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In 2008 all ECB publications feature a motif taken from the €10 banknote.

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Abstract

This paper considers a stylized asset pricing model where the returns from exchange rates, stocks and bonds are linked by basic risk-arbitrage relationships. Employing GMM estimation and monthly data for 18 economies and the US (treated as the domestic country), we identify through a simple test the countries whose assets strongly comove with US assets and the countries whose assets might offer larger diversification benefits. We also show that the strengthening of the comovement of returns across countries is neither a gradual process nor a global phenomenon, reinforcing the case for international diversification. However, our results suggest that fund managers are better off constructing portfolios selecting assets from a subset of countries than relying on either fully internationally diversified or purely domestic portfolios.

JEL classification: F31; G10.

Keywords: asset pricing; exchange rates; international parity conditions; market integration; stochastic discount factor.

Non-Technical Summary

Global diversification of investors' wealth across domestic and foreign assets is a widely accepted principle followed in investment management, with the degree of diversification being selected by asset managers on the basis of the risk attitudes of individual investors. However, diversification can play the risk sharing role predicted by textbook finance theory only if returns across countries and asset classes are not highly correlated.

The worldwide boom in stock markets, the subsequent fall at the turn of the century and the new momentum from 2003 onwards have characterized financial markets worldwide. Such strong comovements might have limited the benefits arising from international portfolio diversification. This question has become particularly relevant since the start of Stage Three of Economic and Monetary Union (EMU) in 1999, as the absence of currency risks and the unified monetary policies for 13 countries in Europe - Greece and Slovenia joined later respectively in 2003 and 2007 - might have increased the correlation between financial markets across EMU countries.

In this paper we propose a simple methodology to identify those countries whose assets are strongly correlated, thereby preventing gains from international diversification. A pre-requisite for measuring financial markets integration is the identification of assets generating identical cash flows, consistent with the law of one price. At country and, therefore, aggregate level, one might consider slightly different assets, provided it is possible to control for the differences in the risk associated with their cash flows. We use standard equity and bond benchmark price indices, which are comparable across time and countries. While comovement is often investigated looking at one specific asset (either the short-term interest rate, or long term bond yields, or else equity returns), our approach is different in that we examine a broader set of assets simultaneously in one single framework.

Using Generalized Method of Moments (GMM) estimation and monthly data over the 1991-2007 sample period for 18 major economies vis-à-vis the US (considered as the investor's country of residence), we identify countries' assets that are strongly correlated with US assets and, as a result, might yield lower diversification gains. We then compare the performance of portfolios that are partially diversified, in the sense that they are invested only in countries which our test identifies as offering significant diversification gains, with a variety of alternative portfolios ranging from a purely domestic portfolio to a global, fully diversified benchmark.

Overall, the results support the view that diversification opportunities exist, but they are limited due to the risk-arbitrage relationships. Therefore, there are gains in holding diversified portfolios and our test can provide guidance on selecting countries offering diversification gains. The performance of portfolios based on the countries' assets selected according to our test is

very close to what could be achieved including all countries' assets examined, and it is superior to a domestic benchmark as well as to very broad global benchmarks based on the MSCI World index and/or the Lehman Global government bond index.

In addition to the in-sample analysis, the out-of-sample performance (over the six year period June 2001-May 2007) of the portfolios selected on the basis of our methods is very satisfactory, with annualized mean returns and Jensen's alpha equal to around 50 basis points higher than those obtained with a global portfolio including all countries in the sample. Moreover, over this period the selected global portfolios outperform both domestic and global benchmarks respectively by 9.5% and 7.3% per year, with Jensen's alpha equal to respectively 9% and 6% per year. In this regard, this paper also contributes to the long-debated discussion of how many assets make a diversified portfolio initiated by Evans and Archer (1968) and subsequently continued by Statman (1987), supporting the view that full spreading of the portfolio's asset risk is superfluous and may be avoided.

Given the extent of cross-border portfolio flows and the gradual rise of asset and liability positions in international balance sheets, it is often pointed out that financial integration is a gradual process and a global phenomenon. If markets happen to be steadily more correlated over time, the benefits of diversification become gradually smaller. To investigate this issue, part of our empirical work is carried out using data for a small subset of countries (Germany, Japan, the Netherlands, Switzerland, the UK and the US) for which we have comparable data on stock and bond returns starting from the early 1980s, and use rolling GMM estimation to measure the degree of comovement over time using a time-varying test for comovement. Overall, we find that the strengthening of comovement is neither a gradual process nor a global phenomenon, reinforcing the economic arguments for an active search of diversification gains, which inspires much asset management practice.

1 Introduction

Global diversification of investors' wealth across domestic and foreign assets is a widely accepted principle followed in investment management, with the degree of diversification being selected by asset managers on the basis of the risk attitudes of individual investors. However, diversification can play the risk sharing role predicted by textbook finance theory only if returns across countries and asset classes are not highly correlated.

The worldwide boom in stock markets, the subsequent fall at the turn of the century and the new momentum from 2003 onwards have characterized financial markets worldwide. Such strong comovements might have limited the benefits arising from international portfolio diversification. This question has become particularly relevant since the start of Stage Three of Economic and Monetary Union (EMU) in 1999, as the absence of currency risks and the unified monetary policies for 13 countries in Europe - Greece and Slovenia joined later respectively in 2003 and 2007 - might have increased the correlation between financial markets across EMU countries (Allen and Song, 2005; Bekaert, Harvey and Ng, 2005; Eiling and Gèrard, 2007).

Most of the literature on international portfolio diversification takes a US perspective and focuses on equity markets. It is generally found that international diversification benefits are small for US investors (De Roon, Nijman and Werker, 2001; Driessen and Laeven, 2007) or it can be achieved indirectly at home through investment in stocks of multinational firms (Rowland and Tesar, 2004) or country funds and depositary receipts (Errunza, Hogan and Hung, 1999). The literature also finds that country specific factors, rather than sectoral factors, drive international diversification benefits and that further gains can be achieved by including currency deposits in equity portfolios (Gèrard, Hillion and de Roon, 2002).[1]

Another branch of the literature focuses on: the correlation between stock and bond returns in the US using present value models (Shiller and Beltratti, 1992), consumption-based asset pricing models (Bekaert, Engstrom, and Grenadier, 2005), dynamic factor models (Baele, Bekaert and Inghelbrecht, 2007) or latent factor models (Pavlova and Rigobon, 2006); and the correlation between S&P500 stocks and non-S&P500 stocks by means of friction- or sentiment-based theories of comovement (Barberis, Shleifer and Wurgler, 2005).[2]

[1] In a seminal paper, Heston and Rouwenhorst (1994) find that differences in country-equity index volatility is due to country-specific factors as opposed to differences in the sectoral mix across countries. This research fostered additional studies, which suggest that the contribution of country risks has fallen more recently (Carrieri, Errunza and Sarkissian, 2004; Campa and Fernandes, 2006), others argue that country risks remain high (De Moor and Sercu, 2006 and 2007, Bekaert, Hodrick and Zhang, 2007). Nevertheless, De Moor and Sercu (2006) argue that the methodology of Heston and Rouwenhorst cannot be used to form portfolios, since their method is based on pure country and sector variances, whereas risk diversification requires also the calculation of covariances.

[2] Cross-market correlation coefficients have also been used to test for contagion. These models generelly assess how correlation coefficients change after a shock (see i.e. Forbes and Rigobon, 2002)

In this paper, we do not aim at finding the determinants of stocks and bonds across countries. We aim at quantifying the degree of comovement across assets and across countries including the effects arising from exchange rate dynamics. The benefits of international diversification arise from the relatively low level of correlation among national equity markets (Solnik, 1974; Elton and Gruber, 1992; De Santis and Gèrard, 1997) and bond markets. It is also well established that exposure to currency risk is a determinant of international equity returns (Dumas and Solnik, 1995; De Santis and Gèrard, 1998). However, returns on equities, bonds and exchange rate across countries and their interlinkages have rarely been studied simultaneously in one single framework. An exception is the study by Hau and Rey (2004, 2006), which develops a theoretical model where exchange rates, stock returns and equity flows are endogenously determined. One of the implications of this model is that higher returns in the home equity market (in local currency) relative to the foreign market are associated with home currency depreciation. This risk-arbitrage relationship is termed "uncovered equity return parity" and was tested by Cappiello and De Santis (2007). We find the same relation in this paper, starting from a different conceptual framework, and develop the model further to incorporate domestic and foreign bonds, such that exchange rates, stocks and bonds are tightly linked by basic risk-arbitrage relationships.

We examine the connection between the excess returns from different asset classes using a discount factor pricing model derived on the basis of minimal assumptions and using only basic principles of asset pricing, following previous work by, *inter alias*, Cochrane (2005) and Brand, Cochrane and Santa Clara (2006). A key contribution of the paper is the proposition of a simple test, which is derived from the structural model, to assess the equilibrium relationships linking the various asset classes considered across countries.

A pre-requisite for measuring comovement is the identification of assets generating identical cash flows, consistent with the law of one price. At country and, therefore, aggregate level, one might consider slightly different assets, provided it is possible to control for the differences in the risk associated with their cash flows. We use standard Datastream equity and bond benchmark price indices, which are comparable across time and countries. Using Generalized Method of Moments (GMM) estimation and monthly data over the 1991-2007 sample period for 18 major economies vis-à-vis the US (considered as the investor's country of residence), we identify countries' assets that are strongly correlated with US assets and, as a result, might yield lower diversification gains.[3] We then compare the performance of portfolios that are partially

[3] Engle (2002) introduced a new family of multivariate GARCH models called dynamic conditional correlations aiming at estimating time varying conditional correlations across assets. However, the complexity of such models increases with the number of assets included, such that estimation is cumbersome and convergence problems can be encountered in numerical algorithms (for a survey see Silvennoinen and Teräsvirta, 2008). Most importantly,

diversified, in the sense that they are invested only in countries which our test identifies as offering significant diversification gains, with a variety of alternative portfolios ranging from a purely domestic portfolio to a global, fully diversified benchmark.

Overall, the results support the view that diversification opportunities exist, but they are limited due to the risk-arbitrage relationships. Therefore, there are gains in holding diversified portfolios and our test can provide guidance on selecting countries offering diversification gains. The performance of portfolios based on the countries' assets selected according to our test is very close to what could be achieved including all countries' assets examined, and it is superior to a domestic benchmark as well as to very broad global benchmarks based on the MSCI World index and/or the Lehman Global government bond index.

In addition to the in-sample analysis, the out-of-sample performance (over the six year period June 2001-May 2007) of the portfolios selected on the basis of our methods is very satisfactory, with annualized mean returns and Jensen's alpha equal to around 50 basis points higher than those obtained with a global portfolio including all countries in the sample. Moreover, over this period the selected global portfolios outperform both domestic and global benchmarks respectively by 9.5% and 7.3% per year, with Jensen's alpha equal to respectively 9% and 6% per year. In this regard, this paper also contributes to the long-debated discussion of how many assets make a diversified portfolio initiated by Evans and Archer (1968) and subsequently continued by Statman (1987), supporting the view that full spreading of the portfolio's asset risk is superfluous and may be avoided.

Given the extent of cross-border portfolio flows and the gradual rise of asset and liability positions in international balance sheets (Lane and Milesi-Ferretti, 2002 and 2003), it is often pointed out that financial integration is a gradual process and a global phenomenon. If markets happen to be steadily more correlated over time, the benefits of diversification become gradually smaller. Looking at correlation alone one cannot reach conclusions with regard to market integration.[4] We simply study how the interdependence across markets and assets has changed over time. To investigate this issue, part of our empirical work is carried out using data for a small subset of countries (Germany, Japan, the Netherlands, Switzerland, the UK and the US) for which we have comparable data on stock and bond returns starting from the early 1980s, and use rolling GMM estimation to measure the degree of comovement over time using a time-varying test for comovement. Overall, we find that the strengthening of comovement is neither a gradual process nor a global phenomenon, reinforcing the case for international

it is hard to test the risk-arbitrage restrictions to assess the potential degree of diversification gains.

[4]Bekaert and Harvey (1995) propose a methodology that allows for the degree of market integration to change through time (see also Bekaert, Harvey and Ng, 2005; Carrieri, Errunza and Hogan, 2007). Flood and Rose (2004, 2005a,b) also develop tests for asset market integration based on an intertemporal asset pricing model.

diversification.[5]

The rest of the paper is organized as follows. Section 2 describes the theoretical setup used to derive basic risk-arbitrage relationships between currency, stock and bond returns. Section 3 then presents the methods that allow us to take the implications of the model to the data using a suitable empirical formulation. Section 4 provides a brief description of the data set, while Section 5 reports the results of the empirical analysis. A final section briefly summarizes and concludes.

2 A Factor Pricing Model of Exchange Rates, Bonds and Stocks

In this section, we present a simple factor pricing model for exchange rates, bonds and stocks which implies a structural relationship of equilibrium conditions between these three asset classes in the form of a three-equation system. We then describe how to implement empirically the model, estimate it using GMM and test its predictions.

2.1 Setup

Modern theories of asset pricing, associated to the stochastic discount factor (SDF), rely on the following pricing equation

$$\mathbf{p}_{t+1} = E_t\left[\mathbf{x}_{t+1} m^h_{t+1}\right], \tag{1}$$

where $\mathbf{p}_{t+1}$ is the price vector of risky assets in period $t+1$; m^h_{t+1} is the SDF (often termed marginal rate of substitution or pricing kernel) of country h's investor that determines the rate at which the investor is willing to substitute consumption next period with consumption in the current period; $\mathbf{x}_{t+1}$ is the gross one-period payoff vector of the risky assets; and $E_t\left[m^h_{t+1}\right] = 1/R^h_{f,t}$ is the period-t price of a risk-free zero-coupon bond in country h.[6] Defining the vector of gross returns $\mathbf{R}_{t+1} = \mathbf{x}_{t+1}/\mathbf{p}_t$, then

$$E_t\left[\mathbf{R}_{t+1} m^h_{t+1}\right] = \mathbf{1}. \tag{2}$$

The basic pricing formula (2) summarizes empirical approaches to asset pricing in that all canonical asset pricing models can be taken to the data using this equation, with the SDF m^h_{t+1} taking a precise parametric formulation depending on the specific utility function assumed.

It is also common practice to use the information available to the investor at time t to price assets. We can incorporate conditioning information by means of instruments $\mathbf{z}_t$ that capture

[5] Longin and Solnik (1995), Goetzmann, et al. (2005) and Baur (2005) found an increase in the international correlation between stock markets. On the other hand, Bekaert, Hodrick and Zhang (2007) and Eiling and Gerard 2007) report significant increases in correlations between European equity markets, but not for North America. Also King, Sentana and Wadhwani (1994) do not find evidence of increasing cross-country correlations.

[6] The result in this subsection may be obtained under a variety of different utility functions and distributional assumptions (see Cochrane, 2005, Ch. 1 and 9 for an excellent overview).

the predictability of discounted returns $\mathbf{R}_{t+1}m^h_{t+1}$. Multiplying both sides of equation (2) by the vector of conditioning information at time t and using the Kronecker product $\otimes$, we can rewrite (2) as follows:

$$E_t\left\{\left[\mathbf{R}_{t+1}m^h_{t+1}-\mathbf{1}\right]\otimes\mathbf{z}_t\right\}=\mathbf{0}, \tag{3}$$

where $\mathbf{z}_t$ is a vector of instruments, including unity.

2.2 Uncovered Interest Rate Parity

Define as S_{t+1} the nominal bilateral exchange rate expressed as the price of the domestic currency h in terms of the foreign currency j. Given equation (2), investing in a foreign bond that offers a gross risk-free rate in local currency $R^j_{f,t}$ and converting the profits in domestic currency yields

$$1=E_t\left[R^j_{f,t}\frac{S_{t+1}}{S_t}m^h_{t+1}\right]=E_t\left[\frac{S_{t+1}}{S_t}\right]\frac{R^j_{f,t}}{R^h_{f,t}}+cov_t\left[m^h_{t+1},R^j_{f,t}\frac{S_{t+1}}{S_t}\right]. \tag{4}$$

The only source of risk in this investment stems from exchange rate fluctuations. The covariance term captures the market price of currency risk.

Under the hypothesis that exchange rates are log-normally distributed, log-linearization of equation (4) gives

$$i^j_{f,t}+E_t\left[s_{t+1}\right]-i^h_{f,t}=rp_{fx,t+1}-\frac{1}{2}var_t\left[s_{t+1}\right] \tag{5}$$

where $i_{f,t}$ denotes the net interest rate of a risk-free zero-coupon bond, s_{t+1} is the change in the exchange rate and $rp_{fx,t+1}=\ln\left(1-cov_t\left[m^h_{t+1},\frac{S_{t+1}}{S_t}\right]\right)$. Equation (5) is the Uncovered Interest Rate Parity (UIP) condition under risk aversion. Assuming that the risk premium on the right hand side of equation (5) is zero implies the 'pure' version of UIP, which is the cornerstone condition of foreign exchange market efficiency under risk neutrality (Fama, 1984).

2.3 Uncovered Return Parity for Equities and Bonds

Investing in a foreign risky asset $r\in(e,b)$, where e and b denote stocks or long-term bonds respectively, and converting the profits in domestic currency yields

$$1 = E_t\left[R^j_{r,t+1}\frac{S_{t+1}}{S_t}m^h_{t+1}\right]= \tag{6}$$

$$E_t\left[R^j_{r,t+1}\right]E_t\left[\frac{S_{t+1}}{S_t}\right]\frac{1}{R^h_{f,t}}+cov_t\left[m^h_{t+1},R^j_{r,t+1}\frac{S_{t+1}}{S_t}\right]+cov_t\left[R^j_{r,t+1},\frac{S_{t+1}}{S_t}\right]\frac{1}{R^h_{f,t}}. \tag{7}$$

Similarly, investing in a domestic risky asset (stock or bond) yields:

$$1=E_t\left[R^h_{r,t+1}m^h_{t+1}\right]=E_t\left[R^h_{r,t+1}\right]\frac{1}{R^h_{f,t}}+cov_t\left[m^h_{t+1},R^h_{r,t+1}\right]. \tag{8}$$

Taking the log difference of equations (7) and (8) and assuming log-normality of asset returns gives the Uncovered Return Parity (URP) condition

$$E_t\left[r^j_{r,t+1}\right]+E_t\left[s_{t+1}\right]-E_t\left[r^h_{r,t+1}\right]=rp^j_{r,t+1}-rp^h_{r,t+1}+\Delta var_t\left[r_{r,t+1}\right], \qquad (9)$$

where $rp^j_{r,t+1} = \ln\left(1-cov_t\left[m^h_{t+1},R^j_{r,t+1}\frac{S_{t+1}}{S_t}\right]-cov_t\left[R^j_{r,t+1},\frac{S_{t+1}}{S_t}\right]\frac{1}{R^h_{f,t}}\right)$ is the foreign risk premium adjusted for the covariance between asset returns in foreign currency and the exchange rate; the domestic risk premium is $rp^h_{r,t+1}=\ln\left(1-cov_t\left[m^h_{t+1},R^h_{r,t+1}\right]\right)$; and $\Delta var_t\left[r_{r,t+1}\right] = \frac{1}{2}var_t\left[r^h_{r,t+1}\right]-\frac{1}{2}var_r\left[r^j_{r,t+1}\right]-\frac{1}{2}var_t\left[s_{t+1}\right]$.[7]

When distinguishing between equity and long-term bonds, equation (9) can be written as follows

$$E_t\left[r^j_{e,t+1}\right]+E_t\left[s_{t+1}\right]-E_t\left[r^h_{e,t+1}\right] = rp^j_{e,t+1}-rp^h_{e,t+1}+\Delta var_t\left[r_{e,t+1}\right] \qquad (10)$$

$$E_t\left[r^j_{b,t+1}\right]+E_t\left[s_{t+1}\right]-E_t\left[r^h_{b,t+1}\right] = rp^j_{b,t+1}-rp^h_{b,t+1}+\Delta var_t\left[r_{b,t+1}\right]. \qquad (11)$$

On the left hand side of (10) and (11), we have the returns that respectively foreign stock and bond markets provide in excess of the returns on the respective assets in the domestic market. These differentials in expected returns across countries compensate domestic investors for taking on (for example) the relatively higher risk of investing in foreign assets. The size of the premia will vary as the risks in domestic and foreign stock and bond markets change; high-risk investments are compensated with a higher premium.

2.4 Equity and Bond Returns Equilibrium

Next, consider the equilibrium condition linking stocks and long-term bonds. *Ex ante*, taking into consideration the risk-return trade-off, an investment in stocks should deliver the same returns of an investment in long-term bonds adjusted for risk. Therefore, making use of (10) and (11) also implies that

$$\left(E_t\left[r^j_{e,t+1}\right]-E_t\left[r^h_{e,t+1}\right]\right)-\left(E_t\left[r^j_{b,t+1}\right]-E_t\left[r^h_{b,t+1}\right]\right)=$$
$$\left(rp^j_{e,t+1}-rp^h_{e,t+1}\right)-\left(rp^j_{b,t+1}-rp^h_{b,t+1}\right)+\Delta var_t\left[r_{e,t+1}\right]-\Delta var_t\left[r_{b,t+1}\right]. \qquad (12)$$

2.5 The Full Parity System

Equations (5), (10), (11) and (12) give the full system of equilibrium conditions linking exchange rate returns to stock returns and bond returns. Empirically, a useful approach is to substitute (5) in the system and make use of the definition of excess returns, which yields the following

[7] Hau and Rey (2006) derive a similar result.

3-equation system:

$$\begin{aligned}E_t\left[es_{t+1}\right]+E_t\left[er_{e,t+1}\right] &= rp^j_{e,t+1}-rp^h_{e,t+1}+\Delta var_t\left[r_{e,t+1}\right]\\ E_t\left[es_{t+1}\right]+E_t\left[er_{b,t+1}\right] &= rp^j_{b,t+1}-rp^h_{b,t+1}+\Delta var_t\left[r_{b,t+1}\right]\\ E_t\left[er_{e,t+1}\right]-E_t\left[er_{b,t+1}\right] &= \left(rp^j_{e,t+1}-rp^h_{e,t+1}\right)-\left(rp^j_{b,t+1}-rp^h_{b,t+1}\right)+\Delta var_t\left[r_{e,t+1}\right]-\Delta var_t\left[r_{b,t+1}\right]\end{aligned} \tag{13}$$

where $E_t\left[er_{r,t+1}\right]\equiv\left(E_t\left[r^h_{r,t+1}\right]-i^h_{f,t}\right)-\left(E_t\left[r^j_{r,t+1}\right]-i^j_{f,t}\right)$ denote the differentials in expected excess returns in equity and bond markets expressed in local currency; and $E_t\left[es_{t+1}\right]=i^j_{f,t}+E_t\left[s_{t+1}\right]-i^h_{f,t}$ are excess returns for borrowing in dollars, converting to the foreign currency and lending at the foreign interest rate.

3 Empirical Implementation

3.1 GMM Estimation and Restrictions to Test Comovement

The system of equations (13) can be estimated by GMM in the following empirical formulation:

$$E_t\left[\begin{array}{c}\left(es_{t+1}-\alpha_0-\alpha_1 er_{e,t+1}-\alpha_2 rp^j_{e,t+1}-\alpha_3 rp^h_{e,t+1}-\alpha_4\Delta var_t\left[r_{e,t+1}\right]\right)\mathbf{z}_t\\ \left(es_{t+1}-\beta_0-\beta_1 er_{b,t+1}-\beta_2 rp^j_{b,t+1}-\beta_3 rp^h_{b,t+1}-\beta_4\Delta var_t\left[r_{b,t+1}\right]\right)\mathbf{z}_t\\ \left(\begin{array}{c}er_{e,t+1}-\gamma_0-\gamma_1 er_{b,t+1}-\alpha_2 rp^j_{e,t+1}-\alpha_3 rp^h_{e,t+1}+\beta_2 rp^j_{b,t+1}+\beta_3 rp^h_{b,t+1}\\ -\alpha_4\Delta var_t\left[r_{e,t+1}\right]+\beta_4\Delta var_t\left[r_{b,t+1}\right]\end{array}\right)\mathbf{z}_t\end{array}\right]=\left[\begin{array}{c}0\\0\\0\end{array}\right]. \tag{14}$$

We estimate the vector of parameters $[\boldsymbol{\alpha},\boldsymbol{\beta},\boldsymbol{\gamma}]$ using the first stage GMM estimation with an identity matrix used as the weighting matrix and test whether the equilibrium conditions implied by the model hold across the asset classes considered. The moment conditions are the sample analog of the population pricing errors.[8]

Moreover, we test the statistical significance of the second moments that characterize the risk premia. Given the GMM estimates of model (14), a test of the validity of the moment conditions is a test of the null hypothesis that the above model is valid against the alternative hypothesis that the pricing errors are statistically significant. This null hypothesis is testable using the J-test for overidentifying restrictions (Hansen, 1982), which is calculated by minimizing the vector of pricing errors, say $\mathbf{g}$, divided by their variance-covariance matrix, Σ: $J=\mathbf{g}'\mathbf{\Sigma}^{-1}\mathbf{g}\sim\chi^2(k-d)$, where k is the number of moment conditions and d is the number of estimated parameters.

In addition to testing the validity of the model, we are ultimately interested in measuring, within system (14), the degree of 'comovement' across asset returns of different countries, a

[8] We also look at the results obtained using the two-stage GMM procedure. In the first stage, we use the identity matrix as the weighting matrix, while in the second stage we use $W=S^{-1}$, where S is the covariance matrix of the pricing errors in the first stage. The results of the two alternative procedures are qualitatively similar.

concept often used and empirically investigated in the empirical literature. In general, the literature refers to comovement as a general pattern of positive correlation in the returns of two or more assets, implying that a common factor drives these returns. While the phenomenon of common movements in national and international financial markets is a stylized fact, we focus on the obvious implication of the above general definition that if the returns from two assets are entirely driven by a common factor and hence comove one to one, then there cannot be diversification gains from investing in both assets. Then, the hypothesis of comovement we wish to test is the particularly strong one of 'no diversification gains.' Under this definition, the restrictions under which the five assets considered in our model comove can be derived directly by using the system (14). Specifically, taking the difference between the first and the second equations in (14) and using the third equation of the system in the resulting equation, it is straightforward to show that comovement requires the validity of the following set of restrictions:

$$\begin{aligned} \beta_0 - \alpha_0 + \gamma_0 &= 0 \\ \alpha_1 + 1 &= 0 \\ \beta_1 + \gamma_1 &= 0 \end{aligned} \tag{15}$$

which can be tested using standard statistical test statistics, such as a Wald test.

3.2 Stochastic Discount Factor

The system (14) requires the various risk premia, which can be estimated conditional on an estimate of the SDF. Given the international dimension of our setting, we estimate m_{t+1}^h using the minimum-variance discount factors approach proposed by Brandt, Cochrane and Santa Clara (2006) in discrete time.

Under incomplete asset markets, the discount factors we can recover from asset markets data are not unique.[9] To allow for incomplete markets and multiple discount factors, Brandt, Cochrane and Santa Clara (2006) consider the case of a single economy with many agents, where individuals' marginal utility growths may not be equal, while the projection of each individual's marginal utility growth on the set of available asset payoffs is the same. Brandt, Cochrane and Santa Clara (2006) imagine to run regressions of individual marginal utility growth on asset market returns to assess how well individuals use existing markets to share risk. These discount factors are the projections of any possible discount factors onto the relevant spaces of asset payoffs, and they are also the minimum-variance discount factors. $m_{t+1}^{h,j}$ can then be written as

[9] If $p_t^h = E_t\left[x_{t+1}^h m_{t+1}^h\right]$, then $p_t^h = E_t\left[x_{t+1}^h\left(m_{t+1}^h + \epsilon_{t+1}\right)\right]$ so long as $E_t\left[x_{t+1}^h \epsilon_{t+1}\right] = 0$, where ϵ_{t+1} is a random variable.

a linear combination of asset returns across country pairs:

$$m_{t+1}^{h,j} = a^j - b_1 R_{e,t+1}^h - b_2 R_{b,t+1}^h - b_3^j R_{e,t+1}^j - b_4^j R_{b,t+1}^j - \mu^j R_{s,t+1}^j \tag{16}$$

where $R_{r,t+1}^h$ and $R_{r,t+1}^j$ denote respectively the gross returns on stocks and bonds in the domestic and foreign country; and $R_{s,t+1}^j$ is the gross return on the foreign risk-free bond. Clearly, the domestic investor faces currency risk when holding $R_{r,t+1}^j$ and $R_{s,t+1}^j$. We estimate the SDFs by means of the basic formula (3) using GMM methodology in the spirit of Hansen (1982), and we use the estimated SDFs to compute country and asset-specific risk premia.

3.3 Risk Premia

Once estimated the SDF, we ought to compute the conditional covariance matrices between stocks, bonds, the estimated SDF and the exchange rate, which evolve over time. GARCH models are among the most widely used specifications of conditional second moments. We assume that - for each bilateral relationship between assets - the conditional covariance matrix $\mathbf{\Sigma}_{t+1}$ follows the bivariate BEKK GARCH(1,1) representation:

$$\mathbf{\Sigma}_{t+1} = \mathbf{C}'\mathbf{C} + \mathbf{A}'\boldsymbol{\eta}_t\boldsymbol{\eta}_t'\mathbf{A} + \mathbf{B}'\mathbf{\Sigma}_t\mathbf{B}, \tag{17}$$

where $\mathbf{C}$, $\mathbf{A}$ and $\mathbf{B}$ are (2×2) matrices of parameters; $\mathbf{C}$ is a lower triangular matrix; and weak restrictions on $\mathbf{A}$ and $\mathbf{B}$ guarantee that $\mathbf{\Sigma}_t$ is positive definite (see Engle and Kroner, 1995).

We estimated, by maximum likelihood, a bivariate BEKK GARCH(1,1) model for each country pair (rather than one multivariate GARCH for the full set of countries) because covariances with the SDF ought to be estimated using asset returns in the currency of country h, while the covariance between asset returns and the exchange rate ought to be estimated using returns in the currency of country j. Hence, bivariate volatility models are more closely related to the theoretical considerations in Section 2.

4 Data

In order to investigate the proposed equilibrium conditions among assets across countries, we use monthly equity index and long-term bond (7-to-10 year maturity) returns for the US, Australia, Austria, Belgium, Switzerland, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, the UK and the relevant bilateral exchange rates vis-à-vis the US dollar. The data are taken from Datastream. The asset returns are continuously compounded returns based on total return Datastream benchmark indices. Such indices include the effect of re-investing dividends and gross coupons respectively into stocks and bonds. Therefore, they are comparable across countries, across time and across assets. We also use Eurocurrency rates offered in the interbank market in London for one-month deposits in the various currencies as reported by the Bank of International Settlements (BIS) and treat the US as the domestic country.

Descriptive statistics of the data are reported in Tables 1 and 2. Due to data availability on comparable bond returns, the sample period examined spans from January 1991 through May 2007, though later in the paper we carry out some of the empirical work for a subset of countries starting from the early 1980s. The summary statistics include means, standard deviations, skewness and kurtosis. Their magnitudes are similar to those previously documented in other studies.

Specifically, Table 1 shows the mean and standard deviation of the excess returns on stock and bond indices as well as exchange rates (annualized and reported in percent). The table shows the well-documented large equity risk premium worldwide, except for Japan which suffered large capital losses during the 1990s. The average excess equity returns range from 0.4% in Japan to 14.1% in Finland, whereas the average excess bond returns range from 1.3% in New Zealand to 4.4% in Italy. The standard deviation of the excess equity (bond) index returns ranges from 11.8% in Australia to 31.1% in Finland (from 3.8% in Finland to 6.4% in Australia). The excess exchange rate returns are generally small and volatile, albeit less than equity returns. The volatility of long-term nominal bond returns and of exchange rates is about 28% and 57% that of equity returns.

Turning to the correlation analysis in Table 2, we note that the stock and bond returns differentials vis-à-vis changes in the exchange rate are negatively correlated except for Australia, Canada and New Zealand, while stock returns differentials are positively correlated with bond returns differentials, except for Japan. Excluding these four countries, the correlations range from -0.16 to -0.41 for stock returns differentials and exchange rate changes, from -0.13 to -0.38 for bond returns differentials and exchange rate changes, and from 0.21 to 0.48 for stock and bond returns differentials. The sign of these correlations is consistent with the equilibrium relationships across markets suggested by the theory outlined in Section 2.

Finally, as for the instruments used in the GMM estimation, we use data for the earnings yield (the inverse of the price/earnings ratio), changes in earnings yields, bond returns and changes in bond returns. These data are also taken from Datastream.

5 Empirical Results

5.1 The Base Case

We first estimate model (14) under the hypothesis that the second moments across countries offset each other. This is the base case scenario and can be interpreted as a test of the international asset pricing model in Section 2.5 under the hypothesis that benchmark portfolios are characterized by the same risk across countries. The economic intuition behind system (14) predicts the following signs for the key parameters of the model: $\alpha_1 <$, $\beta_1 < 0$ and $\gamma_1 > 0$. Then, comovement consistent with the hypothesis of 'no diversification gains' would imply the restrictions $\beta_0 - \alpha_0 + \gamma_0 = 0$, $\alpha_1 + 1 = 0$ and $\beta_1 + \gamma_1 = 0$.

The results reported in Table 3 indicate that, consistent with our theoretical priors, in the majority of cases the estimates of α_1, β_1 and γ_1 are correctly signed and generally statistically significantly different from zero at conventional significance levels. Moreover, the p-value of the J-test for overidentifying restrictions is above 5% for all countries, implying that the model is not statistically rejected.

Specifically, $\widehat{\alpha}_1$ is negative in 13 and statistically significant in 12 out of 18 cases ($\widehat{\alpha}_1 < 0$ for Denmark and New Zealand being significant only at the 10% level), except for Belgium, Ireland, Japan, Spain and Sweden, for which the coefficient is generally not statistically significant (see Table 4). Except for Norway, $\widehat{\beta}_1$ is always negative. However, $\widehat{\beta}_1$ is not statistically significant in the case of Norway, Canada, Italy, Sweden and the UK. $\widehat{\gamma}_1$ is positive in 12 cases, except for Austria, Canada, Denmark, Ireland, Japan and Norway. Counterintuitive values for $\widehat{\alpha}_1 > 0$ and $\widehat{\gamma}_1 < 0$ are statistically significant only for Belgium and Ireland.

Turning to the tests of the restrictions consistent with the absence of diversification gains, the Wald test statistic does not reject the null hypothesis at the 5% level for six economies: Australia, Germany, the Netherlands, New Zealand, Switzerland and the UK (see Table 4). This implies that these countries do not offer statistically significant diversification benefits to a US investor over the sample, comprising one third of the set of countries examined. This implies that a US investor may not need to diversify fully across this set of countries and that the same diversification benefits may be achieved by carefully selecting the subset of countries that do not comove strongly with US equity and bond markets.

Until this point we have assumed that the second moments across countries offset each other, or that benchmark portfolios are characterized by the same risk across countries. Next, we explore the role of country-specific risk premia, and to this end we need to estimate first the US SDF as a preliminary exercise.

5.2 The US Discount Factor

To get a better sense of the discount factors recovered from asset markets, we show in Table 5 expected asset returns computed using the estimated factor loadings of the domestic discount factors (16). We make use of the equivalence principle between factor models and discount factors, that is (ignoring time subscripts for simplicity):

$$E\left[R^i\right] = \alpha + \lambda' \beta_i \Longleftrightarrow m = a - b' f \tag{18}$$

where $\lambda = \sum_{ff} b$ and $\sum_{ff} = E\left[\left(f_t - \mu_f\right)\left(f_t - \mu_f\right)'\right]$ is the variance-covariance matrix of the factors. In the expected returns-beta representation, λ can be interpreted as the price of the risk factor and can be also computed as follows: $\lambda = -E\left[m\left(f_t - \mu_f\right)\right]/E\left[m\right]$, where $E\left[m\right] = a - b'\mu_f$. The results in Table 5 indicate that the 18 different estimated SDFs are all able to price the US risk-free rate, the US equity premia and the US bond premia. The annualized US risk-free rate, US equity premia and US bond premia are estimated to be on average equal to 4.2%, 7.9% and 2.8% respectively.

With respect to the foreign equity and bond premia, these premia are country specific and appear to be characterized by a fair amount of heterogeneity. The expected excess returns range from 0.7% in Japan to a large 13.8% recorded in Finland. The countries that have recorded larger excess returns than the US are Finland, Switzerland, Sweden, Ireland, Spain, the Netherlands, Canada, Australia, Denmark and France. Expected excess returns on long-term bonds are, on average, about one third the expected excess returns on equity and they range between 1.4% in New Zealand and 4.4% in Italy. As for deposits, expected excess returns on the foreign risk-free rates are generally small, as found by Dumas and Solnik (1995) and De Santis and Gerard (1998). They are negative only for Switzerland, Finland, Japan and Sweden.

Turning now to the performance of the asset pricing models, it is useful to illustrate the predicted (fitted) versus the actual excess returns. To obtain a visual idea of the SDFs' correlations and relative magnitudes, we show a scatter plot of the SDF for the US implied by the country pairs estimations (see Figure 1). The US SDF estimated vis-à-vis the UK is plotted against time in Panel B of Figure 1. The same SDF is also plotted on the vertical axis of Panel A of Figure 1 against the US SDF estimated vis-à-vis each of the other countries in our data set. As the graph shows, the US SDFs, with the exclusion of the SDF estimated using Japanese assets, are fairly close though not exactly on the 45-degree line. Excluding Japan, the correlations range between 71% when using Swiss assets and 95% when using Norwegian assets. Theoretically, if all the points were on the 45-degree line, the SDF estimated on a country pair basis would be sufficient to price all assets available. The correlation coefficients are very high, but different from unity. This implies opportunities for risk sharing, which the approach in this paper allows us to quantify and exploit by identifying the countries that offer diversification gains. We use $m^{h,j}_{t+1}$ to estimate the time-varying risk premia.

5.3 The Model with Time-Varying Risk Premia

The estimates of the US SDF reported in the previous section are employed to compute the conditional covariance matrices between stock, bond and exchange rate returns, using the standard bivariate BEKK GARCH(1,1) discussed in Section 3.3. The conditional covariance matrices allow us to compute the time-varying risk premia as well as the time-varying variances. Estimation of a BEKK model involves somewhat heavy computations due to several matrix inversions and non-linearity in parameters. However, we always obtain convergence.

To briefly summarize the core results, we show in Table 6 the estimated average risk premia obtained from the GARCH(1,1) models. On average over the sample examined, the risk premia match closely the actual data reported in Table 1 as well as the expected risk premia estimated using the SDF reported in Table 5. These estimates are, therefore, encouraging.[10]

Note that $rp^{j}_{r,t+1}$ (Column 1) has been disaggregated distinguishing the risk premium on foreign assets $-cov_t\left[m^{h}_{t+1}, R^{j}_{r,t+1}S_{t+1}/S_t\right]$ (Column 2) from $-cov_t\left[R^{j}_{r,t+1}, S_{t+1}/S_t\right]/R^{h}_{f,t}$ (Column 3). The risk premia on foreign assets are always positive. This implies that when marginal utility growth declines, foreign equity and bond returns in the domestic currency rise. In other words, risky assets must promise higher expected returns to induce investors to hold them. As for $-cov_t\left[R^{j}_{r,t+1}, S_{t+1}/S_t\right]/R^{h}_{f,t}$, this term is found to be relatively small over time, and its sign is asset- and country-specific. This implies that the use of $rp^{j}_{r,t+1}$ captures almost enterely the time-varying foreign risk premia.

Endowed with estimates of the risk premia from the BEKK GARCH(1,1) estimation, we are now in a position to estimate the full system (14). Tables 7 and 8 show the results. We note that, except for Belgium, Sweden and Ireland, $\widehat{\alpha}_1$ is always negative in the model specifications with time-varying risk premia. The coefficients are statistically significant in 8 cases. $\widehat{\beta}_1$ is generally negative and it is statistically significant in 10 cases. $\widehat{\gamma}_1$ is positive in 11 cases and statistically significant in 7 cases. In general, the model with risk premia appears not to change significantly the results with respect to the model without risk premia reported earlier in Table 4.

However, when testing the restrictions (15) to test the hypothesis of no diversification gains, the Wald test does not reject the null hypothesis with the US at the 5% significance level for seven countries: Switzerland, Canada, Denmark, France, the Netherlands, New Zealand and

[10] The detailed results of the BEKK bivariate GARCH estimation are not reported to conserve space, but they are available upon request.

Norway. The direct comparison of Tables 4 and 8 shows a lower Wald test statistics for 12 countries pointing to estimates that are marginally more consistent with strong comovement of assets across countries. Overall, however, the results support the previous findings that not all asset markets are integrated and that, therefore, some diversification gains exist from allocating assets internationally.

5.4 Performance of Global and Domestic Portfolios

The statistical results in the previous subsection suggest that significant diversification gains can be achieved by a US investor from some countries, but not from others. In turn, this implies that full diversification may be suboptimal in that a diversified global portfolio can be achieved by using a portfolio with a relatively small number of countries. To provide some evidence on the economic significance of these findings, in this section we investigate whether the earlier statistical results can add economic value to a US investor interested in selecting an internationally diversified portfolio. To this end, we calculate a battery of conventional performance measures for a variety of portfolios. Specifically, we analyze a domestic portfolio comprising only US stocks and/or bonds, which we use as benchmarks for assessing the performance of diversified portfolios; a fully diversified international portfolio of stocks and bonds which includes assets from all the 19 countries in our data set; and two partially diversified portfolios which comprise stocks and bonds only for countries where the null hypothesis of no diversification gains was rejected (for the case with constant and time-varying risk premia, respectively). Moreover, we also examine the performance of common global benchmarks for equities and bonds, and use for this purpose the MSCI World (only stocks) and the Lehman Global (government bonds) index as well as a global portfolio benchmark with equal weights on the MSCI World and the Lehman Global indices.

For simplicity, all the portfolios are equally weighted according to the $1/N$ strategy (DeMiguel, Garlappi and Uppal, 2007), so that the return on the portfolio is $r_p = \sum_{i=1}^{N} w_i r_i$, where $w_i = 1/N$ (N being the number of assets included in the portfolio); r_i is the return on the i-th asset, and the variance of the portfolio returns is $\sigma_p^2 = \sum_{i=1}^{N} w_i^2 \sigma_i^2 + 2 \sum_{i=1}^{N-1} \sum_{j=1+1}^{N} w_i w_j \sigma_{ij}$. In other words, the only decision the investor makes relates to the choice of the countries to include in the portfolio, but once that decision is made each asset in the portfolio is given the same weight. We provide both in-sample and out-of-sample performance results.

5.4.1 In-sample Results

The in-sample results are reported in Table 9. Let us start from the first column, where we present the average returns of the domestic portfolios (including US stocks and/or bonds) in excess of the US risk free rate obtained on average over the entire sample period. We also report, as preliminary calculations, the average excess returns, relative to a domestic benchmark comprising US stocks and bonds, for each two-country portfolio obtained by investing in the US and one other country considered in our sample. We then construct three global portfolios: Portfolio A includes all the 38 assets examined (fully diversified), whereas Portfolios B and C are both partially diversified, constructed using the assets of countries for which the null of no diversification gains was rejected using the model with constant risk premia and with time-varying asset-specific risk premia across country pairs, respectively. Put another way, Portfolios B and C include the countries' assets for which the comovement test is rejected at the 5% significance level as reported in Tables 4 (for Portfolio B) and 8 (for Portfolio C), respectively. Finally, we also report results, in the last three rows, for global benchmarks comprising MSCI World and the Lehman Global indices.

The excess mean return of the fully diversified Portfolio A is about 6% per annum, which compares with 5.33% of the US domestic benchmark (stocks and bonds) and with 4.01% delivered by the global benchmark comprising both MSCI World and the Lehman Global indices. Portfolio A also performs slightly better than the partially diversified Portfolios B and C, largely due to the inclusion of Australia, Canada and Switzerland in the fully diversified portfolio: these three markets generated impressive excess returns but our test would have excluded two of them from the partially diversified portfolios. However, the difference in excess returns between Portfolio A and the two partially diversified Portfolios B and C is miniscule and it is not clear that, once one considers the costs of devoting research resources to monitoring more countries and assets, such difference makes it worth for a fund manager to diversify risk fully.

In the remaining column, we report a battery of common performance measures. When examining the Sharpe ratios, a measure which adjusts for total risk of the portfolio, the domestic benchmark performs better that the global portfolios over the sample period.[11] Nevertheless, the partially diversified portfolios perform better than the global portfolios benchmarks and only slightly worse (0.64 versus 0.62 and 0.61) than the fully diversified portfolio with 19 countries.

We then report the Information Ratio, a measure of risk-adjusted returns relative to the domestic benchmark r_b.[12] The fully diversified portfolios outperform domestic and global benchmarks. Similar results are obtained if we evaluate the performance of the portfolio only involving systematic risk using the Treynor measure, Jensen's alpha and Black-Treynor ratio. For all these measures, we find that the partially diversified Portfolios B and C outperform their respective

[11] The Sharpe ratio of each portfolio is calculated as $SR_p = \left(\overline{r_p - i_f^{US}}\right)/\sigma_p$ where σ_p denotes the standard deviation of the portfolio with excess mean returns $\overline{r_p - i_f^{US}}$.

[12] Specifically, the Information Ratio is calculated as $IR_p = \left(\overline{r_p - r_b}\right)/\sigma_{r_p - r_b}$.

benchmarks and generally deliver risk-adjusted returns hardly distinguishable from the fully diversified portfolio of 19 countries.

5.4.2 Out-of-sample Results

The results are more compelling when examining the out-of-sample performance (see Table 10). In this case, we keep the last six years of data for the out-of-sample analysis. Hence, we estimate the empirical models over the period spanning from January 1991 to May 2001, select the countries to include in the partially diversified portfolio on the basis of the test of the null hypothesis of 'no diversification gains', and then form portfolios to be held over the subsequent six-year period from June 2001 to May 2007.[13] In Panel 1 of Table 10, the benchmark is given by an equally weighted portfolio of US stocks and bonds, whereas in Panel 2, the benchmark is global and is again constructed using MSCI World and Lehman Global with equal weights.

The out-of-sample performance of the selected Portfolios B and C is very satisfactory, yielding annualized mean returns and Jensen's alphas about 50 basis points higher than those obtained with the fully diversified portfolio of 19 countries. Moreover, over this period the selected partially diversified portfolios outperform by 9.5% per year the domestic benchmark and by 7.3% per year the global benchmarks. The results are qualitatively identical for portfolios constructed using time-varying risk premia.[14] In particular, Jensen's alpha is about 9% and 6% per annum vis-à-vis the domestic and the global benchmarks, respectively.

These findings suggest that international diversification does not require investing in a large number of countries and that full diversification is, therefore, suboptimal. This result echoes, in terms of countries rather than individual stocks within one country, the seminal results by Statman (1987), confirming the view that portfolio managers should not enthusiastically advice investing in global benchmarks to spread risk across too many countries' assets.

5.5 Time-Varying Comovement from the 1980s

A widely held view is that the link between stock returns and exchange rates before the 1990s was very tenuous owing to the fact that international asset markets were heavily segmented and illiquid. Therefore, one would expect comovements to be very loose in the 1980s (e.g. Bekaert and Harvey, 1995). As a final exercise, we investigate the evolution of comovement over time. We use comparable data starting from the beginning of the 1980s for a subset of countries, including Germany, Japan, the Netherlands, Switzerland and the UK, and assess developments

[13] Portfolio B is formed by the stocks and bonds of Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, New Zealand, Norway, Spain, Sweden and US. Portfolio C is formed by the stocks and bonds of Austria, Belgium, Switzerland, Denmark, Finland, Germany, Italy, New Zealand, Spain, Sweden and US.

[14] Full results not reported but available upon request.

vis-à-vis the US. We then carry out rolling estimation of the model with a moving window of 10 years and calculate the Wald test statistic for the hypothesis of no diversification gains period by period (monthly). This is a simple way to analyze the monotonicity and pace of asset comovement using our simple test for no diversification gains.

The results reveal that the correlations with US returns were tighter for European assets in the 1980s and quite volatile during the 1990s (see Figure 2). Japanese assets, in contrast, comoved with US assets during the 1990s, but present a diverging path since the Asian financial crisis in 1997.

Except for the Netherlands, the correlations have become looser for all country pairs from 2003 onwards when stock markets started to recover after the burst of the equity bubble in 2000. It could be argued that if the correlations across asset prices become tighter in periods of high volatility of returns, the benefits of diversification become smaller when needed the most. Overall, the strengthening of comovement appears to be neither a gradual process nor a global phenomenon, providing support to the economic arguments for the benefits of global diversification.

6 Concluding remarks

Movements in asset returns are often thought of as being uninterpretable by the uninitiated. The man on the street is reluctant to believe that fundamental forces are at play, attributing much of the day-to-day volatility in these prices to 'sentiment'. Foreign currency returns are considered to be even more impenetrable. Most exchange rates, for example, swing wildly on a day-to-day basis with apparently little connection to other economic and financial variables and often with counterintuitive relations to differences in short-term interest rates across countries. The results of this paper suggest that a full understanding of asset pricing movements is likely to require joint analysis of currency returns and other asset returns across countries.

While huge effort has been put to make progress on understanding the determinants of asset returns, little academic work exists on the link between movements in currency, stock and bond prices both theoretically and empirically. We take a closer look at the connection between the returns from different asset classes, using a discount factor pricing model where the returns from exchange rates, stocks and bonds are tightly linked by basic risk-arbitrage relationships. The results indicate that equity, bond and currency returns are strongly interlinked in a way that is consistent with the simple stylized model proposed.

Moreover, as markets become financially integrated, cross-country correlations across asset classes are expected to increase; thereby reducing the benefits of international portfolio diversification. We shed light on the degree of comovements by means of equilibrium conditions between returns on currencies, stocks and bonds on a bilateral basis for 18 economies and the US in a unified framework. We propose a simple test for comovement, which is derived from the structural model of asset pricing. Application of this test suggests that, while the assets of a subset of countries perfectly comove with US assets over the 1991-2007 period, there are still scope of diversification gains for the US investors. Investors are better off in constructing portfolios selecting assets from such countries, whose assets do not pass the comovement test, than relying on either global or domestic benchmark portfolios. Diversification does not require investing in a large number of different securities.

We have also investigated whether global market comovement in stock and bond markets has gradually reduced the gains from diversification with the implication - if this turns out to be the case - that the economic benefits of diversification would virtually be exhausted in the future. The simplicity of the structural test is such that it also allows us to assess comovement through time. Investigation of the temporal evolution of comovement provides evidence that is in contrast with the view that the strengthening of financial integration might lead to a steady and gradual comovement across asset classes. Therefore, our analysis reinforces the economic arguments in favour of an active search of diversification gains, which inspires much asset management practice.

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Table 1

Summary statistics of excess log equity, bond and exchange rate returns

This table shows summary statistics for monthly annualized local currency denominated log asset returns for 19 countries and annualized log foreign exchange (FX) excess returns for 18 currencies. The exchange rate returns are excess returns for borrowing in dollars, converting to the foreign currency, lending at the foreign interest rate, and converting the proceeds back to dollars. The stock and bond indices are total market returns from Datastream, the interest rates are for one-month Eurocurrency deposits from the Bank for International Settlements. The stock and bond returns are excess returns over the same country's one-month interest rates. The data are monthly observations from January 1991 through May 2007.

	Mean (annualized, %)			Std deviation (annualized, %)			Skewness			Kurtosis		
	stock	bond	FX	stock	bond	FX	stock	bond	FX	stock	bond	FX
Australia	8.40	3.23	1.98	11.84	6.43	9.27	-0.46	-0.19	-0.17	3.12	3.13	2.85
Austria	5.67	3.14	0.20	15.40	4.12	10.17	-0.56	-0.37	-0.25	3.89	2.63	3.75
Belgium	7.97	3.56	0.40	14.60	4.38	10.18	-0.80	-0.22	-0.30	5.04	2.47	3.75
Switzerland	11.06	2.94	-1.31	15.40	4.22	10.91	-1.05	-0.08	-0.05	5.84	3.16	3.07
Canada	8.61	3.96	0.79	13.73	5.76	6.00	-1.10	-0.16	-0.02	7.28	3.51	3.11
Denmark	8.57	3.26	0.99	16.85	5.21	10.05	-0.43	-0.56	-0.22	3.50	3.60	3.68
Finland	14.06	3.07	-0.53	31.06	3.85	11.14	-0.34	-0.01	-0.40	4.09	3.95	4.04
France	8.31	3.10	0.74	17.62	4.68	10.02	-0.56	-0.26	-0.26	3.78	2.44	3.65
Germany	5.71	2.92	0.26	18.47	4.34	10.16	-0.90	-0.44	-0.24	5.82	2.74	3.77
Ireland	10.47	3.11	0.89	17.50	5.41	9.88	-0.34	-0.35	-0.36	4.61	3.98	3.86
Italy	4.88	4.37	0.39	21.26	6.15	10.36	0.29	0.29	-0.45	3.59	4.59	4.43
Japan	0.43	4.03	-2.31	17.87	4.80	11.09	-0.02	-0.65	0.76	3.16	6.21	6.25
Netherlands	8.88	3.23	0.20	16.51	4.30	10.15	-0.97	-0.32	-0.21	4.97	2.68	3.75
New Zealand	5.85	1.29	4.13	15.03	4.02	9.16	-0.34	0.19	-0.38	3.69	3.58	3.63
Norway	8.04	1.85	1.03	21.19	3.88	10.32	-0.92	-0.24	-0.25	5.07	4.20	3.59
Spain	9.22	3.95	0.21	18.63	6.02	10.50	-0.54	0.24	-0.40	4.16	4.41	3.97
Sweden	10.49	0.24	-0.10	23.18	4.13	11.42	-0.17	-0.16	-0.50	3.74	3.16	4.68
UK	5.34	2.15	1.96	13.49	5.42	9.08	-0.69	-0.08	-1.03	3.94	3.62	6.83
US	7.85	2.81	-	13.87	6.07	-	-0.77	-0.31	-	4.57	3.73	-

Table 2
Correlation between asset return differentials and changes in the exchange rate

This table shows monthly correlation coefficients between (i) exchange rate returns and equity returns differentials; (ii) exchange rate returns and bond returns differentials; (iii) equity returns differentials and bond returns differentials; (iv) exchange rate returns and interest rate differentials for a set of 18 countries vis-à-vis the US. The foreign exchange rate is defined as units of US dollars per domestic currency. The stock indices are total market returns from Datastream, the bond price indices are total market returns on 7-10 year maturity benchmarks, the interest rates are for one-month Eurocurrency deposits from the Bank for International Settlements. 'FX' denotes excess returns for borrowing in US dollars, converting to the domestic currency, lending at the domestic interest rate, and converting the proceed back to dollars. The stock and bond returns are excess returns over the same country's one-month interest rate. The data are monthly observations from January 1991 through May 2007.

	FX and equity returns differentials	FX and bond returns differentials	Equity and bond returns differentials	FX and interest rate differentials
Australia	-0.069	0.053	0.146	0.151
Austria	-0.186	-0.357	0.214	0.065
Belgium	-0.221	-0.321	0.200	0.069
Switzerland	-0.288	-0.295	0.303	0.077
Canada	-0.005	0.148	0.160	0.035
Denmark	-0.307	-0.368	0.205	0.013
Finland	-0.285	-0.218	0.312	-0.115
France	-0.351	-0.356	0.435	0.006
Germany	-0.330	-0.319	0.407	0.064
Ireland	-0.301	-0.285	0.281	-0.132
Italy	-0.155	-0.130	0.482	-0.117
Japan	-0.078	-0.203	-0.098	0.137
Netherlands	-0.410	-0.346	0.358	0.072
New Zealand	0.024	0.029	0.107	0.162
Norway	-0.169	-0.240	0.357	-0.057
Spain	-0.266	-0.287	0.458	-0.106
Sweden	-0.295	-0.210	0.468	-0.072
UK	-0.357	-0.376	0.375	-0.124

Table 3

Model with similar risk premia across country pairs

The results refer to the estimation of system (14) by one stage GMM estimation with the optimal weighting matrix being the unity matrix. The instruments used in the system are: lagged one-period earnings yields and lagged one-period change in earnings yields in both the domestic country and the US for stocks; lagged one-period excess bond returns and lagged one-period change in excess bond returns in both the domestic country and the US for bonds. Standard errors are reported in parenthesis. J-Stat denotes the *p*-value of the J-statistic to test the null hypothesis that the overidentifying restrictions are satisfied. Excess returns are expressed vis-à-vis the US. The data are monthly observations from January 1991 through May 2007.

	First equation				Second equation				Third equation				
	Constant	s.e.	FX / Equity	s.e.	Constant	s.e.	FX / Bond	s.e.	Constant	s.e.	Equity / Bond	s.e.	J-Stat
Australia	0.002	(0.002)	-0.799	(0.280)	0.003	(0.003)	-2.786	(1.427)	-0.001	(0.003)	3.732	(1.736)	0.053
Austria	-0.001	(0.003)	-0.555	(0.142)	0.001	(0.002)	-1.639	(0.579)	-0.002	(0.003)	-0.518	(0.905)	0.102
Belgium	0.000	(0.003)	0.942	(0.255)	0.001	(0.002)	-1.745	(0.518)	0.000	(0.002)	0.208	(0.416)	0.089
Switzerland	0.000	(0.002)	-0.571	(0.203)	-0.001	(0.002)	-1.687	(0.546)	0.003	(0.002)	1.183	(0.450)	0.580
Canada	0.001	(0.002)	-0.615	(0.149)	0.002	(0.002)	-0.979	(0.788)	0.002	(0.002)	-1.236	(0.648)	0.207
Denmark	0.001	(0.002)	-0.338	(0.198)	0.001	(0.002)	-1.220	(0.426)	0.001	(0.003)	-0.202	(0.402)	0.103
Finland	0.001	(0.002)	-0.321	(0.156)	0.000	(0.002)	-1.096	(0.386)	0.005	(0.005)	3.042	(0.615)	0.627
France	0.001	(0.002)	-0.479	(0.167)	0.001	(0.002)	-1.572	(0.510)	0.000	(0.002)	2.248	(0.558)	0.342
Germany	-0.002	(0.003)	-1.312	(0.528)	0.000	(0.002)	-1.561	(0.632)	-0.002	(0.002)	0.777	(0.709)	0.161
Ireland	0.000	(0.003)	0.554	(0.380)	0.001	(0.002)	-1.199	(0.474)	0.003	(0.003)	-1.508	(0.593)	0.223
Italy	0.000	(0.002)	-0.172	(0.172)	0.001	(0.002)	-0.367	(0.328)	-0.007	(0.004)	3.339	(0.839)	0.514
Japan	-0.001	(0.002)	0.084	(0.234)	0.000	(0.002)	-1.603	(0.608)	-0.006	(0.004)	-0.314	(0.485)	0.158
Netherlands	0.001	(0.002)	-0.980	(0.257)	0.001	(0.002)	-1.409	(0.520)	0.000	(0.002)	1.881	(0.614)	0.130
New Zealand	0.003	(0.002)	-0.496	(0.300)	0.001	(0.003)	-2.113	(1.169)	0.000	(0.002)	0.970	(0.635)	0.287
Norway	0.001	(0.002)	-0.446	(0.133)	0.001	(0.002)	0.418	(0.554)	-0.001	(0.004)	-1.253	(0.972)	0.287
Spain	0.000	(0.002)	0.142	(0.265)	0.001	(0.002)	-0.899	(0.343)	0.000	(0.002)	1.260	(0.346)	0.431
Sweden	-0.001	(0.003)	0.360	(0.321)	0.001	(0.002)	-0.679	(0.410)	0.001	(0.003)	1.113	(0.468)	0.722
UK	0.001	(0.002)	-0.470	(0.212)	0.001	(0.001)	-0.584	(0.473)	-0.002	(0.001)	0.645	(0.428)	0.203

Table 4
Model with similar risk premia across country pairs:
Testing the hypothesis of 'no diversification gains'

This table presents confidence intervals for the Wald test on the coefficients reported in Table 4. L stands for lower estimate of the 95% confidence interval. U stands for upper estimate of the 95% confidence interval. The restrictions to test the null hypothesis of no diversification gains in system (14) are: $\hat{\beta}_0 - \hat{\alpha}_0 + \hat{\gamma}_0 = 0$, $\hat{\alpha}_1 + 1 = 0$, $\hat{\beta}_1 + \hat{\gamma}_1 = 0$. The *p*-value for this test is obtained from a Wald test statistic, distributed asymptotically as chi-square. The data are monthly observations from January 1991 through May 2007.

	FX / Equity $\hat{\alpha}_1$		FX / Bond $\hat{\beta}_1$		Equity / Bond $\hat{\gamma}_1$		Test of 'no diversification gains'
	L	U	L	U	L	U	p - value
Australia	-1.348	-0.250	-5.583	0.011	0.329	7.134	0.849
Austria	-0.833	-0.277	-2.775	-0.503	-2.292	1.257	0.000
Belgium	0.443	1.442	-2.760	-0.729	-0.608	1.023	0.000
Switzerland	-0.969	-0.174	-2.757	-0.616	0.302	2.064	0.136
Canada	-0.908	-0.322	-2.524	0.566	-2.506	0.034	0.010
Denmark	-0.726	0.049	-2.055	-0.385	-0.989	0.585	0.000
Finland	-0.626	-0.015	-1.854	-0.339	1.836	4.248	0.000
France	-0.807	-0.151	-2.572	-0.573	1.154	3.342	0.010
Germany	-2.348	-0.277	-2.799	-0.323	-0.613	2.166	0.901
Ireland	-0.191	1.299	-2.127	-0.270	-2.671	-0.346	0.000
Italy	-0.509	0.164	-1.009	0.275	1.695	4.983	0.000
Japan	-0.375	0.544	-2.796	-0.411	-1.264	0.636	0.000
Netherlands	-1.485	-0.475	-2.428	-0.391	0.678	3.085	0.896
New Zealand	-1.083	0.091	-4.405	0.179	-0.273	2.214	0.183
Norway	-0.706	-0.186	-0.668	1.504	-3.158	0.652	0.000
Spain	-0.378	0.661	-1.571	-0.227	0.583	1.937	0.000
Sweden	-0.267	0.989	-1.482	0.125	0.195	2.031	0.001
UK	-0.885	-0.055	-1.511	0.342	-0.194	1.484	0.089

Table 5
The US SDF and estimated expected excess returns

The results refer to the estimation of system (16) by one stage GMM estimation with the optimal weighting matrix being the unity matrix. The instruments used to construct the managed portfolios are: lagged one-period change in earnings yields in both the domestic country and the US for stocks; lagged one-period change in bond yields in both the domestic country and the US for bonds. Standard errors are reported in parenthesis. J-Stat denotes the *p*-value of the J-statistic to test the null hypothesis that the overidentifying restrictions are satisfied. Estimated market premia and US risk free rate are annualized values. The data are monthly observations from January 1991 through May 2007.

	US risk free rate	US equity	US bond	Foreign equity	Foreign bond	Foreign currency deposit	J-stat
Australia	4.206	7.935	2.848	8.182	3.272	1.974	0.210
Austria	4.246	7.935	2.848	5.538	3.099	0.208	0.381
Belgium	4.228	7.935	2.848	7.867	3.551	0.408	0.262
Switzerland	4.215	7.935	2.848	11.050	2.908	-1.289	0.390
Canada	4.203	7.935	2.848	8.720	4.040	0.837	0.189
Denmark	4.225	7.935	2.848	8.166	3.239	0.955	0.306
Finland	4.216	7.935	2.847	13.825	3.137	-0.568	0.290
France	4.223	7.935	2.848	8.034	3.095	0.701	0.303
Germany	4.219	7.935	2.848	5.487	2.852	0.279	0.831
Ireland	4.219	7.935	2.848	10.367	3.096	0.888	0.305
Italy	4.208	7.935	2.848	4.980	4.361	0.390	0.583
Japan	4.152	7.935	2.848	0.695	4.116	-2.446	0.138
Netherlands	4.223	7.935	2.848	8.842	3.194	0.212	0.578
New Zealand	4.253	7.935	2.848	5.317	1.361	3.912	0.689
Norway	4.230	7.935	2.848	7.600	1.837	1.010	0.108
Spain	4.209	7.935	2.848	9.053	3.920	0.201	0.687
Sweden	4.201	7.935	2.848	10.571	4.032	-0.095	0.704
UK	4.219	7.935	2.848	5.242	2.079	1.942	0.391

Table 6
Time varying risk premia

Estimated mean market premia are annualized values. The risk premia are obtained from estimating a BEKK GARCH(1,1) model for each country relative to the US. Note that (1) is approximately equal to the sum of (2) and (3), because (2) and (3) are the covariance terms, while (1) is the log of one minus the covariance terms. Returns' variances differentials needed to estimate the full system (14) are reported (in mean) in the last two columns. The data are monthly observations from January 1991 through May 2007.

	Risk premia on US equities	Risk premia on US bonds	Risk premia on foreign equities (adjusted) (1)	Risk premia on foreign equities (2)	Covariance between stock returns and FX (3)	Risk premia on foreign bonds (adjusted) (1)	Risk premia on foreign bonds (2)	Covariance between bond returns and FX (3)	Variance differentials (equities)	Variance differentials (bonds)
Australia	8.281	2.938	7.870	8.234	-0.332	3.691	3.740	-0.039	-0.011	-0.014
Austria	7.789	2.833	5.336	4.977	0.373	3.123	3.109	0.018	-0.017	-0.012
Belgium	8.083	2.917	8.237	7.972	0.300	3.573	3.548	0.031	-0.015	-0.012
Switzerland	8.144	2.903	11.514	10.979	0.606	3.011	3.019	-0.003	-0.018	-0.013
Canada	7.932	2.861	8.134	8.462	-0.293	3.864	3.928	-0.058	-0.009	-0.008
Denmark	8.272	2.941	8.718	8.252	0.500	3.219	3.200	0.025	-0.019	-0.012
Finland	7.574	2.879	14.119	13.398	0.835	3.143	3.141	0.007	-0.040	-0.012
France	8.037	2.973	8.777	8.283	0.532	3.137	3.139	0.002	-0.020	-0.012
Germany	8.094	2.954	5.731	5.279	0.469	2.876	2.869	0.011	-0.021	-0.012
Ireland	8.247	2.907	10.650	10.241	0.458	3.112	3.097	0.020	-0.020	-0.013
Italy	7.720	2.973	5.164	4.848	0.333	4.540	4.592	-0.037	-0.025	-0.014
Japan	8.147	3.056	0.641	0.615	0.030	4.333	4.343	0.000	-0.022	-0.013
Netherlands	8.263	2.933	9.164	8.665	0.539	3.196	3.195	0.006	-0.018	-0.012
New Zealand	8.469	2.836	4.976	5.297	-0.306	1.299	1.342	-0.042	-0.015	-0.010
Norway	8.510	2.996	7.937	7.703	0.270	1.903	1.894	0.011	-0.026	-0.012
Spain	7.975	2.954	9.325	8.845	0.523	3.842	3.807	0.044	-0.023	-0.015
Sweden	8.003	2.870	10.996	10.666	0.392	4.021	4.000	0.030	-0.029	-0.016
UK	8.248	2.942	5.847	5.526	0.340	2.060	1.981	0.081	-0.013	-0.012

Table 7
Model with time varying asset-specific risk premia across country pairs

The results refer to the estimation of system (14) by one stage GMM estimation with the optimal weighting matrix being the unity matrix. The estimated coefficients of the system of equations are reported in the first column for each variable. Standard errors are reported in parenthesis. Estimated constant terms are not reported. For methodology and sample period, see text in Table 4. In addition to the instruments indicated in Table 4, we use also lagged one-period risk premia. The data are monthly observations from January 1991 through May 2007.

	FX and Equity		FX and Bond		Equity and Bond		Foreign equity risk premia		Domestic equity risk premia		Foreign bond risk premia		Domestic bond risk premia		Variances (equity)		Variances (bond)		J-stat
Australia	-0.21	(0.21)	0.07	(0.91)	1.13	(1.10)	-2.57	(1.95)	0.84	(1.62)	2.66	(0.80)	-10.07	(3.14)	-1.59	(1.12)	3.37	(1.53)	0.05
Austria	-0.17	(0.15)	-0.33	(0.73)	-1.51	(1.06)	-5.71	(2.13)	0.10	(1.66)	12.62	(5.70)	-36.72	(12.98)	-0.30	(1.17)	2.34	(5.82)	0.08
Belgium	1.06	(0.24)	-0.93	(0.45)	-0.25	(0.59)	-0.70	(0.68)	0.64	(1.20)	3.09	(3.16)	-15.28	(7.29)	-1.39	(1.04)	-6.79	(3.92)	0.09
Switzerland	-0.78	(0.22)	-1.74	(0.53)	1.49	(0.52)	0.34	(0.88)	-3.79	(2.45)	3.01	(6.37)	-6.85	(4.08)	2.43	(1.53)	-2.51	(1.77)	0.07
Canada	-0.79	(0.18)	-1.26	(0.85)	-1.21	(0.54)	-1.90	(0.73)	2.79	(1.33)	-3.29	(1.38)	7.75	(2.33)	-0.40	(0.53)	-1.02	(1.25)	0.26
Denmark	-0.86	(0.31)	-1.12	(0.50)	0.47	(0.50)	-7.27	(4.39)	-3.35	(1.92)	-6.07	(6.43)	30.97	(11.24)	4.59	(1.57)	-2.38	(2.68)	0.54
Finland	-0.30	(0.31)	-1.44	(0.67)	2.92	(0.98)	7.51	(3.86)	-6.04	(2.88)	-10.32	(8.81)	9.82	(9.38)	1.79	(1.30)	-3.03	(6.09)	0.03
France	-0.98	(0.30)	-1.60	(0.55)	2.29	(0.55)	0.09	(1.99)	-1.40	(1.40)	-28.36	(19.69)	-13.08	(14.54)	2.43	(1.69)	-1.43	(2.50)	0.13
Germany	-0.40	(0.28)	-1.79	(1.09)	0.27	(1.17)	5.68	(4.31)	-2.77	(1.71)	-15.67	(101.2)	-23.10	(36.86)	-4.25	(2.82)	-22.67	(7.84)	0.39
Ireland	0.75	(0.58)	-1.33	(0.60)	-1.13	(0.65)	-10.54	(3.93)	3.98	(1.24)	-11.60	(3.01)	-6.57	(13.50)	-5.51	(1.37)	-5.37	(1.98)	0.01
Italy	-1.09	(0.35)	-0.35	(0.44)	3.09	(1.00)	5.50	(5.39)	2.08	(3.81)	3.78	(2.67)	-24.10	(7.18)	9.60	(2.87)	1.68	(2.24)	0.14
Japan	-0.33	(0.41)	-1.09	(0.49)	-1.12	(0.77)	-22.15	(7.42)	-3.99	(2.07)	-3.69	(1.31)	8.70	(2.63)	3.64	(2.53)	-0.85	(1.45)	0.09
Netherlands	-1.43	(0.29)	-1.60	(0.63)	1.92	(0.56)	0.17	(3.87)	-2.87	(2.43)	51.10	(21.95)	-41.22	(18.37)	1.63	(1.49)	-3.83	(2.88)	0.08
New Zealand	-1.32	(0.46)	-3.34	(2.04)	-0.50	(0.99)	1.70	(3.35)	-5.94	(1.97)	-72.62	(16.37)	7.68	(12.63)	10.02	(3.20)	3.00	(5.53)	0.03
Norway	-0.59	(0.21)	0.86	(0.97)	-1.67	(1.35)	2.97	(1.05)	-1.88	(1.30)	48.48	(14.76)	15.20	(9.89)	0.54	(0.90)	4.81	(3.71)	0.10
Spain	-0.30	(0.21)	-1.16	(0.43)	1.30	(0.36)	-5.98	(1.92)	3.29	(1.44)	17.86	(4.82)	-9.21	(3.48)	-1.19	(1.05)	8.02	(2.16)	0.02
Sweden	0.50	(0.38)	-0.66	(0.64)	1.07	(0.71)	0.78	(2.09)	-0.82	(2.06)	-8.10	(4.16)	-45.20	(32.30)	-0.14	(0.91)	-6.17	(3.17)	0.12
UK	-0.15	(0.27)	-0.70	(0.48)	0.71	(0.46)	-0.10	(0.96)	-0.63	(0.75)	10.41	(2.88)	-0.35	(1.84)	0.79	(0.59)	3.80	(1.26)	0.03

Table 8
Model with time varying asset-specific risk premia across country pairs: Testing the hypothesis of 'no diversification gains'

This table shows confidence intervals for the Wald test on the coefficients reported in Table 8. L stands for lower estimate of the 95% confidence interval. U stands for upper estimate of the 95% confidence interval. The restrictions to test the null hypothesis of no diversification gains in system (14) are: $\hat{\beta}_0 - \hat{\alpha}_0 + \hat{\gamma}_0 = 0$, $\hat{\alpha}_1 + 1 = 0$, $\hat{\beta}_1 + \hat{\gamma}_1 = 0$. The p-value for this test is obtained from a Wald test statistic, distributed asymptotically as chi-square. The data are monthly observations from January 1991 through May 2007.

	FX and Equity $\hat{\alpha}_1$		FX and Bond $\hat{\beta}_1$		Equity and Bond $\hat{\gamma}_1$		Test of 'no diversification gains'
	L	U	L	U	L	U	p - value
Australia	-0.616	0.202	-1.720	1.857	-1.030	3.281	0.002
Austria	-0.462	0.113	-1.764	1.109	-3.589	0.566	0.000
Belgium	0.586	1.526	-1.821	-0.039	-1.415	0.917	0.000
Switzerland	-1.205	-0.349	-2.784	-0.695	0.472	2.508	0.648
Canada	-1.147	-0.442	-2.919	0.406	-2.261	-0.152	0.056
Denmark	-1.465	-0.264	-2.089	-0.142	-0.501	1.451	0.554
Finland	-0.905	0.314	-2.762	-0.123	1.004	4.832	0.004
France	-1.555	-0.396	-2.685	-0.521	1.209	3.379	0.605
Germany	-0.944	0.153	-3.921	0.346	-2.025	2.558	0.025
Ireland	-0.398	1.892	-2.506	-0.162	-2.406	0.139	0.000
Italy	-1.781	-0.392	-1.204	0.513	1.140	5.041	0.045
Japan	-1.122	0.472	-2.040	-0.138	-2.624	0.380	0.000
Netherlands	-1.994	-0.861	-2.843	-0.355	0.824	3.013	0.456
New Zealand	-2.230	-0.410	-7.335	0.655	-2.429	1.437	0.289
Norway	-0.991	-0.184	-1.040	2.752	-4.308	0.974	0.077
Spain	-0.705	0.105	-2.009	-0.313	0.601	1.993	0.007
Sweden	-0.244	1.248	-1.919	0.591	-0.318	2.458	0.001
UK	-0.685	0.377	-1.638	0.246	-0.194	1.604	0.010

Table 9

In-sample performance of domestic, global and diversified portfolios, Jan. 1991 – May 2007

Portfolios B and C are constructed using respectively information from the models with similar risk premia and with time varying asset-specific risk premia across country pairs.

Portfolios	Excess returns (annualized, %)	Sharpe ratio (annualized)	Information ratio (annualized)	Estimated Beta	Treynor ratio (annualized, %)	Jensen's alpha (annualized, %)	Black-Treynor ratio (annualized, %)
US stocks and bonds	5.33	0.72	0.00	1.00	5.33	0.00	0.00
US stocks only	7.85	0.57	0.32	1.70	4.61	-1.22	-0.72
US bonds only	2.81	0.46	-0.32	0.30	9.43	1.22	4.10
Two-country portfolios							
US and Australia	6.56	0.71	0.22	0.99	6.64	1.29	1.31
US and Austria	4.97	0.65	-0.06	0.71	6.99	1.18	1.66
US and Belgium	5.75	0.74	0.08	0.79	7.24	1.51	1.90
US and Switzerland	5.51	0.72	0.03	0.76	7.28	1.48	1.95
US and Canada	6.21	0.71	0.21	1.04	5.94	0.64	0.61
US and Denmark	6.12	0.76	0.15	0.86	7.15	1.56	1.82
US and Finland	6.68	0.63	0.18	1.01	6.61	1.29	1.28
US and France	5.89	0.71	0.11	0.89	6.60	1.13	1.27
US and Germany	4.95	0.59	-0.07	0.89	5.56	0.21	0.23
US and Ireland	6.51	0.76	0.23	0.93	7.02	1.57	1.69
US and Italy	5.17	0.56	-0.02	0.82	6.33	0.81	1.00
US and Japan	2.62	0.30	-0.41	0.80	3.27	-1.65	-2.06
US and Netherlands	5.79	0.73	0.10	0.87	6.64	1.14	1.31
US and New Zealand	6.52	0.72	0.19	0.90	7.21	1.70	1.88
US and Norway	5.66	0.61	0.05	0.92	6.12	0.73	0.79
US and Spain	6.06	0.67	0.13	0.94	6.42	1.03	1.09
US and Sweden	6.22	0.62	0.13	1.03	6.06	0.75	0.73
US and UK	5.52	0.72	0.04	0.86	6.41	0.93	1.08
Fully (A) and partially (B and C) diversified portfolios							
A - Portfolio (all 19 countries)	6.04	0.64	0.09	0.79	7.63	1.82	2.30
B - Portfolio (13 countries as in Table 5)	5.93	0.62	0.08	0.81	7.34	1.62	2.01
C - Portfolio (11 countries as in Table 9)	5.73	0.61	0.05	0.80	7.20	1.49	1.87
Global benchmarks							
D - MSCI World and Lehman Global	4.01	0.55	-0.31	0.83	4.82	-0.42	-0.51
E - MSCI World (stocks only)	5.46	0.42	0.01	1.42	3.83	-2.14	-1.50
F - Lehman Global (bonds only)	2.55	0.50	-0.37	0.24	10.80	1.29	5.47

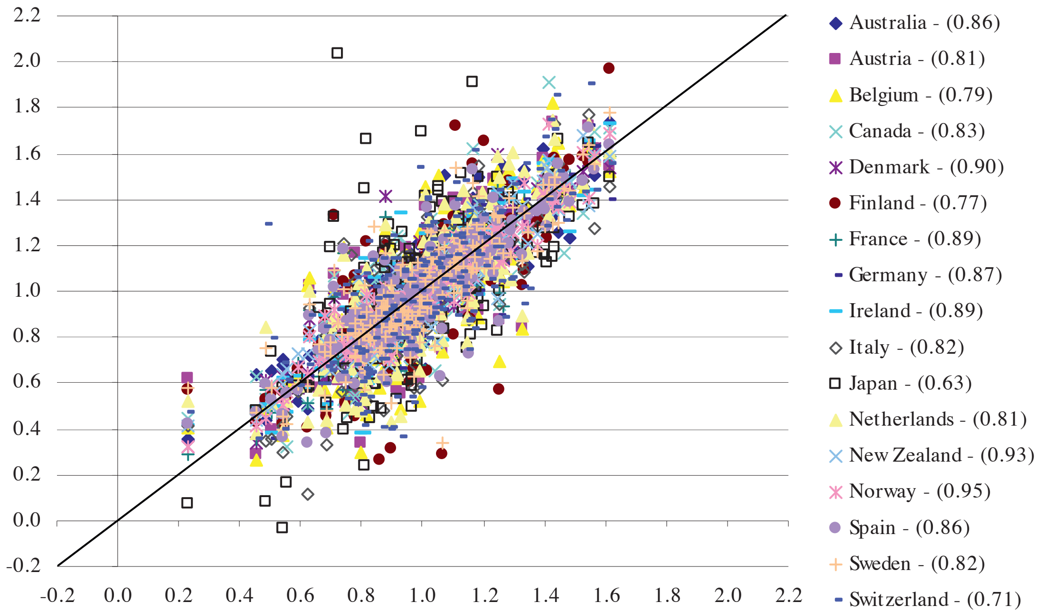
Table 10
Out-of-sample performance of domestic, global and diversified portfolios, June 2001 – May 2007

Portfolios B and C are constructed using respectively information from the models with similar risk premia and with time varying asset-specific risk premia across country pairs. We run the models over the period January 1991 and May 2001 in order to select the countries based on the structural test to form the portfolios to be held over the subsequent six-year period June 2001-May 2007. Portfolio B is formed by stocks and bonds of Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, New Zealand, Norway, Spain, Sweden and US. Portfolio C is formed by stocks and bonds of Austria, Belgium, Switzerland, Denmark, Finland, Germany, Italy, New Zealand, Spain, Sweden and US.

Portfolios	Excess returns (annualized, %)	Sharpe ratio (annualized)	Information ratio (annualized)	Estimated Beta	Treynor ratio (annualized, %)	Jensen's alpha (annualized, %)	Black-Treynor ratio (annualized, %)
Panel 1							
Domestic benchmark (US stocks and bonds)							
US stocks and bonds	2.77	0.48	0.00	1.00	2.77	0.00	0.00
Diversified and global portfolios							
A - Portfolio (all 19 countries)	11.65	1.30	1.40	1.11	10.50	8.58	7.73
B - Portfolio (13 countries)	12.26	1.29	1.46	1.23	10.00	8.86	7.22
C - Portfolio (11 countries)	12.27	1.34	1.47	1.14	10.76	9.11	7.99
D - MSCI World and Lehman Global	4.92	0.73	0.63	1.01	4.86	2.12	2.09
Panel 2							
Global benchmark MSCI World and Lehman Global							
D - MSCI World and Lehman Global	4.92	0.73	0.00	1.00	4.92	0.00	0.00
Diversified, global and domestic portfolios							
A - Portfolio (all 19 countries)	11.65	1.30	1.78	1.23	9.51	5.62	4.59
B - Portfolio (13 countries)	12.26	1.29	1.79	1.31	9.96	6.21	5.04
C - Portfolio (11 countries)	12.27	1.34	1.75	1.23	9.39	5.84	4.48
US stocks and bonds	2.77	0.48	-0.63	0.73	3.79	-0.83	-1.13

Figure 1
The US Stochastic Discount Factor
estimated using the approach of Brandt-Cochrane-Santa Clara (2006)

Panel A: The figure shows the scatter plot of the US SDF estimated on a country pair basis. The US SDF on the vertical axis is estimated vis-à-vis the UK. Theoretically, if all the points were on the 45-degree line, the SDF estimated on a country pair basis would be sufficient to price all assets. Correlation coefficients are reported in parentheses.



Panel B: The US SDF estimated on a country pair basis vis-à-vis the UK

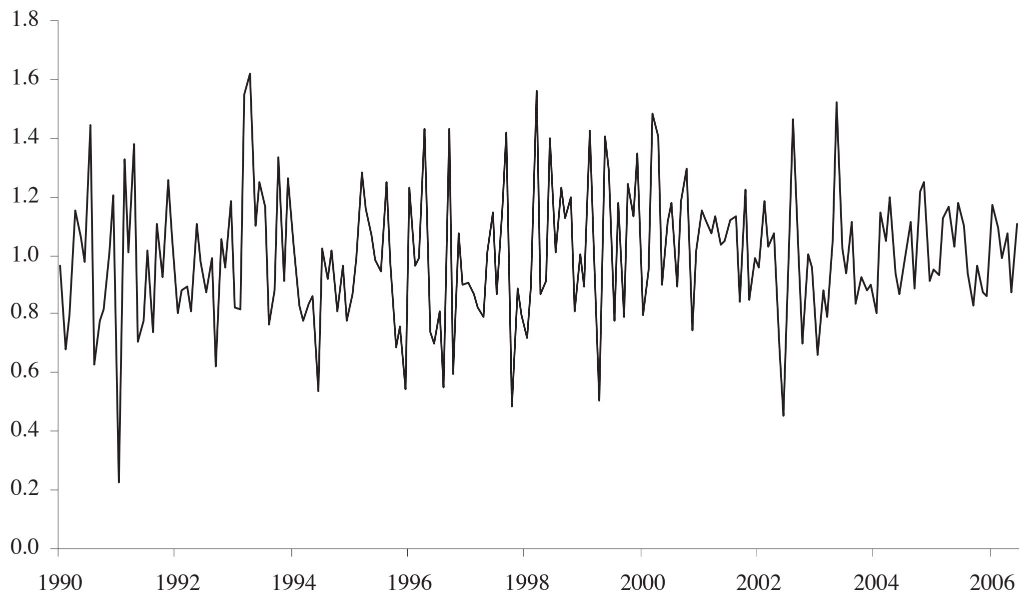
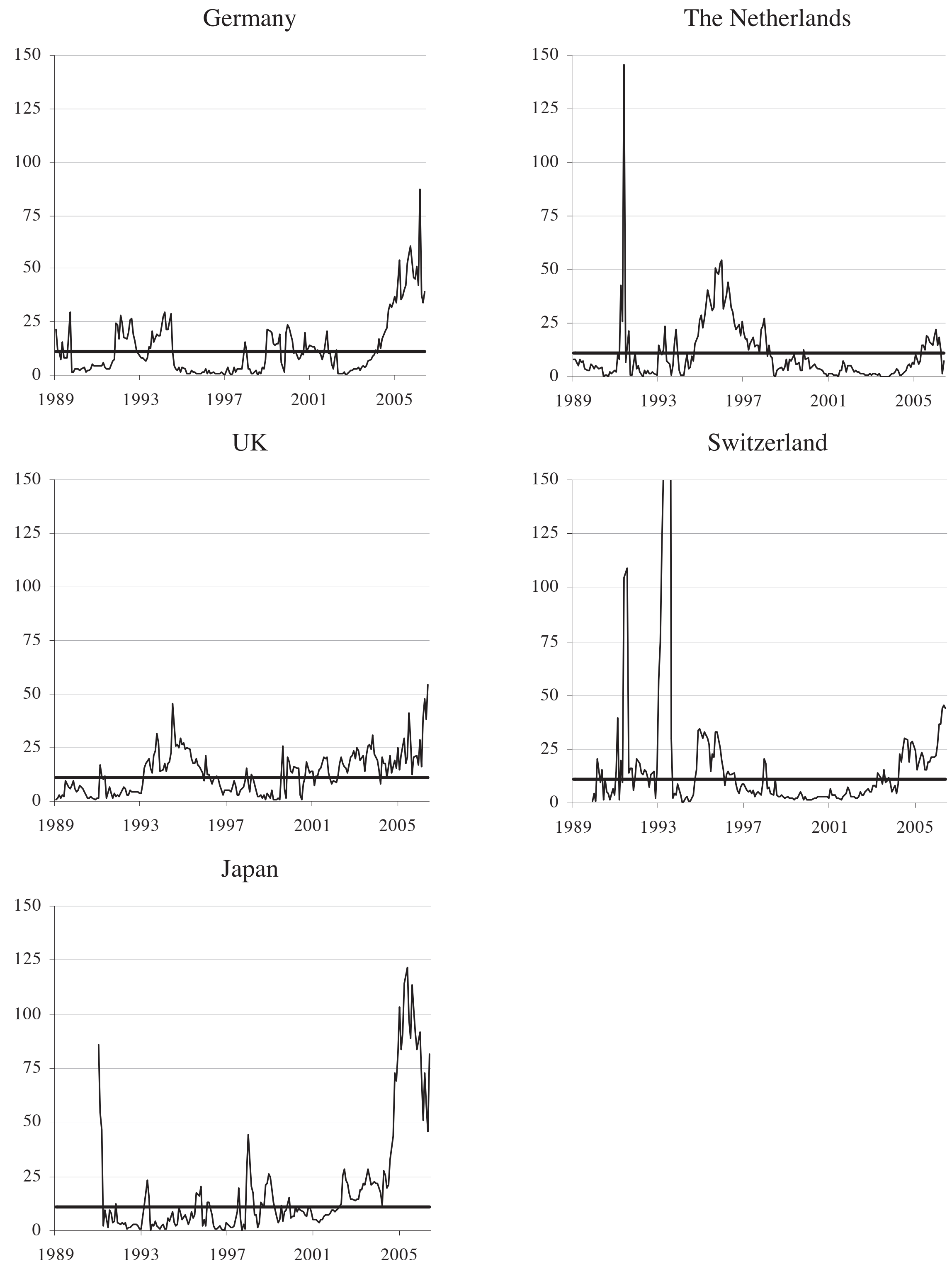


Figure 2
Assessing the Degree of Comovement over Time

The figure shows the time-varying *p*-value from the Wald test: $\hat{\beta}_0 - \hat{\alpha}_0 + \hat{\gamma}_0 = 0$, $\hat{\alpha}_1 + 1 = 0$, $\hat{\beta}_1 + \hat{\gamma}_1 = 0$. The *p*-values are calculated by estimating the system (14) using a 10-year moving window and testing the above restrictions month by month starting from January 1980 for Germany, the Netherlands and the UK; from December 1980 for Switzerland; and from January 1982 for Japan. The Chi Square is reported on the vertical axis.



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