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GOVERNMENT BOND MARKET INTEGRATION IN ASEAN COUNTRIES

Masao Kumamoto[1+]
Juanjuan Zhuo[2]

[1]*Graduate School of Business Administration, Hitotsubashi University, Tokyo, Japan.*
Email: masao.kumamoto@r.hit-u.ac.jp Tel: +81-42-580-8747
[2]*Faculty of Humanities and Social Sciences, Kochi University, Kochi, Japan.*
Email: zhuojj@kochi-u.ac.jp Tel: +81-88-844-8235

(+ Corresponding author)

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ABSTRACT

The development and the integration of the bond market is becoming an important policy issue in ASEAN countries. We investigate government bond market integration in four ASEAN countries. We first decompose yields in ASEAN countries and the United States into global and regional factors using the approximate dynamic factor model. Next, we employ the dynamic conditional correlation method to find that regional markets have been integrated in the sense that their yields are highly and positively correlated with the common regional factor. We also find that the correlation between the global factor and the yield has different signs in different countries. Therefore, we use the pooled mean estimation method to investigate the determinants that make the correlation positive in some countries and negative in others. We find that public interest payments is an important determinant and discover a threshold that depends on public interest payments. The global factor has a significantly negative effect on the yield spread when public interest payments are above the threshold value. From above results, we can conclude that market discipline has been operating in the four ASEAN government bond markets in the sense that investors discriminate between the creditworthiness of the governments' bonds by focusing on the public interest payments.

Contribution/ Originality: This study is one of very few studies which have investigated the government bond market integration by considering the correlation between the yield in each country and the regional or the global factor. We also investigate the determinants of the correlation between the yield and the global factor.

1. INTRODUCTION

Regional economic integration among Association of South East Asian Nations (ASEAN) countries has progressed steadily on the real economic side. Since the ASEAN Free Trade Area (AFTA) was signed in 1992, a Common Effective Preferential Tariff (CEPT) Scheme and its successor, the ASEAN Trade in Goods Agreement (ATIGA), have played a main role in intra-ASEAN free trade in goods. In addition to trade in goods, the 1995 ASEAN Framework Agreement on Services (AFAS) liberalized intra-ASEAN trade in services, and the 1998 ASEAN Investment Area (AIA) created a liberal, transparent environment for investment in the ASEAN region. The establishment of the ASEAN Economic Community (AEC) in 2015 is a symbolic milestone in ASEAN regional economic integration on the real economic side.

Unlike on the real economic side, however, the ASEAN economy is still fragile on the financial side. The "double mismatch in currency and maturity" in financing are recognized has having been among the main causes of the 1997 Asian currency crisis. ASEAN countries depended on short-term foreign currency-denominated bank loans from foreign banks to finance longer-term domestic investment. ASEAN countries have accumulated domestic savings since the crisis. However, much of those savings flowed overseas, especially to the United States, before flowing back into Asian countries. As a result, ASEAN countries have accumulated huge foreign reserves, a large portion of which is in the form of US Treasury securities, while receiving foreign direct and portfolio investments to finance domestic firms. This means that ASEAN's large intraregional savings have not been utilized to finance intraregional investment.

Therefore, the development of the financial intermediary function, especially regional bond markets, is becoming an important policy issue in Asia. It is necessary to reform and harmonize regulations in accordance with international standards and then facilitate regional bond market integration. Accordingly, the Asian Bond Markets Initiative (ABMI) was launched by the ASEAN+3 Finance Ministers' and Central Bank Governors' Meeting in August 2003. The Executives' Meetings of East Asia and Pacific Central Banks (EMEAP) also launched the Asian Bond Fund (ABF) in June 2003. Through these domestic and regional efforts, Asian bond markets have grown rapidly and are considered to be undergoing regional integration. Figure 1 shows the amount of outstanding local currency-denominated government bonds in four ASEAN countries: Indonesia, Malaysia, the Philippines, and Thailand. We can see that the government bond markets in the region have grown rapidly, from about 130 billion US dollars in 2000 to about 570 billion US dollars in 2017.

Bond market integration among Asian countries facilitates greater capital mobility, which can improve the efficiency of capital allocation and hence enhance financial development and economic growth in the region. It also enables investors to diversify their portfolios at a low cost, which can eliminate country-specific risks.

The first objective of this study is to investigate whether the government bond markets are integrated in the four ASEAN countries listed above: Indonesia, Malaysia, the Philippines, and Thailand. We investigate only four countries due to data availability issues. We focus on government bond market integration because integration is a pre-requisite for the development of regional bond markets, including corporate bond markets. Government bond markets provide a risk-free benchmark yield curve for corporate bonds and also support the derivatives market.

As the first step in our analysis, we will employ an approximate dynamic factor model to decompose yields in the four ASEAN countries and the United States into three factors. The first is a global factor that is highly and positively related to the yield in the United States but also affects the yields in ASEAN countries. The second is a regional factor that affects the yields in ASEAN countries highly and positively but is not explained by the global factor. The last is an idiosyncratic shock, based on the idea that idiosyncratic shock can be diversified away via international investment in the integrated market, so that the yield should be influenced only by common factors. This means that, if the government bond market in one country is integrated with the regional (global) government bond market, then the yield in this country might be correlated positively and highly with the regional (global) factor. Therefore, in the second step, we will employ a dynamic conditional correlation (DCC) model to calculate the time-varying conditional correlation between each factor and the yield in each country. The results show that the correlations between the regional factor and the yield in each ASEAN country are significantly positive and high, implying that government bond yields in ASEAN countries are driven by the common regional factor and thus that regional government bond markets are integrated. On the other hand, the correlations between the global factor and the yield in each country have different signs, showing a positive correlation in Malaysia and Thailand and a negative correlation in Indonesia and the Philippines. This means that the effects of the global factor across countries are asymmetric. This leads to a question: Why are the effects of the global factor asymmetric among the four ASEAN countries, and which variables indicate the creditworthiness of government bonds?

The second objective of this study is to investigate the determinants that make the correlation between the global factor and the yield positive in some countries and negative in others. This investigation is related to the analysis of market discipline. As pointed out in Manganelli and Wolswijk (2007) the ongoing government bond market integration might eliminate the market's ability or willingness to discriminate between the creditworthiness of national fiscal policies. Market discipline in the context of the government bond market means that bonds issued by a government with unsound fiscal policies are priced to offer a higher yield to compensate for the higher default risk. Thus, negative assessments by the financial market are reflected in the higher interest burden, which forces governments to avoid unsound fiscal policies. If government bond market integration facilitates an accurate assessment of the risk-return profile of government bonds, it might have improved market discipline. On the other hand, if government bond yields commoved together despite differences in fiscal soundness, the market integration might have obstructed market discipline.

We employ the pooled mean group (PMG) method to investigate the determinants of the government bond yield spreads between each of the four ASEAN countries and the United States. We find that public interest payments is a significant determinant of government bond spreads in ASEAN countries and is also significant in the short run in Indonesia and the Philippines, where public interest payments are higher and yields are negatively correlated with the global factor. Combining these results, we can infer that investors will discriminate between the creditworthiness of government bonds by focusing on public interest payment levels and that a certain threshold value will trigger the investors' decisions. Therefore, we employ the fixed-effects panel threshold method and determine the threshold value and also discover that the global factor has a negative effect on the yield when public interest payments exceed that threshold.

The remainder of this paper is organized as follows. In the next section, we review related studies and investigate government bond market integration. The third section examines the determinants of government bond yields. Finally, the last section concludes the study.

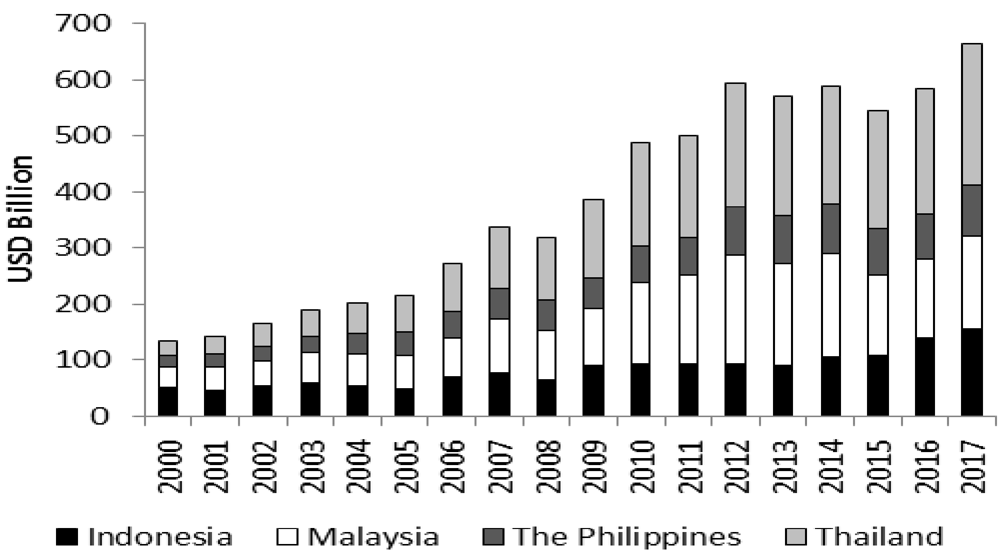


Figure-1. LCY Government Bond Size in 4 ASEAN countries.

2. GOVERNMENT BOND MARKET INTEGRATION

2.1. Related Literature

The definition of a "financially integrated market" used in Baele, Ferreando, Hördahl, Krylova, and Monnet (2004) is adopted in many studies. It is as follows:

> "The market for a given set of financial instruments (services) is fully integrated if all potential market participants with the same relevant characteristics (1) face a single set of rules when they decide to deal with

those financial instruments (services); (2) have equal access to the above-mentioned set of financial instruments and/or services; (3) are treated equally when they are active in the market."

The direct implication of this definition of financial integration is that assets with the same risk level should have the same expected returns; thus, the law of one price must hold because all agents will be free to exploit any arbitrage opportunities. The indicator considered as evidence of the law of one price varies depending on the focus of the study. Some studies focus on price convergence, while others focus on sensitivity, mutual causality, cointegration relationship, market cycle synchronization, and correlation. Table 1 summarizes the approaches to estimation methods in the related literature.

Adam, Jappeli, Menichini, Padula, and Pagano (2002); Baele et al. (2004) and Park (2013) employed β-convergence and σ-convergence measures, which are borrowed from the economic growth literature. β-convergence is based on the idea that higher yields tend to decrease more rapidly, and it examines convergence speed. On the other hand, σ-convergence examines the cross-sectional dispersion in yields to measure the financial integration level at any point in time.

Serletis and King (1997) and Kim, Lucey, and Wu (2006) employed Haldane and Hall (1991) approach. This is based on the Kalman filter method and regresses the yield spread between one country and the internal regional benchmark country ($i_{i,t} - i_{rb,t}$) against the yield spread between the internal benchmark country and the external global benchmark country ($i_{rb,t} - i_{gb,t}$)[1]. If convergence with the internal (external) benchmark country has occurred, the time-varying coefficient will converge toward zero (one) over time.

Mills and Mills (1991); Kasa (1992); Clare, Maras, and Thomas (1995); Serletis and King (1997); Manning (2002); Click and Plummer (2005); Vo (2009) and Calvi (2010) employed the cointegration method. Yields in integrated financial markets cannot diverge arbitrarily from each other; therefore, there must be a stable long-run relationship among yields across countries. Moreover, the number of common stochastic trends will equal the dimension of the system (n) minus the number of linear independent cointegrating vectors—namely, the cointegration rank (r). Therefore, if the cointegration rank is n-1, there is a single common stochastic trend, which provides evidence of a fully integrated financial market. This means that the yields in the process of integration are expected to increase the number of cointegrations. Based on this idea, Rangvid (2001) and Kim et al. (2006) employed the dynamic cointegration method to detect the time-varying number of cointegration ranks by rolling the estimation window.

Kim et al. (2006) and Tsukuda, Shimada, and Miyakoshi (2017) employed the DCC method proposed by Engle (2002). This method is based on the idea that higher correlation between markets indicates greater return comovement and thus greater market integration.

We will develop the DCC method by employing the approximate dynamic factor model proposed by Stock and Mark (1998); Stock and Mark (2002a); Stock. and Mark (2002b). The β- and σ-convergence measures and Haldane and Hall (1991) approach cannot be applied directly to our study since the regional and global benchmark countries to which the yields in the four ASEAN countries converge cannot be chosen a priori and arbitrarily.[2] In addition, the cointegration method is limited in the sense that the existence of a cointegration relationship does not necessarily imply that their yields comove. For example, if the yields in two countries are perfectly negatively correlated, the cointegration vector [1, -1] might be detected. Instead, we will first employ the approximate

[1] For example, Germany can be regarded as an internal regional benchmark country, while the United States can be regarded as an external global benchmark country for euro nations.

[2] This problem holds for the DCC method. For example, Kim et al. (2006) used the DCC method to investigate government bond market integration in EU countries. For such countries, Germany seems to be the preferred benchmark country.

dynamic factor model to decompose the yields in the four ASEAN countries and the United States into the global factor, the regional factor, and the idiosyncratic shock. This process is based on the idea that, if the government bond market in one country is integrated with the regional (global) government bond market, then the yield in this country might be correlated positively and highly with the regional (global) factor. Therefore, in the next step, we employ the DCC method to focus on the signs and magnitudes of the time-varying correlations between each factor and the yield in each country as an indicator of market integration.

Table-1. Related literature: financial market integration.

Author	Countries or Regions / Sample periods / Frequency / Markets	Estimation methods	Findings
Haldane and Hall (1991)	USA, Germany, UK 1976M1 - 1989M8 / daily Foreign exchange markets	Kalman filter approach	The relationship between sterling and the dollar has weakened in a fairly systematic way since the 1970s.
Mills and Mills (1991)	USA, West Germany, UK, Japan 1986M4 - 1989M12 / daily government bond (less than 5 years) markets	Johansen's cointegration analysis	Bond yields are not cointegrated, and in the long run they are determined by their own domestic fundamentals.
Kasa (1992)	USA, Germany, UK, Japan, Canada 1974M1 - 1990M8 / monthly, 1974Q1 - 1990Q3 / quarterly stock markets	Johansen's cointegration analysis	A single common stochastic trend lies behind the long-run comovement of the equity markets.
Clare et al. (1995)	USA, Germany, UK, Japan 1978M1 - 1990M4 / monthly Government bond markets	Engle and Granger's cointegration analysis	During the 1980s, there were low correlations between bond markets in the long run and hence diversification benefits will have been available over this period.
Serletis and King (1997)	Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Netherlands, Spain, UK 1971Q1 - 1992Q1 / quarterly stock markets	Johansen cointegration analysis, Kalman filter approach	The link between the EU stock markets has been strengthening, but the convergence is still in the process of being achieved.
Rangvid (2001)	France, Germany, UK 1960Q1 - 1999Q1 / quarterly Stock markets	dynamic cointegration analysis	The degree of convergence among three major European stock markets has been increased during the 1980s and 1990s.
Adam et al. (2002)	12 euro areacountries 1995M1-2001M9 / daily Inter-bank, government bond, credit (mortgage, corporate loan) markets	β-convergence measure, σ-convergence measure	β-convergence measure implies that convergence accelerates after the adoption of the Euro in 1999. The speed of convergence increase after 1999 in inter-bank loan rate, government bond yield and mortgage interest rate, while it is lower in the corporate-loan rates. σ-

			convergencehas taken place in all four markets.
Manning (2002)	USA, Hong Kong, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Taiwan, Thailand 1988M1 - 1999M2 / weekly, 1988Q1 - 1999Q1 / quarterly Stock markets	Johansen cointegration analysis Kalman filter approach	Equity markets in South East Asia have shown signs of converging during the 1990s. This process appears to have been abruptly halted and somewhat reversed by the Asian financial crisis.
Author	Countries or Regions Sample periods / Frequency Markets	Estimation methods	Findings
Baele et al. (2004)	11 euro area countries (excl. Luxembourg) 1994M1 - 2003M7 for money markets /daily, 1993M1 - 2003M5 for government bond markets / monthly, 1998M1 - 2003M5 for corporate markets / monthly, 1990M1 - 2004M1 for bank credit markets / monthly, 1973M1 - 2003M1 for equity markets / monthly Money markets, government bond markets, corporate bond markets, bank credit markets, equity markets	β-convergence measure, σ-convergence measure	In the euro area, the money market is found to be the most integrated market. The degree of integration in the government bond market has been very high since the introduction of the euro. The euro area corporate bond market seems reasonably well integrated. The state of integration in euro area banking markets varies in different segments. For euro area equity markets, a rising degree of integration has been found.
Click and Plummer (2005)	Indonesia, Malaysia, Philippines, Singapore, Thailand 1998M7 - 2002M12 / daily, 1998M7 - 2002M12 / weekly Stock markets	Johansen cointegration analysis	The ASEAN-5 stock markets are integrated in the economic sense, but that integration is not complete.
Kim et al. (2006)	Belgium, Czechoslovakia, France, Germany, Hungary, Ireland, Italy, Netherlands, Poland, UK 1998M7 - 2003M12 / daily Government bond markets	dynamic cointegration analysis, Kalman filter approach, dynamic conditional correlation approach	The evidence for strong contemporaneous and dynamic linkages between existing EU member bond markets with that of Germany has been found, while for the UK and the three accession countries of Czech republic, Poland and Hungary, such linkages are relatively weak but stable.
Yu, Fung, and Tam (2007)	Japan, China, Hong Kong, Taiwan, Korea, Singapore, Malaysia, the Philippines, Thailand, Indonesia 1996M1 - 2006M1/ daily Government bond markets	β-convergence measure, σ-convergence measure Kalman filter approach, Johansen cointegration analysis, dynamic cointegration analysis,	There is only weak bond market integration in the region and very little progress has taken place since 2003. The apparent lack of progress may be due to the "local" or "idiosyncratic" factors in some Asian economies.

		dynamic conditional correlation approach	
Vo (2009)	Australia, USA, Hong Kong, Indonesia, Japan, South Korea, Malaysia, New Zealand, the Philippines, Singapore, Taiwan, Thailand 1990M2 - 2005M3 / daily Government bond markets	Johansen cointegration analysis, Granger causality analysis	The level of financial integration between countries is found to be low. Low level of correlations and cointegrations indicates that considerable diversification benefits can be obtained by Australian (US) investors contemplating investing in Asian markets.
Calvi (2010)	7 Europe: Belgium, France, Germany, Italy, the Netherlands, Spain, UK, 10 East Asia: China, Hong Kong, Indonesia, Japan, Malaysia, the Philippines, Singapore, South Korea, Taiwan, Thailand 1989M12 - 2009M7 / daily Stock markets	Johansen cointegration analysis, Granger causality analysis	Financial integration in Europe is significantly more advanced than in East Asia. The level of integration between bond markets is found to be higher than between equity markets within Europe, while it is the opposite in the East Asian region.
Park (2013)	China, Hong Kong, India, Indonesia, South Korea, Malaysia, the Philippines, Singapore, Taipei, Thailand 2000M8 - 2011M8 for bonds / weekly, 1991M9 - 2011M11 for stocks / weekly Government bond markets, stock markets	β-convergence measure, σ-convergence measure, principal component analysis	The pace of regional integration of financial markets in Asia's emerging economies has accelerated. Integration of the region's domestic local-currency bond markets with their regional and global counterparts lags the pace of integration of its equity markets. Spillover effects of regional and global financial crises have a significant impact on both domestic equity and bond markets.
Tsukuda et al. (2017)	USA, Japan, Indonesia, Malaysia, the Philippines, Singapore, Thailand, China, South Korea, Hong Kong 2001M1 - 2012M12 / weekly Government bond markets	dynamic conditional correlation approach	Low levels of integration between the local bond markets in the ASEAN4(Indonesia, Malaysia, Philippines, and Thailand) and the external markets have been found. However, Hong Kong and Singapore are highly integrated with the external markets. The Japanese market has minimal effects on the East Asian markets.

2.2. Methodology

Let $X_t = [\tilde{i}_{id,t}, \tilde{i}_{my,t}, \tilde{i}_{ph,t}, \tilde{i}_{th,t}, \tilde{i}_{us,t}]'$ be a 5×1 vector composed of the standardized government bond yields in Indonesia, Malaysia, the Philippines, Thailand, and the United States. Using an approximate dynamic factor model, we decompose the vector as:

$$X_t = \alpha + \begin{bmatrix} \lambda_{id}^g & \lambda_{my}^g & \lambda_{ph}^g & \lambda_{th}^g & \lambda_{us}^g \\ \lambda_{id}^r & \lambda_{my}^r & \lambda_{ph}^r & \lambda_{th}^r & \lambda_{us}^g \end{bmatrix}' \begin{bmatrix} f_t^g \\ f_t^r \end{bmatrix} + \varepsilon_t = \alpha + \Lambda' f_t + \varepsilon_t, \quad (1)$$

where f_t^g is the global factor, which is highly and positively related to the yield in the United States but also affects the yields in ASEAN countries. f_t^r is a regional factor, which is highly and positively related to the yields in ASEAN countries but is not explained by the global factor. ε_t is a 5×1 vector of idiosyncratic shock, and Λ is a 5×2 factor loading matrix.

Next, we assume that the 3×1 vector $Y_t \equiv [i_{i,t} \; f_t^g \; f_t^r]'$ follows the VAR(p) model,

$$Y_t = A_0 + \sum_{i=1}^{p} A_i Y_{t-i} + \varepsilon_t, \; \varepsilon_t = H_t^{\frac{1}{2}} v_t, \; \varepsilon_t | I_{t-1} \sim N(0, H_t), \quad (2)$$

where H_t is a 3×3 conditional covariance matrix, and v_t is an 3×1 innovation vector following an *i.i.d.* standard normal distribution.

We can decompose the conditional covariance matrix H_t as

$$H_t = D_t^{\frac{1}{2}} R_t D_t^{\frac{1}{2}}, \quad (3)$$

where D_t is a 3×3 diagonal matrix of time-varying standard deviations with $h_{ii,t}$ ($i = 1, \cdots, 3$) as the ith element of the diagonal, and R_t is a 3×3 symmetric time-varying correlation matrix,

$$D_t = \begin{bmatrix} h_{11,t} & 0 & 0 \\ 0 & h_{22,t} & 0 \\ 0 & 0 & h_{33,t} \end{bmatrix}, \; R_t = \begin{bmatrix} 1 & h_{12,t} / \sqrt{h_{11,t} h_{22,t}} & h_{13,t} / \sqrt{h_{11,t} h_{33,t}} \\ h_{12,t} / \sqrt{h_{11,t} h_{22,t}} & 1 & h_{23,t} / \sqrt{h_{22,t} h_{33,t}} \\ h_{13,t} / \sqrt{h_{11,t} h_{33,t}} & h_{23,t} / \sqrt{h_{22,t} h_{33,t}} & 1 \end{bmatrix}.$$

The DCC model is estimated through a two-step procedure. In the first step, we obtain D_t by assuming that $h_{ii,t}$ follows a GARCH (1, 1) process:

$$h_{ii,t} = \alpha_i + \beta_{i1} \varepsilon_{i,t-1}^2 + \gamma_{i1} h_{ii,t-1}. \quad (4)$$

The specification of Equation 4 can be justified by the well-known results that GARCH(1,1) model can provide a better fit and exhibit a more reasonable lag structure than the other specification.

In the second step, we standardize the residuals as $\tilde{\varepsilon}_t = D_t^{-\frac{1}{2}}\varepsilon_t$, namely as $\tilde{\varepsilon}_{i,t} = \varepsilon_{it}/\sqrt{h_{ii,t}}$, and use them to estimate dynamic correlation. From Equation 3 we can see that

$$E_{t-1}\left[\tilde{\varepsilon}_t\tilde{\varepsilon}_t'\right] = (D_t)^{-\frac{1}{2}} H_t (D_t)^{-\frac{1}{2}} = R_t. \quad (5)$$

The correlation matrix R_t in Equation 5 can be estimated by specifying matrix Q_t as the following exponential smoother equation:

$$Q_t = (1-\delta_1-\delta_2)\bar{R} + \delta_1\tilde{\varepsilon}_{t-1}\tilde{\varepsilon}_{t-1}' + \delta_2 Q_{t-1}. \quad (6)$$

Q_t is a 3×3 symmetric positive definite matrix, $\bar{R} = E[\tilde{\varepsilon}_t\tilde{\varepsilon}_t']$ is the unconditional covariance matrix of the standardized residuals (unconditional correlation), and δ_1 δ_2 are non-negative parameters that satisfy $0 \le \delta_1 + \delta_2 < 1$. Note that Equation 6 is used solely to provide R_t. The conditional correlation matrix R_t is obtained by

$$R_t = diag(Q_t)^{-\frac{1}{2}} Q_t diag(Q_t)^{-\frac{1}{2}}, \quad (7)$$

where $diag(Q_t)^{1/2}$ is a diagonal matrix of the square root of the diagonal element of Q_t. For R_t in Equation 7 to be positive definite, the only condition that needs to be satisfied is that Q_t is positive definite.

2.3. Empirical results

2.3.1. Data

Our sample comprises Indonesia, Malaysia, the Philippines, and Thailand. As mentioned, we exclude the other ASEAN countries (including Singapore) from our sample due to data availability issues.

Our sample period runs from January 2, 2001 to June 30, 2018, and we use daily data. We calculate the government bond yields from the 10-year government bond total index data denominated in local currency (LCY). The data for ASEAN countries are sourced from *AsiaBondsOnline*, and the US data come from *Datastream*.

2.3.2. Empirical Results

As the first step, we decompose the yields in ASEAN countries and the United States into the global factor, the regional factor, and idiosyncratic shocks using the approximate dynamic factor model. The model can be estimated easily using the principal component method.

Table 2 shows the results of Equation 1. We extract the first two principal components whose eigenvalues are greater than one. The correlation coefficient between the second principal component and the US government bond yield (0.683) is higher than that between the first principal component and the US government bond yield (0.263). The eigenvectors (loading coefficient) of the first principal component in all countries have positive values, indicating that the first principal component has a symmetric effect among ASEAN countries. Moreover, the eigenvector (loading coefficient) of the second principal component on the US government bond yield (0.661) is higher than that of the first principal component (0.229). Thus, we identify the first principal component as regional factor f_t^r and the second principal component as global factor f_t^g.

Table 3 shows the results of the DCC estimation. In the estimation, we set lag length p in Equation 2 to be one based on Schwarz's Bayesian Information Criterion (SBIC). We can see that both the autoregressive conditionally heteroscedastic (ARCH) effects and GARCH effects in each equation are statistically significant.[3] The table also presents the quasi-correlation Q.

We can see that the quasi-correlations between the regional factor and the yield in each country is significantly positive and high. This implies that the government bond yields in ASEAN countries are driven by the common regional factor, and thus that regional government bond markets are integrated.

On the other hand, the quasi-correlations between the global factor and the yield in each country have different signs, showing a positive correlation in Malaysia and Thailand and a negative correlation in Indonesia and the Philippines. This means that the effects of the global factor across countries are asymmetric.

Figure 2 shows the dynamic conditional correlation between each factor and the government bond yield in each country. The figure indicates that the dynamic conditional correlation between the regional factor and the yield in each country is positive and high in all four ASEAN countries. However, the degree of correlation has changed little over time.

These results show that the government bond markets in the sample countries have already been integrated, in the sense that their yields are driven by the common regional factor, but the integration has not deepened, as the correlations have not significantly increased. On the other hand, the dynamic conditional correlation between the global factor and the yield in each country shows different patterns among countries: positive in Thailand (full sample average is 0.389), positive but close to zero in Malaysia (0.059), and negative in Indonesia (-0.332) and the Philippines (-0.494).

The correlation between the global factor and the US government bond yield is very high and stable (0.706). The negative correlations between the global factor and the yields in Indonesia and the Philippines indicate the prevalence of "flight to quality" in these countries: When investors' risk aversion increased following events such as the global financial crisis, investors were reluctant to hold riskier government bonds issued by Indonesia and the Philippines, so that they changed their portfolio from these government bonds to US government bonds. As a consequence, the government bond yield in the United States decreased while those of Indonesia and the Philippines increased.

In this case, the global factor should decrease because it has a positive correlation with the US yield. These results show that the global factor has different impacts on ASEAN countries asymmetrically.

Therefore, we face a question: Why are the effects of the global factor asymmetric among the four ASEAN countries, and which variables identify the creditworthiness of government bonds?

Table-2. Principal component analysis for RISK.

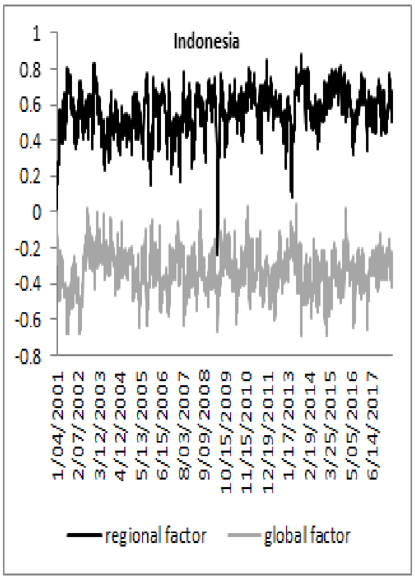
Number	Eigen Value	Proportion	Cumulative Proportion	Eigenvectors (loadings):					Correlation				
				Indonesia	Mayaisia	The Philippins	Thailand	U.S.	Indonesia	Mayaisia	The Philippins	Thailand	U.S.
1	1.324	0.265	0.265	0.516	0.516	0.379	0.522	0.229	0.594	0.593	0.436	0.600	0.263
2	1.068	0.214	0.478	-0.354	0.064	-0.535	0.384	0.661	-0.366	0.067	-0.553	0.397	0.683
3	0.949	0.190	0.668	0.124	-0.623	0.485	-0.117	0.589	0.121	-0.607	0.473	-0.114	0.574
4	0.856	0.171	0.839	0.658	0.098	-0.476	-0.515	0.256	0.609	0.091	-0.441	-0.476	0.237
5	0.803	0.161	1.000	-0.400	0.576	0.328	-0.549	0.315	-0.359	0.516	0.294	-0.492	0.282

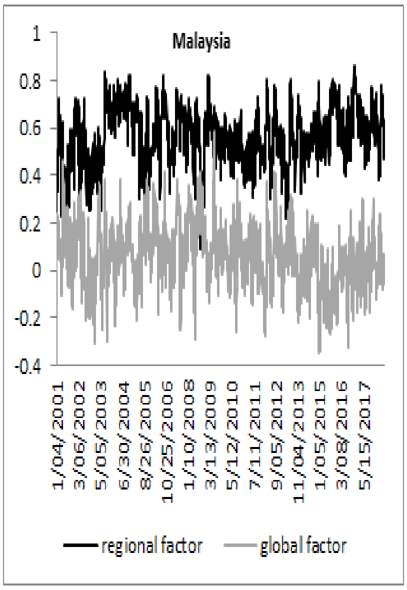
[3] The null hypothesis that $\lambda_1 = 0$ and $\lambda_2 = 0$ can be rejected, which means that the constant conditional correlation (CCC) model is incorrect.

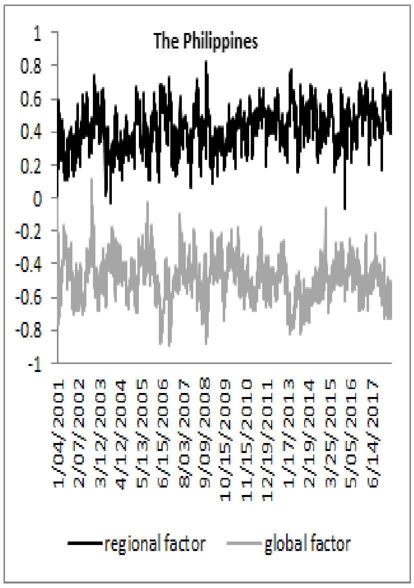
Table-3. Dynamic conditional correlation.

		Indonesia	Malaysia	The Philippines	Thailand
i	ARCH (β_1)	0.124***	0.135***	0.184***	0.082***
		(0.012)	(0.010)	(0.015)	(0.005)
	GARCH (γ_1)	0.870***	0.876***	0.831***	0.916***
		(0.013)	(0.008)	(0.013)	(0.005)
f^g	ARCH (β_1)	0.076***	0.067***	0.073***	0.063***
		(0.008)	(0.007)	(0.006)	(0.006)
	GARCH (γ_1)	0.907***	0.917***	0.912***	0.921***
		(0.009)	(0.009)	(0.008)	(0.008)
f^r	ARCH (β_1)	0.139***	0.112***	0.156***	0.093***
		(0.010)	(0.008)	(0.013)	(0.007)
	GARCH (γ_1)	0.858***	0.881***	0.844***	0.900***
		(0.009)	(0.008)	(0.012)	(0.007)
Corr(i, f^g)		-0.311***	0.047	-0.495***	0.405***
		(0.028)	(0.034)	(0.024)	(0.027)
Corr(i, f^r)		0.588***	0.618***	0.442***	0.618***
		(0.021)	(0.022)	(0.025)	(0.020)
λ_1		0.044***	0.047***	0.048***	0.045***
		(0.004)	(0.003)	(0.003)	(0.003)
λ_2		0.924***	0.924***	0.918***	0.923***
		(0.007)	(0.006)	(0.006)	(0.005)

Note: † Standard errors are in parentheses.
‡ The asterisks *** denote significance at the 1% level.







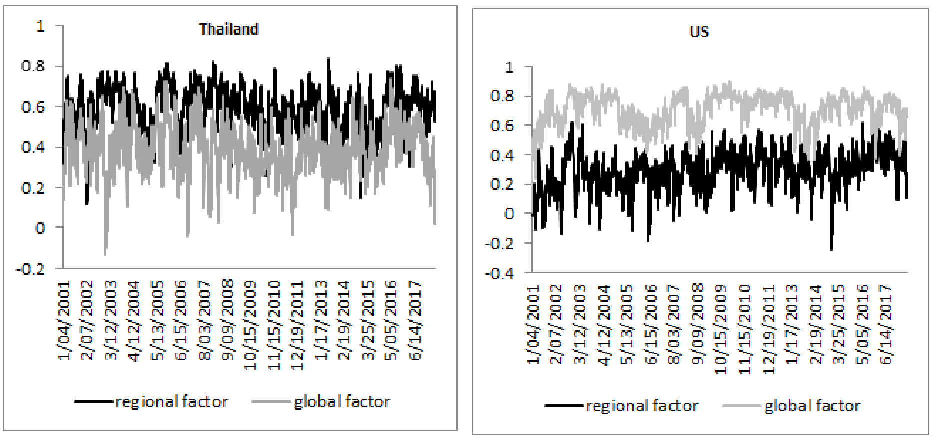


Figure-2. Dynamic conditional correlations.

3. DETERMINANTS OF GOVERNMENT BOND YIELD SPREADS

3.1. Related Literature

We now investigate the determinants that make the correlation between the global factor and the yield positive in some countries and negative in others.

Many studies investigate the determinants of government bond yield spreads. Bernoth, von Hagen, and Schuknecht (2004) show that the important determinants of government bond yield spreads are credit risk, liquidity risk, and investors' risk aversion. As shown in Table 4, many variables and indicators are used to measure these three risks.

Barrios, Iversen, Lewandowska, and Setzer (2009) point out that there are three types of credit risk: default risk, credit-spread risk, and downgrade risk. Default risk is defined as the probability that the issuer will fail to meet obligations either on coupon payments or the repayment of principal at maturity. Credit-spread risk is defined as the probability that the market value of the bond will decline more than the value of other comparable quality bonds. Downgrade risk is defined as the possibility of a downgrade by the credit rating agency. Therefore, fiscal variables—including budget deficits to GDP ratio, government debt to GDP ratio, and debt service (interest payments) to budget revenue ratio—are used to measure fiscal positions. Looking at credit default swaps (CDS) is an alternative way to assess default risk.

Liquidity risk is defined as the possibility that investors will not be able to trade their portfolios quickly enough in the market at a low cost without impacting the market price. The factors that determine liquidity risk include transaction costs, transaction speed, market depth, and market breadth. Therefore, variables such as bid–ask spread (transaction costs), trading volume size (market depth), and the size of bonds' outstanding amount (market breadth) are usually used. Credit risk and liquidity risk are interconnected. An increase in the supply of government bonds might decrease liquidity risk; on the other hand, it is also associated with increased budget deficits and public debt, and might increase credit risk.

Investors' risk aversion reflects their willingness to take a risk. Even if the risk level embedded in a government bond remains unchanged, the demanded risk premium might vary due to the change in the investors' risk aversion. This is usually measured by the spreads between the US Treasury Bond and BBB-corporate bonds and the implied volatility index (VIX) of bonds, stocks, and exchange rates.

Table-4. Related literature: determinants of government bond spreads.

Author	Countries / Bench mark countries	Sample periods / Frequency	Variables	Findings
Bernoth et al. (2004)	13 EU countries/Germany, U.S.	1991-2002/annual	(i) debt/GDP, (ii) fiscal balance/GDP (iii), debt service payments to total revenue ratios, (iv) corporate bond spread, (v)time to maturity of the government bond, (vi)country's outstanding of government bonds/EU outstanding of government bonds, (vii) business cycle variable	Yield spreads of EU countries reflect positive default and liquidity risk premia. The default risk premium is positively affected by the debt and debt service ratios of the issuer country. Liquidity risk premia are reduced with EMU membership, which points to an increase in financial market integration.
Manganelli and Wolswijk (2007)	10 euroa area countries (excl. Luxembourg)/Germany	1999M1-2006M5/monthly	(i) interaction term between main refinancing operations minimum bid rate and rating dummies(AA+, AA, AA-, A+ and A), (ii) AAA rating (liquidity premiums), (iii) country's outstanding/euro area outstanding of government bonds	Spreads tend to be driven by the level of short-term interest rates. Sovereigns with lower credit ratings are forced to pay a higher credit risk premium, which means that market discipline still operating in EMU.
Barrios et al. (2009)	Austria, Belgium, Spain, France, Germany, Greece, Italy, Portugal	2003M3 - 2009M4 / weekly	(i) CDS spread, (ii)bid-ask spread, (iii)risk aversion indicator, (iv) global financial crisis *dummy*	Euro area sovereign bond interest rates are strongly influenced by conditions in global financial markets. Domestic factors like liquidity and credit risk have become more important in the financial crisis to explain yield differentials.
Haugh, Ollivaud, and Turner (2009)	Austria, Belgium, Finland, France, Greece, Italy, Netherlands, Portugal, Spain / Germany	2005Q4-2009Q2/semi-annual	(i) gross and net debt/GDP, (ii) debt service ratio, (iii) expected future fiscal deficits, (iv) corporate bond spread, (v) expected future public pension expenditures, (vi) country's outstanding government bonds/euro-area total outstanding government bonds	Fiscal policies, particularly their effect on future deficits, and the debt service ratiohave an important role in explaining bond yield spreads.
Barbosa and Costa (2010)	10 euro area countries (excl. Luxembourg)/Germany	2007M1-2009M12 or 2010M5	(i) CDS spread, (ii) fiscal balance/GDP, (iii) public debt /GDP, (iv)international invest position, (v) bid-ask spread, (vi) volumes available for trade, (vii)trading volume, (viii)first principal component of BBB corporate bond spreads, CDS indices and stock and bond markets implied	Government bond spreads can largely be explained by differences betweencreditworthiness of national governments, liquidity in domestic bond markets, as well as by the risk premium in international financial markets.

		volatilities	
Author	Countries / Bench mark countries Sample periods / Frequency	Variables	Findings
Bellas, Papaioannou, and Petrova (2010)	14 emerging market economies/U.S. 1997Q1-2009Q2/quarterly	(i) external debt/GDP, (ii) interest payments on external debt/reserves, (iii) short-term debt/reserves, (iv) external debt amortization/reserves, (v) fiscal balance/GDP, (vi) current account/GDP, (vi)trade openness, (vii) financial stress index, (viii) U.S. 3-month Treasury bill rate and 10-year government bond yield, (ix) VIX, (x) political risk	Financial fragility is a more important determinant of spreads than fundamental indicators in the short run. On the other hand, fundamentals are significant determinants in the long run. In addition, other factors, such as political instability, corruption, and asymmetry of information may also affect the spread.
Schuknecht, von Hagen, and Wolswijk (2010)	15 EU countries/Germany U.S. 1999M1-2007M6	(i) debt to GDP, (ii) fiscal balance/GDP, (iii), time to maturity, (iv) size of bond issue, (v) corporate bond spreads, (vi) short-time interest rate, (vii) interaction term between fiscal variables and turmoil and crisis dummy, (viii) country's outstanding of government bonds/EU outstanding of government bonds, (ix) business cycle variable	Bond yield spreads can still largely be explained on the basis of economic principles during the crisis. Markets penalise fiscal imbalances much more strongly since the Lehman default in September 2008. In addition to fiscal deficits and debt,there is also a significant increase in the spread due to general risk aversion.
Belhocine and Dell'Erba (2013)	26 emerging market economies 1994-2011/semi-annual	(i) VIX, (ii) international reserves/GDP, (iii) CPI inflation, (iv)real GDP growth, (v)primary balance/GDP, (vi)public debt/GDP, (vii) money market interest rate, (viii) difference between the debt stabilizing primary balance and actual primart balance	Debt sustainability measured by the difference between the debt stabilizing primary balance and actual primary balance is a major determinant of spreads. Spreads become significantly more sensitive to debt sustainability as public debt increases.
Csonto and Ivaschenko (2013)	18 emerging market economies 2001M1-2013M3/monthly	(i) Economic Risk Rating, (ii) Financial Risk Rating, (iii) Political Risk Rating (from International Country Risk Guide), (iv)VIX, (v) U.S. Federal Funds rate	In the periods of severe market stress, such as during the intensive phase of the Eurozone debt crisis, global factors tend to drive changes in the spreads and the misalignment tends to increase in magnitude and its relative share in actual spreads.

Afonso, Arghyrou, and Kontonikas (2015)	10 euro area countries (excl. Luxembourg)/Germany 1990M1-2010M12/monthly	(i)lagged spreads, (ii) VIX, (iii) bid-ask spread, (iv)expected fiscal balance /GDP, (v) expected debt/GDP, (vi) real effective exchange, (vii) annual growth rate of industrial production, (viii) potential heterogeneity between periphery and core countries (principal components ob government bond yields spreads)	The determinants have changed significantly over time, and changes in the sensitivity of bond prices to fundamentals are also relevant to explain yields over the crisis period. More specifically, during the pre-crisis period macro- and fiscal-fundamentals are generally not significant in explaining spreads. By contrast, since summer 2007 the movements of macro- and fiscal- fundamentals explain spread movements well.

3.2. Empirical Methods

We employ the PMG method proposed by Pesaran, Shin, and Smith (1999). This model has several advantages because it allows the short-run parameters to vary across countries while restricting long-run parameters to be identical across countries. First, it assumes a dynamic model, which can capture the nature of the data. Second, it imposes homogeneity among long-run coefficients, which leads to more stable estimates. Third, it allows the separation of short-term dynamics and adjustment toward long-run equilibrium so that it can consider the heterogeneity in short-run responses across countries.

We start with the ARDL (p, q, …, q) model:

$$s_{i,t} = \alpha_i + \sum_{j=1}^{p} \beta_{i,j} s_{i,t-j} + \sum_{j=0}^{q} \gamma_{1i,j}{}' X_{i,t-j} + \sum_{j=0}^{q} \gamma_{2i,j}{}' Z_{t-j} + \varepsilon_{i,t}, \tag{8}$$

where $s_{i,t}$ denotes the government bond yield spread of country i, $X_{i,t}$ and Z_t, $k_1 \times 1$ is the vector of the country-specific variables expected to affect credit risk and liquidity risk, and $k_2 \times 1$ is the vector of the global variables that are expected to reflect investors' risk aversion, respectively. $\gamma_{1i,j}$ and $\gamma_{2i,j}$ are $k_1 \times 1$ and $k_2 \times 1$ vector of coefficients. Equation 8 can be arranged to obtain the error correction equation:

$$\Delta s_{i,t} = \phi_i \left[s_{i,t-1} - \alpha_i^* - \delta_{1i}{}' X_{i,t} - \delta_{2i}{}' Z_t \right] + \sum_{j=0}^{p-1} \beta_{i,j}^* \Delta s_{i,t-j} + \sum_{j=0}^{q-1} \gamma_{1i,j}^*{}' \Delta X_{i,t-j} + \sum_{j=0}^{q-1} \gamma_{2i,j}^*{}' \Delta Z_{t-j} + \varepsilon_{it}, \tag{9}$$

where

$$\phi_i = -\left(1 - \sum_{j=1}^{p} \beta_{i,j}\right),\ \alpha_i^* = \frac{\alpha_i}{1 - \sum_{j=1}^{p} \beta_{ij}},\ \delta_{1i} = \frac{\sum_{j=1}^{q} \gamma_{1i,j}}{1 - \sum_{j=1}^{p} \beta_{i,j}},\ \delta_{2i} = \frac{\sum_{j=1}^{q} \gamma_{2i,j}}{1 - \sum_{j=1}^{p} \beta_{i,j}},$$

$$\beta_{i,j}^* = -\sum_{m=j+1}^{p} \beta_{i,m}\ (j = 1, \cdots p-1),\ \gamma_{1i,j}^* = -\sum_{m=j+1}^{q} \gamma_{1i,m} \text{ and } \gamma_{2i,j}^* = -\sum_{m=j+1}^{q} \gamma_{2i,m}\ (j = 1, \cdots q-1)$$

By imposing homogeneity restrictions on the long-run coefficients ($\delta_{1i}=\delta_1$, $\delta_{2i}=\delta_2$), Equation 9 can be rewritten as

$$\Delta s_{i,t}=\phi_i\left[s_{i,t-1}-\alpha_i^*-\delta_1'X_{i,t}-\delta_2'Z_t\right]+\sum_{j=0}^{p-1}\beta_{i,j}^*\Delta s_{i,t-j}+\sum_{j=0}^{q-1}\gamma_{1i,j}^*{}'\Delta X_{i,t-j}+\sum_{j=0}^{q-1}\gamma_{2i,j}^*{}'\Delta Z_{t-j}+\varepsilon_{it}. \quad (10)$$

In the analysis, we set lag length $p=q=1$ based on the SBIC. Thus, we estimate the following equation from Equation 10,

$$\Delta s_{i,t}=\phi_i\left[s_{i,t-1}-\alpha_i^*-\delta_1'X_{i,t}-\delta_2'Z_t\right]+\gamma_{1i}^{*\prime}\Delta X_{i,t}+\gamma_{2i}^{*\prime}\Delta Z_t+\varepsilon_{it}. \quad (11)$$

First, we assume that the US government bond is risk-free, so we calculate the government bond yield spreads as the premium paid by ASEAN countries over a US government bond with comparable maturities (10 years).

We adopt explanatory variables following the literature. We use the following country-specific variables as $X_{i,t}$: (i) government budget balance to GDP ratio (*BB*), (ii) public debt to GDP ratio (*PD*), (iii) government interest payments on public debt to budget revenue ratio (*PIP*), and (iv) the expected depreciation rates of the exchange rate in terms of local currency per US dollars (*EX*). The expected depreciation rates of the exchange rate are employed to control for the effects of exchange rate fluctuations, approximated by ex-ante realized values.

For liquidity risk, we cannot obtain relevant variables such as bid–ask spread, the size of trading volumes, or turnover rates. Therefore, we use the public debt to GDP ratio (*PD*) to measure not only credit risk but also liquidity risk. If the coefficient on *PD* is estimated to be positive and significant, this will indicate that the effects of credit risk dominate those of liquidity risk and vice versa.

For global variables Z_t, which are expected to reflect investors' risk aversion, we will extract the first principle component of the following three variables: (i) the spreads between US Treasury Bonds and BBB-corporate bonds, (ii) the implied volatility index (VIX) for US stocks, and (iii) the implied volatility index for yen–euro exchange rates. We will call the first principal component "RISK."

Note that we do not employ CDS data as credit risk variables because they would reflect the investors' subjective assessment of credit risk. However, one of the aims of this study is to investigate whether bond market integration would advance or obstruct investors' ability or willingness to discriminate between the creditworthiness of national fiscal policies. We will thus examine whether investors' subjective assessment of credit risk reflects the relevant fiscal fundamental variables precisely. Therefore, using CDS data would be tautological.

3.3. Empirical Results

3.3.1. Data

Our sample covers 2001Q1 to 2017Q4 with quarterly data.[4]

As explained above, we construct a variable for investors' risk aversion by extracting the first principle component of (i) the spreads between US Treasury Bonds and BBB-corporate bonds, (ii) the implied volatility index of US stocks, and (iii) the implied volatility index of yen–euro exchange rates. We use daily data and then convert them to quarterly data by taking the averages over each quarterly period. The cumulative contribution rate of the first principal component is above 80%, and three eigenvectors (factor-loadings) are about 0.6. Figure 3 displays the

[4] In some countries, fiscal variables are available only from annual data. In those cases, we follow the Chow and Lin (1971) method of interpolating from annual to quarterly data. For example, the annual public debt is interpolated to a quarterly series by using the quarterly budget balance as the related variable.

annual data for BB, PD, and PIP and quarterly data for RISK. The data are from *International Financial Statistics* (IMF) and *Economic Intelligence Unit*.

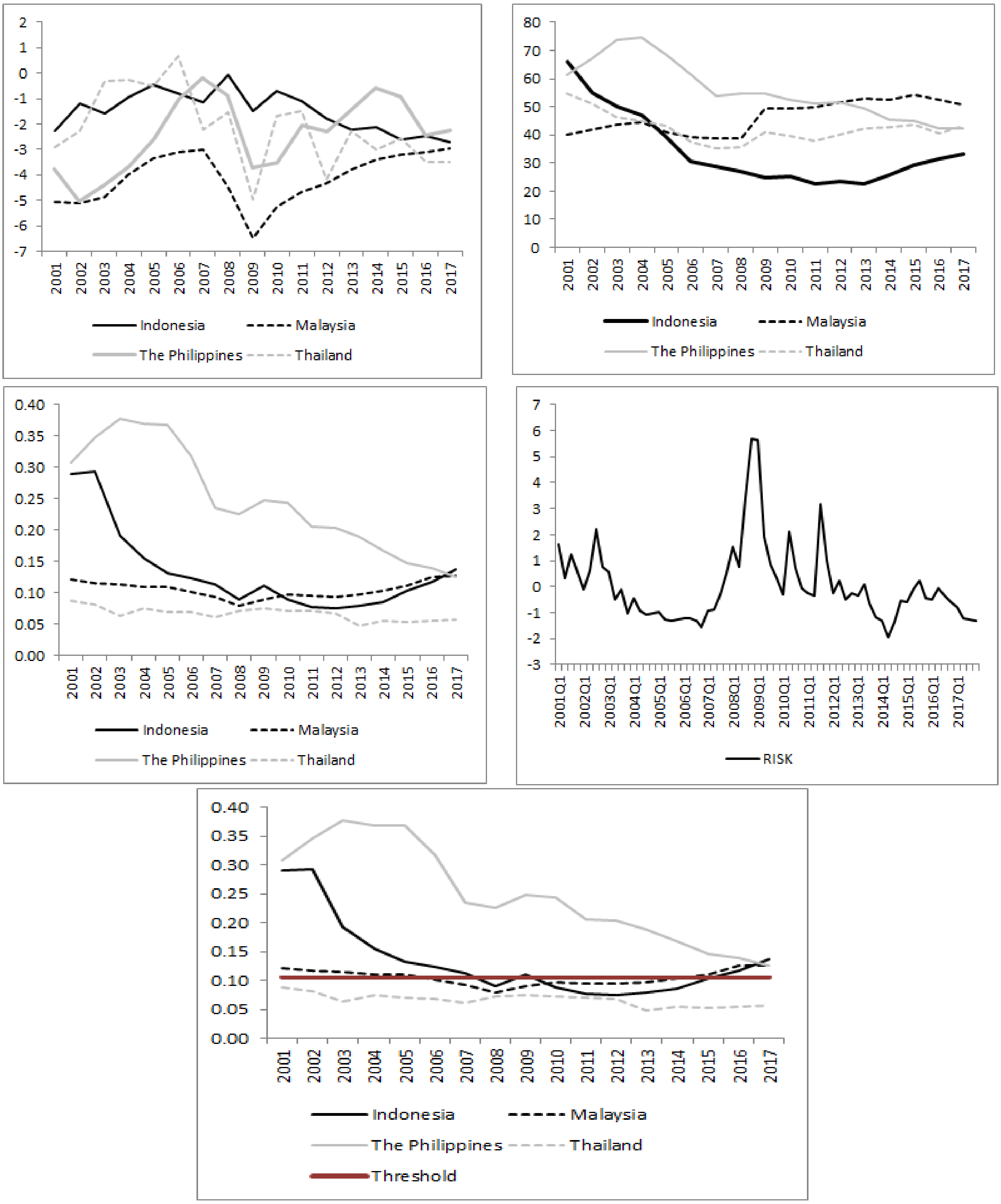


Figure-3. Explanatory variables.
Source: International Financial Statistics (IMF) and Economic Intelligence Unit.

3.3.2. Empirical Results

Table 5 shows the results of the PMG estimation of Equation 11. The table shows that BB is not a significant determinant in all specifications and that PD is also not significant except for specification (2) in the long-run.

Contrariwise, PIP has positive and significant effects on government bond yield in the long-run. This means that PIP is an important determinant of government bond spreads in the four ASEAN countries. These results are consistent with Bernoth et al. (2004) who find that fiscal imbalances are better captured by a measure of debt service than either the deficit to GDP ratio or the debt to GDP ratio. Moreover, PIP is positive and significant in Indonesia and the Philippines in the short run (in specifications [4] and [10]). As shown in Figure 3, PIP levels are higher in Indonesia and the Philippines than in the other two countries. Therefore, the government bond markets in the sample countries have maintained market discipline in the sense that investors discriminate between the creditworthiness of each country by focusing on the public interest payments. These results might offer insights into why the effects of the global factor are asymmetric among the ASEAN countries and why the correlation between the global factor and the government bond yield are negative in Indonesia and the Philippines. The investors' risk aversion (RISK) is positive and significant for all specifications, indicating that, following events that increased investors' risk aversion, investors were reluctant to hold more risky assets and thus changed their portfolios from ASEAN countries' government bonds to those of advanced countries such as the United States. This is known as "flight to quality."

Table-5. Pooled mean group estimation.

			BB	PD	PIP	EXD	RISK	EC
(1)	Long-run		0.0631	0.0080	0.1332***	0.0029	0.0023*	
			(0.1016)	(0.0089)	(0.0506)	(0.0541)	(0.0012)	
	Short-run	Indonesia	-0.0497	0.0089	0.1808*	0.0332	0.0005	0.7811***
			(0.2724)	(0.5472)	(0.1074)	(0.0773)	(0.0053)	(0.1283)
		Malaysia	0.3558	-0.1062	0.4729	-0.0469	-0.0002	1.2244***
			(0.7440)	(0.1810)	(0.9186)	(0.0568)	(0.0022)	(0.1379)
		The Philippines	-0.2296	-0.6394*	0.1076	0.2702*	0.0005	0.8685***
			(0.2802)	(0.3656)	(0.1953)	(0.1381)	(0.0041)	(0.1453)
		Thailand	-0.1012	-0.0336	0.6090*	0.0312	-0.0004	1.0980***
			(0.2920)	(0.0323)	(0.3643)	(0.0915)	(0.0039)	(0.1340)
(2)	Long-run		0.0559	0.0150*		0.0082	0.0021*	
			(0.1027)	(0.0083)		(0.0553)	(0.0013)	
	Short-run	Indonesia	-0.1114	0.3475		0.0325	0.0014	0.7813***
			(0.2755)	(0.5571)		(0.0788)	(0.0054)	(0.1277)
		Malaysia	0.2611	-0.0685		-0.0393	-0.0001	1.1916
			(0.7609)	(0.1795)		(0.0565)	(0.0022)	(0.1394)
		The Philippines	-0.3459*	-0.7886**		0.3247**	0.0009	0.7709***
			(0.1834)	(0.3596)		(0.1353)	(0.0042)	(0.1362)
		Thailand	-0.2421	-0.0265		0.0674	0.0003	1.1329***
			(0.2906)	(0.0329)		(0.0917)	(0.0040)	(0.1333)
(3)	Long-run		0.0179		0.1518***	0.0136	0.0024**	
			(0.0944)		(0.0449)	(0.0539)	(0.0012)	
	Short-run	Indonesia	-0.0660		0.1879*	0.0363	0.0006	0.7834***
			(0.1976)		(0.1065)	(0.0771)	(0.0052)	(0.1264)
		Malaysia	0.3805		0.2274	-0.0423	0.0001	1.2151***
			(0.7376)		(0.8695)	(0.0562)	(0.0021)	(0.1368)
		The Philippines	-0.1727		0.0861	0.2952**	0.0009	0.9359***
			(0.2834)		(0.1982)	(0.1400)	(0.0042)	(0.1439)

		Thailand	0.1713		0.5458	0.0457	0.0002	1.1108***
			(0.1304)		(0.3580)	(0.0910)	(0.0039)	(0.1322)
(4)	Long-run			0.0050	0.1422***	0.0102	0.0026**	
				(0.0085)	(0.0486)	(0.0540)	(0.0010)	
	Short-run	Indonesia		-0.0845	0.1795*	0.0319	0.0006	0.7796***
				(0.3972)	(0.1064)	(0.0768)	(0.0052)	(0.1279)
		Malaysia		-0.0734	0.4463	-0.0457	-0.0002	1.2188***
				(0.1777)	(0.9191)	(0.0559)	(0.0022)	(0.1369)
		The Philippines		-0.5588	0.2498**	0.2619*	0.0004	0.8942***
				0.3639	(0.1244)	(0.1383)	(0.0041)	(0.1447)
		Thailand		-0.0212	0.6594*	0.0365	-0.0005	1.1018***
				(0.0142)	(0.3496)	(0.0908)	(0.0038)	(0.1330)
(5)	Long-run		-0.0307			0.0249	0.0020*	
			(0.0948)			(0.0553)	(0.0012)	
	Short-run	Indonesia	-0.0295			0.0432	0.0014	0.7467***
			(0.1984)			(0.0787)	(0.0054)	(0.1234)
		Malaysia	0.1902			-0.0290	0.0002	1.1769***
			(0.7540)			(0.0558)	(0.0020)	(0.1371)
		The Philippines	-0.2469			0.3739***	0.0013	0.8178***
			(0.1788)			(0.1378)	(0.0043)	(0.1375)
		Thailand	0.0034			0.0786	0.0011	1.1433***
			(0.0797)			(0.0909)	(0.0039)	(0.1304)
			BB	PD	PIP	EXD	RISK	EC
(6)	Long-run			0.0123		0.0144	0.0023**	
				(0.0077)		(0.0552)	(0.0011)	
	Short-run	Indonesia		0.1736		0.0311	0.0014	0.7673***
				(0.3994)		(0.0786)	(0.0054)	(0.1255)
		Malaysia		-0.0399		-0.0377	0.0000	1.1850***
				(0.1764)		(0.0556)	(0.0022)	(0.1383)
		The Philippines		-0.5146		0.3580**	0.0020	0.8260***
				(0.3466)		(0.1381)	(0.0042)	(0.1383)
		Thailand		0.0034		0.0775	0.0004	1.1452***
				(0.0080)		(0.0913)	(0.0039)	(0.1331)
(7)	Long-run				0.1537***	0.0181	0.0027***	
					(0.0436)	(0.0536)	(0.0009)	
	Short-run	Indonesia			0.1788*	0.0321	0.0008	0.7842***
					(0.1036)	(0.0760)	(0.0052)	(0.1266)
		Malaysia			0.2731	-0.0428	0.0001	1.2139***
					(0.8686)	(0.0553)	(0.0020)	(0.1361)
		The Philippines			0.1903	0.2865**	0.0010	0.9487***
					(0.1197)	(0.1397)	(0.0042)	(0.1429)
		Thailand			0.1297	0.0761	0.0011	1.1476***
					(0.1673)	(0.0890)	(0.0037)	(0.1308)
(8)	Long-run		-0.0356				0.0020*	

			(0.0926)				(0.0012)	
	Short-run	Indonesia	-0.0167				0.0014	0.7675***
			(0.1966)				(0.0053)	(0.1194)
		Malaysia	0.3005				0.0004	1.1401***
			(0.7445)				(0.0019)	(0.1282)
		The Philippines	-0.2901				0.0013	0.9873***
			(0.1884)				(0.0045)	(0.1294)
		Thailand	0.0026				0.0007	1.1552***
			(0.0791)				(0.0039)	(0.1303)
(9)	Long-run			0.0125			0.0022**	
				(0.0077)			(0.0011)	
	Short-run	Indonesia		0.1923			0.0015	0.7833***
				(0.3955)			(0.0053)	(0.1200)
		Malaysia		-0.0623			0.0002	1.1446***
				(0.1755)			(0.0021)	(0.1291)
		The Philippines		-0.6003*			0.0022	0.9913***
				(0.3610)			(0.0044)	(0.1290)
		Thailand		0.0031			0.0000	1.1531***
				(0.0080)			(0.0039)	(0.1334)
(10)	Long-run				0.1504***		0.0028***	
					(0.0404)		0.0010	
	Short-run	Indonesia			0.1770*		0.0008	0.8006***
					(0.1035)		(0.0052)	(0.1211)
		Malaysia			0.2824		0.0005	1.1619***
					(0.8550)		(0.0019)	(0.1262)
		The Philippines			0.2346*		0.0009	1.0938***
					(0.1211)		(0.0043)	(0.1281)
		Thailand			0.1367		0.0008	1.1578***
					(0.1674)		(0.0037)	(0.1308)

Note: † Standard errors are in parentheses.
‡ ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

3.3.3. Extensions

In the previous PMG estimation, we found that PIP is a significant determinant of government bond spread in ASEAN countries and is also significant in the short run in Indonesia and the Philippines, where their levels of PIP are higher, and their yields are negatively correlated with the global factor.

Combining these results, we can infer that investors discriminate between the creditworthiness of each government bond by focusing on the level of public interest payments and that investors' decisions might be triggered by a certain threshold value. When investors' risk aversion increases (i.e., the global factor decreases), investors decide to sell the government bonds issued by countries whose public interest payments are higher than the threshold value. This would then increase the government bond yields in these countries and create a negative correlation between their bond yield and the global factor.

Therefore, we employ the fixed-effects panel threshold method proposed by Hansen (1999) to investigate whether the global factor has a threshold effect, in which the PIP level determines the threshold value. We specify the estimation equation as follows:

$$\begin{aligned} i_{i,t} &= \alpha_i + \beta_1 BB_{i,t} + \beta_2 PD_{i,t} + \beta_3 PIP_{i,t} \\ &+ \gamma_1 f_t^r + \gamma_{2,below} f_t^g (PIP_{i,t} < \theta) + \gamma_{2,above} f_t^g (PIP_{i,t} \geq \theta) + \varepsilon_{i,t}, \end{aligned} \quad (12)$$

where α_i is a fixed effect in country *i*, and θ is a threshold parameter to be estimated; γ_{2_below} and γ_{2_above} are coefficients in each regime. We assume that the threshold variable is $PIP_{i,t}$ and the regime-dependent variable is f_t^g[5].

Table 6 shows the estimation results of Equation 12. The threshold parameter is estimated to be 0.1064 with a 95% confidence interval [0.1051 0.1065]. We plot the threshold value of PIP in Figure 2. We see that the PIP in Indonesia and the Philippines is higher than the threshold values in most of the sample periods. The null hypothesis of no threshold can be rejected at a 99% significance level.[6] The estimation results show that PIP and f_t^r are positively significant. We also find that the global factor f_t^r is not significant when the value of PPP is below the threshold value but is negatively significant when it is above the threshold value.

These results confirm our inference that, when investors' risk aversion increases (i.e., the global factor decreases), investors decide to sell the government bonds issued by Indonesia and the Philippines, whose public interest payments exceed the threshold value (0.1064). This in turn increases the government bond yields in these countries and causes a negative correlation between their bond yields and the global factor.

Table-6. Fixed-effects panel threshold estimation.

Threshold value	**0.1064**			
[95% confidence interval]	[0.1051 0.1065]			
F	43			
(P-value)	(0.000)			
	Coefficient	S.E.	t-value	P-value
BB (β_1)	-0.0089	0.0592	-0.1500	0.8810
PD (β_2)	-0.0081	0.0067	-1.2100	0.2280
PIP (β_3)	0.0773***	0.0264	2.9200	0.0040
f^r (γ_1)	0.0825***	0.0050	16.6600	0.0000
f^g ($\gamma_{2,below}$)	0.0177	0.0121	1.4600	0.1470
f^g ($\gamma_{2,above}$)	-0.1066***	0.0128	-8.3500	0.0000
constant (α)	0.0145	0.0046	3.1800	0.0020

Note: +*** denotes significance at the 1% level.

[5] We exclude *RISK* from our regression because it displays multicollinearity with the global factor.

[6] We fit a double-threshold model, but the null hypothesis of a double-threshold model can be rejected.

4. CONCLUSIONS

We examined whether the government bond markets in four ASEAN countries are integrated. We employed the approximate dynamic factor model to decompose the yields in four ASEAN countries and the United States into the global factor, the regional factor, and the idiosyncratic shock and then investigated the time-varying correlations between each factor and the yield in each country using the DCC method. Our results show that the government bond markets in the sample countries are integrated in the sense that their yields are driven by a common regional factor, but the integration has not intensified, as the correlations have not increased. We also find that the global factor has asymmetric effects on government bond yields in the four ASEAN countries: The correlation between the global factor and the government bond yields is positive in Malaysia and Thailand but negative in Indonesia and the Philippines.

Based on these results, we next investigate the determinants of government bond spreads using PMG estimation methods, which allow heterogeneity in the short-run responses across countries. We find that public interest payments are the most important determinant and have positive and significant effects on government bond yields in the long run. They also have positive and significant effects in the short run in Indonesia and the Philippines, where public interest payments are higher and their yields are negatively correlated with the global factor. We also find that investors' risk aversion has positive and significant effects, indicating flight to quality.

We then use the fixed-effects panel threshold method to investigate whether there exists a threshold that depends on public interest payments. We find that the global factor is not significant when public interest payments are below the threshold value but is negatively significant when they are above the threshold.

Combining these results, we can conclude that market discipline has been operating in the four ASEAN government bond markets in the sense that investors discriminate between the creditworthiness of the governments' bonds by focusing on the public interest payments.

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