Stock-Bond Dynamics and the Cross-section of Country Stock Returns*

Sungjune Pyun

National University of Singapore

June 2022

ABSTRACT

This paper demonstrates that countries with a positive relationship between stock and bond returns (SB relationship) have higher future stock market returns. The stock markets of these countries outperform by 6%–8% per year and remain robust after controlling for global yields, well-known return predictors, and standard macroeconomic variables. The decomposition of countries with a positive SB relationship is time-varying. Uncertainty risk that is specific to the country or region dominates global risk in these countries. The evidence suggests that country-specific variance risk is priced across international stock markets.

Keywords: Stock-bond correlation, country stock market, variance risk

*I thank Jennie Bai, Jaewon Choi, Young-ho Eom, Dimas Fazio, Amit Goyal, Allaudeen Hameed, Jaehoon Han, Claire Yurong Hong, Dashan Huang, Chris Jones, Heungju Park, Andrew Rose, Sergei Sarkissian, Johan Sulaeman, Sheridan Titman, and seminar and session participants at SKK University, Yonsei University, the APAD meetings, NUS-PKU International Conference on Quantitative Finance and Economics, and World Symposium on Investment Research for the comments. All errors are my own. Email: `sjpyun@nus.edu.sg`

I. Introduction

While international investors have a substantial bias towards home equity holdings (French and Poterba 1991), foreign equity and bond investments have also increased substantially.[1] In particular, with recent advancements in international exchange-traded funds (ETFs) and passive mutual funds, macroeconomic investments focusing on the global market cycles have become more popular. These strategies count on understanding how country-specific and global risk factors derive the returns of the two major asset classes – bonds and stocks. Therefore, it is natural to expect that the dynamics of these two asset classes have implications for the equity risk premium.

This paper focuses on the cross-section of country stock returns and studies how the dynamics of stock and bond returns affect the country's stock market performance. Equity investments in countries whose stock and bond prices move in opposite directions are safer since the two asset classes will hedge against each other. Figure 1 illustrates the value of the investments when one US Dollar is invested in 1999 to a set of equity markets whose stock prices react most positively to changes in bond prices (proxied by the negative of yield changes) and those that react most negatively. At the end of 2021, the portfolio invested in countries with a positive stock-bond (SB) beta is 7.45 dollars, higher than 1.70 dollars if invested in countries with a negative SB relationship.[2] Moreover, the figure shows that the stock markets of countries with positive SB relationships are much more volatile.

This paper demonstrates that countries with a more positive SB beta have higher uncertainty risk specific to the country. It is well-known that higher uncertainty is associated with

[1]For example, during 1994–2019, foreign portfolio investment in US equity holdings increased at the rate of 12.1% per year while the market capitalization of the US stock market rose by 7.2% per year. During 2003–2019, US equity investment in a foreign country increased by 8.9% per year. During the same period, the market capitalization of the global equity market, excluding the US, has risen by 6.4% per year. Data from the US Treasury International Capital system, Worldbank, and the US Federal Reserve is used to calculate these numbers.

[2]A positive (negative) SB relationship refers to the positive (negative) relationship between the stock market index and sovereign bond returns.

lower stock prices and higher bond prices or lower bond yields, which implies bonds will hedge uncertainty risk embedded in the stock market. In an open economy, where firms produce intermediate or final goods or services to be sold internationally, stocks and bonds have asymmetric exposure to global and local shocks. Therefore, when local uncertainty risk is low, bonds will hedge global uncertainty risk, to which stocks have high exposure. However, as local uncertainty risk increases, bonds no longer hedge global uncertainty risk well, leading to a more positive SB beta. Since global and local uncertainty risk is priced in the global stock market, equity investments in countries with a positive SB beta require a higher risk premium.

Empirically, equity investments in countries whose stock markets respond more negatively to changes in sovereign bond yields (i.e., countries with positive SB relationships) have 6.4% – 7.1% higher returns than negative ones. The return difference remains significant, accounting for currency effects or sovereign default risk. Moreover, it is robust when the relationship is measured after controlling for variation in global bond yields and the global beta of the international capital asset pricing model (ICAPM, Adler and Dumas 1983). The stock market's exposure to sovereign credit risk does not drive the significance.

The risk premia of the equity investment embedded in the SB betas are time-varying. When future stock returns are regressed on the rolling-window SB beta estimates and their time-series average simultaneously, only the rolling-window beta remains significant. Moreover, the cross-sectional regression results show that the SB beta has strong positive predictive power on future stock market returns after controlling for standard macroeconomic variables, the nominal-real covariance, measures of illiquidity, and standard return predictors of international stock market returns.

The data confirms that the time-varying SB relationship is governed by the dominance of country-specific uncertainty risk. The analysis shows that stocks and bonds have asymmetric exposures to local and global risk. When comparing correlations of bond and stock returns across continents, there is a substantial difference in the stock and bond correlations across the region. While stock returns are highly correlated around the world, regardless of their geographical location, bond returns are highly correlated only when they are in neighboring areas.

Moreover, the analysis shows that the SB relationship is higher with more local uncertainty risk. A panel study indicates that the SB relationship, measured as the beta and correlation, is higher when there is more local uncertainty risk. The patterns remain robust to alternative measures of local uncertainty risk, measured by the idiosyncratic volatility of stock market variance from a stochastic volatility model, from intraday trading data, or by the volatility of bond yields. Finally, I show that a high amount of variance risk specific to the country is also priced in the cross-section of country stock returns.

A long-run-risk-based model that builds on Bansal and Yaron (2004) demonstrates the time-varying SB relationship to the dominance of country-specific uncertainty risk. In the model, shocks to "local" consumption growth are decomposed into two components, namely "global" and "country-specific," which are assumed to be uncorrelated. In this economy, sovereign bond yields are determined entirely by the moments of local consumption growth. A unique assumption of the model is that dividend growth depends heavily on global consumption. One intuition consistent with this assumption is that firms produce intermediate goods to be consumed globally.

In standard long-run risk models, two state variables determine bond yields – expected consumption growth and consumption variance. In the standard model, an increase in expected growth or a decrease in variance leads to higher yields. However, shocks to these state variables have conflicting effects on stock prices. Expected growth shocks increase stock prices by increasing expected dividends, but the increase in the discount rate partially offsets the increase. Similarly, positive variance shocks reduce stock prices as the risk premium increases but are partially offset by the lower discount rate. In standard models, the conflicting effects are minor.

In an open economy, stock prices are asymmetrically affected by the two conflicting effects. Since dividends are heavily exposed to global shocks, expected dividends are mainly affected by global shocks. Also, since global factors largely determine the volatility of stock returns, the risk premium will increase more when the volatility of the global component of shocks increases. Therefore, without local shocks, the SB relationship will be almost perfectly negative. However, since the discount rate – the rate that also determines bond yields – is influenced by local shocks, the SB dynamics will be determined by the relative size of the local variance risk. The SB relationship will be more positive when country-specific variance risk dominates.

Moreover, diversifying country-specific uncertainty risk is not simple, even for global investors due to the positive correlation between currency and stock values generated by local uncertainty risk. A higher country-specific variance lowers bond yields and stock prices. If the uncovered interest rate parity (UIRP) holds, as implied in this model, an increase in the country-specific variance also lowers the currency value. Therefore, international equity investments in countries with high country-specific variance risk will become riskier due to the extra positive relationship between currency and equity returns, which is supported empirically by Hau and Rey (2006).

This paper indicates that variance risk specific to the country is the key driver of the international stock market risk premium. Intuitively, whether the equity market dominated by global shocks should have a higher or a lower risk premium is ambiguous. The standard theory such as the ICAPM suggests a higher risk premium for countries that face similar shocks to the world. Bollerslev, Marrone, Xu, and Zhou (2014) and Londono and Xu (2021) also identify global variance risk as an important determinant of the time-varying global risk premium. However, it is also intuitive to expect local factors to be a key driver of the risk premium in the cross-section since global factors, albeit with different sensitivity, should move all stock markets in the same direction. The present work is related to recent works that highlight the importance of local risk factors as determinants of the risk premium (e.g., Bakshi, Carr, and

Wu 2008, Bali and Cakici 2010, Andersen, Fusari, and Todorov 2020) uniquely emphasizing the role of variance risk.

The main contribution of this paper is the empirical cross-country stock market predictability result. Focusing on the emerging market, Bekaert, Harvey, and Lundblad (2007) document the importance of the global liquidity factor in predicting international equity market returns. Hou, Karolyi, and Kho (2011) argue that global momentum is instrumental in explaining international stock returns. In addition, Rapach, Strauss, and Zhou (2013) show a lead-lag relationship between the US and international country stock returns. Cenedese, Payne, Sarno, and Valente (2016) suggest that international stock returns can be reliably predicted using global momentum, country-level term spread, and dividend yields. Bali and Cakici (2010) find that stock market volatility relates to future stock market performance.[3] The present work shows that variance risk, rather than the level of variance, has predictive power of relative stock market performance.

Lastly, this research connects to a large body of studies that link variations in the SB relationship to macroeconomic volatility. In the extant literature, the flight-to-quality perspective prevails, which refers to the phenomenon that the SB relationship becomes more negative when the economy is riskier. For example, using a dynamic equilibrium model, Vayanos (2004) shows that the stock/bond correlation is positive when liquidity is low, which typically coincides with periods characterized by high volatility. Similarly, Connolly, Stivers, and Sun (2005) report a positive predictive relationship between stock market volatility and the SB relationship, whereas Baele, Bekaert, and Inghelbrecht (2010) document the relationship between higher macro uncertainty and the SB relationship. Jones and Pyun (2021) also recently confirm the relationship and show that the relationship should depend on the persistence of shocks. The findings in the present paper suggest that the common global component of volatility captures the flight-to-quality mechanism.

[3]See also, Ferson and Harvey (1993), Bekaert and Hodrick (1992), and Hjalmarsson (2010), among others.

The remainder of the paper is organized as follows: The following section describes the main empirical result on the cross-section of country stock returns. Empirical tests on the channels of the predictability are provided in Section III. Then, Section IV presents a model that supports the observed results. Finally, the article concludes with a discussion of the main findings in Section V.

II. The cross-section of country stock returns

In this section, I present the main empirical findings, explicating the positive link between the time-varying SB relationship and the country's leading stock market returns. I provide evidence that the predictability is driven by the time-varying component of the SB relationship and is not driven by credit risk, inflation, or illiquidity. Moreover, the relationship remains robust after controlling for standard well-known return predictors.

1. Data description

The dataset of the empirical analysis pertains to 30 countries until the end of 2021, selected based on the total stock market capitalization, representativeness within the economic region, and data availability. Fourteen of these countries (Austria, Belgium, Finland, France, Germany, Italy, Netherlands, Norway, Russia, Spain, Sweden, Switzerland, Turkey, and the United Kingdom) are located in Europe. Nine (China, India, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, and Thailand) are from Asia, four (Brazil, Canada, Mexico, and the United States) from America, and two (Australia and New Zealand) are from Oceania. Also, there is one country from Africa (South Africa), respectively. Three G20 countries (Argentina and Saudi Arabia) are excluded from the sample due to the insufficient availability of bond yield data at the daily level. Among the top 20 stock market exchanges, only Iran and Taiwan

Stock Exchange are omitted for the same reason. The details of the data description can be found in Appendix A.

Table I summarizes the sample of this paper, where the means and standard deviations of stock returns, currency returns, and bond yields are reported in Panel A. To ensure a sufficient number of countries have available data at the beginning of the sampling period, the sample based on the total returns index starts in 1999. Those based on the price index commence in 1990. As a result, there are only seven countries at the beginning of the price index sample, which subsequently increases to 21 by 1999. One restriction of the price index sample is that the stock index excludes dividend payments. The main analysis is presented with both the price and the total returns index. In section Section III, I use total returns index to study the performance of the stock markets. To study the drivers of SB betas, I report the results using price index returns. The outputs are not sensitive to this choice qualitatively.

The first set of columns of the panel summarizes the average returns and standard deviations of the country stock index returns. The following two columns are designated for the statistics related to currency returns. During the sample period, emerging markets (e.g., China, India, Indonesia, Mexico, South Africa, and Thailand) have higher returns than those typically classified as developed markets (e.g., countries in the E.U. or Japan). The following two columns describe the mean level of annualized bond yields and the volatility of the first difference in the bond yields. As can be seen from the data and is commonly conjectured, the bond yields and volatility are higher in the emerging market.

2. The cross-section of international stock market returns

For an investor holding local stocks, bonds will hedge the stock position when their prices move in opposite directions. Since bond yields and returns are inversely related, bonds will provide a hedge when a small increase in yields is linked to a large increase in stock prices. To test the link between the SB relationship and future stock market performance, I estimate the SB beta (β^i) as the slope of the regression

$$R^i_{m,t+1} = \alpha^i + \beta^i(-\Delta y^i_{t+1}) + \epsilon^i_{t+1}, \tag{1}$$

where $R^i_{m,t+1}$ is the log stock return of a country index denominated in local currency and Δy^i_{t+1} is the first-difference of the ten-year Treasury bond yield of country i, also in local currency. The "negative" sign is to match the interpretation of the result to the correlation between returns.

The regression slope β^i of (1) is estimated using daily and weekly returns and yields. For stock returns, the total return index and the price index are used separately. While the total return-based index sample is more accurate as the returns include dividends, the sampling period for the price index-based sample is slightly longer. The second to the last column of Table I reports the statistics for the SB daily betas. While in the empirical analysis, the betas are estimated using a rolling window, the betas in this table are estimated once using the entire sample for each country. The statistics provided in this table do not provide any direct insight into the average stock market performance since, as will be shown, the main results of this paper are driven by the time-varying component of the beta.

The cross-sectional correlations of the SB beta with average stock returns, currency returns, and the ICAPM beta[4] are reported in Panel B of Table I. All beta estimates in this table are estimated once using the entire sample. This table shows that the SB beta is positively related to net total stock returns, partially offset by currency returns, which are negatively related to the SB beta. As a result, if converted to a common currency, there is no relationship between average stock returns and the SB beta. The panel also compares the SB beta with the ICAPM beta. According to the ICAPM, investments in countries with a high positive beta should yield unconditionally higher returns. Therefore, if the cross-sectional relationship between the SB

[4]described in the data appendix

beta and stock returns is driven by higher exposure to the global risk factor, one would expect a positive relationship between the two betas. Instead, however, the panel shows that they are negatively related. This result is natural if higher country-specific risk in a county is associated with lower global risk exposure.

One benefit of the empirical estimation of the SB relationship using daily observations is that it improves accuracy by utilizing more observations. Therefore, the availability of high-frequency data is crucial when the relationship between two financial variables is highly time-varying, as explained by Pyun (2019). However, daily estimates may also be subject to microstructure noise, particularly for emerging markets.

Moreover, in international asset pricing, controlling for global price movements is difficult using daily data, as the exchange opening hours vary considerably depending on their geographical location. In this case, lower frequency (i.e., weekly) data may be more accurate. In this empirical analysis, I use daily beta from a 183-calendar day rolling window as a primary measure and supplement the daily measure with the weekly beta estimate that uses a 52-week rolling window. Whenever daily estimates are inappropriate (e.g., when global variables need to be controlled), the weekly beta from a 52-week rolling window will be used as the baseline.

At the end of each month, daily and weekly betas are estimated for each country, and countries are then sorted by the estimates. After that, five index portfolios are formed based on their rankings, and returns for the subsequent month are evaluated. Portfolio 1 contains countries with the most negative SB relationship, and Portfolio 5 includes those with the most positive relationship. Returns are expressed in USD, computed as the sum of the returns in local currency (Returns in local) and currency returns (Currency). The returns reported in USD are also risk-adjusted using the ICAPM as described in the data appendix.

Panel A of Table II lists the results based on the net total index returns, whereas values reported in Panel B are based on the price index returns. For each panel, the results using daily and weekly estimates are provided as a separate subpanel. Overall, these findings are consistent with the hypothesis. Focusing on the first two rows of each subpanel in which USD-based returns are presented, it is evident that investments in countries with a relatively positive SB relationship generate 0.53%–0.94% (6.4%–11.3%) higher subsequent returns compared to those with a negative relationship. Moreover, the difference in returns remains high and statistically significant across all specifications after risk-adjusting returns by the ICAPM.

The last two rows of each panel provide the results after decomposing USD-denominated stock returns into local currency-denominated returns and currency value changes. The return difference between Portfolios 5 and 1 is greater if they are expressed in local currency (0.68%–1.04% per month, 8.2%–12.4% annualized). The currency returns partially offset the difference earned from local stock returns, but most are statistically insignificant.

In estimating the SB betas, the beta may be capturing stock returns' sensitivity to global bond yield changes. Yield changes are highly correlated across countries (e.g., Jotikasthira, Le, and Lundblad 2015, Colacito and Croce 2011). Hence, a high cross-country correlation between yield shocks implies that yield betas may capture the stock market's reaction to particular global shocks.

Therefore, I consider an additional specification where the global yield innovations (and global stock returns in addition to yields) are controlled. The specification is given by

$$R^i_{m,t+1} = \gamma^i_0 + \gamma^i_y(-y^i_{t+1} + y^i_t) + \gamma^i_g \sum_{\forall j}(-y^j_{t+1} + y^j_t) + \gamma^i_{gs} R^*_{m,t+1} + \epsilon^i_{t+1}, \tag{2}$$

where weekly data is used to estimate the regression. Similarly to the main specification, note the negative signs in the yield changes.

The results of this alternative specification are reported in Panel C of Table II. The top part of the panel reports the results when γ^i_{gs} is set to zero, and the bottom part uses the full model. Overall, the results are similar to other panels. Compared to Panel A, the return difference based on both controls is slightly lower at 0.40%–0.53% per month but remains statistically significant. A weaker result is also expected due to possible multicollinearity between local and global yield shocks.

2.1. Default risk

Treasury bonds are subject to sovereign default risk. Moreover, as reported by Pan and Singleton (2008) and Longstaff, Pan, Pedersen, and Singleton (2011), sovereign default risk and the associated risk premium are primarily determined by highly time-varying global factors. Therefore, I examine whether this paper's main return predictability result is due to stock returns reacting to sovereign default risk.

Mathematically, in the absence of any liquidity premium, inflation risk, and double default, it is well known that bond yield can be decomposed as the sum of the risk-free rate and the CDS spread. Any variation in bond yields that is not driven by the default compensation component must hence be due to changes in the risk-free rate. The changes in the bond yield can be represented by

$$\Delta y^i_{t+1} \approx \Delta CDS^i_{t+1} + \Delta RF^i_{t+1}, \tag{3}$$

where CDS^i_{t+1} is the CDS rate and RF^i_{t+1} is the risk-free yield.[5]

Then, I estimate the beta of these two components using the regression

$$R^i_{m,t+1} = \delta^i_0 + \delta^i_1(-\Delta RF^i_{t+1}) + \delta^I_2(-\Delta CDS^i_{t+1}) + \epsilon^i_{t+1}, \tag{4}$$

where $R^i_{m,t+1}$ is the stock return of country i in local currency, and sort the countries by the two beta estimates separately. The negative signs are to match the interpretation to the main

[5] The approximation comes from assuming that

$$\Delta CDS^i_{t+1} \times \Delta RF^i_{t+1} \approx 0.$$

specification, namely the SB beta. Thereafter, portfolios are formed for each of these estimates separately, and returns are evaluated for the subsequent month as in the previous analysis.

Panel D of Table II summarizes the stock returns expressed in USD, the ICAPM risk-adjusted returns, the stock returns expressed in the local currency, and the currency returns of the portfolios. This analysis is based on daily data, and the result for the estimates using weekly data is unreported but very similar.

If default risk is priced in the stock market, stock prices that react most negatively to increased CDS spread (Portfolio 5) should generate higher returns. However, the tabulated findings suggest no evidence thereof – the signs are the opposite of this premise, although the difference is statistically insignificant. In contrast, investments in countries whose stock returns react most negatively to a positive shock in the risk-free bond yield beta (Portfolio 5) have higher returns for the subsequent month, consistent with the main explanation of this paper. These findings suggest that default risk is unlikely to be the source of the main results.

2.2. Evidence of dynamic predictive relationship

The results reported in Table II indicate that the SB betas strongly predict the relative performance of country-level stock market returns. This result compares to Panel B of Table I, which shows no significant unconditional relationship between SB betas and average stock market returns if returns are converted to a common currency. Together, these two results suggest that the SB betas serve as proxies for the time-varying component of the country-level stock market risk premia.

The analyses and discussion in this section have two purposes. Their first is to confirm that the SB betas contain information about the time-varying characteristic of the country-specific equity risk premia. The second objective is to elucidate whether the SB betas are simple proxies of standard macro-economic variables that potentially explain the cross-sectional variation in the equity risk premium.

These two hypotheses are studied using a cross-sectional regression. First, the SB betas are estimated, and the country stock index returns of the leading month are regressed on these estimates in addition to the contemporaneous or lagged values of control variables. Finally, the time-series mean of the regression coefficients and the Fama-MacBeth standard errors are calculated.

I first test whether country-fixed variables (e.g., geographical location) or highly persistent variables (e.g., the degree of development of the economy) can explain the cross-sectional difference in the stock market performance. To test this possibility, I take the time-series average of the beta estimates and use it as a control variable. While the average estimates may contain information about the future, it is a reasonable way to capture fixed characteristics.

Panel A of Table III summarizes the results of the test of this first hypothesis. The first specifications show the regression without any controls and show statistical significance, consistent with the main empirical result reported in Table II. The next regressions control for the time-series average. The coefficient on the time-varying component remains positive and statistically significant, whereas the time-series average coefficient is negative for both the price return and total return-based sample. This evidence strongly suggests that the return predictability of the SB beta is driven by the time-varying rather than the time-constant component.

I also test whether countries that outperform are simply emerging markets or with higher growth potential by incorporating several macroeconomic variables as controls. The variables include the following: the per capita GDP (representing whether the country is in a developed or emerging market economy), the total GDP (representing the size of the country), the country's export share (total export as a fraction of total GDP), the 5-year lagged average growth rate of the country measured using the total GDP, and the inflation rate of the country. Since these characteristics are unlikely to vary much over three decades, the results above already imply that these are not likely to matter. The final set of output in Panel B confirms this prior that economic growth rate, size of the economy, the openness of the economy, or inflation is not driving the predictability.

In Table IV, I repeat the analysis with net total returns. As noted earlier, the sample is shorter in most cases but includes dividends. The results are qualitatively similar to the price index return-based results, but the coefficients of the cross-sectional regression are lower. The difference mainly stems from using a shorter sample period.

One other possibility is that inflation may benefit equity holders by reducing the relative cost of debt. If this is an important channel that drives the relationship between the equity value and bond yields, the stock markets with a relatively high debt-to-equity ratio should benefit most from inflation. Then, to be consistent with the main empirical finding, the stock market in countries with a relatively low debt-to-equity ratio should have a higher risk premium. While it is difficult to rule out this possibility, this implication is against the general intuition that stocks with a high leverage ratio are riskier. Furthermore, since the debt-to-equity ratio tends to be highly persistent, the analysis of Model 2 rules out this possibility.

2.3. The covariance between real growth and inflation

Recent literature suggests that much of the time-variation in the correlation between stock returns in the U.S. are driven by inflation. For example, Campbell, Pflueger, and Viceira (2020) show that the covariance between real output and inflation switches its sign around 2000, which matches when the correlation between stock and bond return switches its sign. (see also David and Veronesi (2014) and Song (2017), among others.) Furthermore, Boons, Duarte, de Roon, and Szymanowska (2020) find that inflation risk is priced among the cross-section of U.S. stock returns. If these two observations were to hold for the cross-section of country stock returns, it is possible that the earlier analysis reported is driven by inflation risk.

This channel is unlikely since countries with a negative SB relationship should require a higher, not a lower, risk premium. To understand this, first, suppose that real growth is a determinant of the stochastic discount factor. If inflation and real growth are positively related, stock markets with high positive exposure to inflation are riskier. These countries have a negative SB relationship since inflation is positively related to yields and negatively related to bond returns. The other possibility is when inflation is positively related to the marginal utility of investors. In this case, stock markets with positive inflation exposure should be riskier. Similar to the above argument, these markets have a more negative SB relationship.

One possibility is when there is priced deflation risk. In this case, stock markets with a positive SB relationship will be riskier as those stock markets will underperform when there is deflationary pressure. The possible significance of inflation risk is tested using inflation, the growth rate in real GDP, and the product of these two variables to proxy the nominal-real covariance. Since a single product should be a noisy measure of the covariance, I also control for the 10-year rolling-window correlation estimate between changes in log GDP and inflation. Then, I replace GDP with real total consumption for robustness.

The results of the cross-sectional regression summarized in Panel B of Table III and Table IV indicate that the main results are unlikely to be driven by the inflation/deflation risk component of sovereign bonds. Most of all, the daily SB remains positive and statistically significant across all specifications, suggesting that the return predictability of SB beta is not driven by the cross-country difference in inflation or nominal-real covariance.

Moreover, the results show that inflation negatively influences future stock market performance, although most are statistically insignificant. Also, in some of the total return-based results, real-nominal covariance is negatively related to future returns. This result may hint that deflation risk may be priced among country stock returns. However, comparing Models 4-7 with Model 1, there is not much difference in the economic significance of the SB beta.

Therefore, it is implausible that deflation risk is the primary driver of the predictability of the SB beta.

2.4. Global market illiquidity

One of the well-known predictors of stock returns in the international context is the exposure to global liquidity factor (Bekaert, Harvey, and Lundblad 2007). Bekaert, Harvey, and Lundblad (2007) show that global stock market illiquidity is a priced factor in the international stock market. Goyenko and Sarkissian (2014) find that the exposure to U.S. Treasury illiquidity is a key driver of international stock returns. Given the significant findings in this literature, it is natural to consider the global illiquidity variables as control variables.

Following Goyenko and Sarkissian (2014), I take the average percentage quoted bid-ask spread of the U.S. treasury with less than 12-month of maturity. Then, the Treasury illiquidity is defined as the residual of the autoregressive model (AR) of order 2 of the measure. Similarly, I follow Bekaert, Harvey, and Lundblad (2007) to calculate the fraction of stocks with zero trading volume and zero returns each day. Finally, I compute the illiquidity measure of Amihud (2002) averaged over the entire stock universe. To be consistent with the Treasury illiquidity measure, I take these measures' AR(2) residual. All variables are at the monthly level.

Stock index returns are regressed on the residuals for the four illiquidity measures separately in addition to the global value-weighted portfolio returns. Then, the slope of this regression is estimated using a rolling window of 60 months. Panel C of Table III and Table IV summarizes the output of the cross-sectional regression using exposures to U.S. illiquidity as control. Overall, the SB beta remains a significant predictor of the cross-section of country stock returns. First, focusing on price index returns, as expected, the three illiquidity measures – Treasury illiquidity, the fraction of zero returns, and the fraction of zero volume stocks– negatively predicts future stock returns. However, the coefficient on the SB beta remains positive and statistically significant. For total returns, after controlling for the SB beta, the coefficients on the three illiquidity measures are no longer negative. In contrast, the SB beta remains statistically significant after the illiquidity controls.

2.5. The relationship to other return predictors

The subsequent analysis investigates the relationship between SB betas and other standard predictors used in the international stock return predictability literature. To answer this question, I consider the return predictors examined by Cenedese, Payne, Sarno, and Valente (2016) as well as Hjalmarsson (2010). They show that country-level dividend yields, term spread, and cross-country momentum are strong predictors of international stock returns.

Following their approach, the dividend yield of each country is estimated annually as the difference between the net total returns and the price returns of the corresponding MSCI index. The term spread is the difference between 10-year yields and one-year yields, and momentum is the average return preceding the measurement time by two to 12 months. The term spread and momentum are estimated every month on the last trading day.

In line with the methodology above, I repeat the cross-sectional analysis using these predictors as control. Since dividend yields are calculated from the total index, only the post-1999 sample is considered in this regression. The first three specifications compare the performance of the SB betas with one additional return predictor in turn, whereas the last one compares the performance with all predictors together.

Panel D of the two tables summarizes the results of this analysis. Overall, the SB beta remains positive and statistically significant for all predictors considered. There is strong evidence that the SB beta outperforms dividend yield, term spread, or momentum. For price index returns, the coefficient on the SB beta is smaller than those results reported in Model 1-3. The main reason is that estimating dividend yields requires the total returns index data.

Since the total return index sample starts in 1999-, the results of Panel D Table III should be compared to Panel A of Table IV rather than those of Table III.

III. What types of equity risk do bonds hedge?

The previous section examines the significance of SB beta as a return predictor for the cross-country stock returns. The analysis shows that the predictability is driven by the time-varying component of the beta and is unrelated to macro variables that are persistent, the exposure to global illiquidity, and standard return predictors such as dividend yields or momentum. Moreover, the predictability is driven neither by default risk nor inflation risk. This section proposes a channel that drives the common variation in the SB relationship and the risk premium.

One possibility is that local uncertainty risk is priced among country stock returns. To understand this channel, consider an uncertainty shock in a closed economy. An uncertainty shock generally leads to lower stock prices and lower bond yields due to increased risk premium in the stock market and precautionary savings motive.

In an open economy, the relationship between stock prices and bond yields could be affected asymmetrically depending on whether shocks are global or local. For example, if a local uncertainty shock affects bonds more than stocks, high local uncertainty risk leads to a more positive SB beta through two channels. When local uncertainty risk is non-existent, bonds will hedge global uncertainty risk that the equity market is heavily exposed to. However, as local uncertainty risk increases, bonds no longer hedge global uncertainty risk well, as bonds will move more due to local uncertainty shocks. Therefore, if local uncertainty risk is priced in the cross-section, we would observe a superior performance for stock markets with a relative positive SB relationship.

This channel relies on two assumptions. First, the equity market is more heavily exposed to global shocks, whereas the bond market depends more on local shocks. There are reasons this may be the case. One possibility is, as evidenced by, for example, Backus, Kehoe, and Kydland (1992), when there is a higher comovement among cross-country output growth than consumption growth. If firms produce goods to be exported, the cross-country correlation between output growth should be higher than consumption growth. Since firms pay dividends from the profits generated, the correlation between stock returns should be higher than between bond yields.

Hypothesis 1. *Stocks are more heavily exposed to global shocks, whereas the bond returns depend more on regional shocks.*

The second assumption is that sovereign bonds should hedge global uncertainty risk in general, but better so when stock and bond returns are negatively related. These are times when local uncertainty risk is relatively low.

Hypothesis 2. *Sovereign bonds should hedge global uncertainty risk in general, but better so when stock and bond returns are negatively related.*

Two testable implications can be derived from the premise. The first implication is that the SB beta or correlation should be more positive when global uncertainty risk dominates. When global uncertainty risk is dominant, stocks and bonds hedge each other. When local uncertainty risk dominates, they do not hedge each other. The second implication is that local uncertainty risk should be priced if correctly measured.

The remainder of this section is devoted to testing these assumptions and implications.

1. Cross-country correlation of stock and bond returns

Evidence shows that a significant fraction of international stock return comovement is driven by a common global factor. Recent research also indicates a large comovement in the interest rate.[6] However, lesser is known about whether stocks or bonds are more correlated across countries. In a consumption-based model, where the local stochastic discount factor determines bond yields and stock returns depend on dividend growth, the Backus-Kehoe-Kydland puzzle almost implies that correlations between global stock returns should be higher than that of bond yields.

Instead of comparing the average level of correlations of all country pairs, this section studies the asymmetric reaction of bonds and stocks to global shocks. Specifically, the analysis of this section questions whether stocks in one region react more to shocks in a different area than bonds. Similarly, this section also studies whether bonds react relatively more to local shocks than stocks.

This hypothesis is tested by first computing the correlations of stock and bond returns for all country pairs, respectively, using the entire sample period. Then, for stocks and bonds separately, I classify each country based on the region and calculate the average of the correlations for countries that belongs to the region pair. If Hypothesis 1 is true, we expect the following to hold. First, the overall average correlation between stock return pairs should be higher than the correlation between bond yield pairs. Second, the difference between stock return correlation and bond yield correlation should be greater if two countries belong to a different region and smaller within the region.

The first panel of Table V shows the average of the correlations of stock returns and bond yields and the difference between the two correlations by region. The first key observation is that stock returns have a higher correlation compared to bonds. The exception is when

[6] See, for example, Bekaert and Harvey (2000), Griffin and Stulz (2001), Bekaert, Harvey, and Ng (2005) and Eiling and Gerard (2015), among others, for globalization and stock returns. See, Jotikasthira, Le, and Lundblad (2015) and Colacito and Croce (2011), for example, for correlation between bond yields.

correlations are computed within the continents of North America (the US and Canada) and Oceania (Australia and New Zealand).

The second observation is that the difference between stock return and bond yield correlations is smaller if countries belong to the same continents. For all continents but Asia, bond yield correlations are comparably higher than stock correlations within the same region. This result suggests that bonds react to local shocks more than stocks, whereas stock return comovement is relatively driven more by global factors.

The final three columns of the table separately summarize the averages after aggregating the countries for each region depending on whether they belong to the same or different regions. Then, a paired t-test is performed based on the difference between the two. Since the sample only includes five regions, the p-value corresponding to the t-distribution of degrees of freedom four is reported. The results confirm some statistical evidence that, compared to stocks, bond return correlations are lower if they belong to the same continent.

Panel B shows the output at the country level. Due to space restrictions, I report only the difference between stock and bond correlations. The patterns are very similar. Compared to bond yields, stock return correlation across countries is much higher if two countries belong to a different continent than when they belong to the same one. The paired t-statistics show that these differences are statistically significant.

In conclusion, Table V confirms the first hypothesis that stocks are more heavily exposed to global shocks, whereas the bond returns depend more on regional shocks.

2. Global consumption growth and dividend growth

Previous analysis suggests bond prices, compared to stocks, are affected relatively more by local shocks. To further understand the driver of the asymmetry, I further investigate the assertion that one of the reasons is related to the dividend growth process being more affected by global shocks compared to consumption shocks.

In a standard consumption-based model, bond yields are entirely determined by the local stochastic discount factor. In contrast, if firms produce intermediate or final goods and services to be exported to profit and pay dividends, dividends will be more exposed to global risk.

The panel regression considered is

$$\Delta d_t^i = \gamma_l \Delta c_t^i + \gamma_g \Delta c_t^* + C_i + T_t + \epsilon_{i,t}, \tag{5}$$

where Δc_t^i and Δd_t^i are annual consumption and dividend growth rates of country i, Δc_t^* is the global consumption growth computed by aggregating all consumption across countries, and and C_i and T_t are country and year fixed effects, respectively. The first panel of Table VI summarizes the results of this regression. The first two columns show the results when local consumption growth is the sole explanatory variable. Consumption and dividend growth are positively related in time series, and the positive relationship disappears when the time-fixed effect is added. The last two columns show the result with both local and global consumption growth. With and without the time-fixed effect, dividend growth responds more to global than local consumption growth shocks.

Panel B further investigates the time-series dynamics for each country. For each country, dividend growth is regressed on local and global consumption growth. The results are similar to what is presented in Panel A. The dividend growth responds more to global than local consumption growth shocks. The average of the adjusted-R^2 of the regression is 0.4. In short, the assumption that dividend growth has a higher exposure to global than local consumption shocks is strongly confirmed in the data.

3. Hedging global uncertainty risk using bonds

The previous two analyses confirm that bond yields are more affected by local shocks, whereas stock returns are much more driven by global shocks. This leads to the main question of this section: What types of risk do sovereign bonds hedge when stock and bond returns are negatively related? With high exposure to global risk for stock returns and stock returns generally being highly correlated with uncertainty risk, bonds may be hedging global uncertainty risk well during times when stock and bond correlations are highly negative. An alternative possibility is that stocks are providing hedge to inflation risk. This section provides several tests to these hypotheses.

To test the hypothesis, I consider the following regression model:

$$\Delta y^i_{t+1} = \delta_0 + \delta_1 \Delta \exp(h^*_{t+1}) + \delta_2 \beta^i \Delta \exp(h^*_{t+1}) + \delta_3 \beta^I + \epsilon^i_{t+1}, \tag{6}$$

Where Δy^i_{t+1} is the first difference in sovereign bond yields for country i, β^i is the SB beta, and $\exp(h^*_{t+1})$ is the variance of stock returns of the global value-weighted index returns estimated using a stochastic volatility model, described in detail in the data appendix. When variance is related to uncertainty, increase in uncertainty should be captured by the increase in the global variance. Also, I consider a specification where the SB beta is replaced by the SB correlation. The SB betas and correlations are estimated as in the main specification but after adopting a 90-calendar-day rolling window, which matches the horizon of the dependent variable.

In this model, sovereign bonds will hedge global uncertainty risk well when an increase in global stock market variance leads to a decrease in bond yields. The goal is to test whether the negative relationship is stronger when the SB beta is negative. If $\delta_2 > 0$, bonds will hedge global uncertainty risk well when stocks and bond prices move in the opposite direction.

Panel A of Table VII summarizes the results of this analysis. In this panel analysis, time-fixed effects are not considered as the goal is to understand how the time-variation in global uncertainty affects bond yields for an average country. The first column suggests no evidence of bonds providing a hedge against global uncertainty risk. One of the reasons may be that expected inflation, which directly relates to changes in bond yields, increases when global uncertainty rises. The following four columns show the coefficients of the interactive regression. As hypothesized, bonds hedge global uncertainty risk better when stock and bond prices move in opposite directions. The results are similar when using the SB correlation instead of the SB betas.

In panel B, I consider the first-order difference of the estimates of real yields as the dependent variable. The first column shows that real yields decrease when global uncertainty increases. The next columns show that real bonds are better hedges of global uncertainty risk when the SB relationship is negative.

These results confirm the second hypothesis that sovereign bonds are better hedges of global uncertainty risk when stock and bond returns are negatively related. In the following subsection, I test for the main implications of the confirmed hypotheses.

Panel C explores an alternative hypothesis, whether stock markets are safer and thus require a lower risk premium since they provide hedges to inflation risk when SB beta is negative. This hypothesis is plausible since nominal bond yields increase when the inflation rate is higher. I consider a panel regression using the annualized contemporaneous changes in the CPI as the dependent variable and stock returns as the independent variable. If stocks provide hedges to inflation risk when SB beta is negative, the relationship between stock returns and inflation should be more positive when the SB beta is negative.

The analysis of panel C rejects this hypothesis. There is little evidence that stocks provide a hedge against inflation. The SB betas tend to be higher with more inflationary pressure, but this relationship disappears as country-fixed effects are added to the regression. This result suggests that, while there is an unconditional cross-sectional relationship between the two, there is no evidence suggesting stocks provide a better or worse hedge to inflation risk depending on the level of the SB beta.

4. SB relationship and local uncertainty risk

The first implication is that high local uncertainty risk should be higher for countries with a more positive SB beta. This subsection tests the validity of this hypothesis. However, estimating the amount of uncertainty risk is not straightforward since uncertainty risk is difficult to measure. Furthermore, decomposing uncertainty that is country-specific versus global is even more challenging. Therefore, I take two different approaches to measure uncertainty risk specific to the country or region.

The first measure is the stochastic volatility model-based measure used in the above analysis. When there is a close connection between economic uncertainty and the volatility of the stock market, a high amount of uncertainty risk should correspond to the volatility of stock market variance. Uncertainty risk specific to the country is proxied by the volatility of variance of the idiosyncratic risk of the country's stock market.

In this stochastic volatility model, the log of stock market variance has constant volatility. In this model, Ito's lemma implies that the volatility of stock market variance is a linear function of the variance. Note that $exp(h_t^i)$ in this model is the variance of the country-specific shocks. The estimate also corresponds to the volatility of country-specific variance.

The second measure uses intraday high-frequency data on the stock market index and applies a regression-based HAR-RV model. I estimate the volatility of variance that comes from the idiosyncratic component of the market variance and use the total volatility of stock market variance to control global uncertainty risk. The limitation is a smaller sample over time (2000 – 2021) and in the cross-section (20 countries). Since these estimates are from a rolling- window, the analysis is out-of-sample. Also, using intraday estimates enables us to estimate variance more accurately and distinguish volatility from the volatility of variance.

The hypothesis is tested using a panel analysis, using SB betas (correlations) as the dependent variable and measures of the amount of global and country-specific uncertainty risk as independent variables. Panel A of Table VIII shows the results using the SB beta as the dependent variable, whereas Panel B is when the correlations are used as the dependent variable.

First, focusing on the first column of Panel A, the SB beta is positively related to the volatility of the stock market variance of the country, controlling for the volatility of the global market variance, which is negatively related to the SB beta. The negative effect on the global volatility of variance weakens in the regression with the time-fixed effect. This outcome is natural since global variables should affect all countries similarly. The last two columns of the panel show the result when the SB beta is regressed on the idiosyncratic volatility of variance, controlling for the total volatility of variance, both of which are estimated using intraday data. The results show that the beta is positively related to the amount of idiosyncratic component of variance risk but negatively related to the global component of variance risk.

Overall, the results using the SB correlation in Panel B are similar. The two panels confirm that higher local uncertainty risk is associated with a positive SB relationship. Conversely, higher global variance is associated with a negative SB return relationship.

5. SB relationship and stock/bond market volatility

The earlier analysis shows that stocks and bonds have asymmetric exposure to local and global risk. When uncertainty shocks are one of the drivers of stock and bond price risk, stock return and bond yield volatility should embed local and global uncertainty information. In particular, controlling for stock return volatility, bond yield volatility should proxy the amount of local uncertainty risk. Similarly, controlling for bond yield volatility, stock return volatility should measure the amount of global uncertainty risk.

This implies that when local volatility is high, the volatility of bond yields will be higher, whereas when global volatility is high, the volatility of stock returns will be higher. From these characteristics, this section examines whether the SB beta or the correlations between stock and bond returns are more positive during periods and countries where local volatility dominates.

Similar to previous analyses, this hypothesis is tested using panel regression with SB betas and SB return correlations as dependent variables while treating country yield and stock volatility as explanatory variables. According to the model implications, the SB return relationship should be more positive if bond yield volatility is higher, controlling for stock market volatility.

Table IX summarizes the panel regression results. Since estimating the volatility of stock returns and bond yields can be done using daily data, I use a shorter estimation window (30 calendar days) for the SB beta (correlation) estimation. The left side of the panel shows the results obtained using the SB beta as the dependent variable. All results show a strong positive relationship between bond yield volatility and the SB beta.

One may think that this outcome is mechanically driven since

$$\beta_d^i = \rho_d^i SD(R_m^i)/SD(\Delta y^i),$$

where R_m^i is the stock return, and Δy^i is the first difference of bond yields. If the correlation ρ_d^i is constant, the SB beta is expected to be higher in magnitude when the stock market volatility is high, and the bond yield volatility is low. Therefore, it may be more appropriate to consider the SB correlation instead as the dependent variable. These are shown on the right side of the table. Overall, the results look similar even when the correlation is modeled as the dependent variable.

The bond yield volatility may seem counter-intuitive given solid empirical evidence, (e.g., Connolly, Stivers, and Sun 2005), commonly known as the flight-to-quality. This hypothesis suggests that when volatility is high, investors become risk averse, and they switch their portfolio holdings from risky stocks to riskless bonds. Therefore, the hypothesis suggests that the SB return correlation will be more negative when volatility is high.

The last two columns of Table IX using the SB return correlation as the dependent variable describe the relationship between the results of this analysis with the flight-to-quality hypothesis. When the time-fixed effect is excluded, stock and bond returns tend to have opposite signs when the stock market variance is high, consistent with the flight-to-quality hypothesis. However, the stock market volatility does not affect the SB return correlation when the time-fixed effect is included. In fact, the sign of the coefficients is positive. There are two implications. First is that the difference in cross-country exposure should not, at least, directly affect the SB correlation through the channels considered here. Second, these results suggest that flight-to-quality is largely driven by global shocks rather than country-specific ones.

In conclusion, these findings strongly suggest that higher volatility in local shocks, proxied by the bond yield volatility, leads to a relatively positive SB return relationship. Conversely, higher global volatility, measured by stock market volatility, leads to a more negative SB return relationship, consistent with the flight-to-quality explanation.

6. Understanding the performance of country stock markets

Finally, this subsection examines if there is any evidence that local uncertainty risk itself is priced in the stock market. To study this plausibility, I repeat the cross-sectional analysis outlined when describing the details of Table III. Since the purpose is to understand the relative performance of cross-country stock returns, I use the sample based on total net returns.

Table X summarizes the results of this regression. Model 1 to 4 uses the bond yield volatility, stock return volatility, the idiosyncratic volatility (Bali and Cakici 2010) of the ICAPM, and the idiosyncratic volatility of variance considered in the previous analysis as return predictors. In this sample considered, there is weak to no evidence of bond yield volatility, stock return volatility, or idiosyncratic volatility being a key determent of the cross-country stock returns, but the idiosyncratic volatility of variance is positively related to country stock returns.

Model 5 to 8 considers the SB beta in addition to these estimates. Among the predictors, the idiosyncratic volatility of variance remains positive and statistically significant. Also, in Model 8, the SB beta is only marginally statistically significant. The SB beta remains positive and statistically significant for all other models considered.

Overall, the results confirm that high country-specific volatility of variance is associated with higher future stock returns. The weaker statistical significance reported for SB beta in Model 8 also suggests that the SB beta may be capturing information about regional uncertainty risk.

IV. The return dynamics in a consumption model

This section provides a stylized consumption-based model consistent with the empirical findings. The SB beta varies due to the relative size of country-specific to global variance risk. If country-specific variance risk is priced in the international stock market, the connection to the stock market risk premium is straightforward.

1. Consumption dynamics and the wealth portfolio

Consider an open economy with one large country and multiple small countries. The large country is referred to as "world" or "global," and the small country as "local." The objective is to compare the SB dynamics and the risk premia of the market portfolio across multiple small countries. As noted above, local refers to a country affected by global and country-specific shocks. Each country has a stochastic discount factor (SDF), represented by recursive preference, as considered by Epstein and Zin (1991) with a risk aversion coefficient of γ and an intertemporal elasticity of substitution coefficient of ψ. Following convention, I let $\theta = \frac{1-\gamma}{1-1/\psi}$. Stocks, bonds, and currency assets are priced by the log of the SDF, which is defined as

$$m_{t+1}^i = \theta \log \beta - \frac{\theta}{\psi} \Delta c_{t+1}^i + (\theta - 1) R_{TW,t+1}^i, \tag{7}$$

where β is the time discount factor, and Δc_{t+1}^i and $R_{TW,t+1}^i$ are the consumption growth and the log returns on the wealth portfolio, respectively for country i denominated in the local currency. The objective is to compare the SB correlation and SB beta across multiple small countries.

The same preference parameters represent the global investor's SDF, except that the global variables with superscript * replace the country-specific variables denoted by superscript i. Superscripts for parameters or variables that are identical across all countries are omitted.

Global consumption growth follows a simple linear process

$$\begin{aligned} \Delta c_{t+1}^* &= \mu + x_t^* + \sqrt{v_t^*} \epsilon_{c,t+1}^* \\ x_{t+1}^* &= \xi_g x_t^* + \sqrt{1-\lambda_x} \varphi_x \sqrt{v_t^*} \epsilon_{x,t+1}^* \\ v_{t+1}^* &= v_{g0} + v_{g1} v_t^* + \sigma_g \sqrt{v_t^*} \epsilon_{v,t+1}^*, \end{aligned} \tag{8}$$

where the volatility of the consumption variance is assumed to depend on consumption volatility, and ϵ_c^*, ϵ_x^*, and ϵ_v^* are correlated standardized random variables. I let ρ_{cv}, ρ_v, and ρ_{cx} be the correlation coefficient between ϵ_c^* and ϵ_v^*, ϵ_x^* and ϵ_v^*, and ϵ_c^* and ϵ_x^*, respectively. $\rho_{cv} \leq 0$ is motivated by the precautionary savings motive, that consumption will be smaller when volatility is higher, consistent with Carroll and Samwick (1998) and Basu and Bundick (2017) and $\rho_v \leq 0$ by Nakamura, Sergeyev, and Steinsson (2017). Finally, ρ_{cx} governs the global average SB correlation, as motivated by Jones and Pyun (2021), but will be set to zero in the baseline model.

The consumption growth of country i also follows a process where the growth shocks can either be country-specific or global. The dynamics are given as

$$\Delta c^i_{t+1} = \mu + x^*_t + x^i_t + \sqrt{v^i_t}\epsilon^i_{c,t+1} + \sqrt{v^*_t}\epsilon^*_{c,t+1} \quad (9)$$

$$x^i_{t+1} = \xi_l x^i_t + \lambda_x \varphi_x \sqrt{v^i_t}\epsilon^i_{x,t}$$

$$v^i_{t+1} = v_{l0} + v_{l1} v^i_t + \sigma_l \sqrt{v^i_t}\epsilon^i_{v,t+1}, \quad (10)$$

where ϵ^i_c, ϵ^i_x and ϵ^i_v are standardized error terms assumed uncorrelated with global counterparts, but correlated with each other by the same correlation matrix assumed for the world, and λ_x is the fraction of the variance of the country-specific component in long-run growth. In this model, the consumption growth variance of country i is the sum of the variance of the country-specific component v^i_t and the global component v^*_t. These dynamics naturally allow local consumption and variance shocks to be correlated with the global counterpart.[7] Moreover, under the dynamics assumed, global consumption growth should equal the cross-sectional average of local consumption growth over a large number of small countries.

In addition to the dynamics, I assume also a local inflation process

$$\pi^*_{t+1} = p_0 + p_1 \pi^*_t + \sigma_{pg}\sqrt{v^*_t}\epsilon^*_{\pi,t+1} \quad (11)$$

$$\pi^i_{t+1} = p_0 + p_1 \pi^i_t + \sigma_{pl}\sqrt{v^i_t}\epsilon^i_{\pi,t+1} + \sigma_{pg}\sqrt{v^*_t}\epsilon^*_{\pi,t+1},$$

[7]This specification is similar to the SDF dynamics of Lustig, Roussanov, and Verdelhan (2011). However, unlike their dynamics, all countries in the present paper have the same exposure to global consumption shocks. The dynamics of this paper consequently do not explain the carry trade puzzle but instead simplify the cross-country comparison of the stock market risk premium. Later in this section, I describe the implications of the main analysis when countries have different exposures to global consumption risk.

where $\epsilon^i_{\pi,t+1}$ and $\epsilon^*_{\pi,t+1}$ are independently distributed standard normal. Similar to the correlation between current and expected consumption shocks, the correlation between shocks to inflation and to current consumption will be denoted by ρ_{nr}, but will be set to zero in the baseline model.

As is standard now, the wealth-consumption ratio is solved using the method of undetermined coefficients. I conjecture that the local wealth-consumption ratio (z^i_t) can be represented by a linear function of the country-specific (v^i_t) and global (v^*_t) consumption growth variance. The global wealth-consumption ratio is only a function of the global consumption growth variance. The appendix presents the details.

2. Bond yields and currency returns

The real sovereign bond is purely a function of the local SDF. Since the local SDF needs to price the risk-free claim, the yield for i (y^i_t) is determined by

$$y^i_t = -E_t[m^i_{t+1}] - 0.5Var_t[m^i_{t+1}], \tag{12}$$

which can be expressed as a linear function of two state variables v^i_t and v^*_t. The yield of the nominal bond can be derived from the nominal SDF ($m^i_{\$,t+1}$), which can be represented by the difference between the real SDF and the rate of inflation ($m^i_{t+1} - \pi^i_{t+1}$). The formula for the yield on the 10-year bond can be solved iteratively as in Jones and Pyun (2021), where the appendix describes the detail.

International investments are realized in the currency of the country one invests in and should be converted to a common currency for a cross-country comparison. If the market is complete, the log of the currency returns (Δq^i_t) are represented by the difference between the local and the global SDF (e.g., Backus, Foresi, and Telmer 2001), resulting in

$$\Delta q^i_{t+1} = m^i_{t+1} - m^*_{t+1}, \tag{13}$$

where a higher q^i implies a higher currency value for country i.

In this model, the UIRP relationship holds, and there is no currency risk premium. This relationship suggests that the model cannot account for the carry trade puzzle. However, the dynamics with the UIRP simplify the comparison of equity market performance across countries. Under the UIRP, the expected currency return in global investments is proportional to the interest rate differential. Thus, comparing the performance of two or more global investments is equivalent to comparing the sum of currency and investment returns denominated in the local currency, less the common currency risk-free rate. If the UIRP holds, this is equivalent to comparing local-currency investment returns over the risk-free rate of the country.

3. Dividend dynamics and stock returns

Two types of firms operate in a local country. The first type produces nontradable goods, which are primarily sold locally. The dividend growth rate of these firms is determined by local consumption shocks. The second type of firm produces final or intermediate goods and services that are sold globally. Therefore, the dividends of these firms are more likely to be affected by global consumption shocks. I assume that the dividend growth (Δd^i) dynamics of the stock market in country i are described by

$$\Delta d^i_{t+1} = \mu_d + \phi\lambda_d(x^i_t + \varphi_d\sqrt{v^i_t}\epsilon^i_{d,t+1}) + \phi(1-\lambda_d)(x^*_t + \varphi_d\sqrt{v^*_t}\epsilon^*_{d,t+1}), \tag{14}$$

where $\epsilon^*_{d,t+1}$ and $\epsilon^i_{d,t+1}$ are assumed to be independent of each other but are correlated with $\epsilon^*_{c,t+1}$ and $\epsilon^i_{c,t+1}$ with a fixed correlation coefficient $\rho_{cd} > 0$. ϕ is the standard leverage parameter in long-run risk models such as Bansal and Yaron (2004). Since dividend growth is relatively more affected by global rather than country-specific shocks, $\lambda_d < 0.5$.

In this framework, shocks to variance or expected growth have contradictory effects on stock prices. A positive shock to variance in consumption or dividend growth may decrease stock prices by raising the risk premium or increase stock price by reducing the discount rate. Higher expected growth has a similar conflicting effect as it will increase the future dividend expectation and the discount rate. The former channel implies a negative correlation between stock and bond returns, whereas the discount rate channel implies a positive correlation. In a standard one-country model, the former channel dominates the latter, and the direction of how the stock price is affected by these shocks is straightforward.

Even in open economy models, the contradictory forces remain. However, the asymmetric exposure to local and global risk factors implies that the former source (i.e., risk premium or expected dividends) will dominate the latter (i.e., discount rate effect) for global shocks. In contrast, for local factors, the discount rate effect dominates. Since bond yields are directly related to the discount rate of the country, the stock returns of countries with little local risk will move more negatively with bond returns.

Panel A of Table XI lists the parameter specifications. Consumption and inflation parameters are calibrated to match the moments of global and local consumption growth and inflation. Consumption variance parameters are estimated for each country and chosen to match the average cross-country moments. Dividend parameters are matched to the moments of local and global stock returns. Due to data availability, I use the sample 1990-2021 to estimate and calibrate the parameters. Finally, in the main specification denoted by "Model 1", I set $\rho_{cv} = -0.3$ following the evidence suggested by Basu and Bundick (2017) and $\rho_v = -0.45$ as in $Nakamura, Sergeyev, and Steinsson$ (2017). The fraction of local shocks in the expected growth process (λ_x) is matched to the local/global yield correlation. The value of this fraction is low (0.25), which is consistent with Colacito and Croce (2011).

The model-implied moments are compared with the data, computed from (i) the US data only or (ii) the world average. Since stock returns with dividends are available for the post-1999 period for many countries, I provide the statistics for two samples, one from 1990 –, which is based on price index returns, and the other from 1999–, based on total returns. The global stock return is computed using the MSCI index, and the global yield is the simple cross-country average of the 10-year yield. The real variables are calculated by subtracting the ex-post realized inflation rate from the nominal values. Appendix A provides the data sources and measurements details.

Panel B of the table reports the moments of the global and local asset pricing variables. Overall, the moments and correlations implied by the model represent the data well, given the relatively simple dynamics assumed. In particular, compared to previous work, the calibrated values better fit the cross-variable relationships such as the correlations between stock returns and bond yields and the cross-country correlations of bond yields and stock returns.

4. The relationship between stock and bond returns

This subsection explores the relationship of the SB beta or SB correlation with the volatility of country-specific risk. As with many consumption-based asset pricing models, the baseline parameter specification of this paper also implies an average negative correlation between stock and bond returns, as the discount rate channel mentioned above is relatively small. However, since the discount rate channel is larger for local shocks, the negative relationship between stock and bond returns will be weaker when country-specific shocks dominate.

The relative significance of country-specific risk within an economy is likely to change over time, and therefore, the relative values of the SB beta and correlations will be time-varying. For example, during an election period or when geopolitical risk becomes dominant, the volatility of the local component will rise in a particular region. In contrast, during global pandemics, global variance risk will dominate. Thus, the SB relationship will become more negative when global risk dominates and more positive when country-specific risk does.

These premises are confirmed in the proposed model. The covariance between stock returns and unexpected changes in bond yields can be expressed as a function of the two variance terms only. This relationship can be expressed (i) as a measure of correlation (SB correlation), dividing the covariance by the standard deviation of bond yields and stock returns, or (ii) as bond yield beta (SB beta), dividing the covariance by the bond yield variance. Following the literature on the SB correlation, this paper focuses on the negative value of this relationship.

The first two panels of Figure 2 illustrate how the nominal (Panel a) and real SB betas (Panel b) vary as country-specific volatility changes. A separate line is shown for different values of λ_d. The baseline case is where the fraction of country-specific shocks to dividend growth is 0.3, which is shown in the black sold line. The benchmark case when dividend growth has equal exposure to country-specific and global shocks ($\lambda_d = 0.5$) is shown in blue 'x.' In these panels, global variance is assumed to remain fixed at its average level.

The SB beta is almost flat in the benchmark case and does not vary with country-specific volatility. However, as the relative global exposure of dividend growth increases, the betas increase in the value of country-specific volatility. In the baseline case ($\lambda_d = 0.3$), the SB beta is strictly higher for countries with higher local volatility. A similar relationship holds when the SB relationship is measured using the SB correlation. Panel (c) and (d) illustrate the results. High country-specific variance is associated with a relatively positive SB correlation for both nominal and real correlations.

5. International equity market risk premia

The previous section suggests that the strength of the SB relationship depends on the relative dominance of country-specific shocks in the economy. This section investigates the link between the SB relationship and the equity risk premium.

As noted earlier, the UIRP relationship holds in this model. Therefore, it is sufficient to compare the risk premium on an international stock market investment in each local currency from the local investor's perspective. The appendix provides a closed-form formula for the equity risk premium denominated in local currency.

Panel (e) of Figure 2 shows the relationship between local consumption volatility and the expected excess returns on the local stock investment. The figure clearly shows that the risk premium is higher when local volatility is higher. Quantitatively, in the baseline model, a country with an SB beta that is two standard deviations lower than the average earns 2.5% less per year than countries with an SB beta that is two standard deviations higher than the average. The difference increases to 3.5% per year when $\lambda = 0.4$.

6. Discussion

Although the model provided in this section qualitatively matches the empirical patterns reported in this paper, there are two limitations to the main specification.

First, the first parametrization does not allow the SB beta or correlation to be positive, also a common feature shared by many standard asset pricing models. One assumption of the baseline model is that dividend growth is inflation neutral. However, for example, when inflation is expected to be high, firms may respond by increasing real investments. As a result, stock prices may either increase or decrease. Campbell, Pflueger, and Viceira (2020) show that the time-variation in the SB relationship is related to the variation in the inflation-output correlation. When this nominal-real correlation is negative, the SB correlation is negative. If a substantial fraction of inflation shocks are global, the variation in nominal-real correlation should drive the worldwide SB relationship more positively. Another driver of the time-varying SB relationship is the correlation between current and expectation shocks(Jones and Pyun 2021). When the correlation between current and expectation components is negative, the SB relationship should be more positive.

In an alternative specification, denoted by "Model 2," I let both the current-expected consumption shock correlation and nominal-real correlation ($\rho_{cx} = -0.4, \rho_{nr} = -0.3$) to be negative. These numbers are chosen arbitrarily to show that the sign of the SB relationship could change with variation in the country-specific volatility. Figure 3 shows the SB beta and correlations for different values of local volatility. These figures show that the SB betas and correlations are now positive for high values of local volatility.

Second, the risk premium between high and lower SB beta countries implied by the model is slightly lower than the empirical evidence of Section II. One potential reason may be that the model is oversimplified to match the cross-sectional variation in the SB betas. To minimize the number of independent processes, the model assumes a square-root process, where the volatility-of-variance depends on the level of volatility. The model assumes zero correlation between shocks to country-specific and global variance shocks. While country-specific and global shocks are, by construction, uncorrelated, their variance shocks may have a non-zero correlation. If they are positively correlated, local variance risk may carry a higher price of risk.

One direct implication of the model is that high global risk should be the key determinant of the global equity risk premium. While this intuition is consistent with the work by Bollerslev, Marrone, Xu, and Zhou (2014), global shocks should affect all countries similarly, in the same direction. Therefore, global shocks may have little influence on the relative value of the risk premium and the SB relationship to its peers. In contrast, country-specific shocks directly impact a country's relative risk premium and the SB relationship compared to the global benchmark.

Several recent studies support the positive association between local volatility and asset returns in an international context. For example, Brennan and Xia (2006) proposes a model in which currency volatility, SDF volatility, and currency risk premia are positively related. Furthermore, using a habit formation model, Stathopoulos (2017) also suggests a positive relationship between consumption growth volatility and local stock risk premia.

This simplified model cannot directly test the ICAPM (Adler and Dumas 1983) because the model assumes homogeneous exposure to global shocks. However, an extension with heterogeneous exposures to global shocks is possible, thereby making it consistent with the carry trade puzzle as, for example, explained by Lustig, Roussanov, and Verdelhan (2014). In this model, a higher global risk exposure should be associated with a negative SB relationship because a higher global exposure amplifies the role of global variance shocks. Hence, a negative SB correlation in the extended model should predict higher currency returns. However, empirical support for this relationship is weak.

V. Conclusion

This paper demonstrates that a country's SB relationship contains information about whether the country currently has a higher risk premium than the rest of the world. This relationship is positive if a country or a region faces more uncertainty risk. For countries or areas that have less uncertainty risk, stock and bond prices move in the opposite direction, providing a hedge against each other. Stocks are generally heavily exposed to global uncertainty risk. In these countries, bonds hedge global uncertainty risk making stock investments safer. Therefore, the risk premium on equity investments in these countries is lower.

Empirically, this paper confirms that sovereign bonds hedge global uncertainty risk well when the SB relationship is negative. When local uncertainty risk is high, stocks and bonds do not hedge well with each other, and the SB return relationship becomes positive. Moreover, the risk premium is higher for stock markets with substantial country-specific variance risk, particularly in the later sample, where more data is available. Therefore, the SB beta, which proxies for these relationships, is a strong predictor of the relative cross-sectional performance of country stock market returns.

This paper reveals that the SB beta strongly predicts international stock market returns. The findings reported in this paper also have implications for the performance of the ICAPM. The ICAPM implies that an investment is likely to have higher future stock returns if the investment returns covary more with the global market portfolio. The analysis of this paper indicates the opposite. As the preceding sections show, investments in countries whose local variance shocks dominate have higher stock returns. In the simplest setting, if total stock market volatility remains constant, these countries are also likely to have a lower beta, and the ICAPM would empirically fail in this context. This intuition is consistent with what is shown in the main table. The high-minus-low spread of the SB beta sorted portfolios is higher after controlling for the ICAPM.

The model presented in this paper explicates why the correlation between stock returns and bond yields varies over time. The standard flight-to-quality-based explanation is that investors react to heightened volatility by reducing their risky stock holdings and increasing their bond holdings. However, the results reported in this paper suggest that flight-to-quality is driven by global uncertainty and unrelated to local volatility shocks. In particular, the empirical evidence presented in this paper indicates that the SB relationship is negative when local stock volatility is low but when bond yield volatility is high.

References

Adler, Michael, and Bernard Dumas, 1983, International Portfolio Choice and Corporation Finance: A Synthesis, *The Journal of Finance* 38, 925.

Andersen, Torben G., Nicola Fusari, and Viktor Todorov, 2020, The Pricing of Tail Risk and the Equity Premium: Evidence From International Option Markets, *Journal of Business and Economic Statistics* 38, 662–678.

Backus, David K., Silverio Foresi, and Chris I. Telmer, 2001, Affine Term Structure Models and the Forward Premium Anomaly, *The Journal of Finance* 56, 279–304.

Backus, David K., Patrick J. Kehoe, and Finn E. Kydland, 1992, International Real Business Cycles, *Journal of Political Economy* 100, 745–775.

Baele, Lieven, Geert Bekaert, and Koen Inghelbrecht, 2010, The Determinants of Stock and Bond Return Comovements, *Review of Financial Studies* 23, 2374–2428.

Bakshi, Gurdip, Peter Carr, and Liuren Wu, 2008, Stochastic risk premiums, stochastic skewness in currency options, and stochastic discount factors in international economies, *Journal of Financial Economics* 87, 132–156.

Bali, Turan G., and Nusret Cakici, 2010, World market risk, country-specific risk and expected returns in international stock markets, *Journal of Banking and Finance* 34, 1152–1165.

Bansal, Ravi, and Amir Yaron, 2004, Risks for the Long Run: A Potential Resolution of Asset Pricing Puzzles, *The Journal of Finance* 59, 1481–1509.

Basu, Susanto, and Brent Bundick, 2017, Uncertainty Shocks in a Model of Effective Demand, *Econometrica* 85, 937–958.

Bekaert, Geert, and Campbell R. Harvey, 2000, Foreign Speculators and Emerging Equity Markets, *The Journal of Finance* 55, 565–613.

Bekaert, Geert, Campbell R. Harvey, and Christian Lundblad, 2007, Liquidity and Expected Returns: Lessons from Emerging Markets, *Review of Financial Studies* 20, 1783–1831.

Bekaert, Geert, Campbell R. Harvey, and Angela Ng, 2005, Market Integration and Contagion, *The Journal of Business* 78, 39–69.

Bekaert, Geert, and Robert J. Hodrick, 1992, Characterizing Predictable Components in Excess Returns on Equity and Foreign Exchange Markets, *The Journal of Finance* 47, 467.

Bollerslev, Tim, James Marrone, Lai Xu, and Hao Zhou, 2014, Stock Return Predictability and Variance Risk Premia: Statistical Inference and International Evidence, *Journal of Financial and Quantitative Analysis* 49, 633–661.

Boons, Martijn, Fernando Duarte, Frans de Roon, and Marta Szymanowska, 2020, Time-varying Inflation Risk and Stock Returns, *Journal of Financial Economics* 136, 444–470.

Brennan, Michael J., and Yihong Xia, 2006, International Capital Markets and Foreign Exchange Risk, *Review of Financial Studies* 19, 753–795.

Campbell, John Y., Carolin Pflueger, and Luis M. Viceira, 2020, Macroeconomic Drivers of Bond and Equity Risks, *Journal of Political Economy* 128, 3148–3185.

Carroll, Christopher D., and Andrew A. Samwick, 1998, How Important Is Precautionary Saving?, *Review of Economics and Statistics* 80, 410–419.

Cenedese, Gino, Richard Payne, Lucio Sarno, and Giorgio Valente, 2016, What Do Stock Markets Tell Us about Exchange Rates?, *Review of Finance* 20, 1045–1080.

Colacito, Riccardo, and Mariano M. Croce, 2011, Risks for the Long Run and the Real Exchange Rate, *Journal of Political Economy* 119, 153–181.

Connolly, Robert, Chris Stivers, and Licheng Sun, 2005, Stock Market Uncertainty and the Stock-Bond Return Relation, *Journal of Financial and Quantitative Analysis* 40, 161–194.

Corsi, Fulvio, 2009, A Simple Approximate Long-Memory Model of Realized Volatility, *Journal of Financial Econometrics* 7, 174–196.

David, Alexander, and Pietro Veronesi, 2014, Investors' and Central Bank's Uncertainty Embedded in Index Options, *Review of Financial Studies* 27, 1661–1716.

Dumas, Bernard, and Bruno Solnik, 1995, The World Price of Foreign Exchange Risk, *The Journal of Finance* 50, 445.

Eiling, Esther, and Bruno Gerard, 2015, Emerging Equity Market Comovements: Trends and Macroeconomic Fundamentals, *Review of Finance* 19, 1543–1585.

Epstein, Larry G., and Stanley E. Zin, 1991, Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: An Empirical Analysis, *Journal of Political Economy* 99, 263–286.

Ferson, Wayne E, and Campbell R Harvey, 1993, The Risk and Predictability of International Equity Returns, *The Review of Financial Studies* 6, 527–566.

French, Kenneth R., and James M. Poterba, 1991, Investor Diversification and International Equity Markets, *American Economic Review* 81, 222–226.

Goyenko, Ruslan, and Sergei Sarkissian, 2014, Treasury Bond Illiquidity and Global Equity Returns, *Journal of Financial and Quantitative Analysis* 49, 1227–1253.

Griffin, John M, and René M Stulz, 2001, International Competition and Exchange Rate Shocks: A Cross-Country Industry Analysis of Stock Returns, *The Review of Financial Studies* 14, 215–241.

Hau, Harald, and Hélène Rey, 2006, Exchange Rates, Equity Prices, and Capital Flows, *Review of Financial Studies* 19, 273–317.

Heber, Gerd, Asger Lunde, Neil Shephard, and Kevin Sheppard, 2009, Oxford-Man Institute's realized library, Working paper, Oxford-Man Institute, University of Oxford.

Hjalmarsson, Erik, 2010, Predicting Global Stock Returns, *Journal of Financial and Quantitative Analysis* 45, 49–80.

Hosszejni, Darjus, and Gregor Kastner, 2021, Modeling Univariate and Multivariate Stochastic Volatility in R with stochvol and factorstochvol, .

Hou, Kewei, G. Andrew Karolyi, and Bong-Chan Kho, 2011, What Factors Drive Global Stock Returns?, *Review of Financial Studies* 24, 2527–2574.

Jones, Christopher S., and Sungjune Pyun, 2021, Consumption growth persistence and the stock/bond correlation, *Working Paper*.

Jotikasthira, Chotibhak, Anh Le, and Christian Lundblad, 2015, Why do term structures in different currencies co-move?, *Journal of Financial Economics* 115, 58–83.

Londono, Juan M., and Nancy R. Xu, 2021, The Global Determinants of International Equity Risk Premiums, *SSRN Electronic Journal*.

Longstaff, Francis A, Jun Pan, Lasse H Pedersen, and Kenneth J Singleton, 2011, How Sovereign Is Sovereign Credit Risk?, *American Economic Journal: Macroeconomics* 3, 75–103.

Lustig, Hanno, Nikolai Roussanov, and Adrien Verdelhan, 2011, Common Risk Factors in Currency Markets, *Review of Financial Studies* 24, 3731–3777.

Lustig, Hanno, Nikolai Roussanov, and Adrien Verdelhan, 2014, Countercyclical currency risk premia, *Journal of Financial Economics* 111, 527–553.

Nakamura, Emi, Dmitriy Sergeyev, and Jón Steinsson, 2017, Growth-Rate and Uncertainty Shocks in Consumption: Cross-Country Evidence, *American Economic Journal: Macroeconomics* 9, 1–39.

Pan, Jun, and Kenneth Singleton, 2008, Default and Recovery Implicit in the Term Structure of Sovereign CDS Spreads, *The Journal of Finance* 63, 2345–2384.

Pyun, Sungjune, 2019, Variance risk in aggregate stock returns and time-varying return predictability, *Journal of Financial Economics* 132, 150–174.

Rapach, David E., Jack K. Strauss, and Guofu Zhou, 2013, International Stock Return Predictability: What Is the Role of the United States?, *The Journal of Finance* 68, 1633–1662.

Song, Dongho, 2017, Bond Market Exposures to Macroeconomic and Monetary Policy Risks, *The Review of Financial Studies* 30, 2761–2817.

Stathopoulos, Andreas, 2017, Asset Prices and Risk Sharing in Open Economies, *Review of Financial Studies* 30, 363–415.

Vayanos, Dimitri, 2004, Flight to Quality, Flight to Liquidity, and the Pricing of Risk, Working paper, National Bureau of Economic Research Cambridge, MA.

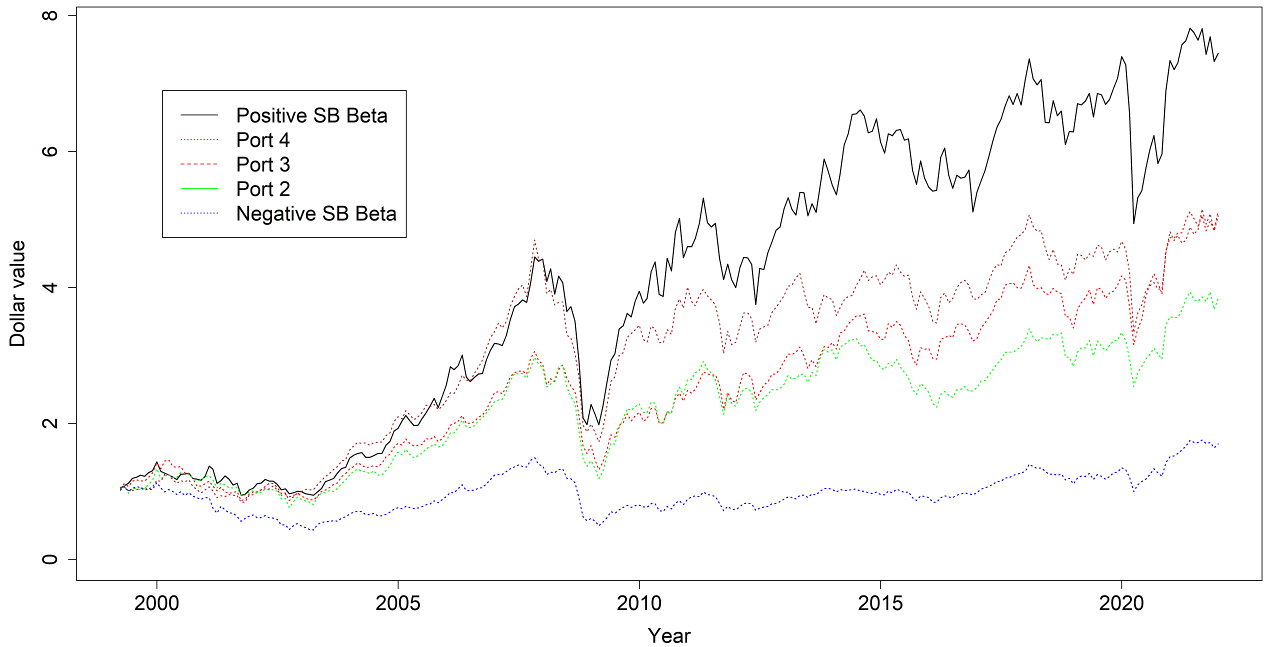
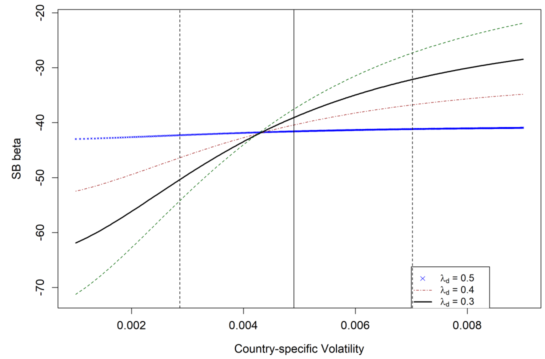
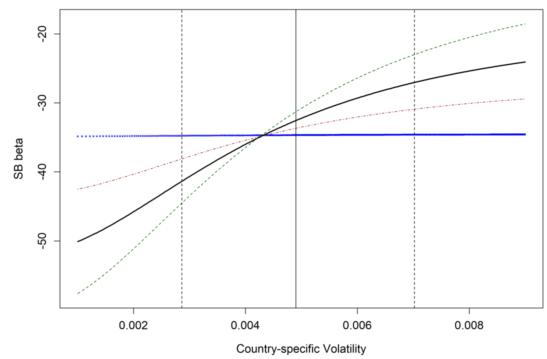


Figure 1. International stock market performance

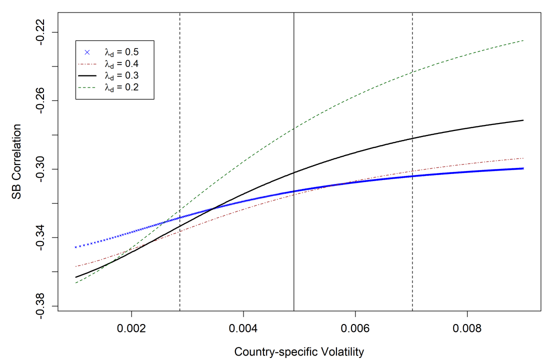
This figure shows the relative performance of the top and bottom quintile equity portfolio of countries sorted by the SB beta. As described in the main text, the SB beta is the negative beta of local stock market returns regressed on changes in ten-year sovereign bond yields.



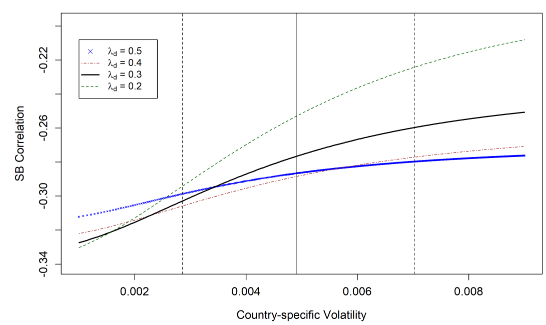
(a) Real SB beta



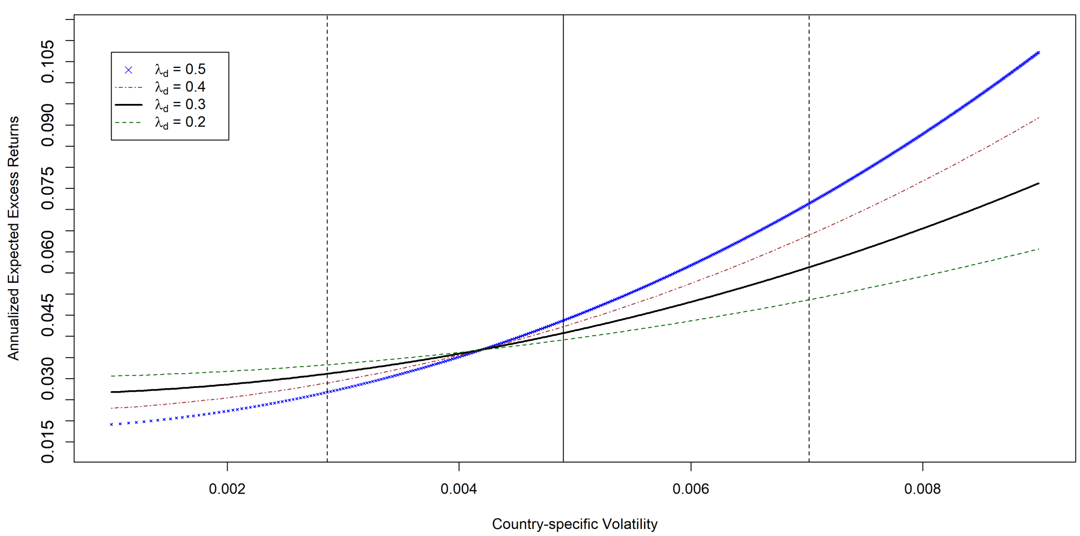
(b) Nominal SB beta



(c) Real SB correlation



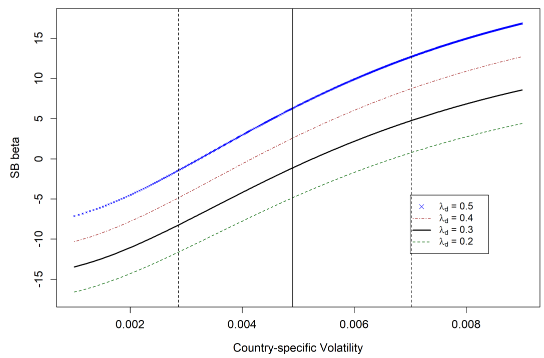
(d) Nominal SB correlation



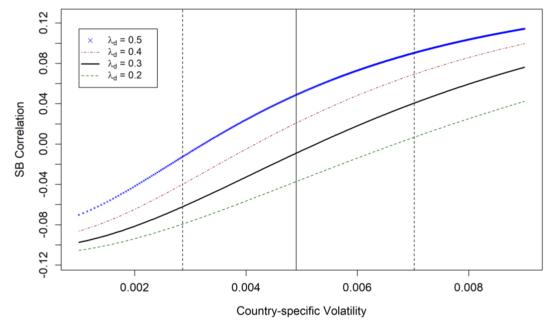
(e) Expected excess stock returns

Figure 2. SB beta and expected excess stock returns

This figure shows how the SB relationships (a-d) and the expected excess market returns (e) vary with different levels of country-specific volatility. SB relationship is measured using (a) the real SB beta, defined as the covariance between stock returns and first-order difference in 10-year real yields divided by the variance of the first-order difference in yields, (b) the nominal SB beta, measured using 10-year nominal yields, (c) the real SB correlation, defined as the correlation between stock returns and first-order difference in 10-year real yields, and (d) the nominal SB correlation, measured using 10-year nominal yields. The solid vertical line shows the mean of the country-specific volatility, whereas dotted lines show the 95% confidence interval.



(a) Positive nominal SB beta



(b) Positive nominal SB correlation

Figure 3. SB beta and country-specific volatility under an alternative specification

This figure shows how the SB relationships vary with different levels of country-specific volatility. SB relationship is measured using (a) the nominal SB beta, defined as the covariance between stock returns and first-order difference in 10-year nominal yields divided by the variance of the first-order difference in yields and (b) correlation between stock returns and first-order difference in 10-year nominal yields. The solid vertical line shows the mean of the country-specific volatility, whereas dotted lines show the 95% confidence interval.

Table I
Summary statistics

This table summarizes the mean and standard deviations of international stock market returns of MSCI net total returns and price index, currency returns, bond yields, and the first-difference of bond yields. Panel A summarizes the means and standard deviations, the SB beta, estimated one-time, using the entire daily data, and the global CAPM beta estimated as described in the main text. Daily data is used to estimate the SB beta, and net total returns are used to calculate the global CAPM beta. Panel B summarizes the cross-sectional correlations of the SB beta and the time-series average of returns as well as the international CAPM beta. The p-values are given in angle brackets.

Panel A. Summary statistics

	Stock Returns						Currency		Bond		SB	CAPM
	Total Returns			Price Index			Returns		Yields		Beta	Beta
Country	Yr–	Mean	Std.	Yr–	Mean	Std.	Mean	Std.	Mean	Std.		
Australia	1999	0.076	0.134	1990	0.046	0.138	−0.002	0.112	0.055	0.096	−0.967	0.67
Austria	1999	0.046	0.244	1993	0.023	0.232	−0.003	0.093	0.034	0.078	−6.207	0.91
Belgium	1999	0.014	0.201	1993	0.027	0.188	0.004	0.093	0.036	0.080	−2.468	0.78
Brazil	2010	0.073	0.213	2010	0.057	0.208	0.058	0.145	0.108	0.074	4.658	1.14
Canada	1999	0.074	0.146	1990	0.059	0.146	−0.002	0.078	0.045	0.091	−2.277	0.72
China	2006	0.079	0.251	2006	0.056	0.252	0.016	0.035	0.035	0.017	−1.888	1.04
Finland	1999	0.045	0.279	1996	0.069	0.282	0.004	0.095	0.030	0.073	−9.614	1.02
France	1999	0.052	0.175	1990	0.049	0.167	−0.007	0.095	0.040	0.092	−4.990	0.83
Germany	1999	0.044	0.208	1990	0.044	0.193	−0.004	0.096	0.036	0.090	−9.652	0.93
India	1999	0.137	0.242	1999	0.130	0.243	−0.024	0.069	0.078	0.054	2.598	0.60
Indonesia	2004	0.152	0.223	2004	0.130	0.223	−0.026	0.096	0.088	0.081	3.216	0.80
Italy	1999	0.012	0.203	1993	0.014	0.207	0.004	0.093	0.042	0.088	5.524	0.84
Japan	1999	0.038	0.176	1990	−0.007	0.192	0.007	0.102	0.018	0.063	−4.580	0.90
Korea	2001	0.108	0.211	2001	0.094	0.211	0.003	0.104	0.039	0.057	−3.010	0.85
Malaysia	1999	0.062	0.138	1999	0.041	0.172	−0.004	0.061	0.041	0.028	1.199	0.57
Mexico	2002	0.126	0.155	2002	0.077	0.227	−0.029	0.112	0.074	0.050	0.801	0.77
Netherlands	1999	0.064	0.180	1991	0.058	0.169	−0.003	0.097	0.037	0.087	−7.714	0.82
Norway	1999	0.083	0.199	1996	0.054	0.204	−0.008	0.109	0.040	0.072	−4.869	1.02
NZ	1999	0.063	0.148	1998	0.019	0.165	0.004	0.113	0.056	0.085	0.742	0.58
Philippines	1999	0.047	0.210	1998	−0.003	0.232	−0.013	0.061	0.093	0.189	0.647	0.70
Russia	2001	0.090	0.285	2001	0.030	0.328	−0.048	0.122	0.055	0.094	6.609	1.17
Singapore	2000	0.063	0.200	2000	0.038	0.209	0.010	0.055	0.027	0.034	−3.519	0.88
S. Africa	1999	0.131	0.175	1997	0.086	0.193	−0.050	0.157	0.099	0.085	3.177	0.74
Spain	1999	0.029	0.205	1993	0.044	0.206	0.008	0.098	0.045	0.098	3.496	0.86
Sweden	1999	0.082	0.208	1991	0.081	0.219	−0.014	0.114	0.043	0.117	−0.868	1.22
Switzerland	1999	0.046	0.133	1995	0.055	0.145	0.016	0.100	0.019	0.057	−7.296	0.77
Thailand	2001	0.096	0.233	2001	0.067	0.233	0.010	0.058	0.036	0.045	−0.180	1.01
Turkey	2011	0.095	0.233	2011	0.069	0.234	−0.179	0.178	0.115	0.124	2.723	0.88
UK	1999	0.044	0.138	1990	0.034	0.141	−0.007	0.091	0.046	0.099	−1.824	0.86
USA	1999	0.072	0.152	1990	0.085	0.147	0.000	0.000	0.043	0.071	−4.506	0.90
World	1999	0.066	0.155	1990	0.056	0.151						1.00

Panel B. Unconditional correlations

	Stock return		Currency	Stock return in USD		ICAPM Beta	
	Net total	Price index	return	Net total	Price index	Net total	Price index
SB Beta	0.348	0.098	−0.272	−0.008	−0.189	−0.343	−0.062
	< 0.0597 >	< 0.6072 >	< 0.1457 >	< 0.9649 >	< 0.3172 >	< 0.0637 >	< 0.7446 >

Table II
SB betas and international stock market performance

This table summarizes the average and the Newey-West t-statistics of the leading month country stock returns in both USD and local currency, USD-denominated returns adjusted by the ICAPM, and currency returns of the quintile portfolios formed after sorting the countries by their lagged SB betas. The betas are estimated using daily or weekly data. The MSCI net total returns (Panels A) and the price index returns (Panel B) are used to proxy country stock returns. Portfolio 5 contains countries with a positive relationship between stock and sovereign bond returns. Panel C shows the results by adding global factors as control variables when estimating the betas. The top part of Panel C controls for changes in global average yields and the bottom for both global average yields and stock returns. Finally, panel D reports the results sorted by the two components of yield changes. The top part is for the sovereign credit default risk component and the bottom is for the risk-free component. Stock returns are regressed on the negative of these two components separately to form the betas.

Panel A. Using net total stock index returns

	Port 1	Port 2	Port 3	Port 4	Port 5	H–L
Daily estimation						
Returns	0.46	0.67	0.79	0.87	0.99	0.53**
in USD	(1.24)	(1.93)	(2.28)	(2.54)	(2.56)	(2.46)
ICAPM	−0.12	0.10	0.46	0.63	0.69	0.81***
	(−1.06)	(0.93)	(2.64)	(2.96)	(4.22)	(4.61)
Returns	0.37	0.56	0.81	0.86	1.05	0.68***
in local \$	(1.14)	(1.95)	(2.96)	(3.14)	(3.47)	(3.24)
Currency	0.07	0.09	−0.05	−0.02	−0.12	−0.19*
returns	(0.51)	(0.66)	(−0.35)	(−0.14)	(−1.03)	(−1.72)
SB Beta	−14.50	−8.14	−3.96	0.68	6.06	20.56
Weekly estimation						
Returns	0.50	0.58	0.75	0.83	1.12	0.61***
in USD	(1.43)	(1.65)	(2.17)	(2.34)	(2.91)	(2.67)
ICAPM	−0.16	0.15	0.34	0.51	0.93	1.09***
	(−1.55)	(0.74)	(2.88)	(3.47)	(4.31)	(5.08)
Returns	0.38	0.47	0.75	0.89	1.17	0.78***
in local \$	(1.26)	(1.63)	(2.79)	(3.13)	(3.74)	(3.55)
Currency	0.11	0.09	−0.03	−0.09	−0.10	−0.20*
returns	(0.77)	(0.62)	(−0.21)	(−0.69)	(−0.88)	(−1.94)
SB Beta	−13.42	−6.41	−2.48	1.69	7.57	20.99

Panel B. Using price stock index returns

	Port 1	Port 2	Port 3	Port 4	Port 5	H–L
Daily estimation						
Returns	0.20	0.61	0.66	0.84	0.94	0.74***
in USD	(0.64)	(2.19)	(2.32)	(2.81)	(2.72)	(3.16)
ICAPM	−0.40	0.11	0.20	0.42	0.50	0.90***
	(−3.58)	(1.13)	(1.58)	(3.06)	(3.08)	(4.86)
Returns	0.12	0.50	0.65	0.82	0.98	0.86***
in local \$	(0.46)	(2.13)	(2.77)	(3.32)	(3.28)	(3.80)
Currency	0.06	0.09	−0.02	0.00	−0.08	−0.14
returns	(0.50)	(0.85)	(−0.20)	(−0.03)	(−0.74)	(−1.15)
SB Beta	−11.09	−5.32	−1.79	2.16	7.63	18.72
Weekly estimation						
Returns	0.26	0.43	0.66	0.78	1.20	0.94***
in USD	(0.90)	(1.53)	(2.27)	(2.62)	(3.52)	(3.81)
ICAPM	−0.24	−0.04	0.21	0.36	0.68	0.92***
	(−2.01)	(−0.42)	(1.68)	(2.69)	(4.21)	(4.95)
Returns	0.21	0.37	0.61	0.79	1.25	1.04***
in local \$	(0.82)	(1.60)	(2.54)	(3.18)	(4.13)	(4.54)
Currency	0.04	0.04	0.03	−0.04	−0.08	−0.12
returns	(0.39)	(0.32)	(0.25)	(−0.39)	(−0.61)	(−0.93)
SB Beta	−10.36	−3.83	−0.51	3.26	9.07	19.43

Panel C. Control for global variables (total returns, weekly data)

	Port 1	Port 2	Port 3	Port 4	Port 5	H–L
Control for average bond yields						
Returns	0.62	0.71	0.66	0.79	1.02	0.40*
in USD	(1.75)	(2.06)	(1.95)	(2.16)	(2.61)	(1.75)
ICAPM	−0.12	0.11	0.25	0.72	0.84	0.95***
	(−1.05)	(1.14)	(2.02)	(3.09)	(3.97)	(4.86)
Returns	0.52	0.63	0.58	0.85	1.11	0.59***
in local \$	(1.65)	(2.21)	(2.24)	(2.94)	(3.51)	(2.69)
Currency	0.10	0.05	0.05	−0.09	−0.13	−0.23**
returns	(0.70)	(0.39)	(0.36)	(−0.74)	(−1.18)	(−2.15)
Control for global stock returns and bond yields						
Returns	0.46	0.67	0.79	0.87	0.99	0.53**
in USD	(1.24)	(1.93)	(2.28)	(2.54)	(2.56)	(2.46)
ICAPM	−0.12	0.10	0.46	0.63	0.69	0.81***
	(−1.06)	(0.93)	(2.64)	(2.96)	(4.22)	(4.61)
Returns	0.37	0.56	0.81	0.86	1.05	0.68***
in local \$	(1.14)	(1.95)	(2.96)	(3.14)	(3.47)	(3.24)
Currency	0.07	0.09	−0.05	−0.02	−0.12	−0.19*
returns	(0.51)	(0.66)	(−0.35)	(−0.14)	(−1.03)	(−1.72)

Panel D. Decomposition of credit default and risk-free components

	Port 1	Port 2	Port 3	Port 4	Port 5	H –L
CDS component						
Returns	0.83	0.60	0.96	0.75	0.86	0.03
in USD	(1.90)	(1.43)	(2.39)	(1.80)	(2.01)	(0.16)
ICAPM	0.06	−0.09	0.33	0.42	0.25	0.19
	(0.45)	(−0.66)	(2.53)	(2.39)	(1.54)	(1.09)
Returns	0.75	0.58	0.84	0.92	0.84	0.09
in local \$	(2.11)	(1.77)	(2.68)	(2.91)	(2.38)	(0.47)
Currency	0.06	−0.02	0.08	−0.22	−0.01	−0.07
returns	(0.35)	(−0.13)	(0.59)	(−1.51)	(−0.12)	(−0.68)
Risk-free component						
Returns	0.69	0.70	0.99	0.59	1.09	0.40*
in USD	(1.57)	(1.70)	(2.49)	(1.50)	(2.30)	(1.77)
ICAPM	−0.08	0.02	0.26	0.24	0.58	0.66***
	(−0.56)	(0.17)	(2.13)	(1.42)	(3.08)	(3.08)
Returns	0.75	0.58	0.84	0.92	0.84	0.09
in local \$	(2.11)	(1.77)	(2.68)	(2.91)	(2.38)	(0.47)
Currency	0.01	0.03	0.03	−0.11	−0.08	−0.08
returns	(0.04)	(0.24)	(0.22)	(−0.82)	(−0.59)	(−0.73)

Table III
Cross-sectional regressions - Price index returns (1990-2021)

This table summarizes the average and the t-statistics of the cross-sectional regression using leading monthly price index country stock returns in USD as the dependent variable and daily SB betas as independent variables. Control variables include the time-series average of the SB beta, total GDP, GDP per capita (GDP/C), five-year GDP growth, inflation (π), the percentage contribution of exports to total GDP (Panel A), first difference in log total real GDP and consumption (Δc) and their product with inflation as well as their 10-year estimate of the correlation with inflation (Panel B), the exposure to innovations in three different US illiquidity measures as described in the main text(Panel C), the dividend yields, term spread, and momentum (Panel D).

Panel A. Time-varying component or persistent component

	$\hat{\beta}_t^i$	$\overline{\hat{\beta}_t^i}$	GDP/C	Total GDP	% Export/GDP	GDP growth	Inflation (π)	R^2
Model 1	0.046∗∗∗							0.098
	(2.60)							
Model 2	0.060∗∗∗	−0.042∗						0.183
	(3.12)	(−1.95)						
Model 3	0.112∗∗		0.021	104.139	0.000	−1.295	−0.130∗	0.441
	(2.49)		(0.91)	(0.46)	(0.06)	(−0.15)	(−1.74)	

Panel B. Nominal-real covariance

	$\hat{\beta}^i$	π	ΔGDP	$\Delta GDP \times \pi$	Δc	$\Delta c \times \pi$	$\rho_{\pi,\Delta\text{GDP}}$	$\rho_{\pi,\Delta c}$	R^2
Model 4	0.050∗∗	−0.158	3.246	0.716					0.318
	(2.32)	(−0.84)	(0.38)	(0.21)					
Model 5	0.039∗∗	−0.021	7.220∗∗				−0.187		0.312
	(2.01)	(−0.27)	(2.03)				(−1.36)		
Model 6	0.053∗∗∗	−0.089∗			−2.903	−0.080			0.332
	(2.64)	(−1.68)			(−0.36)	(−0.58)			
Model 7	0.054∗∗	−0.069			−1.190			−1.190	0.304
	(2.27)	(−1.36)			(−0.36)			(−0.36)	

Panel C. Exposure to global illiquidity

	$\hat{\beta}^i$	Treasury	Amihud	Zero ret.	Zero vol.	R^2
Model 8	0.038∗∗	0.000				0.190
	(2.57)	(−1.30)				
Model 9	0.051∗∗∗		8.434			0.196
	(2.79)		(0.09)			
Model 10	0.043∗∗			−0.383∗∗		0.188
	(2.33)			(−2.17)		
Model 11	0.051∗∗∗				−0.164	0.196
	(2.85)				(−1.16)	

Panel D. Other return predictors

	$\hat{\beta}^i$	Div. yield	Term spread	Momentum	R^2
Model 12	0.022∗∗	−2.600			0.135
	(2.11)	(−0.34)			
Model 13	0.020∗		0.004		0.146
	(1.95)		(0.11)		
Model 14	0.020∗∗			0.622	0.174
	(2.11)			(1.10)	
Model 15	0.021∗∗	−4.412	0.039	0.563	0.294
	(2.06)	(−0.58)	(0.51)	(0.97)	

Table IV
Cross-sectional regressions - Total index returns (1999-2021)

This table summarizes the average and the t-statistics of the cross-sectional regression using leading monthly country net total stock returns in USD as the dependent variable and daily SB betas as independent variables. Control variables include the time-series average of the SB beta, total GDP, GDP per capita (GDP/C), five-year GDP growth, inflation (π), the percentage contribution of exports to total GDP (Panel A), first difference in log total real GDP and consumption (Δc) and their product with inflation as well as their 10-year estimate of the correlation with inflation (Panel B), the exposure to innovations in three different US illiquidity measures as described in the main text(Panel C), the dividend yields, term spread, and momentum (Panel D).

Panel A. Time-varying component or persistent component

	$\hat{\beta}_t^i$	$\overline{\hat{\beta}_t^i}$	GDP/C	Total GDP	% Export/GDP	GDP growth	Inflation (π)	R^2
Model 1	0.037***							0.073
	(3.14)							
Model 2	0.050***	−0.019						0.140
	(3.31)	(−1.06)						
Model 3	0.030***		−0.003	55.127	0.000	8.256	−0.041	0.348
	(2.68)		(−0.45)	(0.73)	(1.27)	(1.02)	(−0.84)	

Panel B. Nominal-real covariance

	$\hat{\beta}^i$	π	ΔGDP	$\Delta GDP \times \pi$	Δc	$\Delta c \times \pi$	$\rho_{\pi,\Delta\text{GDP}}$	$\rho_{\pi,\Delta c}$	R^2
Model 4	0.021**	0.018	6.838	−1.814					0.266
	(2.02)	(0.16)	(1.32)	(−1.02)					
Model 5	0.023**	−0.023	2.524				−0.290*		0.312
	(2.13)	(−0.34)	(0.84)				(−1.92)		
Model 6	0.034***	−0.033			−1.821	−0.121			0.332
	(2.69)	(−0.71)			(−0.32)	(−0.89)			
Model 7	0.032***	−0.017			1.005			1.005	0.304
	(2.64)	(−0.37)			(0.59)			(0.59)	

Panel C. Exposure to global illiquidity

	$\hat{\beta}^i$	Treasury	Amihud	Zero ret.	Zero vol.	R^2
Model 8	0.018**	0.000				0.131
	(2.01)	(−0.62)				
Model 9	0.016*		30.112			0.131
	(1.82)		(0.70)			
Model 10	0.021**			0.031		0.127
	(2.43)			(0.62)		
Model 11	0.015*				0.030	0.123
	(1.65)				(0.65)	

Panel D. Other return predictors

	$\hat{\beta}^i$	Div. yield	Term spread	Momentum	R^2
Model 12	0.025**	0.344			0.116
	(2.34)	(0.05)			
Model 13	0.026**		0.004		0.141
	(2.45)		(0.11)		
Model 14	0.023**			0.591	0.172
	(2.49)			(1.06)	
Model 15	0.027**	−3.249	0.044	0.406	0.278
	(2.44)	(−0.46)	(0.56)	(0.68)	

Table V
Cross-border stock and bond return correlations

This table summarizes the correlations of cross-country stock returns and bond yields and their differences aggregated over the country pairs' geographical locations. Panel A shows the correlations after aggregate them by the country-pair's geographical location. Panel B reports the statistics by each country, but only for the difference between stock and bond correlations. The last three columns summarize the average of the correlation differences separately, depending on whether the paired country belongs to the same or different region. The last column reports the difference between the first two columns. Finally, the statistics are computed for each of these, and a paired t-test is performed.

Panel A. Correlations across regions

Continent		Asia	Africa	Europe	Latin America	Oceania	US& Canada	Continent		
								Different	Same	S-D
Asia	Stock	0.493	0.450	0.437	0.485	0.385	0.457			
	Bond	0.127	0.121	0.139	0.117	0.186	0.179			
	Diff.	0.366	0.330	0.298	0.368	0.199	0.278	0.295	0.366	0.071
Africa	Stock	0.450	.	0.521	0.590	0.428	0.576			
	Bond	0.121	.	0.127	0.248	0.143	0.102			
	Diff.	0.330	.	0.394	0.342	0.285	0.474	0.365		
Europe	Stock	0.437	0.521	0.627	0.538	0.428	0.608			
	Bond	0.139	0.127	0.482	0.138	0.360	0.469			
	Diff.	0.298	0.394	0.145	0.400	0.068	0.139	0.259	0.145	−0.114
Latin	Stock	0.485	0.590	0.538	0.623	0.414	0.630			
America	Bond	0.117	0.248	0.138	0.336	0.086	0.119			
	Diff.	0.368	0.342	0.400	0.287	0.329	0.512	0.390	0.287	−0.103
Oceania	Stock	0.385	0.428	0.428	0.414	0.463	0.461			
	Bond	0.186	0.143	0.360	0.086	0.625	0.492			
	Diff.	0.199	0.285	0.068	0.329	−0.161	−0.031	0.170	−0.161	−0.331
US & Canada	Stock	0.457	0.576	0.608	0.630	0.461	0.747			
	Bond	0.179	0.102	0.469	0.119	0.492	0.752			
	Diff.	0.278	0.474	0.139	0.512	−0.031	−0.004	0.274	−0.004	−0.278
All	Mean							0.292	0.126	−0.151
	T							(11.54)	(1.93)	(−2.12)
	P-value							0.000	0.063	0.051

Panel B. Correlations across regions for each country

Continent		Asia	Africa	Europe	Latin America	Oceania	US& Canada	Continent		
								Different	Same	S-D
Australia		0.293	0.389	0.156	0.445	−0.161	0.033	0.263	−0.161	−0.424
Austria		0.295	0.382	−0.025	0.452	−0.006	−0.030	0.218	−0.025	−0.244
Belgium		0.273	0.363	0.043	0.374	0.046	0.043	0.220	0.043	−0.177
Brazil		0.354	0.247	0.367	0.287	0.329	0.519	0.363	0.287	−0.076
Canada		0.296	0.467	0.135	0.543	−0.021	−0.004	0.284	−0.004	−0.288
China		0.474	0.478	0.392	0.465	0.298	0.431	0.413	0.474	0.061
Finland		0.213	0.327	−0.071	0.377	−0.100	−0.042	0.155	−0.071	−0.225
France		0.314	0.462	0.091	0.461	0.022	0.096	0.271	0.091	−0.180
Germany		0.320	0.490	0.096	0.473	−0.058	0.013	0.247	0.096	−0.151
India		0.389	0.376	0.379	0.441	0.230	0.302	0.345	0.389	0.044
Indonesia		0.410	0.240	0.330	0.289	0.346	0.387	0.318	0.410	0.092
Italy		0.335	0.389	0.262	0.399	0.211	0.324	0.332	0.262	−0.070
Japan		0.341	0.427	0.277	0.319	0.198	0.238	0.292	0.341	0.049
Korea		0.346	0.402	0.306	0.452	0.069	0.254	0.297	0.346	0.050
Malaysia		0.293	0.170	0.206	0.312	0.123	0.188	0.200	0.293	0.094
Mexico		0.382	0.437	0.433	0.287	0.329	0.504	0.417	0.287	−0.130
Netherlands		0.284	0.436	0.065	0.414	−0.025	0.006	0.223	0.065	−0.158
Norway		0.295	0.374	0.118	0.417	−0.009	0.073	0.230	0.118	−0.112
NZ		0.106	0.180	−0.019	0.213	−0.161	−0.094	0.077	−0.161	−0.238
Philippines		0.391	0.357	0.327	0.396	0.358	0.380	0.364	0.391	0.027
Russia		0.325	0.319	0.459	0.309	0.368	0.481	0.360	0.459	0.099
Singapore		0.367	0.299	0.217	0.355	0.022	0.109	0.201	0.367	0.166
S. Africa		0.330	.	0.394	0.342	0.285	0.474	0.365	.	.
Spain		0.332	0.399	0.243	0.425	0.208	0.292	0.331	0.243	−0.088
Sweden		0.304	0.436	0.134	0.449	0.023	0.173	0.277	0.134	−0.143
Switzerland		0.268	0.400	0.163	0.328	0.009	0.128	0.226	0.163	−0.063
Thailand		0.282	0.219	0.246	0.283	0.150	0.218	0.223	0.282	0.058
Turkey		0.300	0.235	0.290	0.237	0.211	0.288	0.254	0.290	0.036
UK		0.310	0.496	0.157	0.481	0.055	0.108	0.290	0.157	−0.133
USA		0.261	0.481	0.144	0.480	−0.041	−0.004	0.265	−0.004	−0.270
	Mean							0.277	0.192	−0.083
	T							(22.07)	(5.71)	(−3.10)

Table VI
Local and global consumption exposure of the dividend growth process

The first panel of this table summarizes the result of the panel regression

$$\Delta d_t^i = \gamma_l \Delta c_t^i + \gamma_g \Delta c_t^* + C_i + T_t + \epsilon_{i,t},$$

where Δc_t^i and Δd_t^i are annual consumption and dividend growth rates of country i, Δc_t^* is the global consumption growth, and C_i and T_t are country and year fixed effects. Panel B shows the time-series regression of dividend growth regressed on local and global consumption growth for each country. The last row summarizes the cross-sectional average of the coefficients and the adjusted-R^2s. The standard error of the average is computed by taking the standard deviation of the coefficients across different countries divided by the number of countries.

Panel A. Panel regression of dividend growth

	Dep var: Δd_t^i				
Δc_t^i	4.950	0.731		1.514	0.731
	(5.32)	(0.99)		(1.78)	(0.99)
Δc_t^*			11.690	9.799	6.537
			(7.72)	(5.04)	(7.33)
FE Country	Y	Y	Y	Y	Y
FE Time	N	Y	N	N	Y
	0.234	0.462	0.330	0.339	0.462

Panel B. Time-series regression of dividend growth by country

	Δc_t^i	Δc_t^*	Adj-R^2		Δc_t^i	Δc_t^*	Adj-R^2
Australia	4.280	6.200	0.481	Malaysia	12.220	−10.440	0.599
	(2.22)	(2.39)			(4.06)	(−1.61)	
Austria	2.640	9.830	0.322	Mexico	5.690	−10.610	0.033
	(0.41)	(1.03)			(2.20)	(−1.61)	
Belgium	−7.220	20.580	0.487	Netherlands	4.010	6.960	0.297
	(−2.48)	(4.44)			(1.40)	(2.22)	
Brazil	3.940	5.190	0.247	Norway	2.550	10.640	0.404
	(2.69)	(1.82)			(0.84)	(1.86)	
Canada	10.100	−3.260	0.585	NZ	3.060	10.320	0.306
	(3.28)	(−0.72)			(0.89)	(4.53)	
China	1.070	10.130	0.236	Russia	1.710	7.950	0.122
	(0.44)	(1.72)			(0.92)	(1.44)	
Finland	8.940	4.280	0.337	Singapore	2.260	10.970	0.566
	(1.46)	(0.64)			(1.67)	(2.92)	
France	−0.040	11.670	0.471	S. Africa	2.260	7.800	0.460
	(−0.01)	(1.25)			(1.26)	(3.19)	
Germany	2.480	8.980	0.409	Sweden	−5.260	17.820	0.560
	(1.04)	(5.29)			(−1.05)	(2.70)	
India	−1.950	16.530	0.362	Switzerland	−0.820	11.070	0.413
	(−1.14)	(3.73)			(−0.28)	(6.15)	
Indonesia	8.530	1.800	0.296	Thailand	5.430	10.790	0.597
	(2.28)	(0.43)			(2.39)	(4.03)	
Italy	0.300	13.160	0.356	Turkey	0.790	14.350	0.338
	(0.08)	(1.86)			(0.92)	(3.37)	
Japan	−14.280	16.220	0.570	UK	−1.290	12.750	0.579
	(−4.96)	(4.42)			(−0.71)	(2.58)	
Korea	−2.570	16.900	0.287	USA	−2.720	12.520	0.542
	(−0.87)	(2.97)			(−1.12)	(7.51)	
Average	1.647	8.968	0.402				
T	(1.61)	(6.37)					

Table VII
Hedging global uncertainty risk

Panel A of this table summarizes the contemporaneous quarterly panel regressions of the quarterly first-order difference in sovereign bond yields regressed on the first difference in the stock market variance ($\exp(h_t^*)$) of the global index, the SB beta, and their product. The variance is estimated using a stochastic volatility model as described in the text. In the last two columns of the panels, the SB beta is replaced by the SB correlation. In Panel B, sovereign yields are adjusted by the lagged quarterly inflation rate. In Panel C, annualized inflation rate is regressed on stock returns, SB beta, and their product. The standard errors are clustered by quarter.

Panel A. Dependent variable is changes in yields

	Dep . variable: First difference in nominal yields				
$\Delta\exp(h_t^*/2)$	1.040	3.253	3.258	3.178	3.180
	(0.34)	(1.06)	(1.09)	(1.03)	(1.05)
$\Delta\exp(h_t^*/2)\times$ SB Beta		0.506	0.512		
		(4.75)	(5.11)		
SB Beta		0.004	0.006		
		(2.85)	(3.21)		
$\Delta\exp(h_t^*/2)\times$ SB Cor				0.501	0.507
				(4.32)	(4.48)
SB Cor				0.114	0.145
				(1.59)	(1.70)
Country Fixed Effect	N	N	Y	N	Y
R^2	0.000	0.017	0.029	0.152	0.025
Number of Obs.	3,131	3,131	3,131	3,131	3,131

Panel B. Dependent variable is changes in the estimated real yields

	Dep . variable: First difference in real yields				
$\Delta\exp(h_t^*/2)$	−55.602	−48.570	−49.940	−47.268	−49.956
	(−2.03)	(−1.79)	(−1.82)	(−1.73)	(−1.81)
$\Delta\exp(h_t^*/2)\times$ SB Beta		1.613	1.338		
		(2.77)	(1.98)		
SB Beta		−0.039	0.026		
		(−3.86)	(2.53)		
$\Delta\exp(h_t^*/2)\times$ SB Cor				1.644	1.428
				(2.95)	(2.01)
SB Cor				−1.701	0.645
				(−3.12)	(1.76)
Country Fixed Effect	N	N	Y	N	Y
R^2	0.007	0.013	0.107	0.016	0.106
Number of Obs.	2,911	2,911	2,911	2,911	2,911

Panel C. Stock markets hedging inflation risk

	Dep. variable: Annualized changes in CPI (%)				
$R^i_{m,t}$	1.750	1.029	0.710	1.039	0.530
	(1.43)	(0.85)	(0.61)	(0.79)	(0.42)
$R^i_{m,t}\times$ SB Beta		0.069	−0.002		
		(1.07)	(−0.05)		
SB Beta		0.055	−0.004		
		(5.82)	(−0.45)		
$R^i_{m,t}\times$ SB Cor				0.017	−0.942
				(0.08)	(−0.50)
SB Cor				2.272	0.151
				(3.72)	(0.43)
Country Fixed Effect	N	N	Y	N	Y
R^2	0.001	0.010	0.101	0.011	0.101
Number of Obs.	2,857	2,911	2,911	2,911	2,911

Table VIII
Local and global volatility of variance and the SB Relationship

This table summarizes the results of the contemporaneous panel regressions of the estimated SB betas (Panel A) and SB correlations (Panel B) regressed on the volatility of stock market variance (VOV) estimated in several ways. $\exp(h_t^*)$ and $\exp(h_t^i)$ are the variance of the global and country stock market returns estimated using a stochastic volatility model, where variance equals the volatility of variance. The (idiosyncratic) volatility of RV is calculated using intraday data of the corresponding stock market index. For each country, the volatility of RV is defined as the forecast error of the HAR-RV Model of Corsi (2009). The Idiosyncratic volatility of RV is computed by regressing the forecast errors of country i's RV on the cross-country simple average forecast error and taking the standard deviation of the residuals.

Panel A. Dependent variable is SB beta

	Dep . Variable: $\hat{\beta}^i$				
$\exp(h_t^i)$	10.573	12.450	88.925		
	(2.74)	(3.21)	(2.24)		
$\exp(h_t^*)$	−17.298	−65.370	−16.884		
	(−2.26)	(−0.61)	(−2.26)		
Idiosyncatic vol. of RV				51.537	34.413
				(4.27)	(3.01)
Volatility of RV				−33.543	−20.957
				(−3.10)	(−2.05)
FE Country	N	N	Y	N	Y
FE Time	N	Y	Y	Y	Y
R^2	0.043	0.302	0.532	0.242	0.525
# of Obs.	2,824	2,824	2,824	1,568	1,568

Panel B. Dependent variable is SB correlation

	Dep: SB correlation (ρ^i)				
$\exp(h_t^i)$	0.578	0.657	0.247		
	(7.22)	(7.89)	(3.87)		
$\exp(h_t^*)$	−0.531	−1.022	−1.536		
	(−8.20)	(−0.37)	(−0.66)		
Idiosyncatic vol. of RV				1.227	0.439
				(4.91)	(1.87)
Volatility of RV				−0.807	−0.261
				(−3.77)	(−1.25)
FE Country	N	N	Y	N	Y
FE Time	N	Y	Y	Y	Y
R^2	0.056	0.406	0.652	0.249	0.612
# of Obs.	2,824	2,824	2,824	1,568	1,568

Table IX
Panel regressions of stock-bond relationship on volatility

This table summarizes the results of the contemporaneous panel regressions of the estimated SB betas/correlations regressed on the volatility of the first difference in local bond yields (SD(Δy^i)) and local stock returns (SD(R_m^i)). The SB betas ($\hat{\beta}^i$) and the SB correlations ($\hat{\rho}^i$) are estimated using daily data on a 30 calendar-day rolling window. Standard errors are clustered by month.

	Dep. var.: $\hat{\beta}^i$				Dep. var.: $\hat{\rho}^i$			
SD(Δy^i)	16.769	14.952	4.953	4.224	0.522	0.494	0.204	0.154
	(3.99)	(4.10)	(3.10)	(2.80)	(3.70)	(3.86)	(2.35)	(2.41)
SD(R_m^i)	−1.600	−0.777	−1.345	−0.976	−0.017	0.023	−0.018	0.010
	(−5.09)	(−2.37)	(−5.98)	(−3.11)	(−2.90)	(3.69)	(−2.98)	(1.97)
FE Country	N	N	Y	Y	N	N	Y	Y
FE Time	N	Y	N	Y	N	Y	N	Y
R^2	0.062	0.206	0.382	0.382	0.049	0.255	0.274	0.468
# of Obs.	8,130	8,130	8,130	8,130	8,130	8,130	8,130	8,130

Table X
Does high country-specific volatility of variance predict relative stock market returns?

This table summarizes the mean and the Fama-Macbeth standard errors of the cross-sectional regression using leading monthly country stock returns converted to USD as the dependent variable and bond yield ($\mathrm{SD}(\Delta y^i)$) and stock return ($\mathrm{SD}(R_m^i)$ volatility, the idiosyncratic volatility of country stock returns with respect to the ICAPM (Ivol), the idiosyncratic volatility of variance (Ivol of variance), and the SB beta($\hat{\beta}^i$) as explanatory variables. bond yield and stock return volatility are estimated using a 90-day rolling window, and Ivol and Ivol of variance is estimated using a 365-day rolling window, the SB beta is estimated using a 180-day rolling window.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Intercept	0.681∗	0.499	0.514	0.526	0.784∗	0.544	0.521	0.559
	(1.75)	(1.38)	(1.46)	(1.45)	(1.92)	(1.41)	(1.47)	(1.47)
$\mathrm{SD}(\Delta y^i)$	91.017	46.763			11.452	−90.111		
	(0.41)	(0.22)			(0.05)	(−0.39)		
$\mathrm{SD}(R_m^i)$		20.835				31.526		
		(0.70)				(1.06)		
Ivol			12.907				15.350∗	
			(1.42)				(1.74)	
Ivol of Variance				19.352∗∗∗				25.663∗∗∗
				(3.02)				(3.52)
$\hat{\beta}^i$					0.027∗∗	0.026∗∗	0.031∗∗∗	0.020∗
					(2.48)	(2.44)	(2.79)	(1.68)
Average R^2	0.079	0.169	0.082	0.083	0.136	0.213	0.129	0.178

Table XI
Calibration

This table provides the parameter specification (Panel A) of the model. Panel B provides the model-implied asset pricing moments based on these parameter specifications. Net total stock returns are used for the post 1999 sample, price index returns are used for the post 1990 sample. Real variables are computed by subtracting the ex-post log changes in the CPI from nominal variables. Δy^i is changes in 10-year yields of country i, and $*$ denotes global variables. R_m^i is the stock return of country i in local currency. R_m^* is the return of the USD-denominated global value-weighted index. All variables are annualized.

Panel A. Parameter Specification

Preference parameters		Consumption parameters	
γ	15	μ	0.0015
ψ	2	$\xi_g = \xi_l$	0.979
β	0.9985	λ_x	0.25
		φ_x	0.044
Dividend Parameters		**Variance parameters**	
μ_d	0.0025	v_{g1}	0.912
ϕ	5.0	$\sqrt{\bar{v_t}^*}$	0.0036
λ_d	0.3	v_{l1}	0.972
φ_d	4.0	$\sqrt{\bar{v_t}^i}$	0.0049
		σ_g	9.0×10^{-7}
		σ_l	2.3×10^{-6}

Correlations	Model 1	Model 2
ρ_{cv}	−0.30	−0.30
ρ_{cd}	0.45	0.45
ρ_{cx}	0.00	−0.40
ρ_{nr}	0.00	−0.30

Panel B. Consumption growth and asset pricing moments

	Model		Data			
			US		World Average	
	Model 1	Model 2	1990–	1999–	1990–	1999–
μ	1.80%	1.80%	1.43%		1.67%	
σ	2.11%	2.11%	1.12%		2.14%	
Real yields (10Y)	1.74%	2.12%	1.96%	1.19%	2.00%	1.89%
Nominal yields (10Y)	3.71%	4.09%	4.20%	3.31%	4.46%	4.22%
Real stock returns	5.89%	4.37%	5.41%	5.08%	3.26%	4.27%
Nominal stock returns	7.87%	6.35%	7.81%	7.20%	5.72%	6.60%
Nominal stock market volatility	21.44%	19.88%	17.44%	18.65%	24.06%	23.30%
SB Cor, real	−0.276	−0.033	−0.216	−0.433	−0.135	−0.333
SB Cor, nominal	−0.302	−0.128	−0.290	−0.598	−0.300	−0.405
$\text{Cor}(\Delta^i y, \Delta y^*)$, nominal	0.658	0.783	0.833	0.832	0.751	0.733
$\text{Cor}(\Delta^i y, \Delta y^*)$ real	0.648	0.708	0.818	0.866	0.689	0.667
$\text{Cor}(R_m^i, R_m^*)$, nominal	0.873	0.865	0.899	0.979	0.758	0.785
SB beta, real	−32.560	−15.749	−2.948	−4.337	−4.623	−6.103
SB beta, nominal	−39.060	−4.136	−3.818	−12.910	−5.778	−12.890

A. Data Appendix

1. Details of the data sources

The dataset consists of international stock index and bond yield data obtained from Bloomberg. As a primary specification, the Morgan Stanley Capital International (MSCI) net total returns index represents the aggregate country-level equity prices. It is supplemented by the price index, which is available daily for a more extended sampling period. I use the indices denominated in local currency to compute daily, weekly, and monthly stock returns. When evaluating the performance of investment strategies, I convert these to USD, using the exchange rates sourced from Bloomberg. As daily returns are never converted to a common currency in this paper, variation in the timing zone is not relevant for the conversion. In addition to the country-level stock returns, I also obtain the stock returns of the global value-weighted portfolio. The MSCI value-weighted stock index returns are used to proxy global stock returns when calculating the international capital asset pricing model (ICAPM) beta, as described below.

Bond yields are represented by the ten-year Treasuries, all of which are denominated in their respective local currency. The main reason for choosing the ten-year maturity yields is data availability. Ten-year yields are available for the longest sampling period at the daily interval, which is critical since the availability of bond yield data mainly restricts the sample. Although this paper does not particularly study the term-structure implications, as shown by Jones and Pyun (2021), there should be a very high relationship between short-term and long-term yields when the main interest is to evaluate the relationship to stock returns. Another reason is that compared to short-term such as the three-month, ten-year yields are less subjected to central bank intervention. The term spread is used as a control variable in the empirical analysis.

I use the sovereign credit default swap (CDS) spread to decompose bond yields into sovereign default spread and the risk-free component. The CDS data is obtained from the intercontinental exchange, whereby the last quoted mid-price of the week and month is chosen to compute the implied default spread in the sovereign bonds. The data covers 2004-2021.

The provided model assumes that the dividend growth process is exposed to local and global consumption shocks. To estimate the exposure, I take the difference in log returns of the net total return index and the price index. Then I convert the value to USD and adjust for inflation. Consumption growth is the annual change in final consumption expenditure in constant 2010 USD, obtained from the Organization for Economic Co-operation and Development. Both consumption and dividend growth are measured annually.

Several country-level macroeconomic variables are used as control variables in the empirical analyses. Global and country-level inflation rates are obtained from the World Bank, and country-level total gross domestic product (GDP), GDP per capita, and total exports, are denominated in USD and sourced from the International Monetary Fund database. Inflation data is used at the quarterly frequency to compute real yields. The data is sourced from the Worldbank, and the measurement follows **?**.

2. Estimation of the international CAPM

Finally, the last column of Table I summarizes the ICAPM beta of Dumas and Solnik (1995). The currency factor is added when estimating the beta and captures temporary deviations from the parity relationship, which plays a crucial role in international investments. The ICAPM beta is estimated using the following equation:

$$R^{i,USD}_{m,t+1} = b^i_0 + b^i_g R^{USD}_{\text{MSCI},t+1} + b^i_1 \Delta q^i_{t+1} + \epsilon^i_{t+1}, \tag{15}$$

where $R^{i,USD}_{m,t+1}$ is the log return of the country i's stock index, $R^{USD}_{\text{MSCI},t+1}$ denotes the log returns of the MSCI World Index, and q^i_{t+1} is the log price of country i's currency relative to USD. Then, risk-adjusted returns are computed as:

$$R^{i,USD}_{m,t} - \hat{b}^i_g R^{USD}_{\text{MSCI},t} - \hat{b}^i_q \Delta q^i_{t+1}.$$

When risk-adjusting the price index (net total) returns, the beta from the ICAPM using price (net total) index returns are used.

3. Variance estimation

Since the relative importance of local and global variance risk influences the time-variation in the SB relationship, in the empirical analysis, I estimate the stochastic volatility (SV) model, where the log of volatility has constant variance. The stochastic volatility model is estimated using the Markov Chain Monte Carlo (MCMC) method and is given by:

$$R^i_{m,t} = b^i_0 + b^i_g R^*_{m,t} + b^i_q \Delta q^i_t + \exp(h^i_t/2)\eta^i_{1,t} \quad (16)$$

$$h^i_t = \mu^i_h + \nu^i_h(h^i_{t-1} - \mu^i_h) + \sigma^i_h \eta^i_{2,t}, \quad (17)$$

where η^i_t and ϵ^i_t are standard normal errors, $R^i_{m,t}$ is the local currency stock market return of country i, R^*m,t is the value-weighted global stock index denominated in USD, Δq^i_t is the change in log currency value relative to USD. I estimate this model for every country and for the global stock index using weekly net total returns. This specification is not affected by asynchronous trading hours of the stock market. I use the MCMC scheme developed by Hosszejni and Kastner (2021) only once using the entire data.[8] In this model, Ito's lemma

[8] In testing for the heteroskedasticity of the first difference in log volatility estimates, the null hypothesis of homoskedasticity is rejected only 5 of the 30 countries

implies that the volatility of variance equals the variance ($\exp(h_t^i)$) of the returns. For the value-weighted index in USD, the estimate model is

$$R_{m,t}^* = b_0^* + \exp(h_t^*/2)\eta_{1,t}^* \tag{18}$$

$$h_t^* = \mu_h^* + \nu_h^*(h_{t-1}^* - \mu_h^*) + \sigma_h^* \eta_{2,t}^*, \tag{19}$$

where η_t^* and ϵ_t^* are standard normal errors.

This return process is similar to a typical ICAPM in that it has the global stock returns and currency returns as two factors. If log volatility has a constant variance, using Ito's lemma, it can be shown that this specification implies the volatility of variance is a direct function of the variance. In this model, the volatility of variance is related to the variance, whereas the model implies that it is related to the volatility. In the empirical section, I test whether the volatility of variance of a country, proxied by $\exp h_t^i$, is associated with the SB correlation and beta.

In addition to the SV model, the volatility of variance is more directly estimated from intraday stock index returns. The stock market realized variance is computed using the sum of squared five-minute index returns, which is available from the Oxford-Man Realized Library Heber, Lunde, Shephard, and Sheppard (2009). The library is initially sourced from the Thomson Reuters Tick History database and covers realized variance estimates for 20 countries from 2000. Among countries with multiple indices in the database, I choose the BSE Sensex index for India and the Shanghai Composite Index for China. The realized variance (RV) is estimated by taking the average over five subsamples to minimize microstructure error in all instances.

I use intraday stock market index data for 20 countries and apply a version of the Heterogeneous Autoregressive Realized Variance (HAR-RV) model of Corsi (2009) to obtain a predicted value of the realized variance at the weekly frequency. The regression used to estimate the variance forecast is

$$RV_{t+1,t+5|t} = \alpha_0 + \alpha_w RV_{t-4,t} + \alpha_m RV_{t-21,t} + \epsilon_{t+1,t+5},$$

where RV_{t_0,t_1} is defined as the sum of squared intraday returns between day t_0 and t_1, both inclusive. Then, I take the first-order difference of the weekly forecast at the end of every week. To estimate the variance innovation for the global stock market, I take the simple average of all variance innovations across countries.[9]

To estimate the volatility of county-specific variance shocks, I estimate a three-month rolling window regression of:

$$RV^i_{w,t+1} - \widehat{RV^i_{w,t+1|t}} = \beta^i_0 + \beta^i_w (RV^*_{w,t+1} - \widehat{RV^*_{w,t+1|t}}) + \epsilon^i_{t+1},$$

where $RV_{w,t+1}$ is the weekly sum of the daily RV and $\widehat{RV_{w,t+1|t}}$ is the prediction formed based on the HAR-RV above. The idiosyncratic volatility of variance of the local stock market is estimated as the root-mean-squared error of the above regression. The idiosyncratic volatility of variance is simply the volatility of the left-hand-side variable.

4. Measurement of illiquidity

Exposures to global illiquidity (Bekaert, Harvey, and Lundblad 2007) and illiquidity of Treasury bonds (Goyenko and Sarkissian 2014) are variables that are known to predict the cross-sectional difference in international stock returns. I follow Goyenko and Sarkissian (2014) to construct a measure of Treasury illiquidity. First, I compute the average percentage quoted bid-ask spread of off-the-run US T-bills maturity with less than one year available from the Center for Research

[9] It can be shown that in the model, with a large number of countries, the cross-country average of all shocks to consumption variance equals shocks to the global variance.

in Security Prices (CRSP) daily Treasury Quotes file. Then, for each month, I take the average spread for each security and the equally-weighted average across assets. Since this measure is persistent, I follow Goyenko and Sarkissian (2014) and take the residual of an autoregressive model of order 2. Each country's exposure to this residual is estimated after controlling for the global stock market index.

Measures of zero returns and zero trading volume is estimated similarly. I use US data to measure the fraction of days that have zero returns (trading volume) for each stock and month. Then, each month, I take the simple average of these fractions to construct a monthly measure of US illiquidity. Similar to the above, I take the residual of an autoregressive model of order 2. Each country's exposure to this residual is estimated after controlling for the global stock market index.

B. Technical Appendix

1. Consumption dynamics and the wealth portfolio

Denote the state vector as

$$\vec{S}_t^i = \begin{bmatrix} \Delta c_t^i & \Delta d_t^i & x_t^* & x_t^i & v_t^* & v_t^i \end{bmatrix}'$$

We can write the conditional mean as

$$\mathrm{E}_t \left[\vec{S}_{t+1} \right] = S_0 + S_1 \vec{S}_t^i,$$

where

$$S_0 = \begin{bmatrix} \mu & \mu_d & 0 & 0 & g_0 & l_0 \end{bmatrix}'$$

and

$$S_1 = \begin{bmatrix} 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & \phi(1-\lambda_d) & \phi\lambda_d & 0 & 0 \\ 0 & 0 & \xi_g & 0 & 0 & 0 \\ 0 & 0 & 0 & \xi_l & 0 & 0 \\ 0 & 0 & 0 & 0 & g_1 & 0 \\ 0 & 0 & 0 & 0 & 0 & l_1 \end{bmatrix}$$

The conditional covariance matrix is

$$\mathrm{Cov}_t\left(\vec{S}_{t+1}, \vec{S}'_{t+1}\right) = V_G v_t^* + V_L v_t^i,$$

where

$$V_G = \begin{bmatrix} 1 & \varphi_d\phi(1-\lambda_d)\rho_{cd} & \sqrt{1-\lambda_x}\varphi_x\rho_{cx} & 0 & \rho_{cv}\sigma_g & 0 \\ \varphi_d\phi(1-\lambda_d)\rho_{cd} & \varphi_d^2\phi^2(1-\lambda_d)^2 & \rho_{cd}\varphi_d\phi(1-\lambda_d)\rho_{cd}\rho cx\varphi_x\sqrt{1-\lambda_x} & 0 & \rho_{cd}\varphi_d\phi(1-\lambda_d)\rho_{cv}\sigma_g & 0 \\ \sqrt{1-\lambda_x}\varphi_x\rho_{cx} & \rho_{cd}\varphi_d\phi(1-\lambda_d)\rho_{cd}\rho_{cx}\varphi_x\sqrt{1-\lambda_x} & \varphi_x^2 & 0 & \sigma_g\varphi_x\rho_v & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ \rho_{cv}\sigma_g & \rho_{cd}\varphi_d\phi(1-\lambda_d)\rho_{cv}\sigma_g & \sigma_g\varphi_x\rho_v & 0 & \sigma_g^2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

and

$$V_L = \begin{bmatrix} 1 & \varphi_d\phi\lambda_d\rho_{cd} & 0 & \sqrt{\lambda_x}\varphi_x\rho_{cx} & 0 & \rho_{cv}\sigma_l \\ \varphi_d\phi\lambda_d\rho_{cd} & \varphi_d^2\phi^2\lambda_d^2 & \rho_{cd}\varphi_d\phi\lambda_d\rho_{cd}\rho_{cx}\varphi_x\sqrt{\lambda_x} & 0 & \rho_{cd}\varphi_d\phi\lambda_d\rho_{cv}\sigma_g & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ \sqrt{\lambda_x}\varphi_x\rho_{cx} & \rho_{cd}\varphi_d\phi\lambda_d\rho_{cd}\rho_{cx}\varphi_x\sqrt{\lambda_x} & 0 & \varphi_x^2 & 0 & \sigma_l\varphi_x\rho_v \\ 0 & 0 & 0 & 0 & 0 & 0 \\ \rho_{cv}\sigma_l & \rho_{cd}\varphi_d\phi\lambda_d\rho_{cv}\sigma_g & 0 & \sigma_l\varphi_x\rho_v & 0 & \sigma_l^2 \end{bmatrix}$$

The SDF of country i can be represented by

$$m_{t+1} = m_0 + M'\vec{S}_{t+1} - (\theta - 1)\vec{A}'\vec{S}_t^i$$

with

$$m_0 = \theta \log \beta + (\theta - 1)\left(\kappa_0 + A_0(\kappa_1 - 1)\right),$$

$$M = \begin{bmatrix} -\gamma & 0 & (\theta-1)\kappa_1 A_{xg} & (\theta-1)\kappa_1 A_x & (\theta-1)\kappa_1 A_g & (\theta-1)\kappa_1 A_l \end{bmatrix}'$$

$$A = \begin{bmatrix} 0 & 0 & A_x & A_{xg} & A_g & A_l \end{bmatrix}'$$

. The values for A is solved by using the method of undetermined coefficients from the Euler equation . $m_{t+1}^i + R_{TW,t+1}^i$ can be represented by:

$$e_{w,0} + E_{w,2}'\vec{S}_{t+1} - E_{w,1}'\vec{S}_t,$$

where $e_{w,0} = m_0 + (\kappa_0 + A_0(\kappa_1 - 1))$ Therefore, we need the following conditions:

$$\begin{aligned}
&A_{xg} = A_x = \frac{1 - \frac{1}{\psi}}{1 - \kappa_1 \xi_g} \\
&\theta(\kappa_1 g_1 - 1)A_g + 0.5E_{w,2}'V_G E_{w,2} = 0 \\
&\theta(\kappa_1 l_1 - 1)A_l + 0.5E_{w,2}'V_L E_{w,2} = 0 \\
&e_{w,0} + E_{w,2}'S_0 = 0,
\end{aligned}$$

where the first equation follows from $\xi_g = \xi_l$ and

$$E_{w,2} = \begin{bmatrix} 1-\gamma & 0 & \theta\kappa_1 A_{xg} & \theta\kappa_1 A_x & \theta\kappa_1 A_g & \theta\kappa_1 A_l \end{bmatrix}'$$

The formula for A_g and A_l is solved from a quadratic equation, but only one of the values provides with a reasonable number. If values of the components of A are known, we can derive the formula for a one-period as well as a 10-year bond.

2. Multi-period bond yields

The log price of a riskless one-period bond ($B_{1,t}$) is derived by

$$\begin{aligned} B_{1,t}^i =& \mathrm{E}_t\left[m_{t+1}^i\right] + 0.5\mathrm{Var}_t\left(m_{t+1}^i\right) \\ =& m_0 + M'S_0 + \left(M'S_1 - (\theta-1)A'\right)\vec{S}_t^i + 0.5M'V_GMv_t^* + 0.5M'V_LMv_t^i \\ =& m_0 + M'S_0 + \left(M'S_1 - (\theta-1)A' + 0.5\Psi'\right)\vec{S}_t^i, \end{aligned}$$

where

$$\Psi' = \begin{bmatrix} 0 & 0 & 0 & M'V_GM & M'V_LM \end{bmatrix}'.$$

Therefore, the yield of a one-period bond is represented by

$$y_t^i = (-m_0 - M'S_0) + \left(-M'S_1 + (\theta-1)A' - 0.5\Psi'\right)\vec{S}_t^i.$$

Now suppose that the n-period bond has a log price

$$B_{n,t}^i = D_{n,0} + D_n'\vec{S}_t^i.$$

Then the $(n+1)$-period bond has a price that is equal to the conditional expectation of

$$\mathrm{E}_t\left[m_{t+1} + B_{n,t+1}\right] + 0.5\mathrm{Var}_t\left(m_{t+1} + B_{n,t+1}\right),$$

where

$$m_{t+1} + B_{n,t+1} = m_0 + D_{n,0} + (M' + D_n)'\vec{S}_{t+1}^i - (theta-1)A'\vec{S}_t^i.$$

The log price of the bond can be solved as

$$\begin{aligned}
B_{n,t+1} =& m_0 + D_{n,0} + (M + D_n)'(S_0 + S_1 \vec{S}_t^i) - (\theta - 1)A'\vec{S}_t^i + 0.5(M + D_n)'\mathrm{Cov}_t\left(\Sigma_{t+1}, \Sigma'_{t+1}\right)(M_1 + D_n) \\
=& m_0 + D_{n,0} + (M + D_n)'S_0 + \left((M + D_n)'S_1 - (\theta - 1)A'\right)\vec{S}_t^i + 0.5\Psi'_n \vec{S}_t^i,
\end{aligned}$$

where

$$\Psi_n = \begin{bmatrix} 0 & 0 & 0 & (M + D_n)'V_G(M + D_n) & (M + D_n)'V_L(M + D_n) \end{bmatrix}'$$

The log of $(n + 1)-$period bond price is therefore

$$B_{n+1,t} = D_{n+1,0} + D'_{n+1}\vec{S}_t^i,$$

where

$$D_{n+1,0} = m_0 + D_{n,0} + (M + D_n)'S_0$$

and

$$D_{n+1} = S'_1(M + D_n) - (\theta - 1)A + \frac{1}{2}\Psi_n.$$

The $(n + 1)-$period yield is derived as

$$y_{n+1,t}^i = Y_{n+1,0} + Y_{n+1}\vec{S}_t^i,$$

where $Y_{n+1,0} = -D_{n+1,0}$ and $Y_{n+1} = -D_{n+1}$. Therefore, Y_{n+1} can further be represented by

$$Y_{n+1} = \begin{bmatrix} 0 & Y_{n+1,xg} & Y_{n+1,x} & Y_{n+1,v} & Y_{n+1,p} \end{bmatrix}'$$

The nominal pricing kernel is

$$m^i_{n,t+1} = m^i_{t+1} - \pi_{t+1},$$

where π^i_t is the one-period expected inflation rate of country i at time t. Define the matrix $N = (M'| - 1)'$ where $(\cdot| \cdot \cdot)$ denotes the augmented matrix of $\cdot$ and $\cdot\cdot$ and $\vec{S}^i_{n,t} = \left(\vec{S}^i_t | \pi^i_t\right)'$. Then, $S_{n,0} = (S_0'|p_0)'$ and

$$S_{n,1} = \left(\begin{array}{c|c} S_1 & 0 \\ \hline 0 & p_1 \end{array}\right)$$

Then, the formula for the nominal multi-period bond follows by replacing M, $S_{n,0}$, $S_{n,1}$ $(A|0)$, and $\vec{S}^i_{n,t}$ with N, S_0, S_1, A, and $\vec{S}^i_t$ respectively.

3. Dividend dynamics and stock returns

The price-dividend ratio ($z^i_{m,t}$) of country i's stock market is conjectured to be a linear function of the local and global state variables. Following the logic above, let the price/dividend ratio can be represented by $z^i_{m,t} = B'\vec{S}^i_t$, where

$$B = \begin{bmatrix} 0 & 0 & B_x & B_{xg} & B_g & B_l \end{bmatrix}'.$$

The solutions for the coefficients can be solved using the Euler equation

$$\mathrm{E}_t[m^i_{t+1} + R^i_{m,t+1}] + 0.5\mathrm{Var}_t[m^i_{t+1} + R^i_{m,t+1}] = 0.$$

$m^i_{t+1} + R^i_{m,t+1}$ can be represented by:

$$e_0 + E_2'\vec{S}^i_{t+1} - E_1'\vec{S}^i_t,$$

where

$$e_0 = m_0 + (\kappa_{m,0} + B_0(\kappa_{m,1} - 1))$$

$$E_2 = \begin{bmatrix} -\gamma & 1 & (\theta-1)\kappa_1 A_{xg} + \kappa_{m,1}B_{xg} & (\theta-1)\kappa_1 A_x + \kappa_{m,1}B_x & (\theta-1)\kappa_1 A_g + \kappa_{m,1}B_g & (\theta-1)\kappa_1 A_l + \kappa_{m,1}B_l \end{bmatrix}'$$

and some E_1, which need not be specified to describe the final formula. One can verify that the coefficients in matrix B solves equations:

$$\begin{aligned}
B_{xg} &= \frac{(1-\lambda_d)\phi - \frac{1}{\psi}}{1-\kappa_1\xi_g} \\
B_x &= \frac{\lambda_d\phi - \frac{1}{\psi}}{1-\kappa_1\xi_l} \\
&((\theta-1)A_g + B_g(\kappa_1 g_1 - 1)) + 0.5E_2'V_G E_2 = 0 \\
&\theta(\kappa_1 l_1 - 1)A_l + 0.5E_2'V_L E_2 = 0 \\
&e_0 + E_2'S_0 = 0,
\end{aligned}$$

where similar to the above, the variance terms solves a quadratic equation, only one of the two gives a reasonable value. Then, market returns are defined as $\Delta d^i_{t+1} + \kappa_{m,0} + \kappa_{m,1}z^i_{m,t+1} - z^i_{m,t}$, which takes the form of

$$R_0 + R'\vec{S}^i_t,$$

where R is defined as

$$R = \begin{bmatrix} 0 & 1 & R_{xg} & R_x & R_g & R_l \end{bmatrix}'$$

. Given the formula for stock returns and bond yields, deriving the second moments and the covariance between stock returns and innovation in 10-year bond yields is straightforward.

4. International stock market risk premium

As shown in the main paper, it is sufficient to derive the risk premium of stock investment implied by the local investor in local currency. To better understand this assertion, the expected excess return of the stock market investment in country i for the global investor is

$$E[R^i_{m,t+1} + \Delta q^i_{t+1}] - y^*_t.$$

Applying the UIRP relationship ($E_t[\Delta q^i_{t+1}] = y^*_t - y^i_t$), one can see that the above becomes

$$E[R^i_{m,t+1}] - y^i_t.$$

The UIRP relationship holds since

$$\begin{aligned} E_t[\Delta q^i_{t+1}] + 0.5Var_t[\Delta q^i_{t+1}] &= E_t[m^i_{t+1}] + 0.5Var_t[m^i_{t+1}] - E_t[m^*_{t+1}] - 0.5Var_t[m^*_{t+1}] \\ &= y^*_t - y^i_t, \end{aligned} \tag{20}$$

and the currency risk premium for the global investor is

$$Cov_t(-m^*_{t+1}, m^i_{t+1} - m^*_{t+1}) = 0,$$

where both of these relationships hold since all countries are homogeneous. Therefore, $Cov_t(m^i_{t+1}, m^*_{t+1}) = Var_t(m^*_{t+1})$.

The risk premium can be derived as

$$\begin{aligned} E_t[R^i_{m,t+1}] + 0.5Var_t[R^i_{m,t+1}] + E_t[m^i_{m,t+1}] + 0.5Var_t[m^i_{t+1}] &= Cov(-m^i_{t+1}, R^i_{t+1}) \\ &= -R'V_G M v^*_t + -R'V_L M v^i_t. \end{aligned}$$