Keeping 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 local Joneses, that is, those living in the same country. 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. Empirical tests reveal strong support for the models predictions. Furthermore, the model is robust to a number of alternative specifications and is easily distinguishable from models of partial integration.

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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 local Joneses, that is, those living in the same country. 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. Empirical tests reveal strong support for the models predictions. Furthermore, the model is robust to a number of alternative specifications and is easily distinguishable from models of partial integration.

1 Introduction

We derive and test a theoretical international asset pricing model based on "keeping up with the Joneses" preferences. In the model, the representative agent from a given country cares about both absolute wealth and the wealth of their neighbors (countrymen). Investors are willing to pay a premium for those stocks with a high correlation with domestic wealth (generally local stocks) because this "helps them to keep up with the local Joneses." Investors require a premium for holding stocks with no, or negative, correlation with domestic wealth (generally foreign stocks). Equilibrium asset prices reflect this observation with the expected return on a local asset depending on its covariance with aggregate world wealth and its covariance with local market wealth.

The contribution of the paper is the following. First, this is the first paper to consider and test the effects of "keeping up with the Joneses" preferences in an international setting.[1] Within a purely domestic setting, similar types of models to ours have been used in Abel (1990), Ferson and Constantinides (1991), Campbell and Cochrane (1999), Chan and Kogan (2000) and Boldrin, Christiano and Fisher (2001) as a possible explanation of the equity risk premium puzzle. Head and Smith (2003) consider these preferences, among others, in their attempt to explain interest rate persistence for a set of countries. Within a purely domestic setting, Galí (1994) focuses on the implications of consumption externalities (like keeping up with the Joneses) in a *symmetric equilibrium* where all the agents hold the same portfolio. He derives a one-factor CAPM where the market risk premium is shown to be lower when the representative agent keeps up with the Joneses.

Importantly, unlike the domestic symmetric equilibrium case of Galí, in an international investment framework there is convincing evidence that the equilibrium is non-symmetric, that is, investors hold different "home-biased" portfolios across countries.[2]

[1] DeMarzo, Keniel and Kremer (2002) show that agents' concern for relative wealth arises "endogenously" when borrowing-constrained investors compete for local resources within their community. Their indirect utility function coincides with the "behavioural" relative preferences of our representative investor. However, in their equilibrium, domestically biased portfolios arise only after imposing some degree of market segmentation across countries for a subset of local investors. In our model like, arguably, among developed economies, markets are fully integrated.

[2] See Lewis (1999) for an extensive survey. Tesar and Werner (1995) show that, to a large extent, this bias is also present among institutional investors. Domestic based regulations do not allow pension funds and life insurance companies to hold significant

The second contribution of the paper is to identify theoretically a specific domestic factor resulting from keeping up with the Joneses preferences that is shown in the empirical tests to have a strong effect on asset prices: namely the domestic market portfolio. Empirically it appears that domestic asset pricing models are able to price local assets more accurately than international models, and international asset pricing models can be improved upon if domestic factors are also included.[3] However, it is not all that clear how to rationalize this finding. A justification would be the presence of partially integrated markets,[4] but models of partial integration imply some restriction on cross border trade. For developed markets such restrictions are no longer observable. Transaction costs and taxes have been also studied and ruled out as relevant arguments.[5] Information costs could be a plausible explanation.[6] However, it may be argued that most international investment is carried out by institutional investors (mutual funds, investment banks or insurance companies) for whom the case of information asymmetry is much weaker. Other authors have proposed that diversification across industries within a country can account for most of the international portfolio risk diversification. This idea, however, has found little empirical support.[7]

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amounts of foreign assets. For example, Intersec Research Corporation report that in 1992 the amount of foreign equity holdings of UK and US life insurance companies was 17.5% and 2.9% respectively. The corresponding numbers for pension funds were 28% and 7.8% respectively.

[3]For example, 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)). King, Sentana, and Wadhawani (1994) find that local risk is priced in an international multi factor model. 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 role of domestic factors in a conditional version of the International CAPM. Harvey (1991) finds that the international CAPM is rejected for developed markets. Dumas, Harvey and Ruiz (2000) reject market integration for 12 developed OECD countries.

[4]For example, Errunza and Losq (1985) derive a model of partial integration which includes both a blobal and a local risk factor. The model predicts a positive risk premium on both of them.

[5]Tesar and Werner (1995) show a higher turnover in cross-border than in domestic stock investments. Cooper and Kaplanis (1994) find no evidence for taxes or exchange risk hedging as explanations of domestically biased portfolios.

[6]Brennan and Cao (1997) study a model of international investment *flows* with asymmetric information between local and foreign investors. The paper's empirical findings yield no conclusive evidence in favour of the model.

[7]Heston and Rouwenhorst (1994) study the role of industry structure across countries in international portfolio diversification. Using a dummy-variable regression model, they find that a country's industrial compositon explains very little of the stocks volatility. Using a larger sample, Griffin and Karolyi (1998) arrive at the same conclusion. Moreover, they

In our model financial markets are frictionless and fully integrated. Investors, endowed with keeping up of the Joneses type of preferences, must *infer* the average country's wealth by means of the information available in the market. We show that, as long as investors believe that the domestic market portfolio is informative about the average aggregate wealth, the optimal aggregate portfolio (hence consumption) will be biased towards domestic assets.

The third contribution of the paper, which offers an important difference with other existing models that consider local factors, is that our model predicts a negative price of risk on the local factor. We find strong empirical support of this finding and hence keeping up with the Joneses behavior rather than evidence of partial integration which requires a positive price of risk on the local factor.

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. We find that the prices of risk associated with the local risk factors are negative and the world price of risk is positive, as predicted by the model. Assets from country k have 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 have a negative beta with respect to the local risk factor, investors from country k require a premium to hold assets from country k'.

The model performs considerably better than the international CAPM and statistically we are unable to reject the presence of keeping up with the Joneses behaviour. In addition, the results are robust to the inclusion of currency risk, macroeconomic risk factors, the Fama and French (1998) HML risk factor, the choice of test assets, the choice of benchmark risk factors, and the introduction of stock returns from Japan and Germany. Furthermore, we find support for the model in both unconditional and conditional tests.

The paper is organized as follows. In section 2 we introduce the model and derive its testable implications. In section 3 we present the unconditional and conditional empirical models that we subsequently estimate.

show that the size of the "country specific" component in stocks return (relative to the world market return and net of the industry effect) is significant in their test due mainly to the inclusion of emerging market economies.

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

Consider a one-period, two-country economy. Let subscript $k \leq 2$ denote country k.[8] There is one only consumption good in the economy that we use as the numeraire. Each household has an initial wealth to be allocated among N risky assets with random gross return r and joint distribution function $F(r)$. At the end of the period, all payoffs are consumed.

The representative consumer in country k solves the following optimal portfolio problem:

$$\begin{array}{ll} x_k^* \in \text{argmax}_x & E\,U(c, C_k) \\ \text{s.t.} & c = w_k\, r'x, \end{array} \tag{1}$$

where c denotes the investor's consumption, C_k denotes the average consumption per capita in country k, x represents the portfolio of weights invested in the risky stocks, w_k is the investor's wealth and r is vector of excess returns. The investment opportunity set is common to all agents and no restrictions are placed on short-selling. For simplicity, and without loss of generality, assume that consumers in both countries have the same utility function and risk-aversion coefficient.

The first order condition from problem (1) can be stated as:

$$E\,U_c(w_k\, r'x_k^*, w_k\, r'X_k^*)'r = 0, \tag{2}$$

where X_k^* denotes the *average* portfolio in country k. We assume that investor's wealth, w_k, coincides with the country's wealth per capita.

Condition (2) allows us to write the optimal portfolio choice in each country as a function of X and $F(r)$. Let $x_k = \Phi[X_k; F(r)]$ represent this mapping.

In order to derive testable asset pricing implications we need to specify the utility function. Assume this to be of the form:

$$U(c, C) = (1-\alpha)^{-1} c^{1-\alpha} C^{\gamma\alpha}, \tag{3}$$

where $\alpha > 0$ is the (constant) relative risk-aversion coefficient and $1 > \gamma > 0$. By setting $\gamma > 0$, the constant *average consumption elasticity* of marginal

[8]The model can be easily generalized for any $K > 2$.

utility (around the symmetric equilibrium), $\alpha\gamma$, is positive as well: increasing the average consumption C makes the individual's marginal consumption more valuable since it helps her to "keep up with the Joneses." In short, we assume the average wealth to be a *positive consumption externality.*

Following Galí (1994), for small values of $E(r)$, the mapping functional $\Phi[X; F(r)]$ can be *approximated* as a function of α, γ and the risk adjusted risk-premia $\Omega^{-1}E(r)$, with $E(r)$ and Ω the mean *excess* return vector and covariance matrix of r, respectively:[9]

$$\Phi[X_k; F(r)] \approx \gamma X_k + (1/\alpha)\,\Omega^{-1}E(r). \tag{4}$$

Assets are in positive net supply. Without loss of generality, let us assume that the first N_1 assets are issued by country 1 firms and the remaining $N_2 = N - N_1$ are issued by country 2 firms. Denote x_M^k the N-dimension *domestic market portfolio* for country k. For country 1 (alternatively, country 2), the first N_1 (last N_2) rows correspond to the capitalization value of each domestic asset as a proportion of country market wealth, W_1 (W_2); the remaining rows are zeros. Denote x_M the *global market portfolio*: the capitalization value of each asset as a proportion of the global market wealth, W. By definition,

$$x_M = \omega_1 x_M^1 + \omega_2 x_M^2,$$

with $\omega_k = \frac{W_k}{W}$, the relative wealth in country k.

2.1 Universal Joneses: The symmetric equilibrium

In a *symmetric* equilibrium the portfolio chosen by each agent within a country (and thus the local average portfolio) is given by a fixed point, x_k^*, of the functional Φ such that:

$$x_k^* = \Phi[x_k^*; F(r)], \text{ for } k \leq 2.$$

Given (4), the optimal portfolio choice will be approximately

$$x^* = (1/\alpha(1-\gamma))\,\Omega^{-1}E(r),$$

in either country. Define the aggregate demand portfolio $\bar{x}$ as the weighted average of the (country) optimal portfolios x_1^* and x_2^*:

[9] Notice that the same result follows *exactly* if we assume a negative exponential utility function and a joint normal distribution for stock returns, like in Roll(1992).

$$\bar{x} = \sum_k \omega_k \, x_k^*.$$

In the symmetric equilibrium, $\bar{x} = x^*$. Then, by market clearing ($\bar{x} = x_M$), the standard CAPM risk return trade-off follows:

$$E(r) = \alpha(1-\gamma)\,\Omega\, x_M, \tag{5}$$

where the assets' risk premium is linearly related to their covariance with the market portfolio. Pre-multiplying both terms in (5) by x_M' we obtain the market price of risk:

$$\lambda_M = \alpha(1-\gamma)\,\sigma_M^2, \tag{6}$$

as a function of the market volatility, σ_M^2. We observe that: (i) keeping up with the Joneses ($\gamma > 0$) leads to a reduction in the price of risk; (ii) in a symmetric equilibrium, the Joneses are *universal*, that is, common across countries; (iii) as a consequence, the only source of systematic risk is the covariance with the global market portfolio.

2.2 Local Joneses: A non-symmetric equilibrium

In this paper, we postulate that investors keep up with the Joneses and that these Joneses are *local*.[10]

In what follows, we will show that the assumption of local Joneses leads to a non-symmetric equilibrium where global and local factors are priced. As a way to motivate this non-symmetric equilibrium, suppose that the representative investor must infer her country's average wealth after observing the portfolio choice of a random sample of size $n < \infty$ among her compatriots. These random observations are drawn from a normal distribution with unknown mean portfolio X_k and known precision $\epsilon > 0$. Denote by $\bar{x}_k$ the value of the sample mean.

Additionally, the investor observes proxies of the market portfolio in the form of market indices. Suppose that the investor's prior of the average country portfolio X_k is a normal distribution centered around the country's market portfolio x_M^k with precision $\tau > 0$. Given this prior distribution and the information collected from the random observations, the representative

[10] In theory, other equilibria may exist where, for example, local investors keep up with *foreign* Joneses. To devise the mechanism that lead to such equilibria is beyond the scope of this paper.

investor can calculate (see De Groot (1970), chapter 9) the posterior distribution of X_k. This distribution is normal with mean $\bar{X}_k$ and precision $\tau+n$, where

$$\bar{X}_k(x_M^k, \bar{x}_k) = \theta x_M^k + (1-\theta)\bar{x}_k,$$

with $\theta = \frac{\tau}{\tau+n}$ the information to signal ratio. This way, the posterior mean average portfolio arises as a weighted average of the sample average portfolio $\bar{x}_k$ and the observed country market portfolio x_M^k. The parameter θ measures how informative the observable domestic market portfolio is about the country's average wealth. On the other side, $(1-\theta)$ is proportional to the precision of the conditional distribution of the sample mean, n, for any given value of X_k. In the limit, when $\tau \to 0$ the prior information conveyed by the market portfolio is totally unreliable and the posterior mean coincides with the sample mean. The same result follows in the limit when either the sample size (n) or the precision of the sample's distribution (ϵ) are very large relative to τ. After deriving the conditional average portfolio, a new (asymmetric) equilibrium is defined as a fixed point of the functional Φ, where the optimal (posterior) portfolio of the representative investor equals the sample's mean:

$$x_k^* = \Phi[\bar{X}_k(x_M^k, x_k^*); F(r)], \text{ for } k \leq 2.$$

Given the return moments Ω, $E(r)$ and the optimal portfolio choice (4), the aggregate portfolio in country k will be:

$$x_k^* = \gamma_a x_M^k + (1/\alpha_a)\Omega^{-1}E(r), \tag{7}$$

with $\gamma_a = \frac{\gamma\theta}{1-(1-\theta)\gamma}$ and $\alpha_a = \alpha(1-(1-\theta)\gamma)$, the redefined "asymmetric" parameters.

Notice that (7) nests several particular cases. If $\gamma = 0$, $x^* = (1/\alpha)\Omega^{-1}E(r)$ in either country, the standard trade-off between risk and return from the international CAPM (ICAPM). If $\gamma > 0$, investors keep up with the Joneses. In such a case, when $\theta \to 0$, in the limit, $x^* = (1/\alpha(1-\gamma))\Omega^{-1}E(r)$: the symmetric equilibrium described in the previous section. Finally, when $\theta \to 1$, in the limit, $x_k^* = \gamma x_M^k + (1/\alpha)\Omega^{-1}E(r)$: the sample mean is ignored and the home bias is maximum.

2.3 Asset pricing implications

Let $r_M^k = r' x_M^k$ be the return on the domestic market portfolio for country k; r_M denotes the return on the world market portfolio. We regress r_M^k onto the world market portfolio return plus a constant:

$$r_M^k = a_k + \beta_k\, r_M + \xi_k$$

Portfolio $\beta_k\, x_M$ represents the projection of the domestic Joneses wealth, x_M^k, onto the *security market line* spanned by the global market portfolio x_M. Define the portfolio $o_k \equiv x_M^k - \beta_k\, x_M$ as a "residual" portfolio with return $or_k = o_k \cdot r$. By construction, this portfolio has zero covariance with the global market portfolio. Also, it has expected return $E(or_k) = E(a_k) = E(r_M^k) - \beta_k E(r_M)$. The net investment in this portfolio is $o_k' \mathbf{1} = (1 - \beta_k)$.

After these definitions, x_M^k can be represented by the following *orthogonal decomposition*:

$$x_M^k = \beta_k\, x_M + o_k \text{ with } \mathrm{Cov}(r_M, or_k) = 0.$$

Finally, given (7), the investor's optimal portfolio can be expressed as follows:

$$x_k^* = \gamma_a o_k + \gamma_a \beta_k\, x_M + (1/\alpha_a)\, \Omega^{-1} E(r), k \leq 2.$$

This 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. Given the orthogonality conditions portfolio o_k replaces the risk-free 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 *standard component*, $\Omega^{-1} E(r)$, corresponds to the highest global Sharpe-ratio portfolio and is common across countries.

Imposing market clearing ($\bar{x} = x_M$), the equilibrium pricing equation (5) becomes:

$$E(r) = \alpha_a\, \Omega \left((1 - \gamma_a \sum_k \omega_k \beta_k)\, x_M - \gamma_a \sum_k \omega_k\, o_k \right), \tag{8}$$

Equation (8) states that the excess return on any asset in our two-country model is explained by its covariance with three risk factors: the market portfolio and two country-specific, zero-beta portfolios.

The two new factors arise in equilibrium induced by the external habit formation in the investors utility function. As long as investors are concerned about keeping up with the Joneses ($\gamma > 0$), the price 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, o_k. Notice that if $\gamma = 0$ equation (8) becomes the standard single beta international CAPM. If $\gamma > 0$ but $\theta \rightarrow 0$ the model reduces to the single beta symmetric equilibrium of Galí (1994).

Define the matrix $\boldsymbol{o}$ of dimension $N \times 3$ as the column juxtaposition of the market portfolio and the orthogonal portfolios, $\boldsymbol{o} \equiv (x_M, o_1, o_2)$. Additionally, define the *wealth vector* $\boldsymbol{W}$ as follows:

$$\boldsymbol{W} \equiv \alpha_a \begin{pmatrix} 1 - \gamma_a \sum_k \omega_k \, \beta_k \\ -\gamma_a \omega_1 \\ -\gamma_a \omega_2 \end{pmatrix}.$$

Given these definitions, the equilibrium condition (8) can be re-written as follows:

$$E(r) = \Omega \, \boldsymbol{o} \boldsymbol{W}. \tag{9}$$

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

$$\boldsymbol{\lambda} = \boldsymbol{o}' \Omega \, \boldsymbol{o} \, \boldsymbol{W}, \tag{10}$$

where $\boldsymbol{o}' \Omega \, \boldsymbol{o}$ is a matrix of dimension 3×3 whose first column (row) includes the market return volatility and a vector of 2 zeros and the remaining elements consist of the covariances between o_k and $o_{k'}$ for $k, k' \leq 2$.

Consider the sign of these prices of risk. From (10), the market price of risk is given by:

$$\lambda_M = \alpha_a \left(1 - \gamma_a \sum_k \omega_k \; \beta_k \right) \sigma_M^2.$$

When $\theta \rightarrow 0$, in the limit, the previous equation becomes (6), the market price of risk in the symmetric equilibrium. The prices of risk for the zero-beta portfolios are given by:

$$\begin{aligned} \lambda_1 &= -\alpha_a \, \gamma_a (\omega_1 \, \mathrm{Var}(or_1) + \omega_2 \, \mathrm{Cov}(or_1, or_2)), \\ \lambda_2 &= -\alpha_a \, \gamma_a (\omega_2 \, \mathrm{Var}(or_2) + \omega_1 \, \mathrm{Cov}(or_1, or_2)). \end{aligned}$$

This system of equations will allow us to test the model's predictions. In the first place, the model predicts that all prices of risk should be increasing (in absolute value) in the aggregate risk aversion coefficient α_a.

Furthermore, *if representative investors in both countries keep up with the local Joneses* (i.e. $\gamma > 0$, $\theta > 0$), there should be two additional risk factors together with the market risk factor. Regarding their sign, the model predicts that, if $\text{Cov}(or_1, or_2) > 0$, λ_1 *and* λ_2 *will be negative.* To understand this result, suppose for the moment that the zero-beta portfolios were orthogonal pairwise ($\text{Cov}(or_1, or_2) = 0$). 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, *partially correlated with the domestic market portfolio* ($\theta > 0$). This investor will be willing to pay a higher price for that asset thus yielding a lower return in equilibrium. As expected, in equilibrium, the price of risk for o_k would be, in absolute terms, increasing in the country's relative market size, ω_k, and the volatility of the hedge portfolio.

If the covariance between both zero-beta portfolios is positive, this just increases 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 country k', thus increasing its equilibrium price.

Finally, solving for $\boldsymbol{W}$ in (10) and replacing it in (9) we obtain:

$$E(r) = \boldsymbol{\lambda}\boldsymbol{\beta}, \tag{11}$$

where $\boldsymbol{\beta} = \Omega\, \boldsymbol{o}\,(\boldsymbol{o}'\Omega\, \boldsymbol{o})^{-1}$ denotes the $N \times 3$ matrix of betas, with the first column as the market betas for the N assets.

According to equation (11), in equilibrium, prices are determined by a linear multi-factor model where, together with market risk there exist two other orthogonal factors (one per country) that capture the investors' concern for keeping up with the domestic Joneses. We name this model as KEEPM, standing for "KEEping up Pricing Model." The rest of the paper deals with testing the asset pricing implications of the model.

3 Empirical Models

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 average returns. In addition, we compare the KEEPM against a set of alternative models that differ in terms of the source of priced risk.

3.1 Unconditional Models

We take the two countries to be the UK and the US.[11] From equation (11), 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. 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 Joneses behavior irrespective of the choice of international risk factors.

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), 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 for $\gamma = 0$. This permits the use of a likelihood

[11] Japan and Germany are introduced into the analysis later.

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 (1981), Adler and Dumas (1983). In addition to exchange rates other macroeconomic factors have been used in international asset pricing models when estimating international versions of Ross's (1976) Arbitrage Pricing Theory (see, for example, Ferson and Harvey (1994)). Along with the currency basket we also include three macroeconomic based factors: world unexpected inflation, world unexpected industrial production, and the return on world money markets.

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

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, λ^{cb} is the currency basket price of risk and β_i^{cb} is the β with respect to the currency basket.

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.

3.2 Conditional Models

The theoretical model that we have developed is static and consequently both the betas and prices of risk are constant. As a result of this the models described above are unconditional. There are two reasons why we wish to consider a conditional asset pricing model which allows expected returns to time vary. First, whilst many asset pricing models are estimated in a static framework, dynamic version of various asset pricing models model are theoretically available and there is evidence that expected excess returns are time-varying (see, for example, Harvey (1991), Chan, Karolyi, and Stulz (1992), Bekaert and Harvey (1995) and DeSantis and Gerard (1997)). We want to test the possibility that our two orthogonal factors are somehow proxying for time-variation in a dynamic version of the ICAPM. Second, whilst we do not derive a dynamic version of the KEEPM model, we can empirically allow for conditioning information in our two new factors to see if it is important.

We introduce conditioning information by scaling the risk factor with the (demeaned) first lag of the dividend yield (see Cochrane (1996)).[12] We estimate two 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

[12] The choice of dividend yield as the conditioning information is arbitrary in our model. However, there is strong empirical evidence that the dividend yield is important in forecasting future returns.

respect to the scaled excess return on the orthogonal UK market portfolio $(or_{uk,t} \times dy_{uk,t-1})$.

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)).

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.[13] 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)).[14]

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

$$\mathbf{r}_t = E(\mathbf{r}) + \boldsymbol{\beta}_k \mathbf{f}_{kt} + \mathbf{u}_t \tag{12}$$

$$E(\mathbf{r}) = \boldsymbol{\beta}_k \boldsymbol{\lambda}_k, \tag{13}$$

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 (13) into (12) and stacking the equations for the N securities gives:

$$\mathbf{r} = \left\{\mathbf{I}_N \otimes \left[(\boldsymbol{\lambda}' \otimes \boldsymbol{\iota}_\mathbf{T}) + \mathbf{f}\right]\right\} \boldsymbol{\beta} + \mathbf{u}, \tag{14}$$

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 $Nk \times 1$

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

[14] 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.

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:

$$\min_{\boldsymbol{\lambda},\boldsymbol{\beta}} \mathbf{u}' \left(\hat{\boldsymbol{\Sigma}}_{\mathbf{u}}^{-1} \otimes \mathbf{I}_T \right) \mathbf{u}, \tag{15}$$

where $\hat{\boldsymbol{\Sigma}}_{\mathbf{u}}^{-1}$ is the residual covariance matrix obtained from estimating (14).[15]

The main focus of the paper is on 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 test 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.

[15] By estimating an unrestricted model and then estimating a restricted version and taking the change in the least squares criterion function as an asymptotically valid Chi-square test (see Gallant and Jorgenson (1979)) we can form a likelihood ratio test of the restrictions. This is important when we want to test Joneses behaviour relative to another international asset pricing model.

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. The cross sectional variation in the individual asset returns is impressive. The mean return is 0.86% per month with a standard deviation of 0.57 and minimum and maximum values of -0.49 and 2.98% per month respectively. All data are denominated in US dollars.

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. Moreover, 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. Furthermore, 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.[16] Notwithstanding this, as a robustness check, we also estimate our model using portfolios which are not affected by survivorship bias. The results are robust to the use of either individual stocks that have survived the whole 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. In the robustness tests we use the Morgan Stanley indices as well.

[16] 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)).

To proxy exchange rate risk we use a currency basket which is a trade weighted index of the USD. 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). All data used in the paper are collected from Datastream except for the HML factor which is kindly provided by Ken French.

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 currency basket is positive, indicating that the USD appreciated over the sample period. 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 lower half of table 1 reports a correlation matrix of the factors and shows that multicollinearity is unlikely to be a problem.

6 Empirical Results

6.1 Unconditional tests

The main empirical results of the paper are presented in panel A of table 2, where we report estimates of the KEEPM using the 100 individual stock returns. The world stock market price of risk is estimated at 0.610 and is statistically significant at the 1% level. The orthogonal US market price of risk is estimated to be -0.135 and the orthogonal UK market price of risk is estimated to be -0.458. Both have the correct sign, and the t-ratios indicate that the price of risk associated with the UK price of risk is statistically significant at the 5% level. The price of risk associated with the US price of risk is not statistically significant. However, it has the correct sign and is an economically meaningful 1.5% per year.

The final column of the panel reports the probability values from a likelihood ratio test (distributed Chi-Square) of the null hypothesis that Joneses behavior is not important, 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 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. Overall, the signs and the statistical significance of the prices of risk provide strong evidence consistent with keeping up with the Joneses behavior.

Panel B of table 2 presents the estimates of the three betas for each asset. The estimated betas with respect to the world market portfolio are all positive. The betas associated with the orthogonal market portfolios exhibit strong evidence of Jones behaviour. The US stocks have positive betas with respect to the US orthogonal market portfolio and negative (some small positive) betas with respect to the UK orthogonal market portfolio. Similarly, UK stocks have positive betas with respect to the UK orthogonal market portfolio and negative betas with respect to the US orthogonal market portfolio.

The evidence so far confirms that investors are willing to give up return for those stocks that are positively correlated with their local market since it keeps them up with their Joneses. Stocks that do not keep them up with their Joneses (stock which have a negative beta) are foreign stocks and a positive risk premium is required to hold them. This effect seems to be stronger in the UK than the US. 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 in each country.

Panel B also contains a test for the null hypothesis of no serial correlation and homoscedastic errors for each of the estimated equations. The null of homoscedastic errors is rejected in only 4 cases and we find evidence against the null of no serial correlation in seven cases. Thus, the models residuals are well specified, which should allow for straightforward interpretations of the estimates. Pricing errors (not reported) for each individual asset are not significantly different from zero at the 5% level more than it would be expected by chance.

6.2 Robustness tests

This section examines the robustness of the results to alternative risk factors, test assets and sourcing of the stock market portfolio data. The estimation results of models with alternative risk factors are presented in Panel A of table 3. 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 35% more of the cross sectional variation in average excess returns than the ICAPM.

The rest of the models in Panel A 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, unexpected inflation, unexpected industrial production and the return on world money markets. The estimated price of currency risk is -0.654% per month, and it is statistically significant at the 5% level. The unexpected industrial production factor has a statistically significant price of risk whilst the money market price of risk and the inflation price of risk are not statistically significant. In this model the $\overline{R}^2$ increases to 38% and therefore, it seems that these two risk factors are important in explaining the cross section of international asset returns.

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.

The final model presented in panel A 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% level and is estimated at -0.559% per month. Of the 50 UK firms, 39 of the HML betas are positive. Of the 50 US firms, 35 of the HML betas are positive. In total, thirty percent of the HML betas are statistically significant, the majority of which are positive. 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.

Panel B of table 3 reports 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 $\overline{R}^2$. Panel C 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.[17] The UK portfolios are formed from the London Business School data base. Stocks are ranked into deciles based on size and then sorted again 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 D reports the estimates of the model using the portfolio data over the shorter time period. The prices of risk associated with the orthogonal local market portfolios are both estimated to be negative. Thus survivorship bias does not appear to be important. Notice that with this set of test assets the price of risk associated with US orthogonal portfolio is now statistically significant.

6.3 Additional Countries

The next 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 all but the Japanese price of risk are statistically significant, lending strong support to our model. The $\overline{R}^2$ is 46%, thus the model performs better in the cross section with the introduction of additional countries. Therefore, it appears that the model is robust to the inclusion of the two additional countries.

6.4 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).

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

Table 5 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 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 46%. Notwithstanding this, there is no effect on the unconditional prices of risk.

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 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 wealths.

We test the model's asset pricing predictions and find that the price of risk associated with the local risk factors are negative and the world price of risk is positive, as predicted by the model. These results are robust to a host of specification tests, and to the use of unconditional and conditional testing frameworks.

When we introduce preferences of the type "keeping-up with the Joneses" in an international setting we can account for the puzzling feature that 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. Whilst we provide direct evidence in this regard, we also believe that our model may have two further implications for so called puzzles in international finance. First, changes in the cost of capital given stock market liberalizations are much smaller than expected theoretically, and second investor exhibit home bias.[18]

Our model may provide 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 and does predicts a home bias.[19] Further research should try and establish whether our model can explain these two further puzzles.

[18] 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).

[19] To see how our model may induce home bias consider equation (7) which describes the portfolio holdings in the asymmetric equilibrium. The extent to which our model is able to explain home bias depends on τ, an exogenous parameter in the model.

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Table 1
Summary Statistics

	R_w	CB	I	IP	WM	HML
Mean	0.632 (4.23)	0.086 (1.34)	0.000 (0.18)	0.000 (0.85)	0.620 (2.34)	0.476 (2.93)
AR(1)	0.039 [0.53]	0.303 [0.00]	-0.035 [0.57]	-0.004 [0.95]	0.070 [0.27]	0.158 [0.01]
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	
HML	-0.169	0.137	0.046	0.095	0.021	1.00

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 except for the HML factor which is kindly provided by Ken French. 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 and HML is the Fama and French international high minus low book-to-market portfolio. 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 the KEEPM

Panel A: Price of Risk Estimates

λ^w	λ^{us}	λ^{uk}	$\overline{R}^2$	LR
0.610 (2.89)	-0.135 (0.85)	-0.458 (2.08)	23	< 0.01

Panel B: Betas and Specification Tests (Part I: Assets 1 through 50)

Stock	β_w	β_{ous}	β_{ouk}	Heter	SC	Stock	β_w	β_{ous}	β_{ouk}	Heter	SC
r_1	0.721	−0.019	0.788	2.74	1.68*	r_{26}	0.768	−0.351	0.787	7.89*	1.89
	(4.94)	(0.09)	(4.55)				(8.38)	(2.44)	(7.24)		
r_2	1.079	−0.932	0.861	4.25	1.94	r_{27}	0.862	−0.468	1.056	0.23	2.12
	(4.18)	(2.30)	(2.81)				(9.68)	(3.35)	(10.00)		
r_3	1.316	−0.281	1.277	7.37	1.97	r_{28}	0.652	−0.387	0.938	3.59	2.24
	(8.01)	(1.09)	(6.55)				(6.93)	(2.62)	(8.41)		
r_4	0.675	−0.236	0.925	0.12	2.24	r_{29}	0.892	−0.399	0.893	1.91	2.11
	(7.23)	(1.61)	(8.34)				(9.09)	(2.60)	(7.67)		
r_5	0.805	−0.446	1.074	4.07	2.11	r_{30}	0.832	−0.039	0.821	1.53	1.86
	(5.39)	(1.90)	(6.06)				(4.91)	(0.15)	(4.04)		
r_6	0.932	−0.339	1.081	2.87	1.96	r_{31}	0.402	−0.261	0.469	3.81	1.82
	(6.05)	(1.40)	(5.90)				(5.77)	(2.39)	(5.68)		
r_7	0.241	−0.066	0.262	4.42	1.78	r_{32}	0.754	−0.173	0.400	2.75	2.15
	(1.54)	(0.27)	(1.41)				(3.98)	(0.58)	(1.78)		
r_8	0.949	−0.234	0.706	2.33	1.72*	r_{33}	1.286	−0.007	1.061	2.35	1.89
	(4.58)	(0.88)	(3.49)				(8.19)	(0.03)	(5.69)		
r_9	0.855	−0.533	1.061	7.03	2.18	r_{34}	1.021	−0.075	1.104	4.44	2.10
	(5.70)	(2.26)	(5.95)				(7.05)	(0.33)	(6.42)		
r_{10}	0.773	−0.175	0.981	3.77	1.91	r_{35}	0.928	−0.535	1.021	2.06	2.13
	(6.27)	(0.91)	(6.69)				(6.31)	(2.32)	(5.85)		
r_{11}	1.031	−0.071	0.868	4.59	2.33	r_{36}	0.659	−0.399	0.606	7.20	1.95
	(8.90)	(0.39)	(6.31)				(6.22)	(2.39)	(4.81)		
r_{12}	0.543	−0.256	0.602	2.12	2.02	r_{37}	0.968	0.135	1.108	1.87	1.71*
	(3.07)	(0.92)	(2.87)				(9.03)	(0.85)	(9.15)		
r_{13}	1.041	−0.645	0.857	3.57	1.73*	r_{38}	0.969	−0.394	0.979	2.14	2.22
	(5.35)	(2.11)	(3.71)				(9.47)	(2.34)	(7.70)		
r_{14}	0.843	−0.086	0.995	2.77	2.00	r_{39}	1.219	−0.504	1.358	4.30	2.06
	(6.65)	(0.44)	(6.78)				(3.85)	(1.01)	(0.85)		
r_{15}	0.838	−0.723	0.518	0.66	1.97	r_{40}	0.549	−0.550	0.563	0.12	1.86
	(4.83)	(2.65)	(2.51)				(6.01)	(3.83)	(5.19)		
r_{16}	1.053	−0.161	0.945	3.49	2.41	r_{41}	0.397	−0.397	0.516	0.20	2.09
	(10.21)	(0.99)	(7.72)				(3.90)	(2.48)	(4.26)		
r_{17}	0.923	−0.236	0.396	2.69	1.66*	r_{42}	0.416	−0.151	0.509	0.28	1.68*
	(3.40)	(0.56)	(1.23)				(3.17)	(0.73)	(3.27)		
r_{18}	0.747	−0.457	0.751	1.05	2.00	r_{43}	0.536	−0.075	0.968	0.43	2.15
	(4.04)	(1.57)	(3.41)				(5.73)	(0.51)	(8.73)		
r_{19}	0.753	−0.431	0.921	4.93	2.19	r_{44}	0.845	−0.424	0.615	5.66	1.79
	(3.99)	(1.45)	(4.10)				(5.76)	(1.84)	(3.53)		
r_{20}	0.832	−0.289	1.018	5.19	2.04	r_{45}	0.717	0.107	0.821	3.38	2.26
	(8.16)	(1.81)	(8.42)				(5.29)	(0.50)	(5.10)		
r_{21}	0.574	−0.527	0.436	6.18	1.75	r_{46}	0.642	−0.473	0.815	4.09	1.79
	(4.11)	(2.40)	(2.63)				(6.58)	(3.09)	(7.04)		
r_{22}	0.617	−0.356	0.938	1.49	2.21	r_{47}	0.840	0.076	0.827	8.28*	2.12
	(4.81)	(1.77)	(6.17)				(7.75)	(0.45)	(6.43)		
r_{23}	0.889	−0.222	1.151	2.16	1.91	r_{48}	0.987	0.159	1.208	3.12	2.30
	(3.58)	(0.57)	(3.98)				(10.56)	(1.09)	(10.92)		
r_{24}	0.655	−0.549	0.806	3.24	2.06	r_{49}	0.684	−0.157	1.057	1.98	2.06
	(3.91)	(2.08)	(4.04)				(7.12)	(1.04)	(9.29)		
r_{25}	1.174	−0.754	1.177	11.47*	1.65*	r_{50}	0.916	0.094	0.639	0.33	1.98
	(7.68)	(3.14)	(6.50)				(4.49)	(0.29)	(2.64)		

Panel B: Betas and Specification Tests (Part II: Assets 51 through 100)

Stock	β_w	β_{ous}	β_{ouk}	Heter	SC	Stock	β_w	β_{ous}	β_{ouk}	Heter	SC
r_{51}	0.906	0.552	0.045	3.01	2.31	r_{76}	0.741	0.933	−0.071	1.28	2.11
	(7.26)	(2.81)	(0.30)				(7.73)	(6.20)	(0.62)		
r_{52}	1.078	1.727	−0.403	5.55	1.92	r_{77}	0.268	0.661	0.141	4.48	2.22
	(6.20)	(6.33)	(1.96)				(1.43)	(2.25)	(0.64)		
r_{53}	0.282	0.651	−0.011	4.10	2.05	r_{78}	0.483	0.517	0.015	2.58	2.27
	(2.83)	(4.14)	(0.09)				(10.26)	(7.00)	(0.27)		
r_{54}	1.484	2.097	0.241	3.28	1.98	r_{79}	0.301	0.340	0.142	2.10	2.07
	(8.67)	(7.81)	(1.19)				(4.02)	(2.90)	(1.60)		
r_{55}	1.050	0.625	0.144	5.27	2.38	r_{80}	0.650	0.845	0.136	0.11	2.24
	(7.80)	(2.96)	(0.90)				(6.58)	(5.45)	(1.16)		
r_{56}	0.799	1.072	−0.008	2.28	1.92	r_{81}	0.591	0.562	0.272	8.54	2.32
	(8.03)	(6.86)	(0.07)				(4.05)	(2.45)	(1.57)		
r_{57}	0.787	0.911	−0.111	1.67	1.97	r_{82}	1.198	1.453	−0.073	1.62	2.25
	(4.64)	(3.42)	(0.55)				(4.91)	(3.79)	(0.27)		
r_{58}	0.648	0.646	0.107	1.54	1.98	r_{83}	0.868	0.978	−0.696	1.89	2.04
	(5.83)	(3.69)	(0.81)				(3.75)	(2.69)	(2.53)		
r_{59}	0.273	0.261	0.067	3.87	2.22	r_{84}	0.756	0.479	−0.685	0.33	1.94
	(3.68)	(2.23)	(0.75)				(1.84)	(0.74)	(1.40)		
r_{60}	0.154	0.166	−0.191	6.97	2.19	r_{85}	0.592	0.861	−0.354	0.90	1.83
	(1.48)	(1.01)	(1.54)				(5.58)	(5.17)	(2.82)		
r_{61}	0.900	1.387	−0.090	3.78	2.06	r_{86}	0.814	1.267	0.051	5.55	1.93
	(5.45)	(5.35)	(0.46)				(6.12)	(6.07)	(0.32)		
r_{62}	0.788	0.966	0.196	1.63	2.07	r_{87}	0.595	0.931	0.183	2.22	2.38
	(5.02)	(4.03)	(1.05)				(5.40)	(5.38)	(1.40)		
r_{63}	0.624	0.702	0.157	1.73	2.25	r_{88}	0.449	0.699	0.047	0.83	2.38
	(5.66)	(4.05)	(1.20)				(4.14)	(4.11)	(0.37)		
r_{64}	0.991	1.228	0.075	3.53	1.93	r_{89}	0.851	0.995	0.015	6.29	2.07
	(10.61)	(8.39)	(0.68)				(8.38)	(6.22)	(0.13)		
r_{65}	0.905	0.561	0.031	0.69	1.96	r_{90}	1.077	1.166	−0.292	0.89	1.87
	(3.95)	(1.56)	(0.12)				(4.17)	(2.87)	(0.95)		
r_{66}	0.498	1.003	−0.040	3.80	2.29	r_{91}	0.392	0.581	0.225	0.53	2.11
	(3.22)	(4.12)	(0.22)				(2.09)	(1.97)	(1.01)		
r_{67}	0.683	1.169	0.146	1.66	1.96	r_{92}	1.012	1.873	0.088	0.95	2.18
	(2.22)	(2.42)	(0.40)				(5.14)	(6.06)	(0.38)		
r_{68}	0.669	0.866	0.152	1.48	2.29	r_{93}	0.663	0.778	0.201	0.67	2.16
	(6.86)	(5.66)	(1.32)				(5.71)	(4.27)	(1.46)		
r_{69}	1.725	1.221	−0.603	0.74	2.23	r_{94}	0.641	0.827	0.194	2.26	2.12
	(4.31)	(1.94)	(1.27)				(3.71)	(3.04)	(0.95)		
r_{70}	0.478	0.802	0.449	0.59	2.05	r_{95}	0.617	0.371	0.075	2.74	1.99
	(3.56)	(3.81)	(2.81)				(5.57)	(2.13)	(0.57)		
r_{71}	0.576	0.958	0.002	12.05*	2.01	r_{96}	0.573	0.615	0.071	2.80	2.30
	(5.85)	(6.19)	(0.02)				(5.32)	(3.64)	(0.55)		
r_{72}	0.836	1.171	0.276	2.82	2.00	r_{97}	0.688	0.793	0.121	1.49	1.97
	(5.71)	(5.09)	(1.59)				(4.51)	(3.30)	(0.66)		
r_{73}	0.859	0.643	−0.090	5.82	1.93	r_{98}	0.174	1.675	−0.087	6.57	2.14
	(5.02)	(2.39)	(0.43)				(0.59)	(3.85)	(0.27)		
r_{74}	0.566	0.681	−0.048	6.91	2.19	r_{99}	0.705	0.564	0.046	1.02	2.08
	(4.93)	(3.78)	(0.36)				(2.81)	(1.43)	(0.16)		
r_{75}	0.927	0.615	−0.537	0.80	2.02	r_{100}	0.532	0.746	−0.195	4.88	2.09
	(3.12)	(1.32)	(1.52)				(5.68)	(5.07)	(1.76)		

This table reports estimates of the prices of risk, along with the cross-sectional $\overline{R}^2$ from 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 of prices of risk from the KEEPM: 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. Panel B reports estimates of the betas with respect to the risk factors: β_w is the beta with respect to the world market portfolio, β_{ous} is the beta with respect to the orthogonal US market portfolio, β_{ouk} is the beta with respect to the orthogonal UK market portfolio. Also reported in Panel B are tests for heteroscedasticity (Heter) and serial correlation (SC) of each equation's residuals. The data are sampled monthly over the period January 1980 to December 2000. * indicates statistically significant at the 5% level.

Table 3
Robustness Tests

λ^w	λ^{us}	λ^{uk}	λ^{cb}	λ^i	λ^{ip}	λ^m	λ^{bm}	$\overline{R}^2$	LR
Panel A: Alternative Models									
0.558 (3.57)								15	
0.786 (3.12)	−0.161 (0.89)	−0.597 (2..25)	−0.654 (4..48)	0.028 (1.53)	0.186 (2.07)	−0.237 (0.92)		38	< 0.01
0.575 (2.73)	−0.115 (0.72)	−0.446 (2.01)					−0.559 (2.68)	22	< 0.01
Panel B: MSCI Market Indices									
0.662 (3.44)	−0.178 (1.18)	−0.432 (1.97)						21	< 0.01
Panel C: New Assets: 40 UK and 40 US									
0.939 (3.93)	−0.153 (0.84)	−0.490 (2.02)						35	< 0.01
Panel D: Portfolio Data: 1980- 1995									
0.423 (2.17)	−0.414 (2.97)	−0.529 (2.45)						10	< 0.01

Panel A of 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 ($\lambda^{ous} = \beta^{ous} = \lambda^{ous} = \beta^{ous} = 0$). 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, 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. Panel B estimates the model using MSCI market portfolio data, Panel C introduces a new set of individual asset returns and Panel D reports estimates using portfolio data. 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}	$\overline{R}^2$	LR
0.372 (3.98)	-0.253 (2.37)	-0.236 (1.81)	-0.161 (1.22)	-0.231 (2.19)	46	< 0.01

This table reports a set of estimates of the prices of risk, along with the cross-sectional $\overline{R}^2$ and likelihood ratio test (LR), 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.

Table 5
Estimates of Prices of Risk: Conditional Models

λ^w	λ^{us}	λ^{uk}	λ^w_{dy}	λ^{us}_{dy}	λ^{uk}_{dy}	$\overline{R}^2$	LR
0.619	−0.147	−0.471	−0.237			23	< 0.01
(2.92)	(0.92)	(2.12)	(0.86)				
0.643	−0.035	−0.508	0.078	−1.508	−0.499	46	< 0.01
(2.63)	(0.20)	(2.01)	(0.25)	(5.56)	(1.73)		

This table reports estimates of the prices of risk, along with the cross-sectional $\overline{R}^2$ and the likelihood ratio test (LR), 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 data are sampled monthly over the period January 1980 to December 2000.

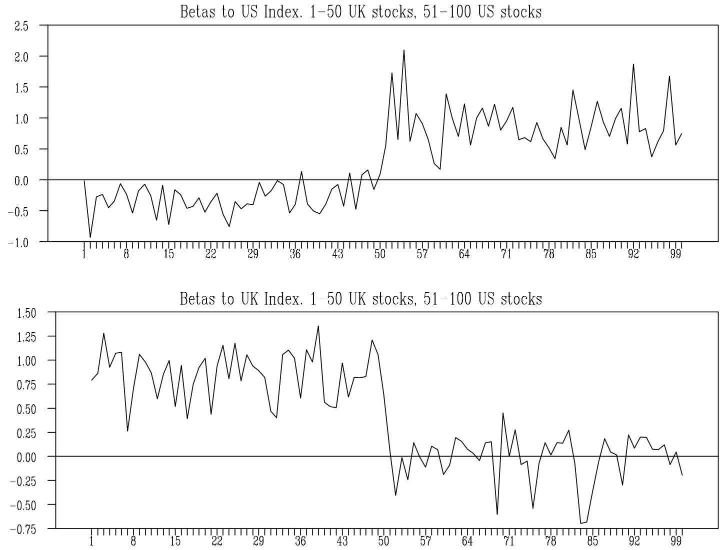

Figure 1: Estimated betas with respect to the orthogonal country factors.