.00	0.96	0.08
EXRET-GE-FX	-0.157	-0.016	0.072	-0.650	-6.294	-3.573	0.050	19.88	2.26	6.69
	(0.059)	(0.154)	(0.855)	(0.628)	(2.363)	(4.000)		0.00	0.69	0.57
EXRET-UK-FX	-0.064	-0.006	1.232	-1.237	-4.696	-7.503	0.019	9.29	1.64	5.87
	(0.064)	(0.153)	(0.769)	(0.643)	(2.544)	(4.096)		0.10	0.80	0.66

Table 3: Covariances and Correlations of VAR Residuals

The table reports the covariances and correlations of the VAR residuals from Table 2. The correlations are in bold above the diagonal. The five variables are the world real equity return (RRET_W), G7 real exchange-rate change (ΔRER), the logarithm of US inflation (USINF), the logarithm of the dividend yield (LOGDP) and logarithm of forward premium (LOGFP). The sample period is 1978:07 to 1998:04.

Variables	RRET_W	ΔRER	USINF	LOGDP	LOGFP
RRETW	15.5486	**0.3425**	**-0.1906**	**-0.8362**	**-0.1199**
ΔRER	2.1097	2.4403	**-0.0607**	**-0.0667**	**-0.0022**
USINF	-0.1709	-0.0216	0.0517	**0.1598**	**0.0109**
LOGDP	-0.1327	-0.0042	0.0015	0.0016	**0.0965**
LOGFP	-0.0172	-0.0001	0.0001	0.0001	0.0013

Table 4: Innovations to Long-Run Stock Returns

Panel A reports the coefficients of the vector defining the innovation in the discounted present value of future world stock market returns. λ_h is not orthogonalized, while λ_{ho} is. The first five variables are the world real equity return (RRET_W), G7 real exchange-rate change (ΔRER), the logarithm of U.S. inflation (USINF), the logarithm of the dividend yield (LOGDP) and the logarithm of forward premium (LOGFP). The sample period is 1978:07 to 1998:04. Panel B reports the covariances and correlation (in bold) of the innovation in the real return and the innovation in the discounted expected future returns.

Panel A: Coefficients of λ_h					
			Shocks to		
Orthogonalized?	RRET_W	ΔRER	USINF	LOGDP	LOGFP
λ_h (No)	-0.101	0.16	-6.39	17.542	-19.987
	(0.137)	(0.208)	(5.015)	(52.132)	(48.246)
λ_{h0} (Yes)	-0.137	0.092	-0.359	0.094	-0.183
	(0.447)	(0.106)	(0.28)	(0.256)	(0.442)
	Are λ_h jointly	$\chi^2(5)$	14.24		
	zero?	P-value	(0.012)		
λ_{hm} (No)	-0.201	0.245	-6.131	13.99	-65.17
	(0.185)	(0.266)	(7.035)	(70.075)	(66.244)
λ_{hq} (No)	-0.1	0.085	0.259	-3.552	-45.183
	(0.093)	(0.133)	(3.839)	(37.584)	(35.625)
λ_{hmo} (Yes)	-0.148	0.098	-0.34	0.087	-0.597
	(0.604)	(0.139)	(0.392)	(0.342)	(0.606)
λ_{hqo} (Yes)	-0.011	0.006	0.02	-0.007	-0.414
	(0.322)	(0.079)	(0.214)	(0.184)	(0.326)
	Are λ_{hm}	$\chi^2(5)$	19.344		
	jointly zero?	P-value	(0.002)		
	Are λ_{hq} jointly	χ^2 (5)	2.138		
	zero?	P-value	(0.829)		

Panel B: Covariance and correlations of news variable					
Shocks to	RRET_W	ΔRER	USINF	Long-run Stock	Long-run RER
	$e1'\varepsilon$	$e2'\varepsilon$	$e3'\varepsilon$	$\lambda_{hm}'\varepsilon$	$\lambda_{hq}'\varepsilon$
$e1'\varepsilon$	15.549	**0.343**	**-0.191**	**-0.207**	**-0.027**
$e2'\varepsilon$	2.110	2.440	**-0.061**	**0.058**	**0.004**
$e3'\varepsilon$	-0.171	-0.022	0.052	**-0.427**	**0.052**
$\lambda_{hm}'\varepsilon$	-2.297	0.256	-0.273	7.936	**0.816**
$\lambda_{hq}'\varepsilon$	-0.172	0.011	0.019	3.758	2.670

Table 5: GMM Estimates of the Constrained Model

Table 5 reports the results of the joint estimation of the VAR equations, forecasting equations and pricing equations. Panel A reports the results of the first block of equations. The five variables in the VAR are the world real equity return (RRET_W), G7 real exchange-rate change (ΔRER), the logarithm of U.S. inflation (USINF), the logarithm of the dividend yield (LOGDP) and the logarithm of forward premium (LOGFP). Panel B reports the coefficients of the forecasting equations for the excess returns. The first four variables in the forecasting equations are the excess returns on the G4 countries stocks in the United States (EXRET-US), in Japan in local currency (EXRET-JP-L), in Germany (EXRET-GE-L), and in the United Kingdom (EXRET-UK-L). The remaining excess returns on the foreign exchange markets in Japan, Germany and the United Kingdom. The sample period is 1978:07 to 1998:04. The first line of panel C reports the prices of risk associated with the five factors implied in the model. The second line of panel C reports the estimated coefficient of relative risk aversion γ in the model. It also reports the test of the overidentifying restrictions of the overall model.

	Coefficients on Regressors					
Dependent Variable	RRET_W (std.err.)	ΔRER (std.err.)	USINF (std.err.)	LOGDP (std.err.)	LOGFP (std.err.)	CONST (std.err.)
Panel A: VAR						
RRET_W	-0.068	0.148	-3.525	1.712	-3.029	12.772
	(0.078)	(0.160)	(0.990)	(0.794)	(2.238)	(4.941)
ΔRER	-0.046	0.025	-0.084	-0.008	-2.869	0.202
	(0.032)	(0.082)	(0.389)	(0.312)	(1.111)	(1.976)
USINF	0.009	-0.007	0.611	0.143	0.359	0.976
	(0.004)	(0.009)	(0.068)	(0.053)	(0.170)	(0.336)
LOGDP	0.000	-0.001	0.036	0.976	0.029	0.167
	(0.001)	(0.002)	(0.010)	(0.008)	(0.022)	(0.050)
LOGFP	0.001	-0.002	0.000	0.000	0.944	0.004
	(0.001)	(0.002)	(0.011)	(0.008)	(0.025)	0.052
Panel B: Forecasting equations						
EXRET-US	-0.083	0.128	-2.758	0.889	-2.332	7.183
	(0.100)	(0.191)	(0.985)	(0.977)	(2.318)	(5.442)
EXRET-JP-L	0.042	0.143	-3.543	2.678	3.378	17.658
	(0.111)	(0.232)	(1.211)	(0.960)	(3.366)	(6.053)
EXRET-GE-L	0.095	-0.431	-3.556	1.363	0.721	9.851
	(0.133)	(0.284)	(1.220)	(1.072)	(2.989)	(6.718)
EXRET-UK-L	0.020	0.142	-2.714	1.841	-0.668	12.695
	(0.109)	(0.222)	(1.195)	(1.041)	(3.134)	(6.451)
EXRET-JP-FX	-0.035	0.039	-0.496	0.448	-9.124	3.475
	(0.069)	(0.167)	(0.914)	(0.769)	(2.293)	(4.834)
EXRET-GE-FX	-0.156	-0.013	0.098	-0.656	-5.997	-3.511
	(0.057)	(0.151)	(0.844)	(0.607)	(2.286)	(3.847)
EXRET-UK-FX	-0.075	-0.007	1.175	-1.351	-4.366	8.236
	(0.062)	(0.149)	(0.766)	(0.627)	(2.377)	(3.972)
Panel C: Constrained prices of risk and estimate of γ						
Prices of Risk	4.940	-5.532	-0.534	0.679	-1.151	
	(2.339)	(4.220)	(0.975)	(1.283)	(1.729)	

γ	5.987	$\chi^2(6)$	2.256
Standard Error	(3.617)	p-value	0.895

Table 6: Estimation, Pricing Components and Pricing Errors from the Static CAPM

This table contains the parameter estimates from the static CAPM pricing model. Panel A reports the parameters from equation (27) and the test of the model's six overidentifying conditions. Panel A1 reports the results for the 1978:07-1998:04 sample, while panel A2 reports the results for the sub-sample of 1978:07-1995:12. Panel B reports the average adjusted percentage monthly excess rates of return, defined in equation (27), for the seven countries in the two sample periods. The pricing model predicts that the average adjusted return is explained by the covariance of a return with the return on the market portfolio, $\gamma V_{i,m}$. The pricing error is the difference between the data and the model's prediction.

	Panel A1: Parameter Estimates (Sample 1978:07-1998:04)	Panel A2: Parameter Estimates (Sample 1978:07-1995:12)
	Coefficients (std. Err.)	Coefficients (std. Err.)
RRET	0.771	0.713
	(0.265)	(0.289)
EXRET-US	0.389	0.354
	(0.213)	(0.226)
EXRET-JP-L	0.372	0.354
	(0.246)	(0.269)
EXRET-GE-L	0.265	0.219
	(0.172)	(0.174)
EXRET-UK-L	0.353	0.324
	(0.205)	(0.226)
EXRET-JP-FX	0.082	0.092
	(0.094)	(0.106)
EXRET-GE-FX	0.038	0.060
	(0.070)	(0.086)
EXRET-UK-FX	0.068	0.077
	(0.082)	(0.094)
γ	3.295	3.125
(std.err.)	(1.758)	(1.811)
$\chi^2(6)$	3.779	0.573
p-value	0.707	0.997

Panel B: Pricing Components and Errors

	Panel B1: Sample: 1978:07 –98:04			Panel B2: Sample 1978:07-95:12		
	Ave. Adj.	$\gamma V_{i,m}$	Pricing Error	Ave. Adj.	$\gamma V_{i,m}$	Pricing Error
EXRET-US	0.479	0.444	0.034	0.445	0.431	0.014
EXRET-JP-$	0.687	0.652	0.035	0.509	0.499	0.009
EXRET-GE-$	0.486	0.484	0.002	0.368	0.351	0.017
EXRET-UK-$	0.587	0.574	0.001	0.460	0.442	0.017

EXRET-JP-FX	0.148	0.153	-0.006	0.158	0.162	-0.004
EXRET-GE-FX	0.098	0.105	-0.008	0.123	0.128	-0.006
EXRET-UK-FX	0.126	0.135	-0.009	0.140	0.146	-0.006

Table 7: Pricing Components and Errors from the Dynamic International Asset Pricing Model

This table reports the average adjusted percentage monthly excess rates of return. The assets returns are excess returns on U.S. stocks, on Japanese stocks in U.S. currency, on German stocks in U.S. currency, on U.K. stocks in U.S. currency, in Japanese foreign exchange, in German foreign exchange and in U.K. foreign exchange. Panel A reports the components of adjusted returns that are due to the local currency equity returns, foreign exchange returns, and the covariation between the two. Panel A1 reports the results for the 1978:07-1998:04 sample, while panel A2 reports the results for the sub-sample of 1978:07-1995:12. Panels B1 and B2 display estimates related to market risk and hedging risk for the two samples. The first column reports the average adjusted percentage monthly excess rates of return. The pricing model predicts that the average adjusted return contains the following components: a term corresponding to covariance with the real market portfolio, γV_{im}, a term corresponding to covariance with the change in real exchange rate, $(1-\gamma)(V_{iq})$, a term corresponding to covariance with inflation $V_{i\pi}$ and a term corresponding to covariance with the innovation in discounted expected future real returns, $(\gamma-1)(V_{i,h})$ and a term corresponding to covariance with the innovation in the change of real exchange rates $(1-\gamma)(V_{i,hq})$.The last column is the pricing error.

	Panel A1: Sample 1978:07-98:04 Components of adjusted returns				Panel A2: Sample 1978:07-95:12 Components of adjusted returns			
	Average Adjusted Returns	Local Equity Premium	Foreign Exchange Excess Returns	Cov (Local Equity Premium, Forex Excess Returns)	Average Adjusted Returns	Local Equity Premium	Foreign Exchange Excess Returns	Cov (Local Equity Premium, Forex Excess Returns)
EXRET-US	0.624	0.624	0.000	0.000	0.517	0.517	0.000	0.000
EXRET-JP-$	0.571	0.547	0.004	0.021	0.533	0.501	0.012	0.020
EXRET-GE-$	0.555	0.564	0.015	-0.024	0.462	0.439	0.037	-0.014
EXRET-UK-$	0.686	0.637	0.064	-0.015	0.593	0.546	0.060	-0.013
EXRET-JP-FX	0.004	0.000	0.004	0.000	0.012	0.000	0.012	0.000
EXRET-GE-FX	0.015	0.000	0.015	0.000	0.037	0.000	0.037	0.000
EXRET-UK-FX	0.064	0.000	0.064	0.000	0.060	0.000	0.060	0.000

Panel B1: Sample 1978:07-98:04

Portion of risk premium due to an assets' covariation with equity and forex components of market return

	Ave. Adj. Returns	$\gamma V_{i,m}$	$(1-\gamma)V_{i,q}$	$V_{i\pi}$	$(\gamma-1)V_{ihm}$	$(1-\gamma)V_{i,hq}$	Pricing Errors
EXRET-US	0.624	0.755	0.033	-0.001	-0.119	-0.037	-0.007
EXRET-JP-$	0.571	1.101	-0.291	-0.002	-0.282	0.075	-0.030
EXRET-GE-$	0.555	0.818	-0.146	-0.002	-0.066	-0.028	-0.020
EXRET-UK-$	0.686	1.004	-0.141	-0.001	-0.131	-0.038	-0.007
EXRET-JP-FX	0.004	0.245	-0.245	0.000	0.019	-0.004	-0.011
EXRET-GE-FX	0.015	0.180	-0.198	0.000	0.066	-0.021	-0.011
EXRET-UK-FX	0.064	0.256	-0.192	0.000	0.017	-0.015	-0.002

Panel B2: Sample 1978:07-95:12

Portion of risk premium due to an assets' covariation with equity and forex components of market return

	Ave. Adj. Returns	$\gamma V_{i,m}$	$(1-\gamma)V_{i,q}$	$V_{i\pi}$	$(\gamma-1)V_{ihm}$	$(1-\gamma)V_{i,hq}$	Pricing Errors
EXRET-US	0.517	0.737	0.028	-0.001	-0.200	-0.040	-0.007
EXRET-JP-$	0.533	1.127	-0.296	-0.002	-0.354	0.065	-0.007
EXRET-GE-$	0.462	0.816	-0.161	-0.002	-0.138	-0.037	-0.016

EXRET-UK-$	0.593	1.035	-0.150	-0.001	-0.246	-0.040	-0.005
EXRET-JP-FX	0.012	0.263	-0.248	0.000	0.005	-0.011	0.003
EXRET-GE-FX	0.037	0.225	-0.200	0.000	0.042	-0.026	-0.003
EXRET-UK-FX	0.060	0.276	-0.200	0.001	0.002	-0.019	0.000

Table 8: Pricing Components and Errors from the Static CAPM
Fama-French (1998) High Book-to-Market Portfolios
Sample: 1978:07-1995:12

This table investigates the ability of the static CAPM to price assets with high book-to-market ratios. It reports the average adjusted percentage monthly excess rates of return for these assets for six countries. The sample is 1978:07 to 1995:12. The pricing model predicts that the average adjusted return is explained by covariance of a return with the return on market portfolio, $\gamma V_{i,m}$. The pricing error is the difference between the data and the model's prediction.

	Ave. Adj.	$\gamma V_{i,m}$	Pricing Error
EXRET-US	0.780	0.385	0.395
EXRET-JP	0.933	0.598	0.335
EXRET-GE	0.778	0.448	0.330
EXRET-UK	1.027	0.591	0.436
EXRET-FR	1.124	0.548	0.577
EXRET-IT	0.578	0.466	0.111

Table 9: Pricing Components and Errors from the Dynamic Asset Pricing Model
Fama-French (1998) High Book-to-Market Portfolios
Sample: 1978:07-1995:12

This table investigates the ability of the dynamic, international asset pricing model to price assets with high book-to-market ratios. It reports the average adjusted percentage monthly excess rates of return for these assets for six countries. The sample is 1978:07 to 1995:12. The pricing model predicts that the average adjusted return contains two parts: a part corresponding to covariance with the real market portfolio, γV_{im}, a part corresponding to covariance with the change in real exchange rate, $(1-\gamma)(V_{iq})$, a part corresponding to covariance with inflation $V_{i\pi}$, a part corresponding to covariance with the innovation in discounted expected future real returns, $(\gamma-1)(V_{i,h})$ and a part corresponding to covariance with the innovation in the change of real exchange rates $(1-\gamma)(V_{i,hq})$.The last column is the pricing error. It is the difference between the data and the model's prediction.

Portion of risk premium due to an assets' covariation with equity and forex components of market return							
	Ave. Adj. Returns	$\gamma V_{i,m}$	$(1-\gamma)V_{i,q}$	$V_{i\pi}$	$(\gamma-1)V_{ihm}$	$(1-\gamma)V_{i,hq}$	Pricing Errors
EXRET-US	0.771	0.651	0.045	-0.001	-0.151	-0.072	0.299
EXRET-JP	0.950	1.029	-0.251	-0.002	-0.330	0.065	0.439
EXRET-GE	0.745	0.765	-0.172	-0.003	-0.114	-0.033	0.303
EXRET-UK	1.014	1.033	-0.153	-0.001	-0.271	-0.036	0.442
EXRET-FR	1.127	0.937	-0.173	-0.001	-0.172	-0.072	0.609
EXRET-IT	0.512	0.732	-0.113	-0.003	-0.157	-0.041	0.093

Fig 1: Average Excess Returns against covariance with current world market returns
(This figure uses col. 1 and 2 in Panel B1 of Table 6)

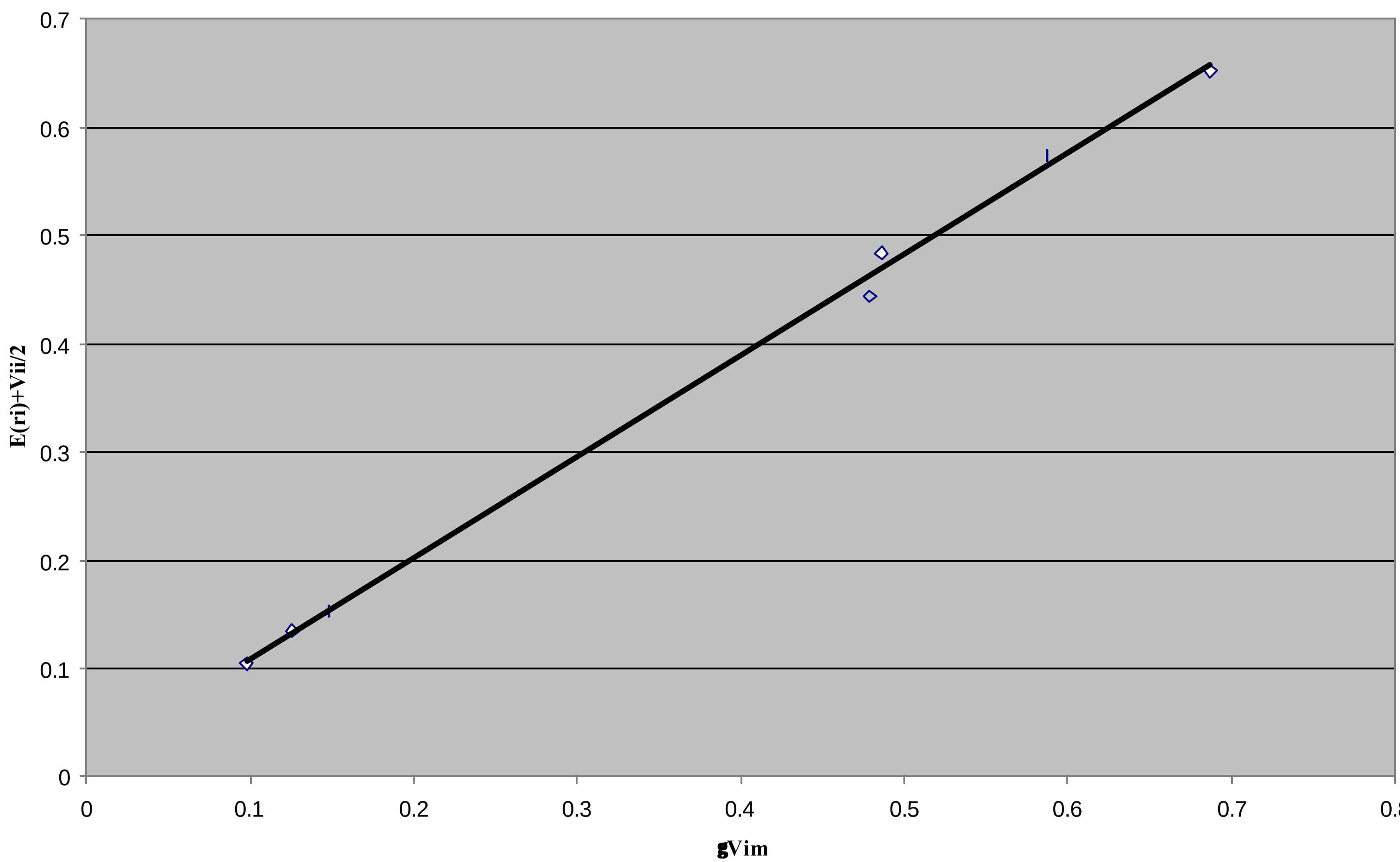
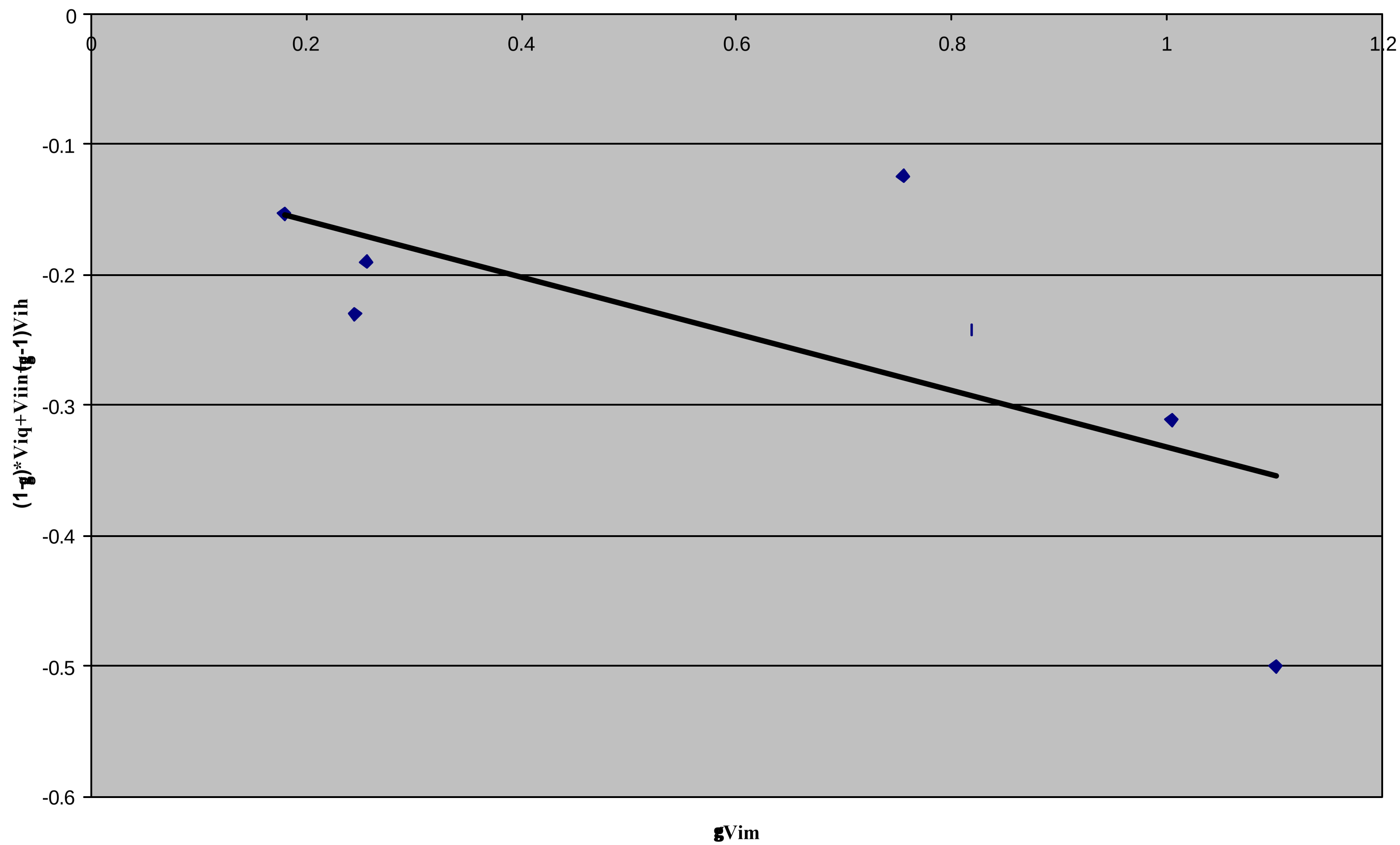


Fig. 2 – Covariance with stock returns vs covariance with other factors.
This figure uses col. 3 and cols. 4 to 7 in Table 7 Panel B1.



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