What Do Stock Markets Tell Us About Exchange Rates?*

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Abstract

The Uncovered Equity Parity (UEP) condition states that countries with equity markets that are expected to perform strongly should experience a currency depreciation. We test this condition for 43 countries and find that exchange rate movements are unrelated to differentials in expected equity market returns, suggesting a systematic violation of UEP. Consequently, a trading strategy that invests in countries with the highest expected equity returns and shorts those with the lowest generates substantial excess returns and Sharpe ratios. These returns partially reflect compensation for global equity volatility risk, but significant excess returns remain after controlling for exposure to standard risk factors.

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"US stocks rallied, sending benchmark indices to the highest level since 2007, [...] while the dollar weakened" (Bloomberg, September 13 2012)

"Stocks have been strengthening, but currencies tell a different story. [...] There is a major disconnect between how stocks are moving and how currencies are moving" (CNBC, August 20 2012)

I Introduction

If a country's equity market is expected to outperform that of other countries, should we expect its currency to appreciate or depreciate? The answer to this question is of great importance to international equity investors, policy makers and, of course, to academics. An investor holding foreign equities is naturally exposed to exchange rate fluctuations. Portfolio performance and the decision regarding whether to hedge foreign exchange (FX) risk will both depend on the covariance between equity and currency returns, as well as expected returns and return volatilities. The relation between equity and currency returns is also important for policymakers as valuation changes induced by FX and equity returns generate significant swings in international investment positions, and the recent crisis has been characterized by increased amplitude of these valuation swings. However, while a vast literature has investigated the link between interest rate differentials and exchange rates across countries, little is known about the relation between exchange rates and international equity returns.[1] This paper fills this gap by providing empirical evidence on whether expected returns on foreign equity portfolios are systematically associated to currency movements.

Our starting point is the work by Hau and Rey (2006), who argue that, if investors cannot perfectly hedge their FX exposure, when a foreign equity market outperforms domestic equities one will observe a depreciation of the foreign currency. Portfolio rebalancing is

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[1]See, e.g., Engel (1996) for a survey of the literature on links between interest rates and FX rates. For recent contributions, see e.g. Burnside, Eichenbaum, Kleshchelski, and Rebelo (2011), Lustig, Roussanov, and Verdelhan (2011), and Menkhoff, Sarno, Schmeling, and Schrimpf (2012a).

the driving force of this prediction in their model: when foreign equities outperform, the FX exposure of domestic investors increases, so that they sell some of the foreign equity to reduce FX risk. These sales of foreign currency-denominated assets have a negative impact on the exchange rate and this depreciation in the exchange rate completely offsets the difference in equity returns across markets.[2] This is the Uncovered Equity Parity (UEP) condition.[3]

Although this parity condition is theoretically appealing, few papers have sought to test it. These studies report that, although the correlations between currency returns and equity return differentials may have the sign predicted by UEP, there is no evidence that exchange rate movements completely offset or substantially reduce expected differences in equity returns across countries (see, e.g., Hau and Rey, 2006; Melvin and Prins, 2011; Cho, Choi, Kim, and Kim, 2012). While the existing studies have tested UEP using statistical methods in a time-series setting, in this paper we analyze the economic consequences of UEP violations from the perspective of an investor in international equity markets. Specifically, we examine the cross-sectional validity of UEP using a portfolio approach and quantify the magnitude of UEP deviations in economic terms. We then assess whether UEP violations can be explained as compensation for risk.

Similar to the recent literature on FX carry trade strategies (Burnside et al., 2011; Lustig et al., 2011; Menkhoff et al., 2012a) we sort equity indices into portfolios according to their *expected* future return differentials with the domestic equity market. We proxy expected equity returns with three predictive variables: dividend yields, term spreads, and trailing cumulative past returns (momentum). These variables are among the most popular candidates proposed in the literature on equity return predictability (e.g., see Rapach and Zhou, 2013, and the references therein).[4] Specifically, using a sample of 43 countries over a period

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[2]Throughout the paper we define the nominal exchange rate as the domestic price of foreign currency.

[3]The same relation between equities and currencies may also be reached by assuming that investors are risk neutral. In that setting, expected currency returns would have to offset expected equity return differentials so that expected excess returns are zero in equilibrium.

[4]While other variables have also been used in the literature for individual stock markets, we focus on these three variables also because they are available for a large cross-section of countries. Barberis (2000),

covering November 1983 to September 2011, we study a trading strategy that is designed to exploit UEP violations by going long markets with the highest expected equity returns and short those with the lowest. We find that this strategy earns an average US-dollar excess return between 7% and 12% per annum, depending on the predictor used to forecast equity returns. The returns from this strategy can be decomposed into a local-currency equity differential component and a pure exchange rate component. The local-currency equity return component accounts almost entirely for the total return. Put differently, the exchange rate component of the total dollar return is close to zero, on average. This suggests that exchange rate changes fail to offset realized equity return differentials and UEP is systematically violated.

After documenting the existence of sizeable returns from a portfolio strategy that exploits violations of UEP, we investigate a risk explanation for these returns. We use standard asset pricing methods to test the pricing power of a number of risk factors conventionally used in international equity and FX markets. This analysis provides evidence that these large average returns can be explained, in part, as compensation for risk. Global equity volatility risk has the strongest cross-sectional pricing power. However, risk does not tell the whole story as, while portfolios that exploit the failure of UEP have significant exposures to global equity volatility risk, they still provide substantial risk-adjusted returns (alpha), and larger Sharpe ratios than conventional strategies based on US-specific or global factors.

In a final set of empirical exercises we demonstrate that our main conclusions regarding the return generating power of strategies that exploit deviations from UEP are robust to focussing on the most recent decade of data, focussing on a restricted cross-section of countries and including market transactions costs.

Cochrane (2008) and Rangvid, Schmeling, and Schrimpf (2014) relate equity returns to dividend yields, while Campbell and Thompson (2008) and Hjalmarsson (2010) analyze both dividend yields and term spreads. We also create 12-month momentum-based forecasts as first used by Jegadeesh and Titman (1993) and more recently by Asness, Moskowitz, and Pedersen (2013).

Related Literature This paper is related to, and builds upon, recent contributions investigating the validity of UEP. Hau and Rey (2006) provide the first empirical evidence for a sample of 17 OECD countries. Their results suggest that although the exchange rate and equity return differentials co-move negatively, the correlation is far from perfect. Cappiello and De Santis (2007) propose a parity condition similar to UEP, deviations from which are due to the existence of time-varying risk premia. Using data for several equity markets, they find mild evidence that exchange rates and equity return differentials are negatively correlated. However, they show that the results are sensitive to the choice of sample period since UEP fares poorly when it is evaluated from the 1980s until the end of 2006.[5] Melvin and Prins (2011) corroborate these findings by showing that, over the last ten years and for the G10 countries, the evidence in favor of UEP is generally weak. A variant of UEP, which explicitly allows for imperfect integration of capital markets across countries, is also investigated in Kim (2011) who finds that UEP is violated for four Asian emerging markets against the US, the UK, and Japan. Using data for US investors' bilateral portfolio reallocations and equity and currency returns, Curcuru, Thomas, Warnock, and Wongswan (2014) find that reallocations and past returns are related negatively, consistently with UEP. But they argue that what drives this result is not a desire to reduce currency exposure, as predicted by UEP, but tactical reallocations toward equity markets that subsequently outperform.

Relative to the empirical research cited above, the innovation of this study is the use of a portfolio-based approach to assess the economic significance of UEP violations rather than focussing on time-series tests. In contrast to preceding studies, our approach also allows us to characterize the risk exposures of an investment strategy that exploits deviations from UEP. There are strong parallels between our study and research that investigates the validity of Uncovered Interest Rate Parity (UIP). UIP states that exchange rates should adjust to

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[5]Dunne, Hau, and Moore (2010), in a recent high-frequency evaluation of UEP, argue that macroeconomic models of equity and exchange rate returns do not explain high-frequency variation of daily returns. However, they find that about 60% of daily returns in the S&P100 index can be explained jointly by exchange rate returns and aggregate order flows in both equity and FX markets.

prevent investors from exploiting interest rate differentials across countries. UEP makes a similar statement about movements in exchange rates and expected equity market return differentials. Our finding that exchange rates do not offset expected equity return differentials echoes similar results in the UIP literature (e.g., Fama, 1984). Also, our empirical setup and the finding that an international equity allocation strategy delivers positive returns mirrors the analysis in recent papers that study FX carry trade returns (Burnside et al., 2011; Lustig et al., 2011; Menkhoff et al., 2012a). It is worth noting, however, that the returns from our equity investment strategy and those of the FX carry trade are very different, in that their empirical correlation is roughly zero.

The work of Koijen, Moskowitz, Pedersen, and Vrugt (2013) is also related to ours. They study a global equity carry strategy in which countries are ranked on dividend yield estimates implicit in equity index futures prices. While their aim is to analyze the performance of the carry strategy, ours is to examine the exchange rate response to expected equity market movements.[6] Also, we conduct our analysis using three predictors of equity market returns (dividend yields, term spreads and momentum), for a broader cross-section of countries (43 versus 13) and over a longer time-series.

Finally, our work is also related to that of Asness et al. (2013) who demonstrate the profitability of value and momentum investment rules for various asset classes, including international equity markets. We also use momentum to build expected equity returns in our analysis and our sorting on dividend yields can be interpreted as an international value signal, although Asness et al. (2013) use book-to-market instead. Again, though, our focus is on what these equity market forecasts can tell us about exchange rate variation and the validity of UEP, rather than whether value and momentum rules are profitable per se.

The rest of the paper is set out as follows. Section II reviews the theory behind UEP

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[6]Also, Koijen et al. (2013) employ a forward looking measure of dividends obtained from equity futures prices under the risk-neutral measure, while we adopt a more conventional approach by sorting equity markets on the basis of the information in current dividend yields, consistent with a large literature on stock return predictability (Welch and Goyal, 2008).

and introduces the international equity strategy used to exploit UEP violations. Section III describes empirical methods. Sections IV and V report the main results, while Section VI describes some extensions and robustness checks. A final section concludes. A separate Internet Appendix contains details of further robustness tests as well as additional analysis.

II Uncovered Equity Parity: Theoretical Motivation and Testable Implications

II.A Uncovered Equity Parity: Theory

The UEP condition was first derived in an equilibrium international portfolio choice model by Hau and Rey (2006). They consider a setting in which risk averse investors form portfolios of domestic and foreign equities, and the investment flows generated by their portfolio decisions determine exchange rates (as well as equity prices).

The two most important assumptions in the model are, first, that investors cannot completely hedge FX risk and, second, that supply of FX is not perfectly elastic. The implication of the first assumption is that differences in equity returns across countries will generate a desire by investors to rebalance their equity portfolios. This will generate order flow in FX markets which, due to the second assumption, leads to changes in equilibrium exchange rates.

As a specific example, consider the case of a domestic investor with an international equity portfolio. When the foreign equity market outperforms the domestic market, the investor finds herself over-exposed to FX risk. Thus she sells some foreign equity, converts the proceeds to domestic currency and buys domestic equity. The sale of FX causes the foreign currency to depreciate, so that strong equity market performance in a country is accompanied by depreciation of its currency.

This negative correlation between the (excess) return on the foreign stock market over the domestic market (when both are measured in their respective local currencies) and the return

on the exchange rate is the key empirical implication of the Hau and Rey (2006) framework. The uncovered equity parity (UEP) condition that they derive has the correlation at minus unity, although a milder and perhaps more reasonable empirical implication of the model is that the correlation is negative, although not perfect. We proceed to test for this negative correlation using a large cross-section of country-level equity market returns. Taking the US as the domestic country, we evaluate whether countries whose equity markets outperform the US market experience exchange rate depreciations while those expected to under-perform the US see their currencies appreciate.

II.B   Testing UEP with a Portfolio Approach

We take a cross-sectional portfolio-based approach to test UEP. In particular, we use a given predictor variable (e.g., the dividend yield) to provide informative forecasts of local-currency equity returns. Using this predictor, and without the need to estimate a fully-fledged forecasting model, we sort countries into portfolios. We then calculate the returns (in US dollars) for each portfolio. UEP implies that any expected differential in stock market performance across countries should be eliminated by exchange rate movements. Therefore, positive average returns from investing in countries with strong predicted equity returns and shorting the ones with low or negative predicted equity returns would indicate that exchange rate movements do not offset equity market return differentials, implying a failure of UEP and quantifying that failure in economic terms.

We use country-level dividend yields, term spreads, and momentum variables as our predictors. These variables are studied in the vast literature on the predictability of equity returns (see, e.g., Welch and Goyal, 2008; Campbell and Thompson, 2008; Cochrane, 2008; Hjalmarsson, 2010; Ferreira and Santa-Clara, 2011; Rapach and Zhou, 2013). These predictors are also available for a large cross-section of countries, allowing us to expand the number of markets usually analyzed in the literature. Our three predictive variables represent dis-

tinct views of what drives equity returns. Dividends are routinely used as fundamentals to explain equity returns, and predictions based on dividend yields can be seen as a basis for value strategies (see, e.g., Cochrane, 2008). The term spread, i.e. the difference between long- and short-term yields, may predict returns because it captures compensation for risk common to all long-term securities.[7] We also use a momentum variable in light of the large body of research that has documented that a strategy of buying equities with high recent returns and selling equities with low recent returns results in large average excess returns (see, e.g., Jegadeesh and Titman, 1993, and Asness et al., 2013). We compute momentum-based predictions of future equity returns using trailing cumulative 12-month returns as in Jegadeesh and Titman (1993) and Asness et al. (2013).

It is worthwhile noting that, in the portfolio formation exercise, we build a set of portfolios for each forecasting variable separately, rather than trying to build a single forecasting model for returns (and then a single set of portfolios) from a combination of the three predictors. We choose this approach since we want to investigate whether our results on UEP are robust to the choice of different predictors for computing expected equity returns. It is not our goal to construct an econometrically optimal forecasting model for index returns. Thus, we do not run any forecasting regressions, univariate or multivariate for the purpose of ranking equity markets.[8]

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[7]Fama and French (1989), for example, argue that the term spread "tracks a term or maturity risk premium in expected returns that is similar for all long-term assets. A reasonable and old hypothesis is that the premium compensates for exposure to discount-rate shocks that affect all long-term securities (stocks and bonds) in roughly the same way."

[8]However, in a further exercise, we do compute the return improvement from combining the returns from the strategies based on the three different predictors. The results of this exercise are discussed later in the text and reported in the Internet Appendix.

III   The Empirical Framework

III.A   Portfolio Formation

We measure the economic significance of UEP deviations as follows: every month, we sort the equity markets in our sample by a candidate predictor variable. The three predictors we employ are dividend yields, term spreads, and momentum. Dividend yields are rolling 12-month cumulative dividends scaled by beginning of year price level. Term spreads are the difference in yields between 10-year government bonds and 3-month bills in each country. We calculate momentum using cumulative returns over a trailing 12-month period.[9]

We then assign each country to one of five portfolios. The one fifth of countries whose equity indices have the lowest expected equity return differential with the US equity market are allocated to the first portfolio (P1), the next fifth to the second portfolio (P2), and so on until the quintile of markets with equity indices exhibiting the highest expected return differential with the US are allocated to the fifth portfolio (P5). Thus, P1 contains equity markets with low expected returns as proxied by either low momentum, low dividend yields or low term spreads. P5, on the other hand, contains high-expected-return investments with strong momentum, high dividend yields, or large term spreads. For each predictor variable we form a long-short portfolio, obtained by going long P5 and short P1, that we call HML^{UEP}.[10] All of the portfolios are held for one month and their holding period return is measured in US dollars. In order to understand the source of profitability from our strategy, we decompose the HML^{UEP} return into two components: (i) the return on the international equity positions in their local currencies (HML^{EQ}) and (ii) the FX component of the HML^{UEP} portfolio return (HML^{FX}). The UEP result would predict that while the HML^{EQ} returns

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[9]In line with several studies on momentum strategies we skip the last month's return in computing the momentum signal. This is because some studies show that there exists a reversal or contrarian effect in equity returns at the one month level which may be related to liquidity or microstructure issues; see, e.g., Korajczyk and Sadka (2004).

[10]In the dividend yield case, for example, this zero-investment portfolio is long equity markets with high dividend yields and short equity markets with low dividend yields.

should be positive on average, the HML^{FX} component should contribute negatively to the total return.

It is important to point out that this international equity strategy could have been implemented using exchange traded funds (ETFs) and index futures contracts. In fact, in our empirical investigation in Section IV, we use MSCI equity indices that are widely used as a basis for a variety of financial products, including futures and ETFs.[11] Given that many of the products linked to the MSCI indices are highly liquid and subject to relatively low transaction costs, the returns from our international equity strategy are not merely theoretical but they represent a reasonable estimate of the economic value of UEP deviations, especially over the last decade or so. In fact, in a robustness exercise we use market-derived transaction costs estimates to argue that trading costs are very unlikely to offset the returns to our strategy.

III.B Asset Pricing Tests

If we find that UEP does not hold, we can proceed to ask whether the returns that are available from our international equity investment universe are reward for bearing risk. Appendix A demonstrates that in a standard no-arbitrage asset pricing framework UEP can be derived as a result of risk neutrality, but under risk aversion, expected excess returns on foreign equity positions will contain risk premia generated by domestic equity risk and the combination of foreign equity risk and FX risk.

We estimate conventional linear SDF models for excess returns in order to explore this possibility. Define the excess returns on portfolio i, with rx^i_{t+1}. This excess return, in our setting, will be the excess return on a portfolio of international investments, with the portfolio return measured in US Dollars. Excess returns must satisfy the Euler equation

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[11]A list of ETFs linked to MSCI indices can be found at www.msci.com/products/indices/licensing/.

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(1)
$$E_t \left(rx_{t+1}^i m_{t+1}^h \right) = 0.$$

If the SDF is linear, $m_{t+1}^h = 1 - b'(h_{t+1} - \mu_h)$, where h_{t+1} denotes a vector of risk factors and μ_h is a vector of factor means, the combination of the linear SDF and the Euler equation (1) leads to the conventional beta representation for excess returns:

(2)
$$E(rx^i) = \lambda' \beta_i.$$

We estimate the parameters of equation (2) using the Generalized Methods of Moments (GMM) of Hansen (1982). We use a one-step approach, with the identity matrix as the GMM weighting matrix. We also compute the J-statistic for the null hypothesis that the pricing errors are zero. In addition to the GMM estimation, we employ the traditional two-pass Fama-MacBeth (FMB) approach (Fama and MacBeth, 1973) and calculate standard errors using the Shanken (1992) correction.

With regards to the risk factors h_{t+1}, we select those that are most relevant for understanding the cross-section of international equity portfolio and currency returns. The first obvious candidate is the US-dollar excess return on the MSCI World portfolio, in the spirit of the International CAPM (see Solnik and McLeavey, 2008, Ch. 4, and the references therein). The other candidate factors are global FX volatility as in Menkhoff et al. (2012a), global equity volatility as in Ang, Hodrick, Xing, and Zhang (2006), the US Fama-French size and value factors and a US momentum factor (Carhart, 1997). We also use the global size, value and momentum factors of Fama and French (2012). The US and global size, value and momentum factors are from Ken French's website. We denote these factors as Size^{US}, Value^{US}, Mom^{US} and Size^G, Value^G, and Mom^G respectively.

We measure monthly global FX volatility as in Menkhoff et al. (2012a). We begin with

daily absolute returns for the cross-section of individual currencies. We then take a cross-sectional average every day and finally average the daily values up to the monthly frequency. Absolute returns are used instead of squared returns to minimize the impact of outliers because our sample includes a number of emerging markets. Thus, global FX volatility is measured as

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(3) \qquad \mathrm{Vol}_t^{FX} = \frac{1}{T_t} \sum_{\tau \in T_t} \left[\sum_{k \in K_\tau} \left(\frac{|r_\tau^k|}{K_\tau} \right) \right],
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where $|r_\tau^k|$ is the daily absolute return for currency k on day τ, K_τ is the number of currencies available on day τ, and T_t is the total number of trading days in month t. As in Menkhoff et al. (2012a), in the empirical analysis we use volatility innovations. These innovations are the residuals of a first-order autoregressive process for the global volatility level.

We build a measure of global equity volatility innovations, denoted as Vol^{EQ}, in a similar fashion to the above, using the local returns of the following equity indices: the US Russell 1000, the UK FTSE-100, Japan's TOPIX, Germany's DAX, and France's CAC 40. We use these indices rather than MSCI data as daily returns on MSCI indices were not available at the beginning of our sample period.[12]

IV Data and Portfolio Results

IV.A Data and Descriptive Statistics

For each country we measure equity market performance using MSCI equity index data obtained from Thomson Datastream. We collect total return indices in local currency and US dollars. The sample period runs from November 1983 to September 2011, but the number of equity indices for which data are available varies over time. We convert daily data into

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[12]We have also tried alternative measures of global equity volatility risk and global FX volatility risk inspired by range-based volatility estimation (see, e.g., Alizadeh, Brandt, and Diebold, 2002). These measures use the percentage high-low range of the equity index or exchange rate instead of the absolute return in equation (3). As there is no qualitative difference in these and the volatility results we report in the paper, we omit them. They are available on request.

non-overlapping monthly observations by sampling on the last business day of each month.

We choose these indices for several reasons. First, MSCI indices have been widely employed in other empirical studies (see, e.g., Hau and Rey, 2006; Bhojraj and Swaminathan, 2006; Rizova, 2010) so their characteristics are well known to academics and practitioners. Second, MSCI usually does not make retroactive changes to the reported returns of the various indices.[13] Third, a wide variety of products (including mutual funds, ETFs, listed index futures and options, over-the-counter derivatives) are linked to these indices. MSCI estimates that over seven trillion US dollars were benchmarked to MSCI indices as of June 2011.

To construct our equity return predictors we retrieve dividend yield data from MSCI, while data on term spreads are extracted from Global Financial Data. Exchange rate data are obtained from Barclays Bank International (BBI) and Reuters via Thomson Datastream. Our dataset covers 43 countries: Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Czech Republic, Denmark, Egypt, euro area, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Kuwait, Malaysia, Mexico, Netherlands, New Zealand, Norway, Philippines, Poland, Portugal, Russia, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, Ukraine, the United Kingdom, and the United States.[14]

Before proceeding with the portfolio analysis, it is worth mentioning that we tested the UEP condition through time-series regression analysis, equivalent to the time-series tests of UIP found in papers such as Fama (1984). More specifically, we examine whether realized differences in equity market returns for a pair of countries (measured in local currency) have explanatory power for changes in the exchange rate between the respective countries. UEP

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[13]In the few instances when those changes are made, because of data problems, the size of the change does not exceed one basis point. Such changes are different from those occurring at regular intervals because of the reconstitution of the equity indices (see, e.g., Madhavan, 2003).

[14]The summary statistics of the international equity index returns, expressed both in local currency and US dollars, and the FX depreciation rates are reported in Table B.1 of the Internet Appendix.

predicts a (perfect) negative relation, but our results suggest no relation at all. We also test whether excess US-dollar returns from an investment in foreign equity over those from an investment in US equity could be explained by the difference in equity returns when measured in local currencies. UEP implies that there should be no relationship, while the data suggest that the relationship is very strong, with an average slope coefficient that is statistically significantly different from zero in virtually all cases and close to unity. In short, this preliminary time-series analysis suggests a significant violation of UEP. We provide full details on these regressions in the Internet Appendix, Section C.

IV.B Portfolios Exploiting UEP Deviations

Table 1 reports descriptive statistics for the international equity portfolio returns, expressed in US dollars, constructed using the predictions of equity returns originating from dividend yields (Panel a), term spreads (Panel b) and momentum (Panel c), respectively. In all cases, sorting equities by expected equity return differentials generates a large cross-sectional average spread in mean portfolio returns: in fact, the average return on the HML^{UEP} portfolio ranges between 7% and 12% per annum across different predictors, with the momentum (term spread) HML^{UEP} portfolio exhibiting the largest (smallest) average annual return. For each predictor, the average portfolio return increases as we move from P1 to P5, and this increasing pattern is monotonic except for the case of the term spread. The portfolios containing equity indices with the lowest (highest) predicted local returns yield negative (positive) excess returns in US dollars. It is thus immediately clear that a strict form of UEP, where FX movements eliminate predictable return differentials across international equity markets, cannot hold in our broad cross-section of countries.

Volatilities are broadly similar across portfolios, with those for HML^{UEP} in excess of 16 percent per annum for all of the predictive variables. Sharpe ratios are also almost monotonically increasing from P1 to P5, and the annualized Sharpe ratio of the HML^{UEP}

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portfolio ranges between 0.42 and 0.70 across different predictive variables.[15]

A more refined insight into the drivers of these returns is provided by the decomposition of HML^{UEP} returns into the returns generated by equity market movements in local-currency terms (HML^{EQ}), and the returns due to changes in exchange rates (HML^{FX}). In all cases, the local-currency component HML^{EQ} accounts for almost all of the returns from the strategy; the FX component is relatively small and not statistically different from zero. The fact that, on average across the three different predictors, the mean return on the FX component is close to zero provides strong evidence against UEP. Exchange rates show no tendency to erode the predictable returns from international equity investment.

Panel (a) of Figure 1 shows the cumulative HML^{UEP} return from the international equity strategy computed using the three different predictive variables over the entire sample period. Panel (b) of Figure 1 presents, as benchmarks, cumulative returns from the FX carry trade strategy as in Menkhoff et al. (2012a) and the cumulative returns from the MSCI World index in excess of the 1-month US T-bill rate. The evidence of strong performance of the international equity strategy, highlighted in Table 1, is further reinforced when compared against alternative international strategies. In fact, over the full sample period, with the exception of the late 1980s, the cumulative excess returns from the international equity strategy computed using dividend yields or momentum are always higher than those exhibited by the two benchmark strategies. For these two predictors of equity returns, at the end of the sample our international equity strategy delivers a cumulative excess return 100 percentage points greater than the cumulative return on the FX carry trade and more than 150 percentage points greater than that of a buy-and-hold strategy for the MSCI World index. However, the end-of-sample cumulative performance of the strategy computed using the term spread as a predictor is only slightly better than that exhibited by the MSCI World index but about

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[15]Tables B.5 and B.6 in the Internet Appendix give estimated turnover rates for the HML^{UEP} portfolios and transition probabilities between the five portfolios separately for each of the predictor variables.

50 percentage points smaller than the FX carry trade.[16] It is also worth noting that each of our three HML^{UEP} return series are slightly negatively correlated with returns from FX carry: the correlations of the returns from the dividend yield, term spread and momentum HML^{UEP} portfolios with carry returns are -0.08, -0.12 and -0.02, respectively.

Figure 2 shows the two components of the returns of our international equity strategy, i.e. HML^{FX} and HML^{EQ}. Consistent with the results in Table 1 , the figure illustrates that most of the excess returns from the strategy originate from the equity component, whereas the FX component is negligible. Figure 2 makes the failure of UEP visually clear. The returns one can earn from forecasting international equity indices in local-currency terms are not offset by movements in exchange rates, regardless of the predictor used to forecast equity returns. Overall, and returning to the question in the title of this paper, equity returns tell us very little, if anything at all, about movements in exchange rates.

While not important for the main thrust of our analysis, it is worth noting that the three sets of HML^{UEP} returns are only slightly correlated across predictors. In fact, the average pairwise correlation between HML^{UEP} returns across the three different predictive variables equals 0.17. This finding suggests that (i) our different predictors convey different information regarding future equity returns and, more importantly, (ii) a combined strategy will deliver a better risk/return trade-off through diversification of the individual strategies' idiosyncratic risk. For example, a simple strategy that equally weights the HML^{UEP} returns originating from the three different predictors delivers an annualized Sharpe ratio of 0.86.[17]

The results also have some implications for the role that currency hedging might play in international equity investment management. At first sight, the results reported in Table 1

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[16]Further details about the dynamics of the portfolios can be found in Tables B.5 and B.6 of the Internet Appendix. More specifically, different predictors generate different turnover patterns in the HML^{UEP} portfolios. Persistent predictors, such as dividend yields or term spread, generate comparatively low turnovers when compared to more volatile predictors (such as momentum). In fact, the absolute change in the HML^{UEP} portfolio weights in a given month generated by the momentum signal is nearly twice as large as that exhibited by dividend yields.

[17]Full descriptive statistics of the equally weighted HML^{UEP} strategy are reported in Table B.7 of the Internet Appendix.

may lead one to the conclusion that currency hedging would generate no consistent benefits to investors concerned only about risk-adjusted portfolio performance (i.e. Sharpe ratios). In fact, the Sharpe ratios of the local-currency return component of our strategies (HML^{EQ}) are virtually identical to the Sharpe ratios of the total return (HML^{UEP}). However, we can also see that the standard deviation of HML^{EQ} returns are always below the corresponding number for HML^{UEP} (Table 1) and currency returns have a significant role to play in maximum drawdowns for HML^{UEP} portfolio returns (Table B.8 of the Internet Appendix). This second set of findings suggests some benefit from hedging currency risk. Overall, we view these results as showing that currency hedging is a decision that ought to be associated with the horizon of the investment. A long-term investor (say, a sovereign wealth fund) may not need to hedge, since over long investment horizons the role of currency risk is minimal. However, a long-term investor which has to match regular liabilities (say, a pension fund) or a short-term investor (say, a hedge fund) may wish to consider hedging since, although infrequent, adverse currency movements may jeopardize the overall performance of the international equity portfolios.

V Asset Pricing Tests

The results of the preceding section demonstrate the empirical failure of the UEP hypothesis. Thus, we now test whether the returns of the portfolios reported in the previous section can be explained by their differing exposure to risk factors. We begin with Fama-MacBeth regressions and GMM estimations of asset pricing models with linear representations for the SDF. We proceed to run time series regressions of portfolio returns on risk factors and test for significant intercepts (i.e. alphas) in these regressions.

V.A Cross-sectional Regressions and GMM Estimations

We present estimates derived from two-pass Fama-MacBeth and GMM. In our baseline models, all specifications contain two risk factors. The first of these is always the excess return on the MSCI World portfolio. We then cycle through the rest of our risk factors in turn (i.e. the US Fama-French factors and the global volatility risk factors discussed in Section III) to assess the pricing power of a given second factor. We estimate the asset pricing models for a cross-section containing 15 portfolios. This set of portfolios comprises the five portfolios generated by sorting on dividend yields, the five created by sorting on term spreads and the five momentum-sorted portfolios. In doing so, we follow the prescription of Lewellen, Nagel, and Shanken (2010) to include portfolios sorted by different variables in the same empirical asset pricing model, as explaining the returns of all these portfolios jointly provides a tougher test for the proposed model.

Table B.2 in the Internet Appendix reports descriptive statistics for the factors that are used in the cross-sectional asset pricing exercise. The time-series averages of the volatility factors are zero by construction. The global equity volatility measure, Vol^{EQ}, has a standard deviation that is two times larger than that of Vol^{FX}, indicating the presence of more extreme returns in international equity markets than in FX markets. The Sharpe ratios of the MSCI World portfolio, the US value and momentum factors are, on average, around 0.4. The global value and momentum factors have Sharpe ratios that are higher than that of the MSCI World portfolio (around 0.5). The US size factor is the only factor with a negative Sharpe ratio, although it is close to zero. Two of the three HML^{UEP} portfolios have much larger Sharpe Ratios than the risk factors, the exception being that based on the term spread (which is also around 0.4).

Tables 2 and 3 report the results of the asset pricing tests.[18] First, it is worth noting that,

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[18]Table B.3 in the Internet Appendix to the paper gives the coefficients from the time-series regressions that underlie the FMB analysis.

in all the estimated models, the MSCI World factor has a risk premium that is statistically indistinguishable from zero. However, looking across specifications all of the other factor risk premia are statistically significant at least at the 10% significance level, and all have the expected sign. The volatility factors have negative risk premia while the US Fama-French factors are associated with positive risk premia.

With regard to overall model fit, the J-statistics and associated p-values indicate that the most successful model is that which includes global equity volatility as the second risk factor. This is the only case for which we fail to reject the null hypothesis of zero pricing errors. While we are not keen to draw very strong conclusions regarding the fit of our models, given the likely low power of our tests in a setting with only 15 portfolios, our analysis suggests that variation in mean returns across international equity portfolios can be at least partially explained as compensation for bearing international equity market volatility risk. Markets that tend to deliver positive returns when international equity volatility is high are useful as volatility hedges and thus deliver smaller expected returns than markets that have returns which are negatively correlated with global volatility.

Looking at three-factor models rather than two-factor models corroborates the evidence on the importance of global equity volatility risk. If we estimate models that always include the MSCI World index and global equity volatility risk on the right hand side, plus one other factor, the third factor is never significant and global equity volatility risk is always significant (Table 4).

The evidence so far suggests that only a global equity volatility risk factor, instead of local US factors, can explain the cross-section of average returns. This result echoes the evidence suggesting that there are common patterns in average returns across international equity markets (e.g., Fama and French, 2012). Therefore we refine and extend our investigation of the strategy based on UEP deviations by including a set of global factors that have been found to be successful in explaining the cross-section of international equity returns. In line

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with Fama and French (2012), we consider global size, value and momentum factors.

It is worth noting that the results based on the global factors are not directly comparable with those reported in previous tables. The global factors are only available from July 1990 and they are constructed using a limited sample of developed markets.[19] Hence, the length of the sample period is reduced relative to that for all of our previous estimations by around one third. The results of the GMM pricing exercise where we substitute global for US Fama-French factors are reported in Table 5. (In the Internet Appendix, in Table B.4, we present comparable Fama-MacBeth estimates.) These results indicate that the global momentum and size factors, in addition to the global equity volatility risk factor, are statistically significant at the 10% level *and* can adequately price the cross-section of 15 portfolios in our sample. The global value factor is statistically insignificant and unable to price the cross-section of 15 international portfolios. However, global equity volatility risk produces, over this shorter sample period, a reasonably high R^2 and the largest p-value for the test of the null hypothesis of zero pricing errors. The other two significant factors generate either lower R^2 or much smaller p-values for the J-statistic.

A graphical view of our cross-sectional asset pricing results can be seen in Figures 3 and 4, which plot mean returns on our 15 portfolios against predicted returns from the various asset pricing models. An asset pricing model that performs perfectly should have all portfolios lining up along the solid 45 degree line. Figure 3 demonstrates the relative success of the global equity volatility factor. Only in this case is the cloud of points representing the portfolios upward sloping and close to the 45 degree line. In all other cases, the points in the plot trace out a roughly horizontal line. Figure 4 also shows that global Fama-French factors perform somewhat better than the US factors. It is worth noting, though, that while global equity volatility performs best of all the factors, some of the pricing errors it generates are large. Looking at Figure 3, for example, it is clear that the portfolios with low mean returns

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[19]Further details about the construction of Fama-French global factors can be found at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/details_global.html.

(the P1 portfolios from each of the three sorting variables) are priced rather poorly. Thus, while our pricing errors are statistically not different from zero, their economic significance might not be small.

In sum, the results from this section help us understand better the failure of UEP that was uncovered in Section IV.B. We should not expect currency movements to entirely eliminate the predictable returns available to those investing internationally as these expected returns are, at least in part, compensation for bearing global equity volatility risk.

V.B   Time-series Tests

We complement the cross-sectional results from Tables 2–5 with time-series regressions of the returns on our 15 portfolios on all risk factors simultaneously. This is likely to be a somewhat more powerful test than the cross-sectional regressions described above (which rely on 15 data points) as it accounts jointly for all of the risk factors over the full sample period.[20]

For each of our 15 portfolios we regress returns on risk factors. Where the risk factors are not themselves portfolio returns (i.e. for Vol^{EQ} and Vol^{FX}) we employ factor mimicking portfolios, obtained as fitted values from regressions of the factor realizations on the set of 15 base assets.[21] Converting non-tradable factors into portfolio returns allows us to scrutinize the factor price of risk in a more natural way (see, e.g., Breeden, Gibbons, and Litzenberger, 1989; Ang et al., 2006; Menkhoff et al., 2012a).

Table 6 presents results from this analysis. the key estimates in the table are the intercepts for the 15 portfolios. At a 10% significance level, four of these intercepts are statistically

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[20]The inclusion of all risk factors simultaneously is not feasible in the cross-sectional asset pricing exercise because of the small size of the cross-section of portfolios (i.e. 15) in our data.

[21]The correlation between the factor-mimicking portfolio returns and the raw factors is equal to 0.3 and 0.35 for Vol^{FX} and Vol^{EQ}, respectively. These figures are in line with similar computations carried out in different contexts (see, e.g., Adrian, Etula, and Muir, 2013). For both factor-mimicking portfolios the average excess returns are very close to and statistically insignificantly different from the factor price of risk obtained for the cross-section of the same base assets. These results are comforting since they imply that the factors price themselves and that there are no arbitrage opportunities (Lewellen et al., 2010).

significant, all are negative and all of those significant cases are portfolios P1 or P2 for a given sorting variable. If we run a Gibbons-Ross-Shanken test for the null hypothesis that the alphas are jointly zero we can decisively reject the null at the 1% significance level. Thus, the time-series evidence suggests that markets with low dividend yields, momentum or term spreads have significantly negative excess returns. The alpha from a long-short strategy that buys P5 and shorts P1 is in the range from roughly 7.5% to 10% per annum across the three predictors, and is strongly significantly different from zero in each case – with p-values of 0.1% for the dividend yield predictor, 1.75% for term spreads, and 2.6% for momentum. It is worth noting that this evidence is similar to that obtained when looking at Figure 3 in our cross-sectional work. Even our best fitting risk factor in the cross-sectional analysis, global equity volatility, priced these low mean return portfolios badly.

Looking at the risk factor exposures, we see that the world stock market return is significant in a few cases, but the betas on this factor tend to be close to zero. The volatility factor exposures are usually significant and negative. In the case of global equity volatility, the factor exposures tend to rise in magnitude as we move from P1 to P5 for each of the three alternative sorting variables. When equity volatility is high, the P5 portfolios tend to deliver lower returns than do the P1 portfolios and thus an investor who dislikes volatility risk demands a larger mean return from the P5 portfolios than he does from the P1 portfolios.

V.C   Summary and Discussion of Empirical Results

Our results thus far deliver several key messages. First, an investor can exploit deviations from UEP and make substantial annual returns in US dollars, in the range from 7% to 12% per annum. This finding clearly indicates that exchange rate changes do not offset expected equity return differentials, and the evidence is similar to that in the FX carry literature, which finds that exchange rate changes do not offset the profits available from exploiting international interest rate differentials. It is tempting to think of the strategy studied here

as the FX carry trade using equities rather than bonds. However, this is not the case because the returns from our international equity strategy are virtually uncorrelated with the returns from the FX carry trade.

These large returns may be due to a combination of risk premia arising in equity and FX markets. Our asset pricing tests suggest that there is some value to this argument. Global equity factors (i.e. global equity volatility risk and, to a lesser extent, global momentum and size factors) are useful in pricing the cross-section of 15 international equity portfolios.

Although all of these results point towards a risk explanation for the large returns from a strategy based on UEP violations, it is important to emphasize that risk premia only account for a fraction of the returns generated by the strategy over time. The time-series evidence tells us that while risk exposures of our 15 portfolios are significant, positive and statistically significant excess returns (up to 10% per annum) remain. This suggests that there may be additional drivers of our portfolio returns.[22]

VI Robustness

We perform a number of additional tests and find that our baseline results are robust to various modeling choices.

VI.A Different Numbers of Portfolios and Alternative Samples

In the first exercise, we assess how the results change as we vary the number of portfolios used to set up the international equity strategy exploiting UEP deviations, and as we change the sample period used to assess the economic value of the strategy. We report the results of these exercises in Tables 7 and 8, respectively. Table 7 (Panels a–c) shows the descriptive statistics of the HML^{UEP} portfolio returns when the number of portfolios used to set up

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[22]Among those potential alternatives, additional sources of risk (e.g. political risk) as well as limits to arbitrage (Menkhoff, Sarno, Schmeling, and Schrimpf, 2012b) could represent plausible candidates that may be able to rationalize the fraction of returns currently left unexplained. We leave these potential explanations for future work.

the international equity strategy ranges between three and six for the three different equity return predictors. The results are qualitatively and quantitatively similar to those reported in Table 1.

Table 8 reports the same descriptive statistics when both the number of portfolios ranges between three and six and the sample period used to assess the international equity strategy is limited to the last ten years of the sample. In comparison to the figures reported in Table 1, i.e. when the number of portfolios is equal to five, the average returns computed over the shorter sample period are smaller, around 7% per annum when the predictors of equity returns are the dividend yield and momentum. In line with the evidence reported in Table 1, the strategy based on term spreads delivers performance that is substantially lower than that based on the other two predictors. Overall, these results suggest that the quality of the various predictors might have deteriorated over time especially during and after the 1990s (see, e.g., Welch and Goyal, 2008). However, on balance, the reduction in average returns is generally offset by a similar reduction in the portfolio return volatility. This ultimately leads to Sharpe ratios for the strategies that are qualitatively similar to those presented in Section IV. The only exception is the strategy based on term spreads, which now has a Sharpe ratio close to zero and shows little ability to predict equity returns.[23]

VI.B   Varying the Universe of Countries

The second set of robustness checks investigates whether the baseline results reported in Section IV are driven by the behavior of a particular country, or subset of countries, within the sample. We do this in different ways: first, we compute the returns of the international strategy using only a small sample of 16 major equity markets. Second, we investigate the returns generated by the international equity strategy if we leave out one equity market in

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[23]This is not surprising given that term spreads are small and highly correlated across countries during the last ten years of our sample (which contains the global crisis period of 2007-2011). The average cross-sectional standard deviation of term spreads is 1.37% in the last ten years of the sample and is about half the standard deviation in the first part of the sample. Thus, in the last decade of our data, the lack of cross-sectional dispersion in term spreads means that there is little information in those data.

the sample at a time.

The results from the first set of robustness checks are reported in Table 9. In this table we report, in three separate panels, the summary statistics of the HML portfolio returns for each of the three predictors, and their decomposition into equity and FX components. Overall, when the international portfolio strategy is constructed using only 16 developed equity markets, the results confirm the evidence reported in Table 1. In fact, the average returns from the various strategies are roughly consistent with those reported for the full set of equity markets, with Sharpe ratios that are equal to about 0.5 on average across predictors. As already noted in Tables 7 and 8, when term spreads are used as predictors of future equity returns, the statistics of interest are lower.

We have also studied how omitting one of our sample countries at a time from the analysis affects the Sharpe ratios of the strategies. Figure B.1 in the Internet Appendix presents results from this exercise in histogram form. The Sharpe ratios of the international equity strategy are not substantially affected by the exclusion of any single equity market. The distributions of Sharpe ratios are centered on the values reported in Table 1 and the lowest Sharpe ratios in each distribution do not differ from the average by more than 0.1.

VI.C   Transactions Costs and Real-world Implementation

A reasonable question to ask is whether the returns achieved by these strategies that exploit deviations from UEP are robust to the inclusion of transactions costs. To estimate costs we spoke to a Delta-One trading desk at a global investment bank to discuss how strategies such as ours might be implemented and what costs might be realized. They suggested that, in current markets, our set of country-level returns were all tradeable, but that the precise manner that one could gain exposure to them would vary across countries. A large subset of country-level returns are easily tradeable in very liquid index futures markets. A second set of countries can be traded using liquid ETFs. Then there is a set of residual countries that

would need to be traded in illiquid ETF or futures markets. As for numerical estimates of trading costs, they gave us country level spread estimates that fell into four bins. These are shown in Table B.10 in the Internet Appendix. One can see from this table how the most developed markets can be traded at very tight spreads around 4 bps, while some emerging markets have spread estimates closer to 100 bps.

Using these spread data, Table 10 presents gross returns and returns net of transactions costs for each of our three signals. We present return statistics for the last 10 years only, as our spread estimates are likely to be most accurate for this subsample. Trading costs are set to half of the bid-ask spread.

The effects of transactions costs on returns are relatively small. In the dividend yield case costs amount to around 90 bps per annum and 150 bps per annum for the momentum signal, but net returns in both these cases are still strong, at close to 6% per annum. However, for the term spread signal, the close to zero gross returns observed over the last decade in Table 8 turn slightly negative once transactions costs are included in Table 10.

Overall, inclusion of transactions costs does not change our main conclusions. For the momentum and dividend yield signals, in the last decade of our sample one could have exploited the failure of UEP to make substantial returns, net of trading costs.[24]

VI.D   Alternative Proxies for Global Equity Volatility Risk

The final check we carry out assesses whether the pricing power exhibited by global equity volatility risk is simply proxying for a US equity volatility effect similar to that documented in Ang et al. (2006). We carry out this exercise by estimating two-factor asset pricing models where in addition to the MSCI World Index we use an index of the implied volatility of the US equity market (VIX). In one specification (Model 1) we compute volatility shocks by using the residuals of an AR(1) applied to the VIX time series while in another specification

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[24]To be conservative, we have experimented with doubling and tripling our spread measures and re-estimating trading costs. Net returns remain positive for the dividend yield and momentum signals.

we compute the innovations by first-differencing the same time series (Model 2). We also report estimates of a model (Model 3) that uses a global equity volatility risk factor based on combining daily equity return data from different sources. We use the Russell, FTSE, CAC, DAX and TOPIX data early in the sample to build our volatility factor, but once daily MSCI return data becomes available we use those data instead.

The results of this exercise are reported in Table B.9 in the Internet Appendix and they clearly show that while global equity volatility risk successfully explains the cross-section of international equity portfolios, the VIX does not. In fact, for both Models 1 and 2, none of the parameter estimates, including the estimated price of risk, are statistically significant and the J-statistics reject the null of zero pricing errors.

VII   Conclusions

This paper investigates the relationship between international equity returns and FX returns using a portfolio approach. Hau and Rey (2006) show that when domestic equity returns are expected to be in excess of foreign equity returns, the domestic currency is expected to depreciate. The resulting Uncovered Equity Parity (UEP) condition suggests that movements of exchange rates are tightly linked to the expected future return differential between foreign and domestic equity markets, expressed in local currency.

We propose a portfolio approach to assess the economic value of deviations from UEP. In our empirical analysis we follow the recent literature on currency markets and carry trade strategies, and sort equity markets into portfolios according to their expected return differentials with the US equity market. Equity index returns are forecast using three different but well-known predictors: dividend yields, term spreads and 12-month momentum.

Using a sample of 43 countries, over a period spanning November 1983 to September 2011, we show that investing in the highest expected equity return quintile portfolio and shorting the lowest expected equity return quintile portfolio generates significant excess

returns between 7% and 12% per annum across the three different predictors. The returns are entirely driven by differentials in equity market returns across countries, so that the exchange rate does not appear to respond at all to relative stock market performance. These returns are associated with some risk factors in international equity markets, notably global equity market volatility risk, but even after accounting for these risk factors, sizeable average returns remain. In fact, the international equity strategy provides alphas up to 10% per annum and larger Sharpe ratios than conventional currency and equity strategies.

Overall, this study provides little or no support for the validity of UEP. Exchange rate movements dramatically fail to offset differentials in country-level equity returns and, to return to the question in the title of this paper, stock market returns tell us very little about exchange rates.

Table 1. Descriptive Statistics of Portfolio Returns

The table reports descriptive statistics for the monthly returns of the international equity portfolios sorted by signals based on local return momentum, dividend yields and term spreads. The holding period is one month. Returns are measured in US dollars and in excess of the US market return. The sample of 43 country indices runs from November 1983 to September 2011. Portfolio 1 (P1) contains the one fifth of country indices that have the lowest value of the signal, whereas portfolio 5 (P5) contains the country indices with the highest values of the signal. HML^{UEP} gives statistics for US-dollar returns on the portfolio that is long P5 and short P1, HML^{EQ} is the return on the positions in local currency and HML^{FX} is the FX component of the HML^{UEP} portfolio return. By definition, $\text{HML}^{UEP} = \text{HML}^{EQ} + \text{HML}^{FX}$. Numbers in brackets are t-statistics for the null that the sample mean return is zero. AC(1) is the first-order autocorrelation.

Panel (a): Dividend yields

	P1	P2	P3	P4	P5	HML^{UEP}	HML^{EQ}	HML^{FX}
Mean	-3.09	2.61	5.58	7.48	8.28	11.37	12.66	-1.29
	[-0.85]	[0.91]	[2.14]	[2.85]	[2.95]	[3.64]	[4.40]	[-1.26]
Median	-0.22	5.47	9.04	7.06	3.96	11.33	10.12	-0.67
Std. Dev.	18.80	14.82	13.54	13.61	14.54	16.20	14.91	5.32
Skew	0.27	-0.07	-0.14	0.03	0.26	-0.38	0.03	-0.84
Kurtosis	4.74	3.49	3.46	3.49	3.80	5.67	4.85	8.93
Sharpe	-0.16	0.18	0.41	0.55	0.57	0.70	0.85	-0.24
AC(1)	0.12	0.11	0.07	-0.06	0.09	0.17	0.18	0.03

Panel (b): Term spreads

	P1	P2	P3	P4	P5	HML^{UEP}	HML^{EQ}	HML^{FX}
Mean	-0.72	3.88	3.39	3.05	6.26	6.98	6.84	0.14
	[-0.24]	[1.44]	[1.27]	[1.14]	[1.85]	[2.20]	[2.38]	[0.11]
Median	1.35	5.73	5.30	0.86	4.76	1.61	2.26	0.57
Std. Dev.	15.87	14.00	13.85	13.89	17.54	16.45	14.91	6.47
Skew	-0.59	-0.05	-0.03	0.15	0.41	0.78	0.87	-0.04
Kurtosis	5.83	2.85	3.84	3.30	5.36	5.79	6.60	4.58
Sharpe	-0.05	0.28	0.25	0.22	0.36	0.42	0.46	0.02
AC(1)	0.10	0.07	0.06	0.02	0.04	0.03	0.02	0.04

Panel (c): Momentum

	P1	P2	P3	P4	P5	HML^{UEP}	HML^{EQ}	HML^{FX}
Mean	-1.71	-1.20	4.70	7.72	10.58	12.29	10.44	1.85
	[-0.50]	[-0.44]	[1.76]	[2.73]	[3.12]	[3.21]	[2.96]	[1.41]
Median	-0.45	-1.74	4.21	7.13	9.42	13.63	12.35	0.26
Std. Dev.	17.75	14.21	13.87	14.66	17.59	19.86	18.29	6.83
Skew	-0.05	-0.15	0.03	0.16	0.02	-0.47	-0.52	1.01
Kurtosis	4.15	3.86	3.66	3.60	4.56	5.57	4.86	9.69
Sharpe	-0.10	-0.08	0.34	0.53	0.60	0.62	0.57	0.27
AC(1)	0.20	0.08	0.02	-0.00	-0.03	0.05	0.08	0.12

Table 2. FMB cross-sectional regressions

The table reports coefficients from Fama-MacBeth regressions of mean portfolio returns on betas to pairs of risk factors. The analysis uses the five portfolios from each of our sorting variables (dividend yields, term spreads and momentum) simultaneously, giving 15 cross-sectional observations. In every specification of the model the first factor is the MSCI World excess return (World) while the choice of the second factor varies across models. Shanken (1992) t-statistics are reported in brackets. The final rows of the table give a χ^2 test of the null that the pricing errors are zero and a set of associated p-values.

	Model 1	Model 2	Model 3	Model 4	Model 5
World	-0.0039	-0.0151	-0.0016	-0.0065	0.0116
	[-0.4735]	[-1.3129]	[-0.1913]	[-0.6926]	[1.0615]
Vol^{FX}	-0.0710				
	[-2.2431]				
Vol^{EQ}		-0.1650			
		[-2.8750]			
Size^{US}			0.0153		
			[1.9028]		
Value^{US}				0.0223	
				[2.4563]	
Mom^{US}					0.0297
					[3.1466]
R^2	0.4519	0.7818	0.4085	0.4811	0.7272
J-stat	28.0878	14.0478	39.0921	30.3972	23.5047
p-value	[0.0088]	[0.3705]	[0.0002]	[0.0041]	[0.0360]

Table 3. GMM asset pricing model estimates

The table reports coefficients from one-step GMM estimations of the two factor asset pricing model. The analysis uses the five portfolios from each of our sorting variables (dividend yields, term spreads and momentum) simultaneously, giving 15 cross-sectional observations. In every specification of the model the first factor is the MSCI World excess return (World) while the choice of the second factor varies across models. The final two rows of the table give the GMM J-statistic and its p-value.

	Model 1		Model 2		Model 3		Model 4		Model 5	
	$\hat{b}$	$\hat{\lambda}$	$\hat{b}$	$\hat{\lambda}$	$\hat{b}$	$\hat{\lambda}$	$\hat{b}$	$\hat{\lambda}$	$\hat{b}$	$\hat{\lambda}$
World	-5.9253	-0.0039	-18.7013	-0.0151	-2.1065	-0.0016	-0.2707	-0.0065	9.1885	0.0116
	[-1.3186]	[-0.4431]	[-1.7716]	[-0.9209]	[-0.4339]	[-0.1614]	[-0.0592]	[-0.6689]	[1.5309]	[0.9992]
Vol^{FX}	-7.2425	-0.0710								
	[-1.8930]	[-2.0634]								
Vol^{EQ}			-4.2229	-0.1650						
			[-2.6703]	[-2.8942]						
Size^{US}					14.8296	0.0153				
					[1.9649]	[1.8737]				
Value^{US}							22.9026	0.0223		
							[2.2265]	[2.1784]		
Mom^{US}									15.0631	0.0297
									[2.3320]	[2.3272]
J-stat	24.0221		9.1355		29.9720		25.6726		22.7898	
p-value	[0.0309]		[0.7626]		[0.0048]		[0.0188]		[0.0443]	

Table 4. GMM three factor pricing model estimates

The table reports coefficients from one-step GMM estimations of a three factor asset pricing model. The analysis uses the five portfolios from each of our sorting variables (dividend yields, term spreads and momentum) simultaneously, giving 15 cross-sectional observations. In every specification of the model the first factor is the MSCI World excess return (World) the second is the global equity volatility factor (Vol^{EQ}) and the choice of the third factor varies across models. The final two rows of the table give the GMM J-statistic and its p-value.

	Model 1		Model 2		Model 3		Model 4	
	$\hat{b}$	$\hat{\lambda}$	$\hat{b}$	$\hat{\lambda}$	$\hat{b}$	$\hat{\lambda}$	$\hat{b}$	$\hat{\lambda}$
World	-16.6754	-0.0114	-16.5914	-0.0087	-18.8223	-0.0186	-9.0898	-0.0067
	[-1.9638]	[-0.9658]	[-1.7888]	[-0.7027]	[-1.8868]	[-1.3322]	[-1.2919]	[-0.5925]
Vol^{EQ}	-24.4586	-0.0355	-25.1859	-0.0408	-19.6438	-0.0284	-14.3510	-0.0259
	[-1.8019]	[-2.8920]	[-2.0523]	[-2.5954]	[-2.4653]	[-2.2739]	[-2.1482]	[-2.2267]
Vol^{FX}	17.9771	0.0004						
	[0.4715]	[0.0321]						
Size^{US}			-12.5098	-0.0067				
			[-0.6729]	[-0.3858]				
Value^{US}					6.6840	0.0092		
					[0.5050]	[0.7510]		
Mom^{US}							8.0796	0.0216
							[1.0712]	[1.3596]
J-stat	9.0337		8.5598		8.9920		12.7194	
p-value	[0.7001]		[0.7400]		[0.7036]		[0.3898]	

Table 5. GMM asset pricing model estimates using global Fama-French factors

The table reports coefficients from one-step GMM estimations of the two factor asset pricing model. The analysis uses the five portfolios from each of our sorting variables (dividend yields, term spreads and momentum) simultaneously, giving 15 cross-sectional observations. In every specification of the model the first factor is the MSCI World excess return (World) while the second factor is either global FX vol, global equity vol or one of the global Fama-French factors. The final two rows of the table give the GMM J-statistic and its p-value.

	Model 1		Model 2		Model 3		Model 4	
	$\hat{b}$	$\hat{\lambda}$	$\hat{b}$	$\hat{\lambda}$	$\hat{b}$	$\hat{\lambda}$	$\hat{b}$	$\hat{\lambda}$
World	-18.6277	-0.0184	-11.6009	-0.0242	-0.3270	-0.0020	2.9167	0.0006
	[-1.9031]	[-1.4368]	[-1.5454]	[-1.6338]	[-0.0880]	[-0.2832]	[0.5551]	[0.0668]
Vol^{EQ}	-3.1003	-0.0923						
	[-2.0228]	[-1.5845]						
Size^{G}			21.8575	0.0112				
			[1.6355]	[1.8002]				
Value^{G}					10.2994	0.0061		
					[1.1736]	[1.1526]		
Mom^{G}							11.5178	0.0186
							[2.7808]	[2.6549]
J-stat	10.9203		16.1777		25.8569		16.8018	
p-value	[0.6175]		[0.2397]		[0.0178]		[0.2085]	

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Table 6. Time-series regressions of portfolio returns on factors and factor mimicking portfolios

The table reports coefficients from time-series regressions of portfolio returns on factors. The right-hand side variables are factor mimicking portfolios for our volatility proxies and the US Fama-French factors. Data are monthly. Newey and West (1987) t-statistics are reported in parentheses. The final two rows give the R^2 of the time series regression and the annualized alpha in percentage points implied by the regression constant.

	Div yield					Term spread					Momentum				
	P1	P2	P3	P4	P5	P1	P2	P3	P4	P5	P1	P2	P3	P4	P5
Constant	-0.006	-0.001	0.001	0.002	0.002	-0.004	-0.001	0.000	-0.002	0.003	-0.004	-0.004	0.001	0.002	0.002
	[-2.220]	[-0.690]	[0.878]	[1.420]	[1.410]	[-1.834]	[-0.298]	[0.160]	[-1.186]	[0.984]	[-1.734]	[-1.991]	[0.675]	[0.830]	[1.434]
World	0.105	0.099	0.087	-0.004	0.029	0.046	0.115	0.077	0.177	0.024	0.109	0.119	0.042	0.046	-0.008
	[1.457]	[1.762]	[1.937]	[-0.099]	[0.643]	[0.846]	[2.034]	[1.550]	[3.526]	[0.386]	[1.992]	[2.345]	[0.751]	[0.888]	[-0.210]
Vol^{FX}	-0.711	-0.013	-0.947	-0.471	-0.447	-0.811	0.040	-0.843	-0.177	-0.627	-0.984	-0.871	-0.335	-0.267	-0.060
	[-3.731]	[-0.090]	[-9.316]	[-5.469]	[-4.539]	[-5.458]	[0.280]	[-7.001]	[-1.807]	[-4.027]	[-6.588]	[-7.059]	[-2.515]	[-2.169]	[-0.697]
Vol^{EQ}	-0.100	-0.213	0.014	-0.143	-0.160	-0.037	-0.174	0.050	-0.161	-0.061	-0.030	0.027	-0.065	-0.182	-0.382
	[-1.502]	[-4.065]	[0.400]	[-5.357]	[-4.865]	[-0.776]	[-3.448]	[1.181]	[-4.825]	[-1.258]	[-0.600]	[0.663]	[-1.327]	[-4.223]	[-14.378]
$Size^{US}$	0.111	0.185	0.098	0.114	0.121	0.173	0.131	0.122	0.096	0.137	0.038	0.195	0.240	0.059	0.101
	[1.119]	[2.521]	[1.577]	[2.079]	[2.038]	[2.439]	[1.698]	[1.733]	[1.408]	[1.518]	[0.481]	[2.842]	[3.159]	[0.847]	[2.034]
$Value^{US}$	0.101	0.046	0.084	0.160	0.141	0.191	0.164	0.136	0.205	0.113	0.040	0.140	0.136	0.207	0.006
	[1.217]	[0.677]	[1.595]	[3.183]	[2.600]	[2.776]	[2.345]	[2.050]	[3.521]	[1.422]	[0.538]	[2.061]	[2.042]	[3.055]	[0.094]
Mom^{US}	-0.105	-0.064	0.049	0.010	0.041	-0.022	0.032	0.051	0.019	-0.068	-0.173	-0.010	-0.006	0.070	0.048
	[-1.923]	[-1.526]	[1.487]	[0.309]	[1.235]	[-0.526]	[0.726]	[1.254]	[0.517]	[-1.188]	[-3.847]	[-0.230]	[-0.131]	[1.753]	[1.430]
R^2	0.373	0.392	0.543	0.534	0.514	0.427	0.283	0.342	0.421	0.263	0.470	0.452	0.240	0.435	0.721
Annual alpha	-7.422	-1.754	1.661	2.662	2.851	-4.718	-0.785	0.381	-2.470	3.123	-4.881	-4.520	1.792	1.874	2.703

Table 7. Portfolio return statistics by number of portfolios

Descriptive statistics for monthly returns on international equity portfolios based on local return momentum, dividend yield and term spreads sorts. Returns are in excess of the US market return. The sample of 43 countries runs from November 1983 to September 2011. We present total US-dollar HML^{UEP} returns, the local-currency equity component of HML^{UEP} returns and the FX component of the HML^{UEP} returns for various choices of the number of portfolios into which the cross-section is split. Numbers in brackets are t-statistics for the null that the sample mean return is zero. AC(1) is the first-order autocorrelation.

(a) Dividend yield

Portfolios	3			4			5			6		
	Total	Equity	FX	Total	Equity	FX	Total	Equity	FX	Total	Equity	FX
Mean	8.59	9.06	-0.47	11.68	12.03	-0.35	11.37	12.66	-1.29	11.56	12.56	-1.00
	[3.79]	[4.37]	[-0.64]	[4.20]	[4.71]	[-0.41]	[3.64]	[4.40]	[-1.26]	[3.21]	[3.80]	[-0.85]
Median	9.69	8.01	0.74	9.32	9.59	0.40	11.33	10.12	-0.67	12.53	9.77	0.55
Std. Dev.	11.75	10.76	3.80	14.44	13.25	4.41	16.20	14.91	5.32	18.68	17.15	6.13
Skew	-0.08	0.15	-0.83	-0.28	0.11	-1.12	-0.38	0.03	-0.84	-0.46	0.13	-1.19
Kurtosis	5.04	4.25	7.04	5.95	5.01	10.38	5.67	4.85	8.93	7.22	5.77	10.25
Sharpe	0.73	0.84	-0.12	0.81	0.91	-0.08	0.70	0.85	-0.24	0.62	0.73	-0.16
AC(1)	0.17	0.17	0.10	0.16	0.16	0.04	0.17	0.18	0.03	0.12	0.14	-0.01

(b) Term spread

Portfolios	3			4			5			6		
	Total	Equity	FX	Total	Equity	FX	Total	Equity	FX	Total	Equity	FX
Mean	4.71	4.86	-0.15	5.34	5.46	-0.12	6.98	6.84	0.14	5.91	6.25	-0.33
	[2.15]	[2.40]	[-0.15]	[1.73]	[2.23]	[-0.10]	[2.20]	[2.38]	[0.11]	[1.69]	[1.98]	[-0.25]
Median	3.47	3.24	-1.08	2.80	4.09	-0.99	1.61	2.26	0.57	1.87	0.93	0.04
Std. Dev.	11.37	10.50	5.28	13.80	12.70	6.12	16.45	14.91	6.47	18.13	16.40	6.89
Skew	0.44	0.65	-0.04	0.69	0.62	0.12	0.78	0.87	-0.04	0.76	0.89	-0.17
Kurtosis	4.49	4.64	4.72	5.28	4.92	4.76	5.79	6.60	4.58	5.41	6.16	4.04
Sharpe	0.41	0.46	-0.03	0.39	0.43	-0.02	0.42	0.46	0.02	0.33	0.38	-0.05
AC(1)	0.08	0.09	0.06	0.05	0.07	0.04	0.03	0.02	0.04	0.03	0.04	0.04

(c) Momentum

Portfolios	3			4			5			6		
	Total	Equity	FX	Total	Equity	FX	Total	Equity	FX	Total	Equity	FX
Mean	11.97	9.77	2.20	12.89	10.59	2.30	12.29	10.44	1.85	12.95	10.96	1.99
	[4.14]	[3.73]	[2.22]	[3.74]	[3.33]	[1.92]	[3.21]	[2.96]	[1.41]	[3.13]	[2.84]	[1.36]
Median	13.36	11.46	1.15	14.89	13.03	-0.09	13.63	12.35	0.26	15.30	12.35	1.02
Std. Dev.	15.01	13.58	5.14	17.90	16.48	6.22	19.86	18.29	6.83	21.50	20.05	7.60
Skew	-0.40	-0.54	0.50	-0.26	-0.44	0.91	-0.47	-0.52	1.01	-0.40	-0.52	0.58
Kurtosis	5.15	4.58	6.63	5.17	4.40	8.42	5.57	4.86	9.69	5.15	5.25	8.08
Sharpe	0.80	0.72	0.43	0.72	0.64	0.37	0.62	0.57	0.27	0.60	0.55	0.26
AC(1)	0.10	0.10	0.15	0.09	0.11	0.18	0.05	0.08	0.12	0.04	0.10	0.08

Table 8. Portfolio return statistics by number of portfolios, last 10 years

Descriptive statistics for monthly returns on international equity portfolios based on local currency return momentum, dividend yield and term spreads sorts. Returns are in excess of the US market return. The statistics in the table are based on a cross-section of 43 countries and return data from the decade ending in September 2011. We give total US-dollar HML^{UEP} returns, the local-currency equity component of the HML^{UEP} returns and the FX component of the HML^{UEP} returns for various choices of the number of portfolios into which the cross-section is split. Numbers in brackets are t-statistics for the null that the sample mean return is zero. AC(1) is the first-order autocorrelation.

(a) Dividend yield

Portfolios	3			4			5			6		
	Total	Equity	FX	Total	Equity	FX	Total	Equity	FX	Total	Equity	FX
Mean	5.29	4.48	0.81	6.38	5.32	1.06	6.80	6.10	0.70	8.77	7.66	1.11
	[2.07]	[1.75]	[0.81]	[2.13]	[1.82]	[0.84]	[1.97]	[1.79]	[0.48]	[2.17]	[1.99]	[0.62]
Median	6.06	3.44	1.67	4.90	1.64	1.37	5.64	0.79	1.36	4.53	3.99	2.60
Std. Dev.	8.09	8.08	3.17	9.46	9.27	3.99	10.91	10.77	4.62	12.76	12.15	5.64
Skew	-0.16	0.02	-0.48	0.11	0.19	-0.49	-0.05	-0.02	-0.49	0.37	0.39	-0.47
Kurtosis	4.36	4.00	4.37	2.97	3.18	3.96	3.44	3.59	3.80	3.51	3.78	3.86
Sharpe	0.65	0.55	0.26	0.67	0.57	0.26	0.62	0.57	0.15	0.69	0.63	0.20
AC(1)	0.12	0.11	-0.12	0.04	0.09	-0.13	0.04	0.07	-0.14	-0.01	0.07	-0.24

(b) Term spread

Portfolios	3			4			5			6		
	Total	Equity	FX	Total	Equity	FX	Total	Equity	FX	Total	Equity	FX
Mean	-0.17	0.90	-1.08	0.66	2.13	-1.47	0.38	2.36	-1.98	-2.44	1.00	-3.44
	[-0.07]	[0.44]	[-0.79]	[0.23]	[0.85]	[-0.90]	[0.12]	[0.86]	[-1.11]	[-0.66]	[0.31]	[-1.69]
Median	1.94	2.39	-2.33	1.93	1.44	-3.33	0.80	1.05	-4.94	0.85	0.67	-5.18
Std. Dev.	7.38	6.51	4.28	8.95	7.93	5.19	10.10	8.70	5.65	11.69	10.20	6.45
Skew	-0.49	-0.37	0.26	-0.03	-0.04	0.20	-0.24	-0.28	0.17	-0.30	-0.27	0.03
Kurtosis	4.46	3.64	3.42	4.73	3.33	3.03	3.63	3.16	2.98	3.02	3.60	2.83
Sharpe	-0.02	0.14	-0.25	0.07	0.27	-0.28	0.04	0.27	-0.35	-0.21	0.10	-0.53
AC(1)	-0.00	-0.11	0.11	0.03	-0.05	0.13	0.11	0.04	0.11	0.14	0.09	0.12

(c) Momentum

Portfolios	3			4			5			6		
	Total	Equity	FX	Total	Equity	FX	Total	Equity	FX	Total	Equity	FX
Mean	7.44	8.62	-1.18	7.65	10.02	-2.38	7.33	10.09	-2.75	7.60	11.30	-3.70
	[2.20]	[2.55]	[-0.98]	[1.95]	[2.53]	[-1.67]	[1.64]	[2.30]	[-1.73]	[1.54]	[2.40]	[-2.12]
Median	11.75	11.48	-1.24	11.73	12.62	-2.49	7.68	11.69	-2.11	9.53	10.84	-2.58
Std. Dev.	10.70	10.70	3.82	12.40	12.55	4.51	14.11	13.85	5.04	15.55	14.89	5.52
Skew	-0.35	-0.26	-0.36	-0.41	-0.23	-0.43	-0.41	-0.29	-0.16	-0.33	-0.08	-0.35
Kurtosis	3.32	3.93	3.97	3.10	3.28	3.85	3.15	3.24	3.87	3.44	3.49	3.36
Sharpe	0.70	0.81	-0.31	0.62	0.80	-0.53	0.52	0.73	-0.55	0.49	0.76	-0.67
AC(1)	-0.01	0.02	0.13	-0.06	-0.01	0.10	-0.08	-0.05	-0.02	-0.07	-0.08	0.01

Table 9. HML^{UEP} Return Components, restricted cross-section

The table reports descriptive statistics for the monthly HML^{UEP} returns of the international equity portfolios sorted by signals based on local return momentum, dividend yields and term spreads. Sorts split the cross-section into five portfolios. The holding period is one month. Returns are measured in US dollars and in excess of the US market return. The sample of includes a cross-section of only 16 developed countries and runs from November 1983 to September 2011. Total returns are decomposed into a local currency equity return and an FX contribution. Numbers in brackets are t-statistics for the null that the sample mean return is zero. AC(1) is the first-order autocorrelation.

(a) Dividend yield

	Total	Equity	FX
Mean	9.943	11.135	-1.193
	[3.809]	[4.578]	[-1.073]
Median	8.349	8.095	-0.786
Std. Dev.	13.544	12.620	5.764
Skew	0.044	0.448	-0.183
Kurtosis	5.619	5.406	4.771
Sharpe	0.734	0.882	-0.207
AC(1)	0.128	0.171	-0.012

(b) Term spread

	Total	Equity	FX
Mean	3.970	5.205	-1.235
	[1.416]	[2.047]	[-0.952]
Median	3.746	4.488	-0.387
Std. Dev.	14.551	13.193	6.733
Skew	0.609	0.556	-0.033
Kurtosis	6.879	7.383	4.176
Sharpe	0.273	0.395	-0.183
AC(1)	-0.048	-0.018	-0.026

(c) Momentum

	Total	Equity	FX
Mean	10.917	8.790	2.127
	[3.221]	[2.857]	[1.576]
Median	13.328	9.199	4.005
Std. Dev.	17.586	15.961	7.001
Skew	-0.573	-0.396	-0.206
Kurtosis	6.212	5.664	3.888
Sharpe	0.621	0.551	0.304
AC(1)	-0.053	-0.035	0.016

Table 10. Portfolio returns net of trading costs

The table reports descriptive statistics for the monthly HML^{UEP} returns of the international equity portfolios sorted by signals based on local return momentum, dividend yields and term spreads. The holding period is one month. Returns are measured in US dollars and in excess of the US market return. The sample contains 43 country indices. For each signal we present gross returns and returns net of trading costs for data from the last 10 years in our sample only, i.e. the ten years up to September 2011. Trading costs are computed using the data contained in Table B.10.

Panel (a): Dividend yields

	Gross	Net
Mean	6.80	5.92
Median	5.64	4.99
Std. Dev.	10.91	10.91
Skew	-0.05	-0.04
Kurtosis	3.44	3.45
Sharpe	0.62	0.54
AC(1)	0.04	0.04

Panel (b): Term spreads

	Gross	Net
Mean	0.38	-0.32
Median	0.80	0.46
Std. Dev.	10.10	10.08
Skew	-0.24	-0.24
Kurtosis	3.63	3.66
Sharpe	0.04	-0.03
AC(1)	0.11	0.11

Panel (c): Momentum

	Gross	Net
Mean	7.33	5.83
Median	7.68	6.95
Std. Dev.	14.11	14.11
Skew	-0.41	-0.41
Kurtosis	3.15	3.16
Sharpe	0.52	0.41
AC(1)	-0.08	-0.09

Figure 1: Cumulative return comparison: international equity portfolios, FX carry and the MSCI World index

For each of our equity index forecasting methods (i.e. momentum, dividend yields and term spreads), we plot the cumulative HML^{UEP} return in US dollars. Alongside those we plot the cumulative HML return on a standard FX carry strategy and the cumulative excess return on the MSCI World index.

(a) HML^{UEP} returns using different predictor variables
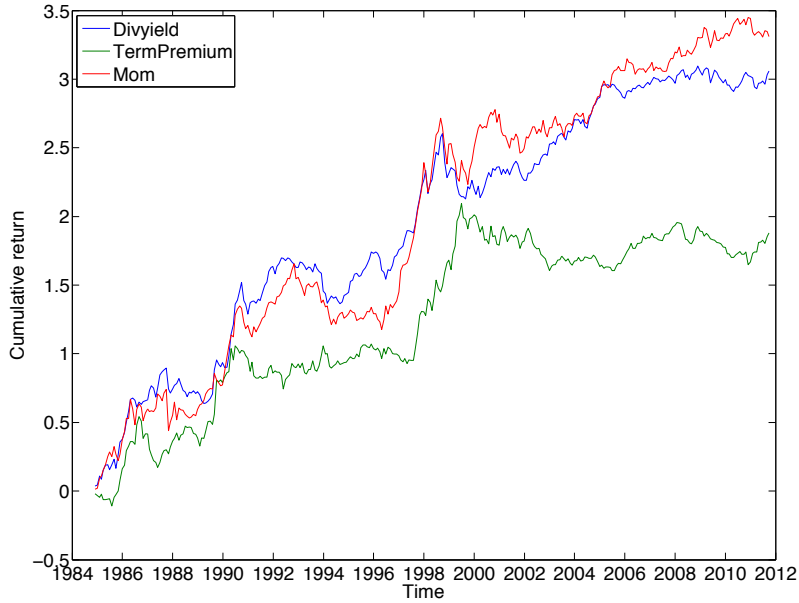
(b) Excess returns on MSCI World and FX Carry
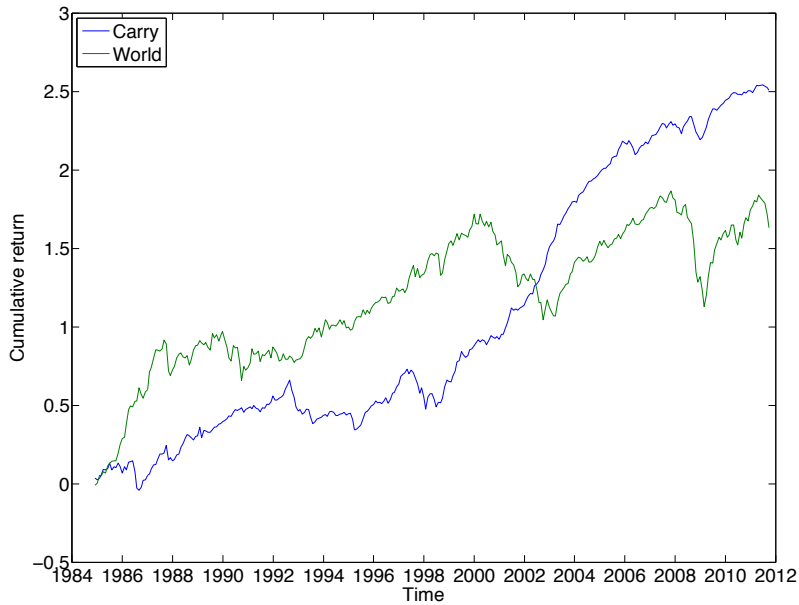
Figure 2: Cumulative return components: international equity portfolios

For each of our equity index forecasting methods (i.e. momentum, dividend yields and term spreads), we plot the cumulative HML^{UEP} US-dollar return. We also plot the cumulative HML^{UEP} return in local currency and then FX component of the HML return. Results are based on splitting the cross-section of countries into five portfolios.

(a) Dividend yield

(b) Term spread

(c) Momentum
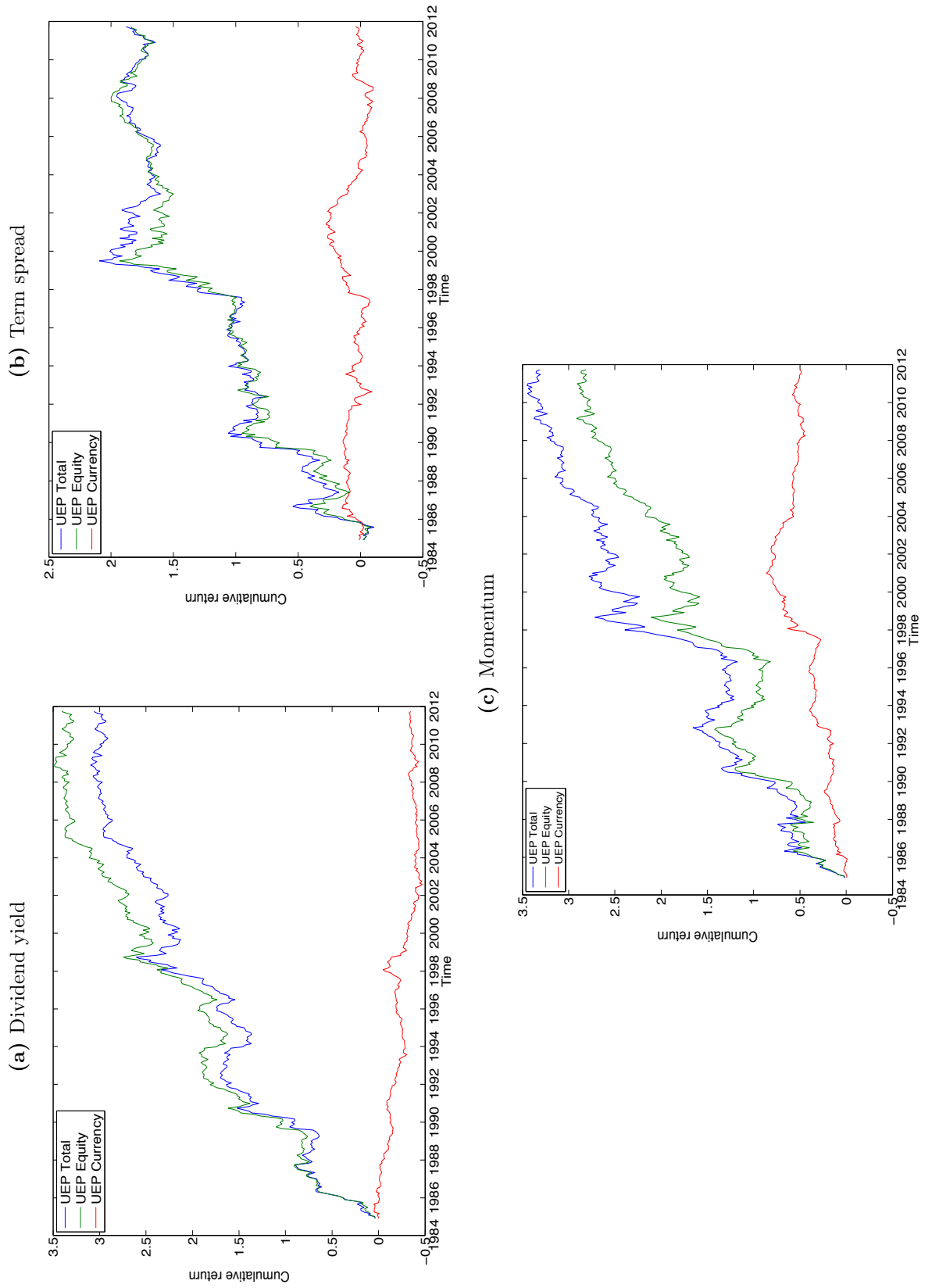
Figure 3: Pricing performance of 2-factor models: US factors

Each panel plots expected returns for the 15 combined portfolios against the expected returns delivered by a two factor model where the first factor is the MSCI World and the second factor is, in turn, residual FX volatility, residual equity volatility, US size, US value and US momentum. All models are estimated using one-step GMM. A $45°$ line is shown for comparison

(a) Vol^{FX}

(b) Vol^{EQ}

(c) Size^{US}

(d) Value^{US}

(e) Mom^{US}
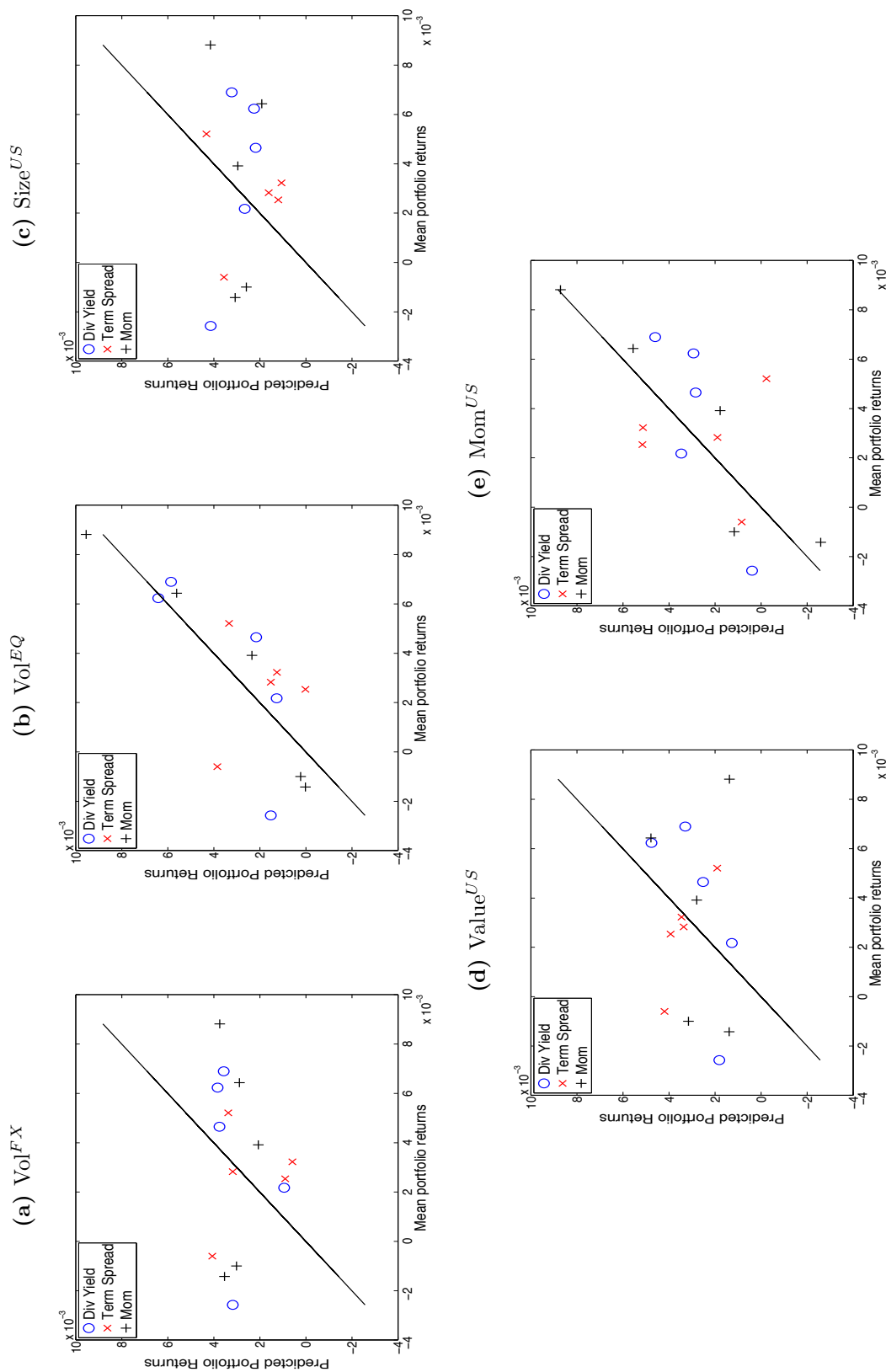
Figure 4: Pricing performance of 2-factor models: global factors

Each panel plots expected returns for the 15 combined portfolios against the expected returns delivered by a two factor model where the first factor is the MSCI World and the second factor is, in turn, residual equity volatility, global size, global value and global momentum. All models are estimated using one-step GMM. A 45° line is shown for comparison

(a) Vol^{EQ}

(b) Size^G

(c) Value^G

(d) Mom^G

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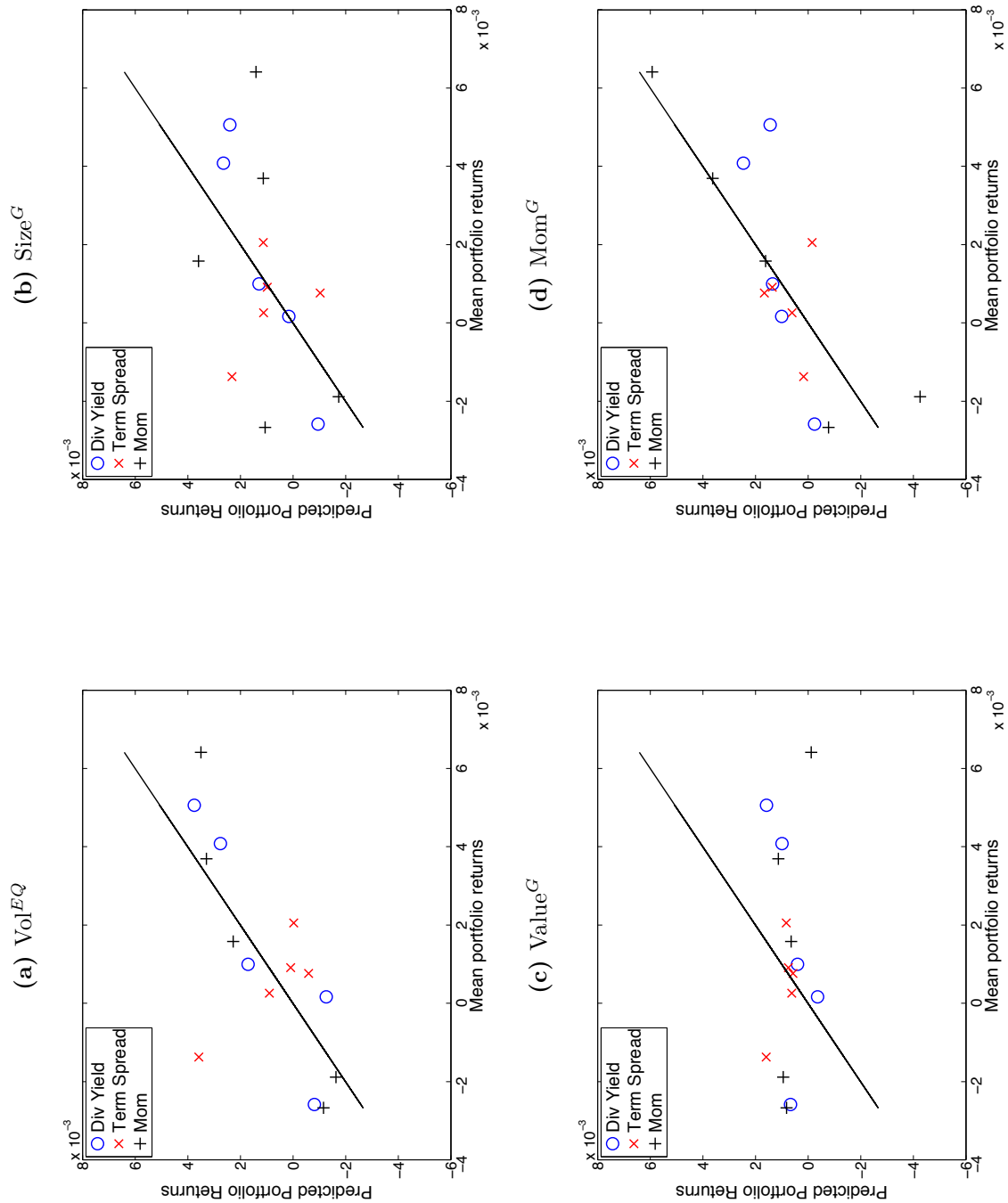Asness, C. S., Moskowitz, T. J., Pedersen, L. H., 2013. Value and momentum "everywhere". Journal of Finance 68, 929–985.

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Internet Appendix (not for publication)

Abstract

This Internet Appendix (not for publication) presents additional results for the paper "What do stock markets tell us about exchange rates?" by Gino Cenedese, Richard Payne, Lucio Sarno, and Giorgio Valente.

A UEP in a standard asset pricing framework

In this section, we provide an alternative derivation of UEP that does not rely on the imperfect hedging assumption, but uses standard no-arbitrage asset pricing theory. Specifically, we show how using the same steps one would use to derive UIP for the case of an international bond investor allows us to derive UEP for the case of an international equity investor.

In the absence of arbitrage opportunities, asset prices satisfy the following Euler equation:

$$(A.1) \qquad\qquad E_t\left(x_{t+1}^j m_{t+1}^h\right) = p_t^j,$$

where p_t is the price of risky asset j in period t; m_{t+1}^h is the stochastic discount factor (SDF) of country h's investor; x_{t+1}^j is the gross one-period payoff of asset j; and $E_t\left[m_{t+1}^h\right] = 1/R_{f,t}^h$ is the period-t price of a risk-free zero-coupon bond in country h.[25] Defining the gross return $R_{t+1}^j = x_{t+1}^j/p_t^j$, then

$$(A.2) \qquad\qquad E_t\left(R_{t+1}^j m_{t+1}^h\right) = 1.$$

Define as S_t the nominal bilateral exchange rate expressed as the price of foreign currency j in terms of domestic currency h, so that an increase in S_t denotes a depreciation of the domestic currency. Assume that an investor takes a position in a foreign equity market. The foreign equity market provides local-currency returns $R_{r,t+1}^j$ at $t+1$. When the proceeds are converted back to the investor's domestic currency, equation (A.2) can be rewritten as

$$(A.3) \quad E_t\left(R_{r,t+1}^j \frac{S_{t+1}}{S_t} m_{t+1}^h\right) =$$
$$= E_t\left(R_{r,t+1}^j\right) E_t\left(\frac{S_{t+1}}{S_t}\right) \frac{1}{R_{f,t}^h} + \operatorname{cov}_t\left(m_{t+1}^h, R_{r,t+1}^j \frac{S_{t+1}}{S_t}\right) + \operatorname{cov}_t\left(R_{r,t+1}^j, \frac{S_{t+1}}{S_t}\right) \frac{1}{R_{f,t}^h}.$$

Similarly, if the investor chooses to invest in the domestic equity market, which provides

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[25] The results of this section may be obtained under a variety of different utility functions and distributional assumptions (see, e.g., Cochrane, 2005, Ch. 1 and 9).

returns $R^h_{r,t+1}$ at time $t+1$, we have:

(A.4) $$1 = E_t\left(R^h_{r,t+1}m^h_{t+1}\right) = E_t\left(R^h_{r,t+1}\right)\frac{1}{R^h_{f,t}} + \text{cov}_t\left(m^h_{t+1}, R^h_{r,t+1}\right).$$

Using equations (A.3) and (A.4) and assuming log-normal returns we can define the following relationship:

(A.5) $$E_t\left(erx^{j,h}_{t+1}\right) = rp^j_{r,t+1} - rp^h_{r,t+1} + \text{var}_t\left(r_{diff,t+1}\right),$$

where the UEP deviations are defined as $erx^{j,h}_{t+1} = r^j_{r,t+1} + \Delta s_{t+1} - r^h_{r,t+1}$; we further define $rp^j_{r,t+1} = \ln\left[1 - \text{cov}_t\left(m^h_{t+1}, R^j_{r,t+1}\frac{S_{t+1}}{S_t}\right) - \text{cov}_t\left(R^j_{r,t+1}, \frac{S_{t+1}}{S_t}\right)\frac{1}{R^h_{f,t}}\right]$ as the foreign equity risk premium adjusted for the covariance between equity returns in foreign currency and the exchange rate; $rp_{r,t+1} = \ln\left[1 - \text{cov}_t\left(m^h_{t+1}, R^h_{r,t+1}\right)\right]$ denotes the domestic equity risk premium; and $\text{var}_t\left(r_{diff,t+1}\right) = \frac{1}{2}\text{var}_t\left(r^h_{r,t+1}\right) - \frac{1}{2}\text{var}_t\left(r^j_{r,t+1}\right) - \frac{1}{2}\text{var}_t\left(\Delta s_{t+1}\right)$ are Jensen's inequality terms. Note that, following the extant literature on exchange rates and international parity conditions, we work in logarithms to derive equation (A.5) for ease of exposition and notation. Throughout the empirical analysis, however, we use discrete returns.

Under risk neutrality, and abstracting from Jensen's inequality terms, the excess return on the left-hand side of equation (A.5) equals zero, yielding the UEP condition. In this case, exchange rate returns and equity return differentials expressed in local currency are perfectly negatively correlated. Using a different set of assumptions, equation (A.5) provides the same predictions as the UEP condition proposed by Hau and Rey (2006). Under non-zero and possibly time-varying risk premia, i.e. in the general formulation of Equation (A.5), UEP deviations reflect compensation for risk arising from both international equity markets and FX markets. In this case, the correlation between exchange rate returns and equity return differentials expressed in local currency is not guaranteed to be minus unity. The correlation is not even guaranteed to be negative and will depend on the covariance between risk premia and returns.

B Additional Tables and Figures

Table B.1. Descriptive Statistics of Individual Returns

The table reports descriptive statistics for individual equity markets. Panel A shows results for the equity returns measured measured in local currency; Panel B shows results for equity returns measured measured in US dollars; and Panel C reports results for the depreciation rates of the US dollar against the foreign currency. The sample of 43 country indices runs from November 1983 to September 2011. AC(1) is the first-order autocorrelation.

Panel (a): International Equity Returns—Local Currency

	Mean	Median	Std. Dev.	Skewness	Kurtosis	AC(1)
Australia	12.24	17.57	16.85	-2.08	19.19	0.02
Austria	9.88	9.77	24.69	-0.24	5.86	0.22
Belgium	11.42	15.94	19.71	-0.88	8.20	0.23
Brazil	21.81	24.98	29.60	-0.43	5.15	0.01
Bulgaria	-12.76	-5.64	34.10	-1.09	7.09	0.39
Canada	10.05	13.61	15.73	-0.77	6.02	0.12
Czech Republic	13.34	13.30	25.35	-0.22	4.31	0.05
Denmark	10.46	16.36	19.09	-0.32	3.68	0.04
Egypt	22.79	7.98	33.02	0.44	4.55	0.23
Finaland	13.23	10.00	32.13	0.20	4.27	0.22
Freance	11.41	19.35	20.21	-0.28	3.75	0.12
Germany	9.96	17.67	22.00	-0.58	4.78	0.08
Greece	12.77	7.34	36.26	1.26	8.08	0.14
Hong Kong	17.73	16.06	27.79	-0.31	6.99	0.07
Hungary	20.58	22.64	34.66	0.28	7.25	0.11
India	15.58	14.85	28.44	-0.04	3.25	0.08
Indonesia	27.03	21.52	43.33	2.54	21.31	0.08
Ireland	4.65	10.80	21.97	-0.47	4.06	0.18
Israel	9.30	19.82	22.80	-0.21	3.86	0.07
Italy	10.80	10.11	23.44	0.42	4.10	0.07
Japan	3.67	5.82	19.92	-0.10	3.99	0.09
Korea	13.32	4.11	32.02	0.88	6.69	0.06
Kuwait	2.83	6.08	26.23	-0.05	3.02	0.31
Malaysia	12.74	14.01	26.66	0.45	6.57	0.09
Mexico	30.19	31.50	27.77	0.17	4.04	0.04
Netherlands	11.18	15.87	18.74	-0.72	4.95	0.09
New Zealand	6.63	7.42	19.05	0.38	5.67	-0.11
Norway	12.80	21.06	24.30	-0.80	4.79	0.13
Philippines	14.13	13.62	29.01	0.30	4.50	0.14
Poland	26.12	14.51	47.31	3.24	28.67	0.11
Portugal	5.97	3.82	20.85	0.18	4.56	0.15
Russia	28.75	31.99	55.64	0.24	5.23	0.16
Singapore	8.45	11.13	24.32	-0.67	8.16	0.10
South Africa	16.15	16.65	20.30	-0.54	5.14	-0.03
Spain	15.75	19.23	22.70	-0.22	4.76	0.14
Sweden	14.91	17.47	24.34	0.03	5.08	0.11
Switzerland	10.44	15.45	17.06	-0.70	5.12	0.16
Taiwan	11.99	4.33	35.15	0.46	4.90	0.10
Thailand	15.08	15.02	36.61	0.40	5.48	0.02
Ukraine	-10.59	1.90	43.19	-0.06	3.43	0.31
United Kingdom	11.11	15.84	16.17	-0.79	5.95	0.04
United States	10.73	15.39	15.60	-0.74	5.13	0.08

Table B.1. (continued)

Panel (b): International Equity Returns—US dollar

	Mean	Median	Std. Dev.	Skewness	Kurtosis	AC(1)
Australia	13.83	15.42	23.37	-1.17	9.31	0.03
Austria	12.66	13.51	27.11	-0.25	6.25	0.19
Belgium	14.02	17.65	21.89	-0.74	8.74	0.21
Brazil	21.45	25.58	39.27	-0.27	4.27	0.07
Bulgaria	-9.30	0.77	38.98	-1.16	6.61	0.41
Canada	11.37	14.59	19.63	-0.66	5.91	0.12
Czech Republic	17.08	19.58	29.72	-0.28	4.20	0.11
Denmark	12.73	16.27	20.67	-0.35	4.47	0.02
Egypt	19.59	10.58	33.51	0.50	5.10	0.26
Finaland	12.92	7.86	32.62	0.12	4.01	0.18
Freance	13.56	15.30	21.93	-0.29	3.75	0.08
Germany	12.48	15.80	23.76	-0.41	4.37	0.05
Greece	10.41	7.54	37.58	0.98	7.62	0.12
Hong Kong	17.74	16.19	27.82	-0.30	6.93	0.07
Hungary	18.48	26.25	38.87	-0.30	5.53	0.12
India	13.88	16.21	31.12	0.08	3.64	0.11
Indonesia	23.37	17.19	50.66	1.67	12.92	0.14
Ireland	4.98	14.77	22.86	-0.64	4.68	0.12
Israel	8.50	17.06	24.54	-0.21	3.74	0.09
Italy	11.70	11.30	25.50	0.19	3.82	0.08
Japan	8.20	6.98	22.66	0.28	3.66	0.10
Korea	13.81	0.52	38.59	1.01	8.37	0.02
Kuwait	4.01	-0.40	27.39	-0.17	3.10	0.34
Malaysia	12.38	11.90	29.17	0.54	8.73	0.14
Mexico	23.81	27.39	31.82	-0.46	4.60	0.11
Netherlands	13.47	17.33	19.65	-0.80	5.09	0.04
New Zealand	8.21	12.87	23.39	-0.05	4.19	-0.01
Norway	14.39	18.58	27.12	-0.72	4.98	0.10
Philippines	11.89	9.68	32.03	0.36	5.19	0.19
Poland	23.76	23.29	49.82	2.30	20.53	0.11
Portugal	5.96	5.96	23.17	0.00	4.52	0.12
Russia	29.33	31.99	56.58	0.22	4.99	0.16
Singapore	10.72	10.72	26.28	-0.54	7.20	0.09
South Africa	15.38	16.73	28.02	-0.51	4.10	0.00
Spain	17.02	15.15	24.97	-0.12	4.28	0.11
Sweden	15.86	18.91	26.05	-0.24	4.00	0.11
Switzerland	13.71	14.98	18.14	-0.23	3.80	0.09
Taiwan	12.37	9.11	37.01	0.44	4.47	0.11
Thailand	15.06	18.20	38.63	0.10	4.92	0.06
Ukraine	-16.74	-31.43	47.94	-0.10	3.76	0.40
United Kingdom	11.63	9.81	18.39	-0.22	4.21	0.07
United States	10.73	15.39	15.60	-0.74	5.13	0.08

Table B.1. (continued)

Panel (c): Depreciation Rates

	Mean	Median	Std. Dev.	Skewness	Kurtosis	AC(1)
Australia	1.59	2.83	11.79	-0.42	4.71	0.08
Austria	2.78	2.00	11.33	0.06	3.31	0.03
Belgium	2.60	3.23	11.27	-0.04	3.53	0.03
Brazil	-0.36	-4.91	20.38	-3.21	32.99	-0.02
Bulgaria	3.46	3.45	10.96	0.06	3.73	-0.05
Canada	1.32	0.43	6.99	0.09	6.91	-0.01
Czech Republic	3.74	4.61	12.57	-0.05	3.07	0.06
Denmark	2.26	2.78	11.03	-0.03	3.29	0.04
Egypt	-3.20	-0.15	5.58	-5.86	55.70	0.26
Finaland	-0.31	2.44	11.45	-0.45	4.22	0.12
Freance	2.15	3.76	11.02	-0.03	3.42	0.04
Germany	2.52	2.59	11.26	0.01	3.26	0.04
Greece	-2.36	-2.21	10.70	-0.35	4.71	0.09
Hong Kong	0.01	-0.03	0.54	0.44	8.32	-0.20
Hungary	-2.10	-3.99	12.85	-0.25	5.05	0.10
India	-1.71	-0.25	6.07	0.14	7.43	0.15
Indonesia	-3.66	-2.78	23.00	-1.76	35.91	0.15
Ireland	0.33	2.72	10.61	-0.36	3.76	0.07
Israel	-0.80	-0.28	6.95	-0.35	5.40	0.03
Italy	0.90	1.99	11.11	-0.20	3.90	0.08
Japan	4.52	-0.05	11.47	0.45	4.96	0.02
Korea	0.49	0.30	13.25	-1.31	22.40	-0.05
Kuwait	1.18	0.40	3.59	-1.07	9.28	0.00
Malaysia	-0.36	0.00	10.54	-0.78	40.29	0.10
Mexico	-6.38	-2.90	11.19	-2.92	29.76	0.13
Netherlands	2.30	2.13	11.31	-0.06	3.43	0.04
New Zealand	1.58	1.99	11.38	-0.19	6.03	0.06
Norway	1.59	1.96	10.95	-0.30	3.96	0.02
Philippines	-2.24	-0.24	8.85	-0.89	9.04	0.08
Poland	-2.36	-2.80	12.93	-0.15	4.26	0.14
Portugal	-0.01	0.94	10.77	-0.23	3.97	0.06
Russia	0.57	0.00	4.35	0.51	21.26	0.26
Singapore	2.27	2.26	5.40	-0.02	6.28	0.06
South Africa	-0.77	-2.00	16.05	-0.18	3.72	0.05
Spain	1.27	1.35	11.25	-0.24	3.95	0.04
Sweden	0.95	1.92	11.66	-0.69	7.05	0.13
Switzerland	3.26	1.91	12.07	0.12	3.62	0.03
Taiwan	0.37	-0.29	5.34	0.29	6.63	0.15
Thailand	-0.02	0.44	10.47	-1.34	32.73	0.18
Ukraine	-6.15	-0.17	13.01	-3.48	19.96	0.33
United Kingdom	0.52	-0.50	10.56	-0.09	5.42	0.09

Table B.2. Descriptive Statistics of Factors

The table presents descriptive statistics for the monthly factors described in the main text: the excess return on the MSCI world portfolio (World), the global FX volatility innovations (Vol^{FX}); the global equity volatility innovations (Vol^{EQ}); the Fama-French factors including the US size and value factors ($Size^{US}$, and $Value^{US}$, respectively); and the US momentum factor (Mom^{US}). Numbers in brackets show t-statistics for the null that the mean return on the factor is zero. AC(1) is the first-order autocorrelation.

	World	Vol^{FX}	Vol^{EQ}	$Size^{US}$	$Value^{US}$	Mom^{US}	$Size^{G}$	$Value^{G}$	Mom^{G}
Mean	5.811	-0.000	0.000	-0.453	3.648	7.814	0.921	4.563	7.247
	[1.973]	[-0.000]	[0.000]	[-0.228]	[1.852]	[2.530]	[0.556]	[2.505]	[2.302]
Median	9.593	-24.999	-51.392	-2.820	3.000	9.540	0.720	3.960	9.360
Std. Dev.	15.560	36.176	86.012	10.481	10.395	16.295	7.634	8.398	14.400
Skew	-0.642	1.846	3.354	0.458	0.230	-1.278	-0.255	0.444	-0.953
Kurtosis	4.583	11.453	22.589	9.285	5.409	11.567	6.257	7.721	9.368
Sharpe	0.373	-0.000	0.000	-0.043	0.351	0.480	0.121	0.543	0.503
AC(1)	0.117	-0.091	-0.038	-0.029	0.148	0.066	-0.010	0.310	0.179

Table B.3. Fama-MacBeth time-series regressions

The table reports factor betas, t-statistics and R^2 for the first-step time-series regressions in the Fama-MacBeth analysis. The five portfolios are generated by sorting countries on dividend yields. In every specification of the model the first factor is the MSCI World excess return (World) while the choice of the second factor varies across models. Only the loadings and t-statistics for the second factor are reported.

Panel (a): Dividend Yield portfolios

	Q1	Q2	Q3	Q4	Q5
Vol^{FX}	-5.879	-2.716	-6.155	-6.015	-5.836
	[-2.087]	[-1.131]	[-2.770]	[-2.468]	[-2.530]
	0.071	0.085	0.075	0.051	0.057
Vol^{EQ}	-2.885	-2.602	-2.473	-4.191	-4.182
	[-1.478]	[-2.473]	[-2.106]	[-4.365]	[-4.510]
	0.073	0.099	0.069	0.083	0.086
Size^{US}	0.306	0.343	0.267	0.286	0.309
	[2.638]	[4.687]	[3.153]	[4.422]	[4.230]
	0.088	0.141	0.093	0.077	0.088
Value^{US}	0.185	0.071	0.129	0.213	0.189
	[1.994]	[0.815]	[1.584]	[2.753]	[2.342]
	0.069	0.083	0.059	0.053	0.055
Mom^{US}	-0.093	0.010	0.018	0.038	0.077
	[-1.317]	[0.181]	[0.347]	[0.749]	[1.483]
	0.065	0.081	0.050	0.030	0.045

The table reports factor betas, t-statistics and R^2 for the first-step time-series regressions in the Fama-MacBeth analysis. The five portfolios are generated by sorting countries on term spreads. In every specification of the model the first factor is the MSCI World excess return (World) while the choice of the second factor varies across models. Only the loadings and t-statistics for the second factor are reported.

	Q1	Q2	Q3	Q4	Q5
			Panel (b): Term Spread portfolios		
Vol^{FX}	-6.500	-1.911	-5.085	-2.753	-5.471
	[-2.165]	[-0.797]	[-2.105]	[-1.337]	[-1.983]
	0.051	0.057	0.041	0.110	0.033
Vol^{EQ}	-3.183	-2.158	-1.769	-2.122	-2.834
	[-1.979]	[-1.934]	[-1.281]	[-2.516]	[-2.123]
	0.054	0.069	0.034	0.118	0.037
Size^{US}	0.320	0.222	0.226	0.209	0.282
	[3.789]	[2.960]	[2.692]	[2.671]	[2.746]
	0.076	0.083	0.055	0.130	0.050
Value^{US}	0.231	0.170	0.153	0.240	0.163
	[2.809]	[1.975]	[1.858]	[3.099]	[1.901]
	0.053	0.070	0.037	0.136	0.030
Mom^{US}	-0.038	0.083	0.008	0.056	-0.066
	[-0.665]	[1.545]	[0.137]	[1.068]	[-0.961]
	0.032	0.064	0.025	0.109	0.025

The table reports factor betas, t-statistics and R^2 for the first-step time-series regressions in the Fama-MacBeth analysis. The five portfolios are generated by sorting countries on momentum. In every specification of the model the first factor is the MSCI World excess return (World) while the choice of the second factor varies across models. Only the loadings and t-statistics for the second factor are reported.

Panel (c): Momentum portfolios					
	Q1	Q2	Q3	Q4	Q5
Vol^{FX}	-6.435	-5.294	-3.549	-4.842	-6.481
	[-2.314]	[-2.071]	[-1.574]	[-1.798]	[-2.567]
	0.087	0.076	0.031	0.046	0.069
Vol^{EQ}	-2.232	-1.736	-2.143	-3.977	-6.539
	[-1.255]	[-1.239]	[-1.772]	[-3.796]	[-4.790]
	0.080	0.068	0.037	0.075	0.133
Size^{US}	0.244	0.318	0.325	0.212	0.427
	[2.269]	[3.866]	[4.140]	[2.673]	[4.731]
	0.092	0.115	0.085	0.056	0.118
Value^{US}	0.163	0.156	0.117	0.258	0.092
	[1.704]	[1.734]	[1.421]	[2.995]	[1.024]
	0.080	0.072	0.031	0.064	0.055
Mom^{US}	-0.189	-0.044	0.006	0.111	0.177
	[-2.965]	[-0.645]	[0.105]	[2.021]	[3.017]
	0.100	0.061	0.024	0.047	0.078

Table B.4. FMB cross-sectional regressions using global Fama-French factors

The table reports coefficients from Fama-MacBeth regressions of mean portfolio returns on betas to pairs of risk factors. The analysis uses the five portfolios from each of our sorting variables (dividend yields, term spreads and momentum) simultaneously, giving 15 cross-sectional observations. In every specification of the model the first factor is the MSCI World excess return (World) while the second factor is one of the equity or FX volatility factors or one of the global Fama-French risk factors. Shanken (1992) t-statistics are reported in brackets. The final rows of the table give a χ^2 test of the null that the pricing errors are zero and a set of associated p-values.

	Model 1	Model 2	Model 3	Model 4
World	-0.0184	-0.0242	-0.0020	0.0006
	[-1.9495]	[-2.0982]	[-0.2817]	[0.0698]
Vol^{EQ}	-0.0923			
	[-1.7038]			
Size^{G}		0.0112		
		[2.0479]		
Value^{G}			0.0061	
			[1.1939]	
Mom^{G}				0.0186
				[2.9427]
R^2	0.5826	0.3626	0.0950	0.6821
J-stat	12.6059	16.4875	28.8320	17.6322
p-value	[0.4787]	[0.2238]	[0.0069]	[0.1720]

Table B.5. Turnover statistics

The table reports time-series mean, median and standard deviation for turnovers from the HML portfolios delivered by each of our three signals, i.e. dividend yields, term spreads and momentum. Turnover is defined as the total absolute change in the HML portfolio weights in a given month. The HML portfolio places equal positive weight on countries in portfolio 5 and equal negative weight on the countries in portfolio 1.

Signal	Mean	Median	Std. Devn.
Div Yield	0.459	0.500	0.346
Term spread	0.656	0.667	0.410
Mom	0.929	1.000	0.430

Table B.6. Transition probabilities

The table reports the probabilities of a country transiting between the five portfolios in our analysis, for each of our three signals, i.e. dividend yields, term spreads and momentum. Specifically, the cell in row i and column j of the table is the probability that a country currently in portfolio i will transit to portfolio j in the next month. Thus the sums of the cells across rows is unity.

Panel (a): Dividend yields

	P1	P2	P3	P4	P5
P1	0.887	0.101	0.006	0.004	0.002
P2	0.107	0.731	0.145	0.016	0.001
P3	0.006	0.146	0.731	0.108	0.008
P4	0.003	0.009	0.121	0.756	0.111
P5	0.001	0.003	0.008	0.106	0.882

Panel (b): Term spreads

	P1	P2	P3	P4	P5
P1	0.849	0.126	0.012	0.003	0.008
P2	0.128	0.641	0.188	0.035	0.009
P3	0.012	0.191	0.582	0.191	0.024
P4	0.005	0.032	0.192	0.638	0.133
P5	0.008	0.011	0.016	0.135	0.829

Panel (c): Momentum

	P1	P2	P3	P4	P5
P1	0.762	0.189	0.033	0.014	0.002
P2	0.191	0.527	0.234	0.040	0.008
P3	0.041	0.219	0.489	0.214	0.036
P4	0.011	0.042	0.229	0.529	0.189
P5	0.003	0.006	0.032	0.186	0.773

Table B.7. Descriptive statistics of the combined portfolio

Panel (a) reports descriptive statistics for the monthly returns of a portfolio that combines the portfolios sorted by local-return momentum, dividend yields and term spreads. The holding period is one month. The sample of 43 country indices runs from November 1983 to September 2011. HML^{UEP} gives statistics for US-dollar returns on the portfolio that puts equal weights on the three portfolios described in the main text; HML^{EQ} is the return on the positions in local currency; and HML^{FX} is the FX component of the HML^{UEP} portfolio return. Numbers in brackets are t-statistics for the null that the mean return is zero. AC(1) is the first-order autocorrelation. Panel (b) presents the correlation matrix of the monthly returns to the three separate momentum, dividend yield and term spread HML portfolios.

Panel (a): Combined portfolio return statistics

	HML^{UEP}	HML^{EQ}	HML^{FX}
Mean	10.21	9.98	0.24
	(3.65)	(3.92)	(0.26)
Median	9.04	7.22	0.13
Std. Dev.	11.84	10.74	4.06
Skew	0.25	0.34	0.58
Kurtosis	6.29	6.37	8.28
Sharpe	0.86	0.93	0.06
AC(1)	0.18	0.19	0.09

Panel (b): Correlations between HML portfolio returns

	Div	Term	Mom
Div	1.000	0.013	0.400
Term	0.013	1.000	0.105
Mom	0.400	0.105	1.000

Table B.8. Maximum Drawdowns

The table shows the maximum drawdown (MDD) of the HML^{UEP} strategies constructed using different signals. The MDD is defined as the maximum peak-to-trough loss of the cumulative profit of a trading strategy. We form the HML^{UEP} strategies using dividend yields, term spreads, and momentum as signals. The combined strategy forms a portfolio that puts equal weights on the other three strategies. A positive value of MDD represents a loss, expressed in US-dollar terms. The equity return component of the MDD is calculated as the local-currency return of the strategy over the peak-to-trough period, whereas the FX return component is the domestic currency depreciation over the same period. That is, $MDD = -[(1 + r^{EQ})(1 + r^{FX}) - 1]$, where MDD is the maximum drawdown in US dollars, r^{EQ} is the local-currency equity return component, and r^{FX} is the depreciation of the domestic currency.

	Dividend Yield	Term Spread	Momentum	Combined strategy
MDD	40.6%	42.5%	41.8%	20.8%
Equity component	-27.5%	-27.5%	-43.9%	-21.1%
FX component	-18.0%	-20.7%	3.7%	0.3%
Peak	10/1998	07/1999	09/1998	11/1992
Trough	04/2000	07/2005	10/1999	05/1994

Table B.9. GMM asset pricing model estimates for various equity volatility definitions

The table reports coefficients from one-step GMM estimations of the two factor asset pricing model. The analysis uses the five portfolios from each of our sorting variables (dividend yields, term spreads and momentum) simultaneously, giving 15 cross-sectional observations. In every specification of the model the first factor is the MSCI World excess return (World). The second factor is either the residual from estimation of an AR(1) process for the VIX (vixRes), the change in the VIX (ΔVIX) or the residual for an AR(1) process estimated for global equity vol (residHybridVol). Pre-2001, equity vol is computed using the returns on the four major indices described earlier. From 2001 onwards, this equity vol measure is computed using daily returns on the entire set of MSCI country indices in our sample. Daily MSCI data are not available before 2001. The final two rows of the table give the GMM J-statistic and its p-value.

|	Model 1 $\hat{b}$	Model 1 $\hat{\lambda}$	Model 2 $\hat{b}$	Model 2 $\hat{\lambda}$	Model 3 $\hat{b}$	Model 3 $\hat{\lambda}$
World	2.4610	0.0008	10.3097	-0.0029	-18.0703	-0.0140
	[0.3266]	[0.1064]	[1.1524]	[-0.2986]	[-1.8387]	[-0.9127]
vixRes	0.0336	0.2529				
	[0.2884]	[0.2059]				
ΔVIX			0.1950	2.1774		
			[1.3757]	[1.2971]		
residHybridVol					-394.8928	-0.0017
					[-2.8107]	[-2.9525]
J-stat	30.0228		22.0199		9.9357	
p-value	[0.0047]		[0.0551]		[0.6992]	

Table B.10. Bid-ask spread estimates by country

The table shows bid-ask spread estimates for each of our sample countries. These spreads were obtained from a global investment bank. For each country, the bank took a view as to which instrument (from available futures and ETFs) was most effective in gaining exposure to the stock market return. Based on this set of classifications, each country was placed in one of four transactions cost categories, shown below. Spreads are estimates as of mid-2014.

Countries	Spread estimate (bps)
USA, UK, Switzerland, Japan, Canada	4
Germany, Italy, France, Netherlands, Spain	
Australia, Sweden, Norway, Denmark, Belgium	10
Finland, Hong Kong, Austria, India, Mexico, Korea	
Taiwan, Brazil, Israel	
Portugal, New Zealand, Ireland, South Africa	30
Singapore, Czech Republic, Greece, Malaysia	
Thailand, Russia	
Indonesia, Poland, Hungary, Kuwait, Philippines	70
Egypt, Bulgaria, Ukraine	

Figure B.1: Sharpe Ratios of International Equity Portfolio Returns: leave-one-out analysis

For each of our equity index forecasting methods (i.e. momentum, dividend yields and term spreads based on 5 portfolios), we leave out one country in turn and compute the Sharpe Ratio. Below is the histogram of Sharpe Ratios derived from this experiment.
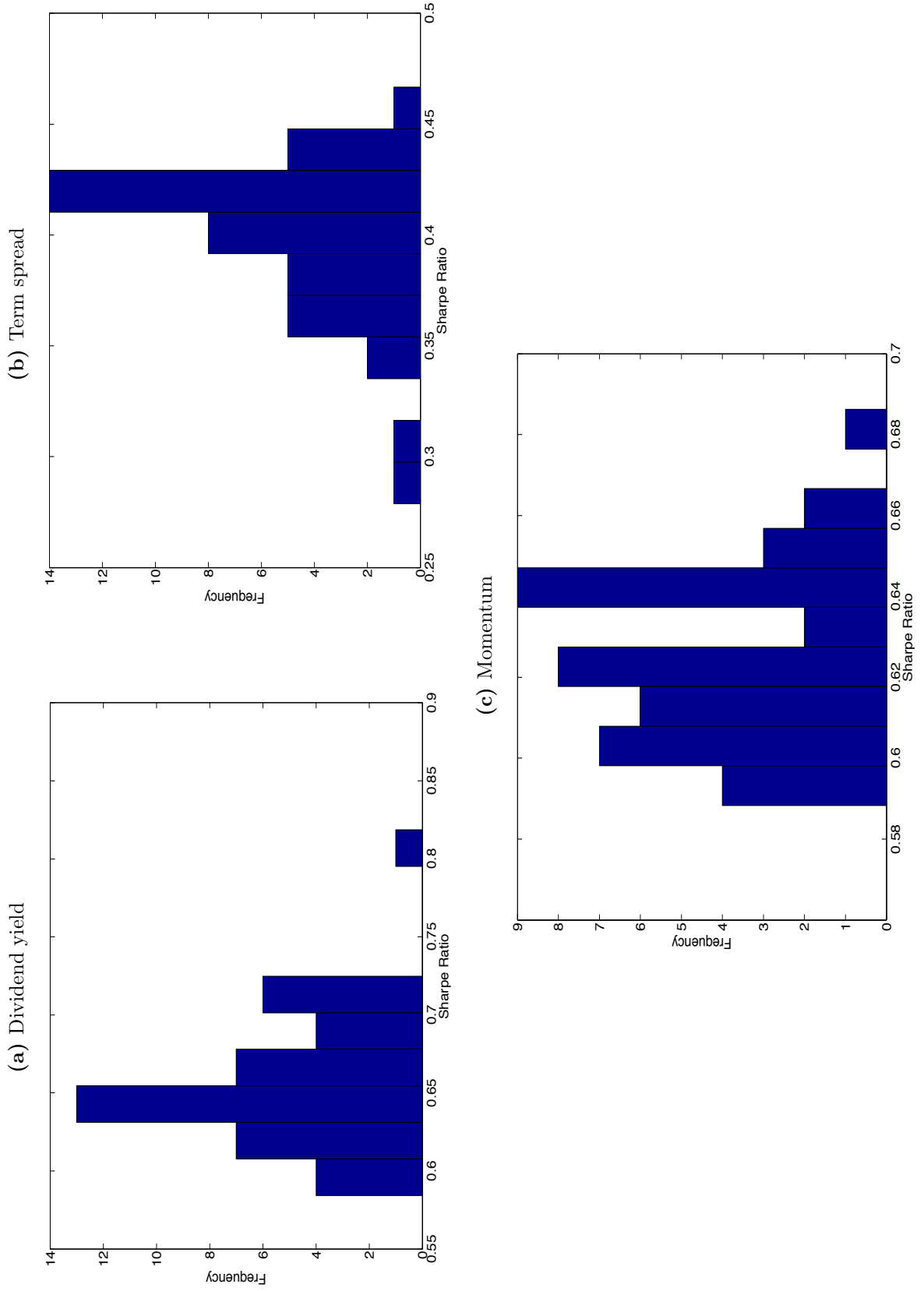
C   Time-series tests of UEP

An alternative method for testing UEP is to run time-series regression; this is an approach similar to the standard method for testing UIP as in Fama (1984). One could use the following formulations, based on equation (7), to test for UEP;

$$(\text{C.1}) \qquad \Delta s_{t+1} = \alpha + \beta \left(r^j_{r,t+1} - r^h_{r,t+1} \right) + \varepsilon_{t+1}, \quad \text{or}$$

$$(\text{C.2}) \qquad erx^{j,h}_{t+1} = \alpha + \gamma \left(r^j_{r,t+1} - r^h_{r,t+1} \right) + \varepsilon_{t+1}$$

where $\varepsilon_{t+1} = rp^j_{r,t+1} - rp^h_{r,t+1} + \text{var}_t \left(r_{diff,t+1} \right) + u_t$ with u_t being a linear combination of rational expectation forecast errors and $\gamma = \beta + 1$. Abstracting from Jensen's inequality issues, if UEP is valid, $\alpha = 0, \beta = -1$ (or $\gamma = 0$) and $\varepsilon_{t+1} \sim iid$ white noise.[26] On the other hand, equation (C.2) also shows that if UEP does not hold, then future excess returns, measured in domestic currency, can be explained using equity return differentials in local currency.

Table C.1, which follows, present estimates from equations (C.1)–(C.2), both for log returns and simple returns. The predictions of UEP are not supported in the data. In estimation of equation (C.1), the slope coefficient β is very close to zero. One can decisively reject the null, implied by UEP, that the slope is -1. The violation of UEP is corroborated by estimation of equation (C.2), which shows that excess equity returns expressed in US dollars move approximately one-for-one with the equity return differential expressed in local currency.

It is important to emphasize that these regressions make use of *ex post*, realized stock market and FX returns to construct left and right hand side variables. Obviously, therefore,

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[26]If the risk premia are not explicitly allowed for in the regressions (C.1) and (C.2) and are subsumed into the error term ε_{t+1}, it may well be that β (γ) deviates from unity (zero) but we would nevertheless expect that $\beta < 0$ ($0 < \gamma < 1$) to be consistent with the basic intuition of UEP that positive returns in the domestic equity market over the foreign equity market are associated with a depreciation of the domestic currency.

this evidence does not necessarily imply the existence of profits originating from the violation of UEP in real time (i.e. using lagged information). Nevertheless, it tells us that even with the use of ex post information about stock market returns, there is no support for the UEP condition in the data.

Table C.1. Time-series regressions for individual countries

The table shows average coefficients for the following three regressions: (1): $(\Delta S_{t+1})/S_t = \alpha + \beta(R^j_{r,t+1} - R^h_{r,t+1}) + \varepsilon_{t+1}$; (2): $\Delta s_{t+1} = \alpha + \beta(r^j_{r,t+1} - r^h_{r,t+1}) + \varepsilon_{t+1}$; (3): $ERX^{j,h}_{t+1} = \alpha + \gamma(R^j_{r,t+1} - R^h_{r,t+1}) + \varepsilon_{t+1}$; where $(\Delta S_{t+1})/S_t$ is the monthly depreciation rate of the domestic currency, $R^h_{r,t+1}$ and $R^j_{r,t+1}$ are the simple monthly returns on the domestic (US) and foreign equity market indices, respectively, and ε_{t+1} is an error term. We run separate time-series regressions for each country and then average the coefficients over countries. Pesaran and Smith (1995) show that this procedure leads to consistent estimates of the average coefficients of panel models. The sample runs from November 1983 to September 2011. Standard errors are reported in parentheses.

	Intercept	Slope	R^2
(1): $\frac{\Delta S_{t+1}}{S_t} = \alpha + \beta(R^j_{r,t+1} - R^h_{r,t+1}) + \varepsilon_{t+1}$	-0.0002 (0.0005)	-0.0411 (0.0177)	3.5%
(2): $\Delta s_{t+1} = \alpha + \beta(r^j_{r,t+1} - r^h_{r,t+1}) + \varepsilon_{t+1}$	-0.0009 (0.0005)	-0.0383 (0.0185)	3.8%
(3): $ERX^{j,h}_{t+1} = \alpha + \gamma(R^j_{r,t+1} - R^h_{r,t+1}) + \varepsilon_{t+1}$	-0.0002 (0.0005)	0.9589 (0.0177)	75.8%