Chapter 7

Infrastructure Bond Market Developments in Asia: Challenges and Solutions

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I. Introduction

Mounting fiscal burdens in the aftermath of the global financial crisis and decreases in bank lending driven by Basel III capital requirements have led to renewed focus on private participation in infrastructure financing. Asia's relatively high economic growth rates and huge infrastructure demand, which have been estimated at $8 trillion for the 2010–2020 period, offer the potential for increased private participation in infrastructure projects (Asian Development Bank Institute 2010).[1] According to the Organisation for Economic Co-operation and Development (OECD) (2006), Asia accounts for about 40% of global infrastructure investment demand of $1.9 trillion per year.

Large banks in developed economies have traditionally been the major financiers of infrastructure projects in emerging economies. According to the World Economic Forum (2011, 2014), commercial banks in developed economies provided an estimated 90% of all private debt for infrastructure

[1] In this chapter, Asia refers to Brunei Darussalam; the People's Republic of China; Hong Kong, China; Indonesia; Japan; the Republic of Korea; the Lao People's Democratic Republic; Malaysia; the Philippines; Singapore; Thailand, and Viet Nam.

financing in 1999–2009. However, banks with short-term liabilities are not well suited to hold long-term assets on their balance sheets. Generally, revenues from infrastructure projects are generated in local currency, while the major financing sources (foreign banks) lend in foreign currency. This situation poses the type of "double-mismatch problem" in terms of maturity and currency that was experienced during the 1997/1998 Asian financial crisis.[2] Given that infrastructure development is critical to promoting economic growth, the gap in infrastructure financing is also a threat to long-term economic growth in Asia.

Infrastructure firms often carry out projects by setting up a special purpose company through which they can raise capital. From the perspective of financing, equity capital mostly consists of investments from the firm or an infrastructure fund, while debt capital includes infrastructure bonds or loans from various international organizations and public and private domestic financial institutions. In some cases, the special purpose company directly raises capital by issuing stocks or bonds.[3]

Each stage of an infrastructure project has different risks and expected returns, and thus requires a different financing method. During the early stage of planning and construction (greenfield), equity investments and bank loans represent the majority of financing. Once the project enters the mature stage (brownfield) and creates stable cashflows, capital can be raised via bond issuance. The participation of international organizations and/or state-owned banks can help an infrastructure project enhance its viability by facilitating the large-scale financing of long-term capital.[4] Investors in infrastructure projects include a diverse range of retail and institutional investors, such as pension funds, insurers, and investment trusts.

Infrastructure bonds are defined as bonds issued to finance infrastructure projects of public interest, including railways, toll roads, and airports. It is necessary for emerging economies to develop a market for infrastructure bonds that can raise the capital needed for infrastructure projects, thereby filling the gap left by commercial banks' increasing reluctance to extend loans

[2] For further discussion on currency and maturity mismatch, currency internationalization, and bond market development in Asia, refer to Hyun and Inukai (2014).
[3] The issuance of general obligation bonds is based on the credibility of the company, while infrastructure (project) bonds are based on the expected future cash flows from a specific project.
[4] When public resources are used, it is critical to design a risk-sharing mechanism to prevent moral hazard and to strike a balance between the public nature of the project and its commercial viability, which is the incentive for private sector participation. For more details on this topic, please refer to Hyun et al. (2008).

in response to the Basel III capital accords. The scope of infrastructure has evolved significantly in recent decades and now comprises a broad range that includes traditional infrastructure projects, such as power, oil and gas, water, hospitals, schools, and prisons, as well as low-carbon, climate-resilient infrastructure, such as renewable energy projects.

The principal and interest payments for infrastructure bonds are based on the expected cash flows from a project rather than the issuer's credibility. Hence, such bonds require an independent, differentiated evaluation method that takes into account uncertainty in expected cash flows in the future. Infrastructure bonds are closely associated with the development of bond markets, and therefore are primarily issued in developed economies with mature markets (e.g., Australia, Canada, Europe, and the United States).

Against this backdrop, local currency bonds can serve as an alternative avenue for infrastructure financing in Asia. The advantages of bond financing for long-term infrastructure projects and financing gaps provide the impetus for the development of local currency bond markets in developing economies. This was the rationale behind the creation of the Asian Bond Markets Initiative, which was launched in 2003 to strengthen the resilience of the region's financial system by developing local currency bond markets as an alternative to using foreign currency-denominated, short-term bank loans for long-term investment financing.[5] Bonds are also suitable financial products for institutional investors with long-term liabilities, such as pension funds and insurers, who are increasing their allocation in infrastructure investments amid the current low interest rate environment. The emergence of more institutional investors in Asia will further spur the development of infrastructure bond markets.

This special chapter will focus on the appropriateness of bonds for infrastructure financing and use empirical analysis to identify the major determinants of infrastructure bond market development in Asia, which in turn can help boost the region's long-term economic growth. This chapter will also address the fundamental challenges to developing infrastructure bond markets in Asia and apply lessons learned from Europe where infrastructure bonds are more commonly used.[6]

[5] To further develop Asian bond markets, a study exploring new debt instruments for infrastructure financing was proposed at the 10th ASEAN + 3 Finance Ministers' Meeting held in Kyoto in May 2007. A copy is available at https://asianbondsonline.adb.org/regional/abmi.php.

[6] In this chapter, Europe refers to Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

II. Determinants of Bond Market Development

Although local currency bond financing can help plug financing gaps for long-term infrastructure projects in Asia, the region's infrastructure bond market is at a nascent stage of development in terms of issuance relative to the high level of investment required. What are the factors that make local currency bond financing difficult for infrastructure projects in the region? This section attempts to answer this question, while reviewing the determinants of bond market development in the literature. The analysis is then extended to the determinants of functioning infrastructure bond markets as a subset of bond markets.

There are several examples in the literature that investigate the determinants of bond market development, including Burger and Warnock (2006), Claessens et al. (2007), Borensztein et al. (2008), Adelegan and Radzewicz-Bak (2009), and Burger et al. (2011). However, only a few studies have attempted to identify empirically the determinants of bond market development in Asia.

Eichengreen and Luengnaruemitchai (2006) exploit panel data from 41 economies for the period 1990–2001 and find that the size of an economy's gross domestic product (GDP) is positively associated with its bond market development. The size and concentration of the banking system—measured by domestic credit provided by the banking sector and the spread between bank lending and deposit rates—influence bond market depth. Their findings suggest that institutional quality—measured by adherence to internationally recognized accounting standards, the level of corruption, and bureaucratic quality—is also important for bond market development.

Bhattacharyay (2011) examines the determinants of Asian bond market development using data for 10 Asian economies for the period 1998–2008. He investigates government and corporate bond markets both separately and together. Combining the results obtained from various multivariate regression models, he finds that the size of an economy (GDP), stage of economic development (GDP per capita), exchange rate volatility, and spread between bank lending and deposit rates affect the size of government bond markets. Similarly, he finds that the stage of economic development and degree of economic openness (ratio of exports to GDP) impact the depth of corporate bond markets.

Baek and Kim (2013) explore the determinants of domestic bond market development primarily by focusing on nine Asian economies for the period 1997–2010, which covers both the 1997/1998 Asian financial crisis and the

more recent global financial crisis. They find that economic size (GDP), the level of economic development (GDP per capita), and the size of the banking sector are positively associated with bond market development. Institutional factors such as the strength of legal rights and depth of available credit information also play critical roles in bond market development.

Dung et al. (2016) examine how macroeconomic determinants influence corporate bonds in 90 developed and developing economies over the period 1970–2013. By employing a generalized method of moments (GMM) model, they explore whether exchange rate variability and the openness of an economy have a significant impact on corporate bond markets. They find that current levels of bond issuance are positively correlated with previous levels.

While there are no empirical studies that attempt to analyze the determinants of infrastructure bond market development in Asia, Asian Development Bank ([ADB] 2015) has reviewed the experience of infrastructure bond market development in Asia and lessons learned from developed economies, including the revenue bond market in the United States and the European Union's Project Bond Initiative (PBI).

Ehlers et al. (2014) provide reasons for why bond financing is difficult. First, infrastructure projects are often complicated and require highly specialized expertise from both governments and investors. Second, there are some risks inherent in infrastructure projects that cannot be controlled by sponsors, including political, regulatory, technological, and macroeconomic risks. Third, bond financing entails co-movement (cyclicality) between total bond markets and infrastructure bond markets. Last, the lack of depth and liquidity of domestic local currency bond markets makes bond financing difficult. Their findings suggest that infrastructure bond markets are closely related to bond markets in general. Therefore, analysis of bond markets can be extended to infrastructure bond markets. Consequently, the further development of domestic local currency bond markets will facilitate bond financing for infrastructure projects in Asia.

III. Empirical Analysis

A. Data

This study contributes to the literature exploring the determinants of infrastructure bond market development by adding institutional factors that are closely associated with the delivery of infrastructure services in Asia and Europe. In both regions, the experience of financial crisis and credit instability

in recent decades has led to the further development of infrastructure bond markets. As ADB (2015) points out, the European Union seeks to facilitate infrastructure bond financing through the PBI by enhancing the credit quality of project bonds issued by private companies. This study attempts to find similarities and differences between Asia and Europe in the context of the PBI.[7] The sample covers 29 economies for the period 2003–2015, thereby incorporating the impact of the global financial crisis and its aftermath on infrastructure bond market development.

In line with Ehlers et al. (2014), this chapter focuses on bonds that finance economic infrastructure such as roads and electricity (though it excludes the oil, gas, and mining industries), as well as social infrastructure such as schools and healthcare. This study merges data from Dealogic and Bloomberg on infrastructure bonds issued by local and national governments, government agencies, and government development banks regardless of whether these bonds are used solely for financing infrastructure projects.[8]

As for the measure of infrastructure bond market development, the size of an economy's infrastructure bond market is expressed as a percentage of GDP. For the explanatory variables, five factors are considered. (Refer to Table A7.1 in the Appendix for a list of all the variables.) First, an economy's size, as measured by GDP, is expected to be positively related to bond market development because small economies are more likely to lack the minimum efficient scale needed for the establishment of deep and liquid bond markets (Eichengreen and Luengnaruemitchai 2006).

Second, economic development, as measured by GDP per capita, is assumed to be positively correlated with bond market development as Burger and Warnock (2006) and Eichengreen and Luengnaruemitchai (2006) suggest. And a government's fiscal balance, measured as revenue minus expenditure, is assumed to be negatively correlated with bond market development; that is, a fiscal deficit is closely associated with the development of a government bond market.

Third, financial development is known to facilitate bond market development. Burger and Warnock (2006) find that banking systems develop

[7] The PBI was created in response to the global financial crisis and subsequent debt crisis in Europe, which has led to a reduction in financing options for infrastructure projects. Traditional funding options such as public sector debt have become less important in the wake of the European debt crisis. In addition, more stringent capital adequacy requirements under Basel III have made bank loans less preferable.

[8] To analyze the determinants of infrastructure bond markets in Asia, bond issuances by supranationals are not included in the database used in this analysis.

in parallel with bond markets. Eichengreen and Luengnaruemitchai (2006) suggest that the banking sector's size is complementary to bond market development. As a proxy variable for financial development, banking sector size is measured as the total value of credit provided by banks divided by GDP.[9]

Fourth, proxy variables for volatility are introduced, which are expected to be negatively associated with bond market development. One proxy is the annual inflation rate and the other is the volatility of the exchange rate, which is measured as the standard deviation of monthly changes in the exchange rate. Economies with low, steady inflation rates and more stable exchange rates tend to have larger bond markets.

Fifth, institutional strength—represented by the freedom from corruption index, property rights index, and investment freedom index—is closely associated with the delivery of infrastructure services. Well-protected property rights, low levels of corruption, and greater investment freedom all facilitate infrastructure bond market development. Each of these indexes has a high degree of correlation with one another. (Refer to Table A7.2 in the Appendix for more information on these indexes.) Therefore, the three indexes are combined into an average institutional index that affects the delivery of infrastructure services.

To better understand the differences between Asia and Europe with regard to indicators of infrastructure bond market development, Table 7.1 reports the mean standard deviation and number of observations for all variables used in the estimation in the sample period 2003–2015 for 29 economies. The variables differ significantly between Asia and Europe. Figure 7.1 and Table 7.1 show that economies in Europe have relatively developed infrastructure bond markets, with an average bond market size that is equivalent to 11.7% of GDP, which compares with Asian bond markets that average 6.8% of GDP. Figures 7.2 and 7.3 show infrastructure bond issuance for individual economies in Asia and Europe. (Refer to Table A7.3 in the Appendix for data on individual economies.)

The generally smaller economies of Asia and the larger discrepancy in the level of economic development between them are reflected by a smaller mean GDP and larger standard deviation in GDP per capita for Asian economies than European economies. These factors can impede the further development of infrastructure bond market liquidity and depth (Eichengreen and Luengnaruemitchai 2004). Measures of institutional factors such as the

[9]With limited data on stock market size (stock market capitalization divided by GDP) due to the merging of exchanges in some instances, stock market size is not included in this analysis.

Table 7.1: Descriptive Statistics

	Asia			Europe		
Variables	**Mean**	**SD**	**OBS**	**Mean**	**SD**	**OBS**
Bond as percent of GDP (%)	6.845	8.75	143	11.730	21.33	221
Log of GDP	26.487	1.84	143	26.857	1.33	221
Log of GDP per capita	9.567	0.97	143	10.608	0.27	221
General government balance (% of GDP)	−0.963	3.74	143	−2.756	4.10	221
Inflation (GDP deflator,%)	3.888	4.71	143	1.656	1.43	221
Volatility of the foreign exchange rate	1.271	0.70	117	0.724	0.50	221
Domestic credit provided by banks (% of GDP)	94.188	48.03	138	118.837	43.48	221
Average institutional factors	48.031	24.28	143	78.289	12.13	221
Property index	48.636	28.10	143	81.425	13.43	221
Corruption index	46.577	24.54	143	75.095	15.62	221
Investment freedom	48.881	22.90	143	78.348	12.23	221

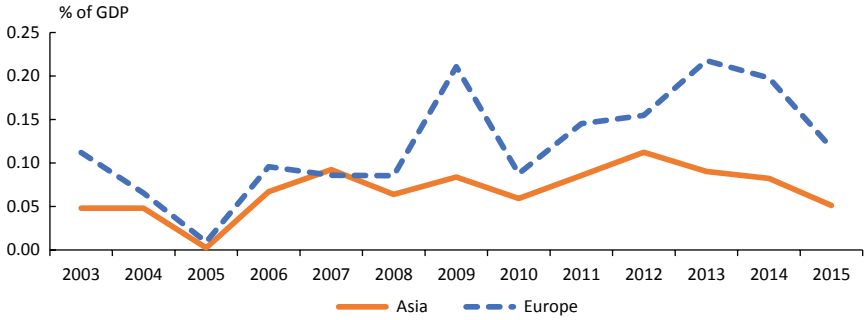
Note: GDP = gross domestic product, OBS = observations, SD = standard deviation.
Sources: Bank for International Settlements, Bloomberg LP, Dealogic, the Heritage Foundation, International Monetary Fund, and World Bank.

corruption freedom index, property rights index, and investment freedom index are also higher on average in Europe than in Asia, which means there is a more favorable environment for infrastructure financing in Europe. Weaknesses in institutional factors are a critical barrier to bond market financing for infrastructure projects in Asia.

Most infrastructure bonds in our sample have been rated by at least one of three international rating agencies. The share of infrastructure bonds rated *AA* or above is about 52% in Europe, while only about 16% of infrastructure bonds in Asia are rated *AA* or above (Figure 7.4). About 57% of infrastructure bonds in Asia have an *A* rating. *BBB*-rated (investment grade) infrastructure bonds are also frequently issued to finance infrastructure projects in Europe.

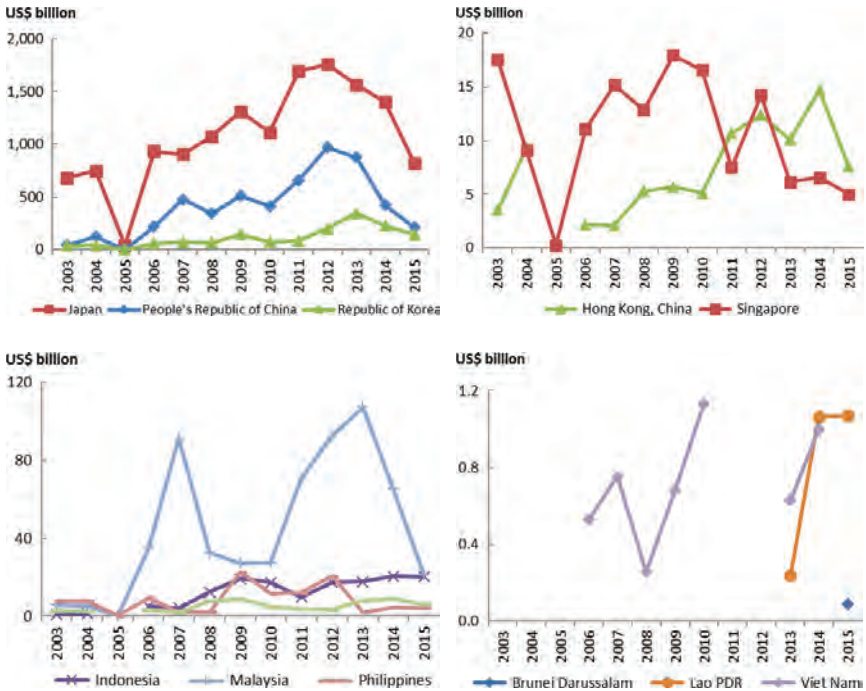
Asian infrastructure bond issuance poses a challenge to corporate issuers because their credit ratings are lower than those of their respective governments, which raises the cost of debt financing for corporates. Therefore, policies that offer preferential treatment for Asian local currency

Figure 7.1: Infrastructure Bonds Outstanding as Share of Gross Domestic Product



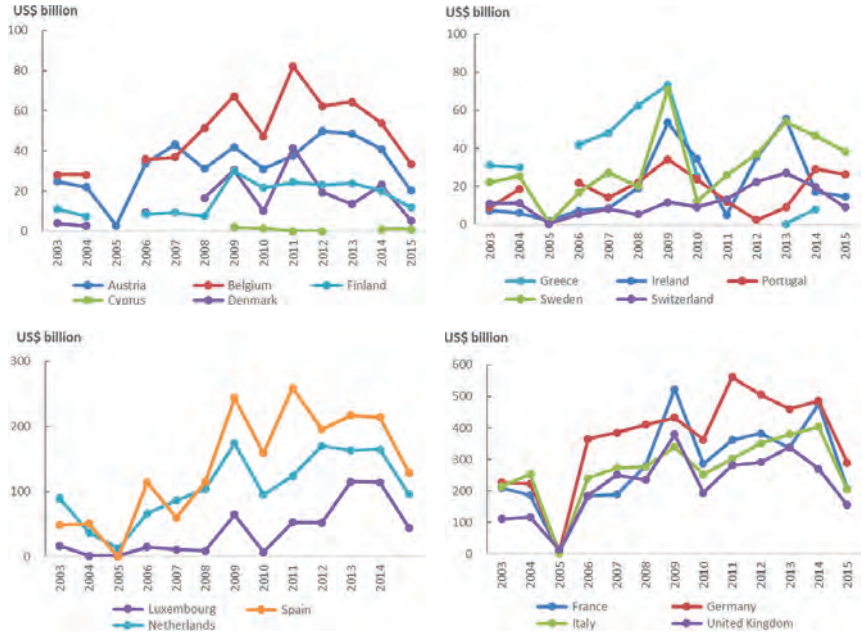
Note: Simple average values for the gross domestic product of all economies in each region are used.
Sources: Bloomberg LP, Dealogic, and World Bank.

Figure 7.2: Infrastructure Bond Issuance in Selected Asian Economies



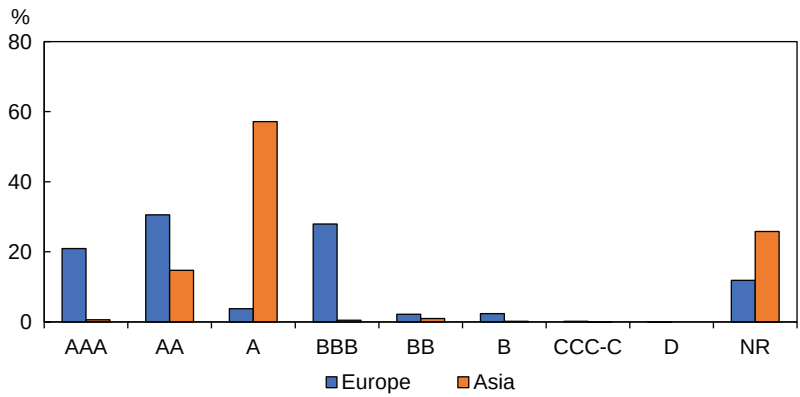
Notes: Lao PDR = Lao People's Democratic Republic, US$ = United States dollar.
Sources: Bloomberg LP, Dealogic, and World Bank.

Figure 7.3: Infrastructure Bond Issuance in Selected European Economies



Note: US$ = United States dollar.
Sources: Bloomberg LP, Dealogic, and World Bank.

Figure 7.4: Distribution of Credit Ratings, 2003–2015



Note: NR = not rated.
Sources: Bloomberg LP and Dealogic.

bond markets through credit-enhancement policies are required to bridge the ratings gap. As an example, the European Investment Bank's Project Bonds Credit Enhancement initiative increases the ratings of infrastructure bonds, and thereby decreases funding costs.[10]

Credit-enhancement programs in Asia can facilitate infrastructure bond issuance by providing Asian investors with higher-rated bonds. The Asian Bond Markets Initiative's Credit Guarantee and Investment Facility is expected to help bridge this gap. However, considering the huge investment needs and financing gap in Asia, this facility will need to be strengthened to successfully facilitate infrastructure bond issuance.

B. Empirical Results

The empirical results show the impact of economy-level explanatory variables on infrastructure bonds, while controlling for firm-level characteristics. The regressions are estimated using panel data and (i) an ordinary least squares (OLS) with fixed-effect model and (ii) a generalized least squares (GLS) model with corrections for heteroskedasticity and panel-specific autocorrelation within economies. These two models are in line with the methodologies of Eichengreen and Luengnaruemitchai (2004) and Claessens et al. (2007), respectively. In addition, the GMM model is applied to mitigate bias and inconsistencies in estimating the static panel data model.[11] The basic model is

$$y_{i,t} = \alpha + \beta_i X_{i,t} + \varepsilon_{i,t}$$

where $y_{i,t}$ stands for the development of infrastructure bond markets and $X_{i,t}$ is a set of explanatory variables that may affect infrastructure bond market development, including economic size, level of economic development, level of finance development, other macroeconomic variables, and institutional variables. $\varepsilon_{i,t}$ is the independent normal distribution error term with mean zero.

Table 7.2 presents empirical results for the major determinants of infrastructure bond issuance for all sample economies in Asia and Europe.

[10] European investors might be prone to take more risks on *BBB*-rated bonds than Asian investors.
[11] Arellano and Bond (1991) suggest the use of variables in first differences and the use of the bond lags and their determinants as instruments. The Arellano–Bover and Blundell–Bond estimators augment Arellano–Bond by assuming that the first differences of instrumental variables are uncorrelated with the fixed effects. This allows the introduction of more instruments and can dramatically improve efficiency. It builds a system of two equations—the original equation and the transformed one—and is known as system GMM, which can solve the endogeneity problem.

Table 7.2: Determinants of Infrastructure Bond Market Development

Variables	Macroeconomic Factors I	Macroeconomic Factors II	Macroeconomic Stability	Financial Market	Institutional Factors	Model 1	Model 2
Ordinary Least Square Fixed effect							
Constant	−162.544***	−49.554**	1.475	−4.066*	−6.648**	−222.449***	−53.696
Europe	0.268	−4.609	7.617***	7.892**	−12.902	−3.060	−6.922
lnGDP	6.372***	—	—	—	—	8.215***	—
ln(GDP per capita)	—	5.758**	—	—	—	—	4.745
General government balance (% of GDP)	−0.509***	−0.588***	—	—	—	−0.495***	−0.505***
Inflation (of GDP deflator)	—	—	−0.503*	—	—	−0.015	−0.175
Volatility of the foreign exchange rate	—	—	1.679*	—	—	1.143	0.916
Domestic credit by banks (% of GDP)	—	—	—	0.054**	—	−0.005	0.029
Average institutional factors	—	—	—	—	0.346**	0.174	0.180
2008 Global crisis dummy	−2.743	−2.12	−3.257	−2.898	−2.641	−3.816	−2.766
Country dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R−squared	0.525	0.516	0.501	0.509	0.508	0.520	0.510
Observations	364	364	338	359	364	338	338
Fixed effect GLS							
Constant	−65.448***	−26.895**	1.656**	−1.872**	−2.631**	−72.741***	−15.468
Europe	5.335	1.589	7.168***	8.098**	−0.590	3.179	1.591
lnGDP	2.529***	—	—	—	—	2.697***	—

ln(GDP per capita)	—	3.054**	—	—	—	—	1.270
General government balance (% of GDP)	−0.535***	−0.518***	—	—	—	−0.553***	−0.546***
Inflation (of GDP deflator)	—	—	−0.190**	—	—	0.068	0.080
Volatility of the foreign exchange rate	—	—	0.451	—	—	0.113	0.028
Domestic credit by banks (% of GDP)	—	—	—	0.026**	—	0.013	0.023***
Average institutional factors	—	—	—	—	0.145**	0.044	0.064
2008 Global crisis dummy	−0.522	−0.023	−0.555	−0.273	−0.427	−0.821	−0.272
Country dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Chi2	598.136	698.422	455.945	726.517	749.829	495.496	579.735
Observations	364	364	338	359	364	338	338
System GMM							
Constant	4.716	−23.290*	3.955***	2.981**	−0.985	10.465	−63.240
Outstanding bonds to GDP (lag 1)	0.701***	0.674***	0.697***	0.699**	0.691***	0.681***	0.64532837***
Europe	1.458	−1.439	0.545	1.733	−0.512	−1.255	−1.580
lnGDP	−0.09636322	—	—	—	—	−0.326	—
ln(GDP per capita)	—	2.660*	—	—	—	—	7.539
General government balance (% of GDP)	−0.043	−0.184	—	—	—	−0.220**	−0.244**
Inflation (of GDP deflator)	—	—	−0.053	—	—	0.048	0.231
Volatility of the foreign exchange rate	—	—	−0.999	—	—	−1.073	−0.610
Domestic credit by banks (% of GDP)	—	—	—	−0.008	—	−0.015	−0.018

(*Continued*)

Table 7.2: (*Continued*)

Variables	Macroeconomic Factors I	Macroeconomic Factors II	Macroeconomic Stability	Financial Market	Institutional Factors	Model 1	Model 2
Average institutional factors	—	—	—	—	0.068	0.067	−0.118
2008 Global crisis dummy	−(1.60)	−(1.48)	−(1.00)	−(1.66)	−(1.65)	−(0.77)	−(1.61)
AR(1) test p-value	0.251	0.253	0.253	0.250	0.250	0.251	0.244
AR(2) test p-value	0.33532445	0.33774074	0.33843568	0.33313419	0.33317319	0.33837465	0.33345492
Hansen test p-value	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Chi-squared statistics	6955.473	7212.594	6612.181	8388.037	8890.922	15885.781	14093.171
Observations	336	336.000	312.000	331.000	336.000	312.000	312.000

Notes: AR = autoregression, GDP = gross domestic product, GLS = generalized least squares, GMM = generalized method of moments.

1. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

2. Macroeconomic factors I refer to GDP and general government budget balance. Macroeconomic factors II include GDP per capita in addition to GDP and general government budget balance. Macroeconomic stability refers to inflation and volatility of exchange rate. Financial market refers to domestic credit by banks. Institutional factors refer to the average of property rights index, corruption index, and investment freedom index. Refer to Appendix Table A7.1 for the description of variables.

Source: Authors' calculations.

The models are estimated using OLS and GLS, as well as the use of GMM to check the robustness of the models.

The OLS regression checks the relationship between explanatory variables and dependent variables. The results show that the coefficient of economic size is positive and statistically significant at the 1% level. Eichengreen and Luengnaruemitchai (2004) emphasize that liquid securities markets require a certain minimum size to attain efficient scale, and therefore the smaller economies of Asia face difficulties in developing their bond markets. The finding that economic size is a critical determinant of infrastructure bond market development is also shown in the results of the OLS and GLS models.

The results also suggest that a general government's budget balance (revenue minus expenditure) negatively affects the infrastructure bond market, which is in line with the findings of Burger and Warnock (2006) and Eichengreen and Luengnaruemitchai (2006). Their results show that a balanced budget is negatively correlated with bond market development. From the regression results in this study, it can be said that economies with fiscal deficits are more likely to utilize bonds to finance infrastructure projects. This result was consistently obtained using the OLS, GLS, and GMM models.

The GLS model shows that domestic credit provided by banks (as a proxy for the banking sector's size) has a positive coefficient and is statistically significant at the 1% level. This indicates that the banking sector, as well as finance development in general, is positively correlated with infrastructure bond market development. In line with Dung et al. (2016), the system GMM analysis shows that the current issuance of infrastructure bonds is positively correlated with the lag variable of infrastructure bond issuance ($t - 1$), indicating that the long-term bond financing of infrastructure projects depends on previous issuances of infrastructure bonds.

C. Difference-in-Difference Methodology

Launched in 2013, the PBI is a European Union effort to facilitate bond financing for infrastructure projects. How do we assess its contribution to the development of infrastructure bond markets in Europe? The simplest way is to estimate the structural impact of the PBI on bond market development by using a dummy variable that takes the value of 1 in 2013 and in all subsequent years. A positive and significant coefficient of the PBI dummy indicates that, given all the other variables in explaining the growth of infrastructure bond

Table 7.3: Difference-in-Difference Estimation for the Impact of the Project Bond Initiative

	Pre-PBI	Post-PBI	Difference
Treatment (Europe)	$\overline{Y}_1^T$	$\overline{Y}_2^T$	$\overline{Y}_2^T - \overline{Y}_1^T$
Control (Asia)	$\overline{Y}_1^C$	$\overline{Y}_2^C$	$\overline{Y}_2^C - \overline{Y}_1^C$
T–C Difference	$\overline{Y}_1^T - \overline{Y}_1^C$	$\overline{Y}_2^T - \overline{Y}_2^C$	$\left(\overline{Y}_2^T - \overline{Y}_2^C\right) - \left(\overline{Y}_1^T - \overline{Y}_1^C\right) = \beta_2$

Notes: PBI = Project Bond Initiative, T–C = Treatment–Control.
Source: Authors' compilation.

markets, the post-PBI period is marked by a structural shift in infrastructure bond market development in Europe.

However, it is difficult to interpret directly the result of the dummy variable in the simple regression. Therefore, this analysis includes both Asia and Europe. To evaluate the impact of the PBI, we employ a difference-in-difference (DID) method to observe the two regions—Europe (treatment group) and Asia (control group)—for the two periods before and after the PBI was launched.[12]

As seen from Table 7.3, in the case where the same units within a group are observed in each period, the average in the second group (Asia) is subtracted from the average in the first group (Europe). This removes bias in the second period comparison between the treatment and control groups that could result either from a permanent discrepancy between the two groups or from a bias in comparisons over time in the treatment group due to other trends[13]:

$$y_{i,t} = \alpha + \beta_0 \text{REGION}_i + \beta_1 PBI_t + \beta_2 (\text{REGION}_i \bullet \text{PBI}_t) + \gamma X_{i,t} + \varepsilon_{i,t}$$

[12] The DID methodology has become very popular since the works of Ashenfelter and Card (1985) and Card and Krueger (1994). The method estimates the impact of a treatment (policy variable) on an outcome (response variable) by comparing the average change over time in the outcome variable for the treatment group to the average change over time for the control group. The simple model is set up for two regions for two periods. One region (Europe) is exposed to a treatment (the PBI) in the second period, but not in the first period. The other group (Asia) is not exposed to the treatment in either period.

[13] This method removes fixed differences between the two regions and common trends or changes over time in factors that affect the two regions equally. The identifying assumption is that, in the absence of the introduction of the PBI, there would have been no differences in the development of infrastructure bond markets between the two regions.

where $y_{i,t}$ stands for the development of infrastructure bond markets and REGION_i is a dummy variable taking the value of 1 if the economy belongs to Europe and 0 otherwise. PBI_t is a policy dummy variable taking the value of 1 in the second period and 0 in the first period. $X_{i,t}$ is a set of explanatory variables that may affect the development of infrastructure bond markets, including economic size, level of economic development, level of finance development, other macroeconomic variables, and institutional variables. The coefficient of interest β_2 is for the interaction term, $\text{REGION}_i \bullet \text{PBI}_t$, which is the same as a dummy variable equal to 1 for those observations in Europe with the PBI in the second period.

The DID results in Table 7.4 show that the PBI as a regional initiative has significantly contributed to infrastructure bond market development in Europe. The coefficients of estimation models I and II (including control variables) show positive and significant impacts on infrastructure bond

Table 7.4: Estimation Results for the Difference-in-Difference Model

Variable	Basic	Model I	Model II
Constant	0.162	–246.287***	–95.986**
Europe	6.962***	–7.273	–14.118
Europe * after 2013	5.686	10.520**	9.648**
After 2013	1.343	–4.375**	–2.569
lnGDP	—	9.077***	—
ln(GDP per capita)	—	—	9.341**
General government balance (% of GDP)	—	–0.558***	–0.615***
Inflation (of GDP deflator)	—	0.116	0.017
Volatility of the foreign exchange rate	—	0.779	0.371
Domestic credit by banks (% of GDP)	—	0.003	0.032
Average institutional factors	—	0.206	0.157
2008 Global crisis dummy	–1.580	–3.178	–1.762
Country dummy	Yes	Yes	Yes
R–squared	0.523	0.537	0.527
Observations	364	338	338

Notes: GDP = gross domestic product;
*** indicates significance at 1%, ** indicates significance at 5%, and * indicates significance at 10% levels.
Source: Authors' calculations.

market development, although the coefficient in the base model, excluding control variables, is positive but not statistically significant. The empirical results show that public initiatives such as the PBI can facilitate increased issuance of infrastructure bonds by mitigating the inherent risks of infrastructure projects.

The results also indicate that economic size and the level of economic development are positively correlated with infrastructure bond market development as other examples from the literature have found. The general government's budget balance is consistently found to have a negative impact on infrastructure bond markets, which implies that a larger fiscal burden makes it more likely that a government will rely on bond financing for infrastructure projects. The coefficient of the global financial crisis dummy is negative, but not statistically significant for both Europe and Asia.

IV. Conclusion

This study attempts to identify the determinants of infrastructure bond market development in Asia, while also evaluating the impact of the PBI on the development of infrastructure bond markets in Europe. It aims to derive policy implications for Asia using the DID method since Europe, in contrast to Asia, has introduced the PBI to finance infrastructure projects at a time when the demand for such financing has increased under the pressure of mounting fiscal burdens.

Based upon the empirical results, an economy's size is positively associated with infrastructure bond market development. As Eichengreen and Luengnaruemitchai (2004) highlight, the small and fragmented economies of Asia face difficulties in developing deep and liquid bond markets because they lack a certain minimum efficient scale. Bond market standardization and harmonization through the ASEAN+3 Bond Market Forum can facilitate the integration of individual Asian bond markets to obtain the minimum efficient scale needed to enhance the liquidity and depth of an integrated regional bond market.[14]

The DID results show that the PBI has contributed significantly to infrastructure bond market development in Europe. Considering the positive impact of the PBI on the development of European infrastructure bond

[14] For details on the harmonization of bond standards in ASEAN+3, refer to Hyun et al. (2010). ASEAN+3 is Association of Southeast Asian Nations plus Japan, the People's Republic of China, and the Republic of Korea.

markets and the relatively lower credit ratings of infrastructure bonds in Asia, ASEAN+3 economies should take policy measures to facilitate the issuance of infrastructure bonds and strengthen the role of the Credit Guarantee and Investment Facility in providing guarantees for infrastructure bonds.

Asia's infrastructure bond markets are still at a nascent stage of development, especially when the amount of issuance is compared with needed investment levels. At the same time, meaningful progress has been achieved in terms of facilitating an environment conducive for the issuance of infrastructure bonds. ASEAN+3 has demonstrated its commitment to developing infrastructure bond markets through the regional Credit Guarantee Investment Facility, which is now providing guarantees for infrastructure bonds. The time is opportune for ASEAN+3 to further strengthen regional initiatives to promote infrastructure bond market development.

Appendix 7.1: Data Description and Correlation Matrix

Table A7.1: Data Description

	Descriptions	Sources
Infrastructure bonds ln(GDP)	Aggregate value of infrastructure bonds issued by an economy	Bloomberg LP, Dealogic
ln(GDP per capita)	Logarithm of GDP	World Bank
	Logarithm of GDP per capita	World Bank
General government budget balance	(Government revenue–government spending) as a ratio to GDP	International Monetary Fund
Inflation (GDP deflator)	Annual inflation rate as measured by the GDP deflator	World Bank
Volatility of the foreign exchange rate	Standard deviation of the change in the exchange rate	Bank for International Settlements
Domestic credit provided by banks	Domestic credit provided by banks as a ratio to GDP	World Bank
Average institutional factors property rights index	Average value of property rights index, corruption index, and investment freedom index	The Heritage Foundation
Corruption index	Range from 0 to 100 (0 = unprotected, 100 = perfectly protected)	The Heritage Foundation
Investment freedom index	Range from 0 to 100 (0 = very corrupt government, 100 = freedom of corruption)	The Heritage Foundation
	Range from 0 to 100 (0 = many restrictions to investment, 100 = no restrictions to investment)	The Heritage Foundation

Note: GDP = gross domestic product.
Sources: Authors' compilation and International Monetary Fund.

Table A7.2: Correlation Matrix between Explanatory Variables

ln(GDP)	1.000									
ln(GDP per capita)	0.268	1.000								
	0.000									
General government budget balance	−0.122	0.121	1.000							
	−0.020	−0.021								
Inflation (GDP deflator)	−0.276	−0.558	0.146	1.000						
	0.000	0.000	−0.005							
Volatility of the foreign exchange rate	0.278	−0.296	−0.035	0.161	1.000					
	0.000	0.000	−0.519	−0.003						
Domestic credit provided by banks	0.122	0.449	−0.032	−0.383	−0.013	1.000				
	−0.021	0.000	−0.542	0.000	−0.816					
Average institutional factors	0.200	0.922	0.153	−0.526	−0.229	0.447	1.000			
	0.000	0.000	−0.003	0.000	0.000	0.000				
Property rights index	0.195	0.920	0.142	−0.523	−0.211	0.454	0.981	1.000		
	0.000	0.000	−0.007	0.000	0.000	0.000	0.000			
Corruption index	0.210	0.876	0.191	−0.481	−0.206	0.433	0.960	0.932	1.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
Investment freedom index	0.171	0.856	0.106	−0.511	−0.237	0.396	0.939	0.887	0.827	1.000
	−0.001	0.000	−0.044	0.000	0.000	0.000	0.000	0.000	0.000	

Notes: GDP = gross domestic product; *p*-value in parentheses: 1 = ln(GDP), 2 = ln(GDP per capita), 3 = General government budget balance, 4 = Inflation, 5 = Volatility of the foreign exchange rate, 6 = Domestic credit provided by banks, 7 = Average institutional factors, 8 = Property rights index, 9 = Corruption index, 10 = Investment freedom index.
Sources: Bank for International Settlements, International Monetary Fund, the Heritage Foundation, and World Bank.

Table A7.3: Overview of Infrastructure Bonds in Asia and Europe, 2003–2015

Asia	**BRU**	**HKG**	**INO**	**JPN**	**KOR**	**LAO**	**MAL**	**PHI**	**PRC**	**SIN**	**THA**	**VIE**
Number of deals	2	872	354	7,464	6,278	12	1,564	239	5,291	286	612	43
Total value ($ billion)	0.09	88.62	146.04	14,032.4	1,490.99	2.37	583.28	106.32	5,269.15	139.85	61.78	4.98
Average value per deal (US$ billion)	0.04	0.10	0.41	1.88	0.24	0.20	0.37	0.44	1.00	0.49	0.10	0.12
Average maturity (without perpetual) (Years)	1.00	5.31	14.01	9.33	6.49	5.91	9.90	11.71	7.04	8.83	7.24	8.73
Share in local currency	100.00	52.52	30.70	99.07	83.77	0.00	95.70	62.07	99.70	79.03	93.19	39.68
Share in $(%)	0.00	33.65	65.39	0.66	9.89	0.00	3.71	33.36	0.25	17.90	4.27	60.32
Share in MTN (%)	0.00	28.60	34.86	0.15	5.68	0.00	51.55	0.00	2.40	36.73	0.20	0.00
Share in regulation S (%)	0.00	53.18	59.62	0.58	4.73	0.00	3.82	10.04	0.74	34.98	8.86	54.00
Share in 144A (%)	0.00	7.44	60.17	0.13	2.80	0.00	2.19	2.91	0.08	10.89	1.12	52.75
Share in private placement (%)	0.00	30.39	9.80	0.10	6.27	100.00	22.51	3.70	2.30	10.77	22.49	12.39
Europe	**AUT**	**BEL**	**CYP**	**DEN**	**FIN**	**FRA**	**GER**	**GRC**	**IRE**	**ITA**	**LUX**	**NET**
Number of deals	550	520	7	296	221	2,750	7,498	108	177	1,277	267	1,307
Total value ($ billion)	428.51	591.26	5.73	176.31	199.50	3,631.23	4,718.41	320.41	265.03	3,494.83	505.74	1,383
Average value per deal (US$ billion)	0.78	1.14	0.82	0.60	0.90	1.32	0.63	2.97	1.50	2.74	1.89	1.06
Average maturity (without perpetual) (Years)	11.26	10.35	6.21	9.18	8.78	8.80	6.93	10.09	13.10	8.24	9.94	9.54
Share in local currency	81.42	97.24	98.38	52.42	81.85	88.74	78.75	98.58	84.60	96.86	62.60	76.46
Share in $(%)	10.88	2.35	1.62	15.71	10.19	7.87	13.30	1.08	12.97	1.85	32.02	16.38

Share in MTN (%)	22.81	9.08	98.38	34.13	30.17	22.41	24.41	4.32	3.09	9.47	51.48	35.73
Share in regulation S (%)	49.40	28.06	74.61	39.26	50.59	23.15	19.36	35.43	47.22	14.09	81.32	37.89
Share in 144A (%)	44.14	19.79	1.54	11.00	32.32	6.26	1.52	26.91	7.78	3.95	37.34	11.24
Share in private placement (%)	3.16	1.31	1.85	2.58	2.17	2.33	3.93	1.99	5.56	0.84	9.11	5.69
Europe	**POR**	**SPA**	**SWE**	**SWI**	**UKG**							
Number of deals	188	1,726	2,579	695	1,657							
Total value ($ billion)	222.33	1,804.01	397.27	153.38	2,825.24							
Average value per deal (US$ billion)	1.18	1.05	0.15	0.22	1.71							
Average maturity (without perpetual) (Years)	10.37	7.68	8.69	12.58	17.06							
Share in local currency	96.99	91.67	42.66	96.21	85.42							
Share in $ (%)	2.87	5.39	23.59	1.44	7.76							
Share in MTN (%)	5.64	22.24	56.85	5.85	13.48							
Share in Regulation S (%)	39.41	27.64	43.80	10.56	29.15							
Share in 144A (%)	29.47	9.40	11.63	4.24	3.89							
Share in private placement (%)	3.07	1.72	6.45	4.15	2.76							

Notes: 144A = Securities and Exchange Commission' Rule, MTN = medium-term note, Regulation S = Regulation S provides an exclusion from the Section 5 registration requirements of the Securities Act of 1933, $ = United States dollar; Asia: BRU = Brunei Darussalam; HKG = Hong Kong, China; INO = Indonesia; JPN = Japan; KOR = Republic of Korea; LAO = Lao People's Democratic Republic; MAL = Malaysia; PHI = Philippines; PRC = People's Republic of China; SIN = Singapore; THA = Thailand; VIE = Viet Nam. Europe: AUT = Austria, BEL = Belgium, CYP = Cyprus, DEN = Denmark, FIN = Finland, FRA = France, GER = Germany, GRC = Greece, IRE = Ireland, ITA = Italy, LUX = Luxembourg, NET = Netherlands, POR = Portugal, SPA = Spain, SWE = Sweden, SWI = Switzerland, UKG = United Kingdom.
Sources: Bloomberg LP and Dealogic.

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