Variance Risk in Global Markets

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Abstract

Innovations in volatility constitute a potentially important asset pricing risk factor that can be tested using the return on variance swaps. We characterize the exposures of returns on equities, bonds and currencies in all regions of the world to U.S. based equity variance risk. We explore implications for global risk premiums and asset return comovements using developed and emerging markets. Regional portfolios across all three asset classes and practically all countries exhibit negative loadings on the variance risk factor. These exposures, combined with the average return to the variance swap, provide statistically and economically significant risk premiums, representing around 50% of the overall risk premiums implied by a simple three-factor model with global equity, bond, and variance risks. This simple three-factor model also explains a substantive fraction of the comovements between international assets. The fit is best for equity correlations and is worse for currency and across asset class correlations.

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1 Introduction

The conditional volatility of the market return changes over time as the economy goes through periods of tranquility and periods of turbulence. It has long been known that these changes in the volatility of asset returns are priced in option markets. Jurek and Stafford (2015), Dew-Becker, Giglio, Le, and Rodriguez (2017), and Ait-Sahalia, Karaman, and Mancini (2019) provide recent evidence. In theory, the price of this volatility risk is negative as increases in volatility are viewed by investors as a deterioration in the investment opportunity set. Hence, assets like variance swaps that pay off positively when the economy unexpectedly becomes more turbulent should have negative expected returns, and they do have negative average returns. Said differently, selling volatility in option markets makes money on average because losses on such strategies occur in bad states of the world. Ang, Hodrick, Xing, and Zhang (2006) argue that aggregate market return volatility should be a priced risk factor in the cross-section of U.S. stock returns, and they find that stocks with a higher sensitivity to volatility risk earn lower average returns consistent with the idea that volatility risk is negatively priced. Other recent papers that argue for a negative price of variance risk in the cross-section of stock returns include Cremers, Halling, and Weinbaum (2015) and Campbell, Giglio, Polk, and Turley (2018).

If increases in equity volatility are indeed viewed by investors as bad times, such increases may also adversely affect returns in other asset classes, unless the asset class provides insurance in such states of the world. In addition, given the increased integration of world capital markets, it is conceivable that such risk is priced globally. Global pricing of this risk is what we examine in this article. Our results are of particular interest for emerging equity markets. When emerging markets first became investable for global investors, a global capital asset pricing model (CAPM), in which the return on the world market is the only priced risk, yielded extremely low discount rates for emerging market assets. While betas of emerging market countries have increased over time (see e.g. Bekaert and Harvey (2018)), international investors continue to find discount rates for emerging market companies counter-intuitively low. Consequently, investors often employ various ad hoc adjustments to discount rates such as adding political risk premiums associated with the default risk of emerging market government bonds to the required return on emerging market equites implied by the CAPM.[1] However, the discount rate for global investors should only reflect globally non-diversifiable risks, and thus these adjustments are likely incorrect. Because emerging market equities also perform poorly during turbulent, high-variance regimes, variance risk may be a true global risk factor across various emerging market asset classes that has the potential to increase their required rates of return. While increases in equity volatility and poor equity market returns often occur together, it is important to recognize

[1] See Bekaert, Harvey, Lundblad, and Siegel (2014) for a discussion of political risk in international valuations.

that the correlation between the return on equity and the return to the variance swap is only -58%, which is far from perfect. Thus, our postulated variance risk factor has the potential to affect expected returns on various assets in addition to the influence from equity market risk premiums. The recent evidence in Londono and Zhou (2017) demonstrating that the ex ante U.S. stock variance risk premium has non-redundant and significant predictive power for the appreciation rates of 22 currencies with respect to the U.S. dollar is supportive of this argument.

Specifically, we seek to explain the excess returns on a variety of assets with a simple three-factor model that includes the return on a benchmark equity portfolio and two additional sources of risk. Because we primarily use U.S. dollar (USD) denominated returns, we also include the excess return on a long-term USD bond. The third source of risk is the return on a variance swap that captures a traded measure of unanticipated increases in volatility.

There are two main parts in the paper. First, we examine the exposure of returns to variance risk at the regional level in developed and emerging equity markets, bond markets, and foreign currency markets. This section also explores whether our three-factor model correctly prices the average excess returns on equities, bonds, and foreign currencies. While the equity and bond exposures strongly vary with the different asset classes we consider, we find a nearly uniform and mainly negative exposure to the variance risk factor. Because the average return on buying volatility is negative, such negative exposures should be compensated by positive risk premiums, and we quantify how much of the global risk premiums assigned by the three-factor model is accounted for by variance risk, finding it to be highly statistically significant and often exceeding 50% of the total risk premium.

Given the short sample, though, it is difficult to distinguish different asset pricing models or to evaluate the fit of factor models using average realized returns. We therefore also ask how much of the cross-country correlation structure is explained by the models for each asset class and how much of the cross-asset correlation structure is explained by the models for each region. For this second part, we use the models to calculate implied correlations across regions, but within asset classes, and then across asset classes, but within regions. Extensive evidence in the literature, for example, Bekaert, Hodrick, and Zhang (2009) and Hou, Karolyi, and Kho (2011)), documents that local factors improve the fit of factor models for equities. We do not include such regional risk factors, and we therefore do not expect our model to fully explain the sample correlation structure. There is much less evidence on how global factor models fare with respect to international bond markets whereas the foreign currency literature mostly focuses on currency-centric models.[2] There is

[2]For bond markets, Xu (2018) is an exception. For currency markets, see Lustig, Roussanov, and Verdelhan (2014), Verdelhan (2018), Lustig and Richmond (2017), and Aloosh and Bekaert (2019).

no evidence to our knowledge on how global factor models fit correlations across asset classes. We find that the global factor model explains a substantive fraction of the comovements between international assets, but the fit is best for international equity correlations and is worse for currency returns and across asset correlations.

The remainder of the article is organized as follows. Section 2 discusses the sources of the data and some summary statistics. Section 3 documents the factor exposures for the three asset classes across the world. Section 4 focuses on the implications of the factor model for risk premiums, and Section 5 analyzes the effects on comovements aross assets. Section 6 considers the impact of currency of denomination (dollar versus local returns), and Section 7 concludes.

2 Data

This section describes the country-specific, regional, and global data used in the empirical analysis, along with some summary statistics. We use MSCI monthly country-level total USD equity returns from January 1995 to November 2018 for a total of 287 observations. The balanced sample consists of 22 developed markets and 25 emerging markets. The developed markets are subdivided into four groups: Developed Commodity countries (denoted DM Commodities) contains Canada, Australia, and New Zealand; Developed Asia includes Japan, Hong Kong, and Singapore, whereas the 16 European countries are split up into those countries that use the euro (denoted EU Euro) and those that do not (denoted EU Non-Euro), to which we add Switzerland and Norway who are not members of the EU. The emerging markets are subdivided into three groups: Emerging Asia; Emerging Europe, Middle East, and Africa (EMEA); and Latin America.[3] Additional information on the regional affiliations of the various developed and emerging markets and which countries are used for each asset class are described in Appendix A. Excess returns are calculated by subtracting the one-month U.S. Treasury Bill return obtained from Ibboston Associates. As a proxy for global equity market risk, we use the excess return on the S&P 500 Index.

Bond market data are from Bloomberg Barclays global indices for developed markets and from JPMorgan's emerging markets bond index (EMBI Global). All bond indices reflect market cap weighted government bonds. For emerging markets, the bonds represent USD

[3]The included emerging market countries and their two-letter ISO codes are the following: Argentina (AR), Brazil (BR), Chile (CL), China (CN), Colombia (CO), Czech Republic (CZ), Egypt (EG), Hungary (HU), India (IN), Israel (IL), Indonesia (ID), Jordan (JO), Korea (KR), Morroco (MA), Mexico (MX), Malaysia (MY), Peru (PE), Pakistan (PK), Philippines (PH), Poland (PL), Russia (RU), Thailand (TH), Turkey (TR), Taiwan (TW), and South Africa (ZA). The included developed countries are the following: Austria (AT), Australia (AU), Belgium (BE), Canada (CA), Switzerland (CH), Germany (DE), Denmark (DK), Spain (ES), Finland (FI), France (FR), United Kingdom (GB), Greece (GR), Hong Kong (HK), Ireland (IE), Italy (IT), Japan (JP), Netherlands (NL), Norway (NO), New Zealand (NZ), Portugal (PT), Sweden (SE), and Singapore (SG).

denominated sovereign debt. Exchange rates are from Bloomberg. Foreign currency returns are calculated as the excess return to investing in the short-term money market of a country (short rates come from Global Financial Data). Thus, foreign currency excess returns reflect the interest rate differential between the foreign currency and the USD and the appreciation of the currency relative to the USD. As a proxy for global fixed income risk, we use the return on the Bloomberg Barclays U.S. Treasury Total Return Bond Index.

Our main innovation is to consider the global pricing of volatility risk. As a proxy for global equity market volatility, we define the return on a one-month variance swap on the U.S. equity market. This return is calculated as the difference between the realized variance during a month, calculated from squared daily returns over the month, and the implied variance given at the beginning of the month as measured by the squared VIX index. That is,

$$r^{vs}_{US,t+1} = \sum_{d=1}^{Ndays} \left(ln \frac{P_{t+1,d}}{P_{t+1,d-1}} \right)^2 \left(\frac{252}{Ndays} \right) - VIX^2_t, \tag{1}$$

where $Ndays$ represents the number of trading days in month $t+1$, $P_{t+1,d}$ is the value of the $S\&P$ 500 index on day d of month $t+1$, and the VIX_t measures the implied volatility of $S\&P$ 500 index options over the next thirty day period, as calculated by the Chicago Board Options Exchange (CBOE), at the end of month t.[4] We use the returns to the variance swap, as we have measured them, because they are easily calculated and should do a reasonable job capturing the innovation in volatility that should be priced in asset markets.

Figure 1 shows the VIX and the variance swap return over its full sample. The spikes in the variance swap are certainly influential data points, and we therefore acknowledge that in 24 years of monthly data it may be difficult to accurately measure the statistics underlying our analysis. Nevertheless, we think it is useful to explore the data keeping this caveat in mind.

Table 1 presents summary statistics for the asset returns of all regions as well as the global risk factor returns (the regional indices are simply the equally weighted averages across countries). The sample means of the annualized excess equity returns range from 1.35% for Emerging Asia to 6.20% for the EU Non-Euro countries. Mean annualized excess bond returns range from -0.07% in Developed Asia to 7.34% in Latin America. The sample means for the currency returns range from -0.95% for Developed Asia to 2.36% for Emerging Asia.

[4] See Exchange (2009) for how the VIX is constructed using a weighted average of put and call option prices with different strike prices. In using the squared VIX as the risk-neutral expectation of the summation of future squared returns, we follow Bollerslev, Tauchen, and Zhou (2009) and Drechsler and Yaron (2011). See Martin (2013, 2017) for a discussion of why the squared VIX is not the risk-neutral conditional variance of future returns when prices can jump and for an alternative calculation that weights option prices differently resulting in a simple variance, $SVIX$, that is appropriate. Ait-Sahalia, Karaman, and Mancini (2019) use data on OTC traded variance swaps to characterize the term structure of variance risk. These data are not publicly available.

The fact that the sample means of bond excess returns exceed the sample means of equity excess returns in Emerging Asia, Latin America, and the EU Euro countries is suggestive that using slightly less than 24 years of monthly data may not provide a long enough sample to allow sample mean returns to accurately reflect true unconditional expected returns. Correlations, on the other hand, may be far better measured.

Table 2 presents summary statistics on the risk factors. The annualized mean returns of the risk factors are 5.20% for equities, 2.61% for long term bonds, and -1.14% for the variance swap. The negative price of variance risk indicates that negative correlation of individual country or regional indexes with the return on the variance swap has the potential to increase required rates of return as a negative exposure to this risk factor combined with a negative price of risk implies a positive increment in expected return. The unconditional correlations between the risk factors are both positive and negative. Excess returns on equities and bonds are somewhat negatively correlated at -0.22, while the excess equity return and the variance swap return are strongly negatively correlated at -0.53. Bond returns and the variance swap return are positively correlated at 0.15.

3 Measuring Global Volatility Risk in Equity, Bond, and Currency Markets

We begin our analysis of equity, bond, and currency market excess return exposures to equity market volatility with a graphical analysis. To demonstrate the sensitivity of returns to the variance swap return, we first divide the sample into quartiles depending on the realized returns to the variance swap. The first quartile contains the months with the lowest realizations of the variance risk factor, while the fourth quartile contains the months with the highest realizations. We then calculate average excess returns for these sub-samples at the regional level. The four regions are simply the equally weighted averages of country excess returns in Developed Markets; Emerging Asia; Emerging Europe, the Middle East, and Africa; and Latin America.

The bars in Figure 2 show the annualized mean excess equity returns for these four portfolios across the different quartiles of realized variance. We see that, across all regions, average excess returns are high, approaching 40% per annum (p.a.), when volatility innovations are low, and average excess returns are negative, also approaching -40% p.a., when volatility innovations are high. The Figure also shows that average excess returns decrease monotonically in Developed Markets, the EMEA, and Latin America; and they almost monotonically decline for the Emerging Asia sample.

Figures 3 and 4 repeat this exercise for the excess returns in the bond and foreign currency markets. Once again we see that when volatility is high, emerging market bonds perform poorly and emerging market currencies depreciate versus the dollar. Conversely, in low volatility states, emerging market bonds do well, and their currencies appreciate relative to the dollar. Latin American bond markets and currencies are particularly notable with USD denominated gains of around 15% p.a. in low volatility environments and losses of about 15% in high volatility environments. The broadly monotonic pattern of emerging market bond returns and fully monotonic pattern of currency returns rather dramatically decreasing with increased U.S. variance swap returns shows that variance risk has the potential to be a source of global risk that affects the returns of major asset classes. The pattern is not entirely monotonic for developed markets, however, as developed market bond and foreign currency average returns in the fourth quartile are higher than they are in the third quartile. It is conceivable that these results are due to the safe haven role of certain foreign bonds and currencies (such as the Swiss franc and the Japanese yen).[5]

Variance risk may be correlated with equity risk, in which case only the orthogonal component would represent an additional source of risk. Therefore, Figures 5, 6, and 7 repeat the exercise of plotting regional average excess returns across the quartiles of realized returns to the variance swap, but now, these Figures also condition first on whether the equity market return is up or down. The top panel of each Figure contains the down market results, and the bottom panel contains the up market results.

It is clear from the top panel of Figure 5 that the four regions all perform much more poorly in high variance down equity markets than in low variance down equity markets. The bottom part of the Figure indicates that average returns are lower in high variance up markets than in low variance up markets. Because variance swap returns and equity returns are correlated (recall Table 2), we mostly lose full monotonicity, but the returns in high variance return markets (4th quartile) are invariably and substantially lower than in the low variance return markets (1st quartile).

For the global bond markets presented in Figure 6, the effect of variance risk is starker in that it changes the sign of returns in the down equity markets. Across all regions, bond market returns are positive in down equity market, low variance return states, but they turn negative in high variance return states. For up equity markets, all bond markets have positive returns, but it is still the case that they are higher in low variance swap return states than they are in high variance swap return states. The patterns are not always monotonic across the regions, but for up equity markets, the pattern is monotonic for Latin America. Figure 6 indicates that Latin American bonds do particularly poorly in volatile down equity markets and do particularly well in quiescent up markets, with the return spread a staggering

[5]See Christiansen, Ranaldo, and Söderlind (2011) and Xu (2018) for a discussion of these issues as they relate to currency returns and international bond returns, respectively.

70%.

The conditional foreign currency returns in Figure 7 show patterns similar to the equity returns in Figure 5. They are mostly negative in bad equity return states in the top panel and mostly positive in good equity states in the bottom panel. Presumably, the dollar's movements are somewhat correlated with the performance of the equity market. Conditional on the up or down equity states, it remains the case that foreign currency returns are higher in low variance return states than they are in high variance return states, and mostly considerably so. Yet again, we do not observe full monotonicity across the four bins. Figure 7 also indicates that part of the extreme bond market performance in Latin America emanates from the currency return as the return in the quiescent up markets minus the return in the volatile down markets is over 35%.

These Figures are suggestive that volatility risk, as proxied by the return on a variance swap, is systematic and not simply reflective of overall equity risk. If volatility risk is systematic, it has the ability to affect the expected returns on a wide variety of asset classes worldwide, including in emerging markets. The following subsections examine this conjecture more rigorously.

To hold constant other sources of risks, we specify a three-factor model. The first risk factor is the return on the S&P 500 Index, which is our proxy for the global equity market excess return. The second risk factor is the excess return on the the U.S. bond market, and the third risk factor is the return on a variance swap, our volatility risk factor. Since each risk factor is either an excess return or a zero-investment derivative contract, we can assess whether the exposures of an asset to the risk factors correctly price the asset by simply regressing the excess return on an asset class in region i, $r_{i,t}$, on the risk factors, $\left(r^e_{US,t}, r^b_{US,t}, r^{vs}_{US,t}\right)$, as in

$$r_{i,t} = \alpha_i + \beta_{i,1} r^e_{US,t} + \beta_{i,2} r^b_{US,t} + \beta_{i,3} r^{vs}_{US,t} + \varepsilon_{i,t}, \tag{2}$$

where the estimated α_i, the "alpha" of the model, measures the average performance of the asset class not explained by exposures to the risk factors with their corresponding average returns. In presenting the results of equation (2), we will superscript the asset classes with an e for equity, a b for bond, and an fx for foreign currency.[6]

3.1 Empirical Results for Equities

This section examines whether volatility risk is important in the pricing of equities in global asset markets when controlling for the returns on the U.S. equity and bond markets.

[6]Standard errors for the estimated parameters are calculated using four Newey and West (1987) lags.

The results are presented in Table 3, which contains two panels.

Panel A reports regression results for our seven regions of the world. In each case the slope coefficients on the U.S. equity excess return are highly significant. The estimated slope coefficients also are relatively similar, ranging from 0.80 for Latin America to 0.95 for the EU Euro region. The U.S. bond return is only marginally significant in one region, the EU Non-Euro region, and the coefficient is negative. The exposures to the variance risk factor are also highly significant in all cases with coefficients ranging from -2.99 for Developed Asia to -5.19 for Latin America. The three-factor model overestimates the average returns realized in the sample as all of the alphas are negative. The alphas for the Developed Asia and Emerging Asia regions and for the EU Euro region are significantly different from zero; and the model overstates these annualized average excess returns by about 6% p.a. This should not be surprising as Table 1 shows that these regions happened to have quite low average returns during this particular sample period. The factor model likely provides more plausible estimates of equity risk premiums for these regions than do the sample averages.

The results in Panel A use data on regional equity indexes that are equally weighted averages of the countries in those regions. Because there are too many countries in the regions to present all the individual country-level results in the paper, Panel B of Table 3 provides additional diagnostic statistics associated with the individual country-level regressions.[7] The means of the slope coefficients across countries for a given region are presented in the first row, and the percent of those coefficients that are significant at the 10% level are presented in the second row. The third row presents the 10-th and 90-th percentiles of the estimated slope coefficients in a region.

Unsurprisingly, most of the individual countries show significant exposures to the global equity return as only in the EMEA countries do we see less than 100% significant coefficients. Yet, there is still cross-country dispersion in the country exposures, especially in the emerging market regions. Whereas for developed markets the 80% range for the coefficients is [0.73,1.11], it increases to [0.49, 1.20] for Latin American and to [0.08,1.44] for the EMEA region.

Similarly, given the aggregate results, it is unsurprising that the percentage of countries with significant exposures to the bond market risk factor ranges between 0% for Latin America and 23% for the Developed countries. The bond exposures of the various equity markets are very dispersed, with large positive and negative exposures, but the average exposure is negative for all four groups. This is consistent with the portfolio results.

Finally, the exposures to the volatility factors are mostly negative and statistically significant, with the percent of significant coefficients above 90%, except for the Emerging

[7] Individual country results are provided in the Online Appendix.

Asia region where it is 78%. We also observe considerable dispersion in the individual coefficient estimates. These range from -7.80 for the 10-th percentile of Latin America to 0.98 for the 90-th percentile of Emerging Asia. The 0.98 coefficient is recorded for Pakistan, the only country for which we find a positive variance risk exposure. In the other three regions, the 10%-90% range for the coefficients is uniformly negative.

At the country level, there are few significant alphas in the regressions (36% in the developed markets; 11% in Emerging Asia and none elsewhere). Note that the factor model understandably produces lower R^2s for the individual countries than for the regional portfolios, with larger R^2's occurring for the developed markets. This finding is largely due to the higher country-specific risks in emerging markets.

3.2 Empirical Results for Bonds

Table 4 contains two panels as in Table 3, but the dependent variables are now USD-denominated excess bond returns. Panel A reports regression results for the same seven regions of the world. As one might expect, the U.S. bond return is highly significant in all regions, with slope coefficients ranging from 0.51 for the EMEA region to 0.99 for the EU Euro region. The slope coefficients on the U.S. excess equity return and the variance swap are significant in six of these seven portfolios, with the exception being Developed Asia. The exposures to the variance risk factor once again show the largest range of coefficients from 1.23 for Developed Asia to -4.98 for Latin America. Yet, the remaining exposures vary in a tight range between -1.33 (EU Euro) and -2.10 (DM Commodities). The only positive coefficient observed in the country returns is for the Japanese bond return, which explains the positive coefficient on Developed Asia. We surmise that the safe haven nature of the Japanese yen is behind this result. The alphas are all insignificant with the largest mispricing estimated at -2.2% for the DM Commodities region.

Panel B of Table 4 reports the means of the coefficients of the individual country regressions, as well as the percent significant and the 10-th and 90-th percentiles of the estimated coefficients. Between 73% (EMEA) and 92% (Latin America) of bond returns for the individual countries have significant exposure to the equity risk factor, while between 55% (EMEA) and 100% (Developed) of the bond returns for the individual countries have significant exposures to the bond market risk factor. Exposure of the individual bond market returns to the variance risk factor shows comparable significance with between 55% (EMEA) and 100% (Emerging Asia) of the countries having significant exposures.

Once again, the magnitudes and the spreads of the estimated coefficients associated with the variance risk factor are larger than the magnitudes and spreads of the estimated coefficients for the other two risk factors. However, the 10-th to 90-th percentile ranges show only one positive coefficient namely for EMEA at 0.29. The alphas are statistically significant in less than 10% of the countries.

3.3 Empirical Results for Currencies

Table 5 is similar to the previous two Tables, but the dependent variables are now USD-denominated excess currency returns. Panel A reports regression results for the same seven areas of the world. The slope coefficients on the U.S. excess equity return are now mostly much smaller than for bond returns, but they are all at least marginally significant. Coefficients on the U.S. bond return are significant in five of the regions, and the exposures are invariably positive. The coefficients on the variance swap are significant in six of the seven markets with the exception being Developed Asia. The exposures to the variance risk factor once again show the largest range of coefficients across the regions ranging from 0.37 for Developed Asia to -2.04 for DM Commodities. As expected, it is the Japanese yen returns that are behind the positive coefficient, as it is the only currency with a positive, albeit insignificant, exposure to the variance swap factor (See the Online Appendix). Again, similar to the bond return analysis, the range is tighter outside these extremes, varying between -0.57 and -1.64. Finally, three of the alphas are marginally significant with the largest mispricing estimated at -3.9% for the EU Euro region.

Examining the summary statistics of the individual country regressions in Panel B indicates that most of the currencies show significant exposure to the equity market with the percent significant across the regions ranging from 80% for the EMEA to 88% for Emerging Asia.

The importance of the bond market risk ranges from 0% significant for Emerging Asia and Latin America to 82% significant for Developed. The bond market risk exposures of currency returns are quite dispersed, with the 10-th to 90-th percentile range of bond market exposures switching signs for all three emerging market groups.

The variance risk factor is significant for 91% of the Developed market currency returns, for 86% of the Latin American currencies, for 60% of the EMEA currencies, but only for 38% of the Emerging Asia currencies. The coefficients on the variance swap risk factor once again show the largest range across the countries of the different regions, with the 90-th percentile values positive for the Emerging Asia and the EMEA region. Not surprisingly, given the regional portfolio results, the alphas are only significant in a small fraction of the emerging markets (less than 20%), but the proportion of statistically significant alphas rises to 73% for developed markets.

4 The Economic Importance of Global Volatility Risk

This section explores the economic importance of volatility risk in more detail. We first examine the implied returns for two models calculated as exposures to risk factors times the average returns of the risk factors. The risk factors of Model 1 include only the excess returns on the equity and bond markets, whereas Model 2 includes the return on the variance swap as an additional risk factor. The results are presented in Table 6.

The first column of Table 6 once again presents the average returns across the different regions for the three asset classes. The second and third columns present the implied expected returns from the two models. In most cases, the average returns are closer to the implied expected returns of Model 1. In 19 of the 21 portfolios, the implied expected return from Model 2 is larger than the implied expected return from Model 1. The exceptions are bonds and currencies for Developed Asia. Although the average return to the variance risk factor is only -1.2% p.a., because the exposures are large, the implied expected returns from Model 2 are sometimes increased quite substantially compared to those of Model 1. Once again, though, we note that the average returns on the asset classes ....

To highlight the economic importance of the variance risk premium as a determinant of the overall expected return in Model 2, we examine the proportions of the risk premiums that are accounted for by variance risk. That is, we examine the ratio of the part of the expected return due to variance risk relative to the total expected return implied by the model:

$$\frac{\beta_{i,3}\mu_3}{\beta_{i,1}\mu_1 + \beta_{i,2}\mu_2 + \beta_{i,3}\mu_3}, \tag{3}$$

where the β_i's are the estimated regression coefficients in equation (2), and μ_1, μ_2, and μ_3 are the sample means of the U.S. equity excess return, the U.S. bond excess return, and the variance swap return, respectively.

The results are summarized in column four of Table 6 with the standard errors of the ratio given in column five.[8] For the equity markets, the proportions of the implied expected returns of Model 2 that are due to the inclusion of the variance swap return range from 47% with a standard error of 5% for Developed Market Commodity countries to 67% with a standard error of 18% for Latin America.

For the bond and foreign currency markets, the results are similar except for the Developed Asia region, which has a large negative contribution due to the positive beta on the variance swap return documented above. For the bond markets, the proportions of the implied expected returns of Model 2 due to the variance swap range from 31% for EU

[8] Appendix B formally describes the GMM system of orthogonality conditions used to conduct inference about the ratio in equation (3).

Euro to 59% for Latin America. For the currency markets, the proportions range from 43% to 67% for the foreign currency markets. Most of these proportions appear statistically significantly different from zero, and they are clearly economically large. In sum, exposure to variance risk almost invariably increases required risk premiums, across all regions and the three major asset classes.

There remains the issue that the two-factor model appears to fit the historical average returns better than the three-factor model, at least for a number for regions. To verify this formally, we conduct standard Gibbons, Ross, and Shanken (1989) tests for the joint significance of the alphas. This test assumes conditional homoskedasticity of innovations in returns, which is generally counterfactual, so we also report an analogous GMM test that corrects for heteroskedasticity and possible autocorrelation.

Table 7 reports the chi-square test statistics and the p-values for three sets of test assets. The column indicated by regional uses the seven regional portfolios, the EM columns use all emerging markets separately, and the DM columns use all of the developed markets. The tests largely confirm our main point that historical average returns have little information that can be used to distinguish models. For the regional portfolios, we only reject the null of zero alphas for Model 2 for equities, at the 5% level for the GMM test and at the 10% level for the GRS test. Other than that, the performance of both models is similar, but of course, it is likely the tests lack power. For emerging markets, we again fail to reject the null of the zero alphas at the 5% level for both bonds and equities, whatever the test considered, but we strongly reject the null under either test for foreign currency returns. The tests thus fail to distinguish Models 1 and 2. For developed markets, the evidence depends on which test is used. There is no evidence against zero alphas for bonds returns under either test. For foreign currency returns, the GRS tests rejects zero alphas for both Model 1 and Model 2; the GMM tests fails to reject both models. For equities, the GMM test rejects both models at the 5% level, but the GRS test only rejects Model 2. Taken jointly, there is somewhat stronger evidence against Model 2 than against Model 1, but only for equities. Moreover, given that the data are undoubtedly heteroskedastic, we have more confidence in the GMM test, and under this test, the models perform about the same. We mostly do not reject the pricing implications of the models, and only do so strongly for both models for emerging market foreign exchange returns, and for developed market equity returns. Furthermore, it is important to remember that our tests rely on historical average returns to test the factor model. However, the period we consider is relatively short and includes a major global financial crisis, making it unlikely that historical returns are representative of long-run risk premiums. It is therefore important to get independent validation on the factor model. We do so now by examining the fit of the models with return correlations.

5 Comovements of Returns

In this section we ask how much of the sample correlation structure of returns is explained by our factor model. Given the statistical noise in average returns, the ability of the factor model to explain comovements of returns provides an alternative, potentially more powerful, test of its usefulness. We investigate comovements of returns from two perspectives. First, we investigate the correlations of returns across regions or countries within an asset class. Here, we build on a large literature that examines international stock return comovements, often focusing on how globalization has increased correlations over time (see e.g. Bekaert, Hodrick, and Zhang (2009) Christoffersen, Errunza, Jacobs, and Langlois (2012); and Pukthuanthong and Roll (2009)). Xu (2018) examines both bond and stock return correlations across countries, showing that bond return correlations are mostly lower than stock return correlations. Bekaert, Ehrmann, Fratzscher, and Mehl (2014) suggest that local factors are necessary to fully explain comovements across worldwide industry equity portfolios. We therefore cast our investigation as determining how much of the cross-region return correlations over the 1995-2018 period can be explained by our very parsimonious global factor model.

Second, we also investigate the correlations across asset classes within each region. While clearly useful from an asset management perspective, there is, in fact, fairly little research on cross-asset correlations, with the exception of research focusing on stock-bond return correlations (see e.g. Baele, Bekaert, and Inghelbrecht (2010)).

The model-implied correlation of two returns, $r_{i,t}$ and $r_{j,t}$, is calculated as in Bekaert, Hodrick, and Zhang (2009) by dividing the model-implied covariance of the two returns by the product of their sample standard deviations:

$$\text{Model Correlation} = \frac{\beta_i' var(f_t)\beta_j}{\sqrt{var(r_{i,t})var(r_{j,t})}}, \tag{4}$$

where $var(f_t)$ is the covariance matrix of the three risk factors and the β_i and β_j are the vectors of factor exposures of the two assets. We first report the ratio of model implied correlations to sample correlations interpreting this ratio as the percentage of the cross-region correlation that is explained by the model.

5.1 Proportion of Correlations Explained

We first report the underlying sample correlations that we would like the model to fit in Table 8. For our period of analysis, these sample correlations are quite high, varying between 61% for Emerging Asia and the EU Euro countries, and 92% for the EU Euro and

EU Non-Euro countries. On average, the correlations are 75%.

Table 9 presents the model-implied results for the equity, bond, and currency markets in three panels. In equity markets, we find that the three-factor model explains a substantive fraction of the cross-country correlations (on average, 73%). The proportion of explained correlation ranges from 57% for the correlation between the Developed Asia and Emerging Asia regions to 88% for the correlation between the EU Euro and Developed Asia regions. It is perhaps telling that the model does not fit as well for nearby regions, indicating that it may be missing a regional factor. The explained proportion is on average 60% for the three Emerging market regions, 80% for the four developed market groups, and 74% when considering emerging markets relative to the four developed market portfolios.

These sample correlations reveal that bond returns indeed show smaller correlations than equity markets, in some cases quite considerably smaller. The average correlation between bond markets is 40%, although there is considerable dispersion with the pairwise correlations as low as 1%. The correlation between the Latin-American and Developed Asian bond markets is very low correlation (3%), and the factor model estimates the correlation to be negative. So, even though the fit is actually good in an absolute sense, when expressed as a fraction of the sample correlation, we obtain a large negative number for the explained proportion. The model also over-fits several correlations, leading to ratios greater than 1. We circumvent this problem below by examining root mean square error statistics for the difference between the sample and model correlations.

Finally, in the foreign currency markets, the three-factor model explains about 30% of the correlations across regions, with the fractions being the highest for the correlations between Developed Commodity region with the Emerging Market regions and the Latin America region with other the regions. Within the emerging market regions, the average proportion is 42%, but it is only 18% within the developed market regions. The proportion for the cross-correlation between developed and emerging market regions is on average 30%. As indicated above, the Developed Commodity countries play a large role here. Actual correlations for currency returns are mostly in-between those for bond and equity markets, varying between 22% for Latin-American and Developed Asia, to 94% for the two European country groups. While the high correlation within Europe is not surprising given the efforts there to reduce currency variation, the fact that they are generally relatively high may be due to a common dollar factor. However, commodity factors may also play a role, as the currency returns of the Developed Commodity countries appear highly correlated with emerging market currencies.[9]

Next, we study the comovements of equity, bond, and foreign currency returns within

[9] Aloosh and Bekaert (2019) show that a dollar currency factor (including the USD, the CAD, the AUD, and the NZD) and a commodity factor describe currency market correlations rather well.

regions in Table 10. The bottom panel of the table reports the actual correlations between the various asset classes for the seven regional portfolios. On average the correlations of returns are highest between bonds and foreign currency, followed by the correlations between equities and foreign currency, with the correlations between equities and bonds being the lowest. However, these averages hide large cross-regional dispersion. The equity-bond return correlation varies from 0.11 in Developed Asia to 0.78 for the Developed Commodity countries. The lowest and highest correlations of equity returns with foreign currency returns occur for the three same regions. The correlation in Developed Asia is 0.36 and in Developed Commodity countries it is 0.83. The correlations of bond returns and foreign currency returns are as low as 0.32 for the EMEA region, but they are as high as 0.93 for the Developed Commodity countries.

The upper panel of the Table 10 reports the proportion of the correlations explained by the three-factor model. In emerging markets, the three-factor model explains, on average, 53%, 43% and 55% of the correlations between equities and bonds, equities and exchange rates, and bonds and exchange rates, respectively. Meanwhile, in developed markets, the model is less successful; it explains, on average, only 39% and 19% of the correlations between equities and foreign currency, and bonds and foreign currency, respectively. For bonds and equities, the Developed Asia correlation (which is low at 0.11) is predicted with the wrong sign, explaining the negative ratio. The fit for the other three regions is 41% on average. When the model correlation overshoots, or the sign is wrong, the ratio we report is not very informative.

5.2 Root Mean Square Error Correlation Analysis

Table 11 provides an alternative, overall perspective on the fit of the model-implied correlations. We provide the root mean square error of the difference between the model-implied correlations and the sample correlations for both within-asset and across-asset correlations. That is, for N asset returns, we calculate

$$RMSE = \sqrt{\frac{1}{N(N-1)/2} \sum_{i=1}^{N} \sum_{j>i}^{N} \left[corr_s(r_{i,t}, r_{j,t}) - corr_m(r_{i,t}, r_{j,t})\right]^2}. \tag{5}$$

where the sub s refers to sample statistic and the sub m refers to the model statistic. We use the regional portfolios as underlying assets (in this case N is seven). We also perform the same analysis for individual counties within emerging or developed markets (the EM and DM columns). Starting with the correlations across countries but within one asset class in Panel A, the RMSE for equities for our regional portfolios is only 0.046. This is a remarkable fit for correlations which average 75%. The fit worsens only slightly when considering individual developed market countries (0.05) or emerging market countries (0.076). The RMSE is 0.070 for the regional bond returns and 0.080 for emerging market bond returns, but worsens considerably for developed market bonds, increasing to 0.273. Given an average correlation among developed market bonds of 48%, this is a relatively poor fit.

The three-factor model has the most difficult time matching the correlations among foreign currency returns, where the RMSE is a respectable 0.100 for emerging markets but increases to 0.443 for developed markets. Because the exposures of foreign currency returns to our global factors are relatively modest, we miss a currency-centric factor that can fully capture the international correlations here.

In Panel B, we report the RMSE for the correlations across asset classes. Here the RMSE statistics vary between 0.114 for emerging market countries and 0.240 for developed markets. This number must be judged relative to an average correlation across asset classes of 43%, for emerging markets, 60% for developed markets.

Finally, Table 11 also reports the same RMSE statistics for Model 1, which does not contain the variance swap return as a risk factor. It is invariably the case that the RMSE produced by the three-factor model, Model 2, is lower than the RMSE produced by the two-factor model, Model 1. However, we must concede that the improvement is marginal and unlikely to be statistically significant.

6 Variance Betas: Dollar versus Local Currency

One potential issue with analysis thus far is that all returns have been measured in dollars. This raises two issues. First, it is conceivable that the bond and equity results are really driven by exposures of the dollar exchange rates to volatility risk. Second, there is considerable interest in hedged investment strategies that mitigate currency exposures. For example, ETFs that are hedged against currency risk have recently become available in the U.S. offering U.S. investors exposure to international bond and equity markets essentially denominated in foreign currency. Such hedged returns would not be subject to a currency factor due to exposure of currencies to variance risk.

In this section, we decompose country-level equity returns into local currency and dollar components. We summarize the results in Figure 8, with more detailed results relegated to the Online Appendix. We run multiple regressions of equity returns on the three risk factors as in equation (2). The bars represent the betas on the variance swap return from these regressions with equity returns denominated in dollars, while the diamonds are the betas from these regressions with equity returns denominated in local currency. The beta from the foreign currency regression is approximately the difference between the height of the bar and the diamond. Diamonds that are filled indicate statistical significance at the 10% marginal level of significance. Bars are shaded according to denote the country's region within emerging and developed markets. We find that most of variance risk betas in emerging market equities arise from the covariances of the variance swap return with the local currency equity returns. The local currency variance risk beta is statistically significant in 18 out of 24 countries.[10] In developed markets the currency component plays a greater role. Here the local currency equity return betas with respect to variance risk are not significant for 8 out of 22 countries, and the currency component adds 50% or more of the variance risk for about 10 countries. The local currency equity return variance risk beta is positive for Switzerland and Finland. Note that the difference between the bar and the diamond measures the exposure of the currency to variance risk. This exposure remains predominately negative for all of the countries. One prominent exception is Japan where the currency exposure is positive, as the exposure of the local currency return is more negative than the exposure of the dollar equity return, reflecting the well-known safe haven property of the yen.

7 Conclusions

This article proposes variance risk as a new risk factor in international finance. We proxy variance risk by the tradable return on a variance swap on the S&P500. We then consider the exposures of three asset classes, country-level equities, bonds, and currencies to this new risk factor, while controlling for equity risk, proxied by the return on the U.S. equity market, and bond risk, proxied by the return on a U.S. bond index. We cast a wide net geographically investigating returns worldwide, including in emerging markets. To keep the analysis manageable, our results focus primarily on regional returns, decomposing emerging markets in three regions (Emerging Asia, Latin-America, and the EMEA), whereas we consider the developed (Non-U.S.) markets mostly as one group, or split them up into four groups (DM Commodities, Developed Asia, EU Euro, EU Non-Euro).

We find almost uniformly negative exposures of returns to variance risk across all asset classes and all regions, including emerging markets. Whereas the equity and bond exposures are logically quite different across the three asset classes, the variance risk betas are rather similar across asset classes. It consequently appears difficult to escape variance risk exposure. Economically, the variance risk factor contributes significantly to global risk premiums, with its contribution hovering in the 40-60% range of the total premium for most portfolios we consider. Because our sample is relatively small, average realized returns are not very informative about differential risks across different assets. Accounting for variance risk matters substantially, and a two-factor model that ignores variance risk would typically

[10] In Turkey and Pakistan, the beta is positive, but it is solidly negative in all other countries.

assign lower risk premiums to most of the assets we consider. Statistical tests on alphas, though, cannot distinguish the two models over a sample period this short.

We also investigate how much of the comovement of international returns can be captured by our three-factor model, both within an asset class and across asset classes. The global factor model also accounts for a substantive fraction of international and cross-asset comovements in returns. The model is more successful in fitting equity return comovements than it is in fitting bond and foreign currency return comovements. Interestingly, for the latter, it is especially the comovements among developed market countries that is sub-par, whereas the fit for regional portfolios is still satisfactory, especially for bond returns. The extant literature has documented that local and regional factors may still matter, but here we demonstrate that a very simple model captures a non-negligible fraction of international asset return comovements. We also examine cross-asset return comovements, and here, the three-factor model does best for the correlations between equity returns and bond returns, capturing on average 47% of the positive correlations, while capturing only 41% of the equity return-foreign currency return correlations and 34% of the bond return-foreign currency return correlations. Yet, overall, our three-factor model always fits comovements of returns better than the two-factor model that ignores variance risk exposure. Uncovering additional risk factors that can improve the fit in this regard is an important challenge for future research.

A Countries

This Appendix lists the regional breakdown for the countries in the sample. For developed markets, the sample includes data for equities, bonds and currencies for all countries. In emerging markets, we do not have data on all asset classes for all countries, and we specify the breakdown.

Developed		Emerging				
Region	Country (ISO Code)	Region	Country (ISO Code)	Equities	Bonds	FX
DM Commodities	Australia (AU)	Emerging Asia	China (CN)	X	X	X
	Canada (CA)		India (IN)	X		X
	New Zealand (NZ)		Indonesia (ID)	X		X
Developed Asia	Hong Kong (HK)		Malaysia (MY)	X	X	X
	Japan (JP)		Philippines (PH)	X	X	X
	Singapore (SG)		Pakistan (PK)	X	X	X
EU Euro	Austria (AT)		South Korea (KR)	X		X
	Belgium (BE)		Taiwan (TW)	X		
	Finland (FI)		Thailand (TH)	X		X
	France (FR)	Emerging EMEA	Bulgaria (BG)		X	
	Germany (DE)		Czech Republic (CZ)	X		X
	Greece (GR)		Cote d'Ivoire (CI)		X	
	Iceland (IE)		Croatia (HR)		X	
	Italy (IT)		Egypt (EG)	X	X	X
	Netherlands (NL)		Hungary (HU)	X	X	X
	Portugal (PT)		Israel (IL)	X		X
	Spain (ES)		Jordan (JO)	X		X
EU Non-Euro	Denmark (DK)		Lebanon (LB)		X	
	Norway (NO)		Morocco (MA)	X	X	X
	Sweden (SE)		Nigeria (NG)		X	
	Switzerland (CH)		Poland (PL)	X	X	X
	United Kingdom (GB)		Russia (RU)	X	X	X
			Turkey (TR)	X	X	X
			South Africa (ZA)	X	X	X
			Ukraine (UA)		X	
		Latin America	Argentina (AR)	X	X	X
			Brazil (BR)	X	X	X
			Chile (CL)	X	X	X
			Colombia (CO)	X	X	X
			Dominican Republic (DO)		X	
			Ecuador (EC)		X	
			El Salvador (SV)		X	
			Mexico (MX)	X	X	X
			Panama (PA)		X	
			Peru (PE)	X	X	X
			Uruguay (UY)		X	
			Venezuela (VE)		X	

B Asymptotic Distribution of the Ratio Statistic

In order to calculate the importance of variance risk in the determination of expected returns, we examined the ratio of the required return from the variance risk factor to the total required return from the three-factor risk model. To examine standard errors for this statistic, we develop a GMM (Hansen (1982)) system of orthogonality conditions used in estimating the underlying parameters of the statistic which implies an asymptotic distribution of the underlying parameters. We then use the delta method to get the standard error of the ratio.

The orthogonality conditions underlying the estimation of the fundamental parameters form a just-identified system. These orthogonality conditions are the OLS orthogonality conditions from each of the regions and the estimation of the unconditional means of the regressors. Analytically, let ε_t be the vector of regression error terms associated with equation (2):

$$\varepsilon_t = r_t - \alpha - \beta_1 r^e_{US,t} - \beta_2 r^b_{US,t} - \beta_3 r^{vs}_{US,t},$$

where r_t is the vector of asset returns, $r_{i,t}$; α is the vector of constants, α_i; β_1 is the vector of $\beta_{i,1}$'s; β_2 is the vector of $\beta_{i,2}$'s, and β_3 is the vector of $\beta_{i,3}$'s from the regional regressions. Also,let μ_1, μ_2, and μ_3 be the unconditional means of the three risk factors. Then, define the vector function of data and parameters

$$g_t(\alpha,\beta,\mu) = \begin{pmatrix} \varepsilon_t \\ \varepsilon_t \times r^e_{US,t} \\ \varepsilon_t \times r^b_{US,t} \\ \varepsilon_t \times r^{vs}_{US,t} \\ r^e_{US,t} - \mu_1 \\ r^b_{US,t} - \mu_2 \\ r^{vs}_{US,t} - \mu_3 \end{pmatrix},$$

and the orthogonality conditions are

$$E\left[g_t(\alpha,\beta,\mu)\right] = 0.$$

The proportion of the expected return that is attributable to exposure to the variance risk is a non-linear function of the underlying β's and μ's. We calculate the standard errors of these proportions by applying the delta method. That is, if θ is the vector of parameters, if Ω is the usual GMM estimate of the asymptotic covariance matrix of the parameters that allows for conditional heteroskedasticity, and if $\mathrm{H}(\theta)$ is the proportion of the expected return due to variance risk, then the standard error of the proportion is

$$\left(\frac{dH(\theta)^{\intercal}}{d\theta}\Omega\frac{dH(\theta)}{d\theta}\right)^{0.5}.$$

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Figure 1: The VIX and the Variance Swap Return

This figure shows time-series plots of the VIX and the variance swap return, which measures global variance innovations. The sample period is monthly date from January 1995 to November 2018.

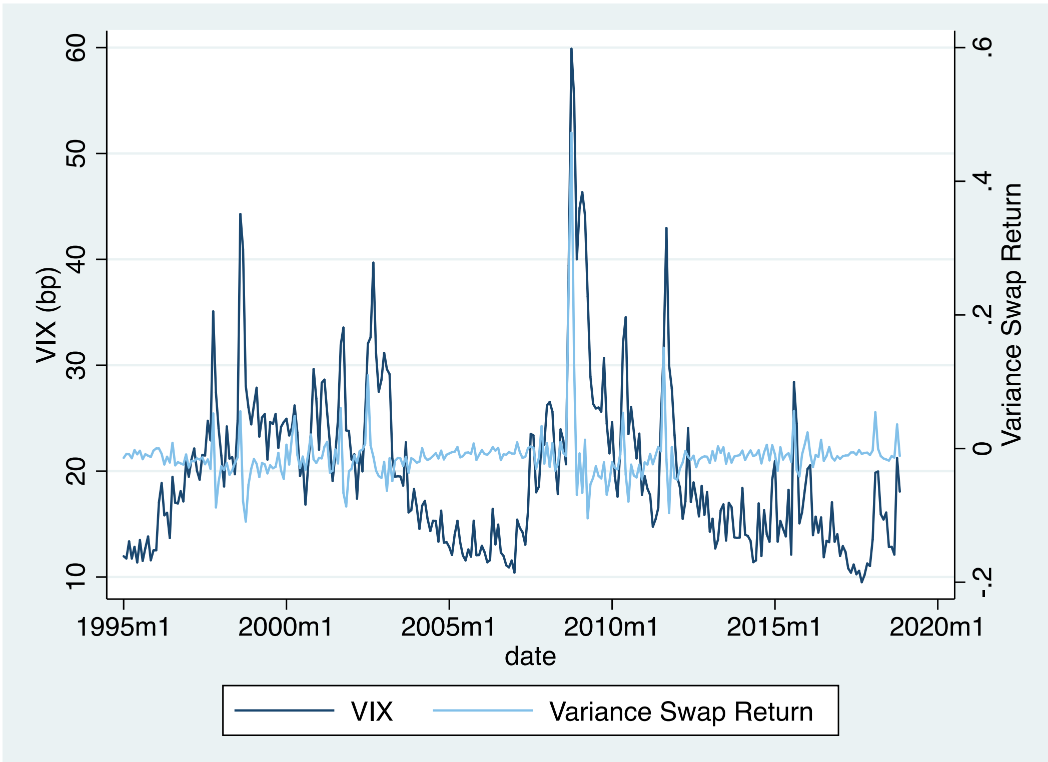

Figure 2: Excess equity returns and global variance by region

The bars show the sample means of annualized excess equity returns for regional portfolios conditional on contemporaneous global variance innovations being within the lowest quartile (No. 1) to the highest quartile (No. 4) of their sample distributions. The regional portfolio returns are an equally weighted averages across countries. The sample period is monthly data from January 1995 to November 2018.

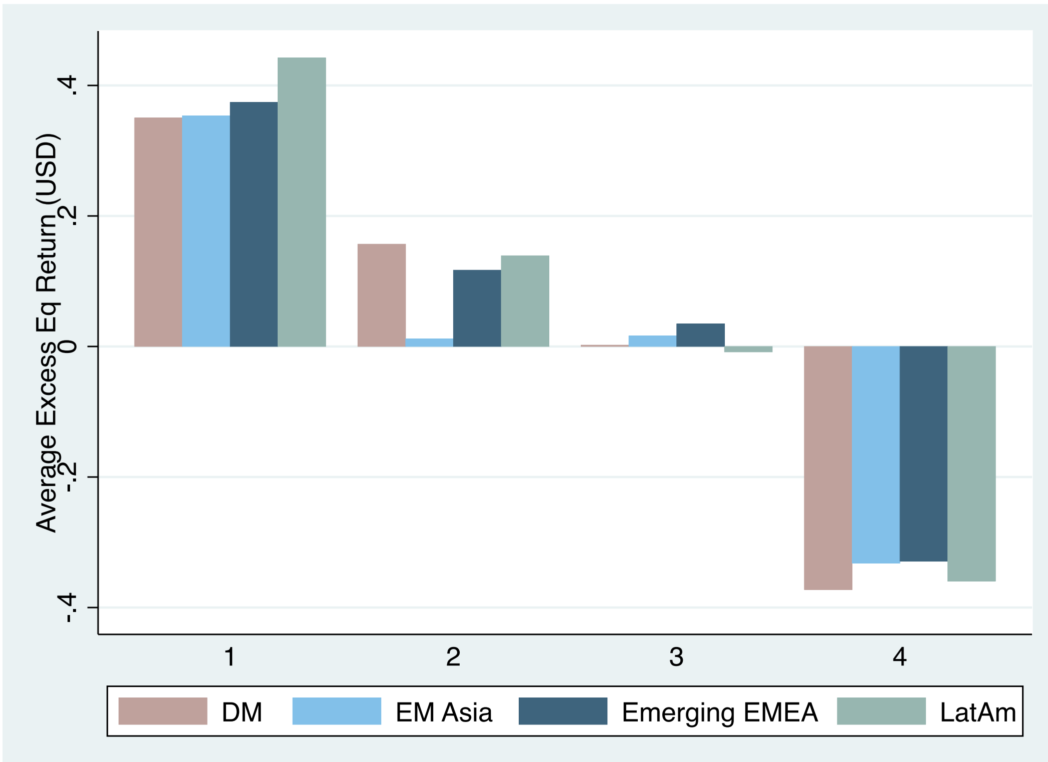

Figure 3: Excess bond returns and global variance by region

The bars show sample mean excess bond returns for regional portfolios conditional on contemporaneous global variance innovations being within the lowest quartile (No. 1) to the highest quartile (No. 4) of their sample distributions. The regional portfolio returns are an equally weighted averages across countries. The sample period is monthly data from January 1995 to November 2018.

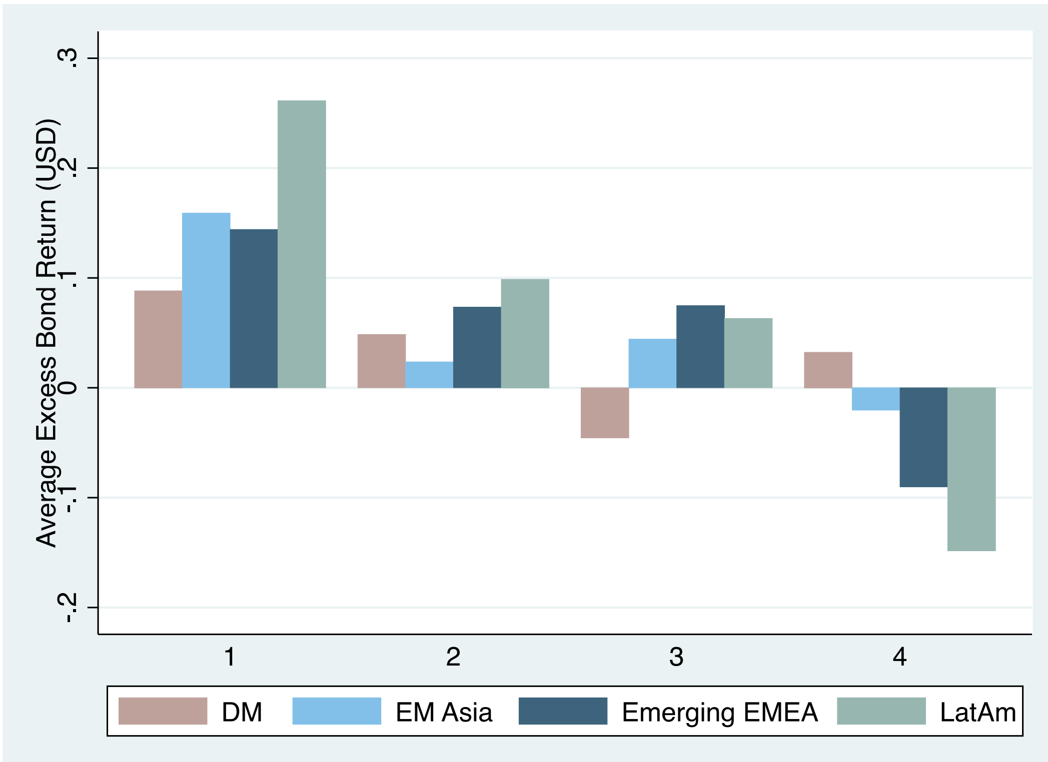

Figure 4: Excess foreign currency returns and global variance by region

The bars show sample mean excess foreign currency returns for regional portfolios conditional on contemporaneous global variance innovations being within the lowest quartile (No. 1) to the highest quartile (No. 4) of their sample distributions. The regional portfolio returns are an equally weighted averages across countries. The sample period is monthly data from January 1995 to November 2018.

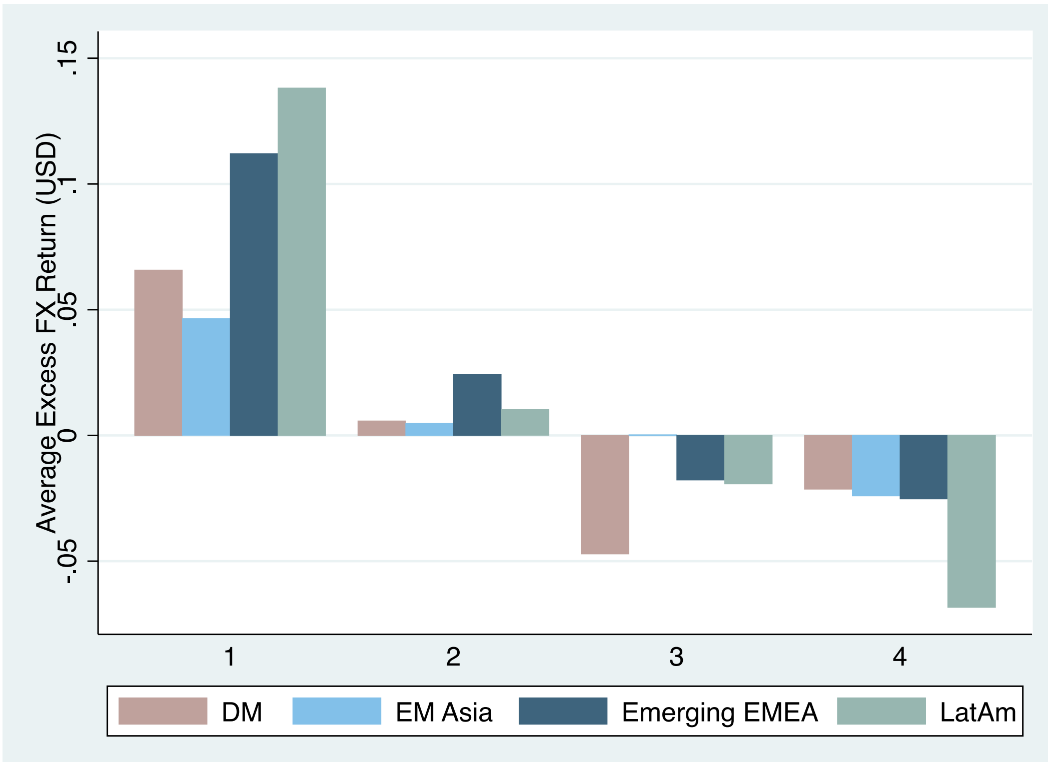

Figure 5: Excess equity returns and global variance by region and global equity market state

The bars show sample mean excess equity returns for regional portfolios conditional on contemporaneous global variance innovations being within the lowest quartile (No. 1) to the highest quartile (No. 4) of their sample distributions after having sorted on down (first panel) versus up (second panel) global equity market returns. The regional portfolio returns are an equally weighted averages across countries. The sample period is monthly data from January 1995 to November 2018.

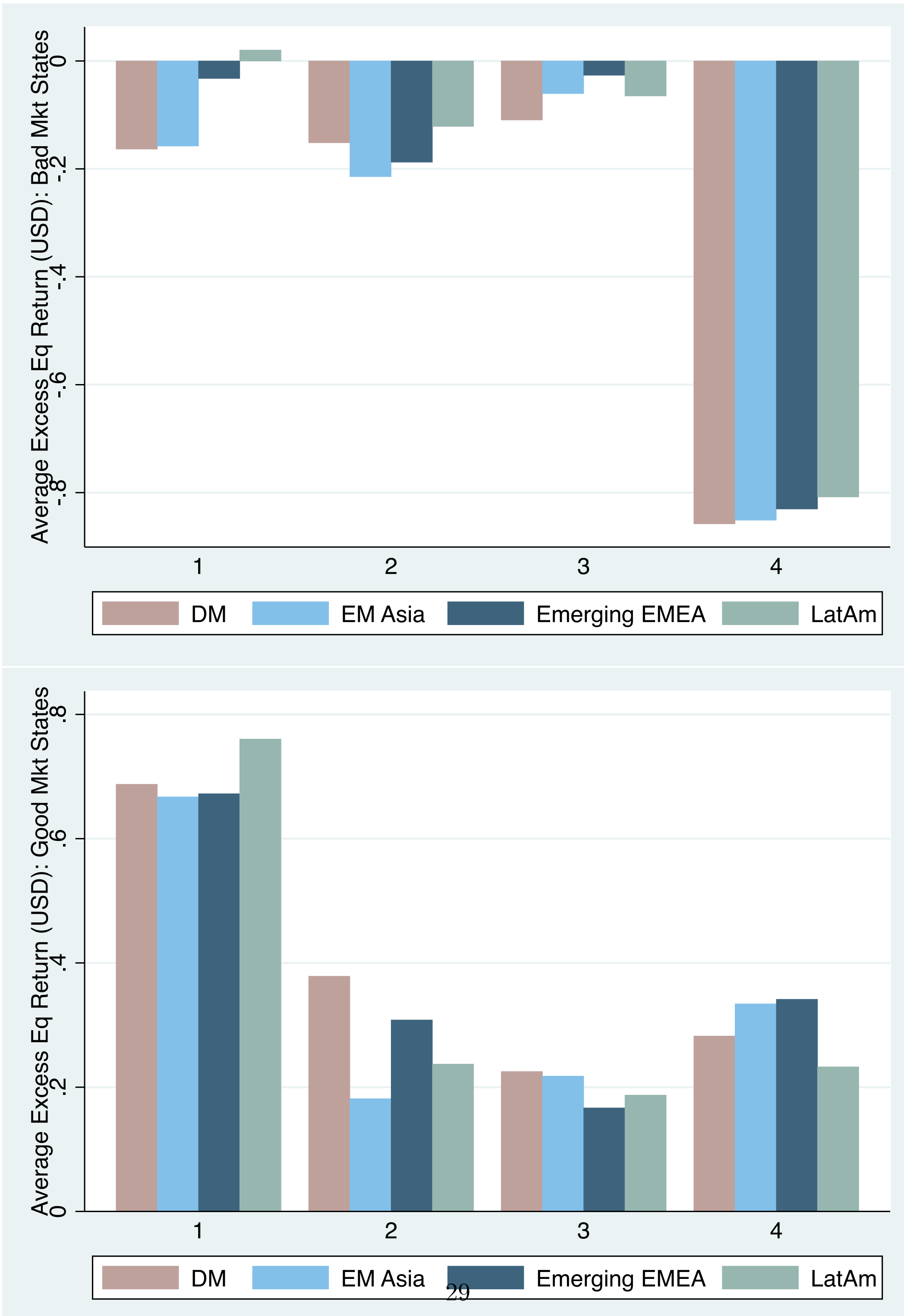

Figure 6: Excess bond returns and global variance by region and global equity market state

The bars show sample mean excess bond returns for regional portfolios conditional on contemporaneous global variance innovations being within the lowest quartile (No. 1) to the highest quartile (No. 4) of their sample distributions after having sorted on down (first panel) versus up (second panel) global equity market returns. The regional portfolio returns are an equally weighted average across countries. The sample period is monthly data from January 1995 to November 2018.

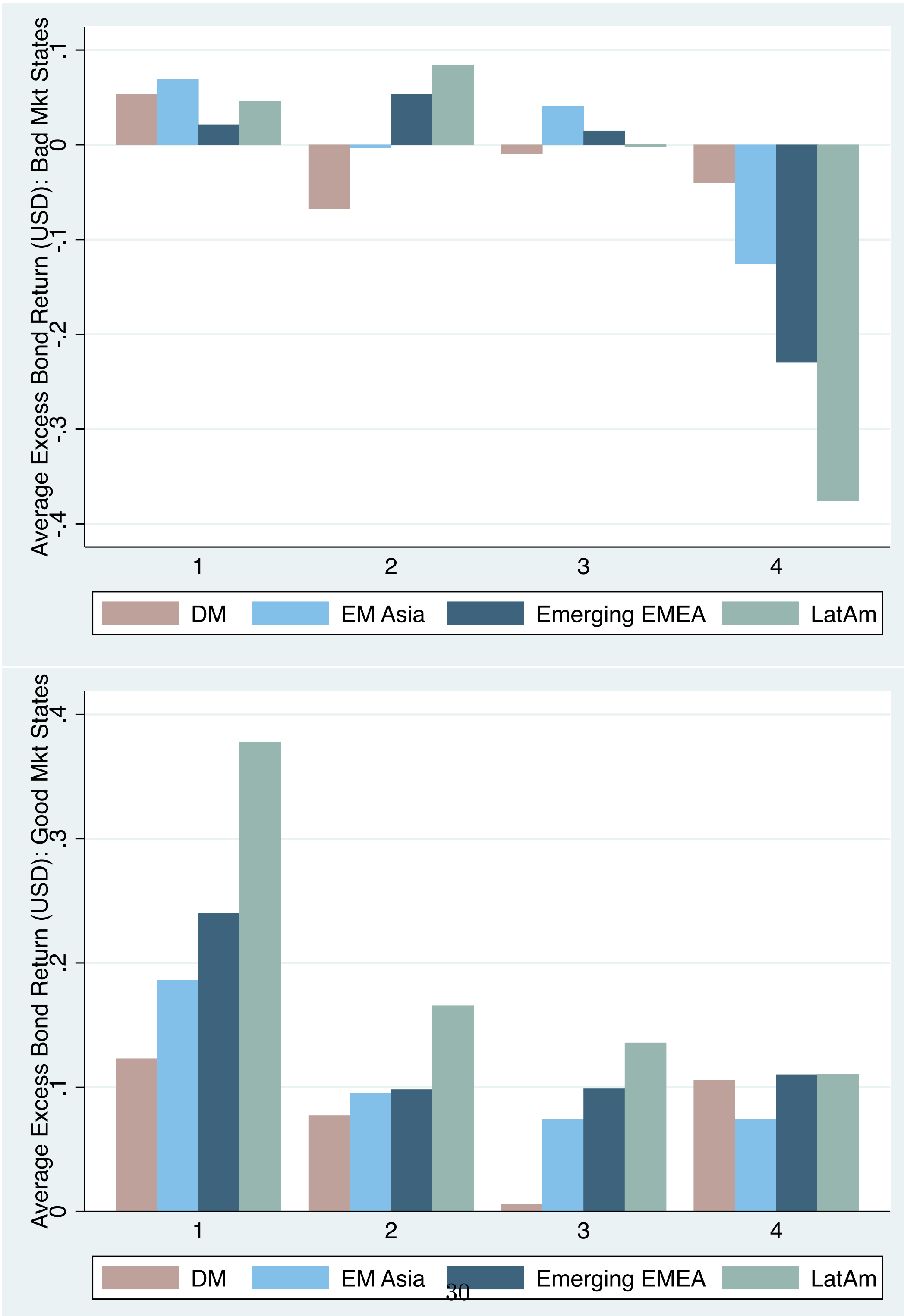

Figure 7: Excess foreign currency returns and global variance by region and global equity market state

The bars show sample mean excess foreign currency returns for regional portfolios conditional on contemporaneous global variance innovations being within the lowest quartile (No. 1) to the highest quartile (No. 4) of their sample distributions after having sorted on down (first panel) versus up (second panel) global equity market returns. The regional portfolio returns are an equally weighted average across countries. The sample period is monthly data from January 1995 to November 2018.

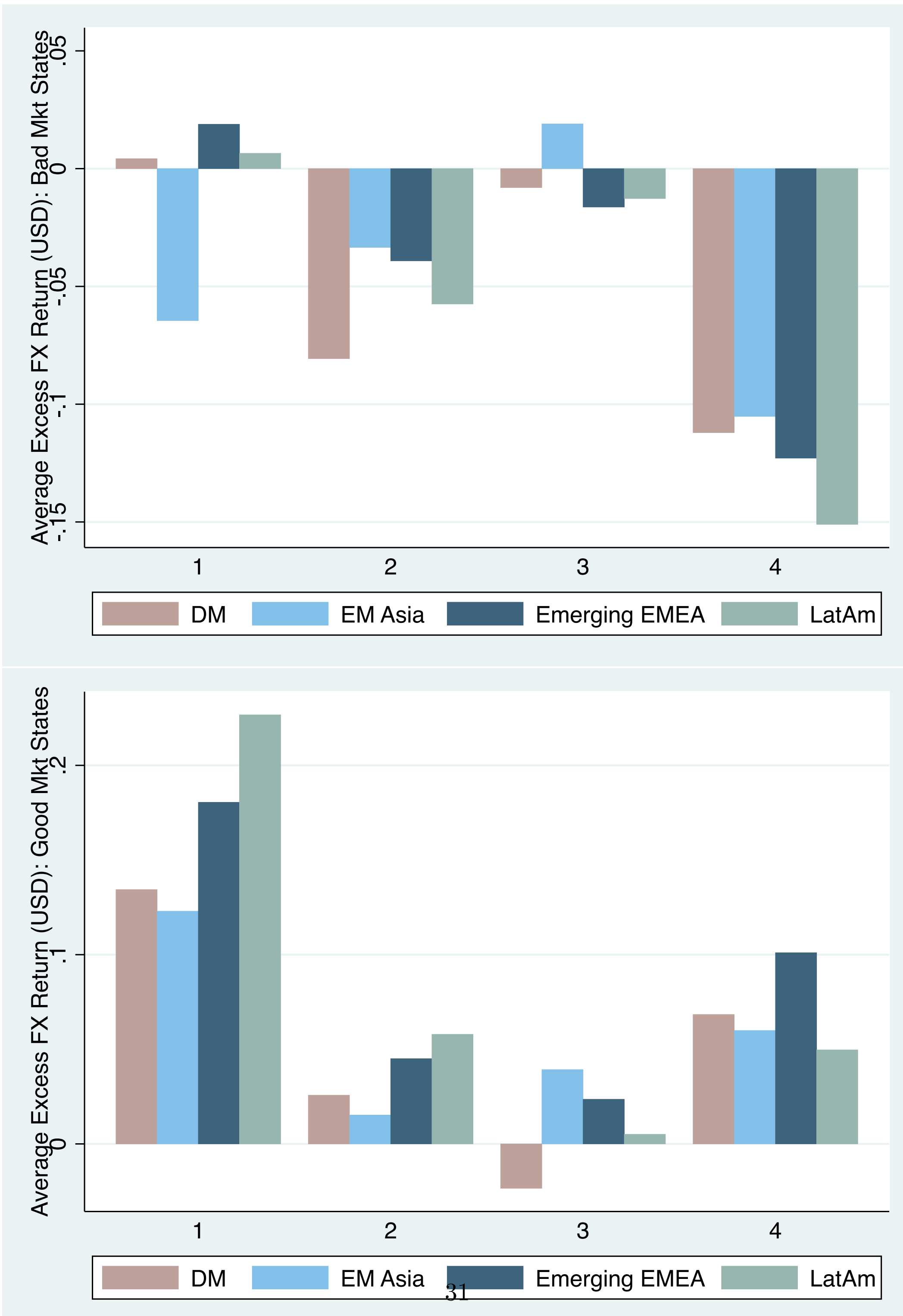

Figure 8: Variance Betas: Dollar versus Local Currency

The bars represent betas from regressions with equity returns in dollars, while the diamonds are the betas from regressions with equity returns in local currency. The beta from exchange rate regressions is, approximately, the difference between the diamond and the bar. Diamonds that are filled in are significant at the 10% level. Bars are shaded to denote the country's region within developed and emerging markets.

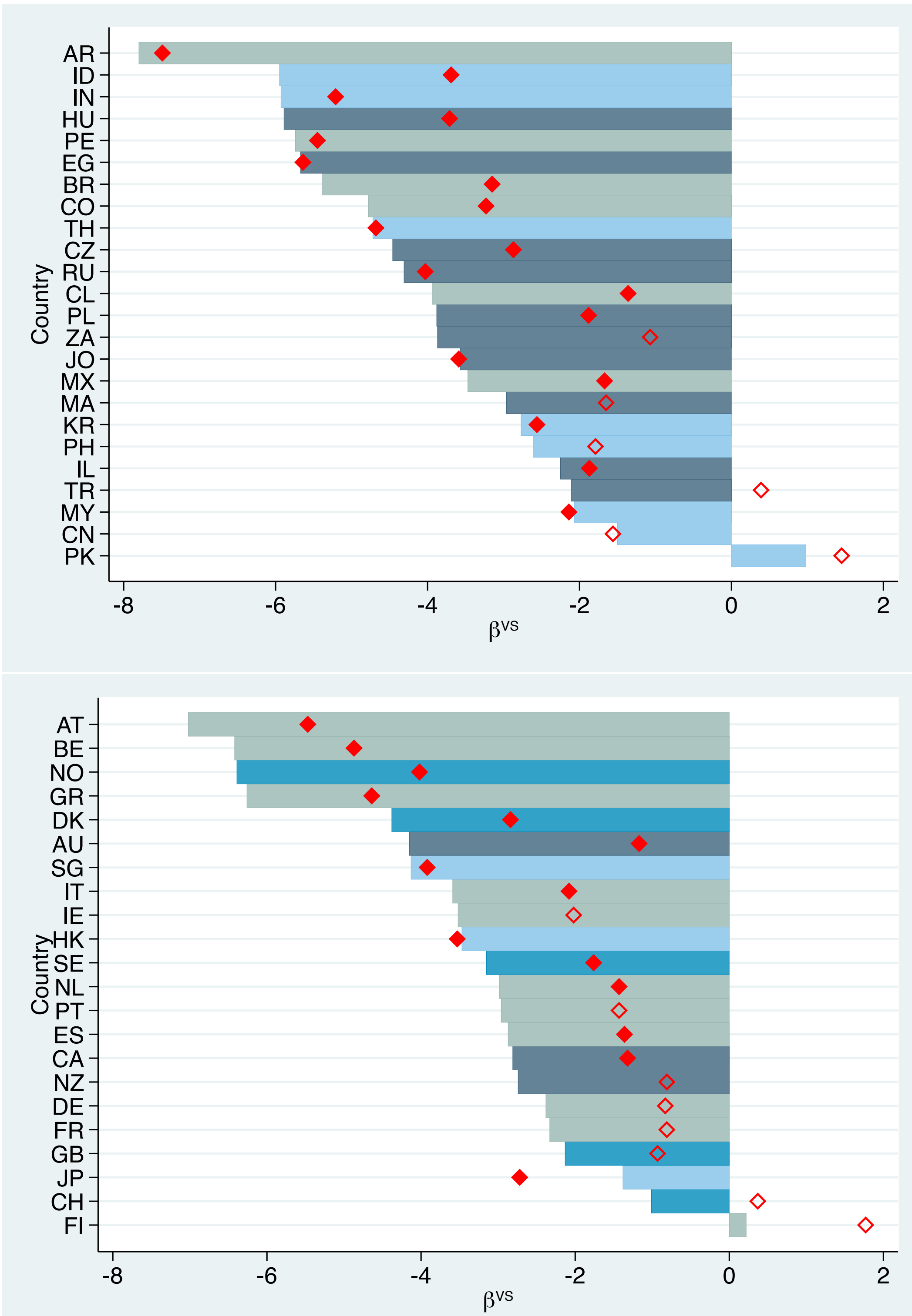

Table 1: Summary Statistics - Regional Index Returns

The summary statistics are the mean, median, and standard deviation (SD) of the excess returns on regional portfolios that are equally weighted country returns. The sample period is monthly data from January 1995 to November 2018.

	N	Mean	Median	SD
Panel A: Excess Equity Returns				
DM Commodities	287	5.54	8.77	18.51
Developed Asia	287	2.02	7.09	19.21
EU, Euro	287	2.23	7.76	20.73
EU, Non-Euro	287	6.20	12.77	18.20
Emerging Asia	287	1.35	7.89	22.74
Emerging EMEA	287	5.05	11.76	21.56
Latin America	287	5.48	13.35	24.67
Panel B: Excess Bond Returns				
DM Commodities	287	4.06	5.76	9.94
Developed Asia	287	-0.07	1.63	11.49
EU, Euro	287	3.08	4.76	10.34
EU, Non-Euro	287	2.63	1.25	8.87
Emerging Asia	265	4.84	5.87	7.01
Emerging EMEA	266	3.52	7.43	14.1
Latin America	287	7.34	11.31	15.42
Panel C: Excess Foreign Currency Returns				
DM Commodities	287	1.89	1.95	9.88
Developed Asia	287	-0.95	-1.06	4.8
EU, Euro	286	-0.61	-0.51	9.94
EU, Non-Euro	287	-0.23	-0.35	8.79
Emerging Asia	287	0.5	2.24	7.29
Emerging EMEA	287	2.36	3.39	7.38
Latin America	287	1.55	5.44	8.15
Panel D: Global Factor Returns				
r^e_{us}	287	5.2	10.49	14.61
r^b_{us}	287	2.61	2.39	4.24
VS_{us}	287	-1.14	-1.27	4.24

Table 2: Summary Statistics for Risk Factors

The table presents the summary statistics for the three risk factors: the excess return on the S&P 500 equity index, the excess return on the U.S. bond index, and the return on the variance swap. Panel A presents the mean, median, and standard deviation (SD). Panel B presents the correlations. The sample period is January 1995 to November 2018.

Panel A: Excess Returns

	N	Mean	Median	SD
r^e_{US}	287	5.20	10.49	14.61
r^b_{US}	287	2.61	2.39	4.24
r^{vs}_{US}	287	-1.14	-1.27	4.24

Panel B: Correlations

	$r^e_{US,t}$	$r^b_{US,t}$	$r^{vs}_{US,t}$
$r^e_{US,t}$	1.00		
$r^b_{US,t}$	-0.22	1.00	
$r^{vs}_{US,t}$	-0.53	0.15	1.00

Table 3: Global Equity Market Returns Priced by Their Exposures to U.S. Equity Market, Bond Market, and Variance Risks

The Table reports regressions of excess equity returns denominated in U.S. dollars on the risk factors from the U.S. equity, bond, and variance markets:

$$r^e_{i,t} = \alpha_i + \beta_{i,1} r^e_{US,t} + \beta_{i,2} r^b_{US,t} + \beta_{i,3} r^{vs}_{US,t} + \varepsilon_{i,t}$$

Panel A presents results for equally weighted regional portfolios in which the N column lists the number of months. Panel B lists summary statistics of the individual country-level regressions: the mean, the percent significant at the 10% level (% signif.), and the 10-th percentile and the 90-th percentile (p10 / p90) of the coefficient estimates. Standard errors are heteroskedasticity consistent. The N column presents the number of countries. The sample period is January 1995 to November 2018.

Region		$r^e_{US,t}$	$r^b_{US,t}$	$r^{vs}_{US,t}$	Constant	N	Adj R2
Panel A: Regional Regressions							
DM Commodities	coef	0.85***	0.18	-3.23***	-0.031	287	0.637
	t-stat	[14.1]	[1.16]	[-6.41]	[-1.36]		
Developed Asia	coef	0.80***	0.011	-2.99***	-0.056**	287	0.527
	t-stat	[13.4]	[0.061]	[-4.35]	[-2.10]		
EU Euro	coef	0.95***	-0.27	-3.65***	-0.062***	287	0.662
	t-stat	[14.5]	[-1.52]	[-6.10]	[-2.66]		
EU Non-Euro	coef	0.84***	-0.28*	-3.41***	-0.013	287	0.692
	t-stat	[16.2]	[-1.80]	[-5.31]	[-0.63]		
Emerging Asia	coef	0.83***	-0.078	-3.16***	-0.064*	287	0.409
	t-stat	[9.03]	[-0.36]	[-3.79]	[-1.87]		
Emerging EMEA	coef	0.84***	-0.14	-3.90***	-0.034	287	0.508
	t-stat	[8.97]	[-0.62]	[-5.38]	[-1.11]		
Latin America	coef	0.80***	-0.20	-5.19***	-0.041	287	0.425
	t-stat	[7.22]	[-0.71]	[-5.41]	[-1.03]		
Panel B: Summary Statistics for Country-Level Regressions							
Developed	mean	0.89	-0.17	-3.45	-0.05	22	0.50
	% signif.	1.00	0.23	0.91	0.36		
	p10 / p90	0.73 / 1.11	-0.59 / 0.29	-6.39 / -1.38	-0.08 / -0.00		0.33 / 0.65
Emerging Asia	mean	0.83	-0.08	-3.16	-0.06	9	0.22
	% signif.	1.00	0.22	0.78	0.11		
	p10 / p90	0.41 / 1.12	-0.64 / 0.82	-5.95 / 0.98	-0.13 / 0.01		0.02 / 0.34
Emerging EMEA	mean	0.84	-0.14	-3.90	-0.03	10	0.24
	% signif.	0.80	0.10	0.90	0.00		
	p10 / p90	0.08 / 1.44	-0.97 / 0.55	-5.78 / -2.18	-0.07 / 0.00		0.06 / 0.38
Latin America	mean	0.80	-0.20	-5.19	-0.04	6	0.28
	% signif.	1.00	0.00	1.00	0.00		
	p10 / p90	0.49 / 1.20	-0.71 / 0.58	-7.80 / -3.47	-0.10 / -0.01		0.13 / 0.45

Table 4: Global Bond Market Returns Priced by Their Exposures to U.S. Equity Market, Bond Market, and Variance Risks

The Table reports regressions of excess bond market returns denominated in U.S. dollars on the risk factors from the U.S. equity, bond, and variance markets:

$$r^b_{i,t} = \alpha_i + \beta_{i,1} r^e_{US,t} + \beta_{i,2} r^b_{US,t} + \beta_{i,3} r^{vs}_{US,t} + \varepsilon_{i,t}$$

Panel A presents results for equally weighted regional portfolios in which the N column lists the number of months. Panel B lists summary statistics of the individual country-level regressions: the mean, the percent significant at the 10% level (% signif.), and the 10-th percentile and the 90-th percentile (p10 / p90) of the coefficient estimates. Standard errors are heteroskedasticity consistent. The N column presents the number of countries. The sample period is January 1995 to November 2018.

Region		$r^e_{US,t}$	$r^b_{US,t}$	$r^{vs}_{US,t}$	Constant	N	Adj R2
Panel A: Regional Regressions							
DM Commodities	coef	0.29***	0.91***	-2.10***	-0.022	287	0.403
	t-stat	[7.03]	[8.13]	[-5.68]	[-1.41]		
Developed Asia	coef	0.068	0.92***	1.23	-0.014	287	0.120
	t-stat	[1.22]	[5.93]	[1.48]	[-0.62]		
EU Euro	coef	0.13**	0.99***	-1.33***	-0.017	287	0.192
	t-stat	[2.40]	[6.58]	[-2.87]	[-0.91]		
EU Non-Euro	coef	0.11***	0.91***	-1.56***	-0.021	287	0.241
	t-stat	[2.71]	[7.87]	[-4.78]	[-1.38]		
Emerging Asia	coef	0.13**	0.82***	-1.78***	0.0027	265	0.402
	t-stat	[2.36]	[7.70]	[-4.13]	[0.21]		
Emerging EMEA	coef	0.32**	0.51***	-1.52***	-0.0083	266	0.164
	t-stat	[2.29]	[3.29]	[-2.66]	[-0.30]		
Latin America	coef	0.40***	0.74***	-4.98***	-0.024	287	0.442
	t-stat	[4.02]	[3.56]	[-6.81]	[-0.93]		
Panel B: Summary Statistics for Country-Level Regressions							
Developed	mean	0.16	0.93	-1.34	-0.02	22	0.23
	% signif.	0.86	1.00	0.77	0.05		
	p10 / p90	0.07 / 0.31	0.76 / 1.05	-2.09 / -0.50	-0.03 / 0.00		0.12 / 0.40
Emerging Asia	mean	0.15	0.84	-2.61	-0.00	4	0.32
	% signif.	0.75	0.75	1.00	0.00		
	p10 / p90	0.06 / 0.21	0.61 / 0.98	-5.14 / -1.24	-0.02 / 0.02		0.20 / 0.57
Emerging EMEA	mean	0.29	0.54	-1.76	0.01	11	0.17
	% signif.	0.73	0.55	0.55	0.09		
	p10 / p90	0.10 / 0.74	0.18 / 0.95	-2.88 / 0.29	-0.01 / 0.03		0.02 / 0.33
Latin America	mean	0.32	0.84	-4.79	-0.02	12	0.35
	% signif.	0.92	0.67	0.92	0.08		
	p10 / p90	0.09 / 0.53	0.43 / 1.13	-9.06 / -1.60	-0.10 / 0.02		0.24 / 0.43

Table 5: Global Foreign Exchange Market Returns Priced by Their Exposures to U.S. Equity Market, Bond Market, and Variance Risks

The Table reports regressions of excess foreign exchange market returns denominated in U.S. dollars on the risk factors from the U.S. equity, bond, and variance markets:

$$r^f x_{i,t} = \alpha_i + \beta_{i,1} r^e_{US,t} + \beta_{i,2} r^b_{US,t} + \beta_{i,3} r^{vs}_{US,t} + \varepsilon_{i,t}$$

Panel A presents results for equally weighted regional portfolios in which the N column lists the number of months. Panel B lists summary statistics of the individual country-level regressions: the mean, the percent significant at the 10% level (% signif.), and the 10-th percentile and the 90-th percentile (p10 / p90) of the coefficient estimates. Standard errors are heteroskedasticity consistent. The N column presents the number of countries. The sample period is January 1995 to November 2018.

Region		$r^e_{US,t}$	$r^b_{US,t}$	$r^{vs}_{US,t}$	Constant	N	Adj R2
Panel A: Regional Regressions							
DM Commodities	coef	0.29***	0.27**	-2.04***	-0.026	287	0.335
	t-stat	[6.57]	[2.20]	[-4.98]	[-1.60]		
Developed Asia	coef	0.078***	0.33***	0.37	-0.018*	287	0.092
	t-stat	[3.28]	[4.77]	[1.13]	[-1.93]		
EU Euro	coef	0.098*	0.43***	-1.50***	-0.039**	286	0.085
	t-stat	[1.81]	[2.76]	[-3.28]	[-2.11]		
EU Non-Euro	coef	0.11**	0.31***	-1.56***	-0.034**	287	0.113
	t-stat	[2.37]	[2.62]	[-4.34]	[-2.09]		
Emerging Asia	coef	0.16***	0.065	-0.57*	-0.011	287	0.128
	t-stat	[4.62]	[0.73]	[-1.72]	[-0.95]		
Emerging EMEA	coef	0.19***	0.23*	-1.19***	-0.0056	287	0.231
	t-stat	[4.61]	[1.86]	[-3.98]	[-0.39]		
Latin America	coef	0.18***	0.054	-1.64***	-0.014	287	0.238
	t-stat	[5.39]	[0.59]	[-5.74]	[-0.98]		
Panel B: Country-Level Regressions							
Developed	mean	0.13	0.37	-1.33	-0.03	22	0.12
	% signif.	0.82	0.82	0.86	0.73		
	p10 / p90	0.07 / 0.25	0.06 / 0.45	-2.01 / -0.21	-0.04 / -0.02		0.06 / 0.23
Emerging Asia	mean	0.15	0.06	-0.53	-0.01	8	0.06
	% signif.	0.88	0.00	0.38	0.12		
	p10 / p90	0.03 / 0.37	-0.03 / 0.23	-2.29 / 0.11	-0.03 / 0.02		0.01 / 0.15
Emerging EMEA	mean	0.19	0.23	-1.19	-0.01	10	0.10
	% signif.	0.80	0.40	0.60	0.10		
	p10 / p90	0.02 / 0.32	-0.19 / 0.48	-2.58 / 0.28	-0.03 / 0.02		0.00 / 0.19
Latin America	mean	0.18	0.05	-1.64	-0.01	6	0.13
	% signif.	0.83	0.00	0.83	0.17		
	p10 / p90	0.01 / 0.31	-0.16 / 0.19	-2.60 / -0.54	-0.06 / 0.03		-0.01 / 0.25

Table 6: Regional Risk Premiums: Does Global Volatility Matter?

The sample mean excess return is $\overline{r_i}$. The implied expected excess return from the two factor model with excess returns on the U.S. equity and bond markets as risk factors is $E(r_{Model1})$. The implied expected excess return from the three factor model that adds the return on the variance swap as an additional risk factor is $E(r_{Model2})$. The implied expected excess returns are calculated using the long-run means for the excess returns on U.S. equities, bonds, and the variance swap, which are 5.20%, 2.61%, and -1.14%, respectively. The proportion of the implied expected return from Model 2 that is due to the variance swap return is $\beta_3 VSP/E(r_{Model2})$. Standard errors (SE) for the proportions are in the last column. The sample period is January 1995 to November 2018.

Asset Class	Region	$\overline{r_i}$	$E(r_{Model1})$	$E(r_{Model2})$	$\frac{\beta_3 VSP}{E(r_{Model2})}$	SE
Equities	DM Commodities	5.54	5.05	8.41	46.56	4.64
	Developed Asia	2.02	4.23	7.34	49.38	5.26
	EU Euro	2.23	4.13	7.92	55.71	8.79
	EU Non-Euro	6.20	3.56	7.10	58.16	9.62
	Emerging Asia	1.35	4.11	7.39	51.74	6.28
	Emerging EMEA	5.05	4.08	8.12	58.05	7.22
	Latin America	5.48	3.92	9.31	67.42	8.02
Bonds	DM Commodities	4.06	4.50	6.68	38.05	14.31
	Developed Asia	-0.07	2.97	1.69	-88.13	189.10
	EU Euro	3.08	3.89	5.27	30.57	17.49
	EU Non-Euro	2.63	3.61	5.23	36.06	18.97
	Emerging Asia	4.84	3.48	5.31	40.57	22.37
	Emerging EMEA	3.52	3.32	4.88	37.75	12.59
	Latin America	7.34	5.01	10.18	59.19	11.23
Exchange Rates	DM Commodities	1.89	2.52	4.63	53.23	7.85
	Developed Asia	-0.95	1.31	0.92	-48.08	51.21
	EU Euro	-0.61	2.04	3.59	50.39	17.34
	EU Non-Euro	-0.23	1.73	3.34	56.35	14.23
	Emerging Asia	0.50	1.02	1.61	42.66	4.96
	Emerging EMEA	2.36	1.77	3.00	47.90	9.13
	Latin America	1.55	1.28	2.98	66.58	4.53

Table 7: Pricing Errors

The Table reports the Gibbons, Ross, and Shanken (1989) (GRS) joint test of the significance of the pricing errors for Model 1, the two-factor risk model, and Model 2, the three-factor risk model, as well as an asymptotic GMM test that allows for conditional heteroskedasticity. The GRS test is

$$T\left(1+E(f)'\hat{\Omega}^{-1}E(f)\right)^{-1}\hat{\alpha}'\hat{\Sigma}^{-1}\hat{\alpha}\sim\chi^2_N$$

where $\hat{\Omega}$ is the covariance matrix of the factors and $\hat{\Sigma}$ is the covariance matrix of the residuals from the test assets. The GMM test is

$$\hat{\alpha}'var\left(\hat{\alpha}\right)^{-1}\hat{\alpha}\sim\chi^2_N$$

where $var\left(\hat{\alpha}\right)$ is the covariance matrix of the $\hat{\alpha}$ which is estimated with the methods of Newey and West (1987) and four lags.

		Regional		EM		DM	
		Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
GRS	Equities	11.6	13.74	9.11	12.23	23.79	35.32
		[0.11]	[0.06]	[1.00]	[0.98]	[0.36]	[0.04]
	Bonds	5.46	6.9	23.39	21.4	8.32	11.32
		[0.60]	[0.44]	[0.22]	[0.32]	[0.98]	[0.91]
	FX	10.16	9.23	165.04	170.67	56.78	51.04
		[0.18]	[0.24]	[0.00]	[0.00]	[0.00]	[0.00]
GMM	Equities	11.21	14.68	15.13	17.75	35.05	40.74
		[0.13]	[0.04]	[0.94]	[0.85]	[0.04]	[0.01]
	Bonds	5.65	7.44	24.5	28	10.24	15.05
		[0.58]	[0.38]	[0.18]	[0.08]	[0.95]	[0.72]
	FX	10.29	11.93	130.83	128.49	21.96	19.93
		[0.17]	[0.10]	[0.00]	[0.00]	[0.46]	[0.59]

Table 8: Correlations of Regional Equity, Bond and Foreign Exchange Markets

The Table reports the sample correlations for excess returns across regional equity, bond, and foreign currency markets. The sample period is January 1995 to November 2018.

Asset Class	Region	DM Comm.	Dev. Asia	Euro	Non-Euro	Em. Asia	EMEA
Equities	Developed Asia	0.80					
	EU Euro	0.80	0.68				
	EU Non-Euro	0.84	0.73	0.92			
	Emerging Asia	0.75	0.83	0.61	0.65		
	Emerging EMEA	0.80	0.71	0.78	0.80	0.73	
	Latin America	0.76	0.71	0.68	0.70	0.72	0.80
Bonds	Developed Asia	0.29					
	EU Euro	0.69	0.30				
	EU Non-Euro	0.76	0.36	0.91			
	Emerging Asia	0.55	0.10	0.30	0.36		
	Emerging EMEA	0.37	0.01	0.14	0.17	0.67	
	Latin America	0.57	0.03	0.25	0.30	0.70	0.66
FX	Developed Asia	0.42					
	EU Euro	0.64	0.48				
	EU Non-Euro	0.70	0.49	0.94			
	Emerging Asia	0.51	0.46	0.37	0.42		
	Emerging EMEA	0.75	0.40	0.75	0.76	0.43	
	Latin America	0.56	0.22	0.32	0.38	0.39	0.59

Table 9: Model-Implied Relative to Realized Regional Correlations for Equity, Bond and Foreign Currency Markets

The Table reports the ratio of model-implied correlations to sample correlations for excess returns on regional equities, bonds and exchange rates. The model-implied correlation of two returns, $r_{i,t}$ and $r_{j,t}$, is calculated as in Bekaert, Hodrick, and Zhang (2009) by dividing the model-implied covariance of the two returns by the product of their sample standard deviations:

$$\text{Model Correlation} = \frac{\beta_i' var(f_t)\beta_j}{\sqrt{var(r_{i,t})var(r_{j,t})}},$$

where $var(f_t)$ is the covariance matrix of the three risk factors and the β_i and β_j are the vectors of factor exposures of the two assets. The model is based on the regression of regional excess returns on the excess returns on U.S. equity, bond, and variance swap markets. The sample period is January 1995 to November 2018.

Asset Class	Region	DM Comm.	Dev. Asia	Euro	Non-Euro	Em. Asia	EMEA
Equities	Developed Asia	0.72					
	EU Euro	0.81	0.88				
	EU Non-Euro	0.79	0.83	0.74			
	Emerging Asia	0.69	0.57	0.87	0.83		
	Emerging EMEA	0.72	0.74	0.75	0.75	0.63	
	Latin America	0.69	0.67	0.79	0.77	0.59	0.58
Bonds	Developed Asia	0.29					
	EU Euro	0.39	0.41				
	EU Non-Euro	0.41	0.36	0.26			
	Emerging Asia	0.73	1.17	0.97	0.90		
	Emerging EMEA	0.69	1.20	1.02	0.96	0.34	
	Latin America	0.74	-0.43	0.89	0.88	0.54	0.43
FX	Developed Asia	0.19					
	EU Euro	0.25	0.13				
	EU Non-Euro	0.28	0.12	0.11			
	Emerging Asia	0.42	0.10	0.25	0.28		
	Emerging EMEA	0.38	0.19	0.18	0.22	0.41	
	Latin America	0.51	0.21	0.39	0.42	0.46	0.40

Table 10: Correlations for Equities, Bonds, and Foreign Exchange within Regions

The Table reports the ratio of model-implied correlations to sample correlations and the sample correlations for excess returns within regions for equity returns and bond returns, equity returns and foreign exchange returns, and bond returns and foreign exchange returns. The model-implied correlation of two returns, $r_{i,t}$ and $r_{j,t}$, is calculated as in Bekaert, Hodrick, and Zhang (2009) by dividing the model-implied covariance of the two returns by the product of their sample standard deviations:

$$\text{Model Correlation} = \frac{\beta_i' var(f_t)\beta_j}{\sqrt{var(r_{i,t})var(r_{j,t})}},$$

where $var(f_t)$ is the covariance matrix of the three risk factors and the β_i and β_j are the vectors of factor exposures of the two assets. The model is based on the regression of regional excess returns on the excess returns on U.S. equity, bond, and variance swap markets. The sample period is January 1995 to November 2018.

	Region	Corr(Eq,Bond)	Corr(Eq,FX)	Corr(Bond,FX)
Model-Implied/Realized	DM Commodities	0.55	0.56	0.36
	Developed Asia	-0.54	0.20	0.11
	EU Euro	0.30	0.35	0.13
	EU Non-Euro	0.39	0.44	0.16
	Emerging Asia	0.50	0.36	0.48
	Emerging EMEA	0.56	0.49	0.61
	Latin America	0.53	0.45	0.55
Sample Correlations	DM Commodities	0.78	0.83	0.93
	Developed Asia	0.11	0.36	0.89
	EU Euro	0.45	0.50	0.92
	EU Non-Euro	0.44	0.54	0.92
	Emerging Asia	0.50	0.66	0.34
	Emerging EMEA	0.51	0.69	0.32
	Latin America	0.77	0.70	0.58

Table 11: Model Fit: Root Mean Square Error

This table reports the root of the mean square error (RMSE) for two models. Model 1 refers to a two factor model with excess returns on the U.S. equity and bond market as risk factors, while Model 2 refers to a three factor model that adds the return on the variance swap as an additional risk factor. The RMSE measure is defined as

$$RMSE = \sqrt{\frac{1}{N(N-1)/2} \sum_{i=1}^{N} \sum_{j>i}^{N} [corr_s(r_{i,t}, r_{j,t}) - corr_m(r_{i,t}, r_{j,t})]^2}$$

where $corr_s$ is the sample correlation, $corr_m$ is the model-implied correlation and N is the number of portfolios. Panel A shows the results for the correlations across countries (within asset class), and Panel B shows the results for the correlations within countries (across asset classes).

	Regional		EM		DM	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Panel A: Across countries, within asset class						
Equities	0.061	0.046	0.084	0.076	0.060	0.050
Bonds	0.083	0.070	0.108	0.080	0.292	0.273
Exchange Rates	0.184	0.170	0.105	0.100	0.468	0.443
Panel B: Within countries, across asset classes						
All asset classes	0.202	0.179	0.127	0.114	0.261	0.240

Country Tables for the Online Appendix

Table A.1: Correlations between Equities, Bonds, and Foreign Exchange Rates for Emerging Market Countries

The Table reports the sample correlations of excess returns within emerging market countries for equity returns and bond returns, equity returns and foreign exchange returns, and bond returns and foreign exchange returns. The sample period is January 1995 to November 2018.

Country	Corr(Eq,Bond)	Corr(Eq,FX)	Corr(Bond,FX)
AR	0.54	0.33	0.16
BR	0.74	0.72	0.53
CL	0.21	0.67	0.34
CN	0.23	0.14	0.02
CO	0.49	0.58	0.46
CZ	.	0.56	.
EG	0.36	0.29	0.08
HU	0.42	0.59	0.46
ID	.	0.63	.
IN	.	0.62	.
KR	.	0.65	.
MX	0.64	0.70	0.55
MY	0.43	0.57	0.17
PE	0.52	0.33	0.36
PH	0.55	0.60	0.43
PL	0.38	0.66	0.30
RU	0.63	0.52	0.55
TH	.	0.41	.
TR	0.63	0.58	0.55
TW	.	0.59	.
ZA	0.55	0.71	0.45

Table A.2: Model-Implied Relative to Realized Correlations between Equities, Bonds, and Foreign Exchange within EM Countries

The Table reports the ratio of model-implied correlations to sample correlations for excess returns within countries for equity returns and bond returns, equity returns and foreign exchange returns, and bond returns and foreign exchange returns. The implied excess returns are the fitted values from the regression of regional excess returns on the excess returns on U.S. equity, bond, and variance swap markets. The sample period is January 1995 to November 2018.

Country	Corr(Eq,Bond)	Corr(Eq,FX)	Corr(Bond,FX)
AR	0.40	0.06	0.18
BR	0.36	0.30	0.30
CL	0.29	0.36	0.47
CN	0.29	0.43	2.71
CO	0.39	0.25	0.48
CZ	.	0.24	.
EG	0.27	0.04	0.42
HU	0.49	0.40	0.40
ID	.	0.12	.
IN	.	0.28	.
KR	.	0.32	.
MX	0.45	0.49	0.40
MY	0.22	0.18	0.51
PE	0.42	0.34	0.36
PH	0.39	0.17	0.25
PL	0.51	0.44	0.71
RU	0.29	0.26	0.16
TH	.	0.26	.
TR	0.36	0.28	0.36
TW	.	0.38	.
ZA	0.48	0.32	0.46

Table A.3: Correlations between Equities, Bonds, and Foreign Exchange within DM Countries

The Table reports the sample correlations of excess returns within developed market countries for equity returns and bond returns, equity returns and foreign exchange returns, and bond returns and foreign exchange returns. The sample period is January 1995 to November 2018.

Country	Corr(Eq,Bond)	Corr(Eq,FX)	Corr(Bond,FX)
AT	0.45	0.54	0.92
AU	0.76	0.81	0.94
BE	0.44	0.48	0.90
CA	0.69	0.75	0.88
CH	0.39	0.44	0.95
DE	0.27	0.40	0.92
DK	0.33	.	.
ES	0.52	0.49	0.89
FI	0.22	0.26	0.92
FR	0.38	0.47	0.91
GB	0.38	0.51	0.78
GR	0.55	0.43	0.70
HK	0.37	.	.
IE	0.28	0.33	0.81
IT	0.53	0.43	0.84
JP	0.20	0.27	0.96
NL	0.33	0.43	0.92
NO	0.59	0.63	0.94
NZ	0.72	0.73	0.95
PT	0.48	0.51	0.77
SE	0.45	0.53	0.92
SG	0.42	0.63	0.83

Table A.4: Model-Implied Relative to Realized Correlations between Equities, Bonds, and Exchange Rates within DM Countries

The Table reports the ratio of model-implied correlations to sample correlations for excess returns within countries for equity returns and bond returns, equity returns and foreign exchange returns, and bond returns and foreign exchange returns. The implied excess returns are the fitted values from the regression of regional excess returns on the excess returns on U.S. equity, bond, and variance swap markets. The sample period is January 1995 to November 2018.

Country	Corr(Eq,Bond)	Corr(Eq,FX)	Corr(Bond,FX)
AT	0.25	0.30	0.14
AU	0.50	0.51	0.34
BE	0.38	0.41	0.14
CA	0.58	0.58	0.32
CH	0.02	0.11	0.09
DE	0.28	0.41	0.13
DK	0.48	.	.
ES	0.26	0.33	0.13
FI	0.43	0.53	0.14
FR	0.26	0.37	0.14
GB	0.27	0.38	0.06
GR	0.30	0.28	0.14
HK	0.71	.	.
IE	0.39	0.47	0.15
IT	0.29	0.36	0.15
JP	-0.25	-0.15	0.12
NL	0.31	0.41	0.14
NO	0.36	0.39	0.15
NZ	0.37	0.40	0.25
PT	0.23	0.27	0.12
SE	0.51	0.56	0.20
SG	0.39	0.41	0.23

Table A.5: Emerging Equity Market Returns Priced by Their Exposures to U.S. Equity Market, Bond Market and Variance Risk

The Table reports regressions of emerging market country excess equity returns denominated in U.S. dollars on the risk factors from the U.S. equity, bond, and variance markets:

$$r^e_{i,t} = \alpha_i + \beta_{i,1} r^e_{US,t} + \beta_{i,2} r^b_{US,t} + \beta_{i,3} r^{vs}_{US,t} + \varepsilon_{i,t}$$

The sample period is January 1995 to November 2018.

Country		$r^e_{US,t}$	$r^b_{US,t}$	$r^{vs}_{US,t}$	Constant	N	Adj R2
AR	coef	0.82***	-0.24	-7.74***	-0.086	255	0.227
	t-stat	[4.51]	[-0.45]	[-4.40]	[-1.04]		
BR	coef	1.27***	-0.70	-5.52***	-0.060	255	0.410
	t-stat	[7.57]	[-1.65]	[-3.53]	[-0.89]		
CL	coef	0.66***	-0.50	-3.90***	-0.041	255	0.351
	t-stat	[5.22]	[-1.65]	[-4.26]	[-0.99]		
CN	coef	1.05***	-0.25	-1.57	-0.069	255	0.256
	t-stat	[7.27]	[-0.54]	[-1.15]	[-1.13]		
CO	coef	0.49***	-0.36	-4.67***	0.0052	255	0.137
	t-stat	[3.55]	[-0.90]	[-3.48]	[0.080]		
CZ	coef	0.65***	0.011	-4.47***	-0.021	255	0.226
	t-stat	[3.92]	[0.027]	[-3.42]	[-0.37]		
EG	coef	0.56***	0.48	-5.42***	-0.0076	255	0.163
	t-stat	[4.32]	[1.15]	[-3.78]	[-0.12]		
HU	coef	1.30***	0.015	-5.78***	-0.058	255	0.406
	t-stat	[7.34]	[0.037]	[-3.29]	[-0.87]		
ID	coef	1.00***	0.71	-6.06***	-0.12	255	0.194
	t-stat	[4.85]	[1.18]	[-2.88]	[-1.48]		
IL	coef	0.72***	-0.54**	-2.18**	0.0080	255	0.332
	t-stat	[5.95]	[-2.03]	[-1.98]	[0.20]		
IN	coef	0.63***	-0.28	-5.94***	-0.048	255	0.256
	t-stat	[4.65]	[-0.82]	[-5.55]	[-0.84]		
JO	coef	0.070	-0.16	-3.72***	-0.047	255	0.076
	t-stat	[0.90]	[-0.51]	[-3.53]	[-1.14]		
KR	coef	1.12***	-0.68*	-2.71*	-0.038	255	0.285
	t-stat	[9.04]	[-1.72]	[-1.81]	[-0.61]		
MA	coef	0.077	0.090	-3.04***	0.010	255	0.052
	t-stat	[0.66]	[0.32]	[-2.77]	[0.24]		
MX	coef	1.13***	-0.28	-3.14***	-0.012	255	0.486
	t-stat	[9.67]	[-0.84]	[-3.23]	[-0.28]		
MY	coef	0.62***	-0.52	-2.07*	-0.030	255	0.168
	t-stat	[3.90]	[-1.37]	[-1.77]	[-0.54]		
PE	coef	0.59***	0.64	-5.92***	-0.031	255	0.205
	t-stat	[3.39]	[1.34]	[-3.16]	[-0.49]		
PH	coef	0.79***	-0.091	-2.56*	-0.071	255	0.222
	t-stat	[4.87]	[-0.22]	[-1.90]	[-1.28]		
PK	coef	0.40**	-0.41	0.97	0.033	255	0.015

Country		$r^{e}_{US,t}$	$r^{b}_{US,t}$	$r^{vs}_{US,t}$	Constant	N	Adj R2
	t-stat	[2.07]	[-0.54]	[0.42]	[0.47]		
PL	coef	1.23***	-0.14	-3.78***	-0.073	255	0.370
	t-stat	[7.05]	[-0.32]	[-2.85]	[-1.19]		
RU	coef	1.48***	-1.08	-4.32**	-0.018	255	0.258
	t-stat	[4.79]	[-1.38]	[-2.14]	[-0.20]		
TH	coef	1.07***	0.84**	-4.98***	-0.15**	255	0.263
	t-stat	[6.24]	[1.97]	[-3.16]	[-2.26]		
TR	coef	1.54***	-0.99	-1.70	0.0037	255	0.265
	t-stat	[6.02]	[-1.47]	[-0.81]	[0.039]		
TW	coef	0.78***	-0.76**	-3.94**	-0.066	255	0.345
	t-stat	[6.65]	[-2.48]	[-2.45]	[-1.23]		
ZA	coef	0.92***	0.23	-3.97***	-0.057	255	0.377
	t-stat	[6.93]	[0.66]	[-3.78]	[-1.20]		

Table A.6: Emerging Equity Markets Exposure to U.S. Equity Market, Bond Market and Variance Risk (Local Currency Returns)

The Table reports regressions of emerging market country excess equity returns denominated in local currency on the risk factors from the U.S. equity, bond, and variance markets:

$$r_{i,t}^{e,LC} = \alpha_i + \beta_{i,1} r_{US,t}^{e} + \beta_{i,2} r_{US,t}^{b} + \beta_{i,3} r_{US,t}^{vs} + \varepsilon_{i,t}$$

The sample period is January 1995 to November 2018.

Country		$r_{US,t}^{e}$	$r_{US,t}^{b}$	$r_{US,t}^{vs}$	Constant	N	Adj R2
AR	coef	0.74***	-0.55	-7.49***	-0.14*	287	0.200
	t-stat	[4.20]	[-1.16]	[-5.23]	[-1.91]		
BR	coef	0.87***	-0.46	-3.15***	-0.079	287	0.331
	t-stat	[6.02]	[-1.37]	[-3.35]	[-1.65]		
CL	coef	0.47***	-0.57**	-1.36*	0.0023	287	0.233
	t-stat	[4.23]	[-2.55]	[-1.76]	[0.070]		
CN	coef	1.09***	-0.11	-1.56	-0.065	258	0.280
	t-stat	[7.48]	[-0.25]	[-1.14]	[-1.13]		
CO	coef	0.23*	-0.38	-3.23**	0.012	287	0.062
	t-stat	[1.83]	[-1.23]	[-2.24]	[0.23]		
CZ	coef	0.51***	-0.26	-2.87**	-0.0080	287	0.183
	t-stat	[3.83]	[-0.77]	[-2.26]	[-0.18]		
EG	coef	0.51***	0.25	-5.64***	-0.026	287	0.145
	t-stat	[3.79]	[0.57]	[-4.13]	[-0.43]		
HU	coef	1.03***	-0.38	-3.71**	-0.034	287	0.353
	t-stat	[6.87]	[-1.25]	[-2.56]	[-0.65]		
ID	coef	0.81***	0.75	-3.69**	-0.089	287	0.196
	t-stat	[4.26]	[1.52]	[-2.24]	[-1.60]		
IL	coef	0.58***	-0.43*	-1.87*	-0.020	287	0.250
	t-stat	[4.84]	[-1.72]	[-1.67]	[-0.55]		
IN	coef	0.51***	-0.26	-5.21***	-0.053	287	0.238
	t-stat	[4.33]	[-0.91]	[-5.71]	[-1.18]		
JO	coef	0.073	-0.22	-3.59***	-0.059	287	0.073
	t-stat	[0.96]	[-0.72]	[-3.27]	[-1.58]		
KR	coef	0.75***	-0.76**	-2.56**	-0.028	287	0.244
	t-stat	[7.22]	[-2.44]	[-1.98]	[-0.56]		
MA	coef	0.0066	-0.28	-1.65	0.031	287	0.015
	t-stat	[0.065]	[-1.21]	[-1.55]	[0.88]		
MX	coef	0.82***	-0.027	-1.67**	-0.040	287	0.378
	t-stat	[8.79]	[-0.096]	[-2.10]	[-1.14]		
MY	coef	0.54***	-0.12	-2.14**	-0.039	287	0.163
	t-stat	[3.91]	[-0.37]	[-2.00]	[-0.91]		
PE	coef	0.57***	0.60	-5.45***	-0.034	287	0.187
	t-stat	[3.50]	[1.35]	[-2.88]	[-0.60]		
PH	coef	0.71***	0.050	-1.79	-0.072	287	0.221
	t-stat	[5.10]	[0.15]	[-1.45]	[-1.65]		
PK	coef	0.37*	-0.42	1.45	0.017	287	0.012

Country		$r^e_{US,t}$	$r^b_{US,t}$	$r^{vs}_{US,t}$	Constant	N	Adj R2
	t-stat	[1.94]	[-0.59]	[0.65]	[0.29]		
PL	coef	0.91***	-0.38	-1.88*	-0.068	287	0.287
	t-stat	[6.87]	[-1.09]	[-1.72]	[-1.46]		
RU	coef	1.29***	-1.06	-4.03**	-0.12	287	0.215
	t-stat	[4.01]	[-1.46]	[-1.99]	[-1.46]		
TH	coef	0.90***	0.76**	-4.68***	-0.13**	287	0.246
	t-stat	[5.80]	[1.98]	[-3.63]	[-2.32]		
TR	coef	1.18***	-1.07*	0.39	-0.057	287	0.197
	t-stat	[5.28]	[-1.81]	[0.22]	[-0.73]		
ZA	coef	0.65***	-0.021	-1.07	-0.025	286	0.287
	t-stat	[5.90]	[-0.086]	[-1.26]	[-0.75]		

Table A.7: Emerging Bond Markets Exposure to U.S. Equity Markets, Bond Markets and Variance Risk

The Table reports regressions of emerging market country excess bond returns denominated in U.S. dollars on the risk factors from the U.S. equity, bond, and variance markets:

$$r^b_{i,t} = \alpha_i + \beta_{i,1} r^e_{US,t} + \beta_{i,2} r^b_{US,t} + \beta_{i,3} r^{vs}_{US,t} + \varepsilon_{i,t}$$

The sample period is January 1995 to November 2018.

Country		$r^e_{US,t}$	$r^b_{US,t}$	$r^{vs}_{US,t}$	Constant	N	Adj R2
AR	coef	0.49***	0.72	-7.70***	-0.10*	287	0.241
	t-stat	[3.66]	[1.33]	[-2.98]	[-1.68]		
BR	coef	0.52***	0.65***	-1.60	0.022	287	0.237
	t-stat	[4.17]	[2.65]	[-1.27]	[0.64]		
CI	coef	0.82*	0.99	0.75	-0.010	247	0.064
	t-stat	[1.86]	[1.43]	[0.31]	[-0.12]		
CL	coef	0.086***	1.13***	-1.45***	0.0023	234	0.634
	t-stat	[2.82]	[14.8]	[-5.15]	[0.27]		
CN	coef	0.062**	0.98***	-1.24**	-0.00056	287	0.566
	t-stat	[1.99]	[8.49]	[-2.10]	[-0.052]		
CO	coef	0.32***	0.87***	-2.55***	-0.0018	261	0.354
	t-stat	[3.83]	[4.79]	[-3.71]	[-0.082]		
DO	coef	-0.11	0.43	-9.06***	-0.010	204	0.409
	t-stat	[-0.82]	[1.01]	[-3.26]	[-0.20]		
EC	coef	0.45**	0.63	-12.1***	-0.10	287	0.373
	t-stat	[2.44]	[1.27]	[-3.47]	[-1.42]		
EG	coef	0.11**	0.57***	-0.74*	0.029	208	0.090
	t-stat	[2.14]	[4.56]	[-1.81]	[1.38]		
HR	coef	0.14	-0.27	0.29	0.0073	267	0.017
	t-stat	[1.56]	[-1.04]	[0.39]	[0.36]		
HU	coef	0.10*	0.70***	-2.35	0.0014	238	0.255
	t-stat	[1.92]	[3.71]	[-1.49]	[0.052]		
LB	coef	-0.0086	0.19	-1.92***	0.031*	247	0.126
	t-stat	[-0.24]	[1.43]	[-3.21]	[1.96]		
MX	coef	0.26***	1.07***	-1.75***	0.0041	287	0.404
	t-stat	[4.72]	[8.74]	[-3.66]	[0.25]		
MY	coef	0.12*	0.84***	-1.93***	-0.0054	265	0.227
	t-stat	[1.84]	[4.83]	[-2.64]	[-0.31]		
NG	coef	0.31*	0.60**	-1.10	-0.041	287	0.004
	t-stat	[1.73]	[2.58]	[-0.70]	[-0.44]		
PA	coef	0.30***	0.96***	-3.04***	0.017	287	0.283
	t-stat	[4.08]	[5.22]	[-6.23]	[0.71]		
PE	coef	0.28**	0.90***	-4.09***	0.0084	287	0.260
	t-stat	[2.45]	[4.09]	[-3.88]	[0.27]		
PH	coef	0.21***	0.61***	-2.13***	0.018	287	0.279
	t-stat	[2.70]	[4.88]	[-4.03]	[1.00]		
PK	coef	0.20	0.93	-5.14***	-0.022	209	0.203

Country		$r^e_{US,t}$	$r^b_{US,t}$	$r^{vs}_{US,t}$	Constant	N	Adj R2
	t-stat	[1.14]	[1.42]	[-2.84]	[-0.39]		
PL	coef	0.16***	0.95***	-1.54***	0.010	287	0.333
	t-stat	[3.09]	[8.85]	[-3.20]	[0.65]		
RU	coef	0.74*	0.18	-1.88	0.037	287	0.125
	t-stat	[1.80]	[0.40]	[-1.24]	[0.57]		
SV	coef	0.18*	0.94***	-4.97***	-0.016	199	0.427
	t-stat	[1.70]	[3.08]	[-2.69]	[-0.45]		
TR	coef	0.41***	0.73***	-1.99***	0.0069	269	0.281
	t-stat	[3.90]	[3.36]	[-3.02]	[0.26]		
UA	coef	0.29	0.38	-6.04***	0.021	222	0.208
	t-stat	[1.42]	[0.82]	[-2.64]	[0.41]		
UY	coef	0.53***	1.50***	-4.57**	-0.031	210	0.319
	t-stat	[3.63]	[3.73]	[-2.58]	[-0.70]		
VE	coef	0.53***	0.26	-4.55***	-0.016	287	0.209
	t-stat	[3.30]	[0.76]	[-4.59]	[-0.35]		
ZA	coef	0.14*	0.90***	-2.88***	-0.0072	287	0.372
	t-stat	[1.92]	[6.36]	[-6.55]	[-0.45]		

Table A.8: Emerging FX Markets Exposure to U.S. Equity Market, Bond Market and Variance Risk

The Table reports regressions of emerging market country excess foreign currency returns denominated in U.S. dollars on the risk factors from the U.S. equity, bond, and variance markets:

$$r_{i,t}^{fx} = \alpha_i + \beta_{i,1} r_{US,t}^{e} + \beta_{i,2} r_{US,t}^{b} + \beta_{i,3} r_{US,t}^{vs} + \varepsilon_{i,t}$$

The sample period is January 1995 to November 2018.

Country		$r_{US,t}^{e}$	$r_{US,t}^{b}$	$r_{US,t}^{vs}$	Constant	N	Adj R2
AR	coef	0.012	0.19	-0.83	-0.057	287	-0.006
	t-stat	[0.18]	[0.77]	[-1.36]	[-1.45]		
BR	coef	0.31***	-0.16	-2.60***	0.026	287	0.120
	t-stat	[3.16]	[-0.80]	[-2.61]	[0.69]		
CL	coef	0.18***	0.15	-2.54***	-0.043**	287	0.200
	t-stat	[3.15]	[0.99]	[-3.12]	[-2.00]		
CN	coef	0.029**	0.049	0.11	0.023***	258	0.013
	t-stat	[2.50]	[1.53]	[1.14]	[4.00]		
CO	coef	0.26***	0.12	-1.39*	-0.016	287	0.148
	t-stat	[5.08]	[0.75]	[-1.95]	[-0.64]		
CZ	coef	0.16**	0.37**	-1.53***	-0.013	287	0.085
	t-stat	[2.26]	[1.98]	[-2.91]	[-0.59]		
EG	coef	0.027	0.52	-0.027	-0.0068	287	0.008
	t-stat	[0.62]	[1.10]	[-0.068]	[-0.15]		
HU	coef	0.23***	0.45**	-2.11***	-0.021	287	0.154
	t-stat	[2.93]	[2.12]	[-3.60]	[-0.85]		
ID	coef	0.19	-0.022	-2.29*	-0.025	287	0.022
	t-stat	[1.44]	[-0.077]	[-1.85]	[-0.55]		
IL	coef	0.17***	0.032	-0.34	0.0057	287	0.117
	t-stat	[4.60]	[0.27]	[-0.53]	[0.33]		
IN	coef	0.13***	0.11	-0.70*	0.0049	287	0.110
	t-stat	[4.08]	[1.32]	[-1.85]	[0.35]		
JO	coef	0.0062	0.0019	0.026	0.018***	287	-0.004
	t-stat	[1.22]	[0.16]	[0.60]	[9.31]		
KR	coef	0.37***	0.23	-0.23	-0.018	287	0.149
	t-stat	[6.19]	[1.14]	[-0.25]	[-0.80]		
MA	coef	0.081**	0.36***	-1.25***	-0.014	287	0.108
	t-stat	[2.01]	[3.06]	[-3.49]	[-0.99]		
MX	coef	0.28***	-0.066	-1.95***	-0.0057	287	0.254
	t-stat	[5.38]	[-0.47]	[-3.89]	[-0.27]		
MY	coef	0.16***	0.10	-0.029	-0.017	287	0.062
	t-stat	[3.51]	[0.85]	[-0.085]	[-1.06]		
PE	coef	0.050**	0.089	-0.54***	0.010	287	0.053
	t-stat	[2.13]	[1.53]	[-2.65]	[1.09]		
PH	coef	0.069*	0.016	-0.85**	-0.011	287	0.042
	t-stat	[1.67]	[0.15]	[-2.20]	[-0.77]		
PK	coef	0.055**	0.034	-0.28	-0.0027	287	0.015

Country		$r^{e}_{US,t}$	$r^{b}_{US,t}$	$r^{vs}_{US,t}$	Constant	N	Adj R2
	t-stat	[2.15]	[0.37]	[-0.81]	[-0.21]		
PL	coef	0.33***	0.33*	-2.01***	-0.010	287	0.232
	t-stat	[4.48]	[1.75]	[-4.02]	[-0.43]		
RU	coef	0.31**	-0.39	0.53	0.012	287	0.068
	t-stat	[2.04]	[-1.15]	[0.63]	[0.39]		
TH	coef	0.16**	-0.034	0.040	-0.0038	287	0.039
	t-stat	[2.36]	[-0.18]	[0.089]	[-0.20]		
TR	coef	0.27**	0.29	-2.46***	0.016	287	0.132
	t-stat	[2.49]	[1.49]	[-2.85]	[0.51]		
ZA	coef	0.27***	0.31	-2.70***	-0.043	286	0.148
	t-stat	[3.90]	[1.34]	[-4.58]	[-1.47]		

Table A.9: Developed Equity Markets Exposure to U.S. Equity Market, Bond Market and Variance Risk (USD Returns)

The Table reports regressions of developed market country excess equity returns denominated in U.S. dollars on the risk factors from the U.S. equity, bond, and variance markets:

$$r^e_{i,t} = \alpha_i + \beta_{i,1} r^e_{US,t} + \beta_{i,2} r^b_{US,t} + \beta_{i,3} r^{vs}_{US,t} + \varepsilon_{i,t}$$

The sample period is January 1995 to November 2018.

Country		$r^e_{US,t}$	$r^b_{US,t}$	$r^{vs}_{US,t}$	Constant	N	Adj R2
AT	coef	0.77***	-0.26	-7.02***	-0.10**	287	0.452
	t-stat	[6.02]	[-0.85]	[-4.60]	[-2.56]		
AU	coef	0.83***	0.14	-4.15***	-0.036	287	0.552
	t-stat	[10.5]	[0.72]	[-5.56]	[-1.23]		
BE	coef	0.75***	0.30	-6.42***	-0.082***	287	0.558
	t-stat	[8.29]	[1.39]	[-5.52]	[-2.62]		
CA	coef	0.96***	-0.0082	-2.81***	-0.018	287	0.646
	t-stat	[14.8]	[-0.048]	[-4.49]	[-0.74]		
CH	coef	0.73***	0.089	-1.01	0.012	287	0.476
	t-stat	[10.4]	[0.44]	[-1.26]	[0.50]		
DE	coef	1.11***	-0.38	-2.38**	-0.031	287	0.651
	t-stat	[12.6]	[-1.58]	[-2.50]	[-1.15]		
DK	coef	0.73***	0.17	-4.38***	-0.0049	287	0.514
	t-stat	[10.4]	[0.80]	[-5.52]	[-0.17]		
ES	coef	0.98***	-0.14	-2.87***	-0.020	287	0.479
	t-stat	[11.3]	[-0.50]	[-3.64]	[-0.58]		
FI	coef	1.41***	-0.078	0.22	-0.0013	287	0.446
	t-stat	[9.96]	[-0.22]	[0.13]	[-0.026]		
FR	coef	0.95***	-0.23	-2.33***	-0.021	287	0.626
	t-stat	[14.1]	[-1.12]	[-3.91]	[-0.91]		
GB	coef	0.74***	-0.19	-2.13***	-0.022	287	0.652
	t-stat	[16.3]	[-1.44]	[-4.47]	[-1.17]		
GR	coef	1.00***	-1.18***	-6.26***	-0.19***	287	0.314
	t-stat	[6.33]	[-2.75]	[-4.00]	[-2.93]		
HK	coef	0.89***	0.29	-3.47***	-0.042	287	0.409
	t-stat	[9.77]	[1.09]	[-2.80]	[-1.08]		
IE	coef	0.87***	-0.46**	-3.52***	-0.078**	287	0.518
	t-stat	[11.1]	[-2.30]	[-2.87]	[-2.20]		
IT	coef	0.88***	-0.25	-3.59***	-0.063*	287	0.440
	t-stat	[9.60]	[-0.98]	[-3.94]	[-1.78]		
JP	coef	0.60***	-0.072	-1.38**	-0.056*	287	0.312
	t-stat	[8.68]	[-0.33]	[-2.08]	[-1.96]		
NL	coef	0.94***	-0.27	-2.98***	-0.023	287	0.651
	t-stat	[13.8]	[-1.47]	[-4.13]	[-0.96]		
NO	coef	0.87***	-0.87***	-6.39***	-0.046	287	0.532
	t-stat	[8.79]	[-3.42]	[-5.10]	[-1.17]		
NZ	coef	0.78***	0.42*	-2.74***	-0.039	287	0.359

Country		$r^{e}_{US,t}$	$r^{b}_{US,t}$	$r^{vs}_{US,t}$	Constant	N	Adj R2
	t-stat	[7.81]	[1.75]	[-3.91]	[-1.11]		
PT	coef	0.73***	-0.0049	-2.96***	-0.064*	287	0.331
	t-stat	[7.61]	[-0.018]	[-2.87]	[-1.74]		
SE	coef	1.11***	-0.59**	-3.15***	-0.0056	287	0.605
	t-stat	[11.1]	[-2.33]	[-3.47]	[-0.18]		
SG	coef	0.91***	-0.18	-4.13***	-0.070*	287	0.455
	t-stat	[10.3]	[-0.77]	[-5.05]	[-1.91]		

Table A.10: Developed Equity Markets Exposure to U.S. Equity Market, Bond Market and Variance Risk (Local Currency Returns)

The Table reports regressions of developed market country excess equity returns denominated in local currency on the risk factors from the U.S. equity, bond, and variance markets:

$$r_{i,t}^{e,LC} = \alpha_i + \beta_{i,1} r_{US,t}^{e} + \beta_{i,2} r_{US,t}^{b} + \beta_{i,3} r_{US,t}^{vs} + \varepsilon_{i,t}$$

The sample period is January 1995 to November 2018.

Country		$r_{US,t}^{e}$	$r_{US,t}^{b}$	$r_{US,t}^{vs}$	Constant	N	Adj R2
AT	coef	0.68***	-0.67**	-5.47***	-0.063*	287	0.472
	t-stat	[6.07]	[-2.42]	[-3.98]	[-1.83]		
AU	coef	0.53***	-0.20	-1.17**	0.0033	287	0.480
	t-stat	[11.8]	[-1.56]	[-2.18]	[0.17]		
BE	coef	0.66***	-0.11	-4.87***	-0.042	287	0.519
	t-stat	[7.19]	[-0.49]	[-4.85]	[-1.46]		
CA	coef	0.73***	-0.037	-1.32**	0.0050	287	0.614
	t-stat	[12.4]	[-0.28]	[-2.22]	[0.26]		
CH	coef	0.72***	-0.45**	0.37	0.046**	287	0.517
	t-stat	[11.8]	[-2.57]	[0.61]	[2.19]		
DE	coef	1.02***	-0.79***	-0.83	0.0081	287	0.620
	t-stat	[12.2]	[-3.61]	[-0.76]	[0.29]		
DK	coef	0.64***	-0.25	-2.84***	0.032	287	0.425
	t-stat	[8.33]	[-1.06]	[-3.14]	[1.11]		
ES	coef	0.88***	-0.58**	-1.36*	0.015	287	0.483
	t-stat	[11.1]	[-2.48]	[-1.72]	[0.49]		
FI	coef	1.32***	-0.50	1.77	0.038	287	0.399
	t-stat	[9.39]	[-1.39]	[0.99]	[0.74]		
FR	coef	0.86***	-0.63***	-0.81	0.015	287	0.621
	t-stat	[15.8]	[-3.46]	[-1.19]	[0.71]		
GB	coef	0.67***	-0.16	-0.93	-0.0076	287	0.629
	t-stat	[16.8]	[-1.07]	[-1.18]	[-0.38]		
GR	coef	0.89***	-1.61***	-4.64***	-0.16***	287	0.299
	t-stat	[6.06]	[-4.06]	[-3.08]	[-2.65]		
HK	coef	0.89***	0.28	-3.53***	-0.045	287	0.409
	t-stat	[9.86]	[1.05]	[-2.83]	[-1.14]		
IE	coef	0.77***	-0.89***	-2.02	-0.043	287	0.444
	t-stat	[9.71]	[-3.84]	[-1.53]	[-1.20]		
IT	coef	0.77***	-0.67***	-2.08**	-0.032	287	0.422
	t-stat	[9.78]	[-2.95]	[-2.07]	[-0.97]		
JP	coef	0.52***	-0.79***	-2.72***	-0.023	287	0.375
	t-stat	[7.90]	[-3.79]	[-3.98]	[-0.77]		
NL	coef	0.85***	-0.68***	-1.43*	0.017	287	0.609
	t-stat	[12.1]	[-3.34]	[-1.88]	[0.74]		
NO	coef	0.74***	-1.05***	-4.02***	-0.0086	287	0.548
	t-stat	[9.35]	[-4.92]	[-3.94]	[-0.28]		
NZ	coef	0.46***	-0.024	-0.81	-0.019	287	0.221

Country		$r^e_{US,t}$	$r^b_{US,t}$	$r^{vs}_{US,t}$	Constant	N	Adj R2
	t-stat	[5.38]	[-0.12]	[-1.40]	[-0.68]		
PT	coef	0.64***	-0.42*	-1.43	-0.030	287	0.311
	t-stat	[6.99]	[-1.74]	[-1.63]	[-0.93]		
SE	coef	0.87***	-0.96***	-1.76*	0.041	287	0.522
	t-stat	[8.27]	[-3.67]	[-1.76]	[1.44]		
SG	coef	0.75***	-0.40*	-3.92***	-0.049	287	0.453
	t-stat	[10.1]	[-1.83]	[-5.57]	[-1.50]		

Table A.11: Developed Bond Markets Exposure to U.S. Equity Markets, Bond Markets and Variance Risk

The Table reports regressions of developed market country excess bond returns denominated in U.S. dollars on the risk factors from the U.S. equity, bond, and variance markets:

$$r^b_{i,t} = \alpha_i + \beta_{i,1} r^e_{US,t} + \beta_{i,2} r^b_{US,t} + \beta_{i,3} r^{vs}_{US,t} + \varepsilon_{i,t}$$

The sample period is January 1995 to November 2018.

Country		$r^e_{US,t}$	$r^b_{US,t}$	$r^{vs}_{US,t}$	Constant	N	Adj R2
AT	coef	0.098*	1.04***	-1.56***	-0.025	287	0.214
	t-stat	[1.94]	[7.06]	[-3.72]	[-1.39]		
AU	coef	0.31***	0.97***	-2.65***	-0.032*	287	0.362
	t-stat	[5.91]	[7.27]	[-5.95]	[-1.66]		
BE	coef	0.10**	1.04***	-1.51***	-0.021	287	0.206
	t-stat	[2.04]	[7.10]	[-3.92]	[-1.16]		
CA	coef	0.25***	0.80***	-1.69***	-0.018	287	0.398
	t-stat	[8.40]	[8.46]	[-3.95]	[-1.25]		
CH	coef	-0.020	0.94***	-1.58***	-0.018	287	0.131
	t-stat	[-0.34]	[5.28]	[-2.93]	[-0.88]		
DE	coef	0.075	1.02***	-1.45***	-0.025	287	0.205
	t-stat	[1.52]	[6.97]	[-3.84]	[-1.43]		
DK	coef	0.091**	1.11***	-1.78***	-0.023	287	0.265
	t-stat	[1.97]	[7.58]	[-4.36]	[-1.39]		
ES	coef	0.17***	0.95***	-1.16**	-0.011	287	0.154
	t-stat	[2.72]	[5.65]	[-2.28]	[-0.50]		
FI	coef	0.093*	0.96***	-1.55***	-0.020	287	0.193
	t-stat	[1.89]	[6.67]	[-4.07]	[-1.16]		
FR	coef	0.093*	1.05***	-1.44***	-0.020	287	0.214
	t-stat	[1.88]	[7.22]	[-3.73]	[-1.15]		
GB	coef	0.073*	0.90***	-1.38***	-0.011	287	0.207
	t-stat	[1.87]	[7.58]	[-3.03]	[-0.68]		
GR	coef	0.45***	0.56**	-0.50	0.017	214	0.107
	t-stat	[3.67]	[2.04]	[-0.57]	[0.41]		
HK	coef	0.067*	0.89***	-2.51***	-0.00055	214	0.631
	t-stat	[1.92]	[8.40]	[-4.96]	[-0.050]		
IE	coef	0.20***	1.13***	-0.85	-0.012	287	0.181
	t-stat	[3.10]	[6.31]	[-0.97]	[-0.49]		
IT	coef	0.17***	0.88***	-1.44***	-0.012	287	0.154
	t-stat	[3.03]	[5.60]	[-2.99]	[-0.56]		
JP	coef	0.068	0.92***	1.23	-0.014	287	0.120
	t-stat	[1.22]	[5.93]	[1.48]	[-0.62]		
NL	coef	0.087*	1.05***	-1.56***	-0.025	287	0.220
	t-stat	[1.75]	[7.24]	[-4.01]	[-1.42]		

Country		$r^{e}_{US,t}$	$r^{b}_{US,t}$	$r^{vs}_{US,t}$	Constant	N	Adj R2
NO	coef	0.16***	0.63***	-2.09***	-0.030	287	0.165
	t-stat	[2.79]	[4.11]	[-4.72]	[-1.47]		
NZ	coef	0.31***	0.94***	-1.97***	-0.016	287	0.259
	t-stat	[5.04]	[5.61]	[-4.07]	[-0.75]		
PT	coef	0.18***	0.76***	-0.79	0.0017	287	0.080
	t-stat	[2.67]	[4.05]	[-1.10]	[0.063]		
SE	coef	0.26***	0.96***	-0.96**	-0.023	287	0.245
	t-stat	[5.19]	[7.24]	[-2.37]	[-1.25]		
SG	coef	0.17***	0.85***	-0.37	0.0050	214	0.399
	t-stat	[5.06]	[11.9]	[-1.38]	[0.47]		

Table A.12: Developed FX Markets Exposure to U.S. Equity Markets, Bond Markets and Variance Risk

The Table reports regressions of developed market country excess bond returns denominated in U.S. dollars on the risk factors from the U.S. equity, bond, and variance markets:

$$r^b_{i,t} = \alpha_i + \beta_{i,1} r^e_{US,t} + \beta_{i,2} r^b_{US,t} + \beta_{i,3} r^{vs}_{US,t} + \varepsilon_{i,t}$$

The sample period is January 1995 to November 2018.

Country		$r^e_{US,t}$	$r^b_{US,t}$	$r^{vs}_{US,t}$	Constant	N	Adj R2
AT	coef	0.10*	0.43***	-1.50***	-0.039**	286	0.089
	t-stat	[1.90]	[2.78]	[-3.34]	[-2.14]		
AU	coef	0.31***	0.36**	-2.84***	-0.038*	287	0.316
	t-stat	[5.58]	[2.39]	[-6.27]	[-1.89]		
BE	coef	0.10*	0.43***	-1.50***	-0.039**	286	0.089
	t-stat	[1.90]	[2.79]	[-3.33]	[-2.14]		
CA	coef	0.25***	0.057	-1.27**	-0.022	287	0.285
	t-stat	[7.82]	[0.51]	[-2.13]	[-1.34]		
CH	coef	0.016	0.53***	-1.26**	-0.032	287	0.051
	t-stat	[0.28]	[2.99]	[-2.13]	[-1.59]		
DE	coef	0.095*	0.43***	-1.51***	-0.040**	287	0.084
	t-stat	[1.76]	[2.75]	[-3.33]	[-2.14]		
DK	coef	0.095*	0.43***	-1.50***	-0.037**	287	0.085
	t-stat	[1.77]	[2.81]	[-3.43]	[-2.00]		
ES	coef	0.10*	0.43***	-1.49***	-0.035*	286	0.091
	t-stat	[1.97]	[2.82]	[-3.30]	[-1.90]		
FI	coef	0.10*	0.43***	-1.50***	-0.039**	286	0.089
	t-stat	[1.90]	[2.79]	[-3.32]	[-2.12]		
FR	coef	0.10*	0.43***	-1.49***	-0.038**	286	0.089
	t-stat	[1.92]	[2.80]	[-3.31]	[-2.09]		
GB	coef	0.065	-0.015	-1.27**	-0.016	287	0.061
	t-stat	[1.61]	[-0.11]	[-2.25]	[-0.91]		
GR	coef	0.11**	0.45***	-1.54***	-0.022	286	0.102
	t-stat	[2.10]	[2.95]	[-3.52]	[-1.23]		
HK	coef	0.0022	0.013	0.062	0.0025*	287	0.012
	t-stat	[0.56]	[1.57]	[1.38]	[1.87]		
IE	coef	0.10*	0.43***	-1.50***	-0.036**	286	0.091
	t-stat	[1.93]	[2.82]	[-3.36]	[-1.98]		
IT	coef	0.10**	0.43***	-1.49***	-0.033*	286	0.092
	t-stat	[1.99]	[2.84]	[-3.31]	[-1.81]		
JP	coef	0.067	0.73***	1.25	-0.034	287	0.085
	t-stat	[1.20]	[4.91]	[1.59]	[-1.55]		
NL	coef	0.10*	0.43***	-1.50***	-0.040**	286	0.088
	t-stat	[1.89]	[2.78]	[-3.33]	[-2.16]		
NO	coef	0.13**	0.21	-2.36***	-0.038*	287	0.132
	t-stat	[2.38]	[1.52]	[-5.14]	[-1.87]		
NZ	coef	0.31***	0.40**	-2.01***	-0.019	287	0.229

Country		$r^e_{US,t}$	$r^b_{US,t}$	$r^{vs}_{US,t}$	Constant	N	Adj R2
	t-stat	[4.68]	[2.25]	[-3.88]	[-0.86]		
PT	coef	0.10**	0.43***	-1.49***	-0.035*	286	0.091
	t-stat	[1.98]	[2.84]	[-3.30]	[-1.89]		
SE	coef	0.25***	0.38***	-1.39***	-0.047**	287	0.172
	t-stat	[4.16]	[2.73]	[-3.06]	[-2.37]		
SG	coef	0.16***	0.24***	-0.21	-0.022**	287	0.173
	t-stat	[5.26]	[2.65]	[-0.70]	[-2.19]		