Stock-bond Correlations and International Stock Market Return Predictability*

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ABSTRACT

This paper shows that the relationship between a country's stock and bond returns strongly predicts future stock market returns across countries. Stock market and bond returns are positively correlated when country-specific variance shocks dominate global variance shocks. Hedging country-specific variance risk is challenging during these times, and equity investors require compensation for bearing country-specific variance risk. Empirically, equity investments in countries with a more positive stock/bond return relationship generate 6-8% higher future returns, which remains robust after controlling for global yields, standard macroeconomic variables, and well-known return predictors. Countries characterized by higher yield volatility as well as lower stock market variance correlation with the global counterpart exhibit more positive stock/bond relationships.

Keywords: Stock-bond correlation, international stock market, return predictability

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I. Introduction

While international investors have a substantial bias towards home equity holdings (French and Poterba 1991), at the same time, foreign equity and bond investments have also increased substantially.[1] In particular, with recent developments of international exchange-traded funds (ETFs) and passive mutual funds, macroeconomic investments focusing on the global market cycles have become more popular. These strategies count on understanding how country-specific and global risk factors derive the returns of the two major asset classes – bonds and stocks.

This paper studies whether the relationship between the country's stock market and bond returns (denoted here as the SB relationship) is associated with the country equity risk premium. A negative SB relationship should be regarded safer for the investor as bonds and stocks provide a hedge against to each other. This paper shows that a positive SB relationship is associated with higher country-specific volatility risk, which is priced in the equity market. When country-specific volatility risk is large, stock and bond prices move independently, since stocks are heavily exposed to global consumption risk while bond yields are entirely determined by the local consumption sector. In contrast, when global volatility risk dominates, bond and stock prices move in opposite directions.

Intuitively, whether a country whose consumption shock is dominated by global shocks should have a higher or a lower risk premium is ambiguous. The risk premium may be higher for the markets that face similar shocks to the world as they have a higher beta to the global wealth portfolio(e.g. Adler and Dumas 1983, De Santis and Gérard 1998). Lettau, Maggiori, and Weber (2014) also demonstrates that the global market factor is priced during bad times, supporting that a high correlation between shocks to the local and global economies is likely to lead to a higher risk premium. In contrast, other recent studies (e.g. Bakshi, Carr, and Wu 2008, Andersen, Fusari, and Todorov 2020) highlight the importance of local risk factors as

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

determinants of the risk premium. This paper confirms the latter: stock markets of countries with a negative SB relationship have lower risk premia since local volatility risk is priced in the stock market.

Empirically, equity investments in countries with a more positive SB relationship have 6.48 – 8.52% higher returns than those with a negative relationship. This relationship is robust after controlling for the variation in global bond yields, currency effects, standard country-specific macroeconomic variables, and return predictors such as the dividend yields, momentum, and term spread. The stock/bond return correlation is also positively related to bond yield volatility but negatively related to the correlation between local/global stock market variance shocks.

A simple consumption-based model presented in this paper shows that the time-varying SB relationship is strongly associated with the nature of the local variance shocks. In the model, consumption growth shocks have two components: one driven by global consumption shocks and the other that is country-specific. Bond yields are determined from the moments of local consumption growth rate. Both higher variance in global and country-specific consumption shocks are associated with lower bond yields. Stock prices fluctuate due to global and local variance shocks as firms produce goods and services to be consumed globally. Therefore, the stock and bond markets have different exposures to global and local variance shocks.

In standard asset pricing models with time-varying consumption variance, the relationship between the returns of real bonds and stocks is negative. High variance implies lower stock valuation as investors require a higher risk premium when volatility is high. It also means lower bond yields since consumption decreases due to the precautionary motive. Hence, bond investments naturally provide a hedge to variance risk embedded in stock investments. In the specific case where global variance shocks entirely determine bond yields, the correlation between stock and bond returns should be strongly negative. As the country-specific shock becomes dominant, bond and stock returns move more independently.

In the model, for the domestic investor, high volatility risk in the country-specific component implies a higher risk premium in their stock investment. The uncovered interest rate parity (UIRP) holds in the currency market, and higher country-specific volatility corresponds to lower bond yields. A lower bond yield implies an expected currency appreciation. Therefore, it is also the case that for the global investor, investments in these countries should have higher expected future returns.

The empirical analysis strongly supports these predictions. The SB return relationship is estimated as the negative of the slope of the regression where stock returns are regressed on the changes in bond yields (called SB beta in this paper), of which both are denominated in local currency. The results show that countries with a positive SB return relationship outperform countries with a negative relationship by 6.48 – 8.52% depending on the data frequency. These results are robust to using different types of stock market indices with a longer sampling period, controlling for the global yield changes, and after risk-adjusting returns using the international capital asset pricing model (Dumas and Solnik 1995).

The risk premia of the equity investment embedded in the SB betas are likely to be time-varying. When future stock returns are regressed both on the rolling-window SB beta estimate and its time-series average, only the rolling-window beta remains significant. Moreover, in the cross-sectional regression, the SB beta remains significant after controlling for standard macroeconomic variables such as population, total gross domestic product (GDP), GDP growth rate, total exports as a proportion of total GDP, and inflation rate.

The data also strongly confirms that the SB return relationship is governed by the variance of the country-specific risk factors. Two analyses are performed to confirm the hypothesis. First, following the model implication, the volatility of bond yields are used to represent the volatility of the local economy, whereas the volatility of stock returns are used to control for global volatility. Using a panel analysis, the results shows that the SB relationship is more negative when the volatility of bond yields is low and when the volatility of stock returns is high. Second, for each country, the stock market variance is forecasted, and the correlation between variance shocks of the local stock index and those of the global index is estimated. The analysis suggests that countries with a high correlation have a more negative SB return relationship.

The empirical analysis also supports the link between the two main drivers of the SB return relationship and future stock market returns. Countries with a high bond yield volatility are associated with higher stock returns. Also, those with a lower local/global yield correlation and lower local/global volatility correlations are associated with higher stock market returns. However, the predictability of these alternative proxies is largely concentrated in the later parts of the sample and the level of significance is lower compread to using the SB relationship directly.

Government bonds are often regarded as risk-free investments, even though default spreads of sovereign bonds fluctuate over time. Therefore, if sovereign default risk is priced among stocks, a negative SB relationship may be associated with a higher risk premium. I further test the possibility that default risk priced in the stock market drives the results by decomposing bond yields into two components: one representing the credit default spread and the other risk-free element. The results confirm that the SB relationship's predictive power mainly derives from the risk-free component of the yield changes.

This paper contributes to three research streams, one of which pertains to the international CAPM. Previous studies in this domain find weak support for the unconditional version of the CAPM. Specifically, Dumas and Solnik (1995) add a currency factor to the traditional CAPM to explain the currency effect in international investments. De Santis and Gérard (1998) find substantial exchange risk premium in the conditional CAPM, but weak evidence of the global market factor being priced among international index returns. According to Brusa, Ramadorai, and Verdelhan (2014), the dollar/carry/market three-factor model performs well in pricing international stocks. While this study does not propose a particular asset pricing model, the results reported here confirm the importance of pricing currency-related factors in international stock market returns.

This study is also related to the literature on international stock market predictability. 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. Rapach, Strauss, and Zhou (2013) show a lead-lag relationship between the US and international country stock returns. Yet, 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. In this paper, a new return predictor is introduced under the premise that it likely contains a different type of information about international stock returns.

Finally, the present research contributes 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, as it is generally assumed that the SB relationship is more positive in a riskier economy. For example, using a dynamic equilibrium model, Vayanos (2004) shows that SB 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 SB relationship, whereas Baele, Bekaert, and Inghelbrecht (2010) document the relationship between higher macro uncertainty and SB correlation. The findings in this paper show that the flight-to-quality mechanism is captured by the common global component of the stock market volatility. After controlling for the global component, the empirical analysis suggests that the bond yield volatility is strictly negatively associated with the SB relationship.

The remainder of the paper is organized as follows: The next section provides a simple model that describes the main intuition of this paper. Section III describes the data used in the analysis. Section IV is designed for the main empirical result, and the paper concludes with the discussion of the main findings, which are presented in Section V.

II. The Model

To understand the main intuition of how higher country-specific volatility of a country affects the relationship between returns on sovereign bonds and the stock market, I consider a highly stylized open economy model with one small country and one large country. I call the large country 'world' or 'global,' and the small country 'local.'

There is a stochastic discount factor (SDF) for each country, which is represented by recursive preference, as considered by Epstein and Zin (1991) with a risk aversion coefficient of γ and an intertemporal elasticity of substitution coefficient of ψ. Following convention, I let $\theta = \frac{1-\gamma}{1-1/\psi}$. Stocks, bonds, and currency assets are priced by the log of the SDF, which is defined as:

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

where β is the time discount factor. Δc_{t+1}^i and $R_{TW,t+1}^i$ are the consumption growth and the log returns on the wealth portfolio for country i.

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

1. Consumption dynamics and the wealth portfolio

Global consumption growth follows a simple Gaussian 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, but the three error terms ϵ_c^* and ϵ_v^* are uncorrelated random variables with mean 0 and standard deviation 1.

The consumption growth of country i also follows a Gaussian process but the shocks are both determined by local and global shocks. The dynamics are given by

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

where ϵ_c^i and ϵ_v^i are standardized error terms uncorrelated with each other as well as with global shocks. Hence, consumption growth variance of country i is the sum of the country-specific component v_t^i and the global component v_t^*. This dynamics naturally allows consumption shocks of country i and consumption variance shocks to be correlated with the global counterpart.

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

$$R_{TW,t+1}^{i/*} = \kappa_0 + \kappa_1 z_{t+1}^{i/*} - z_t^{i/*} + \Delta c_{t+1}^{i/*}, \tag{4}$$

where z_t^i or z_t^* is 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 can be linearized as in Bansal and Yaron (2004). I assume that the local wealth-consumption ratio (z_t^i) is represented as a linear function of the local (v_t^i) and global (v_t^*) consumption growth variance. Solving for the Euler equation, it can be shown that

$$z_t^i = A_0 + A_l v_t^i + A_g v_t^* \tag{5}$$

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

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

Bonds are risk-free claims backed by the government that are priced by the SDF of the country. The yield of a sovereign bond for country i (y_t^i) is determined by the expression

$$y_t^i = -E_t[m_{t+1}^i] - 0.5Var_t[m_{t+1}^i]. \tag{6}$$

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

$$y_t^i = Y_0 + Y_l v_t^i + Y_g v_t^*, \tag{7}$$

where Y_l and Y_g are negative constants. Note that in this model, the two variance shocks of consumption growth entirely determine the time-variation in yields. Bond yields are lower when either the global or the country-specific component of variance is high, consistent with the precautionary savings motive of interest rate determination.

Then, the conditional variance of the yield can be expressed as $(Y_l \sigma_l)^2 v_t^i + (Y_g \sigma_g)^2 v_t^*$.

International investments are realized in the currency of the country invested, which 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.

In this model, the uncovered interest rate parity (UIRP) relationship holds, and there is no currency risk premium. To see 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 since $Cov_t(m_{t+1}^i, m_{t+1}^*) = Var_t(m_{t+1}^*)$.

Hence, higher volatility in the country-specific consumption growth should lead to lower yields as well as a currency appreciation. As will be discussed below, the UIRP relationship suggests that we can directly compare the risk premium of the local stock market denominated in local currency across countries. Under this assumption, the expected currency return component in global investments is proportional to the interest rate differential. For the global investor investing in a country with higher expected currency returns, any additional currency returns earned in expectation are offset by the higher financing cost (global yield).

3. Dividend dynamics and stock returns

Two types of firms are assumed to operate in country i. 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, 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

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

where $\epsilon *_{d,t+1}$ and $\epsilon^i_{d,t+1}$ are assumed to be independent to each other but are correlated with $\epsilon *_{d,t+1}$ and $\epsilon^i_{d,t+1}$ with a fixed correlation coefficient $\rho_c > 0$, respectively. Also, ϕ_f is assumed to be greater than ϕ_d.

Stock market returns of country i ($R^i_{m,t+1}$) are expressed 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's stock market, 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:

$$z_{m,t}^i = B_0 + B_g v_t^* + B_l v_t^i, \tag{11}$$

where the values of $B_g < 0$ and $B_l < 0$ are given in the appendix.

In this specification, dividend growth has a higher exposure to global shocks $\phi_f > \phi_d$. This implies that the price-dividend ratio will depend more on the variance of global shocks than the consumption-wealth ratio. Also, compared to bond yields, the above assumption implies that stock returns will have greater exposure to global variance shocks. Therefore, the ratio of the variance of bond yields to stock returns will be higher when the variance of the country-specific component of consumption growth (v_t^i) is relatively higher than that of the global component (v_t^*).

Then, one can also derive the conditional variance of stock returns as

$$Var_t[R_{m,t}^i] = V_0 + V_l v_t^i + V_g v_t^*,$$

with the expressions for V_0, V_l, and V_g provided in the appendix.

The first panel of Table I shows the parameter specifications. The parameters are chosen to match the moments of global consumption, dividend growth, real yields, stock returns, and the correlation between financial variables across countries. The parameters of the variance process of the local component (ν_0, ν_1, and σ_l) may differ across countries. I assume these values are assumed to be equal to the global variance parameters.

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 either from (i) the US data only or from (ii) the world average. To compute the correlation between global and local stock returns, I use the value-weighted world index. Also, the local/global yield correlation is computed by first taking the cross-sectional average of the changes in yields at each point in time. The details on the data sources and measurements are provided in the next section.

The moments and correlations implied by the model represent the data well, particularly given the relatively simple dynamics assumed.[2] In particular, the calibrated values examined in this paper provide a better fit to the correlations between stock returns and bond yields and the cross-country correlations between bond yields and stock returns.

4. The stock/bond return correlation

In standard consumption-based asset pricing models, the correlation between stock and bond returns is typically negative. For example, in the long-run risk model, an increase in the long-run growth shock increases bond yields and stock prices. An increase in consumption growth variance also plays the same role. As bond returns and bond yields are almost perfectly negatively related, the corresponding correlation between stock and bond returns is negative. In a habit formation model, bond yields can be either procyclical or counter-cyclical. If yields are procyclical, the surplus consumption affects bond yields and stock prices in the same direction, implying a negative SB correlation.

The model of this paper also implies a negative average SB correlation. There are only two shocks – shocks to the variance of the global and local components of consumption shocks – that affect yields to the local bonds. Both shocks affect bond yields negatively. They also impact stock prices in the same direction.

However, the focus here is on the time variation in the SB correlation. The unique feature is that the variance of the global component affects stock prices more than it does for bond yields. There may be times when one of the two components dominates the other. For example, during an election period or when local geographical risk becomes dominant, the volatility of the local component will rise for a particular region. During such times, the local risk is likely to play an important role. Bond yields are likely to move accordingly, whereas stock prices, relatively speaking, are less affected. Thus, stock returns and bond yields are more likely to be unrelated.

[2]For example, Colacito and Croce (2011) use a long-run risk model to derive a high correlation between country-level bond yields. This model does not have a long-run risk component.

On the other hand, when global risk dominates, for example, during the COVID-19 pandemics, global consumption is affected by the spread of the virus. During this period, any vaccine-related news would increase the volatility of the global component of consumption. During such times, global shocks dominate, and the correlation between a country's stock market returns and bond yield shocks should be more negative.

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

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

where the expressions for $SB_l > 0$ and $SB_l > 0$ are given in the appendix. This relationship can be expressed (i) as a measure of correlation, by dividing the covariance with the standard deviation of bond yields and stock returns or (ii) as bond yield beta, by dividing the covariance with the bond yield variance.

Following the literature on the correlation between stock and bond returns, this paper focuses on the negative value of this relationship. Since bond yields and returns are almost perfectly negatively correlated, the SB return correlation is defined as the negative correlation between stock returns and bond yields. The stock/bond beta (SB beta) is defined similarly as the negative of the bond yield beta.

The first two panels of Figure 1 show how the SB correlation is related to the variance of local and global consumption shocks. Panel (a) shows how the SB correlation varies with the level of the local consumption variance, whereas Panel (b) shows how it depends on the level of global variance. In Panel (a), the level of the global variance is kept as constant, at the mean level assumed in Table I. Similarly, in Panel (b), the local variance is constant at its average value. This relationship holds even when the SB relationship is measured using the SB beta. Panel (c) and (d) show the results.

These figures confirm the intuition that the relative value of the local consumption variance to the global variance is strongly related to the SB correlation. It should be noted that the average value of the local consumption variance ν_0 does not affect the SB relationship. Only temporal variations in the variance of the local consumption growth directly affect the SB correlation.

Based on the parameters considered, this model implies that SB correlation is always negative. There are several circumstances when the conditional SB correlation can be theoretically positive. One is when consumption shocks are negatively correlated to the long-run consumption shocks as shown by Jones and Pyun (2021). This is likely to occur when the economy mainly faces short-term transient shocks, such as uncertainty shocks. The second possibility is that stock returns react negatively to inflation shocks, (e.g., Boons, Duarte, de Roon, and Szymanowska 2020).

One key implication of the model is the positive link between local consumption variance and the SB relationship. This implication may seem to contradict the empirical observations suggesting that the relationship is more positive when stock market variance is high. The standard premise is that investors prefer safer bond positions over risky stock positions when volatility spikes as they become more risk-averse. This phenomenon is commonly known as 'flight-to-quality.' It should be noted that the model of this paper implies that only an increase in global volatility should lead to a negative SB correlation. A relative positive shock in the volatility of the local sector should instead lead to a positive SB correlation.

5. International stock market risk premia

The previous section shows that the temporal variation in the SB relationship depends on the relative variance of the two components in consumption growth. The correlation is more negative when local consumption variance is low or when global variance is high. It is more positive when the opposite holds. As the variance of both of these two components is likely to be time-varying, the SB relationship should also be time-varying. This section investigates the link of the time-varying SB relationship to the variation in the equity risk premium across countries.

As noted earlier, the interest rate parity relationship holds in this model. Therefore, the risk premium required by the global investor in a particular stock market equals the risk premium required by the local investor in local currency. To better understand this assertion, the expected excess return of the stock market investment in country i for the global investor is

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

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

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

Therefore, the risk premium on an international stock market investment is determined by the covariance between the local discount factor and stock market returns, which is represented by:

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

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 constants given in appendix. The sign of MRP_l suggests countries with relatively higher variance in the local component will have a higher risk premium on the stock market as well as a relatively positive SB relationship. Hence, countries with high temporal values in their local consumption variance will have a temporal increase in the risk premium.

Panel (e) of Figure 1 shows the relationship between local consumption variance and the market risk premium. As in previous panels, global variance is assumed to stay at the average level. The figure clearly shows that the risk premium is higher when local volatility is higher.

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

The above implication contradicts the intuition that investments in countries closely related to the global economy should have the highest risk premium. For example, the extant literature on CAPM suggests that controlling for currency risk, countries that positively comove with the global value-weighted portfolio must require a higher risk premium. In classical studies, Adler and Dumas (1983) and De Santis and Gérard (1998), for example, propose a two-factor model with the global market factor and a currency factor.

In this paper, the international capital asset pricing model (ICAPM) does not hold. Global market returns are represented by the global cash flow shock as well as their corresponding variance shocks. The high ICAPM beta stock markets are those whose local volatility shocks are inconsequential. Since these countries are likely to have a more negative SB correlation, the model of this paper suggests that ICAPM may not hold ultimately. Nevertheless, the empirical analysis of the following section shows that all key results hold after controlling for the global beta.

One final implication of the model is the role of the correlation between variance shocks across countries. As shown in Panel (f) of Figure 1, the model suggests that as the local volatility increases, the correlation between local and global variance shock should decrease. Hence, the SB correlation should be more negative when local variance shocks are similar to the global variance shocks. Also, the risk premium of the stock market should be higher for countries that have a lower correlation between local and global variance shocks. This implication is also tested in the empirical section.

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, Netherlands, Norway, Russia, Spain, Sweden, Switzerland, Turkey, and the United Kingdom) are located in Europe, nine (China, India, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, and Thailand) are from Asia, three (Canada, Mexico, and the United States) from

North America, two (Australia and New Zealand) are from Oceania, and one is from South America (Brazil) and Africa (South Africa), respectively. Two of the G20 countries (Argentina and Saudi Arabia) are excluded from the sample due to the insufficient availability of bond yield data at the daily level. Among the top 20 stock market exchanges, only Iran and Taiwan Stock Exchange are omitted for the same reason.

The 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 and employ currency returns to convert obtained values to USD, adopting the relevant exchange rates sourced from Bloomberg. In addition to the country-level stock returns, I also compute stock returns of the global value-weighted portfolio. World stock index returns are used to calculate the beta of the international capital asset pricing model (ICAPM), as described in below.

Bond yields are represented by the ten-year Treasuries, all of which are denominated in their respective local currency. One of the reasons for choosing the ten-year maturity yields is data availability. Ten-year yields are available for the longest sampling period at the daily interval, which is critical since the sample is mostly restricted by the bond yield data availability. Another reason is compared to short-term yields such as the three-month yields, ten-year yields are less subjected to central bank intervention. To estimate the term spread, which is used as a control variable in the empirical analysis, I also use the one-year Treasuries.

Table II summarizes the sample of this paper, where the means and standard deviations of stock returns, currency returns, bond yields, and the first difference of the bond yields are reported in Panel A. To ensure a sufficient number of countries have available data at the beginning of the sampling period, the sample based on the total returns index starts in 1999. Those based on the price index commence in 1990. There are only seven countries at the beginning of the price index sample, which subsequently increases to 21 by 1999. One restriction of the more extended price index sample is that the stock index excludes dividend payments.

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

As the relationship between local and global variance shocks is one of the aspects influencing the SB relationship, for the empirical analysis, it is proxied using the correlations between the country-level and the global stock market variance or changes in bond yields. Due deal with asynchronous trading hours, I measure the changes in these variables at the weekly level.

The changes in weekly stock market variance is estimated in one of the two ways. The first measure is based on the classical generalized autoregressive conditional heteroscedasticity (GARCH) model. I estimate the GARCH(1,1) model for each country all at once using daily returns. Then, I form a forecast of the variance for the next five trading days. I take the estimates at the end of the week and take the first order changes over that interval. I also estimate the variance of global stock returns using the value-weighted index.

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

I use intraday stock market index data for 20 countries and apply a version of the Heterogeneous Autoregressive Realized Variance (HAR-RV) model[3] of Corsi (2009) to obtain a predicted value of the realized variance at the weekly frequency. Then, I take the end of week observation and take the first-order difference of the weekly forecast. To estimate the variance innovation for the global stock market, I take the simple average of all variance innovations across countries.[4]

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, as well as country-level total gross domestic product (GDP), GDP per capita, and total exports, all of which are sourced from the International Monetary Fund database. Consumption data is used for the calibration reported in Table I. Annual real consumption is obtained from the website of the Organisation for Economic Co-operation and Development for 23 countries.

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

2. Estimation of the stock-bond relationship and the international CAPM

The SB return relationship in this paper is measured from the first-order difference in bond yields and stock returns. Taking the first difference in yields is from the rationale that yield

[3]Since the goal of the empirical analysis is to measure weekly variance forecasts, I omit the daily component in the HAR-RV model. The regression used to estimate the variance forecast is

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

where RV_{t_0,t_1} is defined as the sum of squared intra day returns between day t_0 and t_1, both inclusive.

[4]This relies on the assumption that the cross-sectional correlation of the variance shocks does not vary in a systematic manner.

changes are almost perfectly negatively correlated with returns on a bond investment. The SB beta (β^i) is estimated as the negative of the slope of the regression

$$R^i_{m,t+1} = \alpha^i - \beta^i(y^i_{t+1} - y^i_t) + \epsilon^i_{t+1}, \tag{13}$$

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 ten-year Treasury bond of country i, also in local currency. The "negative" slope is to match the interpretation of the result to the SB return correlation. The second to the 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:

$$R^{i,USD}_{m,t+1} = a^i + b^i R^{USD}_{\text{MSCI},t+1} + c^i \Delta q^i_{t+1} + \epsilon^i_{t+1}, \tag{14}$$

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

The cross-sectional correlations of the average stock returns, 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 that there is weak to no empirical evidence that supports 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 the price index returns, there is no relationship between the two. A similar relationship is observed regardless of whether currency returns are added to stock returns in local currency.

The patterns are similar if the SB beta is compared with stock or currency returns. The stock market of countries that have a negative SB return relationship underperforms on average. However, if currency returns are added to local currency, the relationship becomes trivial, suggesting that, unconditionally, there is a weak relationship between SB betas and average stock market performance.

IV. Empirical Results

This section presents the main empirical findings, explicating the link between the time-varying SB relationship and the leading country stock market returns. Then, I demonstrate that the SB relationship is connected to proxies representing the volatility of the local component in an international economy. Finally, I provide some robustness test results.

1. International stock return predictability

The earlier model suggests that the SB relationship is related to how the volatility of the local component of consumption shocks is priced in the stock market. In the model, stock prices and bond yields move less closely together if country-specific shocks dominate shocks in an economy. In contrast, they tend to move more closely together when country-specific shocks are almost non-existent. As a result, the correlation between stock and bond returns is more negative when global shocks dominate.

Since the stock market in these countries – those with substantial country-specific risk – is deemed riskier for local investors, the risk premium required for the investors is higher. Therefore, countries with a relatively positive SB return relationship should have a better stock market performance after a positive SB return relationship is observed.

To test this hypothesis, I estimate the regression slope (13) using daily, weekly, and monthly returns and changes in yields, denoting the negative of the slopes by β_d^i, β_w^i, and β_m^i, 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 include dividends, the sampling period for the price index-based sample is longer.

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

Moreover, in international asset pricing, controlling for the 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., 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 needs to be extended to improve the estimation. However, in practice, this may introduce outdated information in the estimate if the relationship is subject to high temporal variation.

Therefore, I use the 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 there is a need to control global variables, the weekly beta from a 52-week rolling window is considered the baseline.

Daily, weekly, and monthly betas are estimated for each country, and then, countries are sorted by the SB beta estimates. Then, five stock market index portfolios are formed based on their rankings, and returns are evaluated for the subsequent months. Portfolio one contains countries with the most negative stock/bond return relationship, and portfolio five 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 (14).

Panel A of Table III shows the results based on the net total index returns, whereas values reported in Panel B are based on the price index returns. The results using daily, weekly, and monthly estimates are provided for each panel. Overall, these findings are consistent with the hypothesis. Focusing on the first two rows of each sub-tables 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 for the sum of global stock and currency returns by applying the ICAPM.

The last two rows of each section of the 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 estimating 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. In particular, in some international asset pricing studies, such as the model developed by Colacito and Croce (2011), bond yield innovations are perfectly correlated across countries. Therefore, the existence of external habit formation (e.g., Stathopoulos 2017) also increases the cross-country correlation between asset returns. Hence, a high cross-country correlation between yield shocks implies that the yield betas maybe capturing 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

$$R^i_{m,t+1} = \alpha'^i - \beta'^i(y^i_{t+1} - y^i_t) - \gamma^i \sum_{\forall j}(y^j_{t+1} - y^j_t) + \epsilon^i_{t+1}, \tag{15}$$

whether either weekly or monthly data is used to estimate the regression. As noted earlier, controlling for the global bond yields at the daily frequency is challenging due to the asynchronous trading hours around the world.

The average returns of the portfolios sorted by the SB beta controlling for the global yield changes (β'^i) are reported in Panel C of Table III. Overall, the results are very 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).

2. The role of country-specific macroeconomic variables

The results reported in Table III show that the SB betas are strong predictors of country-level stock market returns. This result compares to the unconditional relationship between SB betas and average stock market returns shown in Panel B of Table II, which shows that there is essentially no relationship 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 of 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 the previous section. 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 reports these for the net total returns index, and Panel B is designed for the price index. The first two models (denoted by Model 1 – 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, which offers empirical evidence that stock investments in countries with a positive SB return relationship present a better future stock market performance.

The following two models (Model 3 – 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, the results for both panels show that 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 component of the risk premia.

The last four models (Model 5– Model 8) incorporates several macroeconomic variables as control. The variables include: per capita GDP (representing whether the country is in a developed or emerging market economy), total GDP (representing the size of the country), country's 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 temporal variation of the risk premia that the SB beta captures may partially be related to some dimension of the macroeconomic fundamentals. However, standard macroeconomic variables presented here do not entirely explain the time-variation of the risk premia.

Although none of the coefficients on the control variables are statistically insignificant, several observations about 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.

On the other hand, 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 international CAPM. The weaker result is due to potential multicollinearity because ICAPM betas are negatively related to the SB relationship. The negative coefficient on the ICAPM beta confirms that this hypothesis.

In conclusion, the results reported in this section strongly support the hypothesis that the relationship between stock returns and bond yields 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 the standard macroeconomic variables.

3. The relationship to standard return predictors

The subsequent analysis investigates the relationship between SB betas and other standard predictors used in the international stock return predictability literature. In answering this question, I consider the return predictors examined by Cenedese, Payne, Sarno, and Valente (2016). They show that the 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 ten-year yields and one-year yields, and momentum is the average of the returns preceding the measurement time by 2 – 12 months. The term spread and momentum are estimated every month on the last trading day.

In line with the methodology of the previous section, 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.

For both indices considered, the SB beta is positively related to future stock market performance 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 statistical significance remains even after adding these two additional return predictors are added in the cross-sectional regression. The size of the average coefficient also largely remains similar to Panel B of Table IV, where the sampling period is used. If the term spread is added to the specification, only the SB beta is statistically significant. If all other three predictors are added along with the SB beta, the SB beta remains significant in three of the four specifications. The size of the average coefficients does not change much after adding all three additional return predictors. Moreover, none of the other return predictors remain statistically significant.

4. The SB relationship and bond yield volatility

One dimension to which the SB relationship relates is the volatility of the local consumption growth. In particular, the model suggests that the relative level of the volatility of the local component in consumption growth to that of the global component is strictly positively related to the SB return relationship.

In this empirical analysis, the volatility of the local component 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 bond yields are entirely determined by the volatility of the domestic shocks. On the other hand, firms produce goods and services to be consumed internationally. Therefore, the volatility of the stock market is determined by domestic and global consumption. These proxies are imperfect since bond yields are also affected by the shocks to the global component, and stock returns are also affected by domestic shocks. However, if the above premise is correct, the ratio between the volatility of bond yields and stock returns should reasonably measure the ratio of the local to global consumption growth volatility.

This hypothesis is tested by applying a panel regression with the SB betas and SB return correlations as dependent variables while treating bond yield volatility and stock volatility of the country as explanatory variables. According to the model implications, it is expected that, after controlling for stock market volatility, the relationship between SB relationship and bond volatility to be positive. The relationship between the bond/stock volatility ratio should also have a slope in the panel regression.

I choose to estimate the SB betas using the regression as in the main specification but 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[5]. This issue can solvable if, for example, the estimates are non-overlapping.

The SB return correlation (ρ_d^i) is also estimated using the same window. I only present the result using daily SB beta since it is challenging to use weekly or monthly data using a short sampling window. Bond volatility and stock volatility are also estimated using the same rolling window, and I take logs on both volatility estimates.

Table VI summarizes the panel regression results. Panel A shows the main specification results when volatility, the SB beta, and the SB return correlations are estimated from daily data. The left side of the panel shows the results obtained using the SB beta as the dependent variable. For those presented on the right side, the SB correlation is the dependent variable. The first regression suggests that bond volatility is positively related to the SB betas.

This result may seem counter-intuitive given solid empirical evidence, (e.g., Connolly, Stivers, and Sun 2005), commonly known as the flight-to-quality, provided by previous studies on the negative relationship between the SB return correlation and stock market volatility. According

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

to these studies, investors become more risk-averse when volatility spikes and move their risky stock portfolio to a safer bond position. As a result, the SB return correlation is more negative when volatility spikes.

Therefore, to understand the influence of the stock return volatility, a second regression is estimated by including both the stock and bond yield volatility simultaneously. In this regression, the sign and the significance of the bond yield volatility do not change. If bond betas are regressed on the difference between them, the sign of the coefficient is positive and statistically significant.

One may think that this outcome is mechanically driven since

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

where R_m^i is the stock return, and Δy^i is the first difference of bond yields. If the correlation ρ_d^i is constant, the SB beta is expected to be higher in magnitude when the stock market volatility is high, and the bond yield volatility is low. Therefore, I consider alternative specifications, where the SB return correlation replaces the SB betas.

Overall, these results are similar even when the correlation is modeled as the dependent variable. Bond yield volatility is positively related to the correlation, and the sign of the coefficient on the stock market volatility is insignificant. The insignificance may be unexpected given strong negative statistical significance on this coefficient reported by other studies. One conceivable explanation for this result may be the volatility of the common global component captured by the stock market. Hence, the time-fixed effect reduces the significance of a common global effect.

This possibility is tested further in two additional specifications using stock market volatility as a sole independent variable, one of which excludes the time-fixed effect. The values reported in the last two columns of Panel A suggest that the stock market volatility is negatively related to the SB correlation only when the time-fixed effect is excluded. These results strongly indicate that the worldwide stock market volatility entirely drives the flight-to-quality effect. The results of Panel B that uses the price index instead provide a similar outcome.

The preceding analysis does not rely on any overlapping observations when estimating betas, correlations, and volatility. Therefore, the results are unlikely to be driven spuriously. However, when the dependent and the independent variables are highly persistent, it is still possible that the standard errors reported are biased. To understand whether the results are driven by exceptionally highly serially correlated estimates, I consider an alternative specification with the first-order difference for the daily and weekly bond beta, correlation, and volatility estimates. This approach essentially tests whether volatility shocks in bond yields and stock returns lead to higher or lower yield betas.

Panel C summarizes the results of the first differences. The results for only the total returns are presented as those for the price index are very similar. Overall, the relationships between yield beta and volatility also hold when first differences are used. Both daily and weekly SB betas increase as the bond yield volatility increases and as the stock market return volatility decreases. The same relationship holds for the correlation between stock returns and bond yields.

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

5. Variance dynamics and SB relationship

In the model, shocks to consumption growth are decomposed into two components – country-specific and global shocks. The variance of consumption growth of a domestic economy is the sum of the variance of these two components. In previous sections, this paper shows that the SB return correlation is associated with the relative size of the variance of the country-specific component. When the two variance processes are time-varying, the relative size should also depend on the correlation between consumption shocks of the domestic economy and those of the global economy.

This section shows the relationship of this alternative measure to the SB return relationship. The stock market variance is determined by the variance of the shocks to the country-specific component and the global component. As the country-specific variance increases, the correlation between the variance of the country and the global stock market should decrease, leading to a more positive SB relationship. Conversely, if the stock market variance moves less closely with the global stock market variance, the SB return relationship should be more negative.

As outlined in the data section, two measures of stock market variance proxies are used in this framework. The first is the GARCH-based estimation, in which I obtain a series for each country and the value-weighted world index using daily stock returns. Weekly forecasts (i.e., cumulative five-day-ahead-forecast) are formed from the model. The second estimation uses the intra-day high-frequency data. A variant of the HAR-RV model is used to form a weekly forecast of the stock market variance.

Each of these two variance measures has its benefit. First, the GARCH based estimate requires a sufficient amount of data to estimate the model parameters. In the current empirical setting, the GARCH model is estimated once per country index. The MSCI global index is used to measure the global variance. Estimating the model on a rolling basis may be problematic when the sampling period is limited.

Second, the HAR-RV is a regression-based approach that requires less data. Therefore, the analysis based on this estimate is an out-of-sample. Also, by using intraday estimates, a more precise estimation of the stock market variance is possible. However, data availability is an issue. 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.

Similar to above, I use panel regressions to test the association between the two correlations, with the SB relationship as a dependent variable and the correlation between country and global variance shocks as an independent variable. In this analysis, three-month estimation windows are used for both the dependent and independent variables since weekly data is used to estimate the variance shocks.

Panel A of Table VII shows the result of the regression where local/global variance correlation is used as the explanatory variable. The results are shown only for the price index returns in this specification since the results are quantitatively similar to those of the net total index returns. Also, the sample for the RV-based variance correlation begins in 2000 due to data availability. Overall, the panel indicates that the local/global variance correlation is negatively related to the SB return correlation. The results remain significant even after controlling for the yield and the stock return volatility.

In the model, bond yields either move when the variance of the country-specific or the global component fluctuates. In the real world, other factors also drive the time-variation of bond yields, such as inflation shocks, long-run growth shocks, or changes in investors' habits. However, in all of these and in many standard asset pricing models with time-varying volatility, volatility shock is an essential component that moves bond yields. 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/global bond yields.

Therefore, Panel B of Table VII tests whether the SB return 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 yield changes of that particular country is computed. The analysis of Panel A is repeated after replacing the variance correlation with the yield correla Overall, the panel regressions confirm that local/global yield correlation is positively related to the SB return correlations and the SB betas. This relationship remains significant after controlling for the level of yield volatility, which is also positively associated with the SB return relationship.

6. Empirical proxies and the stock market return predictability

The empirical evidence presented in the preceding section indicates that the SB relationship is positively related to the volatility ratio between bond yields and stock returns, the local/global stock variance, and yield correlation. The empirical test of this section aims to ascertain whether these variables are directly associated with future stock market performance.

For this purpose, all empirical proxies – the daily bond yield volatility, stock market volatility, the local/global stock market return variance correlation, the local/global yield correlations – are calculated using the specification in the previous analysis. The stock market variance is also estimated in two ways. Then, every month, the leading monthly stock market returns denominated in USD is regressed on each of these empirical proxies.

Table VIII summarizes the results of the regression, with Fama-MacBeth standard errors as in previous tables. Again, Panel A considers a shorter sample with net total index returns, where the intraday realized variance estimates are available compared to Panel B with price index returns.

In panel A, all the proxies show strong support for the hypothesis that these variables represent time-varying characteristics of the stock market risk premium. The result is particularly robust when the HAR-RV model is applied to intraday stock return variance. The local/global yield correlation is also negatively related to future stock returns, and the bond-stock volatility ratio is positively related to future stock returns. The significance remains robust primarily after controlling for the ICAPM beta. These are all consistent with the model predictions.

Despite the strong result reported in Panel A, the results are much weaker for the price return-based sample. One potential reason may be that fewer countries are in the sample during early periods, which may be severely biased towards developed economies. However, the coefficient on the variance correlation is still statistically significant, consistent with the results of panel A.

In conclusion, these results suggest that empirical proxies of the determinants of the SB return relationship in the international financial market are associated with the time-varying risk premium in the international stock market. Furthermore, these findings support that the SB return relationship contains information about these dimensions, making it a strong return predictor of country stock returns.

7. 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. For example, during the year 2020 alone, Italy's CDS spread reached a maximum of 246bp and a minimum of 96bp. For this reason, in this section, I examine the possibility that the main results of this paper are 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. Hence, any variation in bond yields that is not driven by the default compensation component must 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

$$\Delta y^i_{t+1} \approx \Delta CDS^i_{t+1} + \Delta RF^i_{t+1}, \tag{16}$$

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

$$R^i_{m,t+1} = \alpha^i - \delta^i_1 \Delta RF^i_{t+1} - \delta^i_2 \Delta CDS^i_{t+1} + \epsilon^i_{t+1}, \tag{17}$$

where $R^i_{m,t+1}$ is the stock return of country i in local currency, and sort the countries by the two beta estimates separately. The negative signs in the regression slope is to match the interpretation of the betas to the main specification, the SB beta. Then, portfolios are formed for each of these estimates separately and returns are evaluated for the subsequent month as in the previous analysis.

[6] The approximation comes from assuming

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

.

Table IX summarizes the stock returns expressed in USD, the ICAPM risk-adjusted returns, stock returns expressed in the local currency, and 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 of it. The signs are the opposite to this premise, although the difference is statistically insignificant. On the other hand, 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 driving the main results of this paper.

V. Conclusion

This paper shows that domestic stock and bond returns are closely related to the international stock market risk premium. Moreover, the risk premia that the SB return relationship captures is highly likely to be time varying.

The SB return correlation in an international economy is related to the relative size of the country-specific risk in the local economy. As for country-specific risk increases, bond yields are more likely to respond to an increase in response to a decrease in the variance shock to the country-specific risk. Stock returns, on the other hand, are less affected by those volatility shocks. The relative size of the country-specific risk is captured in other two dimensions – the ratio of the bond yield-to-stock return volatility and the correlation between local and global stock market variance shocks.

Empirically, this paper shows that the SB relationship is related to these two dimensions. Also, these two dimensions embed information on the risk premium of each stock market, particularly in the later sample, where there is more data available. Most of all, the SB beta, which proxies for these relationships, is a strong return predictor of the international stock market.

The findings reported in this paper have crucial implications for the performance of the so-called international CAPM, which implies that an investment is likely to have higher future stock returns if the returns covary more with the global wealth portfolio. This paper suggests the opposite. As was shown in the preceding sections, investments in countries whose local shocks are primarily uncorrelated to global shocks have higher stock returns. Since these countries are also likely to have a lower beta, the international CAPM would fail in this context.

The model presented in this paper explicates why the correlation between stock returns and bond yields varies over time. The standard 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 led by heightened global uncertainty and is unrelated to local volatility. In particular, empirical evidence presented in this paper indicates that the SB relationship is negative when local bond yield volatility is high.

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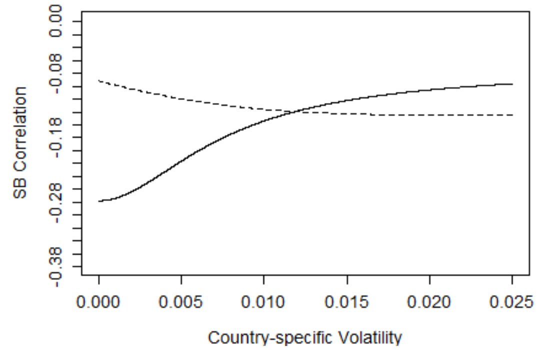
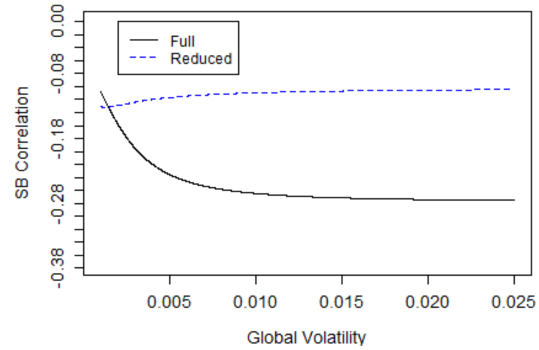
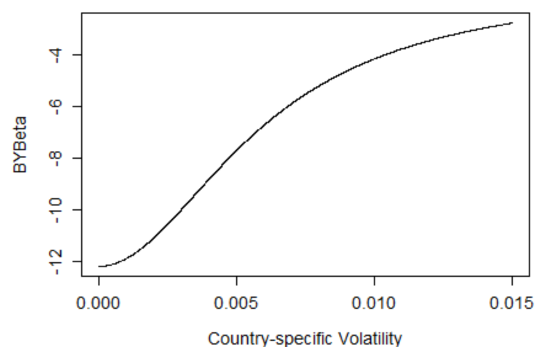


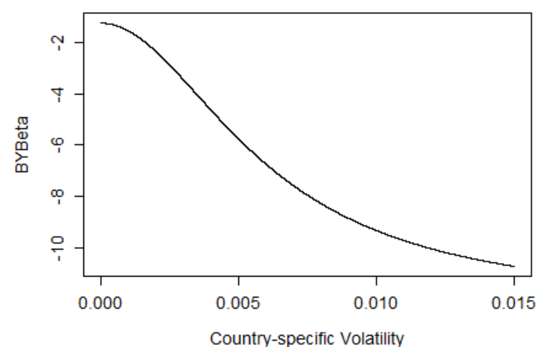
(a) Country-specific CG volatility and SB correlation



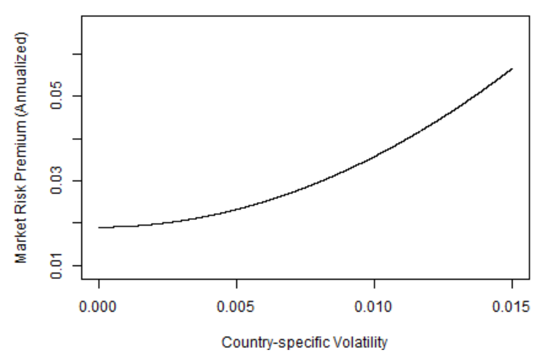
(b) Global CG volatility and SB correlation



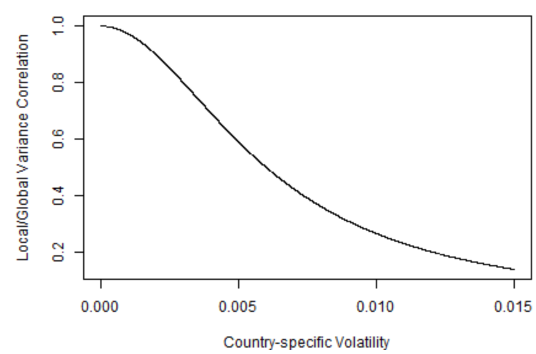
(c) Country-specific CG volatility and SB beta



(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 1. 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 I
Calibration

This table provides the parameter specification (Panel A) used to show the main implication in Figure 1. 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(y)), the correlation between stock returns and bond yields Cor(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 in the sample. R_m^* is the return of the global value-weighted index.

Panel A. Parameter Specification

	Parameters		Parameters
Preference parameters		Consumption parameters	
γ	10	μ	0.002
ψ	1.5		
β	0.9986		
Dividend parameters		Variance Parameters	
μ_d	0.0025	v_1	0.992
ϕ_d	2.5	v_0	2.88×10^{-7}
ϕ_f	6.0	σ_v	0.00125
ρ_c	0.5		

Panel B. Consumption growth and asset pricing moments

	Model	Data (1990-2020)	
		U.S.	World Average
μ	2.40%	2.55%	3.40%
σ	2.94%	1.57%	3.51%
Real yields (y)	2.37%	1.86%	2.54%
Yield volatility	0.41%	0.87%	0.69%
Real stock returns	6.75%	7.07%	5.74%
Stock market volatility	13.97%	14.83%	19.09%
Cor($\Delta y, R_m$)	0.196	0.234	0.224
Cor($\Delta y, \Delta y^*$)	0.766	0.848	0.579
Cor(R_m, R_m^*)	0.927	0.895	0.576

Table II
Summary statistics

This table summarizes the moments 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 (13)- (**??**) 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 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	0.070	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 of the portfolios are reported.

Panel A. Using net total stock index returns

	Port 1	Port 2	Port 3	Port 4	Port 5	L –H
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	$RPTS$	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	L –H
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
$\hat{\beta}^i_d$	0.033∗∗∗		0.051∗∗∗		0.035∗∗	0.020		
	(2.72)		(3.16)		(2.31)	(1.51)		
$\hat{\beta}^i_m$		0.029∗∗		0.038∗∗			0.029∗	0.020
		(2.29)		(2.25)			(1.93)	(1.44)
$\bar{\hat{\beta}}^i_d$			−0.023					
			(−1.11)					
$\bar{\hat{\beta}}^i_m$				−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
$\hat{\beta}^i_d$	0.043∗∗		0.082∗∗∗		0.058∗	0.050		
	(2.41)		(4.10)		(1.92)	(1.62)		
$\hat{\beta}^i_m$		0.057∗∗∗		0.072∗∗∗			0.060∗∗	0.059∗∗
		(3.11)		(3.80)			(2.55)	(2.51)
$\bar{\hat{\beta}}^i_d$			−0.056∗∗					
			(−2.30)					
$\bar{\hat{\beta}}^i_m$				−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
Panel regressions of stock-bond relationship on volatility

This table summarizes the results of the contemporaneous panel regressions of the estimated SB betas regressed on log bond yield volatility, log stock return volatility, the difference between the log bond and stock volatility with country and time fixed effects. 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 daily net total returns (N=7185)

	Dependent variable : $\hat{\beta}^i_d$				Dependent variable : $\hat{\rho}^i_d$			
log(bvol)	3.562		4.265		0.076			
	(5.54)		(6.07)		(6.61)			
log(svol)		−4.732	−5.446		−0.010		0.009	−0.083
		(−4.86)	(−5.74)		(−0.62)		(0.52)	(−4.13)
log(bvol/svol)				4.627		0.0559		
				(6.76)		5.67		
FE Country	Y	Y	Y	Y	Y	Y	Y	Y
FE Time	Y	Y	Y	Y	Y	Y	Y	N
R^2	0.404	0.408	0.422	0.415	0.492	0.490	0.485	0.277

Panel B. Using price index returns (N=8352)

	Dependent variable : $\hat{\beta}^i_d$				Dependent variable : $\hat{\rho}^i_d$			
log(bvol)	3.079		3.689		0.067			
	(5.14)		(5.61)		(6.13)			
log(svol)		−3.263	−4.277		−0.007		0.011	−0.120
		(−3.90)	(−4.78)		(−0.48)		(0.67)	(−5.80)
log(bvol/svol)				3.856		0.048		
				(5.48)		(5.15)		
FE Country	Y	Y	Y	Y	Y	Y	Y	Y
FE Time	Y	Y	Y	Y	Y	Y	Y	N
R^2	0.432	0.428	0.427	0.427	0.544	0.543	0.540	0.191

Panel C. First-difference regressions

	Using net total returns				Using price index returns			
Dep. Variable:	$\Delta\hat{\beta}^i_d$		$\Delta\hat{\rho}^i_d$		$\Delta\hat{\beta}^i_d$		$\Delta\hat{\rho}^i_d$	
Δ log(bvol)	3.945		0.059		3.874		(0.06)	
	(4.15)		(4.50)		(4.64)		4.64	
Δ log (svol)	−3.517		−0.001		−3.914		−0.007	
	(−4.30)		(−0.08)		(−5.12)		(−0.39)	
Δ log (bvol/svol)		4.707		0.042		3.886		0.044
		(5.47)		(3.83)		(5.42)		(4.03)
FE Country	Y	Y	Y	Y	Y	Y	Y	Y
FE Time	Y	Y	Y	Y	Y	Y	Y	Y
R^2	0.193	0.198	0.228	0.227	0.205	0.205	0.231	0.229

Table VII
SB Relationship and local/global correlations

This table summarizes the results of the contemporaneous panel regressions of the estimated SB betas regressed on the local/global variance correlation, local/global yield correlation, log bond yield volatility, log stock return volatility with country and time fixed effects. 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. SB relationship and stock market variance correlations (N=8130 (GARCH), 3667 (RV))

	$\hat{\beta}_d^i$				$\hat{\rho}_d^i$			
Var Cor	−1.324		−1.180		−0.060		−0.061	
GARCH-based	(−3.61)		(−3.28)		(−6.16)		(−6.38)	
Var Cor		−1.700		−0.898		0.031		−0.033
Intraday RV-based		(−2.05)		(−1.32)		(−1.75)		(−2.09)
log (bvol)			1.854	3.835			0.042	0.070
			(5.55)	(5.83)			(5.10)	(4.65)
log (svol)			−2.428	−4.118			0.011	−0.005
			(−3.55)	(−3.41)			(0.80)	(−0.22)
FE Country	Y	Y	Y	Y	Y	Y	Y	Y
FE Time	Y	Y	Y	Y	Y	Y	Y	Y
R^2	0.553	0.526	0.560	0.542	0.663	0.613	0.666	0.619

Panel B. SB relationship and yield correlations (N=8130)

	Using price index returns					
Dep. Var.:	$\hat{\beta}_d^i$			$\hat{\rho}_d^i$		
Yield correlation	−3.217	−3.136	−3.368	−0.082	−0.078	−0.078
	(−5.23)	(−5.13)	(−5.35)	(−4.21)	(−4.12)	(−4.09)
log (bvol)		1.255	3.683		0.040	0.040
		(4.18)	(4.95)		(4.88)	(4.77)
log (svol)			−4.579			0.003
			(−3.74)			(0.24)
FE Country	Y	Y	Y	Y	Y	Y
FE Time	Y	Y	Y	Y	Y	Y
R^2	0.550	0.552	0.5539	0.658	0.632	0.660

Table VIII
Cross-sectional regressions: alternative variables

This table summarizes the mean and the Fama-Macbeth standard errors of the cross-sectional regression using leading monthly country stock returns in USD as the dependent variable and local/global variance correlation, local/global yield correlation, log volatility ratio of the bond yields to stock returns as independent variables. Local/global variance correlation is computed either using a GARCH(1,1) model or a HAR-RV model using intraday stock index data as described in the main text. The local/global variance or yield correlations are computed using weekly data. Panel A provides the results for the total return index, and Panel B is designated for the price index.

Panel A. Total return based sample (2000–)

	Dependent Variable: Next month country stock market returns							
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Var Cor	−0.008∗∗				−0.033			
(GARCH)	(−2.35)				(−1.30)			
Var Cor		−0.011∗∗				−0.015∗∗∗		
(RV)		(−2.43)				(−2.80)		
Yield Cor			−0.005∗				−0.006∗	
			(−1.68)				(−1.87)	
log(bvol/svol)				0.092∗∗				0.106∗
				(2.24)				(1.86)
ICAPM Beta					0.003	0.002	−0.001	−0.004
					(0.55)	(0.55)	(−0.43)	(−1.15)

Panel B. Price return based sample (1990–)

	Dependent Variable: Next month country stock market returns					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Var Cor	−0.012∗			−0.013∗∗		
(GARCH)	(−1.79)			(−2.15)		
Yield Cor		0.007			0.007	
		(0.74)			(0.74)	
log(bvol/svol)			−0.010			0.036
			(−0.14)			(0.53)
ICAPM Beta				0.001	0.004	0.000
				(0.13)	(0.52)	(−0.01)

Table IX
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 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)

A. Technical Appendix

1. Consumption dynamics and bond yields

In the main text, the wealth-consumption ratio and the price-dividend ratio are solved following the methodology from the long-run risk literature, following Bansal and Yaron (2004).

It is conjectured that both the local and global wealth-consumption ratios ($z_t^{i/*}$) are linear functions of the state variables. The local wealth-to-consumption ratio takes the form of $A_0 + A_g v_t^* + A_l v_l^i$. The returns to the local wealth portfolio can be computed as

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

Solving for the Euler equation

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

It is straightforward to derive that A_g solves the quadratic equation

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

where only one of the solutions provides a reasonable value $A_g < 0$, and A_l solves the equation

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

Also, the constant coefficient A_0 can be derived as

$$A_0 = \frac{\log \beta + (1 - \frac{1}{\psi})\mu + \kappa_0 + \kappa_1 A_g v_0 + \kappa_1 A_l \nu_0}{1 - \kappa_1}. \tag{18}$$

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

$$A_0^* = \frac{\log \beta + (1 - \frac{1}{\psi})\mu + \kappa_0 + \kappa_1 A_g v_0}{1 - \kappa_1}. \tag{19}$$

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

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

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.

2. Dividend dynamics and stock returns

The price-dividend ratio ($z_{m,t}^i$) of country i's stock market is conjectured to be a linear function of the local and global state variables: $z_{m,t}^i = B_0 + B_l v_t^i + B_g v_t^*$. The solutions for the coefficients can be solved using the Euler equation

$$\mathrm{E}_t[m_{t+1}^i + R_{m,t+1}^i] + 0.5\mathrm{Var}_t[m_{t+1}^i + R_{m,t+1}^i] = 0,$$

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

It can be shown that B_g and B_l solves

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

and

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

where only one solution has negative values under reasonable parameter values.

3. SB relationship

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

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

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

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

Finally, the stock return - bond yield covariance is

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

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 yield and return shocks.

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 can further be solved as:

$$Cov_t(-m^i_{t+1}, R^i_{m,t+1}) = (-\lambda_c \phi_f \rho_c - \lambda_g \kappa_1 B_g \sigma_g) v^*_t + (-\lambda_c \phi_d \rho_c - \lambda_l \kappa_1 B_l \sigma_l) v^i_t,$$

Where $MRP_g \equiv -\lambda_c \phi_f \rho_c - \lambda_g \kappa_1 B_g \sigma_g > 0$ and $MRP_l \equiv -\lambda_c \phi_d \rho_c - \lambda_l \kappa_1 B_l \sigma_l > 0$.