Stock-bond Correlations and International Stock Market Returns*

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August 2021

ABSTRACT

This paper shows that the stock market of countries with negative stock-bond (SB) return relationships underperform those with positive relationships. Time-varying SB relationship is characterized by the relative amount of country-specific variance risk. When global variance risk dominates country-specific risk, the relationship is more negative. Since variance risk is priced, these countries have a lower risk premium. Empirically, equity markets with a more positive SB relationship outperform by 6-8% per year, which remains robust after controlling for global yields, standard macroeconomic variables, and well-known return predictors. Countries with higher local volatility and country-specific variance risk exhibit more positive SB relationships.

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

*I thank Allaudeen Hammed, Chris Jones, Heungju Park, and Johan Sulaeman, and participants at the 2021 APAD meetings for their comments. All errors are my own. Email: `sjpyun@nus.edu.sg`

I. Introduction

While international investors have a substantial bias towards home equity holdings (French and Poterba 1991), 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 stock market risk premium. Theoretically and empirically, this paper shows that countries whose variance shocks are dominated by country-specific shocks has a less negative or positive SB return relationship. A positive global variance shock negatively affects stock prices and bond yields. Therefore, bonds provide a natural hedge to the stock market against global variance risk. Therefore, when global variance shocks dominate, the SB relationship is negative.

When country-specific variance shocks dominate, bonds no longer provide hedge against global variance risk. If the stock market is more heavily exposed to global shocks than the bond market, the SB relationship will be less negative when local variance shocks dominate global shocks. Moreover, since time-varying global variance shocks are likely to affect all countries in the same direction (e.g., Bollerslev, Marrone, Xu, and Zhou 2014), the amount of country-specific variance risk would be an important driver of the country stock market risk premium.

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

[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.

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 local variance shocks.[2] 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 more due to global variance shocks as firms produce goods and services to be consumed globally. Therefore, the stock and bond markets have different exposures to global and country-specific 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 case where global variance shocks entirely determine bond yields, the correlation between stock and bond returns should be strongly negative. As country-specific variance shocks become dominant, bond and stock prices move more independently.

In the model, for the domestic investor, high country-specific variance risk implies a higher risk premium in their stock investment. In the model, the uncovered interest rate parity (UIRP) holds in the currency market. Since higher country-specific variance corresponds to lower bond yields, this leads to an expected currency appreciation. Hence, the expected returns for the global investor should also be higher for countries with high country-specific variance risk, even if their discount factor does not depend on the country-specific variance risk.

The empirical analysis strongly supports these predictions. The SB return relationship is estimated as the negative slope of the regression where stock returns are regressed on the changes in bond yields (called SB beta in this paper), both denominated in local currency. This

[2]In this paper, "local" shocks are decomposed into "country-specific" and "global" shocks. Country-specific and global shocks are assumed to be uncorrelated.

paper shows that countries with a positive SB return relationship outperform countries with more negative relationships 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 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 time-varying country-specific variance risk. Two analyses are performed to confirm the hypothesis. First, following the model implication, the volatility of bond yields is used to represent the volatility of the local economy, whereas the volatility of stock returns is used to proxy for global volatility. The results of a panel analysis show 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, the variance of the country-specific component of stock market risk is estimated in two ways. For both specifications, the SB return relationship is more negative when the volatility of variance of the global component is higher or when that of the global component is lower.

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 shows that country-specific variance risk is the key driver of the international stock market risk premium. Intuitively, whether the equity market whose shocks are dominated by global shocks should have a higher or a lower risk premium is ambiguous. The standard theory suggests a higher risk premium if the market faces similar shocks to the world. (e.g. Adler and Dumas 1983, De Santis and Gérard 1998). Lettau, Maggiori, and Weber (2014) also 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. Bollerslev, Marrone, Xu, and Zhou (2014) and Londono and Xu (2021) show that global variance risk is important determinant of the time-variation of the global premium. The focus of these papers is on the time-series predictability while this paper focuses on the time-series of the cross-country variation. The analysis of this paper is in line with other recent studies (e.g. Bakshi, Carr, and Wu 2008, Andersen, Fusari, and Todorov 2020) that highlight the importance of local risk factors as determinants of the risk premium.

This paper contributes to two other research streams. First is 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.[3] 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.

This research also 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 negative when the economy is riskier. For example, using a dynamic equilibrium model, Vayanos (2004) shows that SB correlation is positive when liquidity is low, which typically coincides with periods character-

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

ized 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. Recently, Jones and Pyun (2021) confirm the relationship, although the relationship should depend on the persistence of the shocks. The findings in this paper show that the flight-to-quality mechanism is captured by the common global component of the stock market volatility.

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 SB Relationship and Variance Risk

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

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

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

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

The global 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, and ϵ^*_c and ϵ^*_v are standardized normal random variables with correlation coefficient $\rho_{ps} < 0$. A negative correlation is motivated by the precautionary savings motive, which is consistent with **?** and Basu and Bundick (2017).

The consumption growth of country i also follows a Gaussian process where shocks are both determined locally and globally. The dynamics are given as

$$
\begin{aligned}
\Delta c^i_{t+1} &= \mu + \sqrt{v^i_t}\epsilon^i_{c,t+1} + \sqrt{v^*_t}\epsilon^*_{c,t+1} \\
v^i_{t+1} &= \nu_0 + \nu_1 v^i_t + \sigma_l \sqrt{v^i_t}\epsilon^i_{v,t+1},
\end{aligned}
\tag{3}
$$

where ϵ^i_c and ϵ^i_v are standardized normal error terms uncorrelated with global shocks. Hence, consumption growth variance of country i is the sum of the variance of the country-specific component v^i_t and the global component v^*_t. This dynamics naturally allows local consumption and variance shocks to be correlated with the global counterpart.[4] It is also worth noting that if there are many small countries with independent country-specific shocks, the cross-sectional average of consumption growth will equal global consumption growth under the dynamics as-

[4] This dynamics is similar to those of Lustig, Roussanov, and Verdelhan (2011), but in this dynamics, all countries have equal exposure to global shocks. As a result, the dynamics of this paper does not explain the carry trade puzzle but, makes the interpretation of the country stock market risk premium simpler.

sumed above. The average of cross-country variance shocks will also equal global variance shocks.

In addition to the full dynamics (the "full" model), I also consider a special case where the volatility of country-specific and global variance shocks is assumed to be constant (the "restricted" model). A closed-form solution for the restricted model, in the simplest form, can only be derived under the assumption of $\rho_{ps} = 0$. Hence, three models are compared. 1) the full model, 2) the full model with $\rho_{ps} = 0$, and 3) and the restricted model. This particular distinction aims to differentiate the role of consumption variance from consumption variance risk.

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

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

where z^i_t 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 is solved using the method of undetermined coefficients. I conjecture that the local wealth-consumption ratio (z^i_t) can be represented by a linear function of the country-specific (v^i_t) and global (v^*_t) consumption growth variance. It can be verified that

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

where the values $A_g < 0, A_l < 0$ and A_0 are given in the 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 local SDF. The yield of a sovereign bond for country i (y_t^i) is determined by

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

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 the two variance shocks of consumption growth entirely determine the time-variation in yields in this model. Bond yields are lower when global or the country-specific component of variance is higher, consistent with the traditional precautionary savings motive of interest rate determination.

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

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

$$\begin{aligned} E_t[\Delta q^i_{t+1}] + 0.5Var_t[\Delta q^i_{t+1}] &= E_t[m^i_{t+1}] + 0.5Var_t[m^i_{t+1}] - E_t[m^*_{t+1}] - 0.5Var_t[m^*_{t+1}] \\ &= y^*_t - y^i_t, \end{aligned} \tag{9}$$

and the currency risk premium for the global investor is

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

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

The UIRP relationship suggests that the model is unable to explain the carry trade puzzle. However, as shown in the following section, the dynamics simplifies the comparison of equity market performance across countries. Under the UIRP, the expected currency return in global investments is proportional to the interest rate differential. Thus, analyzing the performance of global investments is equivalent to comparing the sum of currency and investment returns denominated in local currency, less the common currency risk-free rate. If the UIRP holds, this is equivalent to comparing local-currency investment returns in excess of the local risk-free rate across countries.

3. Dividend dynamics and stock returns

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

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

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

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

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

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

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

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

Under a general consumption-based asset pricing framework with time-varying volatility, volatility shocks have two contradictory effects on stock prices. First, higher volatility increases the risk premium of the equity investment, leading to a lower valuation ("risk premium channel"). Second, the discount rate may decrease as higher volatility reduces the risk-free rate. A lower discount rate implies a higher valuation. In a closed economy, the former dominates the latter, e.g., as in the long-run risk model of Bansal and Yaron (2004), the price-dividend ratio is lower when volatility is higher.

For both country-specific and global consumption variance, the importance of the risk premium channel increases as the consumption multiplier (ϕ_d and ϕ_f) increases. The magnitude of the risk-free channel does not depend on these multipliers. Therefore, in this specification, where dividend growth is assumed to have a higher exposure to global shocks ($\phi_f > \phi_d$), the price dividend ratio will be more negatively affected by global variance shocks than by country-specific variance shocks ($B_g < B_l$). B_l can even be positive when ϕ_d is extremely low.

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

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

with the expressions for V_0, V_l, and V_g provided in the appendix. In the full model, the variance of stock market variance is also a function of local and global consumption variance. In the restricted model, the variance of stock market variance is much lower but still depends on the two volatility components due to the negative correlation assumed between consumption growth and consumption variance.

The dynamics also imply that stock returns will have greater exposure to global shocks compared to bond yields. The result is that, in the full model, the variance of bond yields will depend more on country-specific variance shocks, whereas the variance of stock returns will depend more on global variance shocks. Therefore, the ratio between bond yield variance will be relatively higher to stock market variance when the variance of the country-specific consumption growth (v^i_t) is relatively high and lower when the global variance (v^*_t) is high.

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, and the correlation between financial variables across countries. The country-specific and global dividend multipliers ϕ_d and ϕ_f and the correlation between consumption and dividend shocks are matched empirically from the stock market index and consumption growth to the values later shown in the empirical section. However, this simplified model is not meant to explain the equity risk premium puzzle.[5]

The second panel of the table reports the moments of the global and local asset pricing variables. The model-implied moments are compared with the data, computed from (i) the US data only or from (ii) the world average. To compute the correlation between global and

[5]The model does not have any components that represent internal or external habit (Campbell and Cochrane 1999), long-run risk (Bansal and Yaron 2004), or disaster risk (Barro 2006), etc.

local stock returns, I use the value-weighted world index. The local/global yield correlation is computed based on the assumption that global yield is the simple cross-sectional average of country yields. 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. In particular, the calibrated values examined provide a better fit than previous work to the correlations between stock returns and bond yields and the cross-country correlations between bond yields and stock returns.

In the data, the average correlation between local/global stock returns (0.798) is much higher than the average correlation for bond yields (0.579). This is consistent with the intuition of the model that the stock market is more heavily exposed to global variance shocks than the bond market. The order of the correlations is also consistent with other previous studies (e.g., Colacito and Croce (2011)).

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 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 provided in this paper also implies a negative average SB correlation. This is because 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 of the variance shocks lead to lower yields and positive bond returns. Since high variance generally implies lower valuation, stock returns are negative. The correlation between stock and bond returns is, therefore, unconditionally negative.

In this model, the variance of the country-specific and global components have different effects on stock prices. If the stock market is heavily exposed to global shocks, stock prices will react more negatively to global variance shocks and less to country-specific variance shocks. Moreover, the magnitude of the country-specific variance shock is likely to be time-varying. 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 country-specific risk is likely to play an important role. Since the "risk-free rate channel" is relatively stronger for if country-specific variance risk dominates, the SB correlation will be less negative during such times.

On the other hand, when global risk dominates, for example, during the COVID-19 pandemics, a common shock affects all countries. During this period, any vaccine-related news would increase the volatility of the global component of consumption. During these times, global shocks dominate, and the correlation between a country's stock market returns and bond yield shocks should be more negative. The influence of global volatility shocks on the SB correlation is likely affect all countries alike.

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 SB_l and SB_l 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 stock/bond return correlation, 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 would vary as the country-specific volatility (Panel a) and global volatility (Panel b) fluctuates in the full and restricted model. In Panel (a), the level of the global variance is assumed to be constant, at its mean level of Table I. Similarly, in Panel (b), the local variance is constant at its average value. The full model clearly shows that when local variance shocks dominate, the SB correlation is less negative. Conversely, when global variance shocks are large, the correlation becomes more negative.

This relationship holds even when the SB relationship is measured using the SB beta. Panel (c) and (d) show the results. Substantial country-specific variance shocks are associated with a less positive yield beta, whereas high global variance shock is related to a more negative yield beta.

The panels are supplemented with alternative specifications of the model. Overall, similar patterns are observed even when $\rho_{ps} = 0$. However, the panels suggest that the variation in the SB correlation is amplified through the precautionary savings channel. When consumption reacts negatively to variance shocks, the influence of a variance shock on the stock market is more substantial because both cash flow and discount rate are affected.

The particular case with ρ_{ps} can directly be compared with the restricted model. The purpose of considering the restricted model is to study how time-varying variance risk affects the SB relationship and whether the variation is affected more directly by variance rather than variance risk. In fact, the covariance between stock returns and bond yield is constant, which implies, any variation in the relationship is driven by the denominator, i.e., higher stock market variance when variance is high. It is evident that the correlation will approach zero when country-specific variance or global variance increases. In short, these figures suggest that the time-variation in SB correlation in the manner shown in the full model is driven by time-varying variance risk rather than time-varying variance.

One key implication of the model is the positive link between local consumption variance and the SB relationship. This implication may contradict empirical observations, suggesting that the relationship may be more positive when the market is volatile. 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 risk should lead to a negative SB correlation. Higher country-specific volatility should instead lead to a positive SB correlation. Since global volatility risk should affect all countries alike, in the model, cross-country differences in the SB relationship should be driven mainly by the country-specific component.

5. International stock market risk premia

The previous section shows that the strength of the SB relationship depends on the relative importance of local variance shocks in the economy. The SB correlation is more negative when the economy is dominated by global variance shocks, whereas it is more positive when it is dominated by local variance shocks. As the variance of both of these two components is likely to be time-varying, the SB relationship should also vary. This section investigates the link between the SB relationship and the equity risk premium.

As noted earlier, the interest rate parity relationship holds in this model. Therefore, the risk premium 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, it is sufficient to compare the risk premium on an international stock market investment in local currency as the covariance between the local discount factor and stock market returns:

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

where $R^i_{m,t+1}$ is the stock market return of country i in local currency and MRP_g and MRP_l are positive under reasonable parameter specification as given in appendix. While the influence of the global variance may be similar across countries, the influence of the country-specific components is likely to differ. Therefore, $MRP_l > 0$ suggests that countries with high country-specific variance are likely to have a higher risk premium. Since variance is likely to fluctuate more when it is high, these times are more likely to coincide with times when country-specific variance risk is high. Therefore, countries with higher country-specific volatility and more variance risk should have a higher 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 remain fixed at its mean 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.

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

This 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 and currency factors.

This simplified model cannot directly test whether the international capital asset pricing model (ICAPM) holds. This is because the model assumes all countries are exposed equally to global shocks. However, higher global risk exposure will be associated with a lower SB correlation because it will increase the relative importance of global variance shocks. Therefore, empirically, countries with a negative SB correlation are likely to have a higher global beta. Furthermore, since a negative SB correlation implies lower expected returns, the slope of the ICAPM could be less positive or even negative.

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. The MSCI value-weighted stock index returns are used to proxy global stock returns when calculating the international capital asset pricing model (ICAPM) beta, as described below.

Bond yields are represented by the ten-year Treasuries, all of which are denominated in their respective local currency. One of the reasons for choosing the ten-year maturity yields is data availability. Ten-year yields are available for the most extended sampling period at the daily interval, which is critical since the availability of bond yield data mainly restricts the sample. 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 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. As a result, there are only seven countries at the beginning of the price index sample, which subsequently increases to 21 by 1999. One restriction of the more extended price index sample is that the stock index excludes dividend payments.

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

Since the size of local and global variance shocks as well as their relationship are the aspects influencing the SB relationship, in the empirical analysis, I estimate a stochastic volatility (SV) model using the Markov Chain Monte Carlo (MCMC) method. The stochastic volatility model estimated is

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

where η^i_t and ϵ^i_t are standard normal, $R^i_{m,t}$ is the stock market return of country i in local currency, $R^* m, t$ is the value-weighted global stock index denominated in USD, Δq^i_t is the change in log currency value relative to USD. I estimate this model once for every country as well as for the global stock index using weekly net total returns. I use the MCMC scheme developed by Hosszejni and Kastner (2021). In this SV model, the log of volatility has constant volatility. Using Ito's lemma, it can be shown that this specification implies the volatility of variance is a linear function of variance. There is slight discrepancy with the model, but volatility and variance should be highly correlated. In the empirical section, I test whether the SB correlation is higher when the variance of the country-specific component is more volatile. Within the above SV framework, this is equivalent to testing whether the SB correlation is higher when $\exp h^i_t$ is higher.

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

I use intraday stock market index data for 20 countries and apply a version of the Heterogeneous Autoregressive Realized Variance (HAR-RV) model[6] of Corsi (2009) to obtain a predicted value of the realized variance at the weekly frequency. Then, I take the first-order difference of the weekly forecast at the end of every week. To estimate the variance innovation for the global stock market, I take the simple average of all variance innovations across countries.[7]

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

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

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

To calibrate the model and estimate the dividend process's local and global risk exposure, I take the difference in log-returns of the net total return index and the price index. Then I convert the value to USD and adjust for inflation. Consumption growth is the annual change in final consumption expenditure in constant 2010 USD, obtained from the Organisation for Economic Co-operation and Development.

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

[6]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 intraday returns between day t_0 and t_1, both inclusive.

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

and country-level total gross domestic product (GDP), GDP per capita, and total exports, all sourced from the International Monetary Fund database.

Finally, in the last part of the analysis, I use the sovereign credit default swap (CDS) spread to decompose bond yields into sovereign default spread and the risk-free component. The CDS 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 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 $R_{m,t+1}^{i,USD}$ is the log return of the country i's stock index, $R_{\text{MSCI},t+1}^{USD}$ denotes the log returns of the MSCI World Index, and q_{t+1}^{i} 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 weak 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 price index returns, there is no relationship between the two. Moreover, a similar relationship is observed regardless of whether currency returns are added to stock returns in local currency.

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 time-varying country-specific variance risk. Finally, I provide some robustness test results.

1. International stock return predictability

The earlier model suggests that the relationship between stock and bond returns is more positive when country-specific variance risk becomes more substantial. Also, since high country-specific variance risk is priced, countries and times with a positive SB return relationship are associated with higher future stock returns.

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 slightly 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 panel section 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 yield betas may capture the stock market's reaction to particular global shocks.

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

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

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 months).

2. The role of country-specific macroeconomic variables

The results reported in Table III show that the SB betas strongly predict the relative performance 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 offer 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 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 potentially due to multicollinearity because ICAPM betas are negatively related to the SB return 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 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.

The SB beta is positively related to future stock market performance for both indices considered, even after controlling for any alternative predictors. Dividend yields and momentum remain statistically significant, particularly when the SB beta is estimated using daily data. However, most of the 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 three other predictors are added to 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. Local and global exposure of the dividend growth process

Before studying the relationship between the SB return relationship and the variance dynamics, this section tests the model's primary assumption of Equation (10) that the dividend growth process has a higher exposure to global consumption shocks than to consumption shocks of the particular country.

The panel regression considered is

$$\Delta d_t^i = \gamma_l \Delta c_t^i + \gamma_g \Delta c_t^* + C_i + T_t + \epsilon_{i,t}, \tag{16}$$

where Δc_t^i and Δd_t^i are annual consumption and dividend growth rates of country i, Δc_t^* is the global consumption growth computed by aggregating all consumption across countries, and and C_i and T_t are country and year fixed effects, respectively.

The first panel of Table VI summarizes the results of this regression. The first two columns show the results when local consumption growth is the sole explanatory variable. Consumption and dividend growth are positively related in time series, and the positive relationship disappears when the time-fixed effect is added. The last two columns show the result with both local and global consumption growth. With and without the time-fixed effect, dividend growth responds more to global than local consumption growth shocks.

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

In short, the assumption that dividend growth has a higher exposure to global than local shocks is strongly confirmed in the data.

5. The SB relationship and bond yield volatility

The model shows that the SB return relationship is more positive when local variance risk is high. Since variance are likely to fluctuate more when variance is high, the SB return relationship will be more positive when local variance is relatively higher than the global.

In this empirical analysis, the volatility of the local consumption shocks is proxied by the volatility of bond yields. In contrast, the volatility of the global component is proxied by the volatility of the stock returns. The logic behind this is that the volatility of the domestic shocks entirely determines bond yields. On the other hand, the stock market is more heavily exposed to global consumption shocks. Therefore, the volatility of the stock market is primarily determined by domestic and global consumption. Of course, these proxies are imperfect since bond yields are also affected by the shocks to the global component, as for example shown by Jotikasthira, Le, and Lundblad (2015), and stock returns are also affected by domestic shocks. However, under the premise, bond yield volatility should represent local volatility controlling for stock market volatility. Also, the stock market volatility should represent global volatility controlling for bond yield volatility.

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

The SB betas and correlations are estimated as in the main specification but after adopting a 30-calendar day rolling window. The reason is simple. Using long-horizon estimates in regressions could be problematic if the dependent variables are based on overlapping regressions, as these may generate spuriousness in regression estimates, especially when explanatory variables are also highly serially correlated[8]. This issue is solvable if, for example, the estimates are non-overlapping. I only present the result using daily SB beta since it is challenging to use a short sampling window for weekly or monthly data. Bond yield volatility and stock volatility

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

are also estimated using the same rolling window. The yield volatility is defined as the standard deviation of the daily first difference in yields.

Table VII summarizes the panel regression results. Panel A shows the main specification results using the net total returns index, which begins from 1999. Panel B uses the price index, which begins from 1990. 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. All results show a strong positive relationship between bond yield volatility and the SB beta.

One may think that this outcome is mechanically driven since

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

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

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

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

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

6. Variance dynamics and the SB relationship

This section takes a more direct approach and tests the relationship between the volatility of stock market variance and the SB return relationship. As outlined in the data section, two measures of stock market variance proxies are used in this framework. The first is an SV model given in Equation (**??**), which is estimated using an MCMC scheme. In this model, the log of stock market variance has constant volatility, which by Ito's lemma implies that the volatility of stock market variance is higher when volatility is higher. Note that h_t^i in this model, theoretically, is the log variance of the country-specific shocks. The second measure uses intraday index data, and weekly variance forecasts are estimated using the HAR-RV model.

Each of these two variance measures has its benefit. First, the SV model requires a sufficient amount of data to estimate the model parameters. In the current empirical setting, the SV model is estimated once per country index. Thus, estimating the model on a rolling basis may not produce an accurate estimate of variance.

Second, the HAR-RV is a regression-based approach that requires less data. Therefore, the analysis based on this estimate is 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 intraday 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, panel regressions are used with the SB relationship as a dependent variable. Panel A of Table VIII shows the result of the regression using the SV model. The test is whether a higher country-specific variance is associated with a positive SB return relationship. Since the volatility of variance equals the variance, this test is equivalent to testing whether a positive SB return relationship is associated with the volatility of variance. The results are shown only for the net total return index in this specification. The result for the price index is similar, because the correlation estimates are very similar.

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

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

In the model, bond yields either move when the variance of the country-specific or the global component fluctuates. In 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 affects bond yields. Thus, 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 VIII 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 variance correlations with yield correlations. Overall, the panel regressions confirm that local/global yield correlation is positively related to the SB return correlations and the SB betas. Moreover, this relationship remains significant after controlling for the level of yield volatility, which is also positively associated with the SB return relationship.

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

Table IX summarizes the results of the regression, with Fama-MacBeth standard errors as in previous tables. The results are based on the net total return index since intraday index data is only available from 2000. The result of this table should be interpreted with caution since the estimation of the local volatility of consumption variance may contain substantial noise.

Overall, the results confirm that high country-specific volatility of variance is associated with higher future stock returns. In addition, a lower correlation between local/global variance shocks, which indicates high country-specific variance risk, is also associated with a higher risk premium.

In conclusion, these results suggest that empirical proxies of the determinants of the SB return relationship in the 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 the size of variance risk of the country-specific component, which is priced in the stock market.

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 return predictability result of this paper is due to stock returns reacting to sovereign default risk.

Government yields are decomposed into two parts: the default risk premium and the risk-free component. Mathematically, in the absence of any liquidity premium, inflation risk, and double default, bond yield is equivalent to the sum of the risk-free rate and the CDS spread. 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

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

where CDS^i_{t+1} is the CDS rate and RF^i_{t+1} is the risk-free yield.[9]

I estimate the beta of these two components using the regression

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

where $R^i_{m,t+1}$ is the stock return of country i in local currency, and sort the countries by the two beta estimates separately. 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.

[9] The approximation comes from assuming

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

.

Table X 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 a country's SB relationship contains information about whether the country currently has a higher risk premium than its neighbors. If this correlation is positive, the country is likely to be facing higher variance risk to its neighbors, which leads the stock market and the Treasury market to move in the same direction.

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. The SB beta, which proxies for these relationships, is a strong international stock market return predictor.

Most of all, the SB relationship is extremely straightforward to estimate compared to other measures of country-specific variance risk. For example, estimating the variance risk premium would require using option pricing data, and decomposing the global component in the variance risk premium from the country-specific component can be challenging. Estimating the volatility of variance is also likely to be complicated and may involve substantial estimation errors. On the other hand, the SB relationship is easily estimable as long as Treasury yield data and stock market index data are readily available.

This paper shows that the SB return correlation is a strong predictor of international stock market returns. The findings reported in this paper also have implications for the performance of the so-called 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 the preceding sections show, investments in countries whose local shocks are primarily uncorrelated to global shocks have higher stock returns. Empirically, 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 driven by heightened global uncertainty and is unrelated to shocks 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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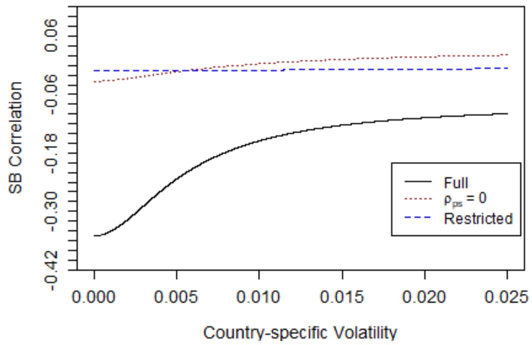
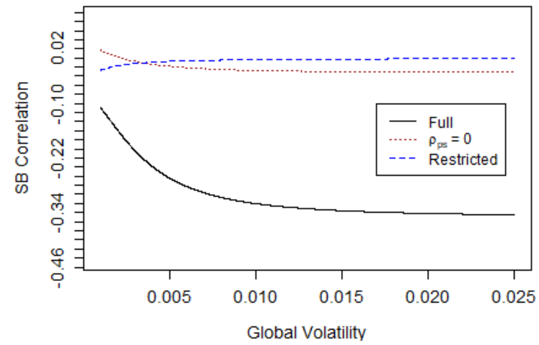
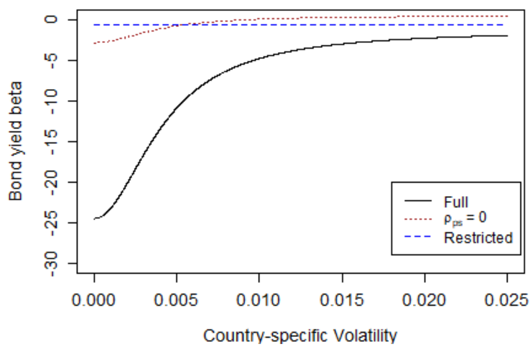


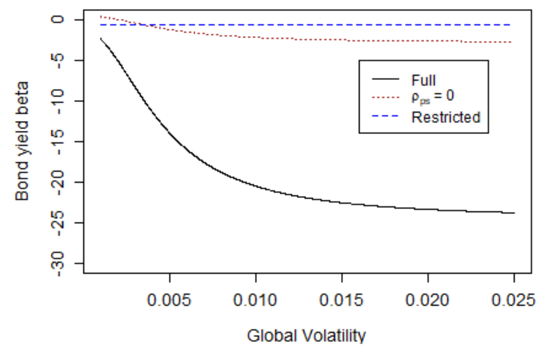
(a) Country-specific CG volatility and SB correlation



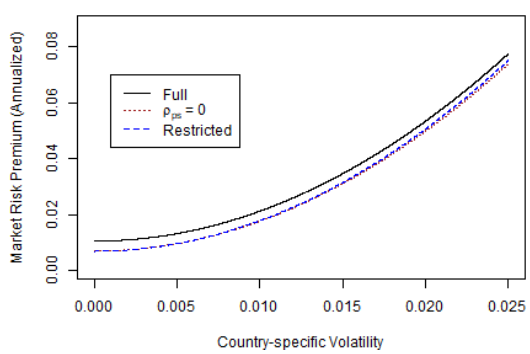
(b) Global CG volatility and SB correlation



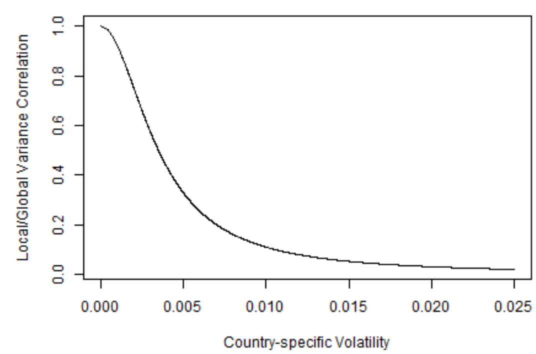
(c) Country-specific CG volatility and SB beta



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

Panel B. Consumption growth and asset pricing moments

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

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
$\hat{\beta}_d^i$	0.033***		0.051***		0.035**	0.020		
	(2.72)		(3.16)		(2.31)	(1.51)		
$\hat{\beta}_m^i$		0.029**		0.038**			0.029*	0.020
		(2.29)		(2.25)			(1.93)	(1.44)
$\bar{\hat{\beta}}_d^i$			−0.023					
			(−1.11)					
$\bar{\hat{\beta}}_m^i$				−0.016				
				(−0.70)				
GDP per cap					0.000	0.000	0.000	0.000
					(−0.28)	(−0.62)	(−0.14)	(−0.47)
% Export/GDP					0.000	0.000	0.000	0.000
					(0.08)	(−0.06)	(−0.28)	(0.12)
Population					0.000	0.000	0.000	0.000
					(0.83)	(0.84)	(0.56)	(1.03)
GDP growth					0.010	0.009	0.005	0.005
					(0.90)	(0.89)	(0.46)	(0.55)
Inflation					−0.001	0.000	−0.001	0.000
					(−1.13)	(−1.00)	(−1.11)	(−0.80)
ICAPM beta						0.000		0.000
						(−0.09)		(−0.14)

Panel B. Price index returns (N=380)

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

Table V
Cross-sectional regressions controlling for additional predictors

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

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

	Dependent variable : Leading monthly returns in USD							
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
$\hat{\beta}^i_d$	0.031∗∗∗		0.029∗∗		0.029∗∗		0.027∗∗	
	(2.80)		(2.55)		(2.52)		(2.36)	
$\hat{\beta}^i_m$		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
$\hat{\beta}^i_d$	0.028∗∗		0.023∗∗		0.022∗		0.025∗∗	
	(2.56)		(2.04)		(1.93)		(2.17)	
$\hat{\beta}^i_m$		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
Local and global consumption exposure of the dividend growth process

The first panel of this table summarizes the panel regression

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

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

Panel A. Panel regression of dividend growth

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

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

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

Table VII
Panel regressions of stock-bond relationship on volatility

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

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

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

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

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

Table VIII
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. Using stochastic volatility model (N=6981)

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

Panel B. Using intraday variance (N=3671)

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

Panel C. Using bond yields (N=7287)

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

Table IX
Does high country-specific volatility of variance predict relative stock market performance?

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, the local volatility of variance shocks, local realized variance, and the international CAPM beta as independent variables.

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

Table X
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 using the method of undetermined coefficients.

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

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

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

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

solves the Euler equation

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

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

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

and A_l solves the equation

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

One intuitive way of selecting the value from the two is to use the intuition that the coefficient of the full model should be comparable to those of the restricted model.

Also, the constant coefficient A_0 can be derived as

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

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

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

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

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

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

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

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

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

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.

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

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

where,

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

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

2. Dividend dynamics and stock returns

The price-dividend ratio ($z_{m,t}^i$) 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

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

and

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

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

Similarly, the coefficient B_g^r and B_l^r under the restricted value is given as

$$B_l^r = \frac{0.5(\phi_d \rho_c - \gamma)^2 + (\theta - 1)(\kappa_1 \nu_1 - 1)A_l^r + 0.5(1 - \rho_c^2)\phi_d^2}{1 - \kappa_1 \nu_1}$$
$$B_g^r = \frac{0.5(\phi_f \rho_c - \gamma)^2 + (\theta - 1)(\kappa_1 v_1 - 1) * A_g^r + 0.5(1 - \rho_c^2)\phi_f^2}{1 - \kappa_1 v_1}$$

3. The SB relationship

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

$$y_{t+1}^i - E_t[y_{t+1}^i] = Y_l \sqrt{v_t^i} \sigma_l \epsilon_{v,t+1}^i + Y_g \sqrt{v_t^*} \sigma_g \epsilon_{v,t+1}^*,$$

and unexpected stock returns is

$$R_{m,t+1}^i - E_t[R_{m,t+1}^i] = \phi_d \sqrt{v_t^i} \epsilon_{d,t+1}^i + \phi_f \sqrt{v_t^*} \epsilon_{d,t+1}^* + \kappa_{m,1}\left(B_l \sigma_l \sqrt{v_t^i} \epsilon_{v,t+1}^i + B_g \sigma_g \sqrt{v_t^*} \epsilon_{v,t+1}^*\right)$$

The conditional variance of stock returns is

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

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

Finally, the stock return - bond yield covariance is

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

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

4. International stock market risk premium

As shown in the main paper, it is sufficient to derive the risk premium of stock investment implied by the local investor in local currency. The risk premium can be derived as

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

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

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

Where $MRP_g \equiv -\lambda_c(\phi_f \rho_c + \kappa_1 B_g \sigma_g \rho_{ps}) - \lambda_g(\rho_{ps}\rho_c\phi_f + \kappa_1 B_g \sigma_g) > 0$ and $MRP_l \equiv -\lambda_c(\phi_d \rho_c + \kappa_1 B_l \sigma_l \rho_{ps}) - \lambda_l(\rho_{ps}\rho_c\phi_f + \kappa_1 B_l \sigma_l > 0$. Under the restricted model, the risk premium is $-\lambda_c \phi_f \rho_c v^*_t - \lambda_c \phi_d \rho_c v^i_t$.