Keeping, not catching, up with the Joneses: An international asset pricing model*

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Abstract

We derive an international asset pricing model that assumes investors have preferences of the type "keeping up with the Joneses." In an international setting investors compare their *current* wealth with that of their peers who live in the same country. Investors value domestic assets because they are more highly correlated with the domestic benchmark. In equilibrium, this gives rise to a multifactor CAPM where, together with the world market price of risk, there exists country-specific prices of risk associated with *deviations* from the country's average wealth level. Unconditional and conditional empirical tests provide strong support for the theoretical model. The model has implications for the pricing of assets that are traded internationally and the home bias puzzle.

1 Introduction

In this paper we provide a theoretical international asset pricing model that is derived by modifying the standard representative agent, consumption-based asset pricing model. In our model, the representative agent from a given country cares about both absolute wealth and the wealth of their neighbors (countrymen). This behavior is known as "keeping-up with the Joneses." Equilibrium asset prices reflect this observation. Investors are willing to pay a premium for those stocks with a high correlation with domestic wealth (generally local stocks) because this "keeps them up with the Joneses." Investors require a premium for holding stocks with no, or negative, correlation with domestic wealth (generally foreign stocks). Thus, expected returns on a local asset will depend on its covariance with aggregate world wealth and its covariance with local market wealth. These features of the model provide pricing that is consistent with the notion that local factors are important in determining local expected returns. We show in the paper (it is very intuitive from an economic standpoint) that an agent who has this type of preferences will exhibit a home bias with respect to the optimal holdings of an agent who has standard preferences.

We test the model's asset pricing predictions using stock returns from the US and the UK. Since we are considering two countries, our model implies a three-factor model: the world market price of risk, the price of risk of the indicator of US wealth and the price of risk of the indicator of UK wealth. For the indicator of the wealth level in the US and in the UK, which represent the second argument of the utility function of, respectively, British and American investors, we use indexes of the corresponding domestic stock market portfolios. We find that the prices of risk associated with the local risk factors are negative and statistically significant and the world price of risk is positive, as predicted by the model. In our tests, assets from country k show positive betas with respect to the country k local risk factor and negative betas with respect to the country k' local risk factor. This confirms the idea that investors in country k are willing to pay a premium for country k local assets because they help them to keep up with the (domestic) Joneses. Conversely, since assets from the foreign country show a negative covariance with the local risk factor, investors from country k require a premium to hold assets from country k'.

The model performs about 50% better, in terms of describing the cross-section of returns, than the international CAPM. Moreover, the results of the model are robust to the inclusion of currency risk measured using a currency basket or bilateral rates, macroeconomic risk factors, the Fama and French

(1998) HML factor, and local interest rate factors. Furthermore, the model is robust to both unconditional and conditional versions, the choice of test assets, the currency denomination of the returns, the choice of benchmark assets and the introduction of stock returns from Japan and Germany.

Similar types of models to ours, in a domestic setting, have been used in Abel (1990), Ferson and Constantinides (1991) and, more recently, Campbell and Cochrane (1999), Chan and Kogan (2000) and Boldrin, Christiano and Fisher (2001) as a possible explanation of the equity risk premium puzzle. The idea is that the utility of an investor depends on personal wealth as in traditional models, but also on the path of wealth of "the neighbors." An individual who achieves a high degree of wealth will draw less utility from it when "the neighbors" enjoy (and have enjoyed) an even higher level than another agent with the same level of wealth but surrounded by less affluent households. The utility function of these individuals has two arguments, the first is the level of wealth, as in traditional utility models, and the second (and utility is decreasing in it) represents the history of wealth of other agents that are used as a reference. The model is based on "*catching-up* with the Joneses."

In our case, however, the individual investor compares her wealth with the (domestic) economy's aggregate wealth cross-section wise, that is, at a given point in time instead of relative to the *history* of aggregate wealth. This makes sense in an open economy context like ours where a given investor will derive utility relative to the average wealth among her peers, i.e., those living in the same country. To our knowledge, this is the first paper using this type of preferences in a open economy framework. Our model is based on "*keeping-up* with the Joneses." Finally, Basak, Shapiro and Tepla (2002) study some theoretical implications of benchmarking. Their model's predictions provide indirect evidence in favor of keeping up with the Joneses behavior.

Our model is an attempt to reconcile and explain three closely related observations in the empirical literature on international asset pricing which can be thought of as puzzling. First, even though there are no restrictions in cross-border investment, the performance of international asset pricing models tend to improve when domestic factors are included. Second, changes in the cost of capital given stock market liberalizations are much smaller than expected theoretically. Third, investor exhibit home bias.[1] There is an en-

[1]Cho, Eun and Senbet (1986) reject the international APT and the assumption of market integration that it implies. See also Gultekin, Gultekin and Penati (1989) and Korajczyk and Viallet (1989). Griffin (2001) claims that the world book-to-market factor is a proxy for a domestic factor. Chan, Karolyi and Stulz (1992) find support for the

ticing link between these observations. When stock markets are liberalized and they move from segmentation to integration, the pricing of the local stocks will move from being determined by a domestic asset pricing model to being determined by an international asset pricing model. The covariances between local stocks and the international risk factors are (in most cases) considerably lower than covariances with local risk factors, and the world risk premium is lower than the domestic risk premium. Consequently, according to standard international asset pricing models, upon liberalization the local stock markets cost of capital should fall. As these changes take place, simultaneously, due to risk sharing arguments, investors should hold a portfolio of international assets where their domestic market is held according to its weight in the world market portfolio.

To date there is no clearly accepted explanation for the observed empirical regularities. Models that attempt to explain the role of both international and domestic factors in asset pricing specify a partial-integration relationship where costs of investment or restrictions on investment cause domestic factors to be important in pricing local stocks (see, for example Errunza and Losq (1985) and Hietala (1989)). A potential problem these models have is that home bias exists even between countries where there are no restrictions. Furthermore, it is not clear that costs arguments are binding since investors have access, in their local markets, to country funds and mutual funds that hold foreign assets. Moreover, it is relatively simple to enter foreign markets directly and buy stock. Whilst there are arguments that investors avoid foreign stocks because of information asymmetries,[2] they lack power if we believe in the CAPM where investors simply need to buy a proxy for the foreign market portfolio (through for example, a tracker fund or mutual fund).

Our model provides a way for explaining these empirical puzzles since keeping up with the Jones behavior is consistent with full integration across countries (in the sense of a unique world market price of risk) while allowing for the presence of local risk factors. Additionally, the model does not necessarily predict a large fall in the cost of capital given a liberalization

role of domestic factors in a conditional version of the International CAPM. Bekaert and Harvey (1995) find evidence of time-varying integration of emerging stock markets. Hardouvelis, Malliaropulos and Priestley (1999) find local factors and international factors are important in pricing European assets. Dumas, Harvey and Ruiz (2000) reject market integration for 12 developed OECD countries. Bekaert and Harvey (2000) and Henry (2000) find the impact of liberalization to be smaller than expected (see Stulz (1999) for an excellent review). Home bias has been documented in many studies (see Lewis (1999) for a recent review).

[2]See Brennan and Cao (1997) and Kang and Stulz (1997).

and does predicts a home bias.

The paper is organized as follows. In section 2 we introduce the model and the equilibrium and show that this model induces a home bias. In section 3 we present the unconditional and conditional empirical models that we subsequently estimate. The empirical methodology is discussed in section 4. Section 5 presents the data. The empirical results are reported in section 6 and section 7 offers a conclusion.

2 The model

Assume there are K different countries. In each country $k \in 1, ..., K$ there exists a representative investor whose utility function is given by

$$u(x, \phi_k) = -\exp(-\pi_k(x - \phi_k)).$$

There are two periods and one only consumption good. At the beginning, every investor has a unit of the consumption good. All consumption takes place in the second period, after the uncertainty is solved.[3] In the first period, each agent chooses the portfolio of assets that maximizes the utility of her second period wealth, x. However, as an argument in her utility function, there is an *external habit formation* represented by the domestic *contemporaneous* average wealth, ϕ_k. The agent is concerned about the "excess" (relative to her peers) wealth, $x - \phi_k$, rather than her absolute wealth x. The parameter $\pi_k > 0$ represents the investor's absolute risk aversion coefficient.

In choosing her portfolio, the agent faces no restriction on the proportion of wealth invested in domestic or foreign assets. Assets payoffs are expressed in units of the consumption good. Globally, there exist N assets whose returns, r, follow a joint normal distribution $r \sim \mathcal{N}(\overline{r}, \Omega)$, with Ω a positive definite matrix.[4]

For each country, ϕ_k will represent the average wealth in country k that can be obtained by investing in portfolio $\boldsymbol{\phi_k}$ with return r_k. Portfolio $\boldsymbol{\phi_k}$ may, in principle, contain both domestic as well as foreign stocks; hence it

[3] We look at a one-period model and, as a result of it, we focus on a version of the keeping up with the Joneses preferences that uses wealth rather than consumption. As it will become clear in Section 3, this simplification has implications for the test of the model's predictions.

[4] Of course, we could include a domestic risk-free asset in the investment opportunity set. However, as it will become clear later, it is easier to illustrate the intuition behind the model when all the the investor's wealth is held in risky assets.

should not to be confounded with the domestic (closed economy) market portfolio. We assume that $\boldsymbol{\phi_k}$ is public information for all k. World-wide, assets are assumed to be in positive net supply. Let x_M be the global portfolio of outstanding securities with return r_M. Every element in x_M represents the market capitalization value of the corresponding asset relative to the aggregated global wealth. For each agent/country, portfolio $\boldsymbol{\phi_k}$ can be decomposed into the sum of two orthogonal portfolios:

$$\boldsymbol{\phi_k} = o_k + \beta_k\, x_M,$$

with $\beta_k = \frac{E(r_k r_M)}{E(r_M^2)}$. Portfolio $\beta_k\, x_M$ represents the projection of the domestic Joneses wealth onto the *global capital market line* spanned by the equilibrium global portfolio x_M. Portfolio o_k is a "residual" portfolio with return $or_k = o_k \cdot r$.[5] Notice that, unless $\beta_k = 1$, the projection of the domestic Joneses onto the global capital market line involves a long ($\beta_k > 1$) or short ($\beta_k < 1$) position in the market portfolio.[6] Thus, the net investment in the orthogonal portfolio will be $o_k'\mathbf{1} = (1 - \beta_k)$.

Each investor chooses a portfolio $\omega \in \Re^N$, $\omega \cdot r = x$, that maximizes the expected utility of future wealth, such that:

$$\omega_k = o_k + \beta_k\, x_M + \frac{1}{\pi_k}\, \Omega^{-1} E(r), \qquad (1)$$

where $E(r) = \overline{r} - a/c\mathbf{1}$ is the excess return vector, with $a = \mathbf{1}'\Omega^{-1}\overline{r}$ and $c = \mathbf{1}'\Omega^{-1}\mathbf{1}$; the ratio a/c represents the expected return on the minimum variance portfolio of (purely) risky assets.

Equation (1), which represents a portfolio, has three components. Portfolio o_k is country specific and can be interpreted as a *hedge portfolio*: for each country k, portfolio o_k hedges the risk involved in keeping up with the (local) Joneses. More explicitly, if $\beta_k > 1$, country k wealth pattern, $\boldsymbol{\phi_k}$, carries a higher systematic risk than the aggregated world wealth pattern; to keep up with the Joneses the hedge portfolio o_k will be sold short and the proceeds will be invested in the world market portfolio x_M. Conversely, if $\beta_k < 1$, the market portfolio will be sold short and the portfolio o_k will be held long.

In the standard absolute portfolio choice problem (i.e. no external habit formation) this portfolio leverage would be financed by borrowing or lending at the riskfree rate. However, in the presence of keeping up with the

[5] The central dot $(\cdot)$ represents the inner product of two vectors.

[6] To see this, notice that $\boldsymbol{\phi_k}'\mathbf{1} = x_M'\mathbf{1} = 1$, with $\mathbf{1}$ a column vector of ones.

Joneses preferences, these positions are matched by, respectively, short or long investments in the corresponding (domestic) orthogonal portfolio o_k. In this sense, the orthogonal portfolio replaces the riskfree rate as the *country-specific, zero-beta asset.*

The *projection component*, $\beta_k\, x_M$, corresponds to that part of the domestic Joneses perfectly correlated with the global market portfolio. The net investment in both portfolios amounts to 100% of the country's wealth. However, given the investor's preferences, portfolio (1) will be different from the benchmark portfolio $\boldsymbol{\phi_k}$ (otherwise it would imply that markets are segmented and thus the problem would be trivially solved). The difference comes through the zero net-investment portfolio $\Omega^{-1}E(r)$ that the agent holds in proportion to her risk-tolerance coefficient, $1/\pi_k$. This *standard component* corresponds to the highest global Sharpe-ratio portfolio and is common across countries.

A Digression on the Home-Bias Puzzle

At this point it is interesting to analyze the relationship between the observed home bias in domestic portfolios and the predictions of our model for portfolio choice.[7]

In the absence of a external habit formation (i.e. no keeping up with the Joneses) the optimal portfolio for the CARA investor in country k would be:

$$\omega_k^* = \frac{1}{c}\,\Omega^{-1}\mathbf{1} + \frac{1}{\pi_k}\,\Omega^{-1}E(r). \tag{2}$$

Comparing portfolios (1) and (2) we observe that the difference between our model's prediction and the standard portfolio choice is given by the following zero net-investment portfolio:

$$\omega_k - \omega_k^* = o_k + \beta_k\, x_M - \frac{1}{c}\,\Omega^{-1}\mathbf{1}.$$

Obviously, if there is any bias towards domestic assets induced by keeping up with the Joneses, it has to come through the country-specific hedge portfolio o_k: if the portfolio o_k is biased itself towards domestic assets (that is, long positions in domestic assets and zero or short positions in foreign

[7] Although their papers are set in a domestic framework, our model has implications for the home-bias at home studied by Coval and Moskowitz (1999, 2001).

assets) our model will be *consistent with the observed home-bias across countries*. Notice that the net investment in portfolio o_k is $1 - \beta_k$. Hence, the long positions in domestic assets could be financed by selling short foreign assets and holding long the market portfolio (if $\beta_k \geq 1$) or by selling short the market portfolio (if $\beta_k < 1$) and investing the proceeds *only in domestic assets.*

Market Equilibrium

Let W denote the aggregated (worldwide) market value. In equilibrium:

$$W\, x_M = \sum_{k=1}^{K} W_k\, \omega_k,$$

where W_k is the (equilibrium) market value of country k assets. Replacing ω_k by the partial equilibrium result (1) gives:

$$W\, x_M = \sum_{k=1}^{K} W_k (o_k + \beta_k\, x_M) + \sum_{k=1}^{K} \frac{W_k}{\pi_k}\, \Omega^{-1} E(r).$$

Let $H^{-1} = \sum_{k=1}^{K} \frac{W_k}{\pi_k}$ denote the aggregated (equilibrium) risk tolerance coefficient. Thus, the market equilibrium condition can be rearranged as follows:

$$E(r) = H\, \Omega \left((W - \sum_{k=1}^{K} W_k \beta_k)\, x_M - \sum_{k=1}^{K} W_k\, o_k \right). \tag{3}$$

Equation (3) states that the excess return on any asset is explained by its covariance with $K+1$ risk factors: the market portfolio and K country-specific, zero-beta portfolios. Notice that the market portfolio x_M is weighted by $W - \sum_{k=1}^{K} W_k \beta_k$. This implies that, in equilibrium, when consumers keep up with the Joneses, *not all the market risk is priced*; only the "active" systematic market risk, that is, the market risk implied by *beating* and not just *mimicking* the Joneses.[8] The other K factors arise in equilibrium induced

[8] To see this, notice that if every investor held the benchmark portfolio (i.e. $\omega_k = \phi_k$ for every $k \in K$) then, by market clearing, $x_M = \sum_{k=1}^{K} \frac{W_k}{W}\, \phi_k$ and thus, $W - \sum_{k=1}^{K} W_k \beta_k = 0$. The "net" market risk (or active systematic market risk) would be zero.

by the external habit formation in the investors utility function. Since investors are concerned about keeping up with the Joneses, the price (hence return) of a given asset also depends on the asset's potential for hedging that risk, captured by its covariance with the zero-beta hedge portfolios.

Define the matrix $\boldsymbol{o}$ of dimension $N \times K+1$ as the column juxtaposition of the market portfolio x_M and portfolios o_k for $k = 1, ..., K$. Additionally, define the *wealth* vector $\boldsymbol{W} \in \Re^{K+1}$ as follows:

$$\boldsymbol{W} = H \begin{pmatrix} W - \sum_{k=1}^{K} W_k \, \beta_k \\ -W_1 \\ \vdots \\ -W_K \end{pmatrix}.$$

Given these definitions, the equilibrium condition (3) can be re-written as follows:

$$E(r) = \Omega \, \boldsymbol{o}\boldsymbol{W}. \tag{4}$$

Pre-multiplying both terms in equation (4) by the transpose of matrix $\boldsymbol{o}$ we obtain the equilibrium condition for the vector of prices of risk, $\boldsymbol{\lambda} \in \Re^{K+1}$, with the market price of risk , λ_M, as the first component:

$$\boldsymbol{\lambda} = \boldsymbol{o}'\Omega \, \boldsymbol{o} \, \boldsymbol{W}, \tag{5}$$

where $\boldsymbol{o}'\Omega \, \boldsymbol{o}$ is a matrix of dimension $(K+1) \times (K+1)$ whose first column (row) includes the market return volatility and a vector of K zeros and the remaining elements consist of the covariances between o_k and $o_{k'}$ for all $k, k' \in 1, ..., K$.

Consider the sign of these prices of risk. From (5), the market price of risk is given by:

$$\lambda_M \propto \left(W - \sum_{k=1}^{K} W_k \, \beta_k \right) \mathrm{Var}(r_M).$$

According to our model, if the average (capitalization weighted) β_k is above one, the market price of *active* risk would be negative. The intuition behind this result is the following: If, on average, investors want to hold a long position in the market portfolio to keep up with their respective Joneses, then they would be willing to "pay" in order to hold the market portfolio. In equilibrium, an asset that covaries positively with the global market portfolio would have a negative market risk premium, hence a higher price than an asset with negative market beta. In this case, the aggregated projection component induced by the external habit formation dominates over the standard risk-return trade-off. On the other side, if $0 < \sum_{k=1}^{K} \frac{W_k}{W} \beta_k < 1$ then the market price of risk would be positive although smaller than in the standard case.

The price of risk for the zero-beta portfolio o_k is given by:

$$\lambda_k \propto -W_k \operatorname{Var}(or_k) - \sum_{k' \neq k} W_{k'} \operatorname{Cov}(or_{k'}, or_k).$$

Abstracting from the covariance term, the signs of these prices of risk should all be negative. That is, if the zero-beta portfolios were all pairwise orthogonal then the price of risk would be easily isolated and strictly negative. The intuition for the negative sign would be as follows: An asset that covaries positively with portfolio o_k will hedge the investor in country k from the risk of deviating from the (domestic) Joneses. This investor will be willing to pay a higher price for that asset thus yielding a lower return in equilibrium. The price of risk for o_k would be, in absolute terms, increasing in the country's market size, W_k, and the volatility of the hedge portfolio.

If the covariance between zero-beta portfolios is predominantly positive across countries, this would just increase the absolute value of the negative prices of risk for every country's hedge portfolio: An asset that covaries positively with portfolio o_k will hedge an investor from country k and, indirectly, investors from other countries, thus increasing its equilibrium price.

If, for instance, there exists a country whose hedge portfolio o_k is negatively correlated with the remaining hedge portfolios (i.e., whose "Joneses" move opposite to those of the rest of the countries) then, depending on the size of its market (W_k) relative to the total market value (W), it could be the case that this country's *own* price of risk, λ_k, remains negative but the rest turn positive. Thus, if W_k is large enough, an asset with positive covariance with *any* hedge portfolio (except o_k) will have a lower price for the investor in country k. In equilibrium, due to the "size" of this investor, this effect would dominate any other hedging consideration.[9]

[9]Notice, however, that the conditions necessary for this situation to arise are rather contrived.

Finally, solving for $\boldsymbol{W}$ in (5) and replacing it in (4) we obtain:

$$E(r) = \boldsymbol{\lambda}\,\boldsymbol{\beta}, \tag{6}$$

where $\boldsymbol{\beta} = \Omega\,\boldsymbol{o}\,(\boldsymbol{o}'\Omega\,\boldsymbol{o})^{-1}$ denotes the $(N \times K+1)$ matrix of betas, with the first column as the market betas for the N assets.

According to equation (6), in equilibrium, prices are determined by a linear multi-factor model where, together with market risk (redefined now in terms of *active* market risk), there exist other orthogonal factors (one per country) that capture the investors' concern for keeping up with the domestic Joneses. In the next section we will study the asset pricing implications of this model.

3 Empirical Models

In order to test the model described above, which we refer to as the Keeping-Up with the Jones Pricing Model (KEEPM), we would need to use $\boldsymbol{\phi_k}$. However, this is unobservable to the econometrician. Instead we need to find a measurable portfolio that proxies domestic wealth. This is done by taking the total stock market index of each country. Note that $\boldsymbol{\phi_k}$ may contain foreign components. However, so may the local stock market index in each country, since it may include foreign firms that are listed there and multinational corporations that own foreign subsidiaries.

Given that we choose stock market indices to proxy $\boldsymbol{\phi_k}$, and assuming we were to include all countries in the analysis, the global market portfolio would be, by construction, $x_M = \sum_{k=1}^{K} \frac{W_k}{W} \boldsymbol{\phi_k}$. This would have the effect of setting the world market price of risk to zero.[10] In the model, this would arise in the extreme case when $\pi_k \to \infty, \forall\ k$. According to equation (3), there would be no *active* systematic market risk; the model, however, will still retain its predictions on the orthogonal local market prices of risk. Furthermore, in the actual tests where the market clearing condition is not met (since we have a sub-set of the actual data) we can interpret the prices of risk on the orthogonal local factors as lower bounds, as long as $\text{Cov}(or_k, or_{k'}) > 0$ for those countries k' not included in the sample.[11]

In the empirical tests, we consider the performance of the KEEPM, in terms of whether the model's risk factors are priced and have the correct sign as well as the model's ability to capture the cross-sectional variation in

[10] Thus, as long as we do not include all countries it should be positive.

[11] Which is likely to be satisfied by those countries with a non-negligible "wealth," $W_{k'}$.

average returns. In addition, we compare the KEEPM against a set of alternative models that differ in terms of the source of priced risk. We consider international versions of asset pricing models based on the Capital Asset Pricing Model (ICAPM), ICAPM with currency risk (ICAPMCR), international arbitrage pricing model (IAPT), and Fama and French's international two factor model (IFF). We also consider a model that has local risk factors, based on the notion that markets may not be fully integrated.

Our comparisons with these alternative models are best seen from the point of view of the (necessary) arbitrage condition in equilibrium:

$$1 = E(mr)$$

where r is return and m is the corresponding stochastic discount factor (SDF). According to the KEEPM, m can be expressed as:

$$m = a_0 + a_1 r_w + b_1 or_{us} + b_2 or_{uk} + u,$$

where r_w is the return on the world market portfolio, or_{us} is the return on the orthogonal US stock market portfolio, or_{uk} is the return on the orthogonal UK stock market portfolio, and u is an error term. It is possible that there are other factors that are important in terms of describing m and end up in u. For example, currency risk may be priced and in this case we could write:

$$m = a_0 + a_1 r_w + a_2 cr + b_1 or_{us} + b_2 or_{uk} + u,$$

where cr is currency risk. What is relevant from our point of view is that the coefficients b_1 and b_2 are significant *along with* other determinants of the SDF. Therefore, our tests take the form of augmenting the KEEPM with additional factors and testing whether our factors are statistically significant in the presence of these alternative factors, i.e. testing $b_1 = b_2 = 0$ in the above equation. In essence, what we want to know is whether keeping-up with the Joneses behavior is pervasive, whatever other risk factors are pricing assets internationally. Of course, we also test whether a_1 and a_2 are statistically different from zero. We consider unconditional and conditional models.

3.1 Unconditional Models

In the discussion of the asset pricing models we set $K = 2$, which we assume are the UK and the US.[12] From equation (6), this implies a three-factor model with the world market price of risk, the US orthogonal stock market price of risk, and the UK orthogonal stock market price of risk:

$$E(r_{i,t}) = \lambda^w \beta_i^w + \lambda^{ous} \beta_i^{ous} + \lambda^{ouk} \beta_i^{ouk},$$

where $E(r_{i,t})$ is the expected excess return on asset $i \in 1, ..., N$ at time $t \in 1, ..., T$, β_i^w is stock i's β with respect to the world stock market portfolio, λ^w is the world stock market price of risk, β_i^{ous} is stock i's β with respect to the orthogonalized US stock market portfolio, λ^{ous} is the US orthogonalized stock market price of risk, β_i^{ouk} is stock i's β with respect to the orthogonalized UK stock market portfolio, and λ^{ouk} is the UK orthogonalized stock market price of risk. The model predicts that $\lambda^{ous} < 0$, and $\lambda^{ouk} < 0$. We test these predictions and examine whether the model can explain the cross-section of average returns.

Whilst our central concern is with testing our theoretical model, we also consider its performance and robustness relative to a class of other international asset pricing models. The first model is the international CAPM (ICAPM) based on extending the Sharpe (1964) and Lintner (1965) model (see Black (1974)). This model assumes complete integration of capital markets and that purchasing power parity (PPP) holds:

$$E(r_{i,t}) = \lambda^{ICAPM} \beta_i^{ICAPM},$$

where λ^{ICAPM} is the ICAPM market price of risk and β_i^{ICAPM} is stock $i's$ β with respect to the excess return on the world stock market portfolio. Comparing the KEEPM and the ICAPM, it is clear that the ICAPM is nested within the KEEPM. This permits the use of a likelihood ratio test to examine whether the restrictions that KEEPM places on the ICAPM are valid.

Since it is well known that PPP does not hold, at least in the short and medium term (see, for example, Grilli and Kaminsky (1991), Wu (1996) and Papell (1997)) investors may be exposed to real exchange rate risk. Theoretical models that incorporate currency risk include Solnik (1974), Stulz (1981b), Adler and Dumas (1983) and Anderson and Danthine (1983).

[12] We later set $K = 4$ by introducing Japan and Germany into the analysis.

In empirical tests, inflation differentials can be omitted since they are small at monthly horizons and exchange rate risk is modeled using changes in exchange rates. In order to rule out the possibility that the orthogonal market portfolios are proxying for exchange rate risk, we reestimate our model including currency risk.

Currency baskets have been used to proxy general exchange rate movements in studies of the cross-section of stock returns within a country. For example, Jorion (1991) finds evidence that exchange rate risk is not priced for a set of 20 US industries. Antoniou, Garrett, and Priestley (1999) find evidence that exchange rate risk is priced for a small cross-section of UK stocks. With respect to the cross-section of aggregate cross-country returns, Ferson and Harvey (1993) find that exchange rate risk is priced for international stock markets. Within the context of our model and test assets, we augment the model with currency risk as follows:

$$E(r_{i,t}) = \lambda^{w}\beta_i^{w} + \lambda^{ous}\beta_i^{ous} + \lambda^{ouk}\beta_i^{ouk} + \lambda^{cb}\beta_i^{cb},$$

where λ^{cb} is the currency basket price of risk and β_i^{cb} is the β with respect to the currency basket. Note that for this model and each of the subsequent models we set $\lambda^{ous} = \beta_i^{ous} = \lambda^{ouk} = \beta_i^{ouk} = 0$ and test these restrictions with a likelihood ratio test. This amounts to testing whether there is evidence of any "keeping-up" with the Jones behavior irrespective of the choice of international risk factors.

A potential problem with the use of a currency basket is that it may cancel out important dynamics in bilateral exchange rate movements that affect stocks differently to that of the currency basket. An alternative way to specify currency risk is to use bilateral rates (see, for example, Dumas and Solnik (1995) and DeSantis and Gerard (1998)). Therefore, we also estimate a model with the US dollar (USD) bilateral rates against the Japanese Yen (JPY), British Pounds (GBP) and German Marks (DM):

$$E(r_{i,t}) = \lambda^{w}\beta_i^{w} + \lambda^{ous}\beta_i^{ous} + \lambda^{ouk}\beta_i^{ouk} + \lambda^{JPY}\beta_i^{JPY} + \lambda^{GBP}\beta_i^{GBP} + \lambda^{DM}\beta_i^{DM},$$

where λ^{JPY} is the JPY currency price of risk, β_i^{JPY} is the β with respect to the change in the USD/JPY, λ^{GBP} is the GBP currency price of risk, β_i^{GBP} is the β with respect to the change in the USD/GBP, λ^{DM} is the DM currency price of risk, and β_i^{DM} is the β with respect to the change in the USD/DM.

Another class of models use multiple risk factors based on Ross's (1976) Arbitrage Pricing Theory (APT) and Merton's Intertemporal CAPM (we call this model the IAPT). Chen, Roll, and Ross (1986) use macroeconomic factors to proxy state variables in a test of Ross's APT on US stock returns and Ferson and Harvey (1994) use them in an international setting. We include three macroeconomic based factors: world unexpected inflation, world unexpected industrial production, and the return on world money markets:[13]

$$E(r_{i,t}) = \lambda^{w}\beta_i^{w} + \lambda^{ous}\beta_i^{ous} + \lambda^{ouk}\beta_i^{ouk} + \lambda^{ui}\beta_i^{ui} + \lambda^{uip}\beta_i^{uip} + \lambda^{wm}\beta_i^{wm},$$

where λ^{ui} is the inflation price of risk, β_i^{ui} is the β with respect to unexpected inflation, λ^{uip} is the industrial production price of risk, β_i^{uip} is the β with respect to unexpected industrial production, λ^{wm} is the world money market price of risk, and β_i^{wm} is the β with respect to the return on the world money market.

Fama and French (1998) suggest a two factor model for international asset pricing that includes the excess return on the world stock market portfolio and the international high minus low book-to-market factor (HML):

$$E(r_{i,t}) = \lambda^{w}\beta_i^{w} + \lambda^{ous}\beta_i^{ous} + \lambda^{ouk}\beta_i^{ouk} + \lambda^{HML}\beta_i^{HML},$$

where λ^{HML} is the price of risk associated with the HML risk factor and β_i^{HML} is the β with respect to the HML risk factor. We test whether our model is robust to the inclusion of the HML risk factor.

All the asset pricing models above assume that the local stock markets are completely integrated into world markets. In the light of this, the final unconditional model we consider has additional local risk factors to facilitate the analysis of whether the orthogonal local market risk factors are proxying for local risk that arises due to markets not being perfectly integrated.[14] To proxy this we choose the change in each market's riskfree rate of return. Our main motivation for this is that investment opportunity sets may be different in both countries, and in this case, following Merton (1973), the riskfree rate may be used to form a hedge portfolio against changes in the local market investment opportunity set. The specification of the model is:

[13] We also estimate a version of this model including currency risk.

[14] See, for example, Errunza and Losq (1985) and Cooper and Kaplanis (1994) for models of partial integration which give rise to both international and local factors.

$$E(r_{i,t}) = \lambda^w \beta_i^w + \lambda^{ous} \beta_i^{ous} + \lambda^{ouk} \beta_i^{ouk} + \lambda^{usdrf}\, I_k\, \beta_i^{usdrf} + \lambda^{ukdrf}\, I_{k'}\, \beta_i^{ukdrf},$$

where there are $i \in 1, ..., N$ assets, half from country k and half from country k', λ^{usdrf} is the price of risk associated with changes in the US (country k) riskfree rate, β_i^{usdrf} is the beta with respect to change in the US riskfree rate, λ^{ukdrf} is the price of risk associated with changes in the UK (country k') riskfree rate, and β_i^{ukdrf} is the beta with respect to change in the UK riskfree rate. I_k is an indicator function that takes value 1 if asset i belongs to country k, zero otherwise. $I_{k'}$ does the analogous for country k'. Consequently, the change in the US riskfree rate only enters into the equations for the US stock returns and the change in the UK riskfree rate only enters into the equations for the UK stock returns.

3.2 Conditional Models

The models described above are unconditional and, therefore, assume that expected returns are constant. There is considerable evidence that expected excess returns are time-varying. In this case, the unconditional version of the models above may be too restrictive. Harvey (1991), Chan, Karolyi, and Stulz (1992), Bekaert and Harvey (1995) and DeSantis and Gerard (1997) provide evidence that expected returns time-vary in international asset pricing models.

We introduce conditioning information by scaling the risk factor with the (demeaned) first lag of the dividend yield (see Cochrane (1996) and (2001)). We estimate three conditional versions of our model. The first allows for time-variation in the world market price of risk only, and consequently allows us to test whether our orthogonal risk factors are robust to time variation in expected return in the world market portfolio. In this model we use the one period lagged world stock market dividend yield to scale the world stock market excess return:

$$E(r_{i,t}) = \lambda^w \beta_i^w + \lambda^{wdy} \beta_i^{wdy} + \lambda^{ous} \beta_i^{ous} + \lambda^{ouk} \beta_i^{ouk},$$

where λ^{wdy} is the price of risk associated with scaled excess return on the world market portfolio, and β_i^{wdy} is the β of stock i with respect to the scaled excess return on the world market portfolio ($r_{w,t} \times dy_{w,t-1}$).

The second conditional model allows for time variation in the orthogonal risk factors as well as the world market portfolio. The orthogonal US excess return market portfolio is scaled by the one period lagged US dividend yield, and the orthogonal UK excess return market portfolio is scaled by the one period lagged UK dividend yield:

$$E(r_{i,t}) = \lambda^{w}\beta_i^{w} + \lambda^{wdy}\beta_i^{wdy} + \lambda^{ous}\beta_i^{ous} + \lambda^{ousdy}\beta_i^{ousdy} + \lambda^{ouk}\beta_i^{ouk} + \lambda^{oukdy}\beta_i^{oukdy},$$

where λ^{ousdy} is the price of risk associated with scaled excess return on the orthogonal US market portfolio, β_i^{ousdy} is the β of stock i with respect to the scaled excess return on the orthogonal US market portfolio ($or_{us,t} \times dy_{us,t-1}$), λ^{oukdy} is the price of risk associated with scaled excess return on the orthogonal UK market portfolio, and β_i^{oukdy} is the β of stock i with respect to the scaled excess return on the orthogonal UK market portfolio ($or_{uk,t} \times dy_{uk,t-1}$).

The final conditional model attempts to place more intuition on the choice of the conditioning information. The difference in the dividend yields between the US and UK stock markets is employed since it may reflect information on the relative differences between investors views of the two stock markets:

$$E(r_{i,t}) = \lambda^{w}\beta_i^{w} + \lambda^{wdy}\beta_i^{wdy} + \lambda^{ous}\beta_i^{ous} + \lambda^{ousddy}\beta_i^{ousddy} + \lambda^{ouk}\beta_i^{ouk} + \lambda^{oukddy}\beta_i^{oukddy},$$

where λ^{ousddy} is the price of risk associated with scaled excess return on the orthogonal US market portfolio, and the scaling variable is the one period lagged difference in the US and UK dividend yields (ddy_{t-1}), β_i^{ousddy} is the β of stock i with respect to the scaled excess return on the orthogonal US market portfolio ($or_{us,t} \times ddy_{t-1}$), λ^{oukddy} is the price of risk associated with scaled excess return on the orthogonal UK market portfolio, and β_i^{oukddy} is the β of stock i with respect to the scaled excess return on the orthogonal UK market portfolio ($or_{uk,t} \times ddy_{t-1}$).

In all these models we have allowed for time variation in the prices of risk and assumed that the betas are constant. This follows from empirical evidence that suggests that the time variation in betas is much smaller than that of time variation in the prices of risk (see, for example Braun, Nelson, and Sunier (1995) for evidence regarding the time variation in conditional betas).

4 Empirical Methodology

This section describes the econometric methodology that we employ to estimate the prices of risk and betas. All our models are estimated using a one-step, simultaneous, non-linear seemingly unrelated regression approach (NLSUR) (see McElroy, Burmeister, and Wall (1985)). This methodology has the advantage over the traditional Fama and MacBeth (1973) two step methodology in that it avoids the errors in variables problem of estimating betas in one step and then the prices of the risk in a second step.[15] Moreover, using NLSUR allows for correlations in the residual variance-covariance matrix which will lead to more efficient estimates (both asymptotically and in most small samples, see Shaken and Zhou (2000)).[16]

Given a k factor model and a set of N test assets over T observations, the asset pricing model can be expressed as:

$$\mathbf{r}_t = E(\mathbf{r}) + \boldsymbol{\beta}_k \mathbf{f}_{kt} + \mathbf{u}_t \tag{7}$$

$$E(\mathbf{r}) = \boldsymbol{\beta}_k \boldsymbol{\lambda}_k, \tag{8}$$

where $\mathbf{r}_t$ is a N vector of excess security returns, $\mathbf{f}_{kt}$ is a k vector of observations on the k risk factors, $\boldsymbol{\beta}_k$ is a $N \times k$ matrix of betas (sensitivities of returns to the factors), $\mathbf{u}_t$ is a N vector of residual error terms, $E(\mathbf{r})$ is a N vector of expected excess returns and $\boldsymbol{\lambda}_k$ is a k vector of prices of risk. Substituting equation (8) into (7) and stacking the equations for the N securities gives:

$$\mathbf{r} = \left\{ \mathbf{I}_N \otimes \left[\left(\boldsymbol{\lambda}' \otimes \boldsymbol{\iota}_\mathbf{T} \right) + \mathbf{f} \right] \right\} \boldsymbol{\beta} + \mathbf{u}, \tag{9}$$

where $\mathbf{r}$ is a $NT \times 1$ vector of excess returns, $\boldsymbol{\lambda}$ is a $k \times 1$ vector of prices of risk, $\mathbf{f}$ is a $T \times k$ matrix of observations of the k factors, $\boldsymbol{\beta}$ is a $Nk \times 1$ vector of sensitivities, $\mathbf{I}_N$ is a $N \times N$ identity matrix and $\otimes$ is the Kronecker product operator. The NLSUR estimators are those that solve the following minimization problem:

$$\min_{\boldsymbol{\lambda}, \boldsymbol{\beta}} \mathbf{u}' \left(\hat{\Sigma}_{\mathbf{u}}^{-1} \otimes \mathbf{I}_T \right) \mathbf{u}, \tag{10}$$

[15] When estimating the models with the orthogonal market portfolios we do omit the estimation error which arises from their construction.

[16] Connor and Korajczyk (1993) argue that residuals may be cross correlated due to industry specific factors that are not pervaisve across the whole cross section.

where $\hat{\Sigma}_{\mathbf{u}}^{-1}$ is the residual covariance matrix obtained from estimating (9).[17]

The main focus of the paper is in testing the statistical significance and sign of the prices of risk associated with our theoretical model. We also evaluate the performance of this model relative to the models discussed in the preceding section. We are interested in examining whether the prices of risk associated with our asset pricing model are statistically and economically important in the light of the inclusion of other asset pricing model factors, and whether we can jointly restrict the KEEPM risk factors to be zero. In addition, in order to compare the performance of the various models we report a cross-sectional $\overline{R}^2$ which indicates the extent to which the model can explain the cross sectional variation in average returns over the sample period. Assessment of pricing errors and analysis of the specification of the models residuals also make up part of our investigation.

5 Data

We present a brief discussion of the data used in the empirical section of the paper, focusing on the tests assets and the different risk factors.

5.1 Test Assets

The test assets that we use are a random sample of 50 individual stock returns from the US and 50 individual stock returns from the UK. This set of N =100 test assets is the primary focus of the empirical work. We also include a second set of 80 test assets (40 UK, 40 US) which we use for robustness tests of the model on both an independent set of assets and on whether the number of assets (i.e. 100 or 80) is important in the analysis. The choice of a maximum of 100 test assets is limited due to the large nonlinear system that needs to be estimated.

[17] It is possible to iterate on the variance covariance matrix, $\hat{\Sigma}_{\mathbf{u}}$, and reestimate until this matrix converges. This should provide more efficient estimates if there is information to be extracted from this process. However, we do not do this because it makes calculating likelihood ratio tests more difficult. If we do not iterate, we can estimate the unrestricted model and output $\hat{\Sigma}_{\mathbf{u}}$ and then estimate the restricted version using $\hat{\Sigma}_{\mathbf{u}}$. It is then straightforward to take the change in the least squares criterion function as an asymptotically valid Chi-square test (see Gallant and Jorgenson (1979)). This is not possible when iterating on the variance-covariance matrix. When we do estimate the models by iterating on $\hat{\Sigma}_{\mathbf{u}}$, we find that there is very little difference in parameter estimates, standard errors, or the value of the least squares criterion function. Therefore, interating on $\hat{\Sigma}_{\mathbf{u}}$ appears to be unimportant in our case. Some findings on this are reported in the results section.

Monthly stock prices for the period January 1980 to December 2000 are collected. This sample period is chosen due to the existence of capital controls in the UK in the 1970s. Total excess returns are calculated by subtracting the three month US T-bill rate from the total returns. All data are denominated in US dollars. The returns are also translated into Great British Pounds (GBP) and excess returns are constructed by subtracting the UK 3 month t-bill from the GBP returns. This allows us to tests the robustness of the model to the denomination of the currency.

We test the model using individual securities, which implies that the firms have to survive the sample period. This induces some survivorship bias on the sample and therefore provides an additional motivation for keeping the sample period relatively short since the extent of survivorship bias can be limited by shortening the length of the sample period. However, there are other motivations for using individual securities. We might expect our model to perform better on assets that have survived the period. This is not because they have survived the sample, but rather because they are likely to be large, international firms that are relevant for our asset pricing model. Small firms are less likely to be traded internationally because of higher information and transaction costs and low levels of liquidity. These stocks are unlikely to be affected by international factors, and more likely to be priced as if the local market is segmented. Therefore, we should test our model on assets that are likely to be priced by it.

Other reasons for using individual assets are, first, the asset pricing model, like all asset pricing models, is a statement about individual assets and not portfolios based on some firm characteristic. The use of portfolios stems from the desire to reduce the errors-in-variables problem that is inherent in the Fama and MacBeth (1973) two-step estimation technique, which is often used to estimate asset pricing models. Since we use a one-step estimation procedure, there is no errors in variables problem and hence no need to form portfolios for this reason.

Second, the formation of portfolios raises a number of problems in its own right related to data-snooping biases (see Brennan, Chorida and Subrahmanyam (1998)) and spreads of risk and return.[18]

Notwithstanding this, as a robustness check, we also estimate our model using portfolio data which is not affected by survivorship bias. The results are robust to the use of either individual stocks that have survived the whole

[18] The data snooping biases studies focus on the lack of power of tests because portfolios are formed on some empirical characteristic found to be relevant in earlier empirical work (Lo and Mackinley (1990) and Berk (2000)) or because portfolio formation may eliminate important return characteristics by averaging into portfolios (Roll (1977)).

sample, or portfolios of stocks that have no survivorship bias.

5.2 Risk Factors

The risk factors are the excess return on the world market portfolio and the excess returns on the US and UK market portfolios (orthogonalized relative to world market portfolio). The respective market portfolios are the total market portfolios provided by Datastream International. These indices include a wider selection of stocks than the Morgan Stanley indices, and therefore, are likely to be more representative of the true market portfolios in each country. In the robustness tests we use the Morgan Stanley indices as well.

To proxy exchange rate risk we use a currency basket which is a trade weighted index of the USD. We also consider bilateral exchange rates of the dollar against the GBP, JPY and DM. Other risk factors based on macroeconomic factors are, world unexpected inflation, derived from the IMF world consumer price index, world unexpected industrial production derived from the OECD aggregate industrial production index, and the return on world money markets derived from Salomon Brothers world money market index. The unexpected inflation and industrial production factors are the residuals from autoregressions whilst all other factors are return-based.

We also consider the international high minus low book-to-market factor (HML). To proxy local risk factors that might arise due to less than full integration, we use the change in the UK 3 month T-bill rate and the change in the US 3 month T-bill rate. All data used in the paper are collected from Datastream except for the HML factor which is from Ken French's homepage.

Table 1 provides summary statistics on the risk factors. We report the mean and standard deviation of the factors, the 1st order autocorrelation coefficient and p-values for a test that this is zero. A correlation matrix of the risk factors is also included. The mean excess return on the world market portfolio is 0.63% per month. The corresponding excess returns in the US and the UK are 0.83% and 0.80% per month, respectively. The currency basket is positive, indicating that the USD appreciated over the sample period. However, note that in comparison with the bilateral rates, the mean return on the currency basket is smaller in absolute terms than that of USD rates against the GBP and the JPY. Moreover, whilst the USD has appreciated against the DM and GBP, it has depreciated against the JPY. This observation could be important since the currency basket may cancel out important dynamics in the bilateral rate movements. Therefore, we use the currency basket, and then test the robustness of this by replacing it with the bilateral rates.

The unexpected inflation and industrial production factors both have zero means and their autocorrelation coefficients are also zero, which confirms that they are unexpected. The money market factor has a positive mean of 0.62% per month. The HML factor has a mean return of 0.48% per month. The change in the risk free rate of return is negative over the sample period for both countries, and the change in the UK risk free rate of return is higher than that of the US. Overall, most of the risk factors have insignificant first order autocorrelation coefficients.

The lower half of table 1 reports a correlation matrix of the factors. In general, for those factors that enter models together the correlations are low. The highest correlations are between the currency basket and the individual currencies, as expected, but they do not enter the same model.

6 Empirical Results

6.1 Unconditional tests

The main empirical results of the paper are presented in table 2, panel A, where we report estimates of the KEEPM. The world stock market price of risk is estimated at 0.607% per month and is statistically significant at the 1% level. The orthogonal US market price of risk is estimated to be -0.625% per month, and the orthogonal UK market price of risk is estimated to be -1.051% per month. Both have the correct sign, and the t-ratios indicate that both of these prices of risk are statistically significant at the 1% level. The model explains 23% of the cross-sectional variation in excess returns. This is reasonable when we consider that we use excess stock returns of individual assets within the context of an international asset pricing model. The signs and the statistical significance of the prices of risk provide strong evidence in favour of keeping up with the Joneses behavior.

The estimated betas with respect to the world market portfolio are, on average, 0.705 for the 50 US stock, and 0.809 for the 50 UK stocks. Out of these, the betas of 49 UK and 47 US firms are statistically different from zero at the 5% level. Both the US and UK stocks have, on average, a level of systematic risk lower than that of the world market, and the UK stocks have on average higher risk that the US stocks. Whilst the average betas are lower than one, there is a good spread of world market betas. For example, the maximum and minimum values are 1.715 and 0.144 in the US and 1.309 and 0.239 in the UK.

Turning to the betas with respect to the orthogonalized country portfolios, the average beta of the US stocks to the orthogonalized US market portfolio is 0.884, 45 are statistically significant at the 5% level, and all are positive (max=2.096, min=0.168). The average beta of the UK stocks to the orthogonalized UK market portfolio is 0.851, 47 are statistically significant at the 5% level, and all are positive (max=1.353, min=0.265).

As the prices of risk associated with the orthogonalized country portfolios are negative, this suggests that investors are willing to give up expected return in order to hold stocks that are highly correlated with their domestic benchmark: the more highly correlated, the more the investors are willing to give up in order to hold the stocks. This is "keeping-up" with the Joneses behavior.

The average beta of the UK stocks with respect to the orthogonalized US market portfolio is -0.294, 23 are statistically significant at the 5% level, and 46 of the 50 are negative. The average beta of the US stocks to the orthogonalized UK market portfolio is -0.021, 5 are statistically significant at the 5% level, and 21 are negative. Again, the negative betas here suggest that, for UK investors, holding US stocks will not keep them up with their Joneses, since they are negatively correlated, and thus they require a positive risk premium to hold US stocks. The patterns of the betas with respect to the orthogonalized country market portfolios are illustrated in figure 1. Here, we clearly see the pattern of positive and negative betas. Given these betas, investors require, on average, a positive risk premium for those stocks that are negatively correlated to their domestic benchmark. These results are exactly in line with the models' predictions.

Pricing errors (not reported) for each individual asset are significantly different from zero at the 5% level never more than it would be expected by chance. Analysis of serial correlation and heteroscedasticity of the residuals is undertaken using the Durbin Watson statistics to test the former and using the Breusch-Pagan test to consider the latter. Out of the one hundred residuals, only 4 reject the null hypothesis of no serial correlation and 5 reject the null hypothesis of homoscedasticity at the 5% level. Thus, the models residuals are well specified, which should allow for straightforward interpretations of the estimates.

6.2 Robustness tests

This section examines the robustness of the results to alternative risk factors, test assets, currency denomination of the test assets, market portfolio data, and potential market segmentation.

Panel B of table 2 reports the results from estimating unconditional models with new risk factors. To provide a general benchmark for our model, we report in the first row an estimate of the ICAPM. The world market price of risk is estimated to be positive at 0.558% per month, and it is statistically significant at the 1% level. The ICAPM is able to explain 15% of the cross sectional variation in average excess returns. Therefore, our model is able to explain 50% more of the cross sectional variation in average excess returns than the simple ICAPM. The final column of the panel reports the probability values from a likelihood ratio test (distributed Chi-Square) of the null hypothesis that the restrictions the ICAPM imposes on the KEEPM are acceptable, that is, $\lambda^{ous} = \beta_i^{ous} = \lambda^{ouk} = \beta_i^{ouk} = 0$. The probability value is less than 0.01, and thus we clearly reject the null hypothesis at any reasonable significance level.

The rest of the models in Panel B are extensions of the KEEPM to include additional risk factors. The second row of panel B reports an estimate that includes a currency basket of the US dollar. The estimated price of currency risk is -0.234% per month, and it is statistically significant at the 1% level. Thirteen of the US firms have a negative exposure and 17 UK firms have a negative exposure. For an exporter, a negative exposure implies the stock return rises as the home currency depreciates, as it would be expected according to theory. However, note that a positive exposure is not inconsistent with theoretical predictions if the firms are importers of inputs into their production process. Furthermore, the extent of the exposure can depend on the competitive nature of the industry a firm is based in, along with its ability to alter factors such as sourcing of inputs, pricing, production location and marketing. Importantly, the inclusion of the currency basket does not affect the estimates of the prices of risk in our model. The $\overline{R}^2$ decreases by 1% which indicates that the currency basket does not improve the cross sectional explanation of average excess returns. The likelihood ratio test rejects the null that $\lambda^{ous} = \beta_i^{ous} = \lambda^{ouk} = \beta_i^{ouk} = 0$.

The next model in the third row of panel B includes the unexpected inflation and industrial production factors along with the return on world money markets. The unexpected industrial production factor has statistically significant prices of risk and the money market price of risk is marginally significant. In this model the $\overline{R}^2$ increases to 52% and therefore, it seems that these two risk factors are important in explaining the cross section of international asset returns. However, whilst the macroeconomic variables are important in explaining the cross section of average excess returns, they do not have a statistical or economic impact on the prices of risk associated with the orthogonalized country portfolios (or the world market portfolio) and the likelihood ratio test indicates the KEEPM factors can not be omitted.[19]

In row four of panel B, we replace the macroeconomic factors with bilateral exchange rates. Only the USD/DM rate is statistically significant at the 5% level. The estimated prices of risk for the three bilateral exchange rate are negative which is consistent with the estimate for the currency basket.[20] The cross sectional $\overline{R}^2$ is now 27% and indicates that a richer description of the cross-section of average returns can be obtained by using bilateral rates rather than a currency basket. Of course this does not rule out the fact that an even richer picture of exchange rate risk may be obtained with a wider choice of bilateral rates. The restrictions of setting the KEEPM factors to zero are easily rejected.

The final model presented in panel B includes the HML factor along with the factors in our model. The estimate of the HML price of risk is statistically significant at the 1% and is estimated at -0.825% per month. Of the 50 UK firms, 39 of the HML betas are positive and 13 of these are statistically significant at the 5% level. Of the 11 negative betas, 3 are statistically significant. Of the 50 US firms, 38 of the HML betas are positive and 14 of these are statistically significant at the 5% level. Of the 12 negative betas, none are statistically significant. In total, thirty percent of the HML betas are statistically significant, the majority are positive and, therefore, as the HML premium increases, stock returns fall. The inclusion of the HML factor has no material impact on the orthogonal prices of risk. The $\overline{R}^2$ is actually slightly lower than in our model and, once again, it is easy to reject the restrictions that the KEEPM factors are jointly zero.

It appears that, at an international level, macroeconomic factors and bilateral exchange rates perform better that the HML factor. However, it should be noted that our test assets may bias against finding an impact of the HML factor. If the HML factor proxies for default risk and this is

[19] We reestimate this IAPT model with the addition of the currency basket. The currency basket price of risk is statistically significant and the industrial production price of risk remains statistically significant. However, the price of risk on the money market factor is no longer marginally significant. The cross sections $\overline{R}^2$ does not improve. Note that the correlation (table 1) between the currency basket and the money market factor is -0.617 and this could affect the estimation of the models that includes both these factors.

[20] The USD/DM and USD/GBP bilateral rates have a correlation coefficient of 0.43, so we reestimate the model without the USD/DM rate. The USD/GBP price of risk in this case is estimated to be -0.396 but is not statistically significant (p-value of 0.14). Irrespective of which currencies are included in the model, they do not affect the estimates of the local market prices of risk.

prevalent in firms that fail, then given that all our firms have survived, we may not uncover the full impact of the factor.

Panel C reports the estimates of the model using the first set of 100 test assets that are denominated in GBP. The model is robust to the currency denomination of the test assets. In panel D we report estimates of the model when using the MSCI indices rather than the Datastream indices. There is little change in the results when employing the MSCI indices, both in terms of the size of the estimated coefficients or the cross-sectional $\overline{R}^2$.

A possible (alternative) interpretation of our results is that the orthogonal country returns are proxying for local market risk factors that are important in explaining returns because the local stock markets are to some extent segmented (partially integrated) from international markets, and investors in each market must hedge against unexpected changes in each market opportunity set. To test this we reestimate the model and include the change in the US riskfree rate and the change in the UK riskfree rate to proxy for the local risk factors.

Panel E reports these results and shows that these two local risk factors do not affect the estimated prices of risk of our model and the Chi-Square test indicates the restrictions that the KEEPM factors are zero are rejected. The price of risk associated with the change in the UK riskfree rate is statistically significant and estimated to be negative, whilst the corresponding price of risk for the US riskfree rate is not statistically significant. Notice that the $\overline{R}^2$ increased to 31% with the inclusion of these local risk factors. Of course, it is possible that the change in the riskfree rate proxies for some of the global macroeconomic factors reported in panel A, or for changes in expected returns captured by the conditional versions of the model we estimate.

Panel F of table 3 reports the results from estimating our model using 80 new assets, 40 of which are from the US and 40 from the UK. The model is robust to both the use of a new set of independent test assets and a reduction of the number of equations in the system from 100 to 80. The $\overline{R}^2$ is higher for this set of assets than the first 100 test assets, 35% as opposed to 23%.

A final check we undertake is to estimate the model using portfolio data in order to examine if the survivorship bias present in using stocks that have survived the period affects the estimates. We have data on portfolios of UK stocks sorted on size and beta and data on portfolios of US stocks sorted by size.[21] The UK portfolios are formed from the London Business School data base. Stocks are ranked into deciles based on size and then sorted again

[21] We thank Gareth Morgan for providing the UK stock portfolios and Øyvind Norli for providing the US stock portfolios.

into 5 beta portfolios, providing a total of 50 portfolios. The US stocks are formed into 50 size portfolio. The data are from CRSP. The portfolio data span the shorter time period of 1980 to the end of 1995. In order to avoid using the smallest stocks in each country, which are unlikely to be traded internationally, we undertake the analysis omitting the smallest 10 portfolios from each country, leaving us with 80 portfolios.

Panel G reports the estimates of the model using the portfolio data over the shorter time period. Despite the fact that we are using a much wider set of assets, the estimates still find support for our model. The prices of risk associated with the orthogonal local market portfolios are both estimated to be negative and statistically significant and are of similar magnitude to those estimated with individual stock returns.

A final consideration we make is to examine if there are any benefits from iterating on the variance-covariance matrix in the estimation process. The model estimates when we iterate on the variance-covariance matrix are: $\lambda^{w} = 0.535(2.55)$, $\lambda^{us} = -0.501(3.25)$, and $\lambda^{uk} = -0.956(4.39)$, which are very close to the estimates obtained in table 2 when not iterating on the variance-covariance matrix. In fact, it is not possible to reject the restriction that the prices of risk estimated using NLSUR and ITNLSUR are the same, $\chi^2(3) = 5.020$ [0.17]. The differences between the objective function value (multiplied by the number of observations) of the model estimated by iterating and that estimated by not iterating is only 3.23. In sum, iterating on the variance-covariance matrix has little impact on the estimated coefficients and their respective standard errors. Therefore, we choose to report the NLSUR estimates due to its advantage in terms of calculating tests of restrictions.

6.3 Conditional Tests

This section of the paper allows for time variation in the estimated prices of risk by scaling the risk factors with information variables. This methodology was developed in domestic asset pricing models by Cochrane (1996) and extended by Letteau and Ludvigson (2001).

Table 3 reports the results from estimating the conditional models. The first model allows for time variation in the world market price of risk by scaling the excess return on the world market portfolio by the world market demeaned dividend yield. This allows us to check if the orthogonalized country portfolios are proxying for time variation in the world market price of risk. We find that the scaled world factor is not statistically significant and the inclusion of this factor does not improve the $\overline{R}^2$ or affect the estimates of the prices of risk associated with the orthogonal country portfolios. Thus, time variation in the world price of risk is not that important for our cross section of returns and choice of instrument.

The next conditional model allows for time variation in both the world market price of risk and the orthogonalized country portfolios' prices of risk. The returns on the two orthogonal market portfolios are scaled with their respective market, demeaned, dividend yields. The price of risk associated with the scaled US orthogonalized market portfolio is statistically significant, and thus indicates variation in this price of risk. The UK scaled price of risk, along with the world scaled price of risk, are not statistically different from zero. Note that when we allow for time variation in the local market prices of risk, the $\overline{R}^2$ increases to 35%. Notwithstanding this, there is no effect on the unconditional prices of risk.

The final conditional model we estimate uses the difference in the US and UK dividend yields to condition the two country portfolios, whilst the world market portfolio is scaled by the world dividend yield. This conditioning has the impact of improving the $\overline{R}^2$ even further to 40%. The prices of risk associated with the US scaled orthogonalized market portfolio is statistically significant at the 9% level and the UK scaled orthogonalized market portfolio is statistically significant at the 5% level. Like all previous models, there is no effect on the unconditional prices of risk.

A conditional version of the KEEPM where the prices of risk are associated with the orthogonal market portfolios on their own lagged dividend yields, leads to a significant improvement in the model ability to explain the cross-section of expected returns. Furthermore, conditioning on the differences in the dividends yields, leads to a near 100% improvement in the model's ability to explain the cross-section of expected returns.

6.4 Additional Countries

A final consideration we make is to include more countries into the analysis. Japan and Germany are chosen because they have large developed equity markets that have been relatively free from restrictions over the sample period. We collect a random sample of twenty five stocks from each of the four markets to provide a system of one hundred equations.

Table 4 reports the estimates for the four countries. The prices of risk for the orthogonal components of the local market indices are all negative and statistically significant, lending strong support to our model. The price of risk associated with the Japanese local market is the highest, followed by that of Germany. The prices of risk associated with the UK and the US are now similar, whereas in the analysis with just the UK and the US, the UK price of risk was somewhat larger. The world market price of risk is about half the size of the estimate when only the UK and the US are included in the analysis.

The $\overline{R}^2$ is 22%, just under the one we get for the model with only the US and UK. It appears that the model is robust to the inclusion of the two additional countries. As a further check we collected another 20 randomly selected stocks from each country and reestimated the model. The estimates are robust to this check, that is, to the number of assets and the choice of assets.

7 Conclusion

This paper derives a theoretical international asset pricing model by modifying the standard representative agent, consumption-based asset pricing model. In this model, equilibrium asset prices reflect the notion that agents care about both absolute wealth and the wealth of their countrymen. This gives rise to investors paying a premium for stocks which have a high correlation with domestic wealth as it is precisely these the stocks that "keep them up with the Joneses." Investors require a premium for holding stocks with no, or negative, correlation with domestic wealth. Thus, the expected return on a local asset will depend on its covariance with aggregate world wealth and covariances with different local market wealth.

We test the model's asset pricing predictions and find that the price of risk associated with the local risk factors are negative and statistically significant and the world price of risk is positive, as predicted by the model. Analyzing the stock's betas confirms the idea that investors in country k are willing to pay a premium for country k local assets because they help them to keep up with their (domestic) Joneses. Conversely, since assets from the foreign country show a negative covariance with the local risk factor, investors from country k require a premium to hold assets from country k'. These results are robust to a host of specification tests, and to the use of unconditional and conditional testing frameworks.

This model has implications for the portfolio selection of the individuals and for equilibrium asset prices. In particular, our model is consistent with empirical findings that investors exhibit a home bias, and empirical findings that local factors are important in determining local expected returns.

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Table 1
Summary Statistics

	R_w	CB	I	IP	WM	P	Y	DM	HML	DUSRF	DUKRF
Mean	0.632 (4.23)	0.086 (1.34)	0.000 (0.18)	0.000 (0.85)	0.620 (2.34)	0.175 (2.65)	−0.291 (3.46)	0.071 (3.37)	0.476 (2.93)	−0.024 (0.644)	−0.040 (0.60)
AR(1)	0.039 [0.53]	0.303 [0.00]	−0.035 [0.57]	−0.004 [0.95]	0.070 [0.27]	0.317 [0.00]	0.085 [0.18]	0.052 [0.41]	0.158 [0.01]	0.159 [0.01]	0.021 [0.73]
Correlations											
R_w	1.000										
CB	-0.314	1.000									
I	-0.078	-0.069	1.000								
IP	-0.055	0.097	0.044	1.000							
WM	0.096	-0.614	0.065	-0.137	1.000						
P	-0.232	0.708	-0.018	0.048	-0.471	1.000					
Y	-0.372	0.521	-0.069	0.062	-0.139	0.312	1.000				
DM	-0.211	0.485	-0.085	0.009	-0.091	0.433	0.541	1.000			
HML	-0.169	0.137	0.046	0.095	0.021	0.149	0.131	0.089	1.000		
DUSRF	-0.086	0.162	-0.055	0.141	0.018	0.062	0.195	0.256	0.011	1.000	
DUKRF	-0.178	0.105	0.058	0.045	-0.024	0.207	0.166	0.046	0.007	0.110	1.000

The table presents summary statistics of the risk factors over the sample period 1980-2000. The data are sampled monthly and are collected from Datastream. In the first row the table lists the risk factors: R_w is the excess return on the Datastream world value weighted market portfolio, CB is the currency basket, I is inflation, IP is industrial production, WM is the world money market, P is the US dollar/British Pound exchange rate, Y is the US dollar/Japanese Yen exchange rate, DM is the US dollar/German Mark exchange rate, HML is the Fama and French international high minus low book-to-market portfolio, DUSRF is the change in the US riskfree rate of return, and DUKRF is the change in the UK riskfree rate of return. The second row of the table records the mean of the factor with its standard deviation below in parenthesis. The third row of the table reports the first order autocorrelation coefficient with a probability value in brackets below for a test that the first order autocorrelation coefficient is significantly different from zero. The rest of the table reports correlation coefficients between the risk factors.

Table 2
Estimates of Prices of Risk: Unconditional Models

λ^{w}	λ^{us}	λ^{uk}	λ^{cb}	$\lambda^{£}$	$\lambda^{¥}$	λ^{dm}	λ^{i}	λ^{ip}	λ^{m}	λ^{bm}	$\overline{R}^2$	LR
Panel A: KEEPM												
0.607	−0.625	−1.051									23	
(2.88)	(3.99)	(4.79)										
Panel B: Robustness Tests												
0.558											15	< 0.01
(3.57)												
0.568	−0.588	−1.015	−0.234								22	< 0.01
(2.70)	(3.74)	(4.63)	(2.19)									
0.541	−0.645	−0.866					−0.012	−0.475	0.441		52	< 0.01
(2.15)	(3.41)	(3..30)					(0.69)	(4.93)	(1.65)			
0.496	−0.547	−0.926		−0.290	−0.381	−0.665					27	<0.01
(2.30)	(3.42)	(4.93)		(1.31)	(1.54)	(2.35)						
0.573	−0.591	−1.007								−0.825	21	<0.01
(2.71)	(3.78)	(4.59)								(5.98)		
Panel C: Original Assets Denominated in UK Pounds												
0.642	−0.835	−0.932									26	
(3.06)	(4.65)	(4.80)										
Panel D: MSCI Market Indices												
0.649	−0.679	−1.025									21	
(3.38)	(4.57)	(4.69)										
Panel E: Additional Local Risk Factors												
λ^{w}	λ^{us}	λ^{uk}	λ^{usdrf}	λ^{ukdrf}								
0.509	−0.557	−0.959	−0.017	−0.130							31	<0.01
(2.35)	(3.43)	(4.42)	(0.84)	(2.73)								
Panel F: New Assets: 40 UK and 40 US												
0.816	−0.563	−0.950									35	
(3.40)	(3.14)	(3.93)										
Panel G: Portfolio Data: 1980- 1995												
0.506	−0.840	−1.238									10	
(2.10)	(5.25)	(4.95)										

This table reports estimates of the prices of risk, along with the cross-sectional $\overline{R}^2$ from alternative, unconditional versions of the KEEPM model. LR reports the probability value from a likelihood ratio test that tests whether the KEEPM risk factors can be jointly restricted to zero ($\lambda^{ous} = \beta^{ous} = \lambda^{ous} = \beta^{ous} = 0$). Panel A reports estimates from the KEEPM. Panel B reports estimates from versions of the KEEPM which are augmented with additional risk factors. Panel C reports estimates from the KEEPM when the returns are denominated in Britsih pounds. Panel D reports results when using MSCI market indices instead of Datastream indices. Panel E reporets results of the KEEPM when including local risk factors. Panel F reports results using a new sample of 80 stocks, 40 from each country. Panel G reports results using portfolio return data. λ^{w} is the world stock market price of risk, λ^{us} is the orthogonal US stock market price of risk, λ^{uk} is the orthogonal UK stock market price of risk, λ^{cb} is the currency basket price of risk, $\lambda^{£}$ is the US$ bilateral rate to the British Pound, $\lambda^{¥}$ is the US$ bilateral rate to the Japanses Yen, λ^{dm} is the US$ bilateral rate to the German Mark, λ^{i} is the inflation price of risk, λ^{ip} is the industrial production price of risk, λ^{m} is the money market price of risk, and λ^{bm} is the book-to-market price of risk. The data are sampled monthly over the period January 1980 to December 2000.

Table 3
Estimates of Prices of Risk:Conditional Models

λ^w	λ^{us}	λ^{uk}	λ^w_{dy}	λ^{us}_{dy}	λ^{uk}_{dy}	λ^{us}_{ddy}	λ^{uk}_{ddy}	$\overline{R}^2$
0.618 (2.91)	−0.637 (4.05)	−1.063 (4.81)	−0.237 (0.86)					23
0.715 (3.10)	−0.612 (3.65)	−1.111 (4.67)	−0.149 (0.46)	−1.836 (3.49)	−0.0001 (0.02)			35
0.791 (3.33)	−0.664 (3.86)	−1.235 (5.01)	−0.373 (1.19)			−0.517 (1.67)	0.544 (1.99)	40

This table reports estimates of the prices of risk, along with the cross-sectional $\overline{R}^2$, from conditional versions of the KEEPM model. Conditioning is achieved by scaling the risk factor by a dividend yield. The first model in row 2 reports estimates from conditioning the world stock market price of risk.with the first lag of the demeaned world stock market dividend yield. The second model in row 3 reports estimates from conditioning the world stock market price of risk with the first lag of the demeaned world stock market dividend yield and conditioning the orthogonal country returns with their respective dividend yields. The third model in row 4 reports estimates from conditioning the world stock market price of risk.with the first lag of the demeaned world stock market dividend yield and conditioning the orthogonal country returns with the difference in their respective dividend yields. The data are sampled monthly over the period January 1980 to December 2000.

Table 4
Estimates of the Prices of Risk: US, UK, Japan, Germany

λ^{w}	λ^{us}	λ^{uk}	λ^{jp}	λ^{ge}	$\overline{R}^2$
0.266 (2.81)	−0.641 (5.88)	−0.599 (4.55)	−1.018 (7.50)	−0.648 (6.26)	22

Table 4 reports a set of estimates of the prices of risk, along with the cross-sectional $\overline{R}^2$ from the basic model using 25 excess stock returns from each of the following countries: US, UK, Japan and Germany. The data are sampled monthly over the period 1980 to end 2000.

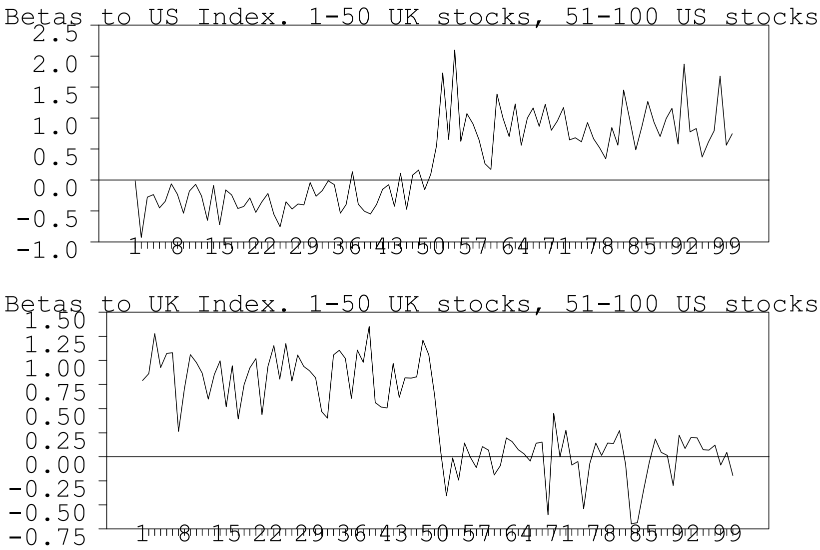

Figure 1: Betas with respect to the orthogonal market portfolios