The Dynamics of Stock and Bond Returns and the International Stock Market Risk Premium*

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ABSTRACT

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

Keywords: Stock-bond correlation, international stock market, local variance risk, global variance risk

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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.In particular, with recent developments in international exchange-traded funds and passive mutual funds, macroeconomic investments focusing on global market cycles have become popular. These strategies count on understanding how country-specific and global risk factors derive the returns of two major asset classes – bonds and stocks.

This paper finds that equity investments in countries with a negative relationship between stock and bond returns (denoted here as the SB relationship) have lower risk premia. It is natural to expect investments in these countries to be safer since bonds and stocks provide a 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, those that react most negatively, and the global value-weighted portfolio. At the end of 2020, the portfolio invested in countries with a positive SB relationship would be 6.31 dollars, higher than 3.51 dollars if invested in the global portfolio and 1.58 dollars if invested in countries with a negative SB relationship . Moreover, the value of the positive SB relationship portfolio fluctuates much more. I demonstrate that these countries have higher variance risk specific to the country, which cannot be easily hedged by investors.

Existing evidence indicates that time-varying variance is related to equity pricing. For example, in the US equity market, Bollerslev, Tauchen, and Zhou (2009) and Drechsler and Yaron (2011) show that the risk premium on market variance predicts future market returns. Moreover, Pyun (2019) suggests that the strength of such predictability should be time-varying. This paper demonstrates that the relative stock market performance depends on the amount of variance risk specific to the country. Since time-varying global risk is likely to affect the risk premium of all markets in the same direction (e.g., Bollerslev, Marrone, Xu, and Zhou 2014), country-specific variance risk should be an important determinant of the relative stock market performance. This assumption implies that countries with a more positive SB return relationship should have higher future returns.

Empirically, equity investments in countries whose stock market respond more negatively to changes in local bond yields (i.e., countries with positive SB relationships) have 6.48% – 8.52% higher returns than negative ones. The return difference remains significant, accounting for currency effects, and it is robust even when the relationship is measured after controlling for variation in global bond yields. Standard country-specific macroeconomic variables and return predictors such as dividend yields, momentum, and term spread do not explain the return difference. Moreover, the SB relationship is positive when various proxies of country-specific variance risk are high.

A simple consumption-based model is presented to show that a time-varying SB relationship is strongly associated with the dominance of country-specific variance 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. Thus, the variance in these two components of consumption growth determines bond yields. One key assumption of the model, which is validated later empirically, is that stock markets are more heavily exposed to global shocks compared to the consumption process. This assumption is motivated by the fact that firms produce goods and services to be consumed globally. Therefore, the stock and bond markets will also have asymmetric exposures to global and country-specific variance shocks.

In standard asset pricing models, where consumption variance varies over time, the relationship between the returns of real bonds and stocks is negative. Stock prices are lower when variance is high as investors require a higher risk premium during these times. Moreover, bond yields are lower since consumption decreases due to the precautionary motive, implying a negative SB relationship. In addition to these direct effects, bond yields also indirectly affect stock prices. If bond yields decrease, the discount rate of future dividends could fall, thus marginally increasing stock prices. This indirect channel is often ignored in a one-country model because the direct channel dominates.

Therefore, if there is no country-specific risk, the SB relationship will be strongly negative. However, as the country-specific risk increases, this relationship will increase due to the asymmetric exposure of stocks and bonds to the two variance components. To observe this, one should consider increasing global or country-specific variance, which would lead to an equal amount of decrease in yields. Both of these variance shocks will also reduce stock prices. However, since stocks are heavily exposed to global variance shocks, stock prices will react more negatively if yield changes are driven by the variance of the global component rather than changes driven by the variance of the country-specific component. Therefore, stock prices will react more to yield changes when global shocks dominate. The correlation between stock and bond returns (SB correlation) will also increase. Since lower bond yields induced by a higher country-specific variance lowers the discount rate of dividends, it will partially offset the stock price decrease caused by a heightened risk premium. As a result, the countries with more country-specific variance risk will have a more positive or less negative SB relationship, regardless of how the relationship is measured.

Moreover, hedging country-specific variance risk is not simple, even for global investors. A higher country-specific variance lowers bond yields and stock prices. If the uncovered interest rate parity (UIRP) holds, as implied in this model, then 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 also supported empirically by Hau and Rey (2006).

The empirical analysis strongly supports these predictions. The SB relationship is estimated as the negative slope of the regression where stock returns are regressed on changes in bond yields (called SB beta), both denominated in local currency. As noted earlier, countries with a positive SB relationship outperform countries with more negative relationships by 6.48% – 8.52%, depending on the data frequency. These results are robust for using the price index, which is available for a longer sample period; after controlling for the global yield changes; after controlling for sovereign default risk; and after risk-adjusting returns using the international capital asset pricing model (ICAPM; Dumas and Solnik 1995).

Furthermore, 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 and common return predictors of international stock market returns.

The data also strongly confirms that the time-varying SB relationship is governed by the relative dominance of country-specific variance risk. Two analyses are performed to verify the hypothesis. First, in the model, a square-root variance process is assumed where the volatility of variance strictly depends on the level of volatility. If this assumption holds, then the volatility of variance should be monotonically related to the level of volatility. Based on this premise, I use bond yield volatility to represent the volatility of the local economy, and I control for global volatility using the stock market return volatility, which should have a higher exposure to global shocks. Second, I use stock market data to estimate variance shocks of the country-specific component directly. For the considered specifications, the SB relationship is always more negative when global variance risk dominates local variance risk.

This paper indicates that country-specific variance risk is the key driver of the international stock market risk premium. Intuitively, whether the equity market whose shocks are dominated by global shocks should have a higher or a lower risk premium is ambiguous. The standard theory suggests a higher risk premium if the market faces similar shocks to the world. (e.g.,˜ Adler and Dumas 1983, De Santis and Gérard 1998). Lettau, Maggiori, and Weber (2014) also demonstrate that the global market factor is priced during bad economic times, supporting the theory that a high correlation between shocks to the local and global economies is likely to lead to a higher risk premium. Furthermore, Bollerslev, Marrone, Xu, and Zhou (2014) and Londono and Xu (2021) show that global variance risk is an important determinant of the time variation of the global premium. While these papers mainly study time-series predictability, the present paper focuses on relative cross-country performance. The analysis of this paper is consistent with other recent studies (e.g. Bakshi, Carr, and Wu 2008, Andersen, Fusari, and Todorov 2020) that highlight the importance of local risk factors as determinants of the risk premium.

This paper also contributes to two other research streams. The first is the literature on international stock market predictability. On the one hand. focusing on the emerging market, Bekaert, Harvey, and Lundblad (2007) document the importance of the global liquidity factor in predicting international equity market returns. On the other hand, 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. However, 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.[1] In the present paper, a new return predictor is introduced that contains new information about the international stock market risk premium.

The second research stream pertains 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 flight-to-quality mechanism is captured by the common global component of volatility.

The remainder of the paper is organized as follows: The next section provides a simple model that describes the main hypothesis of this paper. Section III describes the data used in the analysis. Section IV presents the main empirical result, Section V provides the test results of the model assumptions and implications. The paper concludes with a discussion of the main findings in Section VI.

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

II. Understanding the Relationship between Stock-Bond Return Dynamics and Variance Risk

In this section, I provide a stylized consumption-based model that demonstrates the connection between the two types of variance risk – country-specific and global variance risk – and the SB correlation or SB beta.

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." As noted above, local refers to a country affected by both 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

$$m^i_{t+1} = \theta \log \beta - \frac{\theta}{\psi} \Delta c^i_{t+1} + (\theta - 1) R^i_{TW,t+1}, \tag{1}$$

where β is the time discount factor, and Δc^i_{t+1} and $R^i_{TW,t+1}$ are the consumption growth and the log returns on the wealth portfolio, respectively for country i denominated in the local currency.

The global investor's SDF is represented by the same preference parameters, 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

$$\begin{aligned} \Delta c^*_{t+1} &= \mu + \sqrt{v^*_t} \epsilon^*_{c,t+1} \\ v^*_{t+1} &= v_0 + v_1 v^*_t + \sigma_g \sqrt{v^*_t} \epsilon^*_{v,t+1}, \end{aligned} \tag{2}$$

where the volatility of the consumption variance is assumed to depend on consumption volatility, and ϵ_c^* and ϵ_v^* are standardized random variables with correlation coefficient $\rho_{ps} < 0$. A negative correlation 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).

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

$$\begin{aligned} \Delta c_{t+1}^i &= \mu + \sqrt{v_t^i}\epsilon_{c,t+1}^i + \sqrt{v_t^*}\epsilon_{c,t+1}^* \\ v_{t+1}^i &= \nu_0 + \nu_1 v_t^i + \sigma_l \sqrt{v_t^i}\epsilon_{v,t+1}^i, \end{aligned} \tag{3}$$

where ϵ_c^i and ϵ_v^i are standardized error terms assumed to be uncorrelated with global counterparts. Hence, the consumption growth variance of country i is the sum of the variance of the country-specific component v_t^i and the global component v_t^*. These dynamics naturally allow local consumption and variance shocks to be correlated with the global counterpart.[2] 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 full dynamics (the "full" model), I also consider a special case where the volatility of country-specific and global variance shocks is assumed to be constant (the "restricted" model). This particular distinction aims to differentiate the role of consumption variance from consumption variance risk. However, the closed-form solution for the restricted model can be derived in the simplest form under the assumption of $\rho_{ps} = 0$. Hence, three models are compared: 1) the full model, 2) the full model with $\rho_{ps} = 0$, and 3) the restricted model.

[2]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.

The return on the global and country i's wealth portfolio can both be linearized as

$$R^{i/*}_{TW,t+1} = \kappa_0 + \kappa_1 z^{i/*}_{t+1} - z^{i/*}_t + \Delta c^{i/*}_{t+1}, \tag{4}$$

where z^i_t and z^*_t are the log wealth-to-consumption ratio of country i and the world, respectively, and κ_0 and κ_1 are common constants as defined in Campbell and Shiller (1988).

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. It can be verified that

$$z^i_t = A_0 + A_l v^i_t + A_g v^*_t \tag{5}$$

with the values $A_g < 0, A_l < 0$ and A_0 given in the appendix.

Furthermore, the global wealth-consumption ratio is a linear function of only one state variable: $z^*_t = A^*_0 + A_g v^*_t$, for some constant A^*_0

2. Bond yields and currency returns

The 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

$$y^i_t = -E_t[m^i_{t+1}] - 0.5Var_t[m^i_{t+1}]. \tag{6}$$

Bond yields (y^i_t) can be expressed as a linear function of two state variables. It can be shown that

$$y^i_t = Y_0 + Y_l v^i_t + Y_g v^*_t, \tag{7}$$

where Y_l and Y_g are negative constants. Note that shocks to two variance components entirely determine the time-variation in yields. Bond yields are lower when the global or country-specific variance is higher, consistent with the traditional precautionary savings motive of interest rate determination.

Then, the conditional variance of the yield can be expressed as $(Y_l\sigma_l)^2 v_t^i + (Y_g\sigma_g)^2 v_t^*$. In the restricted model, the variance of bond yields is constant.

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_t^i) are represented by the difference between the local and the global SDF (e.g., Backus, Foresi, and Telmer 2001), resulting in

$$\Delta q_{t+1}^i = m_{t+1}^i - m_{t+1}^*, \tag{8}$$

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

The UIRP relationship holds in this model, and there is no currency risk premium. To observe this relationship, the expected return on a local currency investment is

$$\begin{aligned} E_t[\Delta q_{t+1}^i] + 0.5Var_t[\Delta q_{t+1}^i] &= E_t[m_{t+1}^i] + 0.5Var_t[m_{t+1}^i] - E_t[m_{t+1}^*] - 0.5Var_t[m_{t+1}^*] \\ &= y_t^* - y_t^i, \end{aligned} \tag{9}$$

and the currency risk premium for the global investor is

$$Cov_t(-m_{t+1}^*, m_{t+1}^i - m_{t+1}^*) = 0,$$

where both of these relationships hold because $Cov_t(m_{t+1}^i, m_{t+1}^*) = Var_t(m_{t+1}^*)$. Hence, lower country-specific consumption growth variance leads to higher yields. However, since the currency is expected to depreciate in the future, there is no gain from an international bond investment.

The UIRP relationship suggests that the model is unable to account for the carry trade puzzle. However, as shown below, the dynamics 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 in excess of the domestic risk-free rate across countries.

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

$$\Delta d^i_{t+1} = \mu_d + \phi_d \sqrt{v^i_t} \epsilon^i_{d,t+1} + \phi_f \sqrt{v^*_t} \epsilon^*_{d,t+1}, \tag{10}$$

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 $\rho_c > 0$. Under the aforementioned assumption, which will be validated empirically below, ϕ_f is assumed to be greater than ϕ_d.

Stock market returns of country i ($R^i_{m,t+1}$) are represented by

$$R^i_{m,t+1} = \Delta d^i_{t+1} + \kappa_{m,0} + \kappa_{m,1} z^i_{m,t+1} - z^i_{m,t},$$

where z^i_m is the price-dividend ratio of country i, and $\kappa_{m,0}$ and $\kappa_{m,1}$ are constants determined by the average of the price-dividend ratio. Similar to the above, the price-dividend ratio is conjectured to be a linear function of both local and global variance of consumption shocks:

$$z^i_{m,t} = B_0 + B_g v^*_t + B_l v^i_t, \tag{11}$$

with the values of B_g and B_l given in the appendix.

In this framework, variance shocks have two contradictory effects on stock prices. First, higher volatility increases the risk premium on the equity investment, leading to a lower valuation ("risk premium channel"). Second, since higher volatility reduces the risk-free rate, the discount rate of a stock will also decrease ("risk-free rate channel"). These two effects are conflicting because an increase in the risk premium reduces current equity prices, whereas a decrease in the risk-free rate increases stock prices by lowering the discount rate. In a single country model, the risk-free channel is often ignored, since the former dominates the latter.

In an international economy, the two sources of variance shocks commonly reduce the risk-free rate, thereby also reducing the discount rate of equity investment. The mechanism of this channel is similar to the case of a closed economy. However, the difference is that country-specific and global variance shocks affect stock prices differently through the risk premium channel. If stocks are more heavily exposed to global shocks than bonds (i.e., $\phi_f > \phi_d$), an increase in global variance will reduce equity prices substantially. In contrast, country-specific variance shocks have a minor effect on equity prices.

Therefore, between the two channels, the relative strength of the risk premium channel increases as global variance shocks become dominant in a country. In this case, stock prices will respond more negatively to variance shocks. In contrast, the relative importance of the risk-free channel will increase when country-specific variance shocks dominate in the local economy. During these times, stock prices do not react much to variance shocks. Under particular parametrization, stock prices may even increase.

Then, the conditional variance of stock returns

$$Var_t[R^i_{m,t}] = V_0 + V_l v^i_t + V_g v^*_t,$$

with the expressions for V_0, V_l, and V_g provided in the appendix. The variance of stock market variance can also be computed and will also be a function of the two variance processes.

The model assumes that stock returns will have greater exposure to global shocks compared to bonds. This assumption implies that the variance of bond yields will depend relatively more on country-specific variance shocks, while stock returns will rely more on global variance shocks. Therefore, the of bond yield variance to stock market variance will be higher when the variance of country-specific consumption growth (v_t^i) is high and lower when global variance (v_t^*) is high.

Panel A of Table I lists the parameter specifications. The parameters are chosen to match the moments of global consumption, dividend growth, and real yields, as well as the correlation between financial variables across countries. The precautionary savings correlation ρ_{ps} is taken from Jones and Pyun (2021) and matches the value estimated by Basu and Bundick (2017). The country-specific and global exposures of dividend growth (ϕ_d and ϕ_f) and the correlation between consumption and dividend shocks (ρ_c) are matched empirically from the stock market index and consumption growth. The simplified model is not meant to explain the equity risk premium puzzle.[3]

The second panel of the table reports the moments of the global and local asset pricing variables. The model-implied moments are compared with the data, computed from (i) the US data only or (ii) the world average. To calculate the correlation between global and local stock returns, I use the value-weighted world index. The local/global yield correlation is computed based on the assumption that global yield is the simple cross-sectional average of the country bond yields. The details on the data sources and measurements are provided in Section III.

Overall, the moments and correlations implied by the model represent the data well, given the relatively simple dynamics assumed. In particular, compare 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.

In the data, the average correlation between local and global stock returns (0.798) is much higher than the average correlation for bond yields (0.579). This result is consistent with the intuition of the model that the stock market is more heavily exposed to global variance

[3]The model does not have any components that represent internal or external habit (Campbell and Cochrane 1999), long-run risk (Bansal and Yaron 2004), or disaster risk (Barro 2006). Although adding these components helps with matching the equity moments, it complicates the analysis.

shocks than the bond market. Moreover, the empirical observation on the relative size of the correlations is also consistent with the data moments reported in earlier studies (e.g., Colacito and Croce 2011).

4. The relationship between stock and bond returns

As with many consumption-based asset pricing models, the parameter specification of this paper also implies an average negative correlation between stock and bond returns. This negative correlation arises because there are only two shocks in the model– shocks to the variance in the global and local components of consumption shocks – that affect the yields of local bonds. Positive shocks to either variance process lead to lower bond yields and stock prices. Thus, stock prices react positively to bond yields under general parameter specifications, and the SB correlation is negative.

However, the SB relationship varies depending on whether country-specific or global shocks dominate the country in the model. For example, on the one hand, if the majority of variance shocks in a country are driven by the global component, stock returns and bond yields will move in the same direction, leading to a negative SB relationship. On the other hand, if country-specific risk dominates, stock returns and bond yields are more likely to move independently.

The stock price reaction to changes in bond yields will also be less positive when country-specific risk dominates. Due to the asymmetric exposure to global risk for bonds and stocks, the stock market will react differently to changes in bond yields, depending on the origin of the shock. A single unit decrease in bond yields led by a global variance shock will reduce stock prices more than a country-specific shock that decreases by a single unit. Therefore, the SB relationship, measured by the stock price sensitivity, will be more positive when country-specific variance risk dominates.

At times, when country-specific variance risk will dominate, and at other times, global component will be dominant. The relative importance of these two components within an economy is likely to change over time. For example, during an election period or when local geographical risk becomes dominant, the volatility of the local component will rise in a particular region. The SB relationship will consequently be more negative when global risk dominates and more positive when country-specific risk dominates.

These premises are confirmed in the proposed model. The covariance between stock returns and unexpected changes in bond yields can be expressed as

$$Cov_t(R^i_{m,t+1} - E_t[R^i_{m,t+1}], y^i_{t+1} - E_t[y^i_{t+1}]) = SB_l v^i_t + SB_g v^*_t, \tag{12}$$

with values of SB_l and SB_l given in the appendix. This relationship can be expressed (i) as a measure of correlation, dividing the covariance by the standard deviation of bond yields and stock returns or (ii) as bond yield 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. Since bond yields and returns are almost perfectly negatively correlated, the SB correlation is the negative correlation between stock returns and bond yields. The SB beta is defined similarly, as the negative of the bond yield beta.

The first two panels of Figure 2 illustrate how the SB correlation varies as country-specific volatility (Panel a) and global volatility (Panel b) fluctuates under the full and the restricted models. In the model, since volatility of the variance is assumed to be connected to the level of volatility, high volatility will correspond to high variance risk. For graphical illustration, in Panel (a), the level of global variance is set at a fixed value, at its average level as calibrated in Table I. Similarly, in Panel (b), the country-specific variance is set to be fixed at the average value. The full model, as denoted by the solid line, clearly shows that the SB correlation is less negative when local variance is high. Conversely, when global variance is large, the correlation becomes more negative.

This relationship holds even when the SB relationship is measured using the SB beta. Panel (c) and (d) illustrate the results. High country-specific variance is associated with a relatively positive SB beta, whereas a high global variance are associated with a more negative SB beta.

The values under alternative specifications of the model are also displayed in the panels. The values when $\rho_{ps} = -0.15$ and 0 are shown in the figure. Overall, similar patterns are observed.

The SB correlation is more negative when global variance is higher and country-specific variance is lower. The key difference in these specifications is that the values the SB correlation can attain are much narrower, since stock prices largely move due to shocks to dividend growth. Given that shocks to dividends do not directly affect bond yields, the SB correlation must be small in absolute value. Therefore, the mechanism is amplified by assuming a negative correlation between cash flow shocks and variance shocks.

As mentioned above, the aim of studying the restricted model with constant volatility of variance is to distinguish the role of the level of variance from variance risk. The full model with $\rho_{ps} = 0$ can be directly compared with the restricted model as both assume zero correlation between consumption growth and consumption variance. In the restricted model, the covariance between stock returns and bond yield is constant, implying that any SB correlation will converge to zero when the market becomes more volatile regardless of the source.

One key implication of the model is the positive link between country-specific consumption variance and the SB relationship. This implication may seem to contradict the well-known empirical observation that the relationship is more negative when the markets are risky. This phenomenon, known as "flight-to-quality," suggests that investors prefer safer bond positions over risky stock positions when variance spikes. It should be noted that the model in this paper implies that only an increase in global variance risk, or variance, should lead to a negative SB correlation. Moreover, since global shocks affect all countries' SB relationships, the relative value of the SB correlation or beta of a country relative to others would be largely driven by the dominance of country-specific variance risk.

5. International equity market risk premia

The previous section suggests that the strength of the SB relationship depends on the relative dominance of two kinds of variance risk in the economy. The SB correlation is more negative when global variance risk dominates country-specific risk. As the variance of these two components is likely to be time-varying, the SB relationship should also vary. This section investigates the link between the SB relationship and the equity risk premium.

As noted earlier, the interest rate parity relationship holds in this model. Therefore, the risk premium of the currency and equity investment required by the global investor should equal the risk premium required by the local investor in the same 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 equation becomes

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

Therefore, it is sufficient to compare the risk premium on an international stock market investment in local currency from the local investor's perspective:

$$MRP_t = Cov_t(-m^i_{t+1}, R^{i,}_{m,t+1}) = MRP_g v^*_t + MRP_l v^i_t,$$

where $R^i_{m,t+1}$ is the stock market return of country i in local currency and MRP_g and MRP_l are positive under reasonable parameter specification as given in the appendix. While a global variance shock should affect all country stock markets in the same direction, it is not the case for country-specific variance shocks. $MRP_l > 0$ suggests that countries with high country-specific variance should have a higher risk premium. Since variance is also likely to fluctuate more when variance is high, countries with higher country-specific variance risk should also have a higher risk premium.

Panel (e) in Figure 2 depicts the relationship between local consumption variance and the market risk premium. As in the previous panels, global variance is assumed to remain fixed at its mean level. The figure clearly shows that the risk premium is higher when local volatility is higher.

One direct implication of the model is that high global variance risk should be a 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.

For example, on the one hand, when global variance increases, the SB relationship and the risk premium of all countries are affected in the same direction. Therefore, global shocks have relatively little influence on the relative position of the risk premium and the SB relationship in the world. On the other hand, 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) propose 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.

One final implication of the model is the role of the correlation between domestic and global variance shocks. As illustrated in Panel (f) of Figure 2, the model suggests that as country-specific variance risk dominates, the correlation between local and global variance shock should decrease. However, the SB correlation should be more negative when a country's variance shock is highly correlated with global shocks. Moreover, the risk premium of the stock market should be higher for countries whose variance shock is different from global variance shocks. In the empirical section, I use the local-global variance shock correlation as an explanatory variable in understanding the SB relationship's cross-sectional and time-series properties.

This simplified model cannot directly test whether the ICAPM (Adler and Dumas 1983) holds, because the model assumes that all countries are equally exposed to global shocks. It is possible to extend the model where countries have heterogeneous exposures to global shocks, thereby making it consistent with, for example, Lustig, Roussanov, and Verdelhan (2014). In this model, a higher global risk exposure should be associated with a negative SB relationship because the higher global exposure amplifies the role of global variance shocks. In this model, a negative SB correlation should predict higher currency returns, however, empirical support for this relationship is weak.

III. Data and Estimation

1. Data

The implications of the model are tested using data pertaining to 30 countries, 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, the Netherlands, Norway, Russia, Spain, Sweden, Switzerland, Turkey, and the United Kingdom) are located in Europe, while nine (China, India, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, and Thailand) are from Asia, three (Canada, Mexico, and the United States) from North America, and two (Australia and New Zealand) from Oceania. In addition, one is from South America (Brazil) and another is from Africa (South Africa). Two 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 the Iran and Taiwan Stock Exchanges are omitted for the same reason.

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. In addition to the country-level stock returns, I also compute 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 ICAPM beta, as described below.

Bond yields are represented by the 10-year Treasuries, all of which are denominated in their respective local currency. Data availability is the main reason for choosing the ten-year maturity yields as they are available for the longest sampling period at the daily interval for many countries, which is critical since the availability of bond yield data mainly restricts the sample. Although the provided model does not study the term-structure implications, as shown by Jones and Pyun (2021), a strong relationship should exist between the SB correlations computed using short-term and long-term yields. Another reason is that compared to short-term yields such as one-month yields, ten-year yields are less subject to central bank intervention. The term spread is used as a control variable in the empirical analysis.

Table II summarizes the sample of this paper, with the means and standard deviations of stock returns, currency returns, bond yields, and the first difference of the bond yields reported in Panel A. To ensure that 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, and those based on the price index commence in 1990. There are hence 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.

In Panel A, the first set of columns summarizes the average returns and standard deviations of the country stock index returns, while the next two columns list 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 EU or Japan). The subsequent two columns describe the mean level of annualized bond yields and the volatility of the first difference in the bond yields. As the data indicates and is commonly conjectured, the bond yields and volatility are higher in emerging markets.

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 model is estimated using the Markov chain Monte Carlo (MCMC) method and is given by:

$$\begin{aligned} R^i_{m,t} &= \beta^i_0 + \beta^i_m R^*_{m,t} + \beta^i_q \Delta q^i_t + \exp(h^i_t/2)\epsilon^i_t \\ h^i_{t+1} &= \mu^i_h + \varphi^i_h(h^i_t - \mu^i_h) + \sigma^i_h \eta^i_t, \end{aligned} \tag{13}$$

where η_t^i and ϵ_t^i are standard normal errors, $R_{m,t}^i$ is the local currency stock market return of country i, $R_{m,t}^*$ is the value-weighted global stock index denominated in USD, and Δq_t^i 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 employ the MCMC scheme developed by Hosszejni and Kastner (2021) only once using the entire data.[4]

This return process is similar to that of a typical ICAPM, in that it has the global stock returns and currency returns as two factors. If log volatility has a constant variance, then 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 variance of variance is more directly estimated from intraday stock index returns. The stock market realized variance (RV) 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 RV 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 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 Corsi's (2009) Heterogeneous Autoregressive Realized Variance (HAR-RV) model to obtain a predicted value of the realized variance at the weekly frequency. The regression used to estimate the variance forecast is

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

[4]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

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.[5]

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. The volatility of variance of the local stock market is estimated as the root-mean-squared error of the above regression, and the value for the global market is simply the volatility of the right-hand-side variable. The correlation between the variance of the local and global stock returns is the square of the R-square of the regression above.

The 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., and I then 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. The global and country-specific inflation rates are obtained from the World Bank and country-level total gross domestic product (GDP), GDP per capita, and total exports, all denominated in USD and sourced from the International Monetary Fund database.

Finally, in the last part of the 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

[5] 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 global variance.

data is obtained from the intercontinental exchange, where the last quoted mid-price of the week and month is chosen to compute the implied default spread in sovereign bonds.

2. Estimation of the SB relationship and the international capital asset pricing model

The SB relationship in this paper is measured from the first-order difference in bond yields and stock returns. Taking the first difference in yields is based on the rationale that there is almost a perfect negative relationship between yield changes and bond returns. The SB beta (β^i) is estimated as the negative of the slope of the regression

$$R^i_{m,t+1} = \alpha^i - \beta^i(y^i_{t+1} - y^i_t) + \epsilon^i_{t+1}, \tag{14}$$

where $R^i_{m,t+1}$ is the log stock return of a country index denominated in local currency and y^i_{t+1} is the yield on a 10-year Treasury bond of country i, also in local currency. The purpose of the "negative" slope is to match the interpretation of the result to the SB correlation. The second last column of Table II reports the statistics for the SB beta. In this table, I use daily data of total returns for stock returns and bond yields and estimate the regression slope once using the entire sample for each country.

Finally, the last column of Table II 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:

$$R^{i,USD}_{m,t+1} = a^i + b^i R^{USD}_{\mathrm{MSCI},t+1} + c^i \Delta q^i_{t+1} + \epsilon^i_{t+1}, \tag{15}$$

where $R^{i,USD}_{m,t+1}$ is the log return of country i's stock index, $R^{USD}_{\mathrm{MSCI},t+1}$ denotes the log returns of the MSCI World Index, and q^i_{t+1} is the log price of country i's currency, all expressed in USD.

The cross-sectional correlations of the average stock and currency returns, the ICAPM beta, and the bond yield betas are reported in Panel B of Table II. According to the ICAPM, investments in countries with a high positive beta should yield higher returns unconditionally. However, for the post-1990 period, the results suggest weak evidence to support the relationship. Instead, in some cases, countries with a higher global beta are associated with negative returns, for example if betas are estimated from the net total returns index. For price index returns, there is no relationship between the two. Moreover, a similar relationship is observed regardless of whether currency returns are added to stock returns in local currency.

Similar patterns are observed if the average SB betas are compared with average stock or currency returns. If local currency stock market returns are compared with the SB beta, they have a positive relationship. However, if currency returns are added to local currency, the positive relationship disappears, suggesting a weak unconditional relationship between SB betas and average stock market performance.

IV. Empirical Results

In this section, I present the main empirical findings, explicating the positive link between the time-varying SB relationship and the leading country's relative stock market returns. Then, I demonstrate that the SB relationship is connected to proxies representing time-varying country-specific variance risk. Finally, I provide some robustness test results.

1. The cross-section of international stock market returns

The model of this paper suggests that the SB relationship is more positive when country-specific variance risk becomes more substantial. Moreover, global variance risk is likely to affect all countries simultaneously, thus increasing the risk premium for all countries. Since variance risk is priced as shown by Bollerslev, Tauchen, and Zhou (2009) and Drechsler and Yaron (2011), countries and times with a relatively positive SB relationship are associated with comparably higher future stock returns.

To test this hypothesis, I estimate the regression slope (14) using daily, weekly, and monthly returns and changes in yields, denoting the negative of the slopes by $\hat{\beta}^i_d$, $\hat{\beta}^i_w$, and $\hat{\beta}^i_m$, respectively. 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 they the returns include dividends, the sampling period for the price index-based sample is slightly longer.

One benefit of the empirical estimation of the SB relationship using daily observations is that it improves accuracy by utilizing a higher number of 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 or monthly) data may be more accurate. However, as many observations are needed to obtain a precise estimate, the sampling frequency cannot be too low. The sampling period must thus be extended to improve the estimation, although this may introduce outdated information in the estimate if the relationship varies over time.

Therefore, I use daily beta from a 183-calendar day rolling window as a primary measure and supplement the daily measure with the monthly beta estimate that uses a 36-month rolling window. In addition, whenever daily estimates are inappropriate (e.g., when global variables need to be controlled), the weekly beta from a 52-week rolling window is considered as the baseline.

At the end of each month, daily, weekly, and monthly betas are estimated for each country, and countries are then sorted by the estimates. Thereafter, 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 contains 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 given by Equation (15).

Panel A of Table III 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, weekly, and monthly estimates are provided as a separate subpanel. Overall, these findings are consistent with the hypothesis. Focusing on the first two rows of each subpanels in which USD-based returns are presented, it is evident that investments in countries with a relatively positive SB relationship generate 0.54%–0.71% (6.48%–8.52%) higher subsequent returns compared to those with a negative relationship. 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 difference in returns between Portfolios 5 and 1 is greater if they are expressed in local currency (0.68%–0.83% per month, 8.16%–9.96% annualized). The currency returns partially offset the difference earned from local stock returns, but most are statistically insignificant.

In the estimation of the SB betas, the beta may be capturing stock returns' sensitivity to global bond yield changes. As also shown in Table I, yield changes are highly correlated across countries. This observation is supported by both the model specification considered by Colacito and Croce (2011), where yield innovations are perfectly correlated across countries, and empirically as reported by Jotikasthira, Le, and Lundblad (2015). Hence, a high cross-country correlation between yield shocks implies that yield betas may capture the stock market's reaction to particular global shocks.

To investigate the possibility that the SB betas measures stock markets' reaction to global yield shocks, I also consider an additional specification where the global yield innovations are controlled. The specification is given by

$$R^i_{m,t+1} = \gamma^i_0 + \gamma^i_y(y^i_{t+1} - y^i_t) + \gamma^i_g \sum_{\forall j}(y^j_{t+1} - y^j_t) + \epsilon^i_{t+1}, \tag{16}$$

whether either weekly or monthly data is used to estimate the regression. Similarly to the main specification, the SB beta ($\hat{\beta}'^i = -\hat{\gamma}_y^i$) is defined as the negative of the slope.

The average returns of the portfolios sorted by the SB beta controlling for the global yield changes ($\hat{\beta}'^i$) are reported in Panel C of Table III. Overall, the results are similar to other panels. The return difference based on monthly data is slightly lower at -0.40% per month. However, a weaker result is also expected due to possible multicollinearity between local and global yield shocks and a small number of observations used for the regression (36 months).

2. The role of country-specific macroeconomic variables

The results reported in Table III indicate that the SB betas strongly predict the relative performance of country-level stock market returns. This result compares to Panel B of Table II. In the panel, it is shown that there is no 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 analysis and discussion in this section have two purposes. Their first objective is to confirm that the SB betas contain information about the time-varying characteristic of the country-specific equity risk premia. The second purpose 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 as described in Section III. Then, the country stock index returns of the leading month are regressed on SB estimates in addition to the contemporaneous or lagged values of several macroeconomic variables. Finally, the time-series mean of the regression coefficients and the Fama-MacBeth standard errors are calculated.

Table IV summarizes the cross-sectional regression results. Panel A and B report these for the net total returns index and price index, respectively. The first two models (named Model 1 and Model 2) do not include any control variables in both panels. Regardless of the index and sample used, the slope coefficients for both daily and monthly beta estimates are positive and statistically significant. These findings confirm the conclusions of Table III, offering empirical evidence that stock investments in countries with positive SB relationship outperforms those with negative relationships.

The subsequent two models (Model 3 and Model 4) uses the time-series averages of the daily and monthly betas as control variables in the regression. If some country-fixed characteristics– such as geographical locations, languages used, culture, or religion – determine the overall level of the risk premium for a country, any statistical significance observed in the first two models should show up in the time-series average. However, according to the results for both panels, the level of significance increases after controlling for the time-series average. The size of the coefficient also increases for the rolling window estimate of the SB beta, suggesting that any country-fixed effect is unlikely to be driving the results. In conclusion, these results strongly suggest that the estimates contain information about the time-varying characteristic of an economy.

The last four models (Models 5–8) incorporates 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, the inflation rate of the country, and the ICAPM beta estimate of the corresponding index.

Overall, the results are weaker when these standard macroeconomic control variables are included, suggesting that the risk premia captured by the SB beta may partially be related to some dimension of the macroeconomic fundamentals. However, standard macroeconomic variables presented here do not entirely explain the variation in the risk premia.

Although the coefficients on the control variables are statistically insignificant, several observations regarding the signs of the coefficients are worth noting. First, a higher GDP growth rate generally implies higher future stock returns, consistent with the general perception that developing countries may have a higher risk premium. Second, the percentage contribution of exports to the total GDP generally has a negative loading for the price index-based sample, suggesting that higher global exposure of firms does not necessarily imply higher returns, as roughly implied by ICAPM.

In contrast, inflation exerts a negative influence on future stock market performance, indicating that the main results are unlikely to be driven by the inflation risk component of sovereign bonds. Finally, the statistical significance of the bond yield beta is weaker after controlling for the beta of the ICAPM. The weaker result is potentially due to multicollinearity because ICAPM betas are negatively related to the SB relationship. The negative coefficient on the ICAPM beta suggests that multicollinearity may be driving the insignificance.

In conclusion, the results reported in this section strongly support the hypothesis that the relationship between stock and bond returns captures information on the time-varying characteristic of the stock market risk premia. Moreover, the risk premia captured by the SB beta are not simply explained by standard macroeconomic variables.

3. The relationship to other standard 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 of Table IV, I consider the cross-sectional regression of Fama and MacBeth. The results are summarized in Table V. Similar to the arrangement of the previous table, results using net total index returns are reported, followed by those obtained from price returns. Since dividend yields are calculated from the total index, only the post-1999 sample is considered in this regression. The first six specifications compare the performance of the yield betas with one additional return predictor in turn, whereas the last two compare the performance with all predictors together.

The SB beta is positively related to future stock market performance for both indices considered, even after controlling for any alternative predictors. Dividend yields and momentum remain statistically significant, particularly when the SB beta is estimated using daily data. However, most of the results remains statistically significant even after adding these two return predictors in the cross-sectional regression. The size of the average coefficient also largely remains similar to Panel B of Table IV, where a longer sampling period is used with the price index.

If the term spread is added to the specification, only the SB beta is statistically significant. If all three other predictors are added to the SB beta, the SB beta remains significant in three of four specifications. The size of the coefficient of the SB beta does not change much after adding all three other predictors. Moreover, none of these other return predictors explain future stock returns in a significant manner.

4. The role of sovereign default risk

In this paper, bond yields are estimated using Treasury bonds, which are subject to sovereign default risk. Moreover, empirical evidence suggests that sovereign default risk and the premium are time varying. Therefore, in this section, I examine the possibility that the main return predictability result of this paper is due to stock returns reacting to sovereign default risk.

Government yields are decomposed into two parts: the default risk premium and the risk-free component. Mathematically, in the absence of any liquidity premium, inflation risk, and double default, bond yield is equivalent to 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 the risk-free rate. Therefore, the difference between bond yields and default compensation should be the risk-free yield in a given country. The changes in the bond yield can be represented by

$$\Delta y^i_{t+1} \approx \Delta CDS^i_{t+1} + \Delta RF^i_{t+1}, \tag{17}$$

where CDS^i_{t+1} is the CDS rate and RF^i_{t+1} is the risk-free yield.[6]

I estimate the beta of these two components using the regression

$$R^i_{m,t+1} = \delta^i_0 + \delta^i_1 \Delta RF^i_{t+1} + \delta^i_2 \Delta CDS^i_{t+1} + \epsilon^i_{t+1}, \tag{18}$$

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. I then multiply the slope by -1 to match the interpretation to the main 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.

Table VI 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 weekly and monthly data, as sovereign CDS is not as liquid during the sample's early periods.

If default risk is priced in the stock market, stock prices that react most negatively to an increase in the CDS spread (Portfolio 5) should generate higher returns. However, the tabulated findings suggest no evidence thereof – the signs are the opposite to 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.

[6] The approximation comes from assuming that

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

V. Testing Model Assumptions and Implications

This section provides the results of the empirical tests of the presented model. I first begin with a test of the model's primary assumption of Equation (10) that the dividend growth process has a higher exposure to global consumption shocks than to local consumption shocks. Then, I provide multiple evidence that supports the implication that SB relationship is more positive when local variance risk dominates global variance risk.

1. Local and global exposure of the dividend growth process

The panel regression considered is

$$\Delta d_t^i = \gamma_l \Delta c_t^i + \gamma_g \Delta c_t^* + C_i + T_t + \epsilon_{i,t}, \tag{19}$$

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 C_i and T_t are country and year fixed effects, respectively.

The first panel in Table VII summarizes the results of this regression. The first two columns present 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 each country's time-series dynamics. For each country, dividend growth is regressed on local and global consumption growth. The results are similar to those 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 shocks is strongly confirmed in the data.

2. The volatility of bond yields and stock returns

The model shows that the SB relationship is more positive when variance risk specific to a country is high. When variance is likely to fluctuate more when it is high, the SB relationship must be more positive when local variance, in addition to the volatility of variance, is relatively higher than global variance.

In this empirical analysis, the volatility of the local consumption shocks is proxied by the volatility of bond yields. In contrast, the volatility of the global component is proxied by the volatility of the stock returns. The logic behind this is that the volatility of domestic shocks entirely determines bond yields, whereas the stock market is more heavily exposed to global consumption shocks. Therefore, the volatility of the stock market is primarily determined by domestic and global consumption.

This hypothesis is tested by applying a panel regression with SB betas and SB correlations as dependent variables while treating country yield and stock volatility as explanatory variables. According to the model implications, the SB relationship should be more positive if bond yield volatility is higher, controlling for stock market volatility. Similarly, the relationship will be negative in time-series when stock market volatility is higher.

The SB betas and correlations are estimated as in the main specification but after adopting a 30-calendar-day rolling window. The reason is simple: using long-horizon estimates in regressions could be problematic if the dependent variables are based on overlapping regressions, as these may generate spuriousness in regression estimates, especially when explanatory variables are also highly serially correlated.[7] This issue is solvable if, for example, the estimates are non-overlapping. I only present the result using daily SB betas, since the use of a short sampling window for weekly or monthly data is challenging. Naturally, bond yield and stock volatility are also estimated using the same rolling window. The yield volatility is defined as the standard deviation of the daily first difference in yields.

Table VIII summarizes the panel regression results. Panel A shows the main specification results using the net total returns index, which begins from 1999. Panel B uses the price index,

[7]See, for example, Hodrick (1992) or Stambaugh (1999)

which begins from 1990. The left side of the panel displays the results obtained using the SB beta as the dependent variable. All results indicate 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 in bond yields. If the correlation ρ_d^i is constant, the SB beta is expected to be higher in magnitude when stock market volatility is high and bond yield volatility is low. Therefore, it may be more appropriate to consider the SB correlation instead as the dependent variable. The right side of each panel of the table presents the result when the SB correlation is used as the dependent variable. Overall, these results are similar to the case when the betas are used as the dependent variable.

The result for 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. The flight-to-quality hypothesis suggests that when volatility is high, investors become risk-averse, and they switch their portfolio holdings from risky stocks to risk-less bonds. Therefore, the hypothesis suggests that the SB correlation will be more negative when volatility is high.

The last two columns of Table VIII using the SB correlation as the dependent variable describe the relationship between the results of this analysis with the flight-to-quality hypothesis. When time-fixed effects are excluded, the SB correlation is negative when stock market variance is high, consistent with the flight-to-quality hypothesis. However, stock market volatility does not affect the SB correlation when the time-fixed effect is included. This outcome is natural since global volatility shocks, represented by stock market volatility affect all countries similarly. The common fluctuation in the SB correlation is captured by the time-fixed effect.

The results also suggests that the cross-country difference in global exposure should not, at least, directly affect the SB correlation through the channels considered here. If certain countries have higher exposure to global shocks, their SB correlation should be more negative. These countries should also have a higher stock market volatility. The fact that the significance of stock market volatility disappears suggests that the SB correlation is not affected by the cross-country difference in global consumption exposure.

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

3. Country-specific and global variance risk

This section takes a more direct approach and tests whether high volatility of the country-specific component in stock market variance is associated with a relatively positive SB relationship. As outlined in Section III, two measures of stock market variance proxies are used in this framework. The first is the SV model given in Equation (13), which is estimated using an MCMC scheme. As described earlier, $\exp(h_t^i)$ in this model is the variance of the country-specific shocks. In the SV model, this value is also the volatility of country-specific variance. The second measure uses intraday index data, and weekly variance forecasts are estimated using the HAR-RV model.

Each of these two variance measures has its benefit. First, the SV model requires sufficient amount of data to estimate the model parameters. In the current empirical setting, the SV model is estimated once per country index, which is potentially subject to look-ahead bias. Second, the HAR-RV is a regression-based approach that requires less data. Therefore, the analysis based on this estimate is out-of-sample. Moreover, by using intraday estimates, a more precise estimation of the stock market variance is possible. However, data availability is an issue since the sample period is short, and the data spans only 20 countries. Estimating the intra-day variance for the global index is also challenging. For the HAR-RV analysis, the variance shock of the global stock market is measured as the average of variance shocks.

Panel regressions are used with the SB relationship as a dependent variable, while treating the volatility of variance estimates as explanatory variables. Panel A of Table IX presents the result of the regression using the SV model. The test evaluates whether a higher country-specific variance is associated with a positive SB relationship. Since the volatility of variance equals the variance, this test is equivalent to testing whether a positive SB relationship is associated with the volatility of variance. The results are shown only for the net total return index in this specification.

Overall, the results confirm the premise that higher local variance or volatility of variance in the stock market is associated with a positive SB relationship. Conversely, higher global variance is associated with a negative SB return relationship. Similar to the results in the previous sections, the global variable becomes statistically insignificant, suggesting that the cross-country difference in global consumption exposure is unlikely to be empirically associated with the SB relationship.

Panel B presents the results using the RV. The sample begins in 2000 due to data availability. In addition to the volatility of RV for the local and global components, I also estimate the correlation between local and global variance shocks. If local variance shocks dominate, this correlation should be low. Overall, the results confirm the prediction that higher local volatility of variance is associated with a positive SB relationship. The local-global variance correlation is also negatively related to the SB correlation.

In the model, bond yields move when either the variance of the country-specific or global component fluctuates. Therefore, if volatility shocks are central drivers of bond yields, the correlation between local/global variance shocks should also be related to the correlation of local and global bond yields.

Panel C of Table IX tests whether the SB correlation is more negative when the local-global yield correlation is high. Global yield changes are measured as the simple average of yield changes across all countries during the week in measuring global yield changes. Then, for each country and every quarter, the correlation between the global average and the yield changes of that particular country is computed. The analysis of Panel A is repeated after replacing variance correlations with yield correlations. The regression results confirm that the correlation between local and global yields is positively related to the SB correlations and the

SB betas. Moreover, this relationship remains significant after controlling for the level of yield volatility, which is also positively associated with the SB relationship.

In the model, it is assumed that local volatility shocks are priced in the stock market. I conclude this section by asking whether higher country-specific variance risk estimated in the manner of this paper could also be used as a measure of the relative risk premium. For this purpose, I consider several empirical proxies defined earlier – volatility of country-specific consumption variance estimated using intraday data, local RV, and the local-global variance correlation – calculated for every country and every month using the earlier specification. Then, every month, the leading monthly stock market returns denominated in USD are regressed on each of these empirical proxies.

Table X summarizes the results of the regression, with Fama-MacBeth standard errors as in previous tables. The results are based on the net total return index since intraday index data is only available from 2000. Overall, the results confirm that high country-specific volatility of variance is associated with higher future stock returns. In addition, a lower correlation between local and global variance shocks, which indicates high country-specific variance risk, is also associated with a higher risk premium.

In conclusion, while some of these aforementioned measures are subject to look-ahead bias, these results suggest that empirical proxies of the determinants of the SB relationship are associated with the time-varying risk premium in the international stock market. Furthermore, the findings support that the SB relationship contains information about the size of variance risk of the country-specific component, which is priced in the stock market.

VI. Conclusion

This paper demonstrates that a country's SB relationship contains information about whether the country currently has a higher risk premium than the global average. If this correlation is positive, the country is likely to be facing higher variance risk than its neighbors, which causes the stock and bond prices to move in the same direction. During this period, the risk premium on equity investments is relatively higher since countries face higher variance risk.

Empirically, this paper also shows that the SB relationship is related to country-specific variance risk. Moreover, the risk premium of each stock market is higher for countries with substantial country-specific variance risk, particularly in the later sample, where more data available. Therefore, the SB beta, which proxies for these relationships, is a strong international stock market return predictor.

Most importantly, the SB relationship is extremely straightforward to estimate compared to other measures of country-specific variance risk. For example, estimating the variance risk premium (e.g., Bollerslev, Tauchen, and Zhou 2009) would require to use of option pricing data, and decomposing the global component in the variance risk premium from the country-specific component can be challenging. Estimating the volatility of variance is also likely to be complicated and may involve substantial estimation errors. Nevertheless, the SB relationship is easy to estimate as long as Treasury yield data and stock market index data are readily available.

This paper further demonstrates that the SB beta is a strong predictor of international stock market returns. The findings reported in this paper also have implications for the performance of the so-called ICAPM. The ICAPM implies that an investment is likely to have higher future stock returns if the returns covary more with the global wealth portfolio. However, this paper suggests the opposite. As the preceding sections show, investments in countries whose local shocks are primarily uncorrelated with global shocks have higher stock returns. Since these countries are also likely to have a lower beta, the ICAPM empirically fails in this context.

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. The results reported in this paper suggest that flight-to-quality is driven by global uncertainty and is unrelated to shocks to local volatility. In particular, the empirical evidence presented in this paper indicates that the SB relationship is negative when local bond yield volatility is high.

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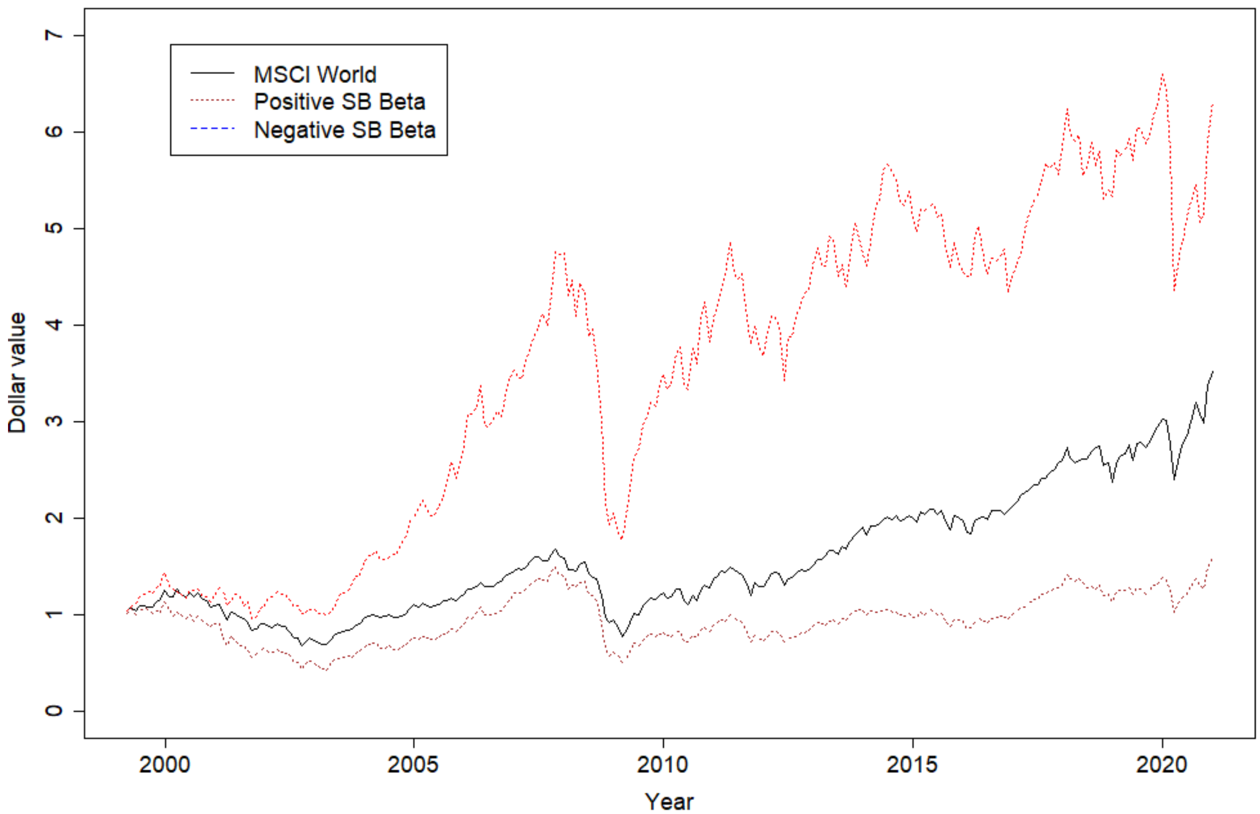


Figure 1. International stock market performance

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

Table I
Calibration

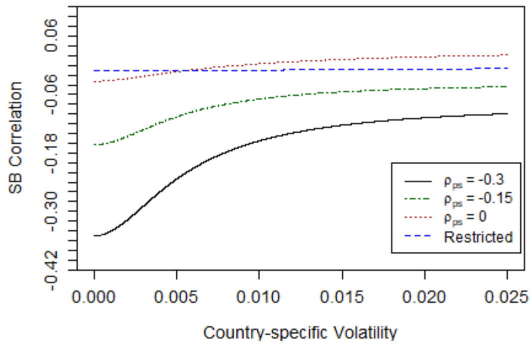
This table provides the parameter specification (Panel A) used to show the main implication in Figure 2. The model-implied asset moments based on the parameter specifications are provided in Panel B. Stock market returns are calculated from net total return indices. y denotes real bond yields adjusted for inflation assuming zero inflation risk premium. The volatility of bond yields (SD(Δy)), the correlation between stock and bond returns Cor($-\Delta y, R_m$), and the correlation between local and global changes in yields Cor($\Delta y, \Delta y^*$) are calculated using nominal values. Δy^* is calculated by taking the cross-sectional average of changes in yields for all countries, ignoring any currency effect. R_m^* is the return of the USD-denominated global value-weighted index.

Panel A. Parameter Specification

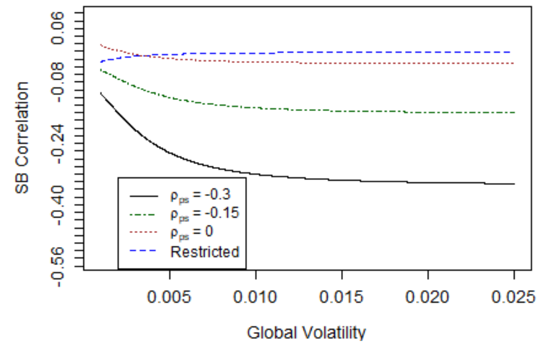
	Parameters		Parameters
Preference parameters		Consumption parameters	
γ	10	μ	0.0018
ψ	1.5	ρ_{ps}	-0.30
β	0.9992		
Dividend parameters		Variance parameters	
μ_d	0.003	· Global variance	
ϕ_d	1.65	v_1	0.991
ϕ_f	8.5	$v_0/(1-v_1)$	0.0035
ρ_c	0.55	σ_v^*	0.001
		· Local variance	
		ν_1	0.991
		$\nu_0/(1-\nu_1)$	0.0055
		σ_v^i	0.0007

Panel B. Consumption growth and asset pricing moments

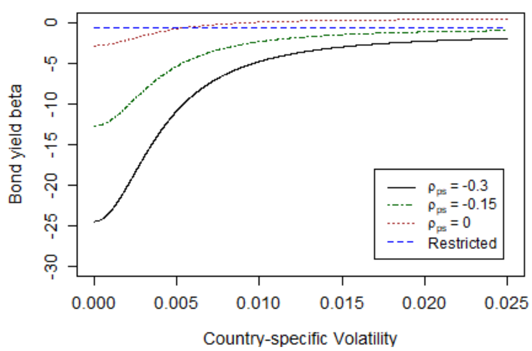
	Model	Data (1990-2020)	
		U.S.	World Average
μ	2.16%	2.33%	2.57%
Cor($\Delta c, \Delta c*$)	0.537	0.648	0.547
Local volatility ($\sqrt{v^i + v^*}$)	2.26%	1.26%	2.41%
Global volatility ($\sqrt{v^*}$)	1.21%		1.28%
Real yields (y)	1.88%	1.14%	1.69%
Yield volatility (SD(Δy))	0.88%	0.87%	1.02%
Cor($\Delta y, \Delta y^*$)	0.607	0.848	0.579
Cor($-\Delta y, R_m$)	-0.222	-0.234	-0.224
Cor(R_m, R_m^*)	0.961	0.895	0.798



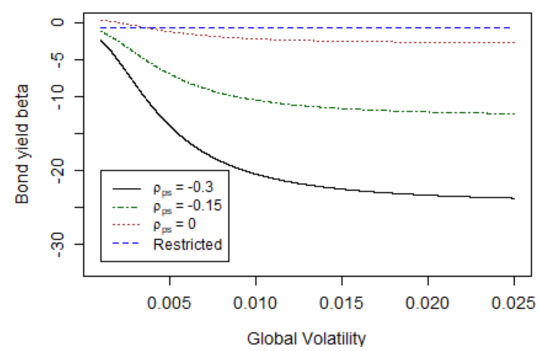
(a) Country-specific CG volatility and SB correlation



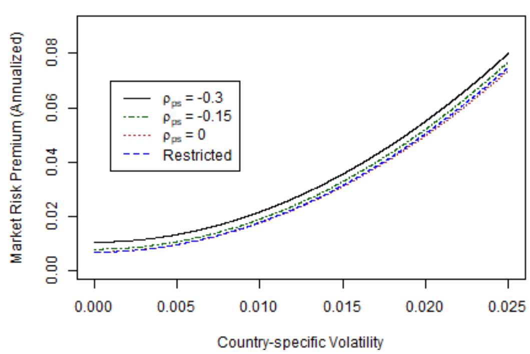
(b) Global CG volatility and SB correlation



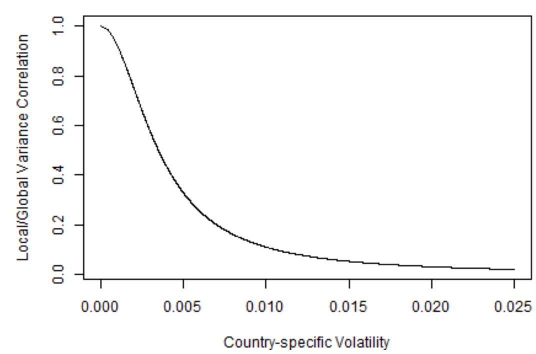
(c) Country-specific CG volatility and SB beta



(d) Global CG volatility and SB beta



(e) Country-specific CG volatility and the stock risk premium



(f) Country-specific CG volatility and local/global variance correlation

Figure 2. SB relationship and the stock market risk premium

This figure shows the relationships between (a) the volatility of the country-specific component in consumption growth (CG, $\sqrt{v_t^i}$) and the SB return correlation, (b) volatility of the global component in CG ($\sqrt{v_t^*}$) and the SB return correlation, (c) $\sqrt{v_t^i}$ and SB beta, (d) $\sqrt{v_t^*}$ and SB beta, (e) $\sqrt{v_t^i}$ and the risk premium on the equity portfolio, and (f) $\sqrt{v_t^i}$ and the correlation between shocks to $\sqrt{v_t^i}$ and $\sqrt{v_t^*}$ implied by the model.

Table II
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, and the global CAPM beta estimated as described in (14)- (15) 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 among the time-series average of the betas and stock returns statistics.

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.		(Net)
Australia	1999	0.073	0.137	1990	0.044	0.140	−0.001	0.113	0.056	0.010	−4.353	0.73
Austria	1999	0.029	0.247	1993	0.010	0.234	−0.001	0.094	0.036	0.007	−7.296	1.22
Belgium	1999	0.011	0.204	1993	0.025	0.191	0.006	0.094	0.038	0.007	−3.406	1.07
Brazil	2010	0.093	0.220	2010	0.061	0.221	0.057	0.147	0.109	0.021	5.156	0.72
Canada	1999	0.067	0.148	1990	0.055	0.147	−0.003	0.078	0.046	0.008	−6.729	0.79
China	2006	0.100	0.255	2006	0.077	0.256	0.015	0.035	0.035	0.005	−1.728	1.06
Finland	1999	0.040	0.284	1996	0.067	0.286	0.007	0.096	0.031	0.007	−12.261	1.37
France	1999	0.043	0.177	1990	0.043	0.168	−0.005	0.096	0.041	0.007	−7.859	1.10
Germany	1999	0.040	0.212	1990	0.042	0.196	−0.002	0.097	0.037	0.007	−11.884	1.22
India	1999	0.132	0.246	1999	0.124	0.246	−0.025	0.070	0.078	0.010	2.640	0.73
Indonesia	2004	0.160	0.225	2004	0.137	0.225	−0.027	0.098	0.089	0.023	3.217	0.74
Italy	1999	0.003	0.205	1993	0.008	0.209	0.006	0.094	0.043	0.011	4.933	1.07
Japan	1999	0.034	0.179	1990	−0.011	0.194	0.011	0.103	0.019	0.006	−12.209	0.77
Korea	2001	0.113	0.208	2001	0.099	0.209	0.013	0.095	0.040	0.009	−3.111	1.06
Malaysia	1999	0.067	0.139	1999	0.046	0.174	−0.003	0.062	0.042	0.007	1.105	0.31
Mexico	2002	0.121	0.152	2002	0.072	0.225	−0.029	0.114	0.075	0.012	0.326	0.79
Netherlands	1999	0.053	0.181	1991	0.050	0.171	0.000	0.098	0.038	0.007	−10.134	1.10
Norway	1999	0.076	0.203	1996	0.049	0.208	−0.007	0.110	0.041	0.008	−9.194	1.06
NZ	1999	0.072	0.146	1998	0.025	0.155	0.005	0.114	0.058	0.009	−2.002	0.52
Philippines	1999	0.048	0.211	1998	−0.004	0.225	−0.011	0.061	0.095	0.028	0.729	0.58
Russia	2001	0.090	0.282	2001	0.030	0.325	−0.048	0.122	0.055	0.015	5.357	1.23
Singapore	2000	0.062	0.203	2000	0.038	0.213	0.011	0.056	0.027	0.008	−3.935	0.91
S. Africa	1999	0.132	0.178	1997	0.086	0.197	−0.049	0.160	0.099	0.018	2.839	0.78
Spain	1999	0.027	0.208	1993	0.043	0.208	0.010	0.099	0.046	0.010	2.998	1.06
Sweden	1999	0.073	0.211	1991	0.075	0.214	−0.012	0.115	0.045	0.009	−10.792	1.25
Switzerland	1999	0.038	0.133	1995	0.050	0.147	0.018	0.101	0.020	0.006	−10.413	0.72
Thailand	2001	0.097	0.228	2001	0.067	0.228	0.015	0.057	0.037	0.011	−0.190	0.78
Turkey	2011	0.081	0.229	2011	0.056	0.231	−0.141	0.150	0.108	0.035	3.047	1.07
UK	1999	0.038	0.140	1990	0.031	0.142	−0.007	0.092	0.047	0.009	−7.132	0.88
USA	1999	0.064	0.154	1990	0.081	0.149	0.000	0.000	0.044	0.009	−8.051	0.95
World	1999	0.057	0.149	1990	0.050	0.151						1.00

Panel B. Correlation matrix

	SB Beta	Net Ret	Price Ret	Currency Ret	Net Ret in USD	Price Ret in USD
ICAPM Beta (Net)	−0.342	−0.355		0.294	−0.382	
ICAPM Beta (Price)	−0.139		0.055	0.150		0.076
SB Beta	1.000	0.434	0.198	−0.274	0.112	−0.068

Table III
SB betas and international stock market performance

This table summarizes the leading month country index stock returns (in USD/local currency), returns adjusted by the ICAPM, and currency returns sorted by their SB betas estimated using daily, weekly, and monthly data. The net total returns (Panels A) and the price index returns (Panel B) are used to proxy country stock returns. Portfolios are formed by the SB beta rankings, and the mean of the one-month predictive returns and the Newey-West t-statistics, with 12 lags, of the portfolios are reported. Panel C controls for changes in global yields when estimating the SB beta.

Panel A. Using net total stock index returns

	Port 1	Port 2	Port 3	Port 4	Port 5	H–L
Daily estimation						
Returns	0.18	0.47	0.61	0.64	0.72	0.54**
in USD	(0.45)	(1.29)	(1.71)	(1.72)	(1.74)	(2.44)
ICAPM	−0.15	0.08	0.36	0.45	0.68	0.83***
	(−1.04)	(0.74)	(2.67)	(2.37)	(4.07)	(4.16)
Returns	0.13	0.39	0.67	0.65	0.90	0.76***
in local $	(0.38)	(1.29)	(2.43)	(2.19)	(2.75)	(3.49)
Currency	0.05	0.08	−0.06	−0.01	−0.18	−0.23**
returns	(0.34)	(0.59)	(−0.44)	(−0.10)	(−1.49)	(−2.00)
Weekly estimation						
Returns	0.28	0.32	0.53	0.52	0.93	0.65***
in USD	(0.74)	(0.86)	(1.45)	(1.38)	(2.27)	(2.73)
ICAPM	−0.18	0.10	0.32	0.30	0.92	1.11***
	(−1.77)	(0.60)	(2.47)	(2.03)	(4.32)	(5.16)
Returns	0.22	0.26	0.35	0.62	1.05	0.83***
in local $	(0.68)	(0.85)	(2.11)	(2.06)	(3.14)	(3.60)
Currency	0.06	0.06	−0.07	−0.09	−0.11	−0.17
returns	(0.40)	(0.41)	(−0.47)	(−0.68)	(−0.97)	(−1.59)
Monthly estimation						
Returns	0.15	0.26	0.32	0.72	0.71	0.57**
in USD	(0.47)	(0.87)	(1.13)	(2.27)	(1.95)	(2.34)
ICAPM	−0.18	−0.01	−0.07	0.42	0.46	0.66***
	(−1.17)	(−0.11)	(−0.43)	(2.80)	(2.31)	(3.27)
Returns	0.13	0.30	0.31	0.71	0.80	0.68***
in local $	(0.44)	(1.26)	(1.27)	(2.79)	(2.61)	(3.04)
Currency	0.02	−0.05	0.01	0.01	−0.09	−0.10
returns	(0.20)	(−0.40)	(0.10)	(0.05)	(−0.80)	(−0.90)

Panel B. Using price stock index returns

	Port 1	Port 2	Port 3	Port 4	Port 5	H–L
Daily estimation						
Returns	−0.07	0.40	0.53	0.67	0.60	0.66***
in USD	(−0.20)	(1.36)	(1.83)	(2.17)	(1.61)	(2.70)
ICAPM	−0.50	0.08	0.25	0.33	0.43	0.93***
	(−3.15)	(0.51)	(1.82)	(2.09)	(2.16)	(4.50)
Returns	−0.10	0.39	0.58	0.66	0.73	0.82***
in local $	(−0.34)	(1.53)	(2.46)	(2.59)	(2.29)	(3.54)
Currency	0.03	0.02	−0.05	0.01	−0.13	−0.16
returns	(0.28)	(0.15)	(−0.46)	(0.06)	(−1.04)	(−1.22)
Weekly estimation						
Returns	0.02	0.23	0.50	0.67	0.66	0.66**
in USD	(0.05)	(0.77)	(1.71)	(2.08)	(1.76)	(2.57)
ICAPM	−0.35	−0.02	0.22	0.28	0.44	0.81***
	(−2.45)	(−0.15)	(1.60)	(1.60)	(2.01)	(3.83)
Returns	0.00	0.25	0.49	0.67	0.81	0.81***
in local $	(0.01)	(1.05)	(2.04)	(2.51)	(2.45)	(3.40)
Currency	0.01	−0.03	0.02	0.00	−0.14	−0.15
returns	(0.09)	(−0.24)	(0.16)	(0.01)	(−1.06)	(−1.09)
Monthly estimation						
Returns	0.55	0.52	0.46	0.87	0.96	0.42**
in USD	(1.72)	(1.81)	(1.57)	(2.67)	(2.68)	(2.06)
ICAPM	−0.11	0.08	0.28	0.41	0.85	0.96***
	(−0.85)	(0.71)	(2.07)	(2.79)	(4.64)	(4.77)
Returns	0.60	0.44	0.57	0.88	1.07	0.50***
in local $	(2.28)	(1.82)	(2.31)	(3.39)	(3.61)	(2.72)
Currency	−0.05	0.07	−0.10	−0.01	−0.11	−0.07
returns	(−0.40)	(0.69)	(−0.85)	(−0.07)	(−0.93)	(−0.64)

Panel C-1. Net total returns controlling for global yields

	Weekly beta					
	Port 1	Port 2	Port 3	Port 4	Port 5	H–L
Returns	0.25	0.56	0.62	0.85	0.96	−0.71***
in USD	(0.78)	(1.89)	(2.15)	(2.67)	(2.67)	(−2.83)
ICAPM	−0.07	0.13	0.32	0.40	0.78	−0.88***
	(−0.59)	(1.09)	(2.08)	(2.55)	(3.97)	(−4.22)
Returns	0.34	0.54	0.62	0.86	1.09	−0.76***
in local $	(1.19)	(2.22)	(2.57)	(3.35)	(3.67)	(−3.54)
Currency	−0.07	0.02	0.00	0.00	−0.13	0.07
returns	(−0.58)	(0.18)	(−0.01)	(−0.02)	(−1.14)	(0.62)

Panel C-2. Net total returns controlling for global yields

	Monthly beta					
	Port 1	Port 2	Port 3	Port 4	Port 5	H –L
Returns	0.35	0.51	0.47	0.52	0.75	−0.40*
in USD	(0.94)	(1.39)	(1.31)	(1.36)	(1.76)	(−1.65)
ICAPM	−0.17	0.12	0.20	0.53	0.79	−0.96***
	(−1.50)	(1.19)	(1.76)	(2.74)	(3.99)	(−5.08)
Returns	0.30	0.46	0.50	0.60	0.92	−0.62***
in local $	(0.92)	(1.49)	(1.83)	(2.03)	(2.65)	(−2.68)
Currency	0.05	0.05	−0.02	−0.08	−0.17	0.22**
returns	(0.34)	(0.39)	(−0.16)	(−0.64)	(−1.42)	(2.01)

Table IV
Cross-sectional regressions controlling for common macro-variables

This table summarizes the average and the Fama-MacBeth standard errors of the cross-sectional regression using leading monthly country stock returns denominated in USD as the dependent variable and daily and monthly SB betas as independent variables. Control variables include the time-series average of the betas, the ICAPM beta, GDP per capita, population, GDP growth rate, inflation rate, and the percentage contribution of exports to the total GDP. Panel A provides the results for the total return index, and Panel B is designated for the price index.

Panel A. Net total index returns (N=260)

	Dependent variable : Leading monthly returns in USD							
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
$\hat{\beta}_d^i$	0.033∗∗∗		0.051∗∗∗		0.035∗∗	0.020		
	(2.72)		(3.16)		(2.31)	(1.51)		
$\hat{\beta}_m^i$		0.029∗∗		0.038∗∗			0.029∗	0.020
		(2.29)		(2.25)			(1.93)	(1.44)
$\bar{\hat{\beta}}_d^i$			−0.023					
			(−1.11)					
$\bar{\hat{\beta}}_m^i$				−0.016				
				(−0.70)				
GDP per cap					0.000	0.000	0.000	0.000
					(−0.28)	(−0.62)	(−0.14)	(−0.47)
% Export/GDP					0.000	0.000	0.000	0.000
					(0.08)	(−0.06)	(−0.28)	(0.12)
Population					0.000	0.000	0.000	0.000
					(0.83)	(0.84)	(0.56)	(1.03)
GDP growth					0.010	0.009	0.005	0.005
					(0.90)	(0.89)	(0.46)	(0.55)
Inflation					−0.001	0.000	−0.001	0.000
					(−1.13)	(−1.00)	(−1.11)	(−0.80)
ICAPM beta						0.000		0.000
						(−0.09)		(−0.14)

Panel B. Price index returns (N=380)

	Dependent variable : Leading monthly returns in USD							
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
$\hat{\beta}_d^i$	0.043∗∗		0.082∗∗∗		0.058∗	0.050		
	(2.41)		(4.10)		(1.92)	(1.62)		
$\hat{\beta}_m^i$		0.057∗∗∗		0.072∗∗∗			0.060∗∗	0.059∗∗
		(3.11)		(3.80)			(2.55)	(2.51)
$\bar{\hat{\beta}}_d^i$			−0.056∗∗					
			(−2.30)					
$\bar{\hat{\beta}}_m^i$				−0.024				
				(−1.16)				
GDP per cap					0.000	0.000	0.000	0.000
					(0.69)	(0.59)	(0.49)	(0.35)
Total GDP					0.000	0.000	0.000	0.000
					(−0.99)	(−0.93)	(−0.79)	(−0.72)
% Export/GDP					0.000	0.000	0.000	0.000
					(−0.42)	(−0.43)	(−0.62)	(−0.48)
GDP growth					0.011	0.012	0.020	0.021
					(0.54)	(0.59)	(0.96)	(1.03)
Inflation					−0.001	−0.001	−0.001	0.000
					(−1.30)	(−1.08)	(−1.18)	(−0.99)
ICAPM beta						0.003		0.000
						(0.95)		(−0.00)

Table V
Cross-sectional regressions controlling for additional predictors

This table summarizes the average and the Fama-Macbeth standard errors of the cross-sectional regression using leading monthly country stock returns in USD as the dependent variable and daily and monthly SB betas as independent variables. Control variables include standard return predictors of international stock returns, such as dividend yields, past annual stock market performance excluding the past month, and the term spread. Panel A provides the results for the total return index, and Panel B is designated for the price index.

Panel A. Net total index returns (N=260)

	Dependent variable : Leading monthly returns in USD							
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
$\hat{\beta}_d^i$	0.031∗∗∗		0.029∗∗		0.029∗∗		0.027∗∗	
	(2.80)		(2.55)		(2.52)		(2.36)	
$\hat{\beta}_m^i$		0.025∗∗		0.022∗		0.019∗		0.021∗
		(2.08)		(1.77)		(1.66)		(1.75)
Div yield	0.114∗∗	0.079					0.090	0.077
	(2.02)	(1.51)					(1.59)	(1.48)
Term spread			0.000	0.000			0.000	0.000
			(0.84)	(0.99)			(0.96)	(0.96)
Momentum					0.012∗	0.011	0.010	0.008
					(1.68)	(1.57)	(1.34)	(1.18)

Panel B. Price index returns (N=260)

	Dependent variable : Leading monthly returns in USD							
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
$\hat{\beta}_d^i$	0.028∗∗		0.023∗∗		0.022∗		0.025∗∗	
	(2.56)		(2.04)		(1.93)		(2.17)	
$\hat{\beta}_m^i$		0.026∗∗		0.022∗		0.017		0.021∗
		(2.08)		(1.66)		(1.40)		(1.66)
Div yield	0.190∗∗∗	0.154∗∗∗					0.163∗∗∗	0.149∗∗∗
	(3.16)	(2.72)					(2.77)	(2.70)
Term spread			0.000	0.000			0.000	0.000
			(0.68)	(0.71)			(0.85)	(0.87)
Momentum					0.013∗	0.010	0.008	0.006
					(1.67)	(1.52)	(1.06)	(0.88)

Table VI
Does sovereign default risk explain the results?

This table summarizes the leading monthly country index stock returns (in USD/local currency), the excess returns of the global CAPM, and currency returns sorted by the negative of the CDS beta (Panel A) and the negative of the risk-free yield beta (Panel B). The negative sign is taken so that the interpretation matches that of the main result. The risk-free yield is defined as the difference between nominal yields and the CDS spread. The risk-free bond yield beta is the negative slope of the country's stock returns regressed on changes in the risk-free yield. The estimates are obtained from monthly data using a 36-month rolling window or weekly data using a 12-month rolling window. Newey-West t-statistics are reported in parenthesis.

Panel A. Sorted by (negative of) CDS beta

	Port 1	Port 2	Port 3	Port 4	Port 5	H –L
Weekly Estimate						
Returns	0.58	0.49	0.55	0.48	0.38	−0.20
in USD	(1.31)	(1.08)	(1.47)	(1.00)	(0.90)	(−1.03)
ICAPM	0.08	0.12	0.41	0.12	−0.10	−0.18
	(0.66)	(0.85)	(3.02)	(0.86)	(−0.73)	(−1.12)
Returns	0.59	0.55	0.59	0.54	0.48	−0.12
in local $	(1.69)	(1.61)	(1.97)	(1.43)	(1.43)	(−0.63)
Currency	−0.01	−0.07	−0.04	−0.06	−0.10	−0.09
returns	(−0.08)	(−0.44)	(−0.33)	(−0.42)	(−0.62)	(−1.14)
Monthly Estimate						
Returns	0.68	0.62	0.62	0.11	0.51	−0.17
in USD	(1.49)	(1.40)	(1.73)	(0.24)	(1.16)	(−0.91)
ICAPM	0.26	0.44	0.45	−0.37	−0.04	−0.30**
	(2.32)	(3.22)	(3.52)	(−2.63)	(−0.29)	(−2.16)
Returns	0.66	0.77	0.65	0.12	0.63	−0.02
in local $	(1.93)	(2.33)	(2.28)	(0.31)	(1.80)	(−0.13)
Currency	0.02	−0.14	−0.03	−0.01	−0.12	−0.14
returns	(0.14)	(−0.92)	(−0.22)	(−0.07)	(−0.80)	(−1.57)

Panel B. Sorted by (negative of) risk-free yield beta

	Port 1	Port 2	Port 3	Port 4	Port 5	H –L
Weekly Estimate						
Returns	0.33	0.50	0.49	0.55	0.75	0.42**
in USD	(0.88)	(1.31)	(1.28)	(1.47)	(1.88)	(2.04)
ICAPM	−0.03	0.31	0.35	0.24	0.57	0.60***
	(−0.26)	(1.81)	(2.54)	(1.72)	(2.97)	(3.16)
Returns	0.27	0.41	0.59	0.60	0.89	0.62***
in local $	(0.86)	(1.29)	(1.91)	(1.99)	(2.88)	(3.05)
Currency	0.06	0.09	−0.09	−0.05	−0.14	−0.19**
returns	(0.42)	(0.64)	(−0.73)	(−0.36)	(−0.96)	(−2.04)
Monthly Estimate						
Returns	0.23	0.38	0.74	0.59	0.62	0.39*
in USD	(0.59)	(0.99)	(2.11)	(1.48)	(1.59)	(1.66)
ICAPM	0.03	0.28	0.26	0.23	0.59	0.56***
	(0.18)	(2.11)	(2.15)	(1.63)	(2.91)	(2.77)
Returns	0.14	0.48	0.68	0.55	0.82	0.67***
in local $	(0.42)	(1.56)	(2.36)	(1.74)	(2.70)	(2.85)
Currency	0.09	−0.09	0.05	0.03	−0.20	−0.29**
returns	(0.66)	(−0.67)	(0.43)	(0.24)	(−1.41)	(−2.56)

Table VII
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 result of 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 cross-sectional standard deviation of the coefficients divided by 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 VIII
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 first difference in local bond yields and local stock returns. 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.

Panel A. Using daily net total returns (N=7872)

	Dependent variable : $\hat{\beta}^i_d$					Dependent variable : $\hat{\rho}^i_d$				
SD(Δy^i)	1.399	1.742		1.599	2.297	0.078	0.031		0.079	0.090
	(2.90)	(3.01)		(2.88)	(3.75)	(2.91)	(2.40)		(2.92)	(3.21)
SD(R^i_m)			−4.664	−1.121	−1.340			−0.024	−0.005	−0.018
			(−5.88)	(−4.59)	(−4.99)			(−1.45)	(−1.25)	(−3.38)
FE Country	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
FE Time	Y	N	Y	Y	N	Y	N	Y	Y	N
R^2	0.382	0.210	0.392	0.392	0.242	0.453	0.275	0.451	0.454	0.263

Panel B. Using price index returns (N=10416)

	Dep. variable : $\hat{\beta}^i_d$					Dependent variable : $\hat{\rho}^i_d$				
SD(Δy^i)	2.220	2.569		2.695	5.151	0.040	0.086		0.038	0.138
	(4.04)	(5.01)		(4.55)	(9.37)	(4.26)	(6.36)		(4.09)	(10.02)
SD(R^i_m)			−4.094	−3.766	−8.507			−0.076	0.009	−0.172
			(−6.96)	(−4.47)	(−10.17)			(−5.96)	(0.62)	(−8.69)
FE Country	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
FE Time	Y	N	Y	Y	N	Y	N	Y	Y	N
R^2	0.426	0.161	0.355	0.432	0.235	0.536	0.179	0.373	0.537	0.218

Table IX
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 regressed on the volatility of stock market variance (VOV) estimated in several ways. Panel A uses a stochastic volatility model where the VOV equals the variance of the returns. Panel B uses the intra-day RV of a country stock index and the cross-sectional global average at a given week to estimate the VOV. Panel C uses the first-difference in bond yields as proxy for variance shocks. variance correlation is the correlation between shocks to the local RV and their global average, yield correlation is the correlation between first difference of local bond yields and their global average. The SB betas ($\hat{\beta}^i$) are estimated using daily data on a 30-day rolling window. In some regressions, the SB betas are replaced with the SB return correlation ($\hat{\rho}^i$) .

Panel A. Using stochastic volatility model (N=6981)

	Dep. variable : $\hat{\beta}^i_d$				Dependent variable : $\hat{\rho}^i_d$			
$\exp(h^i_t)$	1.055	−0.090	1.056	1.998	0.055	0.029	0.055	0.080
	(2.99)	(−0.80)	(2.99)	(3.47)	(3.21)	(2.95)	(3.21)	(3.09)
$\exp(h^*_t)$			13.990	−67.450			−0.043	−1.208
			(0.16)	(−3.46)			(−0.03)	(−2.64)
FE Country	Y	Y	Y	Y	Y	Y	Y	Y
FE Time	Y	N	Y	N	Y	N	Y	N
R^2	0.400	0.282	0.3997	0.2257	0.491	0.269	0.4911	0.2822

Panel B. Using intraday variance (N=3671)

	Dep. variable : $\hat{\beta}^i_d$				Dependent variable : $\hat{\rho}^i_d$			
Local VOV	6.182	4.724			0.159	0.180		
	(2.50)	(2.24)			(3.60)	(3.21)		
Global VOV	−8.059	−8.720			−0.293	−0.193		
	(−1.63)	(−2.45)			(−2.66)	(−2.11)		
Variance correlation			−2.401	−6.172			−0.046	−0.115
			(−1.87)	(−6.22)			(−1.74)	(−4.09)
FE Country	Y	Y	Y	Y	Y	Y	Y	Y
FE Time	Y	N	Y	N	Y	N	Y	N
R^2	0.421	0.287	0.420	0.289	0.497	0.356	0.495	0.355

Panel C. Using bond yields (N=7287)

	Dep. variable : $\hat{\beta}^i_d$				Dependent variable : $\hat{\rho}^i_d$			
Yield correlation	−3.823	−1.017	−4.144	−3.368	−0.161	−0.102	−0.165	−0.112
	(−3.64)	(−0.69)	(−4.14)	(−1.11)	(−6.06)	(−2.85)	(−6.20)	(−3.06)
$SD(\Delta y^i)$			2.149	3.683			0.049	0.074
			(3.26)	(4.95)			(2.30)	(2.53)
$SD(R^i_m)$			−1.137	−4.579			−0.009	−0.017
			(−3.53)	(−3.74)			(−1.96)	(−2.68)
FE Country	Y	Y	Y	Y	Y	Y	Y	Y
FE Time	Y	N	Y	N	Y	N	Y	N
R^2	0.403	0.201	0.411	0.246	0.496	0.301	0.498	0.283

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 local/global variance correlation, the volatility of country-specific variance shocks (VOV), local stock market realized variance estimated from intraday data. The international CAPM beta is added as a control variable.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Country-specific VOV	0.052**	0.047**				
	(2.22)	(2.04)				
Variance correlation			−0.011**	−0.013***		
			(−2.41)	(−3.01)		
Local RV					0.003	0.002
					(1.27)	(1.13)
ICAPM Beta	−0.006		−0.002		−0.006	
	(−1.50)		(−0.56)		(−1.34)	

A. Technical Appendix

1. Consumption dynamics and bond yields

In the main text, the wealth-consumption ratio and the price-dividend ratio are solved using the method of undetermined coefficients.

It is conjectured that both the local and global wealth-consumption ratios ($z_t^{i/*}$) are linear functions of the state variables. The returns to the local wealth portfolio can be computed as

$$\Delta c_{t+1} + \kappa_0 + \kappa_1 z_{t+1}^i - z_t^i.$$

A closed-form solution for the restricted model can only be derived under the restriction $\rho_{ps} = 0$. If the consumption-wealth ratio takes the form of $A_0^r + A_g^r v_t^* + A_l^r v_t^i$ it can be shown that

$$A_g^r = \theta \frac{(1-1/\psi)^2}{2(1-\kappa_1 v_1)}$$
$$A_l^r = \theta \frac{(1-1/\psi)^2}{2(1-\kappa_1 \nu_1)}$$

solves the Euler equation

$$E_t[m_{t+1} + R_{TW,t+1}] + 0.5Var_t[m_{t+1} + R_{TW,t+1}] = 0.$$

In the full model, the local wealth-to-consumption ratio takes the form $A_0 + A_g v_t^* + A_l v_l^i$. It is straightforward to derive that A_g solves the quadratic equation

$$\theta(\kappa_1 \sigma_g A_g)^2 + 2(\kappa_1 v_1 - 1 + \theta \rho_{ps}(\kappa_1 \sigma_g)(1-1/\psi))A_g + \theta((1-\frac{1}{\psi})^2) = 0,$$

and A_l solves the equation

$$\theta(\kappa_1 \sigma_l A_l)^2 + 2(\kappa_1 \nu_1 - 1 + \theta \rho_{ps}(\kappa_1 \sigma_l)(1-1/\psi))A_l + \theta((1-\frac{1}{\psi})^2) = 0.$$

One intuitive way of selecting the value from the two is to use the intuition that the coefficient of the full model should be comparable to those of the restricted model, which assumes constant volatility of variance. Only one of the two values provides a reasonable value and is very close to the restricted model.

Also, the constant coefficient A_0 can be derived as

$$A_0 = \frac{\log\beta + (1-\frac{1}{\psi})\mu + \kappa_0 + \kappa_1 A_g v_0 + \kappa_1 A_l \nu_0}{1-\kappa_1}.$$

Deriving the value for the restricted model is also straightforward, but is not necessary for the purpose of this paper.

Similarly, for the global-wealth consumption ration, following the same logic, $z_t^* = A_0^* + A_g v_t^*$, where

$$A_0^* = \frac{\log\beta + (1-\frac{1}{\psi})\mu + \kappa_0 + \kappa_1 A_g v_0}{1-\kappa_1}.$$

In the full model, the price of each risk factor is derived as

$$m_{t+1}^i - E_t[m_{t+1}^i] = \lambda_c(\sqrt{v_t^i}\epsilon_{c,t+1}^i + \sqrt{v_t^*}\epsilon_{c,t+1}^*) + \lambda_l\sqrt{v_t^i}\epsilon_{v,t+1}^i + \lambda_g\sqrt{v_t^*}\epsilon_{v,t+1}^*,$$

where $\lambda_c = \gamma$, $\lambda_g = (\theta-1)\kappa_1 A_g \sigma_g$, $\lambda_l = (\theta-1)\kappa_1 A_l \sigma_l$.

The one-period bond yield for country i can be derived from

$$y_t^i = -\mathrm{E}_t[m_{t+1}^i] - 0.5\mathrm{Var}_t[m_{t+1}^i],$$
$$y_t^i = Y_0 + Y_g v_t^* + Y_l v_t^i,$$

where

$$\begin{aligned}
Y_g =&(1-\theta)A_g(\kappa_1 v_1 - 1) - 0.5\left(\lambda_c^2 + \lambda_g^2\right)\\
Y_l =&(1-\theta)A_l(\kappa_1 \nu_1 - 1) - 0.5\left(\lambda_c^2 + \lambda_l^2\right)\\
Y_0 =&-\theta\log\beta + \gamma\mu - (\theta-1)(\kappa_0 + (\kappa_1-1)A_0 + \kappa_1 A_g v_0 + \kappa_1 A_l \nu_0).
\end{aligned}$$

It is straightforward to show that Y_g and Y_l are always negative.

For the restricted model, a one-period bond yield for country i is

$$y_t^i = Y_0^r + Y_g^r v_t^* + Y_l^r v_t^i,$$

where,

$$\begin{aligned}
Y_g^r =&(1-\theta)A_g^r(\kappa_1 v_1 - 1) - 0.5\lambda_c^2\\
Y_l^r =&(1-\theta)A_l^r(\kappa_1 \nu_1 - 1) - 0.5\lambda_c^2.
\end{aligned}$$

The value for Y_0^r can be derived but is not necessary for the purpose of this paper.

2. 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: $z^i_{m,t} = B_0 + B_l v^i_t + B_g v^*_t$. The solutions for the coefficients can be solved using the Euler equation

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

Using the Campbell-Shiller decomposition, one can solve the function above using the state variables, collect the terms associated with v^i_t and v^*_t to solve for the coefficients.

It can be shown that B_g and B_l solves

$$0.5\left(\lambda_g + \kappa_{m,1} B_g \sigma_g\right)^2 + 0.5(\phi_f \rho_c - \lambda_c)^2 + 0.5(1-\rho_c)^2 \phi_f^2 + (\theta-1)(\kappa_1 v_1 - 1)A_g + B_g\left(\kappa_{m,1} v_1 - 1 + (\rho_c \phi_d - \lambda_c)\kappa_1 \sigma_l \rho_{ps}\right) = 0$$

and

$$0.5\left(\lambda_l + \kappa_{m,1} B_l \sigma_l\right)^2 + 0.5(\phi_d \rho_c - \lambda_c)^2 + 0.5(1-\rho_c)^2 \phi_d^2 + (\theta-1)(\kappa_1 \nu_1 - 1)A_l + B_l\left(\kappa_{m,1} \nu_1 - 1 + (\rho_c \phi_f - \lambda_c)\kappa_1 \sigma_g \rho_{ps}\right) = 0,$$

where only one of the values between the two provides a reasonable value. Similar to the consumption-wealth ratio, one value is very close to the restricted model when $\rho_{ps} = 0$.[8]

Similarly, the coefficient B^r_g and B^r_l under the restricted model is given by:

$$B^r_l = \frac{0.5(\phi_d \rho_c - \gamma)^2 + (\theta-1)(\kappa_1 \nu_1 - 1)A^r_l + 0.5(1-\rho_c^2)\phi_d^2}{1 - \kappa_1 \nu_1}$$
$$B^r_g = \frac{0.5(\phi_f \rho_c - \gamma)^2 + (\theta-1)(\kappa_1 v_1 - 1)A^r_g + 0.5(1-\rho_c^2)\phi_f^2}{1 - \kappa_1 v_1}$$

3. The SB relationship

To compute the covariance between stock returns and changes in bond yields, I first compute the unexpected changes in bond yields.

$$y^i_{t+1} - E_t[y^i_{t+1}] = Y_l \sqrt{v^i_t}\sigma_l \epsilon^i_{v,t+1} + Y_g \sqrt{v^*_t}\sigma_g \epsilon^*_{v,t+1},$$

[8] The second value is unrealistic since both coefficients are positive and leads to excess volatility in the price-divided ratio (25% annualized)

and unexpected stock returns is

$$R^i_{m,t+1} - E_t[R^i_{m,t+1}] = \phi_d\sqrt{v^i_t}\epsilon^i_{d,t+1} + \phi_f\sqrt{v^*_t}\epsilon^*_{d,t+1} + \kappa_{m,1}\left(B_l\sigma_l\sqrt{v^i_t}\epsilon^i_{v,t+1} + B_g\sigma_g\sqrt{v^*_t}\epsilon^*_{v,t+1}\right)$$

The conditional variance of stock returns is

$$Var_t[R^i_{m,t+1}] = \left(\phi_d^2 + (\kappa_{m,1}B_l\sigma_l)^2\right)v^i_t + \left(\phi_f^2 + (\kappa_{m,1}B_g\sigma_g)^2\right)v^*_t$$

Under the restricted model the variance is $\phi_d^2 v^i_t + \phi_f^2 v^*_t$

Finally, the stock return - bond yield covariance is

$$SBCov^i = \left(Y_g\kappa_{m,1}B_g\sigma_g^2\right)v^*_t + \left(Y_l\kappa_{m,1}B_l\sigma_l^2\right)v^i_t$$

The bond yield beta is computed by dividing the covariance with yield variance, and the correlation is calculated by dividing by the standard deviations of yields and stock returns. The SB covariance is constant under the restricted model.

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. The risk premium can be derived as

$$E_t[R^i_{m,t+1}] + 0.5Var_t[R^i_{m,t+1}] + E_t[m^i_{m,t+1}] + 0.5Var_t[m^i_{t+1}] = Cov(-m^i_{t+1}, R^i_{t+1})$$

Therefore, the risk premium for the global investor under the full model can further be solved as:

$$Cov_t(-m^i_{t+1}, R^i_{m,t+1}) = MRP_g v^*_t + MRP_l v^i_t,$$

where $MRP_g \equiv -\lambda_c(\phi_f\rho_c + \kappa_1 B_g\sigma_g\rho_{ps}) - \lambda_g(\rho_{ps}\rho_c\phi_f + \kappa_1 B_g\sigma_g) > 0$ and $MRP_l \equiv -\lambda_c(\phi_d\rho_c + \kappa_1 B_l\sigma_l\rho_{ps}) - \lambda_l(\rho_{ps}\rho_c\phi_f + \kappa_1 B_l\sigma_l) > 0$.