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Foreign Investors and the Market for Indonesian Government Local-Currency Bonds

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Summary

Before 2000, foreign investors held few bonds issued by governments in emerging markets that were denominated in local currency. Since 2000, such holdings have grown rapidly; in Indonesia, foreigners held nearly 40% of all local-currency bonds by 2019. This thesis examines the determinants of the yields and intra-month volatility of ten-year Indonesian local currency bonds and uses daily data to investigate the trading behaviour of foreign investors of different types.

The first study, entitled "The determinants of local-currency government bond yields", investigates the determinants of the yield on ten-year Indonesian government bonds in the secondary market. Utilising monthly data from March 2004 to September 2019, it is shown that yields decrease with a reduced short-term domestic rate and a lower probability of default as captured in the upgrade to an investment grade; and increase with a rise in the U.S. 10-year bond yields, as a proxy to represent the risk-free asset, and a heightened global risk appetite as measured by the VIX index.

The next study, entitled "Foreign investors and volatility in the local-currency government bond market", identifies several factors that may cause volatility in the local-currency government bond market. Two measures of volatility, which are an ARCH/GARCH model on monthly data as used in previous studies of emerging markets, and an intra-month measure derived from daily data, are compared. The two measures are not strongly correlated, which implies that ARCH/GARCH

models based on end-of-month data are poor approximations of intra-month price or yield volatility. The results reveal that the VIX index plays an important role in heightening intra-month volatility, but the impact could be reduced following an increase in the share of foreign investors' holdings.

In the last study, titled "The daily trading behaviour of different types of investors", a unique data set of daily transactions in the secondary market for Indonesian local-currency government bonds, disaggregated by type of investor, is analysed. An autoregressive distributed lag (ARDL) approach, which focuses on the long-run and short-run relationships between the response and explanatory variables, is utilised to explain their trading behaviour from 2 January 2008 to 31 December 2019. The results suggest that global risk, the return on Indonesia's 12-month bills, the expectation of exchange rate depreciation and the country's probability of default are significant determinants of net trading by foreign investors. Since net purchases by foreign investors must equal net sales by domestic investors, these findings suggest that foreign investors have a different sensitivity to these factors from domestic investors. Further, the disaggregation of foreign investors reveals other findings. Amongst other things, mutual funds and insurance companies & pension funds show greater sensitivity to the global risk indicators, as represented by the VIX index and Bloomberg's U.S. financial condition index. The COVID pandemic has caused foreign investors to sell Indonesian bonds continuously and in substantial quantities so that their market share was close to half of its 2019 level by December 2021.

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Chapter 1

Introduction

In the past three decades, financial liberalisation has had a massive impact on the development of the financial market in emerging economies. The remarkable economic growth in those economies has transformed the members into favourite destinations for investment fund managers seeking opportunities to diversify their portfolios. Specifically, the decline of the interest rates in developed markets[1] after the subprime mortgage crisis in 2008 has encouraged them to seek higher returns elsewhere despite the risks (i.e., currency risk, political risk, default risk). The left panel of Figure 1.1 shows that in Southeast Asian emerging markets, the participation of foreign investors in developing the local-currency bond market has been increasing over time. Their shares of total bonds outstanding at the end of December 2019, before the coronavirus pandemic, were greater than in March 2008. In Indonesia, a significant decline in their shares was mainly but not entirely caused by a sudden increase in the total outstanding local-currency tradable government bonds to strengthen the financial capacity during the pandemic, from IDR2,752.74 trillion at the end of December 2019 to IDR4,155.60 trillion at the end of March 2021. While at a similar period, foreign investors reduced their holdings from IDR1,061.86 trillion to IDR951.41 trillion. A relaxation in the reg-

[1]Source: https://data.oecd.org/interest/long-term-interest-rates.htm #indicator-chart

ulation, as a response to the pandemic, also has allowed the government to exceed the maximum limit of 3% debt-to-GDP ratio for three years and Bank Indonesia, as the central bank, to buy government bonds with longer maturities (more than one year) in the primary market.

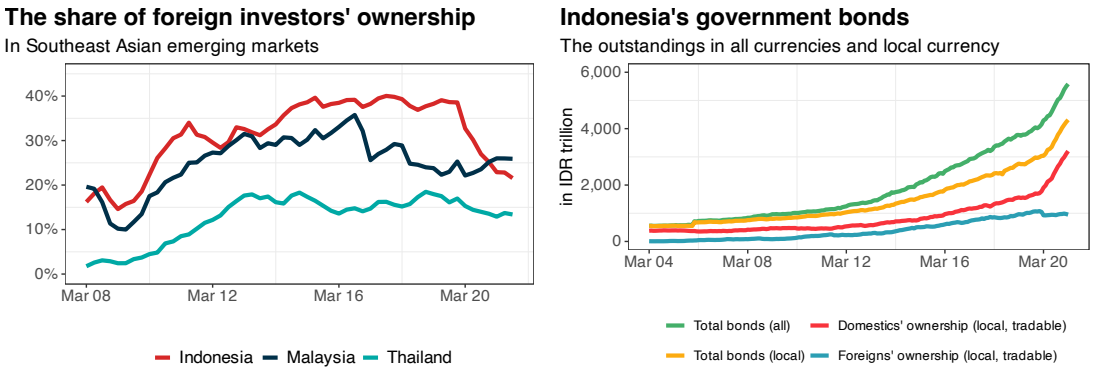


Figure 1.1: The foreign investors' participation the EMEs' local-currency bonds market.

Since the passage of the regulation regarding government bonds in 2004, the government of Indonesia has depended more on issuing the bonds than on negotiating new loans to finance the deficit. Moreover, the right panel of Figure 1.1 presents another fact. In financing the deficit through the issuance of bonds, the government relies more on issuing bonds denominated in the local currency, the Indonesian rupiah (IDR), than in global currencies (i.e., the U.S. dollar, Euro, and Japanese yen). The higher interest rate offered on Indonesia's government bonds and an upgrade in the sovereign credit ratings has attracted foreign investors to invest their funds in Indonesia's local-currency bond market. As a result, before the coronavirus pandemic in 2020, the share of foreign investors' ownership peaked at 41.5% or equal to IDR874.75 trillion, although by the end of 2021, their share had fallen to 19.5% or equal to IDR891.4 trillion, so there was no actual fall in the nominal amount.

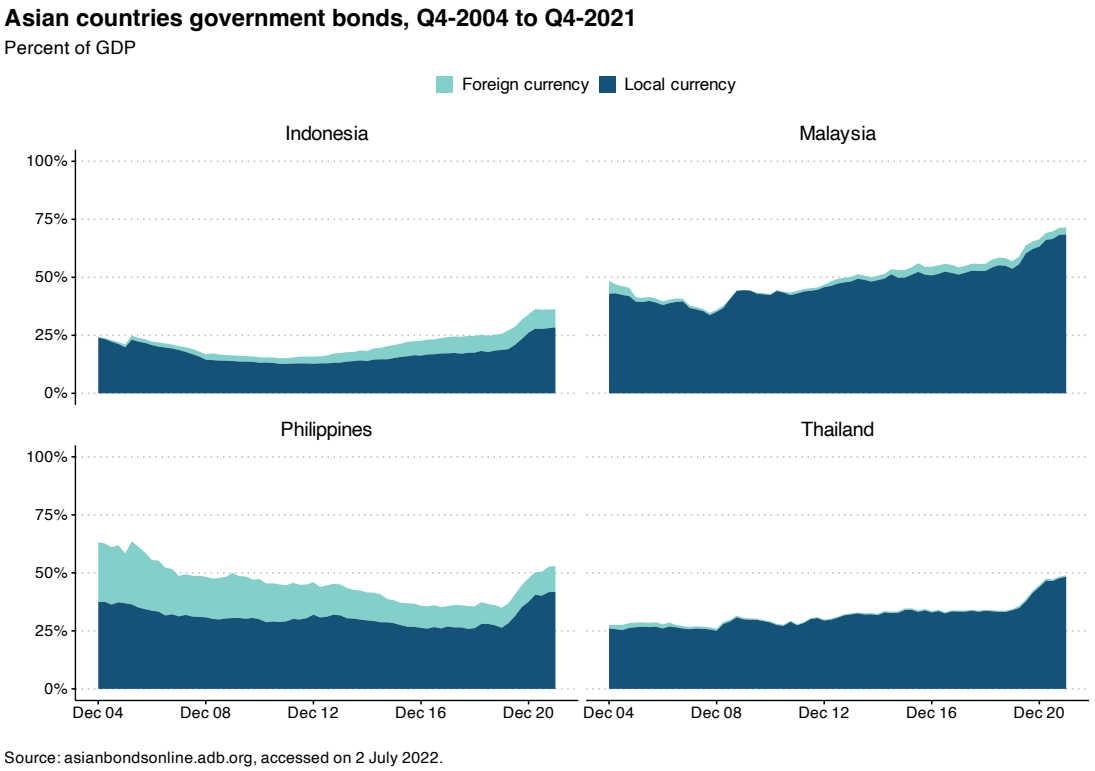


Figure 1.2: The currency compositions of the government bonds in Southeast Asian emerging market.

Furthermore, as shown in Figure 1.2, the Indonesian government has maintained the issuance of government bonds relatively well. From 2004 until 2021, the ratio between outstanding government bonds and the GDP has been relatively lower than in other emerging countries in Southeast Asia. On average, the ratio during that period is 17.4%. While in Malaysia, the Philippines, and Thailand, the ratios are 47.6%, 31.1%, and 31.5%, respectively. In addition, similar to Indonesia, those countries have depended more on issuing bonds denominated in local currency, than foreign currencies.

1.1 Background: Indonesia

Many opportunities offered by financial globalisation also benefited Indonesia, which had suffered a direct consequence of turbulence in the late 1990s. The event forced President Soeharto, who had ruled for 32 years, to step down and

bequeath a debt of IDR451.4 trillion, 51.1% of the GDP, at the end of 1998. Under a new leader, President Habibie, the number increased to IDR863.6 trillion, 56.4% of the GDP, at the end of 1999 and IDR1,150.6 trillion, 73.7% of the GDP, at the end of 2000, mainly due to the continuous depreciation of rupiah. Moreover, the domestic instability had caused S&P to decide to downgrade the country rating seven notches from BBB- to CCC+ on 15 May 1998[2]. From then until 2002, the credit rating agency categorised Indonesia as a selective default[3] two times on 29 March 1999 and 23 April 2002. As for the debt, at the end of 2002, the number increased to IDR1,223 trillion, 67.2% of the GDP. In one of the many efforts to deal with the debt, which mainly consisted of loans in foreign currencies, Indonesia enacted law Number 24 in 2002 regarding Government Debt Securities.

To finance the budget deficit, Indonesia relies more on issuing bonds instead of negotiating new loans with some existing lenders. Accordingly, the proportion of government bonds to address the deficit has increased drastically in the last 17 years, from 46.0% in March 2004 to 86.6% in March 2021. Additionally, to avoid the crowding-out effect in the domestic market, diversify the instrument, and utilise the financial globalisation opportunity, Indonesia started issuing government bonds in other currencies in 2004. Nevertheless, as of March 2021, their proportion of total government bonds was still below the local-currency bonds (22.8% vs 77.2%).

Since Fitch categorised Indonesia as an investment-grade country on 15 December 2011, the development of Indonesia's sovereign credit rating from 2004 to 2021, as illustrated in the left panel of Figure 1.3, could be divided into two periods: a non-investment grade period from March 2004 to November 2011 and an investment-grade period from December 2011 to March 2021. Taking into consideration that

[2]Source: https://www.bi.go.id/en/iru/economic-market-data/Documents/Indonesia-Sovereign-Rating-April-2020.pdf, accessed on 1 July 2022

[3]According to S&P, an 'S.D.' rating is assigned when S&P Global Ratings believes the obligor has selectively defaulted on a specific issue or class of obligations, but it will continue to meet its payment obligations on other issues or classes of obligations promptly.

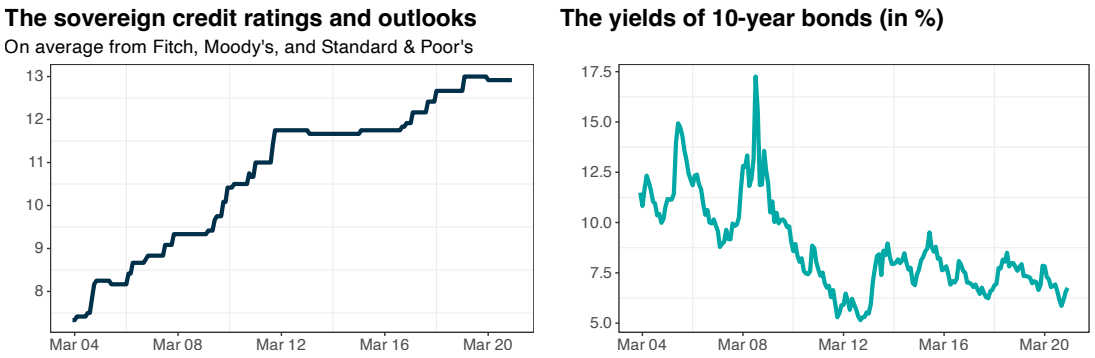


Figure 1.3: Indonesia's sovereign ratings development and the 10-year bond yields.

the sovereign rating is an opinion about a country's risk or creditworthiness, an upgrade to investment grade status could be interpreted as Indonesia having high market potential in the future. Although the CRAs were heavily criticised for their part in worsening the Eurozone crisis (Binici and Hutchison, 2018) and their rating committee tend to rely more on subjective judgment (De Moor et al., 2018), their opinions still play an important role in reducing asymmetric information in the financial market. Accordingly, the government could benefit from the status because the existing and potential investors could see Indonesia's probability of default was reduced so that theoretically they might ask for a lower yield when buying the government bonds in the primary market. Hence, an upgrade in rating also could drive the current foreign investors to increase their holdings or attract new investors; there is also the possibility that some portfolio managers have the mandate to invest in a specific bond grade. As a result, the cost of issuing government bonds declines.

Furthermore, as a developing economy, Indonesia's domestic market is still vulnerable to any shock in the global financial market. For example, in 2008, the government needed to cancel the plan to finance the deficit by issuing government bonds in Q4-2008 because of a significant yield increase, which raised the issuance cost. As shown in the right panel of Figure 1.3, the yields increased significantly from around 11.82% in July 2008 to 17.26% in October 2008.

Table 1.1: Indonesia's bonds yields vs. the U.S. bond yields

	US 10-year bond yield	Indonesia IDR 10-year bond yield	Indonesia USD 10-year bond yield	Bilateral rate against the U.S. dollar (nominal)	Bilateral rate against the U.S. dollar (% - changes year on year)	Returns in USD on IDR bond
	(1.1a)	(1.1b)	(1.1c)	(1.1d)	(1.1e)	(1.1f)
Dec-04	4.19	10.42	6.70	9,270	-	-
Dec-05	4.41	13.62	6.81	9,815	5.88	4.54
Dec-06	4.71	10.18	6.00	8,986	-8.45	22.07
Dec-07	4.07	10.02	6.25	9,390	4.50	5.68
Dec-08	1.99	11.89	9.33	10,850	15.55	-5.53
Dec-09	3.78	10.06	5.34	9,420	-13.18	25.07
Dec-10	3.04	7.61	4.54	9,005	-4.41	14.47
Dec-11	1.71	6.03	3.93	9,060	0.61	7.00
Dec-12	1.55	5.19	2.91	9,630	6.29	-0.26
Dec-13	2.99	8.45	5.40	12,160	26.27	-21.08
Dec-14	2.10	7.80	4.09	12,380	1.81	6.64
Dec-15	2.25	8.99	4.70	13,785	11.35	-3.55
Dec-16	2.45	7.97	4.28	13,470	-2.29	11.28
Dec-17	2.40	6.32	3.57	13,565	0.71	7.27
Dec-18	2.63	8.03	4.44	14,375	5.97	0.35
Mean	2.95	8.84	5.22	11,011	3.62	5.28
St. Dev.	1.03	2.25	1.62	2,040	9.93	11.60

Notes: (i) Returns in USD (US dollar) on IDR (Indonesian rupiah) bond: Indonesia IDR 10-year bond yield$_t$−IDR over USD (% - changes year on year)$_{t+1}$. (ii) The bilateral rate is measured as the number of IDR that a USD buys. Therefore, a rise in the number of the IDR represents a depreciation of the IDR relative to the USD.

However, because Indonesia has adopted a floating exchange rate system since 1997, investing in Indonesia's domestic financial market has several ups and downs for foreign investors, as shown in Table 1.1. Several events are considered to have an essential part in affecting the performance of the rupiah. In 2008, the subprime mortgage crisis caused the rupiah to depreciate by 15.55% compared to 2007. In 2013, the widening of the current account deficit due to declines in coal prices, as one of the main commodity exports, influenced the rupiah to weaken by 26.27% compared to 2012. In this period, the ratio between current-account and the GDP declined from 1.42% in Q1-2011 to -2.61% in Q1-2013, -4.24% in Q2-2013, -3.71% in Q3-2013, and -2.05% in Q4-2013. Further, in 2015, China's economic growth slowdown, as the main destination for export besides Japan[4], and the market players' anticipation of the U.S. interest rate hike pushed the rupiah depressed by 11.35% compared to 2014.

In particular, regarding the taper tantrum in 2013, when the global risk was

[4]According to data taken from https://wits.worldbank.org/CountryProfile/en/Country/ IDN/Year/2013/Summary, retrieved on 6 March 2021

heightened due to the Federal Reserve's policy to reduce the purchases of the U.S. treasury bonds, Basri (2018) argues that Indonesian authorities had managed the episode relatively well compared to the Asian Financial Crisis in 1997/1998. He explains that the adoption of the flexible exchange rate and inflation-targeting regime and the policy to ensure sufficient liquidity in the domestic financial system had supported the country in addressing the unfavourable situation. However, as an emerging country, the Indonesian government still has to pay attention to the heightening volatility in the global financial market that might have a spillover effect on the domestic bonds market. In particular, from the perspective of the government, the existence of foreign investors in the domestic market needs to be managed attentively. On the one hand, their existence could diversify the investors and contribute to the development of pricing mechanisms. While on the other hand, the pressure from their end investors during unfavourable financial market conditions could intensify the vulnerability of the domestic market.

1.2 Research objectives

Previous literature has discussed the role of foreign investors in influencing the local-currency bond market. Utilising a quarterly data set from Q1-1969 to Q4-2011 in 13 developed markets, Andritzky (2012) finds that a higher foreign investors' participation is associated with a decline in the bond yields, where the effect is more prominent in the euro area economies. Peiris (2013) then strengthen the finding. Compiling a quarterly data set from Q1-2000 to Q1-2009 in ten emerging economies, the author finds a consistent result, where an increase in foreign holdings would lower the domestic bond yields. In the latter study, Ebeke and Lu (2015) investigates a similar relationship and their finding is relatively similar to the earlier studies, with an additional result that the benefit of having higher participation of the foreign investors in the domestic market will hold if the country

has a sound macroeconomic indicator.

Further, focusing more on the volatility in the domestic market that might be caused by the foreign investors' decisions, Andritzky (2012) provides statistical evidence that a higher share of foreign investors has a positive relationship with the volatility. However, related to this particular issue, Peiris (2013) has a different finding. He argues that the relationship has a different direction in each emerging economy. Exploring even further, Ng et al. (2019) and Timmer (2018) investigate the heterogeneity of different types of foreign investors' behaviour. Utilising a quarterly data set from 2011 to 2015 that covers the Asia-Pacific government and corporate bonds held by asset managers all over the world, they outline different patterns of the mutual funds and the insurance, annuity, and pension companies during a financial stress episode in 2013.

Given the improvement in Indonesia's credit ratings that reflect a reduced probability of default, and the Indonesian government's decision to rely more on the issuance of local-currency bonds in financing the deficit, Indonesia's domestic bond market is a fruitful area of research, particularly because of the existence of daily data over a fairly long period Moreover, a more frequent data set compared to the previous literature that covers several notable events from 2004 to 2019 has allowed this study to explore the determinants of bond yields and the volatility in an emerging economies' bonds market. Furthermore, as related to the foreign investors' trading behaviour, the daily data set can be utilised to investigate different types of their behaviour from 2 January 2008 to 31 December 2021. Nevertheless, due to a significant decline in foreign ownership shares that might affect their behaviour, the period for the main analysis will be restricted from 2 January 2008 to 31 December 2019. Hence, this thesis aims to answer three questions: (1) What are the determinants of bond yields? (2) Which variables could influence market volatility? (3) How do foreign investors respond to the development in global and domestic factors?

The thesis will be constructed as follows. Chapter 2 explores the determinants of bond yields. Chapter 3 investigates the volatility. Chapter 4 examines foreign investors' behaviour. Lastly, chapter 5 compiles the findings from the main chapters.

Chapter 2

The determinants of local-currency government bond yields

Contents

2.1 Introduction

The presence of foreign investors in developing local-currency bond markets has been discussed in several works of literature. Intuitively, increasing their participation could support the government's effort to diversify the bondholders' base, generating more demand in the primary market and creating more liquidity in the secondary market. Hence the government could reduce its bond issuance cost and decrease the state budget burden in paying the interest. Further, assuming that foreign and domestic investors are maximising risk-adjusted returns, foreign investors could play an important role in heightening volatility due to their flexibility to reallocate their investments to more favourable assets in other countries if the domestic investors have limited opportunities to follow the foreign investors' decisions. Consequently, a substantial increase in the cost of issuance would distract the government from executing its plans. Besides, it is important to note that each agent participating in the domestic bond market might have different preferences. For example, insurance companies & pension funds could be categorised as long-term institutional investors due to their preference for long-tenure bonds. As a result, they may tend to be less sensitive to any rapid financial market development.

In particular, significant economic and financial reforms in emerging market economies (EMEs) and financial market integration have attracted foreign investors to allocate their funds to EMEs' local currency bond markets. Moreover, after the crisis, the total debt of emerging market economies has multiplied from less than USD244 billion of 400 bonds at the end of 2007 to more than USD3 trillion of 2,300 bonds at the end of 2017, with bonds issued by Brazil, Mexico, China, Indonesia, and Russia representing 45.9% of the emerging market index value developed by J.P. Morgan[1]. In Indonesia, as a representative of the biggest five, the foreign-owned share of total local currency tradable bonds has increased 17 times from 2.17%

[1]According to Vanguard Research, obtained from personal.vanguard.com/pdf/ISGEMB.pdf

(IDR8.42 trillion) in March 2004 to 38.64% (IDR1,029.39 trillion) in September 2019, as shown in the left panel of Figure 2.1. Moreover, in the last ten years, the foreign-owned share of Indonesia's local-currency bond market has been the highest among Asian countries. According to the latest data from Asian Development Bank[2], the number is much greater than Malaysia (22.99%), Thailand (17.21%), South Korea (12.16%), Philippines (4.88%), and Vietnam (0.77%). Considering those backgrounds and the availability of relevant data, then Indonesia's bond market is interesting to analyse.

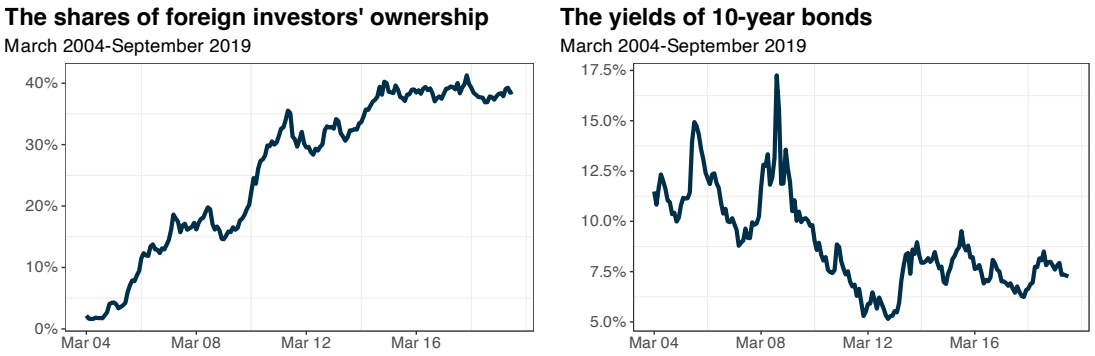


Figure 2.1: The share of foreign investors' ownership and the 10-year bond yields.

However, even though Indonesia's bond market has developed significantly since the aftermath of the Asian crisis, it is still vulnerable to any shock in the global financial market. In Q4-2008, for example, Indonesia's government had to cancel its plan to issue bonds because of the increase in bond yields. During that period, Indonesia's 10-year bond yield increased from 11.82% in July 2008 to 17.26% in October 2008, as shown in the right panel of Figure 2.1. As a result, it raised the cost needed to bear by the government to issue bonds in the primary market. Meanwhile, during a similar period, the share of foreign investors decreased from 18.99% (IDR100.01 trillion) to 17.13% (IDR92.81 trillion). Learning from that experience, the government has paid increasing attention to foreign investors' holdings of domestic government bonds. Motivated by those observations, this study formally investigates the effects of foreign investors' participation on

[2]The data are obtained from asianbondsonline.adb.org/data-portal/

local-currency bond yields in Indonesia.

To this end, a monthly data set on tradable local-currency government bonds from March 2004 to September 2019 is utilised, which disaggregates the bondholders based on their domicile (domestic investors vs foreign investors). The features of the data set allow this study to control for other possible determinants of bond yields, such as the ratio of government debt to industrial production, the sovereign debt ratings from Fitch, Moody's, and Standard & Poor's, and key forward-looking variables such as inflation and exchange rate expectations. In this study, the VIX index is included as a proxy to capture global financial conditions. Developed by the Chicago Board of Options Exchange (CBOE) based on 30-day future S&P 500 index options, some works of literature note a significant information flow from the volatility in the U.S. stocks market to other markets across countries. Further, given that the foreign investors variable in our data set could be differentiated into governments/central banks (the officials) and non-governments/central banks (the privates), the finding is expected to contribute to the discussion about the role of foreign investors in determining bond yields in an emerging country.

This chapter focuses on analysing the effects of foreign investors' holding on bond yields using time-series methodologies of ordinary least squares (OLS), two-stage least squares (2SLS), and autoregressive distributed lag (ARDL). By considering an important achievement that has influenced the domestic bonds market, which is the investment-grade status earned by Indonesia starting from the end of 2011, the observation period is divided into two sub-periods. The sub-periods are the non-investment grade rating period (March 2004–November 2011) and investment-grade rating (December 2011–September 2019). Our results are that in the context of Indonesia: (1) the VIX index plays a vital role in determining the bond yields; (2) foreign investors' participation contributes to lower bond yields; (3) the disaggregation of the foreign investors and the employment of a shorter observable period cannot capture the relationships between the shares of the privates' and the

officials' holdings, and (4) a rating upgrade is estimated to have a greater impact in reducing the bond yields when the rating reaches investment-grade status.

The rest of the chapter is organised as follows. Section 2 reviews the related literature, followed by section 3, which illustrates the theoretical model. Section 4 explores the data set. Section 5 reports the empirical analysis. Section 6 provides an alternative methodology. Section 7 discusses other relationships using a more detailed database. Lastly, section 8 concludes the findings.

2.2 Literature review

As countries are more integrated into the international system, emerging and advanced economies have more flexibility in financing their budget deficit. Issuing bonds in local currency tends to be more attractive and becomes the primary source of financing. This phenomenon has intrigued many scholars and led them to pay more attention to the bond market development in those countries, especially after the global financial crisis in 2008, where the volatility in the financial market had escalated significantly. During that period, Morgan Stanley Capital International's emerging market index, which measures the performance of the stock market in 26 developing countries[3] declined about 45% to 454.34 on 27 October 2008 from 823.69 on 26 September 2008. Before the crisis, the index peaked at 1,249.73 on 19 May 2008. Andritzky (2012) mentions that after the crisis, the composition of the bondholders in the domestic markets of advanced economies tended to be different, with the domestic institutions increasing their share at the expense of foreign investors. In addition, as Arslanalp and Tsuda (2014) describe after the 2008 crisis, the domestic banks started to increase their holdings of government debt in most advanced countries, from about 15% of GDP in 2004 to

[3]Argentina, Brazil, Chile, China, Colombia, Czech Republic, Egypt, Greece, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Qatar, Russia, Saudi Arabia, South Africa, Taiwan, Thailand, Turkey, and United Arab Emirates.

20% of GDP in 2011. In investigating the determinants of the bond yields and the bondholders' contributions to the development of the bond market, this study follows closely several works of literature, which are Peiris (2013), Ebeke and Lu (2015), Andritzky (2012), and Arslanalp and Tsuda (2014).

Peiris (2013) examines the significance of foreign participation in developing the bond market, particularly in reducing local-currency bond yields, since established literature had not investigated the benefit and cost of their participation even further due to limited data availability. Moreover, previous research in this field has tended to focus more on examining the determinants of the local-currency government bond yields in emerging markets (EMEs). At the same time, the increasing size of the outstanding stock of domestic bonds in emerging economies has attracted foreign investors' interest. According to data from the Emerging Markets Trade Association, from 2002 to 2006, their holdings increased by seven times in nine countries. Since domestic investors are more likely to implement buy-and-hold investment strategies and therefore trade only infrequently, the presence of foreign investors in the domestic market could contribute to improving price mechanisms and market liquidity.

Compiling quarterly data from Q1-2000 to Q1-2009 in ten large EMEs[4] from the Asian Development Bank (ADB) and the International Monetary Funds (IMF), Peiris (2013) employs a panel data estimation approach and uses several macroeconomic indicators as control variables, such as the short-term nominal policy interest rate, inflation, the deficit to GDP ratio, the government debt, broad money growth, real GDP growth, the U.S. Treasury (UST) long-term note yields, and the current account balance, in addition to the countries' long-term bond yields and the share of foreign holdings in the domestic government bond market. From the estimation, the author finds that a 1% increase in foreign holdings will drive a lower bond yield by six basis points, on average. As for the control variables,

[4]Brazil, Czech Republic, Hungary, Indonesia, Malaysia, Mexico, Poland, South Korea, Thailand, and Turkey

only five indicators influence the yields: the policy interest rate, inflation, fiscal deficit, current account deficit, and U.S. interest rate.

Ebeke and Lu (2015) document the influence of foreign investors' ownership on the domestic bond yields and its volatility in 13 EMs[5] from Q2-2004 to Q2-2013. Besides comparing the relationship between the observable variables, a period before and after the crisis in 2008, different to other literature, they also take into account the non-linear effect of the samples' macroeconomic performance, which are real GDP growth, forward exchange rate depreciation, current account balance-to-GDP, public external debt-to-GDP, and inflation. Furthermore, to address the regressors' endogeneity issue, they employ an instrumental variable method where they rely on the second lag of foreign holdings and a financial remoteness measurement. As for the latter instrumental variable, the authors assume the closer the countries are to the financial centres (e.g., London, New York, and Tokyo), the more they are financially integrated and the higher the foreign holdings. The results of the OLS regressions show (i) in the whole sample and the period after the crisis, the foreign holdings have negative relationships with bond yields and positive relationships with the yields volatility, and (ii) the advantage will hold if a country has sound macroeconomic indicators, for example, when its total external debt- and the short-term debt of the GDP are less than 90% and 21.5%, respectively.

Further, covering a period of observation from Q1-1969 to Q4-2011 in 13 advanced markets[6], Andritzky (2012) finds that a significant negative correlation exists between bond yields and the foreign investors' holdings of the government bond as a 1% increase in their holdings would lead to lower yields by 3.2 to 4.3 basis points, where the effect is more prominent in the euro area economies. Moreover, the causality test also shows that a pull effect, where lower yields attract foreign

[5]Brazil, Czech Republic, Hungary, Indonesia, Republic of Korea, Malaysia, Mexico, Poland, Slovakia, South Africa, Thailand, and Turkey

[6]Australia, Canada, France, Germany, Greece, Ireland, Italy, Japan, South Korea, Portugal, Spain, United Kingdom, and the United States

investors, appears to be more dominant than a push effect, where a rise in demand leads to a decline in bond yields. Also, following the demand for sovereign debt, which are currency and deposits, securities other than stocks, and loans in 24 countries, Arslanalp and Tsuda (2014) explain that foreign investors reallocated their investments in the period of the euro area crisis from 2010 to 2012. Especially for the foreign banks and the foreign non-banks, they decreased their ownership in high-spread euro area countries (Belgium, Greece, Ireland, Italy, Portugal, and Spain) and increased their ownership in traditional reserve countries (Japan, Switzerland, the United Kingdom, and the U.S.).

To be more specific, this study attempts to re-explore the influence of foreign investors' holdings on the local currency bond yields in Indonesia by utilising a monthly data set from March 2004 to September 2019. Moreover, as a contribution to the literature, our data set could disaggregate the foreign investors into two categories: foreign central banks/governments and foreign non-central banks/governments to enrich a data set developed by Arslanalp and Tsuda (2014) on a quarterly basis from Q1-2004 to Q2-2019, which covers 24 advanced countries.

2.3 Theoretical model

To motivate the study, foreign investors' demand for an emerging market economy (EME)'s local-currency government bonds, which is used in the initial model, will be defined. Further, considering Indonesia's status as an emerging country that tends to be riskier than an advanced country, the key assumptions of the model are that investors are risk-averse, invest for one year, and have three investment options: into the risk-free asset (proxied by the U.S. government bonds), EMEs' bonds denominated in U.S. dollars, and EMEs' bonds denominated in local currency (in Indonesia's case the Indonesian rupiah). Then, following González-Rozada and Yeyati (2008), the arbitrage relation between investing in risk-free

assets and EMEs' dollar-denominated bonds that the foreign investors would meet could be written as follows.

$$\underbrace{(1-q_t)(1+r_t)+q_tV}_{\text{a}} = \underbrace{(1+r_t^f)}_{\text{b}} + \underbrace{\varphi_t q_t}_{\text{c}} \tag{2.1}$$

where q is the probability of default, r is an emerging country's 1-year interest rate (i.e., the dollar-denominated bonds), V is recovery value after default (assumed to be constant), r^f is an advanced country's 1-year interest rate (considered as a risk-free asset; i.e., the U.S. government bonds), φ is the parameter of investor's risk measurement, which is time-varying, proxied by Chicago Board Options Exchange's Volatility Index (VIX index). Accordingly, equation 2.1 is divided into three parts: a represents the expected returns from investing in EMEs' dollar-denominated bonds with a maturity of 1 year, b is the expected returns from investing in risk-free asset with similar maturity, and c is the premium that is required by risk-averse foreign investors.

Then, considering that foreign investors might be interested to invest in EMEs' local-currency-denominated bonds, they need to consider the exchange rate risk to calculate the attractiveness of this kind of bond. Therefore, the relationship between an EME's dollar-denominated bonds and its local-currency bonds could be explained as follows.

$$r_t = r_t^{local} - \left(\frac{E_{t+1}^e - E_t}{E_t} + u_t - \delta\right) \tag{2.2}$$

where r_t^{local} is the interest rate of the emerging market's 1-year local-currency bonds, E_t is the current price of the U.S. dollar in terms of an EME's local currency (i.e., Indonesian rupiah), and E_{t+1}^e is the expectation of the price for the next one year. u_t is the measure of the exchange rate volatility to capture the amount of

risk required by foreign investors to compensate for the exchange rate uncertainty. The variable is represented by the historical volatility of the exchange rate between the Indonesian rupiah and the U.S. dollar. δ represents the observation that the default risk of local-currency-denominated bonds is much lower than dollar-denominated bonds because of the considerable holding of domestic institutions and individuals. Hence, equation 2.2 indicates that the interest rate differential between an EME's local-currency and dollar-denominated bonds with a similar maturity equals the sum of foreign investors' expectation of the depreciation rate and the exchange rate uncertainty, minus the difference in the default risk between those bonds.

Furthermore, considering that a sovereign's probability of default could be influenced by its macroeconomic fundamentals, the macroeconomic variables are denoted as follows.

$$q_t = q(X_t) \tag{2.3}$$

where X_t is a vector of macroeconomic fundamentals that possibly affects the default rate (e.g., the foreign reserves, the growth domestic product growth rate, and the current account balance).

By combining equations 2.1, 2.2, and 2.3, the final model could be written as follows.

$$r_t^{local} = r_t^f + \left[\varphi_t + (1 + r_t^f) - V\right] \frac{q(X_t)}{1 - q(X_t)} + \frac{E_{t+1}^e - E_t}{E_t} + u_t - \delta \tag{2.4}$$

The equation 2.4 suggests the arbitrage relationships faced by foreign investors who consider investing in an EME's local-currency bond market and taking into account the bond yields, which could be seen as returns or risks. Based on the

equation, the hypothesis for the equilibrium relationship between the emerging market's bond yields and the observable variables could be as explained as follows. A rise in a risk-free asset interest rate (r_t^f), global risk (φ_t, proxied by the VIX index), the expected depreciation rate ($[E_{t+1}^e - E_t]/E_t$), and the exchange rate volatility (u_t) would increase the EME's domestic risks, which could be translated as an increase in the bond yields (r_t^{local}). In contrast, a stronger fundamental macroeconomic variable (X_t) and a lower probability of default (q_t, proxied by the sovereign's credit rating) would increase the EME's attractiveness in the global financial market, which in turn could lead to lower bond yields.

In this study's empirical analysis, considering the data availability, the r_t^{local} will be represented by the yields of Indonesia's government bond with a tenure of 10 years, which will be used as the dependent variable. To be in line in terms of tenure, the r_t^f that represents the risk-free asset will use the yields of the U.S. treasury with tenure 10-year as well. Table 2.1 summarises the expectation of the relationships between the dependent variable, Indonesia's 10-year bond yields, and independent variables.

Table 2.1: Initial hypothesis of the relationships between Indonesia's 10-year bond yields and the independent variables

Independent variables	Expectations
The interest rate of the risk-free asset: The return (yield) of 10-year U.S. treasury note	Positive
The global risk measure: VIX index	Positive
Macroeconomic variables: IDR tradable bonds over industrial output and the government loans over industrial output to measure the debt to GDP ratio	Positive
Macroeconomic variables: The 3-month interbank offer rate to capture the domestic short-term rate	Positive
Macroeconomic variables: The expectation of the inflation rate	Positive
The expected depreciation rate: The expectation of Indonesian rupiah (IDR) against the U.S. dollar in the next 12 months	Positive
The volatility of the US$ exchange rate: The standard deviation of the exchange rate between IDR and the USD in the last 20 days	Positive
The investment-grade status: Taking into account the sovereign's ratings and outlooks; a higher status means a lower probability of default	Negative

In the initial model, taking into account the research objective and the data avail-

ability, the foreign holdings' share in Indonesia's government bonds market and a dummy variable that represents the subprime mortgage crisis in 2008 will be included as the independent variables. Meanwhile, the volatility of the US$ exchange rate will be excluded because it could have a higher correlation with the expected depreciation rate.

2.4 Data

To investigate the determinants of Indonesia's 10-year bond yields, this study follows Baillie and DeGennaro (1990) and Elyasiani and Mansur (1998)'s approach by utilising a monthly data set. The reasons are (i) a longer period of observation could be employed in aiming to have a better perspective in understanding the market volatility; (ii) other related variables could be included, e.g., government debt, industrial production output, and inflation rate expectation; and (iii) the settlements process and the delays in the clearing, if any, could be ignored.

In this study, Indonesia's bond yields (IG10) will be assigned as the dependent variable in all specifications. The independent variables will consist of several global and domestic factors, which are the VIX index (VIXI); the share of foreign investors' ownership in Indonesia's government bonds for all maturities (FORH); expected inflation rate year-on-year (IDIE); Indonesia sovereign rating and outlook for foreign currency long-term debt (RTNG); a percentage difference of the forward rate in the next month and the spot exchange rate against the U.S. dollar (EXFP) as a proxy to measure the domestic exchange rate performance; the ratio of total Indonesian rupiah tradable bonds to industrial output (TOID) and the ratio of government loans in any currencies to industrial output (LOID), both of which are used as proxies to measure the debt to GDP ratio; the interbank 3-month rate as a proxy to measure the short-term interest rate (IBOR); and the U.S. Treasury 10-year bond yield (UG10). Due to some of the variables being available on a

monthly basis (i.e., industrial output, inflation expectation, and foreign holdings' share), this study will use the end-of-month number for those variables. However, specifically for the VIX index, this study uses the daily average of the VIX index within a month in order to capture the global financial market's monthly volatility.

Also, two dummy variables are created to represent the period after Fitch upgraded Indonesia's rating to an investment-grade status (DMRT), where one is assigned to a period from December 2011 to September 2019 and zero to March 2004 to November 2011; and to capture the 2008 crisis caused by the subprime mortgage crisis (DMCR), where one is assigned to a period from September 2008 to February 2009. In particular, this study follows Ahmed et al. (2017)'s method in developing the later dummy variable.

For the rating variables (Indonesia's rating: RTNG and the peer countries' rating: MART, PHRT, and THRT), Kim and Wu (2008)'s method is followed to convert into numbers a sovereign rating and its outlook, which is associated with the rating, published by the rating agencies. However, unlike their rating conversion range that starts from zero for default to 20 for AAA (S&P), our conversion ranges from one for default to 21 for AAA (Fitch and S&P) and Aaa (Moody's). Another difference is due to a shorter interval in assigning sovereign ratings compared to Fitch and Moody's; they choose to concentrate on the rating and 6-month outlook from S&P alone, while this study considers the ratings and outlooks from all of those biggest rating agencies. In converting the rating and outlook, each rating is assigned a number. Then the number is added with the associated outlook conversion. For example, Indonesia's sovereign ratings and outlooks on 8 February 2017 are BBB- (12) with a positive outlook (0.25) from Fitch (12.25), Baa3 (12) with a stable outlook (0.00) from Moody's (12.00), and BB+ (11) with a positive outlook (0.25) from S&P (11.25); averaging those number, then the rating and outlook on that specific day is 11.83. In detail, the ratings and outlooks conversion and Indonesia's sovereign credit ratings and outlooks development are shown in

Table 2.9 and Table 2.10 in the Appendix section.

Table 2.2: Summary statistics of variables

	Mean	Std. Dev.	Min.	Max.	Var.	Skew.	Kurt.
A MONTHLY DATASET: The main variables used in the models: 187 obs; Mar-2004 to Sep-2019, end of month, except VIXI which is on average within a month.							
IG10 – Indonesia's 10-year bond yields (%)	8.96	2.33	5.19	17.30	5.42	0.78	3.27
FORH – The share of foreign holdings: All types (%)	26.19	12.34	1.63	41.29	152.28	-0.57	1.96
VIXI – VIX index	18.29	8.34	10.13	62.25	69.51	2.63	11.86
TOID – The ratio of total of government Indonesian rupiah tradable bonds to industrial output	2.75	0.81	1.62	4.99	0.65	0.57	2.36
LOID – The ratio of total of government loans in any currencies to industrial output	2.15	0.55	1.30	3.28	0.30	0.02	1.74
EXFP – The forward point (expected depreciation of the IDR/USD) (%)	0.73	1.11	-1.13	6.48	1.24	2.93	12.96
IBOR – The interbank offer rate (%)	7.70	2.14	4.21	14.68	4.57	1.33	5.01
IDIE – The inflation rate expectation (%)	6.26	3.32	2.53	18.10	11.00	1.63	5.63
UG10 – The US's 10-year bond yields (%)	3.03	1.02	1.46	5.14	1.05	0.38	1.92
RTNG – Indonesia's credit ratings and outlooks, on average	10.58	1.63	7.33	13.00	2.65	-0.43	1.83
MART – Malaysia's credit ratings and outlooks, on average	15.00	0.20	14.25	15.25	0.04	-2.41	10.84
PHRT – The philippines's credit ratings and outlooks, on average	10.64	1.94	7.75	14.00	3.76	0.00	1.57
THRT – Thailand's credit ratings and outlooks, on average	13.87	0.32	13.00	14.25	0.10	-2.17	6.01
Disaggregating the foreign investors: 80 obs; Feb. 2013 to Sep. 2019.							
FCBP – The share of foreign holdings: Central banks/governments (%)	7.23	0.61	5.92	8.55	0.37	0.50	2.58
FNBP – The share of foreign holdings: Non-central banks/governments (%)	30.09	2.62	23.49	34.37	6.84	-1.08	3.09

Further, Table 2.2 presents the summary statistics of the observable variables. During the observable period, the average 10-year bond yield is 8.96%, much greater than the U.S. 10-year bond yields and the average of the peer countries (3.03% and 4.03% respectively). Without neglecting the risk, this condition could make investing in Indonesia's government bonds more attractive than other financial assets. On the other hand, the share of foreign investors' holdings has been increasing significantly, from the lowest 1.63% to the greatest 41.29%. An upgrade in Indonesia's credit rating and the outlook that reduces Indonesia's probability of default could play an essential role in increasing the appeal of the domestic market. Particularly among the foreign investors, as of September 2019, the share of the private (non-central banks/governments)' holdings in total tradable Indonesia's government bonds was much greater than the officials (central banks/-

governments), 31.72% vs 6.92%, respectively.

The share of foreign investors' ownership data set is compiled from the Ministry of Finance of the Republic of Indonesia, while the other variables are obtained from Bank Indonesia, Bloomberg, CEIC data, Reuters, investing.com, and countryeconomy.com; as depicted in more detail in Table 2.8 and Figure 2.2 in the Appendix section.

2.5 Empirical analysis

2.5.1 Working models

Several econometric models are established to utilise the observable variables. To mitigate the endogeneity issue, this study follows Gelos et al. (2011)'s method by using lagged values of the regressors, except for the Chicago Board Options Exchange Volatility Index (VIX index). In the baseline specification, this study estimates Indonesia's 10-year bond yields (IG10) as a function of the VIX index (VIXI), the share of the foreign investors' holdings (FORH), the total of IDR tradable bonds over industrial output (TOID), the total of government loans over industrial output (LOID), the forward point that represents the expected depreciation of the local currency (EXFP), the interbank offer rate (IBOR), the inflation rate expectation (IDIE), and the U.S. 10-year bond yields (UG10), or more formally the model is specified as follows:

$$\mathrm{IG10}_t = \beta_0 + \beta_1 \mathrm{VIXI}_t + \beta_2 \mathrm{FORH}_{t-1} + \eta \Gamma_{t-1} + \epsilon_t \tag{2.5}$$

where Γ_{t-1} are a 6 x one-dimensional vector of the control variables, which are TOID_{t-1}, LOID_{t-1}, EXFP_{t-1}, IBOR_{t-1}, IDIE_{t-1}, and $\mathrm{UG10}_{t-1}$; η is a 6 x one-

dimensional vector of the control variables' coefficients; and ϵ_t is a white noise term. Considering that during the observable period, at least, there was an upgrade of Indonesia's rating to investment grade status, the whole period of observation is divided into two sub-periods. The sub-periods are (a) non-investment grade rating from March 2004 to November 2011 and (b) investment grade rating from December 2011 to September 2019. Particularly in the whole period, two dummy variables that represent the investment-grade status (DMRT) at t and the 2008 crisis period (DMCR) at t are included. Further, even though the variable is available, the average of Indonesia's ratings and outlooks (RTNG) is not utilised in the model because it has been captured in the dummy variable of the investment-grade status (DMRT).

In assessing Indonesia's 10-year bond yields' determinants, the study employs an ordinary least square (OLS) and autoregressive distributed lag (ARDL) model, where the relationships among variables in the long-run and short-run will be able to be examined. Another reason to employ the ARDL method, as suggested by Shrestha and Bhatta (2018), is because of the stationarity issues in some observable variables, as shown in Table 2.11 in the Appendix section. The ARDL approach is specified as follows:

$$\Delta \text{IG10}_t = \beta + \sum_{i=1}^{n_1} \theta \Delta \Theta_{t-i} + \xi \Xi_{t-1} + \sigma_t \tag{2.6}$$

where Θ_{t-i} and Ξ_{t-1} are a 9 x one-dimensional vector of the independent variables, which are IG10_{t-1}, VIXI_t, FORH_{t-1}, TOID_{t-1}, LOID_{t-1}, EXFP_{t-1}, IBOR_{t-1}, IDIE_{t-1}, and UG10_{t-1}; Δ is the first difference; θ is a 9 x one-dimensional vector of the short-run dynamic coefficients; ξ is a 9 x one-dimensional vector of the long-run dynamic coefficients; and σ_t is a white noise term. As for the dummy variables, the model will include them in the short-run equation only. Further, if the existence of cointegration among the observable variables is confirmed, then the

equation above can be converted into an error correction term (ECT) as follows:

$$\Delta \text{IG10}_t = \beta + \sum_{i=1}^{n_1} \theta \Delta \Theta_{t-i} + \delta \text{ECT}_{t-1} + \nu_t \tag{2.7}$$

where δ is the speed of adjustment and ECT_{t-1} denotes how quickly the dependent variable converges to equilibrium. If the δ is negative and statistically significant, then the long-run relationship can be concluded to be captured in the model.

In the ARDL model, this study restricts the lag to only one period for consistency since the share of foreign holdings is controlled by the total of Indonesian rupiah tradable bonds, which is divided by the industrial output (TOID). In order to test the existence of cointegration among the variables, the ARDL bound test will be applied. If the F-statistic is greater (lesser) than the upper (lower) bound critical value, then the null hypothesis of no correlation can be rejected (accepted), and the long-run relationship in the model can be concluded. However, if the value lies between the upper and lower bounds, then the long-run relationship is inconclusive, in which case, the error correction term (ECT) needs to be examined. If the ECT is negative and significant, then a long-run relationship among variables can be concluded, and the next step can be taken to find out the relationships among the observable variables in the long and short run.

In estimating the models to investigate the determinants of Indonesia's local-currency 10-year bond yields, hypotheses are developed based on expectations that higher participation of any institutions, whether in the primary or secondary domestic bond market, would improve the pricing mechanism and enhance the market development. In particular, to some degree, the capital account openness and the attractiveness of the bonds issued by EMEs have raised foreign investors' interest in investing in EMEs' domestic bond markets. In addition, as a developing country and considering the large domestic market, foreign investors may

view Indonesia has enough potential to grow. Based on that assessment, investing in Indonesia's government bonds, in particular, would be more attractive. Accordingly, an increase in the market liquidity (demand and offer in the secondary market or demand in the primary market) due to their participation would raise the competition and decrease (increase) the bond yields (prices), a situation where the government could take the benefit by the decline in the cost of issuance. Further, a heightened global market uncertainty would make investing in the emerging economies' market more vulnerable than the advanced economies' market because the government bonds issued by the latter economies are more likely to be categorised as risk-free assets. As a result, heightening uncertainty in the global financial market would increase the bond yields since the investors would ask for a more risk premium to invest in the emerging economies' government bonds.

Moreover, a higher ratio between government debt (represented by the outstanding local-currency tradable bonds and government loans) and industrial production output (as a proxy of the monthly GDP) could be associated with more limitations for the government in managing its expenditures because the government needs to manage the debt more carefully to avoid a decrease in the investors' trust. As a consequence, the bond yields are expected to increase to compensate for the potential risk. A similar positive relationship is expected to be found in the relationships between Indonesia's government bond yields and a risk-free global financial instrument (i.e., the U.S. government bonds), the inflation rate expectation, the short-term interest rate, and the performance of the exchange rate, where a hike in those rates or depreciation of Indonesia rupiah over the U.S. dollar would lead to an increase of Indonesia's bond yields. Meanwhile, upgrading the sovereign ratings and outlook would decrease the yield since it could increase the country's confidence in the market and attract new investors. In contrast, a more volatile global financial market is expected to have a positive relationship with the yield since investors would likely ask for more premiums as compensation for an increase in domestic risk.

Finally, by dividing the whole period of observation into two sub-periods, the investment-grade status is expected to influence how the regressors determine the bond yields. More specifically, a positive relationship is expected between the global financial market uncertainty, proxied by the VIX index, and the bond yields. However, the degree of relationship is anticipated to be lessening when the sovereign has earned the prestigious status from any credit rating agency. In addition, this study also differentiates the whole period and the first sub-period into two different specifications with the inclusion of the dummy variable crisis (DMCR). The approach is conducted to understand whether the dummy variable could influence the specification in determining the bond yields.

2.5.2 Statistical results

The results are presented in a series of tables, each showing a regression for the whole period and then for two sub-periods. In particular, Table 2.3 shows the outputs from the baseline specification, where the observable variables at the level are used. Meanwhile, in aiming to address the stationarity issue, this study uses the first difference between the observable variables and an ARDL approach. The outputs of those approaches are shown in Table 2.4 and Table 2.5, respectively. In addition, to understand the level of multicollinearity in each model, this study also calculates the variance inflation factor (VIF) for each variable, with a value greater than ten treated as indicative of a significant issue, and shows the numbers below the main results of Table 2.3 and Table 2.4. Specifically, in columns c and d of Table 2.3, where the VIFs for the variable of interest, that is, the share of foreign holdings, are 11.31 and 11.32, it could be that some of the control variables determine the foreign investors' decision to invest in Indonesia's bond market. Therefore, the results in those columns (2.3c and 2.3d) are statistically weaker than other columns (2.3a, 2.3b, and 2.3e).

Table 2.3: The OLS outputs – assessing the bond yields' determinants, at level

Dep. variable: Indonesia's 10-year bond yield: $IG10_t$	2004M03-2019M09	2004M03-2019M09	2004M03-2011M11	2004M03-2011M11	2011M12-2019M09
	(2.3a)	(2.3b)	(2.3c)	(2.3d)	(2.3e)
VIX index$_t$	0.070***	0.057***	0.082***	0.076***	0.040**
	(3.200)	(3.084)	(2.882)	(2.803)	(2.385)
FORH$_{t-1}$: The foreign holdings' share$_{t-1}$	-0.111***	-0.109***	-0.109**	-0.109**	-0.032
	(-7.042)	(-7.028)	(-2.329)	(-2.324)	(-0.912)
IDR tradable bonds over industrial output$_{t-1}$	0.280	0.221	-0.422	-0.413	0.077
	(1.591)	(1.259)	(-0.338)	(-0.329)	(0.501)
Government loans over industrial output$_{t-1}$	-0.232	-0.304	1.932***	1.860**	-1.090**
	(-0.458)	(-0.585)	(2.749)	(2.540)	(-2.381)
The forward point$_{t-1}$	0.025	-0.002	-0.093	-0.110	0.137**
	(0.235)	(-0.016)	(-0.533)	(-0.624)	(2.421)
Interbank offer rate$_{t-1}$	0.511***	0.493***	0.469***	0.460***	0.522***
	(8.303)	(7.732)	(3.419)	(3.324)	(10.641)
Inflation rate expectation$_{t-1}$	0.006	0.000	-0.018	-0.018	0.158***
	(0.154)	(0.009)	(-0.266)	(-0.272)	(2.891)
US 10-year bond yield$_{t-1}$	0.345**	0.347**	-0.047	-0.054	0.271**
	(2.122)	(2.083)	(-0.163)	(-0.185)	(2.354)
Dummy variable: Investment grade status	0.605	0.488	-	-	-
	(1.315)	(1.139)	-	-	-
Dummy variable: The subprime mortgage crisis	-	0.959	-	0.425	-
	-	(1.112)	-	(0.543)	-
Constant	4.961**	5.668***	2.621	3.027	4.587*
	(2.313)	(2.609)	(0.884)	(0.998)	(1.882)
Observations	186	186	92	92	94
R^2	0.840	0.842	0.794	0.795	0.806
Adjusted R^2	0.832	0.833	0.774	0.773	0.788
Multicollinearity test: Variance Inflation Factors					
VIX index$_t$	2.19	3.17	2.80	3.89	1.15
FORH$_{t-1}$: The foreign holdings' share$_{t-1}$	9.07	9.16	11.31	11.32	6.65
Government loans over industrial output$_{t-1}$	8.19	8.32	1.85	1.93	9.86
IDR tradable bonds over industrial output$_{t-1}$	5.88	6.07	11.96	11.96	5.66
The forward point$_{t-1}$	1.73	1.80	2.59	2.71	1.09
Inflation rate expectation$_{t-1}$	4.44	4.48	5.88	5.88	3.13
Interbank offer rate$_{t-1}$	5.12	5.26	7.58	7.68	2.15
US 10-year bond yield$_{t-1}$	5.83	5.83	3.58	3.59	1.72
Dummy variable: Investment grade status	7.55	7.84	-	-	-
Dummy variable: The subprime mortgage crisis	-	2.42	-	2.79	-

[1]***, **, * denote significance at 1%, 5%, 10% respectively. [2]*t-statistics* in parentheses. [3] 2004M03–2019M09: a whole sample period of observation, 2004M03–2011M11: non-investment grade period, and 2011M12–2019M09: investment grade period.

The main estimation results in Table 2.3 show that the VIX index has a significantly positive effect on Indonesia's 10-year bond yields, whether in the whole period of observation or all of the sub-periods. In the whole period, as shown in column 2.3a, a 1 unit increase in the VIX index at t would increase the bond yields at t by 7.0 basis points (bps)[7]. In the first and second sub-period, as shown in columns 2.3c and 2.3e, a similar increase would raise the bond yields by 8.2 bps and 4.0 bps. These findings are consistent with the inclusion of the dummy variable crisis in the models (a whole period and the first sub-period only), as presented in columns 2.3b and 2.3d. The role of the VIX index in determining Indonesia's bond yields might relate to Raddatz and Schmukler (2012)'s findings. By focusing more on 38 emerging market economies and observing a period from Q1-1990 to Q2-2014, they find that during heightened volatility in the global financial market, foreign investors would lessen their investment, as captured in declined average

[7]100 bps = 1%

gross inflows. Accordingly, such a condition could lead to lower bond prices (higher bond yields). In particular, the VIX index's effect is the highest in the sub-period when considering a period from March 2004 to November 2011, when Indonesia's credit rating was still below the investment-grade level (8.2 bps). The effect is smaller in the sub-period when Indonesia's credit rating has been upgraded to the investment-grade level (4.0 bps). It implies that sovereign rating status is essential in determining the local-currency bond yields in an emerging market.

In the whole period of observation, it appears that foreign investors' participation in Indonesia's domestic bond market at $t-1$ has a negative relationship with the bond yields at t. In this period, a 1% increase in their share is associated with a reduction in the 10-year bond yields of 11.1 bps (column 2.3a) and 10.9 bps (2.3b). Perhaps it is because an increase in foreign investors' demand for local-currency bonds can help to increase the overall demand for these bonds, which can in turn lead to lower interest rates (i.e., coupon) that are offered on the bonds. As a result, the bond yields may decrease as the bond interest rates on the bonds decrease. In other words, an increase in their demand may lead to higher bond prices as well, which can be translated as lower bond yields. Moreover, the presence of foreign investors in the domestic market can improve pricing mechanisms in the market, assuming that they have more expertise and more sophisticated technology (i.e., more advanced analytical tools and wider access to global market data) than local investors, which can help them to make more informed investment decisions. Those conditions, then, could encourage liquidity in the bonds market, which can make it easier for the government to issue the bonds at a reasonable cost in the primary market and for investors to buy and sell bonds in the secondary market. Nevertheless, using the OLS framework and considering some of the VIFs are greater than 10, the results only hold for the whole period of observation. Even though the relationship directions are negative in the sub-periods, the results are less reliable to be explored statistically.

Further, from March 2004 to September 2019, both variables representing the debt-to-GDP ratio have different effects on the bond yields. The ratio of IDR tradable bonds to industrial output at $t-1$ is not statistically significant in influencing the bond yields at t in all period observations, whether in the whole period or sub-periods. Meanwhile, the ratio of loans to industrial output at $t-1$ is not statistically significant in the whole period but statistically significant in the sub-periods and has different directions of relationships in each sub-period. In the earlier sub-period, a 1-unit increase in the ratio of government loans to industrial output would be followed by a 1.93% (column 2.3c) and 1.86% (column 2.3d) increase in the bond yields. In the latter sub-period, a 1-unit increase in the ratio of government loans to industrial output would be followed by a 1.09% decrease in bond yields. Perhaps, it is because of the crowding-out effect in the latter sub-period, where the issuance of government bonds has lessened the source of capital in the domestic market. Consequently, the demand for corporate bonds, which could be critical in encouraging the development of private sectors, decreases. Therefore, by increasing the budget financing through government loans, the crowding-out effect would be lessened, making the bond prices more competitive and declining the bond yields.

An expectation of the depreciation of the Indonesian rupiah against the U.S. dollar only influences the bond yields in the last sub-period. A 1% increase in the forward point at $t-1$ is associated with an increase in the bond yields at t by 13.7 bps. The result underlines a spillover effect from the currency market to the bond market in the case of Indonesia. It strengthens the hypothesis that Bank Indonesia, as a monetary institution that maintains the local currency, has a crucial role in maintaining the stability of the bonds market. The interbank offer rate at $t-1$, which represents the 3-month interest rate, also has a positive relationship with the 10-year bond yields at t. In a whole period, a 1% increase in the short-term rate would increase the bond yields by 51.1 bps (column 2.3a) and 49.3 bps (column 2.3b). Meanwhile, in the first and second sub-periods, a

similar increase would increase the bond yields by 46.9 bps (column 2.3c), 46.0 bps (column 2.3d), and 52.2 bps (column 2.3e). A positive relationship between the short-term and long-term interest rates defines a condition where the market players demand more premiums to compensate for the risk embedded in the long-term investment assets.

Moreover, a positive relationship between the U.S. bond yields at $t-1$ and Indonesia's bond yields at t during the whole period of observation indicates that any development in the U.S. bonds market could affect the performance of Indonesia's local-currency bond market. A 1% increase in the U.S. bond yields in the previous period would raise the domestic bond yields by 34.5 bps (column 2.3a) and 34.7 bps (column 2.3b). Nevertheless, this finding only holds for the last sub-period, not the first sub-period. A 1% increase in the U.S. bond yields in the previous period would raise the domestic bond yields by 27.1 bps (column 2.3e). As for the dummy variables, both of them are not statistically significant in affecting the bond yields.

To check the robustness of the findings in Table 2.4, a similar specification using the first difference of the observable variables and the ARDL method is conducted. The estimation results are displayed in Table 2.4 and Table 2.5.

Table 2.4 presents outputs from a similar method but with the utilisation of the first difference of the observable variables. The VIFs, which are less than 10, show that the coefficients in the specifications do not have an issue with the multicollinearity issue. In general, the results show that only the changes in the VIX index at t and the U.S. bond yields at $t-1$ would influence the change in Indonesia's bond yields at t. A 1 unit change in the VIX index is associated with an increase in the change of Indonesia's bond yields by 7.3 bps (column 2.4a) and 7.2 bps (column 2.4b). By comparing the sub-periods, the results also show that a more favourable credit rating status has lessened the importance of the VIX index in influencing bond yields. In the first sub-period, a 1 unit change in the

VIX index would escalate the change of the bond yields by 9.5 bps (column 2.4c) and 9.4 bps (column 2.4d). In the last sub-period, a similar change would effect an increase in the change of the bond yields by 1.7 bps. However, the result is not statistically not significant.

Table 2.4: The OLS output – assessing the bond yields' determinants, at the 1st difference

Dep. variable: Indonesia's 10-year bond yield: $\Delta IG10_t$	2004M03-2019M09	2004M03-2019M09	2004M03-2011M11	2004M03-2011M11	2011M12-2019M09
	(2.4a)	(2.4b)	(2.4c)	(2.4d)	(2.4e)
ΔVIX index$_t$	0.073***	0.072***	0.095***	0.094***	0.017
	(3.334)	(3.355)	(4.104)	(3.812)	(1.267)
ΔFORH$_{t-1}$: The foreign holdings' share$_{t-1}$	-0.016	-0.011	-0.082	-0.080	0.025
	(-0.326)	(-0.261)	(-0.945)	(-0.981)	(0.499)
ΔIDR tradable bonds over industrial output$_{t-1}$	0.200	0.203	-0.236	-0.221	0.733
	(0.609)	(0.618)	(-0.227)	(-0.221)	(1.599)
ΔGovernment loans over industrial output$_{t-1}$	0.545	0.557	0.887	0.883	-1.288
	(1.172)	(1.206)	(1.576)	(1.567)	(-1.131)
ΔThe forward point$_{t-1}$	-0.009	-0.011	-0.061	-0.061	0.028
	(-0.212)	(-0.235)	(-0.844)	(-0.832)	(0.570)
ΔInterbank offer rate$_{t-1}$	0.083	0.079	0.116	0.114	0.136
	(0.526)	(0.504)	(0.477)	(0.468)	(1.044)
ΔInflation rate expectation$_{t-1}$	-0.028	-0.025	-0.045	-0.044	0.052
	(-0.678)	(-0.651)	(-0.881)	(-0.893)	(0.805)
ΔUS 10-year bond yield$_{t-1}$	0.682**	0.700***	0.819**	0.824**	0.639***
	(2.490)	(2.623)	(2.077)	(2.081)	(2.674)
Dummy variable: Investment grade status	0.062	0.073	-	-	-
	(0.676)	(0.869)	-	-	-
Dummy variable: The subprime mortgage crisis	-	0.156	-	0.043	-
	-	(0.259)	-	(0.076)	-
Constant	-0.036	-0.047	-0.008	-0.012	-0.015
	(-0.439)	(-0.651)	(-0.091)	(-0.143)	(-0.367)
Observations	185	185	91	91	94
R^2	0.306	0.308	0.401	0.401	0.170
Adjusted R^2	0.271	0.268	0.343	0.335	0.091
Multicollinearity test: Variance Inflation Factors					
ΔVIX index$_t$	1.09	1.14	1.12	1.18	1.14
ΔFORH$_{t-1}$: The foreign holdings' share$_{t-1}$	1.14	1.17	1.35	1.39	1.22
ΔIDR tradable bonds over industrial output$_{t-1}$	1.78	1.78	2.79	2.82	3.31
ΔGovernment loans over industrial output$_{t-1}$	1.69	1.70	2.51	2.52	3.18
ΔThe forward point$_{t-1}$	1.12	1.12	1.33	1.33	1.07
ΔInterbank offer rate$_{t-1}$	1.17	1.18	1.36	1.36	1.09
ΔInflation rate expectation$_{t-1}$	1.12	1.13	1.22	1.23	1.10
ΔUS 10-year bond yield$_{t-1}$	1.03	1.06	1.06	1.08	1.25
Dummy variable: Investment grade status	1.02	1.07	-	-	-
Dummy variable: The subprime mortgage crisis	-	1.16	-	1.17	-

[1]***, **, * denote significance at 1%, 5%, 10% respectively. [2]*t-statistics* in parentheses. [3] 2004M03–2019M09: a whole sample period of observation, 2004M03–2011M11: non-investment grade period, and 2011M12–2019M09: investment grade period.

The importance of the credit rating status also could be seen in the relationships between the changes in the U.S. bond yields at $t-1$ and Indonesia bond yields at t in different sub-periods. In the first sub-period, a 1% change in the U.S. bond yields is associated with an increase in the change of Indonesia's bond yields by 81.9 bps (column 2.4c) and 82.4 bps (column 2.4d), while in the last sub-period by 63.9 bps (column 2.4e). It means that the increase to a higher level of credit rating status would lessen the dependency of Indonesia's bond yields on the U.S. bond yields. As in the whole observable period, the positive relationship between those variables is also statistically significant. A 1% change in the U.S. bond

yields would raise Indonesia's bond yields by 68.2 bps (column 2.4a) and 70.0 bps (column 2.4b). As for the relationships between the changes in Indonesia's bond yields and the other independent variables, the results will not be explored even further since they are not statistically significant.

Table 2.5: The ARDL outputs – assessing the bond yields' determinants

Dep. variable: ΔIndonesia's 10-year bond yields$_t$	2004M03–2019M09	2004M03–2019M09	2004M03–2011M11	2004M03–2011M11	2011M12–2019M09
The long-run	(2.5a)	(2.5b)	(2.5c)	(2.5d)	(2.5e)
VIX index$_t$	0.037	-0.050	0.026	-0.006	0.029
	(0.551)	(-0.584)	(0.741)	(-0.131)	(0.543)
FORH$_{t-1}$: The foreign holdings' share$_{t-1}$	-0.207**	-0.185**	0.026	0.036	0.088
	(-2.270)	(-2.214)	(0.369)	(0.501)	(0.578)
IDR tradable bonds over industrial output$_{t-1}$	0.698	0.135	-6.166***	-6.574***	0.473
	(0.695)	(0.142)	(-2.781)	(-2.857)	(0.622)
Government loans over industrial output$_{t-1}$	0.281	-0.429	3.773***	3.426***	-0.149
	(0.151)	(-0.245)	(3.312)	(3.039)	(-0.072)
The forward point$_{t-1}$	-0.531	-0.797	-0.567*	-0.724**	0.163
	(-0.967)	(-1.364)	(-1.925)	(-2.241)	(0.604)
Interbank offer rate$_{t-1}$	0.318	0.202	0.461**	0.431*	0.294
	(0.847)	(0.535)	(2.054)	(1.898)	(1.059)
Inflation rate expectation$_{t-1}$	0.063	0.013	-0.039	-0.049	0.358*
	(0.297)	(0.065)	(-0.330)	(-0.414)	(1.708)
US 10-year bond yield$_{t-1}$	-1.157	-1.111	-1.992***	-2.124***	0.233
	(-1.163)	(-1.183)	(-3.047)	(-3.105)	(0.454)
Error correction term$_{t-1}$	-0.138**	-0.142**	-0.403***	-0.392***	-0.269**
	(-2.320)	(-2.431)	(-4.336)	(-4.287)	(-2.158)
The short-run	(2.5f)	(2.5g)	(2.5h)	(2.5i)	(2.5j)
ΔVIX index$_t$	0.072***	0.070***	0.082***	0.080***	0.014
	(5.492)	(5.427)	(4.230)	(4.218)	(0.880)
ΔFORH$_{t-1}$: The foreign holdings' share$_{t-1}$	-0.041	-0.055	-0.131	-0.165*	-0.028
	(-0.767)	(-1.042)	(-1.526)	(-1.926)	(-0.459)
ΔIDR tradable bonds over industrial output$_{t-1}$	0.152	0.203	1.639	1.951*	0.519
	(0.377)	(0.512)	(1.541)	(1.846)	(1.109)
ΔGovernment loans over industrial output$_{t-1}$	0.378	0.431	-1.012	-1.050	-0.932
	(0.857)	(0.996)	(-1.474)	(-1.557)	(-0.744)
ΔThe forward point$_{t-1}$	0.027	0.038	0.097	0.114	-0.000
	(0.527)	(0.763)	(1.208)	(1.434)	(-0.001)
ΔInterbank offer rate$_{t-1}$	0.209*	0.213*	0.518***	0.517***	0.143
	(1.866)	(1.933)	(3.040)	(3.091)	(0.981)
ΔInflation rate expectation$_{t-1}$	-0.038	-0.030	-0.068	-0.062	-0.015
	(-0.789)	(-0.645)	(-1.177)	(-1.085)	(-0.178)
ΔUS 10-year bond yield$_{t-1}$	0.729***	0.745***	1.126***	1.173***	0.516*
	(3.829)	(3.987)	(4.427)	(4.673)	(1.948)
Dummy variable: Investment grade status	-0.017	-0.138	-	-	-
	(-0.068)	(-0.565)	-	-	-
Dummy variable: The subprime mortgage crisis	-	0.991***	-	0.843*	-
	-	(2.695)	-	(1.932)	-
Constant	1.701	2.542**	6.886***	7.928***	-0.524
	(1.514)	(2.217)	(3.238)	(3.676)	(-0.184)
Observations	185	185	91	91	94
Adjusted R^2	0.304	0.330	0.539	0.556	0.125
Root Mean Square Error	0.571	0.560	0.599	0.588	0.387
Long-run relationships	Yes	Yes	Yes	Yes	Yes
Autocorrelation	No	No	No	No	No
Stability (no structural break)	Yes	Yes	Yes	Yes	Yes

[1] ***, **, * denote significance at 1%, 5%, 10% respectively. *t-statistics* in parentheses. [2] All regressors are lagged 1 period, except VIX index. [3] 2004M03–2019M09: a whole sample period of observation, 2004M03–2011M11: non-investment grade period, and 2011M12–2019M09: investment grade period.

Further, as displayed in Table 2.5, the post-estimation tests show that all ARDL specifications have no issues with autocorrelation and stability. In addition, the long-run relationships between Indonesia's bond yields and the observable variables happen in the whole observable period and all sub-periods, whether with or without the inclusion of the dummy variables to the models. Regarding the speed of adjustment, the coefficients of the ECT in Table 2.5 columns 2.5a, 2.5b, 2.5c,

2.5d, and 2.5e suggest that any deviation from the long-run equilibrium between variables are corrected at about 13.8%, 14.2%, 40.3%, 39.2%, and 26.9% in each month. Relatively similar to Table 2.3, a negative relationship between the share of foreign holdings and the yield can be found in the whole period, particularly in the long run. A 1% increase in their share at $t-1$ could lead to a decrease of the yields by 20.7 bps (column 2.5a) and 18.5 bps (column 2.5b) at t.

Holding all other variables are constant, columns 2.5c and 2.5d also show that a higher ratio between IDR tradable bonds over industrial outputs at $t-1$ could reduce the bond yields at t in the first sub-period. But such a negative relationship cannot be found in a relationship between the ratio of government loans over industrial output at $t-1$ and the bond yields at t. A higher number of the latter ratio at $t-1$ is associated with a raise in the bond yields at t. Further, in the first sub-period of the ARDL specification, a positive relationship also can be found in the relationship between the interbank offer rate at $t-1$ and the bond yields at t. It suggests that a rise in the short-term rate in the previous period could drive higher bond yields in the current period. Especially about a negative relationship between the U.S. 10-year bond yields at $t-1$ and Indonesia's bond yields at t, it is against the initial hypothesis that an increase in the risk-free asset at $t-1$ would drive foreign investors to ask more premiums so that will increase the bond yields at t. Nevertheless, the VIX index, as the main variable of the study, does not appear to influence Indonesia's 10-year bond yields. The results are different to the OLS outputs, as shown in Table 2.3.

In addition, the findings obtained from the OLS at the first difference and the ARDL's short-run relationship specifications are also compared. In these specifications, a similar pattern where the relationship between the VIX index and the bond yields is significantly positive in the whole period of observation and the first sub-period can be found. Columns 2.5f, 2.5g, 2.5h, and 2.5i of Table 2.5 provide evidence that a 1-unit change in the VIX index at t generates 7.0-8.2 bps changes

in the bond yields at t. Similar to the outputs presented in column 2.4e of Table 2.4, the ARDL approach also could not find convincing evidence that there is a positive relationship between the VIX index and the bond yields in the last sub-period. It highlights the finding that, since an upgrade to the investment-grade status, the VIX index has lost its influence in driving the performance of the bond yields.

Furthermore, by using the ARDL approach, a consistent positive relationship between yields on government bonds issued by Indonesia and the U.S., which is categorised as a risk-free asset, can be found in all periods of observations, even though in the last sub-period, it is statistically significant at 10% level. A 1% change in the US 10-year bond yields would generate an increase in the change of the bond yields by 51.6-117.3 bps. Lastly, regarding a dummy variable that reflects the subprime mortgage crisis, the output obtained from the ARDL approach confirms that a worsening global financial market could increase the bond yields by 99.1 bps (column 2.5g).

2.6 An alternative method

2.6.1 Working models

In aiming to exercise another approach other than the OLS and ARDL, in this section, a 2SLS method is utilised. In particular, a strong negative relationship between the foreign holdings' share at $t-1$ and the bond yields at t in the whole period of observation as presented in columns 2.3a and 2.3b of Table 2.3 and columns 2.5a and 2.5b of Table 2.5 may not be causal due to omitted variables. In employing the method, I use several instrumental variables that I argue are related to the share of foreign holdings (FORH), but are not directly related to Indonesia's local currency 10-year bond yields (IG10). Considering the data availability, the

instruments that will be used are the average ratings and outlooks from Fitch Ratings, Moody's Investors Service, and S&P Global ratings at the end of the month of the peer countries that are located in a similar region with Indonesia. The peer countries are Malaysia, the Philippines, and Thailand. The hypothesis is that any development of their ratings, particularly a downgrade or negative outlook, would impact foreign investors' behaviour, who are thinking of investing in bonds issued by governments of ASEAN members in general, including Indonesia.

Due to the model's feature, where the share of foreign holdings at $t-1$ is assigned as the dependent variable in the first stage regression, the variable of interest to represent the risk, the VIX index, is lagged by one period, $t-1$. This particular approach is different from the OLS and ARDL models used previously. The instrumental variables are explored to predict the share of foreign holdings at $t-1$, then lagged by two periods (at $t-2$) to address the endogeneity issue. Therefore, in the 2SLS framework, this study includes those variables to find the effect of the share of the foreign investors' holdings (FORH) at $t-1$ on the bond yields (IG10) at t. It is also worth mentioning that following the approach, the models used in this 2SLS framework are relatively different from those utilised in the previous section and could yield different results. Formally, the models are defined as follows:

$$\widehat{\text{FORH}}_{t-1} = \widehat{\pi}_0 + \widehat{\pi}_1 \text{VIXI}_{t-1} + \widehat{\vartheta}_2 \Gamma_{t-1} + \widehat{\zeta}_3 \Lambda_{t-1} + \mu_t \tag{2.8}$$

as the first stage (reduced regression) where the endogenous explanatory variables FORH_{t-1} are predicted using Λ_{t-1}, a 3 x one-dimensional vector of a combination of the credit ratings of Malaysia, the Philippines, and Thailand in period $t-2$ (i.e., MART_{t-2}, PHRT_{t-2}, and THRT_{t-2}). In this combination, only a dummy variable that represents an investment grade status (DMRT) is included because it is related to the differentiation of the whole period into two sub-periods. Then

another step is to develop the second-stage regression where FORH_{t-1} in Equation 2.5 are replaced by their predictions obtained from Equation 2.8. The final model is defined as follows:

$$\text{IG10}_t = \beta_0 + \beta_1 \text{VIXI}_{t-1} + \beta_2 \widehat{\text{FORH}}_{t-1} + \eta \Gamma_{t-1} + \epsilon_t \tag{2.9}$$

where Γ_{t-1} are a 6 x one-dimensional vector of the control variables, which are TOID_{t-1}, LOID_{t-1}, EXFP_{t-1}, IBOR_{t-1}, IDIE_{t-1}, and UG10_{t-1}. Specifically, the dummy variable investment grade at $t-1$ is included in the whole period. Further, to be considered a good model, Ullah et al. (2021) suggest that each model needs to satisfy several post-estimation tests: (i) an endogeneity test to check for possible endogeneity issues (the null hypothesis needs to be accepted); (ii) a weak instrument test to investigate the relevancy of the instruments, where they must be strongly correlated with the endogenous variable but should be uncorrelated with the error term (the null hypothesis needs to be rejected); and (iii) an over-identification test to check the validity of the instruments (the null hypothesis needs to be accepted). Besides, the F-statistics from the first-stage regression also could be analysed to understand the relevance of the instruments. A higher F-statistics means that the instruments could be used in the 2SLS regression.

2.6.2 Statistical results

The 2SLS outputs must satisfy the endogeneity, weak instrument, and over-identification tests to be considered a good model. Then, following the choice of instrumental variables explained in the previous section, the analysis will be referred to a model where the instrument variables to define the share of foreign investors' holdings consist of the average ratings and outlooks from Fitch, Moody's, and S&P for Malaysia, Philippines, and Thailand. Those variables are lagged by two periods

to address the endogeneity issue. In particular, the inclusion of the peer countries' average ratings and outlooks is based on an assumption a contagion effect could be a push factor in controlling the capital flow (Forbes and Warnock, 2011) because these countries, similar to Indonesia, are affiliated with a regional grouping called the Association of Southeast Asian Nations (ASEAN) that fosters economic coordination among their members. Then, following this model, as displayed in Table 2.6, the overall signs of the coefficients suggest that the share of foreign investors' holdings, relative to the total outstanding of the local-currency domestic tradable bonds, has a negative relationship with the bond yields. Meanwhile, the VIX index has a positive relationship. However, those findings are statistically weaker than the results obtained from the OLS and ARDL.

Further, considering the post-estimation tests' results, it appears that the outputs in the whole period of observation tend to be more convincing statistically. In this model, the tests show evidence that the instrument variables are exogenous, strong, and valid (at a 5% level). In particular, column 2.6a of Table 2.6 shows the first stage of instrumental variables for the foreign holdings' share. The average ratings and outlooks assigned for Malaysia at $t-2$ appear to affect the foreign investors' decision to invest in Indonesia's domestic bond market at $t-1$. Since the relationships between the instrumental variable and the share of foreign investors' holdings are statistically proven to be positive, the interpretation is that a 1 unit increase in Malaysia's average ratings and outlooks could raise the share by 12.6%. When Malaysia's default probability declined (represented by the increase in their ratings and outlooks), foreign investors' confidence in investing in Indonesia's domestic bonds market also increased. Accordingly, they reallocated their investment to Indonesia, considering both countries are located in Southeast Asia and members of ASEAN.

Table 2.6: The 2SLS output – assessing the bond yields' determinants

	2004M03–2019M09		2004M03–2011M11		2011M12–2019M09	
	$\widehat{\text{FORH}}_{t-1}$	IV: IG10$_t$	$\widehat{\text{FORH}}_{t-1}$	IV: IG10$_t$	$\widehat{\text{FORH}}_{t-1}$	IV: IG10$_t$
	(2.6a)	(2.6b)	(2.6c)	(2.6d)	(2.6e)	(2.6f)
VIX index$_{t-1}$	0.067	0.032*	0.148***	0.018	-0.005	0.019*
	(1.170)	(1.790)	(3.632)	(0.579)	(-0.109)	(1.700)
IDR tradable bonds over industrial output$_{t-1}$	5.864***	-0.054	24.565***	-3.027**	-0.232	-0.003
	(6.460)	(-0.194)	(18.248)	(-2.085)	(-0.449)	(-0.021)
Government loans over industrial output$_{t-1}$	-5.242***	0.615	-5.600***	3.280***	-10.139***	-1.620*
	(-3.201)	(0.875)	(-4.363)	(3.879)	(-7.382)	(-1.780)
The forward point$_{t-1}$	-0.621**	0.192	0.022	0.122	-0.243	0.145***
	(-2.025)	(1.620)	(0.082)	(0.585)	(-1.619)	(2.644)
Interbank offer rate$_{t-1}$	-0.809***	0.591***	0.204	0.488***	-0.047	0.530***
	(-2.727)	(7.683)	(0.669)	(3.430)	(-0.278)	(10.550)
Inflation rate expectation$_{t-1}$	0.480***	-0.056	-0.083	-0.066	-0.253**	0.130**
	(2.963)	(-1.081)	(-0.500)	(-0.941)	(-2.119)	(2.572)
US 10-year bond yield$_{t-1}$	-3.556***	0.579***	1.233*	-0.328	-1.349***	0.241
	(-5.515)	(2.771)	(1.668)	(-0.883)	(-3.082)	(1.511)
The predicted value of the foreign holdings' share (FORH)$_{t-1}$	-	-0.039	-	0.012	-	-0.080
	-	(-1.080)	-	(0.237)	-	(-0.964)
IV: Malaysia's credit ratings and outlooks, on average$_{t-2}$	12.626***	-	5.168***	-	5.537***	-
	(10.355)	-	(3.686)	-	(3.637)	-
IV: Thailand's credit ratings and outlooks, on average$_{t-2}$	-0.190	-	2.317***	-	-	-
	(-0.157)	-	(3.202)	-	-	-
IV: The Philippines's credit ratings and outlooks, on average$_{t-2}$	0.737*	-	-0.579*	-	0.248	-
	(1.814)	-	(-1.702)	-	(0.470)	-
Dummy variable: Investment grade period (IG)$_{t-1}$	-1.329	0.530	-	-	-	-
	(-0.569)	(1.068)	-	-	-	-
Constant	-159.217***	1.852	-134.080***	5.151	-27.405	7.950
	(-6.748)	(0.624)	(-6.783)	(1.258)	(-1.455)	(1.614)
Observations	185		91		94	
R^2	0.912	0.809	0.948	0.741	0.885	0.790
Adjusted R^2	0.906	0.799	0.942	0.716	0.873	0.771
F-statistics	-	38.092	-	19.609	-	21.051
Endogeneity test: Durbin-Watson	-	0.117	-	0.018	-	0.449
Endogeneity test: Wu-Hausman	-	0.124	-	0.028	-	0.471
Weak test: the foreign holdings' share$_{t-1}$	-	0.000	-	0.000	-	0.000
Over-identification test	-	0.053	-	0.007	-	0.005

[1] ***, **, * denote significance at 1%, 5%, 10% respectively. [2] *t-statistics* in parentheses. [3] 2004M03–2019M09: a whole sample period of observation, 2004M03–2011M11: non-investment grade period, and 2011M12–2019M09: investment grade period. [4] Endogeneity test: H_0: variables are exogeneous. [5] Weak test: H_0: instruments are weak. [6] Over-identification test: H_0: instruments are valid.

Further, other results provided by the 2SLS specification reveal that the interbank offer rate and the U.S. bond yields at $t-1$ are proven to determine the bond yields at t in the whole period. In column 2.6b of Table 2.6, the interbank offer rate has a positive relationship with Indonesia's 10-year bond yields, where a 1% increase of the variable would generate a rise in Indonesia's 10-year bond yields by 59.1 bps. The result is in line with Warnock and Warnock (2009)'s report that finds a 1% increase in the 3-month interest rate could be associated with a raise of the domestic bond yields by 37 bps. Meanwhile, a 1% hike in the U.S. bond yields with similar maturity would increase Indonesia's 10-year bond yields by 57.9 bps. Those results are consistent with the findings from the OLS regression as presented in columns 2.3a and 2.3b of Table 2.3.

2.7 Discussions

In this part, basically, similar frameworks defined in Equations 2.8 and 2.9 are employed. However, foreign investors are divided into two types: central banks/-governments (the officials) and non-central banks/governments (the privates). Due to their characteristic, the former type of foreign investors is expected to be less sensitive to sudden and unexpected events in the global financial market. In addition, taking into account the data availability, the study can only cover a period from February 2013 to September 2019, when Indonesia is categorised as one of the sovereigns with an investment grade status.

As displayed in column 2.7a of Table 2.7, it appears that the officials' decision to invest in Indonesia's bond market tends to be influenced by Malaysia's and the Philippines's domestic risks. An upgrade in those countries' ratings and outlooks would lead the officials to increase their shares in Indonesia's bonds market. Meanwhile, column 2.7b of Table 2.7 shows that the privates' decisions would be driven only by Malaysia's domestic risks. A 1 unit increase in Malaysia's rating

and outlooks could push their confidence in Indonesia's government bonds by increasing their shares in the market. Nevertheless, in column 2.7c of Table 2.7, any compelling evidence showing the shares of their holdings have an impact on the bond yields from February 2013 to September 2019 cannot be found. Perhaps, more observations are needed to capture their roles in determining the bond yields. Hence, the results are quite different to Beltran et al. (2013)'s study, which explains a close relationship between the officials' ownership and the yield of the UST 5-year in the short-run and long-run.

Table 2.7: The 2SLS output – assessing the bond yields' determinants, disaggregating foreign investors, investment grade period (Feb. 2013 - Sep. 2019)

	$\widehat{\text{FCBP}}_{t-1}$	$\widehat{\text{FNBP}}_{t-1}$	IV: IG10$_t$
	(2.7a)	(2.7b)	(2.7c)
VIX index$_{t-1}$	-0.013	0.001	-0.002
	(-1.327)	(0.027)	(-0.109)
IDR tradable bonds over industrial output$_{t-1}$	-0.553***	0.417	0.015
	(-3.401)	(0.737)	(0.028)
Government loans over industrial output$_{t-1}$	-0.082	-11.352***	-7.098***
	(-0.182)	(-7.059)	(-2.708)
The forward point$_{t-1}$	-0.014	-0.168	-0.002
	(-0.256)	(-1.184)	(-0.019)
Interbank offer rate$_{t-1}$	0.163***	-0.260	0.173
	(3.132)	(-1.582)	(0.903)
Inflation rate expectation$_{t-1}$	0.043	-0.253**	-0.122
	(0.991)	(-2.396)	(-1.081)
US 10-year bond yield$_{t-1}$	0.030	-1.647***	-0.695
	(0.406)	(-3.856)	(-1.087)
The predicted value of the foreign: central bank/government holdings' share (FCBP)$_{t-1}$	-	-	0.751
	-	-	(1.412)
The predicted value of the foreign: non-central bank/government holdings' share (FNBP)$_{t-1}$	-	-	-0.597**
	-	-	(-2.264)
IV: Malaysia's credit ratings and outlooks, on average$_{t-2}$	1.362***	5.058***	-
	(3.621)	(3.354)	-
IV: Thailand's credit ratings and outlooks, on average$_{t-2}$	-	-	-
	-	-	-
IV: The Philippines's credit ratings and outlooks, on average$_{t-2}$	0.299**	-0.623	-
	(2.646)	(-1.258)	-
Constant	-16.187***	-14.712	32.399***
	(-3.219)	(-0.781)	(2.868)
Observations		79	
R^2	0.761	0.867	0.175
Adjusted R^2	0.730	0.850	0.067
F-statistics: FCBP$_{t-1}$	-	-	23.947
F-statistics: FNBP$_{t-1}$	-	-	8.659
Endogeneity test: Durbin-Watson	-	-	0.000
Endogeneity test: Wu-Hausman	-	-	0.000
Weak test: FCBP$_{t-1}$	-	-	0.000
Weak test: FNBP$_{t-1}$	-	-	0.000
Over-identification test	-	-	-

[1] ***, **, * denote significance at 1%, 5%, 10% respectively. *t-statistics* in parentheses. [2] Endogeneity test: H_0: variables are exogeneous. [3] Weak test: H_0: instruments are weak. [4] Over-identification test: H_0: instruments are valid.

2.8 Conclusions

In this chapter, a monthly data set from March 2004 to September 2019 is used to investigate the determinants of Indonesia's 10-year bond yields. To this aim, time-series methodologies of ordinary least squares (OLS), autoregressive distributed lag (ARDL), and two-stage least squares (2SLS) are employed. In addition, following the development in the global financial market and Indonesia's credit ratings, the observable period is differentiated into two sub-periods: non-investment grade (March 2004-November 2011) and investment-grade (December 2011-September 2019). Specifically, the objectives of the differentiation are to understand whether the investment-grade status would lessen the impact of the global financial risk on the domestic market and raise the attractiveness of the Indonesian bonds market.

In general, the results from the OLS and the ARDL methods show that global financial market conditions and sovereign rating status have an important role in influencing the local-currency bond yields in an emerging market. In particular, the VIX index's effect is prominent in the sub-period when Indonesia's credit rating was still below the investment grade and less significant in the sub-period when Indonesia's credit rating has been upgraded to the investment grade by at least one credit rating agency.

The utilisation of OLS regression on the observable variables, at the level and the first difference, and ARDL specifications, to capture long-run and short-run relationships, reveals inconsistent results on the relationships between the participation of foreign investors in the previous period and the bond yields in the current period. By observing the observable variables at the level, the OLS outputs show a significant negative relationship between foreign holdings' share at $t-1$ and bond yields at t in the period from March 2004 to September 2019. This finding also can be found in the long-run relationship obtained from the ARDL specification in a similar period of observation, which indicates higher participation of foreign

investors in the domestic bond market would be followed by reduced bond yields in the secondary market. The economic mechanism is because they often have more experience in the global markets than local investors, which can support their understanding in assessing the risks and opportunities in the domestic market. Accordingly, foreign investors can improve the overall quality of the market by providing more transparent and reliable pricing, thus contributing to a more developed domestic market that can push the bond yields to be lower than a less developed market. Although the study has focused on Indonesia, which has been exposed to the development in the sovereign credit rating status, the statistical result is consistent with the previous literature (Peiris (2013), Ebeke and Lu (2015), and Andritzky (2012)).

However, such a condition cannot be found in other OLS specifications at the level that examine two different sub-periods, from March 2004 to November 2011 and from December 2011 to September 2019. In the former period, the result is not reliable because of the multicollinearity issue, even though the coefficient's sign is negative and significant. Meanwhile, in the latter, it is because the negative coefficient is not statistically significant. Likewise, the employments of the OLS regression on the first difference of the observable variables and the outcomes obtained from the short-run relationship of the ARDL specification do not support the finding that higher foreign investors' participation contributes to lower bond yields because the coefficients are not statistically significant in all periods of observations (i.e., the whole period and the sub-periods). Moreover, different from the other coefficients that suggest negative relationships, the OLS regression on the first difference that observe a period from December 2011 to September 2019 yields a positive relationship between foreign holdings' share at $t-1$ and bond yields at t. But the result is not discussed even further since it is not statistically significant.

Further, the assignments of the peer countries' ratings and outlooks as the instruments in the 2SLS specification expose another finding. From March 2004 to September 2019, it appears that Malaysia's domestic condition is considered important by foreign investors to manage their portfolios. An upgrade in their ratings and outlooks (on average) would drive foreign investors to reallocate more funds to Indonesia's bonds market. Nevertheless, the utilisation of the 2SLS approach cannot strengthen the main findings obtained from the OLS and ARDL, where heightened uncertainty in the global financial market would harm the domestic bonds market and higher participation of foreign investors in Indonesia's local currency bonds market would lessen the bond yields.

Additionally, another result is different from Beltran et al. (2013)'s study that explains a close relationship between the officials' ownership and the yield of the UST 5-year in the short-run and long-run. By differentiating the foreign investors into the privates and the officials, the statistical output finds that such a relationship did not exist in Indonesia's bonds market from February 2013 to September 2019. In conclusion, even though the average share of the foreign investors' holdings peaked at around 40%, their participation in the secondary market benefits the development of the government bonds market in Indonesia and cannot be overlooked.

For future research, following the role of foreign investors that might influence the development of the domestic bonds market, another approach could be explored by using vector autoregression (VAR) then followed by impulse response function (IRF) analysis. By using those approaches, the effect of a shock in foreign holdings' share on the bond yields could be investigated even further. In addition, it could be interesting as well to extend the observable period in order to understand whether the findings are held after the shocks in the financial market due to the spread of coronavirus, which was declared by the World Health Organisation as a worldwide pandemic on 11 March 2020.

2.9 Appendix

2.9.1 Tables

Table 2.8: Description of variables

Code	Definition	Measurement unit	Data sources
IG10	Generic bid yields of local currency 10-year government bonds (constant maturity in approximate 10 years), end of the month.	In percentage	Bloomberg
FORH	All foreign investors' ownership in tradable Indonesian rupiah government bonds - the share over total tradable, end of the month.	In percentage	Indonesia MoF
FCBP	Foreign central banks/governments' ownership in tradable Indonesian rupiah government bonds - the share over total tradable.	In percentage	Indonesia MoF
FNBP	Foreign non-central banks/governments' ownership in tradable Indonesian rupiah government bonds - the share over total tradable.	In percentage	Indonesia MoF
VIXI	An index developed by the Chicago Board Options Exchange (CBOE) based on 30-day future S&P 500 index options; a proxy to capture global financial conditions, especially during financial anxiety. On average within a month.	Index	Reuters
TOID	The ratio of total Indonesia rupiah tradable bonds to industrial output; a proxy to measure the debt of GDP, end of the month.	A numerical	Indonesia MoF, World Bank
LOID	The ratio of government loans in any currencies to industrial output; another proxy to measure the debt of GDP, end of the month.	A numerical	Indonesia MoF, World Bank
IBOR	Interbank 3-month offer rate, end of the month. Indonesia's short-term interest rate.	In percentage	CEIC Data
IDIE	The average of expected inflation YoY according to Bloomberg's survey of domestic commercial banks' economists in Indonesia.	In percentage	Bloomberg
EXFP	A differential between spot exchange rate Indonesia rupiah (IDR)/US dollar (US$) and 1-month forward exchange rate IDR/US$ (the forward point) divided by the spot, end of the month.	In percentage	Bloomberg
UG10	Generic bid yields of the U.S. Treasury 10-year government bonds (constant maturity in approximate 10 years), end of the month.	In percentage	Bloomberg
RTNG	Indonesia sovereign rating development from Fitch, Moody's, and Standard and Poor's; incorporated with the outlook, end of the month. A numerical conversion is equivalent to the grade, on average.	A numerical	Bank Indonesia
MART	Malaysia's sovereign rating development from Fitch, Moody's, and Standard and Poor's; incorporated with the outlook. A numerical conversion is equivalent to the grade, on average at the end of the month.	A numerical	countryeconomy.com
PHRT	The Philippines's sovereign rating development from Fitch, Moody's, and Standard and Poor's; incorporated with the outlook. A numerical conversion is equivalent to the grade, on average at the end of the month.	A numerical	countryeconomy.com
THRT	Thailand's sovereign rating development from Fitch, Moody's, and Standard and Poor's; incorporated with the outlook. A numerical conversion is equivalent to the grade, on average at the end of the month.	A numerical	countryeconomy.com
DMRT	A dummy variable to represent Indonesia's investment grade status. Zero is the non-investment grade period (Mar-04 to Nov-11) and one is the investment grade period (Dec-11 to Sep-19).	A numerical	Author's calculation
DMCR	A dummy variable to represent the subprime mortgage crisis in 2008. Zero is non-crisis and one is in crisis (September 2008 to February 2009.	A numerical	Author's calculation, following Ahmed et al. (2017)

Table 2.9: The ratings and outlook conversions

Rating scale	Fitch	Moody's	S&P	Status
21	AAA	Aaa	AAA	Investment grade
20	AA+	Aa1	AA+	
19	AA	Aa2	AA	
18	AA-	Aa3	AA-	
17	A+	A1	A+	
16	A	A2	A	
15	A-	A3	A-	
14	BBB+	Baa1	BBB+	
13	BBB	Baa2	BBB	
12	BBB-	Baa3	BBB-	
11	BB+	Ba1	BB+	Speculative grade
10	BB	Ba2	BB	
9	BB-	Ba3	BB-	
8	B+	B1	B+	
7	B	B2	B	
6	B-	B3	B-	
5	CCC+	Caa1	CCC+	
4	CCC	Caa2	CCC	
3	CCC-	Caa3	CCC-	
2	CC	Ca	CC	
1	C - WD	C	R/SD/D	
0.25	Outlook: Positive			
0.00	Outlook: Stable			
-0.25	Outlook: Negative			

Table 2.10: Indonesia's ratings development

(a) Fitch

Announcement	Rating	Outlook
2-Apr-08	BB	Stable
25-Jan-10	BB+	Stable
24-Feb-11	BB+	Positive
15-Dec-11	BBB-	Stable
21-Dec-16	BBB-	Positive
20-Dec-17	BBB	Stable

(b) Moody's

Announcement	Rating	Outlook
2-Apr-08	Ba3	Stable
11-Jun-09	Ba3	Positive
16-Sep-09	Ba2	Stable
21-Jun-10	Ba2	Positive
17-Jan-11	Ba1	Stable
18-Jan-12	Baa3	Stable
8-Feb-17	Baa3	Positive
13-Apr-18	Baa2	Stable

(c) S&P

Announcement	Rating	Outlook
4-Apr-08	BB-	Stable
23-Oct-09	BB-	Positive
12-Mar-10	BB	Positive
8-Apr-11	BB+	Positive
2-May-13	BB+	Stable
21-May-15	BB+	Positive
19-May-17	BBB-	Stable
31-May-19	BBB	Stable

Table 2.11: The unit root test, Mar. 2004–Sep. 2019 (a whole sample period)

Variables		Lag	Obs.	Z(t)	p-val.
	at level				
IG10	Indonesia's 10-year bond yields	0	186	-2.11	0.24
FORH	The share of foreign holdings: All types	0	186	-1.89	0.34
FCBP	The share of foreign holdings: Central banks/governments	0	79	-2.35	0.16
FNBP	The share of foreign holdings: Non-central banks/governments	0	79	-1.55	0.51
VIXI	VIX index	0	186	-3.42	0.01
TOID	The ratio of total of government Indonesian rupiah tradable bonds to industrial output	0	186	-0.52	0.89
LOID	The ratio of total of government loans in any currencies to industrial output	0	186	-1.90	0.33
EXFP	The forward point (expected depreciation of the IDR/USD)	0	186	-7.98	0.00
IBOR	The interbank offer rate	0	186	-1.27	0.64
IDIE	The inflation rate expectation	0	186	-2.02	0.28
RTNG	Indonesia's credit ratings and outlooks, on average	0	186	-1.59	0.49
UG10	The US's 10-year bond yields	0	186	-1.44	0.57
MART	Malaysia's credit ratings and outlooks, on average	0	186	-4.19	0.00
PHRT	The philippines's credit ratings and outlooks, on average	0	186	-0.93	0.78
THRT	Thailands's credit ratings and outlooks, on average	0	186	-2.72	0.07
	at Δ: the 1^{st} difference of the level				
IG10	Indonesia's 10-year bond yields	0	185	-12.41	0.00
FORH	The share of foreign holdings: All types	0	185	-12.14	0.00
FCBP	The share of foreign holdings: Central banks/governments	0	78	-8.19	0.00
FNBP	The share of foreign holdings: Non-central banks/governments	0	78	-9.78	0.00
VIXI	VIX index	0	185	-12.41	0.00
TOID	The ratio of total of government Indonesian rupiah tradable bonds to industrial output	0	185	-19.13	0.00
LOID	The ratio of total of government loans in any currencies to industrial output	0	185	-17.37	0.00
EXFP	The forward point (expected depreciation of the IDR/USD)	0	185	-19.88	0.00
IBOR	The interbank offer rate	0	185	-6.92	0.00
IDIE	The inflation rate expectation	0	185	-10.12	0.00
RTNG	Indonesia's credit ratings and outlooks, on average	0	185	-12.52	0.00
UG10	The US's 10-year bond yields	0	185	-13.16	0.00
MART	Malaysia's credit ratings and outlooks, on average	0	185	-13.57	0.00
PHRT	The philippines's credit ratings and outlooks, on average	0	185	-13.24	0.00
THRT	Thailand's credit ratings and outlooks, on average	0	185	-13.92	0.00

Note: Variables which are stationary at the level: VIXI, EXFP, MART, and THRT. IDR refers to the currency of Indonesia, Indonesian rupiah, while USD refers to the US dollar.

Table 2.12: Cross-correlation table, at level: Mar. 2004–Sep. 2019

	IG10	FORH	FCBP	FNBP	VIXI	TOID	LOID	EXFP	IBOR	IDIE	RTNG	UG10	MART	PHRT	THRT
IG10	1.00	-0.14	0.52	-0.26	0.36	-0.34	-0.02	0.20	0.84	0.33	-0.18	0.25	0.15	0.19	-0.06
FORH	-0.14	1.00	-0.09	0.97	0.05	0.57	-0.79	-0.24	-0.05	-0.61	0.36	-0.30	0.13	0.52	0.08
FCBP	0.52	-0.09	1.00	-0.32	0.12	-0.62	0.32	0.24	0.57	0.58	-0.52	0.01	0.68	0.09	-0.07
FNBP	-0.26	0.97	-0.32	1.00	0.01	0.68	-0.83	-0.28	-0.18	-0.71	0.46	-0.29	-0.03	0.47	0.09
VIXI	0.36	0.05	0.12	0.01	1.00	-0.08	-0.12	0.03	0.25	0.01	0.10	-0.06	-0.05	0.25	0.12
TOID	-0.34	0.57	-0.62	0.68	-0.08	1.00	-0.76	-0.26	-0.30	-0.82	0.87	0.10	-0.32	0.53	0.24
LOID	-0.02	-0.79	0.32	-0.83	-0.12	-0.76	1.00	0.21	0.03	0.68	-0.71	-0.01	0.16	-0.64	-0.24
EXFP	0.20	-0.24	0.24	-0.28	0.03	-0.26	0.21	1.00	0.04	0.22	-0.16	0.09	0.05	0.00	-0.06
IBOR	0.84	-0.05	0.57	-0.18	0.25	-0.30	0.03	0.04	1.00	0.21	-0.22	0.15	0.29	0.15	-0.16
IDIE	0.33	-0.61	0.58	-0.71	0.01	-0.82	0.68	0.22	0.21	1.00	-0.63	0.06	0.25	-0.36	-0.11
RTNG	-0.18	0.36	-0.52	0.46	0.10	0.87	-0.71	-0.16	-0.22	-0.63	1.00	0.26	-0.30	0.68	0.35
UG10	0.25	-0.30	0.01	-0.29	-0.06	0.10	-0.01	0.09	0.15	0.06	0.26	1.00	-0.04	0.09	-0.28
MART	0.15	0.13	0.68	-0.03	-0.05	-0.32	0.16	0.05	0.29	0.25	-0.30	-0.04	1.00	0.28	-0.06
PHRT	0.19	0.52	0.09	0.47	0.25	0.53	-0.64	0.00	0.15	-0.36	0.68	0.09	0.28	1.00	0.34
THRT	-0.06	0.08	-0.07	0.09	0.12	0.24	-0.24	-0.06	-0.16	-0.11	0.35	-0.28	-0.06	0.34	1.00

Notes: IG10 : Indonesia's 10-year bond yields; FORH : The share of foreign holdings - All types; FCBP : The share of foreign holdings - Central banks/governments; FNBP : The share of foreign holdings - Non-central banks/governments; LOID : The ratio of total of government loans in any currencies to industrial output; TOID : The ratio of total of government Indonesian rupiah tradable bonds to industrial output; VIXI : VIX index; EXFP : The forward point (expected depreciation of the IDR/USD); IBOR : The interbank offer rate; IDIE : The inflation rate expectation; RTNG : Indonesia's credit ratings and outlooks, on average; UG10 : The US's 10-year bond yields; MART : Malaysia's credit ratings and outlooks, on average; PHRT : The philippines's credit ratings and outlooks, on average; THRT : Thailands's credit ratings and outlooks, on average

2.9.2 Figures

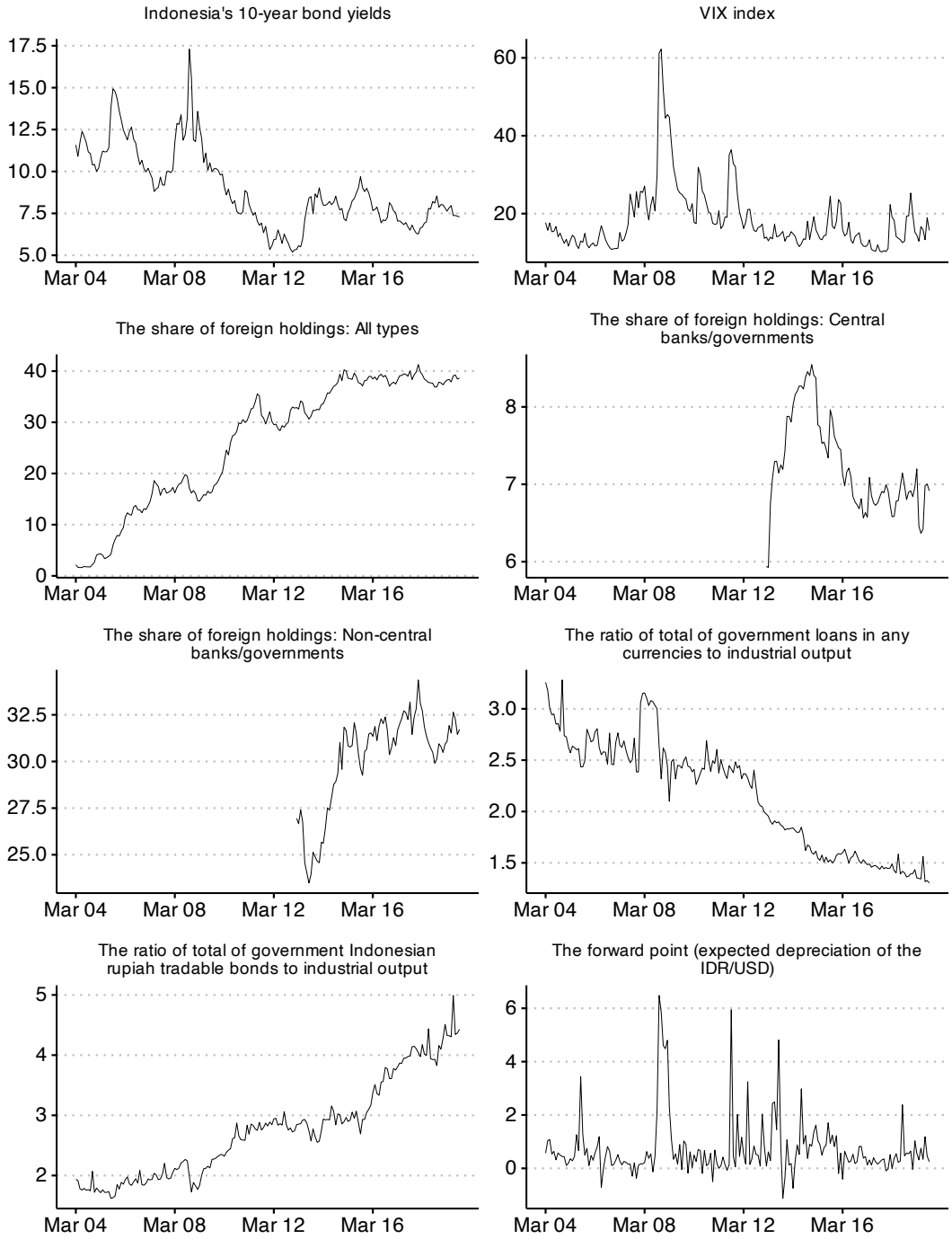


Figure 2.2: The observable variables, Mar. 2004–Sep. 2019

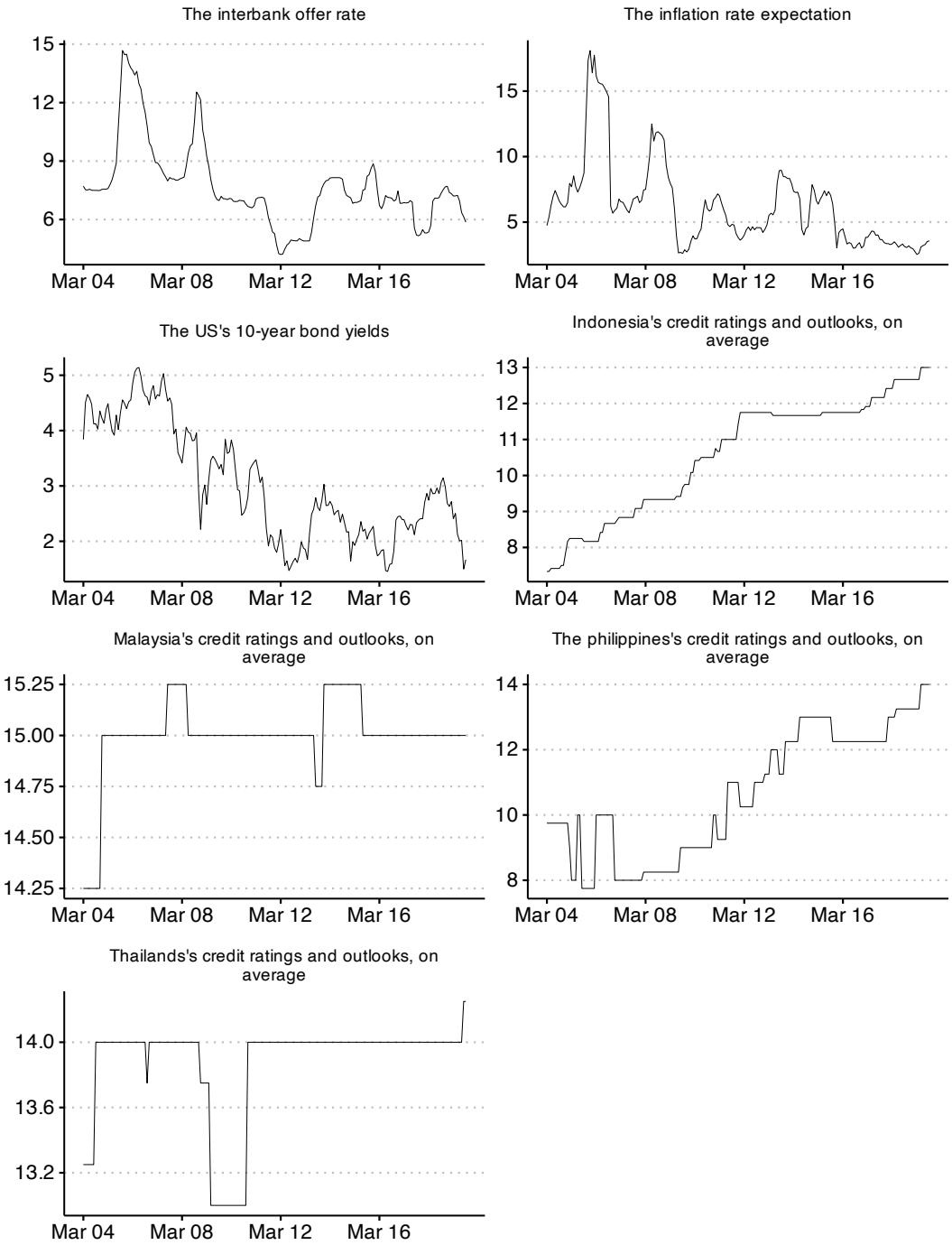


Figure 2.3: The observable variables, Mar. 2004–Sep. 2019 (cont.)

Chapter 3

Foreign investors and volatility in the local-currency government bond market

Contents

3.1 Introduction

Since the passage of Act number 24 of the year 2002 on Government Bonds, the role of the bonds in financing the budget deficit has become more critical than negotiating a new loan. Among others, the passage of the Act is intended to reduce the government's dependency on external financing that could be exposed to currency risk and provide more transparency on public debt management since the government needs to coordinate with the House of Representatives and the central bank to issue the bonds. Moreover, relying more on issuing bonds in the domestic market could widen the opportunity for the private sector to diversify their portfolios and encourage the development of the money market to provide more liquidity in the short term. Nevertheless, the financial market openness system, which Indonesia adopted, offers both benefits and risks in developing a resilient domestic bond market. On the one hand, if domestic investors tend to buy and hold (Peiris, 2013), the capital inflow provided by the foreign investors could develop the domestic market by increasing its liquidity. However, on the other hand, the greater flexibility of foreign investors in adjusting their portfolios could, in certain circumstances, cause sudden capital outflows as they reallocate their funds to a lower-risk market. Further, given that several episodes of financial stress happened between 2004 to 2019, policymakers in emerging markets worry that such episodes might damage the stability of the local-currency bond market. Consequently, a worsened condition in the market could divert the government's attention in executing its plans.

A number of papers suggest that some exogenous variables and different types of investors have often had significant effects on the stability of the domestic financial markets of emerging economies. In particular, some recent studies have focused on the following issues: the role of local investors in stabilising the market (e.g., Adam et al. (2014); Zhou et al. (2014); Adler et al. (2016)), the impact of foreign investors on the volatility of prices and yields (e.g., Peiris (2013); Ebeke

and Lu (2015)), the characteristics of the bondholders (e.g., Arslanalp and Tsuda (2014)), and global risk in determining capital flows (e.g., Forbes and Warnock (2011); Raddatz and Schmukler (2012); Puy (2016)). However, previous research findings are somewhat mixed on many issues, especially the relationship between foreign investors' participation and volatility.

For example, by compiling monthly data from 2000 to 2009 for ten large emerging markets (EMs)[1] and using a generalised conditional heteroscedasticity (GARCH) method, Peiris (2013) provides statistical evidence that foreign investors' participation in the local currency bond market has enhanced volatility in South Korea and reduced it in Malaysia, Mexico, and Turkey. In comparison, the authors cannot find similar evidence in other observable countries, including Indonesia and Poland. Nevertheless, a later study conducted by Ebeke and Lu (2015) on 13 EMs[2] from Q2-2004 to Q2-2013 tends to strengthen the findings that foreign ownership has a positive relationship with the bond yields volatility. Further, by utilising a GARCH model and a higher frequency dataset from December 2004 to August 2013 in the Polish bond market, they found no evidence that foreign holdings would influence the bond volatility during the whole sample period. Nonetheless, when the sample is restricted to a period after the subprime mortgage crisis, from December 2008 to July 2013, the results show a positive relationship where higher foreign investors' holdings in the local currency bond market seem to lead to a rise in bond volatility.

Additionally, according to Zhou et al. (2014), who investigates the capital flow and the volatility using 400 international mutual funds and 540 Mexican mutual funds from January 2007 to April 2014, foreign mutual funds investors (bond and equity) tended to follow their peers' decision to sell the assets compared to domestic investors (70% vs 50%) and the behaviour escalated drastically around heightened

[1]Brazil, Czech Republic, Hungary, Indonesia, Malaysia, Mexico, Poland, South Korea, Thailand, and Turkey

[2]Brazil, Czech Republic, Hungary, Indonesia, Republic of Korea, Malaysia, Mexico, Poland, Slovakia, South Africa, Thailand, and Turkey

market volatility in 2013 due to the U.S. Federal Reserve's announcement about tapering. Moreover, by relying on bondholders' data at daily and weekly frequency covering 2000-2014 and employing both an ordinary least squares (OLS) model and a GARCH model[3], they conclude that the participation of foreign investors in the domestic market could enhance volatility because they tend to be more sensitive to the latest conditions in the global market than domestic investor because of the home bias and their policies in allocating the assets. They also find that domestic investors play different roles in mitigating the volatility: banks appear to escalate volatility during normal times but then, along with pension funds, soften the volatility during the stress caused by the shock in the CBOE volatility index (VIX index), which is often regarded as a measure of global risk appetite. To measure the effect on volatility, their study relies on the relationship between the standard deviation of the 10-year local-currency bond yields and the interaction between the share of each type of foreign investors' ownership, the global financial shock indicator, and a dummy variable of the period with extreme capital flows (stress period).

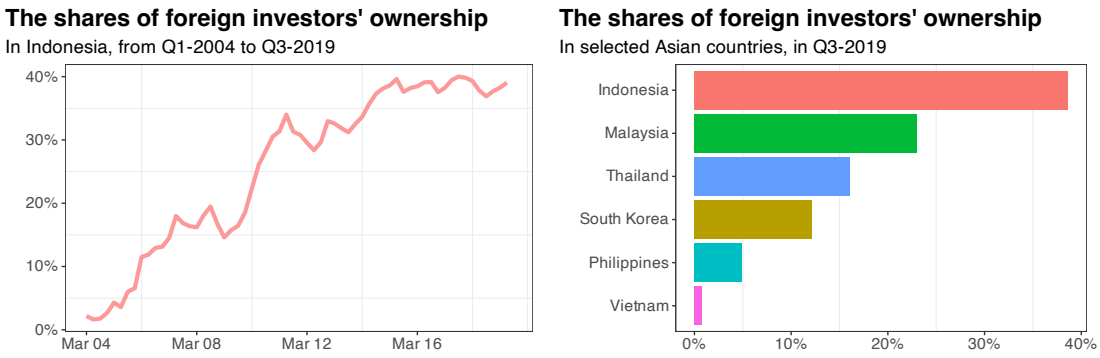


Figure 3.1: The shares of foreign investors' ownership in Asian bonds market.

[3]In their models, volatility of the Mexican 10-year local-currency bond yields is assigned as the dependent variable and defined by (i) within-week volatility: the standard deviation of daily yields within a week, divided by the weekly mean; and (ii) 5-day rolling volatility: the standard deviation of daily yields in the last five days, divided by the mean in those five days. As for the independent variables, the study utilises global financial shocks (represented by the VIX index or volatility of the U.S. 10-year bond yields [within-week and 5-day rolling]); the interaction between the share of each type of foreign investors' ownership, the global financial shock indicator, and a dummy variable of the period with extreme capital flows (stress period); and control variables (change in short-term interest rate, change in foreign reserves, or exchange rate depreciation).

As a developing financial market with experience dealing with the Asian financial crisis and the subprime mortgage crisis, foreign participation in the Indonesian local-currency government bond market cannot be unnoticed. The left panel of Figure 3.1 shows that the share of foreign holdings has increased by 17 times from 2.17% in Q1-2004 to 38.64% in Q3-2019. In addition, their share of the bond market has been the greatest in the last ten years among Asian countries. According to the Asian Development Bank (ADB)[4], as of Q3-2019, foreigners held 38.64% of total tradable domestic bonds outstanding, much greater than the foreign holdings in other countries in Asia, which are Malaysia (22.99%), Thailand (16.11%), South Korea (12.16%), Philippines (4.93%), and Vietnam (0.77%). In addition, Indonesian sovereign credit ratings from Fitch, Moody's, and Standard & Poor's suggested that the probability of default has decreased significantly. On 15 December 2011, Fitch upgraded the rating to an investment-grade level BBB- with a Stable outlook. Their statement explains that the upgrade was awarded following low and declining debt ratios and resilient economic growth. In the following years, the other credit rating agencies upgraded Indonesia's rating to Baa3 with a Stable outlook on 18 January 2012 (Moody's) and BBB- with a Stable outlook on 19 May 2017 (Standard & Poor's).

The government announced its intention to reduce the foreign investor share of the local-currency bond market from 38% to 20% in five years[5], with the aim of shielding the local-currency bond market from shocks in the global financial market. This is an indication that the presence of foreign investors in the bond market remains controversial. Notwithstanding, even if foreign investors' demand for Indonesian bonds is more sensitive to global risk appetite than that of domestic investors, our theoretical model illustrates that a larger foreign share does not necessarily increase the impact of the risk appetite on the domestic market's volatility if foreign investors are also more sensitive to yield.

[4]The data are obtained from asianbondsonline.adb.org/data-portal/

[5]Source: https://www.bloomberg.com/news/articles/2018-08-23/indonesia-wants-foreigners-to-own-less-of-its-bonds-in-long-run

A particular issue is that a GARCH model on monthly data as employed in most previous studies contains no information about the volatility within the month because it is based on a single residual in a regression using end-of-month data. In the case of Indonesia, a daily data set ranging from 1 March 2004 to 30 September 2019 on the Indonesia 10-year IDR bond yields and prices can be used to yield a measure of the local-currency bond market volatility within the month. There is little correlation between the residuals obtained from the GARCH model and the volatility measures based on daily data of bond yields and bond prices (i.e., using the standard deviation and the squared root of the realised variance (realised volatility)). Specifically, it suggests that the GARCH method does not accurately capture intra-month volatility in the Indonesian local-currency bond market.

Unlike ARCH/GARCH models with end-of-month data, by modelling volatility using daily data, this study can estimate the within-month standard deviations of the bond yields and prices and then use these as the dependent variable in a monthly regression model. Thus, to compare the statistical results, relatively similar ARCH/GARCH models with end-of-month data on end-of-day data can be estimated, which is much better to explain day-to-day volatility due to the changes in the global risk appetite. In addition, many factors could influence the movement of the financial market. Accordingly, some portfolio managers need to adjust their investment policy quickly to increase their profit or reduce losses. Hence, daily data could be an advantage in investigating their reaction following any development in the local-currency bond yields/prices in response to changes in the global market. Therefore, utilising high-frequency data to examine Indonesia's government bond market volatility and the bondholders' behaviour is a sensible approach. Based on the background explained previously, the objectives of this study are to identify domestic or global factors that may affect volatility in Indonesia's local currency government bond market and to clarify whether foreign investors' presence in the domestic market would lessen or worsen the volatility.

The econometric outputs in this study find that the 30-day future of the US's S&P index options, an underlying measure of the VIX index, plays an essential role in heightening volatility in the domestic bond market. The result is robust to the utilisation of the alternative approach. It is relatively similar to González-Rozada and Yeyati (2008) 's finding that global factors (i.e. Credit Swiss First Boston's High Yield Index, US 10-year bond yields, and Standard & Poor's credit rating) play a substantial part in determining the volatility of emerging market spreads (i.e. J.P. Morgan's emerging market bond index). However, based on the outputs, the impact could be reduced following an increase in the share of foreign investors' holdings. The reduced impact is probably because of their role in deepening the domestic market by improving the turnover ratio and their strategies to prioritise holding intermediate-term and long-term bonds rather than short-term bonds. Besides, the statistical results also show that the ratio of short-term external debt to foreign reserves is equally essential as a variable that could influence volatility.

The rest of the chapter is structured as follows. Section 2 reviews related literature, followed by section 3, which illustrates the theory. Section 4 describes the data. Section 5 specifies the methodology and explains the statistical outputs. Section 6 checks the outputs by using another method. Section 7 explores the findings. Finally, section 8 concludes.

3.2 Literature review

This study is related to several works of literature. However, some have different methods for measuring volatility in the local-currency bond market.

Andritzky (2012) explores unbalanced quarterly data from 1969 to 2011 in G20 advanced and euro area countries[6]. To measure volatility, the author calculates

[6]Australia, Canada, France, Germany, Greece, Ireland, Italy, Japan, South Korea, Portugal, Spain, United Kingdom, and the United States.

a rolling standard deviation of 10-year government bond yields on end-of-quarter data within four quarters. In his statistical model, the author uses a pooled regression by estimating the four-quarter standard deviation as a function of real GDP growth, budget balance, and the share of domestic government bonds ownership differentiated by foreign investors, private non-bank financial institutions (e.g., financial intermediaries, insurance companies, pension funds), and public sector (including central banks). The main result provides statistical evidence that a 1% increase in foreign investors' holdings shares is associated with a 0.0089 unit increase in the domestic bond market volatility. In addition, the model cannot find any critical contribution from other observable institutions in determining the volatility. As for the relationship between the volatility and the control variables, different to the real GDP growth, the budget balance shows a significantly positive coefficient.

Peiris (2013) analyses monthly data from 2000 to 2009 in ten emerging economies, including Indonesia. The author employs a GARCH model to investigate the relationship between local-currency bond yield volatility and foreign participation. In the mean equation of the model, the long-term local-currency bond yield for each observable economy is estimated as a function of its lagged value. Meanwhile, in the variance equation of the model, the squared residual of the mean equation, as a proxy to measure the volatility, is estimated as a function of the share of foreign investor holdings[7]. The study finds that the contribution of foreign investors in determining local-currency bond market volatility differs in each emerging economy. The relationship is significantly positive in Korea, suggesting that higher participation of foreign investors is associated with higher volatility. However, the relationship is significantly negative in Malaysia, Mexico, and Turkey, suggesting that higher participation of foreign investors could be beneficial for developing the local currency bonds market. For the rest of the observable countries, which are Brazil, Czech Republic, Hungary, Indonesia, Poland, and Thailand, the coefficient

[7]In exponential form

is not significant. A possible explanation for the different results could be the different roles of the domestic investors in each country in deepening the domestic bond markets.

Further, Ebeke and Lu (2015) examine two kinds of data sets: quarterly data from Q2-2004 to Q2-2013 in 13 emerging economies, including Indonesia, and monthly data from December 2004 to July 2013 in Poland. An OLS approach is used as the main model and an instrumental variable method to check the robustness of the quarterly data set. This study is closest to the present one in design because it uses higher-frequency (weekly) data to measure volatility. In the main model, the volatility for each country is measured by calculating the standard deviation within 12 weeks (one quarter) on weekly changes of 5-year local-currency bond yields. They find that a 1% increase in the share of foreign holdings is associated with a 0.0068 unit increase in the volatility in the observation period from 2004 to 2013. However, the results are inconsistent when the observation period is differentiated into the pre-crisis period (before 2008) and post-crisis (after 2008). In the pre-crisis period, the coefficient is not statistically significant, while after 2008, a 1% increase in foreign holdings share is associated with a 0.0198 unit increase in volatility. In the full period, positive relationships can also be found between other regressors, real GDP growth volatility and the ratio of the current account balance to GDP, and the bond yield volatility. Nevertheless, after 2008, the relationship between the ratio of the current account balance to GDP and the bond yield volatility is diminishing.

Lastly, Ebeke and Lu (2015) apply a GARCH model on a monthly data set in Poland. In the mean equation of the model, the 5-year bond yields variable is estimated as a function of the one-month lagged value of the bond yields (in $t-1$) and the share of foreign investors' holdings (in t). In the variance equation of the model, the squared residuals of the mean equation, which is used as a proxy to measure the domestic bond market volatility, are estimated as a function of the

share of foreign investors' holdings (in t). The statistical results show that in the entire period of observation from December 2004 to July 2013, the coefficient is not statistically significant, suggesting that foreign investors do not contribute to determining domestic bond market volatility (similar to Peiris (2013)'s finding). Nevertheless, from December 2008 to July 2013, the relationship between the share of foreign holdings and the volatility is significantly positive, suggesting that the presence of foreign investor could harm the development of the local-currency government bonds market.

3.3 Theoretical model

Even though a large body of empirical literature has provided a consistent effect of global risk appetite, as measured by the VIX index, on local currency bond yield volatility (i.e. Zhou et al. (2014), Ebeke and Lu (2015)), this study could not disregard mixed findings of foreign investors' contribution in determining the volatility in a domestic bond market and a possibility of their participation in increasing the liquidity. Moreover, in any circumstance when foreign investors' demand for local-currency bonds is more sensitive to VIX index than domestic investors' demand, it does not necessarily follow that a larger share of the foreign investors in a domestic bond market could increase the effect of VIX index on the volatility. The situation can be explained by a simple framework where the effect of the volatility of the VIX index on the volatility of bond yields (VOLY) is formulated as a function of the share of foreign investors' holdings (FORH). By assuming the impact of the VIX index (VIXI) will have more influence on the foreign investors (c_1) than on the domestic investors (c_2), then $c_1 > c_2$. The demand function of foreign investors (BF) and domestic investors (BD) could be

defined as:

$$\mathrm{BF} = \mathrm{a}_1 + b_1 Y - c_1 \mathrm{VIXI} \tag{3.1}$$

$$\mathrm{BD} = \mathrm{a}_2 + b_2 Y - c_2 \mathrm{VIXI} \tag{3.2}$$

where Y is the bond yield. Other assumptions are that when the VIX index increases by DZ, the total demand for the bonds has to stay the same, and the bond yield (Y) increases by DY. Since this study intends to include the interaction between the VIX index and the share of foreign holdings, the marginal effect of DZ on DY is a measure of the conditional effect of the VIX index on domestic bond market volatility. Taking into account that the change in total demand is equal to zero, the equation is formulated as follows:

$$\begin{aligned}\text{Change in total demand} = 0 = \mathrm{FORH}\ (\mathrm{b}_1 DY - c_1 DZ) + \\ (1-\mathrm{FORH})(\mathrm{b}_2 DY - c_2 DZ)\end{aligned} \tag{3.3}$$

Then, by solving for DY in terms of DZ in Equation 3.3, the equation will be as follows.

$$\mathrm{DY}=[\mathrm{c}_2 + (c_1 - c_2) \times \mathrm{FORH}] \times \frac{DZ}{[b_2+(b_1-b_2)\times \mathrm{FORH}]} \tag{3.4}$$

If $c_1 > c_2$ and $b_1 = b_2$, where the foreign investors have more sensitivity to the VIX index but a similar sensitivity to the bond yield as the domestic investors, the Equation 3.4 could be simplified to be as follows.

$$\mathrm{DY}=[\mathrm{c}_2 + (c_1 - c_2) \times \mathrm{FORH}] \times \frac{DZ}{b_2} \tag{3.5}$$

where the bond yield volatility ($\frac{dDY}{dDZ}$) increases with the changes in the foreign holdings' share. However, in another case that $c_1 = c_2$ and $b_1 > b_2$, the results will be the opposite as follows.

$$\text{DY}=[\text{c}_2 \times DZ] \times \frac{1}{[b_2+(b_1-b_2)\times \text{FORH}]} \tag{3.6}$$

In addition, if $c_1 > c_2$ and $b_1 > b_2$, $d(\frac{dDY}{dDZ})/dFORH$ could be >0 or <0. Therefore, a greater VIX index sensitivity of the foreign investors may not increase the effect of the VIX index on the bond yield if the demand of the foreign investors for domestic bonds responds more to an increase in the bond yield than the demand of the domestic investors.

From Equation 3.4, if the share of foreign holdings is equal to zero, then $DY = (c_2/b_2) \times DZ$. If the share of foreign holdings is equal to 1, then $DY = (c_1/b_1) \times DZ$. When the market is entirely foreign investors with no participation from the domestic investors, dDY/dDZ is greater when the share of foreign holdings is equal to 0 if $\frac{c_2}{b_2} < \frac{c_1}{b_1}$ or $\frac{c_1}{c_2} > \frac{b_1}{b_2}$.

If they are equal ($\frac{c_1}{c_2} = \frac{b_1}{b_2}$, assigned with w), then Equation 3.4 will become as follows:

$$\text{DY}=\text{c}_2 \times [1 + w \times \text{FORH}] \times \frac{DZ}{b_2\times[1+w\times \text{FORH}]} = \frac{c_2}{b_2} \times DZ \tag{3.7}$$

This case suggests that the share of foreign holdings makes no difference from the bond yield volatility caused by the VIX index. If $\frac{c_1}{c_2} > \frac{b_1}{b_2}$, the model predicts that the interaction term of VIX index and the foreign holdings' share will be positive; inversely, if $\frac{c_1}{c_2} < \frac{b_1}{b_2}$, the interaction term will be negative. Therefore, the effect of the share of foreign holdings on the VIX index depends on domestic and foreign investors' relative sensitivity to the bond yield and VIX index.

In the remainder of this chapter, this study plans to estimate an ARCH/GARCH model, as appropriate, where the residuals of the dependent variable are a function of past values of the dependent variable and independent variables to end-of-month bond yield data as has been done in previous studies. Alternatively, for the model specifications for the period 2004 to 2019 and employing the monthly dataset, it is possible to calculate the volatility of the bond market within each month by exploiting a daily dataset of Indonesia's IDR 10-year government bond yields and prices, which are available from 1 March 2004 to 30 September 2019. This is done for both yields and prices since it is not clear whether it is the volatility of price or yields that one should be concerned about, and they are not perfectly correlated, since their ratio changes with the level of interest rates. In particular, price volatility gets higher relative to yield volatility as interest rates fall, as they have done over the period. More specifically, this study uses the mid-yield to maturity and the mid-price to maturity variables and selects the bonds with a constant maturity of approximately ten years.

In summary, this study is particularly interested in the coefficient of foreign holdings' share, the VIX index, and their interaction, which captures the conditional effect of the VIX index on volatility varies with the foreign holdings' share. Moreover, to examine the role of foreign investors in determining market liquidity, the turnover ratio (the proportion of bonds traded in a given time interval) is estimated as a function of the lag of their shares, the lag of the ratio of the value of total local-currency tradable bonds to industrial output, and the VIX index.

3.4 Data

In aiming to develop a proxy variable to measure the domestic bond market volatility, it is not clear theoretically which variable should be concerned with as the reference point: the volatility of bond yields or prices. Since bond yields and prices are inversely related, particularly in long-dated bonds, and considering the nature of those variables, the price volatility has increased relative to yield volatility as interest rates have come down. Accordingly, to measure the volatility from March 2004 to September 2019, two variables are used, which are the standard deviation within a month of daily bond (i) yields (VOLY) and (ii) prices (VOLP); of these, VOLY has rather less variation over the sample than VOLP.

In this study, Indonesia's 10-year bond yield (IG10Y), and the volatility variables, VOLY and VOLP, will be used as the dependent variable in different specifications. The VIX index (VIXI) and the share of foreign investors (FORH), which hold Indonesia's local-currency government bonds, will be used as the independent variables. The VIX index, which acts as a proxy to measure global financial condition, is developed by the Chicago Board Options Exchange based on 30-day future S&P 500 index options. Since this study utilises a monthly dataset, the daily observations of the VIX index are averaged to give an idea of the global financial market's volatility within a month. As for the foreign holdings' share, given that data at a daily frequency is only available from March 2008, a different approach has been taken. This study will use the end-of-month data from March 2004, instead of utilising the daily average of the foreign holdings' shares within a month. Further, in aiming to be in line with the latter variable, all control variables will use the end-of-month data as well.

Besides the variables of interest, VIXI and FORH, several control variables also will be included in the model.

1. The ratio of the total local-currency tradable government bonds to industrial

output (TOID) as a measurement of the debt to GDP (industrial output data are available monthly, but GDP data are not).

2. An average of the expected year-on-year inflation, which is obtained from Bloomberg's survey of domestic commercial banks' economists in Indonesia (IDIE).

3. The ratio of non-IDR government bonds with a maturity of less than 1 year to the foreign reserves maintained by the central bank (XDDV), to measure the short-term external debt over the foreign reserves. To create the variable, both of them have been converted to the U.S. dollar.

Comparing several measures of the volatility in Indonesia's local-currency bonds market, Figure 3.2 illustrates that the patterns between the standard deviations of the bond yields (VOLY) and prices (VOLP), the residuals (RESSQ), and the realised volatility (RVOL) are pretty different. Specifically, the residuals are obtained from a simple regression model as shown in Equation 3.8 as follows.

$$\begin{aligned} \text{IG10Y}_t &= \beta_0 + \beta_1 \text{FORH}_{t-1} + \beta_2 \text{TOID}_{t-1} + \beta_3 \text{IDIE}_{t-1} + \\ &\quad \beta_4 \text{XDDV}_{t-1} + \epsilon_t \end{aligned} \tag{3.8}$$

Those residuals are compared with VOLY, VOLP, and RVOL because the assumption is they will be relatively similar to the dependent variable to be used in the variance equation of the ARCH/GARCH approach; an approach that was used by Peiris (2013) and Ebeke and Lu (2015). In particular, the VIX index is not included in Equation 3.8 to lessen the effect of volatility due to any spillover from the global financial market.

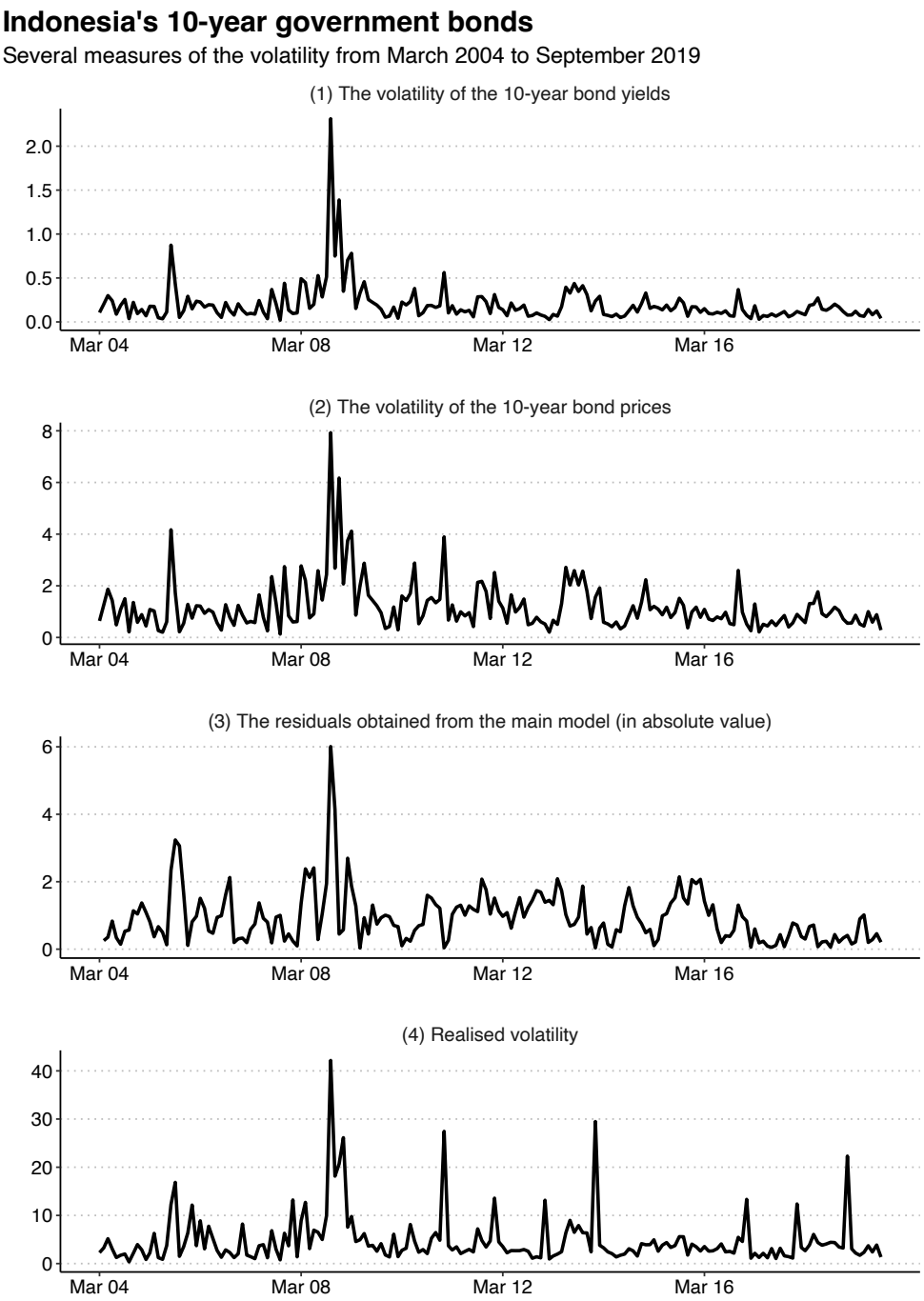


Figure 3.2: Comparing the volatility of the Indonesia's 10-year bond yields and bond prices based on daily data (standard deviation within respective month); the residual obtained from the main model based on monthly data, and the realised volatility following Chatziantoniou et al. (2021)'s method. In the main model (as illustrated in Panel 3), the yields of the 10-year bond are estimated as a function of the foreign holdings' share, the ratio of total Indonesian rupiah tradable bonds to industrial output, the inflation rate expectation, and the ratio of short-term external debt to the foreign reserves. Meanwhile, the realised volatility (as shown in Panel 4) is computed as the square root of the realised variance, which considers the daily returns (based on the 10-year bond prices) and the number of tradings within respective month.

Meanwhile, the realised volatility is measured by following Chatziantoniou et al. (2021)'s method[8], as shown in Equation 3.9 as follows.

$$RVOL_t^m = 100\sqrt{12\sum_{j=1}^{\tau}\left(logP_{t,j} - log_{t,j-1}\right)^2} \tag{3.9}$$

where RVOL_t^m is the annualised volatility and $logP_{t,j}$ is the natural logarithm of the daily market bond price at day j of the month t. Further, by assuming an equal number of trading days in each month, the RVOL_t^m is then scaled with $\sqrt{\frac{22}{\tau}}$, where τ is the number of trading days per month and 22 is the average number of trading days per month. This method is used as a comparison with the others because it takes into account the underlying volatility of the asset returns that are relatively unobserved (Herrera et al., 2018)[9].

Figure 3.2 shows that VOLY, VOLP, RESSQ, and RVOL reached their highest points in October 2008, when the subprime mortgage crisis that occurred in 2008 was getting more attention after Lehman Brothers filed for bankruptcy in September 2008. However, it appears that RESSQ (Panel 3) and RVOL (Panel 4) are too sensitive in capturing the bonds market volatility. Several spikes in October 2006 and February 2016 as captured by RESSQ and January 2014, January 2018, and January 2019 as captured by RVOL are not reflected in the domestic and global financial market. Ahmed et al. (2017) find that from 2008 to 2018, the period of each crisis could be differentiated as follows: the subprime mortgage crisis from September 2008 to February 2009, the eurozone debt crisis from July 2011 to December 2011, the taper tantrum from May 2013 to August 2013, and the yuan devaluation from July 2015 to September 2015.

In addition, from March 2004 to September 2019, the correlation between VOLY

[8]Even though their study focuses more on the oil price in the commodity market, the method is not too different to Pan (2018)'s method, which calculates the volatility of the U.S. Treasury 10-year note.

[9]On another paper, Andersen et al. (2006) argue that the realised volatility is strongly reliable in measuring the underlying volatility.

and VOLP is relatively high, at 0.95. In comparison, the correlations between those variables and RESSQ are 0.49 and 0.39, respectively. Whereas, the correlations between VOLY and VOLP; and RVOL are 0.71 and 0.67. However, from December 2011 to September 2019, when Indonesia's credit rating was upgraded to the investment-grade status, it appears that RESSQ has a smaller correlation with the intra-month volatility variables, VOLY and VOLP. As a result, their correlations are reduced to 0.06. Similarly, RVOL's correlations with VOLY and VOLP also lessened to 0.33.

Further, by estimating a simple regression of VOLY on VOLP and the lag of the 10-year bond yield (IG10Y), the results show that both independent variables statistically have a positive relationship with VOLY. A 1-unit increase in the VOLP and the lag of IG10Y statistically would increase the VOLY by 0.21 units and 0.01 units. Therefore, considering the previous explanation, this study will refer to VOLY and VOLP to capture the volatility in Indonesia's local-currency bonds market.

The bond investors' ownership data are compiled by the Ministry of Finance of the Republic of Indonesia, while the other variables are obtained from Bank Indonesia, Bloomberg, and Organisation for Economic Co-operation and Development, as depicted in more detail in Table 3.7. The descriptive summaries, the correlations, and the unit root test of the observable variables are provided in Table 3.8, 3.9, 3.10, and 3.11 in the Appendix section. In addition, Figure 3.7 presents the graph of the other observable variables.

3.5 Empirical analysis

3.5.1 Analytical framework

In the first model, this study uses monthly data to estimate an autoregressive conditional heteroscedasticity (ARCH) and a generalised autoregressive conditional heteroscedasticity (GARCH) model, which simultaneously models the bond yields and volatility. According to Ruppert (2011), a simple model (e.g. autoregressive moving average model) may not be suitable to capture volatility variation in financial markets because the conditional variance is constant. In contrast, GARCH can capture varying volatility since the model considers the previous period's information about volatility and forecast variance to estimate the current variance. Gelos et al. (2011)'s method is adopted by using lagged values of the regressors to mitigate the endogeneity issue, except for the Chicago Board Options Exchange Volatility Index (VIX index) because of its availability on a daily frequency. Considering that the global financial market moves rapidly, some critical information could be missed if the VIX index is lagged.

The model is divided into two equations: the mean equation, Equation 3.10, to assess the determinants of the yields, and the variance equation, Equation 3.11, to examine the variance of the dependent variable, which is the bond yields or prices, as a proxy to measure the domestic bond market volatility. In general, the ARCH model is defined as follows:

$$\Phi_t = \alpha_0 + \alpha_1 \text{Foreign holdings' share}_{t-1} + \eta\Gamma_{t-1} + \epsilon_t \tag{3.10}$$

$$\begin{aligned}\sigma_t^2 = {} & \beta_0 + \beta_1 \text{VIX index}_t^2 + \beta_2 \text{Foreign holdings' share}_{t-1} + \\ & \beta_3 \text{VIX index}_t^2 \times \text{Foreign holdings' share}_{t-1} + \zeta\epsilon_{t-1}^2\end{aligned} \tag{3.11}$$

where Φ is a 2 x one-dimensional vector of the dependent variable, which are Indonesia's 10-year bond yields and prices. Then Γ is a 3 x one-dimensional vector of the control variables, which are the ratio of IDR tradable bonds to industrial output$_{t-1}$, the inflation rate expectation$_{t-1}$, and the ratio of short-term external debt to foreign reserves$_{t-1}$; η is a 3 x one-dimensional vector of the control variables' coefficients in the equation, respectively; and ζ is the coefficient of the ARCH term; defined as the information about volatility from the previous period. As for the GARCH model, there will be an additional variable $\theta\sigma_{t-1}^2$ as the GARCH term in the variance equation (Equation 3.11); interpreted as the forecast variance of the last period.

In Equation 3.10, besides the theory about foreign investors' role in influencing a local-currency bonds market (i.e., bond yields) explained in the previous section, the other hypotheses are that any increase in the expected inflation rate (IDIE), a higher ratio between short-term external debt and foreign reserves (XDDV), and a greater debt to GDP ratio would increase Indonesia's 10-year bond yields.

In particular, regarding the variables of interest, the VIX index and the foreign holdings' share, the interaction between them is calculated and then included in the model shown in Equation 3.11. Several previous studies conclude that the VIX index has an essential role in influencing the financial market in emerging economies. By studying 38 emerging market economies from Q1-1990 to Q2-2014, Adler et al. (2016) explains that a shock to the VIX index could lead to a decline in gross inflow. Tsang et al. (2021) also describe, as an exogenous variable, the VIX index is statistically significant in determining the bond returns[10] in ASEAN4 countries (Indonesia, Malaysia, Philippines, and Thailand) from 18 March 2011 to 14 November 2019. A 1-unit increase in the VIX index is associated with a 0.030 unit hike in the 10-year bond returns. The results proved robust to the different maturities of the observable countries' domestic bonds: 1-year, 3-year, 5-year, and

[10]The variable is estimated by differencing the actual bond yields and its Hodrick-Prescott (HP) trends.

7-year. Therefore, considering these findings, this study expects that the impact of the VIX index on the domestic bond market volatility would depend on the share of the bonds owned by foreign investors.

Further, since several notable events occurred from March 2004 to September 2019, this study also observes a sub-period of December 2011 to September 2019, when Fitch labelled Indonesia as an investment-grade country on 15 December 2011. The main objective of observing this sub-sample is to understand whether an investment-grade status, which could be interpreted as a relatively better expectation of domestic market conditions, would reduce the impact of the volatility in the global financial market.

3.5.2 Estimation results

Since the objective of the study is to determine the bond market volatility, the analysis of the statistical results presented in Table 3.1 will be focused more on the variance equation. Further, the results are divided into two models that utilise different variables used as the dependent variable: (i) Indonesia's 10-year bond yields and (ii) Indonesia's 10-year bond prices. In all specifications, the ARCH term positively correlates with the conditional variance σ_t^2. Therefore, information about volatility from the previous period would heighten the volatility in the current period could be inferred.

Table 3.1: ARCH outputs – determining the bond yields and prices; and examining their volatility

Dependent variable:	IG10Y: Indonesia 10-year IDR bond yields$_t$				IG10P: Indonesia 10-year IDR bond prices$_t$			
	A whole period	Investment grade period	A whole period	Investment grade period	A whole period	Investment grade period	A whole period	Investment grade period
Mean equation:	(3.1a)	(3.1b)	(3.1c)	(3.1d)	(3.1e)	(3.1f)	(3.1g)	(3.1h)
FORH$_{t-1}$: The foreign holdings' share$_{t-1}$	-14.808***	17.990***	-14.975***	17.918***	-7.825	-16.342	-7.906	-20.761
	(-15.093)	(6.534)	(-15.614)	(6.499)	(-1.218)	(-0.814)	(-1.028)	(-1.094)
IDR tradable bonds over industrial output$_{t-1}$	0.240	-0.431*	0.244	-0.435*	3.907***	5.417***	3.973***	5.893***
	(1.419)	(-1.670)	(1.425)	(-1.677)	(4.311)	(3.013)	(4.621)	(3.484)
Inflation rate expectation$_{t-1}$	0.132***	0.177***	0.132***	0.176***	-1.196***	-0.770*	-1.184***	-0.661
	(4.937)	(3.339)	(5.029)	(3.298)	(-8.341)	(-1.842)	(-7.682)	(-1.633)
Short-term external debt over foreign reserves$_{t-1}$	10.865*	27.847***	12.257**	27.811***	-510.340***	-542.766***	-512.809***	-538.841***
	(1.840)	(4.412)	(2.035)	(4.477)	(-14.374)	(-10.948)	(-14.568)	(-11.745)
Dummy variable: Investment grade period	0.469**	-	0.450**		-1.009		-0.872	
	(2.376)	-	(2.320)		(-0.674)		(-0.513)	
Constant	10.940***	1.211	10.961***	1.258	104.912***	100.327***	104.556***	99.724***
	(23.303)	(1.162)	(23.503)	(1.175)	(43.802)	(12.864)	(41.466)	(14.452)
Variance equation:	(3.1i)	(3.1j)	(3.1k)	(3.1l)	(3.1m)	(3.1n)	(3.1o)	(3.1p)
VIX index$_t^2$	0.001**	0.004	0.002	-0.002	0.001*	0.004*	-0.000	-0.025
	(2.495)	(1.567)	(1.249)	(-0.083)	(1.832)	(1.669)	(-0.259)	(-0.975)
FORH$_{t-1}$: The foreign holdings' share$_{t-1}$	-3.648**	-2.562	-2.805	-8.395	1.528	5.054	-1.241	-20.799
	(-2.192)	(-0.270)	(-1.200)	(-0.316)	(1.007)	(0.574)	(-0.554)	(-0.914)
VIX index$_t^2$xFORH$_{t-1}$	-	-	-0.003	0.017	-	-	0.008	0.078
	-	-	(-0.494)	(0.213)	-	-	(1.395)	(1.112)
Constant	-1.059*	-2.247	-1.244*	-0.167	1.406**	-0.665	2.001***	9.073
	(-1.840)	(-0.649)	(-1.765)	(-0.017)	(2.342)	(-0.208)	(3.178)	(1.082)
ARCH term: ϵ_{t-1}^2	0.788***	0.889***	0.797***	0.893***	0.849***	0.632**	0.812***	0.593**
	(3.272)	(2.613)	(3.260)	(2.655)	(3.506)	(2.107)	(3.444)	(2.174)
Observations	186	94	186	94	186	94	186	94

[1] ***, **, * denote significance at 1%, 5%, 10% respectively. [2] z-statistics in parentheses. [3] Dummy variable: no investment grade 0, investment grade 1 (Dec. 2011–Sep. 2019).

Columns 3.1i and 3.1j present the ARCH model without the inclusion of an interaction term between the squared VIX index at t and the foreign holdings' share at $t-1$ in the variance equation for the whole period of March 2004 to September 2019 and the sub-period of December 2011 to September 2019 when Indonesia had investment-grade status, respectively. The former model provides evidence of a positive relationship between the squared VIX index at t and volatility at t; and a negative relationship between foreign holdings' shares at $t-1$ and volatility at t. A 1-unit increase in the squared VIX index is associated with a 0.001-unit increase in volatility. Hence, it strengthens the initial hypothesis about the spillover effect from the global financial market to Indonesia's domestic bond market.

In contrast, a 1% increase in the foreign holdings' share is associated with a 3.65 unit decline in volatility. The latter evidence tends to be different to Ebeke and Lu (2015), which explain that higher participation of foreign investor could contribute to increased volatility in the domestic bond market. In column 3.1j, the relationship between the squared VIX index and volatility in the investment-grade period turns out to be positive as well, while the relationship between the foreign holdings' share and the volatility keeps negative. The effect of the investment-grade status obtained by Indonesia in this period and more limited observations than the previous model could be a few reasons why their coefficients are not statistically significant. Columns 3.1k and 3.1l display specifications with an additional variable: the interaction between the squared VIX index at t and foreign holdings' share at $t-1$. However, the results are not statistically significant in both periods of observation.

Further, the bond prices are employed as the dependent variable for the rest of the columns 3.1m to 3.1p. Taking into account the different variances between the bond yield (5.45) and the bond price (119.57), a different response of the dependent variable to a change in the independent variable could be expected. Columns 3.1m and 3.1n provide evidence of a positive relationship between the

VIX index and volatility, whether during a whole observation period or the sub-period. A 1-unit increase in the VIX index could increase volatility by 0.001 and 0.004 units, respectively. Meanwhile, from similar specifications, the negative relationships between foreign holdings' shares and volatility as displayed in columns 3.1i and 3.1j do not hold. Instead, in columns 3.1m and 3.1n, the statistical results indicate that foreign investors' participation in the domestic market could lead to a rise in volatility. But they are not statistically significant. Similarly, the outcomes presented in columns 3.1o and 3.1p are also less reliable statistically because the coefficients in those specifications are not significantly different from zero. Therefore, they will not be investigated.

This study then employs a GARCH model on these specifications to check the consistency of the findings. But the results are insufficient to be explored even further since the convergence of the models is not achieved. In the next section, an alternative specification using a simple ordinary least squares method will be employed to test the initial hypothesis and examine the results obtained from the ARCH approach.

3.6 An alternative method

3.6.1 Analytical framework

In this alternative approach, this study implements a simple ordinary least squares (OLS) by estimating the domestic bond market volatility (proxied by a standard deviation of daily Indonesia 10-year IDR bond yields, VOLY, and bond prices, VOLP), over the month at t as a function of VIX index at t, the share of the foreign holdings' share at $t-1$, the ratio of total IDR tradable bonds to industrial output at $t-1$, the inflation rate expectation at $t-1$, and the ratio of short-term external debt to the foreign reserves at $t-1$. Except for the VIX index, the

lagged values of other independent variables are used to address an endogeneity issue, where the dependent variable might influence the independent variables. In particular, regarding the VIX index that will not be lagged, the assumption is Indonesia's market size is relatively small and less likely will influence the U.S. market. In other words, the possibility of the VIX index at t affecting Indonesia's bonds market at t is relatively much higher than the other way around.

About a multicollinearity issue, where the independent variables are highly correlated, can be seen in the variance inflation factors of the OLS outputs. If the numbers are less than ten, the issue could be disregarded. In addition, this study also examines other specifications with the interaction term between the VIX index at t as the variable of interest and the share of foreign holdings at $t-1$ as a conditional factor. The objective of including the interaction term in the specifications is to learn how the effect on the volatility at t of a change in the value of the VIX index at t depends on the share of foreign holdings at $t-1$. Therefore, the initial framework is more formally specified as follows:

$$\begin{aligned}\Pi_t \; &= \beta_0 + \beta_1 \text{VIX index}_t + \beta_2 \text{Foreign holdings' share}_{t-1} + \\ &\beta_3 \text{VIX index}_t \times \text{Foreign holdings' share}_{t-1} + \eta \Gamma_{t-1} + \epsilon_t\end{aligned} \tag{3.12}$$

where Π is a 2 x one-dimensional vector of dependent variables, which are VOLY and VOLP; Γ are a 3 x one-dimensional vector of the control variables, which are IDR tradable bonds to industrial output$_{t-1}$, the inflation rate expectation$_{t-1}$, and the short-term external debt to foreign reserves$_{t-1}$; η is a 3 x one-dimensional vector of the control variables' coefficients; and ϵ_t is a white noise term. In these models, the lag of the dependent variable, VOLY$_{t-1}$ and VOLP$_{t-1}$, are added. The hypothesis is that a previous period of volatility could define the current volatility in the bond market. Moreover, a dummy variable (DMRT) is created to consider the periods of the investment-grade status. In DMRT, one is assigned

to a period since Fitch upgraded Indonesia's rating to an investment-grade status from December 2011 to September 2019 and zero to another period from March 2004 to November 2011.

Further, since this study is also interested in exploring the impact of the change in the VIX index on the volatility, following an increasing share of the foreign holdings, Equation 3.12 is derived, and the results are displayed as follows.

$$\begin{aligned}\Delta\Pi_t \; &= \alpha_0 + \alpha_1 \Delta\text{VIX index}_t + \alpha_2 \Delta\text{Foreign holdings' share}_{t-1} + \\ &\alpha_3 \Delta(\text{VIX index}_t \times \text{Foreign holdings' share}_{t-1}) + \xi \Delta\Gamma_{t-1} + \epsilon_t\end{aligned} \tag{3.13}$$

or also could be rewritten as the following equation.

$$\begin{aligned}\Delta\Pi_t \; &= \alpha_0 + \alpha_1 \Delta\text{VIX index}_t + \alpha_2 \Delta\text{Foreign holdings' share}_{t-1} + \\ &\alpha_3 [(\Delta\text{VIX index}_t \times \text{Foreign holdings' share}_{t-2}) + \\ &(\Delta\text{Foreign holdings' share}_{t-1} \times \text{VIX index}_t)] + \xi \Delta\Gamma_{t-1} + \epsilon_t\end{aligned} \tag{3.14}$$

3.6.2 The relationship between the bond yields' standard deviation (VOLY) and the bond prices' standard deviation (VOLP)

Due to the inverse relationship between bond yields and prices, in the bonds that have a long tenure, the price volatility will increase more compared to yield volatility as interest rates decline. In a zero-coupon bond with no interest payments, the price at maturity (M) is defined as follows:

$$\mathrm{M} = \mathrm{P}(1 + \mathrm{y}/100)^n \tag{3.15}$$

$$ln(\tfrac{P}{M}) = -n \times ln(1 + (\tfrac{Y}{100})) \tag{3.16}$$

where P is the current price of a bond, Y is the current yield on an n-year bond (%), and n is the number of years to maturity. Then, for a 10-year bond, where n = 10 and by assuming M = 1 (the price of the bond will back to 100%, at par, on the date of its maturity), the formula will become:

$$P = exp[-10 \times ln(1 + \tfrac{Y}{100})] \tag{3.17}$$

For example, if Y = 5%; $(1 + (\tfrac{Y}{100})) = 1.05$, P = 0.6139.

This study uses the standard deviations of the bond yields (VOLY) and the bond prices (VOLP) to measure the volatility in Indonesia's domestic bonds market. Therefore, by differentiating Equation 3.16:

$$\frac{dln(\frac{P}{M})}{dY} = -\frac{n}{100}(1 + \frac{Y}{100})^{-1} < 0 \tag{3.18}$$

then, by differentiating the Equation 3.18 again, the results is:

$$\frac{d^2 ln(\frac{P}{M})}{d^2 Y} = \frac{n}{10000}(1 + \frac{Y}{100})^{-2} > 0 \tag{3.19}$$

Since Equation 3.19 is the opposite sign to Equation 3.18, for a given change in the bond yield (Y), the bond price (P) changes by less at higher values of Y. Consequently, yield volatility (VOLY) will be greater relative to price volatility (VOLP) at higher Y. This is essential considering this study uses 10-year Indonesian rupiah bonds and Y has changed quite a lot over the observation period.

3.6.3 Estimation results

The statistical outputs of Equation 3.12 are provided in Table 3.2. Relatively similar to the ARCH's statistical outputs provided in Table 3.1, the OLS's statistical outputs are also differentiated by the dependent variable: (i) the bond yields' standard deviations, from columns 3.2a to 3.2d, and (ii) the bond prices' standard deviations, from columns 3.2e to 3.2h.

Column 3.2a displays the OLS's results for the whole observation period with an additional dummy variable that represents Indonesia's credit rating status without including the interaction term. In comparison, column 3.2b shows the statistical results for the sub-period without including the dummy variable and the interaction term as the regressors in the model. The results in these two columns highlight the VIX index's critical role in determining volatility in Indonesia's domestic bond market. In addition, a restriction applied during the observation period indicates that its influence diminishes during the investment-grade period. A 1-unit increase in the VIX index is associated with an intensified volatility of 0.022 and 0.006 units in the whole observation period and sub-period, respectively.

Table 3.2: The OLS outputs – investigating volatility proxied by VOLY and VOLP variable, all variables of monthly dataset, at level

	VOLY: Indonesia 10-year IDR bond yield, volatility$_t$				VOLP: Indonesia 10-year IDR bond price, volatility$_t$			
	A whole period	Investment grade period	A whole period	Investment grade period	A whole period	Investment grade period	A whole period	Investment grade period
	(3.2a)	(3.2b)	(3.2c)	(3.2d)	(3.2e)	(3.2f)	(3.2g)	(3.2h)
VIXI$_t$: VIX index$_t$	0.022***	0.006***	0.034***	0.025	0.086***	0.037***	0.119***	0.216
	(3.113)	(2.912)	(3.201)	(0.785)	(4.393)	(2.647)	(3.782)	(0.905)
FORH$_{t-1}$: The foreign holdings' share$_{t-1}$	-0.512	-0.071	0.446	0.797	-0.229	-1.042	2.658	7.131
	(-1.604)	(-0.297)	(1.093)	(0.579)	(-0.175)	(-0.630)	(1.350)	(0.701)
VIXI$_t$xFORH$_{t-1}$	-	-	-0.056**	-0.051	-	-	-0.164*	-0.481
	-	-	(-2.462)	(-0.616)	-	-	(-1.710)	(-0.775)
IDR tradable bonds over industrial output$_{t-1}$	-0.015	-0.040**	-0.020	-0.042**	-0.337**	-0.276**	-0.356**	-0.298**
	(-0.449)	(-2.141)	(-0.630)	(-2.213)	(-2.291)	(-2.160)	(-2.460)	(-2.281)
Inflation rate expectation$_{t-1}$	0.019***	0.010	0.020***	0.011*	0.046**	0.038	0.045**	0.045
	(2.652)	(1.576)	(2.723)	(1.737)	(2.140)	(0.865)	(2.132)	(1.071)
Short-term external debt over foreign reserves$_{t-1}$	4.101***	2.753***	3.857***	2.882***	21.098***	15.600***	20.269***	16.828***
	(3.992)	(3.927)	(4.191)	(4.116)	(3.658)	(3.296)	(3.580)	(3.529)
The dependent variable$_{t-1}$	-0.145	0.201**	-0.204	0.196**	-0.116	0.176**	-0.145	0.167**
	(-1.004)	(2.355)	(-1.281)	(2.270)	(-1.103)	(2.250)	(-1.324)	(2.093)
Dummy variable: Investment grade period	0.117*	-	0.097*	-	0.263	-	0.195	-
	(1.860)	-	(1.731)	-	(0.970)	-	(0.748)	-
Constant	-0.218	0.085	-0.389*	-0.235	0.146	1.087	-0.327	-1.927
	(-1.165)	(0.826)	(-1.701)	(-0.454)	(0.251)	(1.428)	(-0.460)	(-0.502)
Observations	186	94	186	94	186	94	186	94
Adjusted R^2	0.514	0.381	0.533	0.378	0.442	0.286	0.450	0.286

[1] ***, **, * denote significance at 1%, 5%, 10% respectively. [2] *t-statistics* in parentheses. [3] Dummy variable: no investment grade 0, investment grade 1 (Investment grade period). [4] VOLY and VOLP are the standard deviation of Indonesia 10-year bond yield and price, respectively. [5] A whole period: March 2004 to September 2019; Investment grade period: December 2011 to September 2019. [6] The multicollinearity test (VIF) are provided in Table 3.12. [7] The statistical results that use the 1st difference of the observable variables are displayed in Table 3.3.

Nevertheless, the sign of the dummy variable's coefficient in column 3.2a opposes the diminishing effect of the restrained observation period. It appears a better credit rating status for the country would not lessen volatility in the domestic bond market. A possible reason could be that investors have a different assessment method in allocating their portfolios and do not entirely rely on the opinion of the credit rating agencies. Besides, the result tends to be similar to Afonso et al. (2014)'s finding that explores the impact of sovereign credit rating announcements on bond market volatility in 21 European Union countries from 2 January 1995 to 24 October 2011. They cannot find strong statistical evidence that the upgrade influences volatility in the same country. Instead, they mention the spillover effect, where any upgrade (downgrade) in one country would lead to a decrease (increase) in the volatility of the other countries.

The negative relationship between foreign holdings' shares and volatility is similar in these different periods. It means there is a tendency that a greater contribution of the foreign investors, compensated by a lower share of the domestic investors' holdings, would be beneficial for the stability of the domestic market. However, sufficient evidence is needed because the coefficients are not statistically significant. Further, the results find that a higher inflation rate expectation and a greater ratio of the short-term external debt to foreign reserves could increase the volatility in the observation period. A 1% increase in these variables is associated with an increase in the volatility by 0.019 and 4.101 units. Perhaps, it is because of Indonesia's experience during the Asian financial crisis in 1998, when the inflation rate went up significantly to 77.6% from 11.1% in 1997. Even though, learning from the crisis, Indonesia has stipulated law number 23/1999 on the central bank to underline Bank Indonesia's independence to monitor the inflation rate and maintain a reasonable local currency level.

Moreover, the statistical result strengthens the importance of foreign reserves in stabilising the domestic bond market. By exploring 38 emerging market coun-

tries from Q1-1990 to Q2-2014, Adler et al. (2016) explain that a higher reserve could be beneficial in lessening the impact of the external shock. According to Bank Indonesia's statement, the international standard adequacy of the reserve is recommended to be equal to three months of import. An adequate reserve is essential to mitigate deeper depreciation in the Indonesian rupiah in a case of a sudden reversal of the capital. In addition, it could be utilised to maintain the sustainability of the domestic financial market, especially in the more volatile market due to several events that occurred in the global market, e.g. gradual increases in the U.S. Federal Reserve's rate after the crisis. During the observation period, Indonesia's foreign reserves have increased 232.25% from USD37.4 billion in March 2004, equivalent to financing 6.5 months of imports and payment of external government debt maturing in less than one year, to USD124.3 billion in September 2019, equivalent to finance 6.9 months of imports and payment of external government debt maturing in less than one year.

Next, different to the hypothesis, Indonesia's tradable bonds to industrial output as a proxy to measure the debt ratio negatively affects volatility. A 1-unit increase in this indicator could decrease volatility by 0.015 and 0.040 units in the whole period of observation and sub-period, respectively, although the statistical significance can only be found in the period when Indonesia had been labelled as one of the investment-grade countries. The negative relationship is probably because the trend of the debt to GDP ratio tends to be declining, from 52.04% in 2004 to 30.18% in 2019[11], much lower than the ceiling of 60% stated in the State Finances Law 17/2003. As long as the deficit to GDP ratio is kept below or equal to 3%, it might suggest that the government still has enough room to increase its current debt to execute its plans, including developing the infrastructure in the domestic bond market.

Further, particularly in the sub-period, a positive relationship between the previ-

[11]The data are obtained from International Monetary Fund's Global Debt Database on 13 October 2021.

ous period's volatility and the current period's volatility could be considered an indication for the policymakers to take a necessary response so that the volatility in the domestic market could be anticipated quickly. The coefficient sign is negative but not statistically significant in the observable period.

In columns 3.2c and 3.2d, the statistical results of the specifications by including the interaction variable are provided. Consequently, the coefficients' signs of the VIX index and the foreign holdings' share might be changed due to the multicollinearity issue. Nonetheless, the outputs find a consistent positive relationship between the VIX index and volatility in both observation periods. The difference is that the coefficient is statistically insignificant in the sub-period. The other differences, compared to columns 3.2a and 3.2b, are a positive relationship between the foreign holdings' share and volatility and the significance of the inflation rate's coefficient in the sub-period. As for the rest of the control variables' coefficients, the results tend to be similar.

In including the interaction term, considering the VIX index is an exogenous variable, this study hypothesises that the effect of the VIX index on volatility in Indonesia's bond market might vary depending on the foreign holdings' share. The results provided in columns 3.2c and 3.2d indicate that the relationships between the interaction term and volatility are negative in both observation periods. Particularly in the whole period, when the statistical result is more reliable, the negative coefficient suggests that the VIX index's impact on the domestic bonds market's volatility could be minimised following an increase in the foreign holdings' share. As shown in column 3.2c, each additional 1% of the foreign holdings' share at $t-1$ decreases the effect of the VIX index at t on the volatility at t by 0.056 unit. The left panel in Figure 3.3 illustrates the effect of the VIX index on the bond market volatility getting smaller when the share of foreign holdings increases.

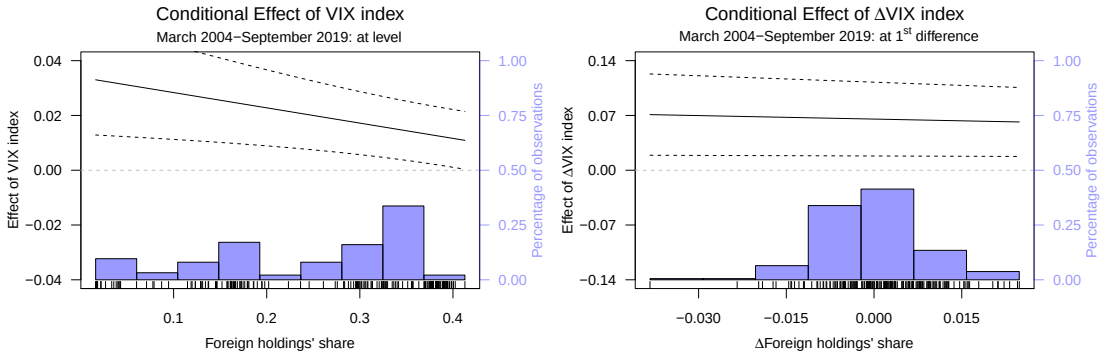


Figure 3.3: The conditional effect of VIX index, at level and first difference

By exploring Vietnam's stock market, Batten and Vo (2015) find that foreign investors consider a degree of information asymmetry essential in deciding their investment policy. They would prefer to invest in large companies that could provide a lower degree of information asymmetry. Therefore, less favoured companies must improve their transparency in managing their assets to become increasingly attractive to foreign investors. Further, considering that foreign investors in emerging markets also are assumed to have more expertise and more advanced technology, an increase in their participation, to a certain degree, could develop the domestic market by improving market transparency. In Indonesia's bonds market, a critical role of foreign investors is in lessening the volatility, as presented in column 3.2c of Table 3.2, possibly because of their contribution to enhancing the bonds market transparency. An increase in market transparency would then promote a more developed bonds market that is more resilient to the volatility in the global financial market. To this purpose, in collaboration with Bank Indonesia, as the central bank, the Government of Indonesia established the Investor Relation Unit[12] in 2005 to communicate Indonesian economic policy to the current and potential investors. Specifically, the Ministry of Finance, as the government bonds issuer, provide any guidelines related to the issuance of the bonds on their website regularly (i.e., issuance plans and results, outstanding, ownership by a different type of investors, next budget's year issuance calendar, etc.)[13].

[12]The information could be obtained by visiting https://www.bi.go.id/en/iru/default.aspx.
[13]The information could be obtained by visiting https://www.djppr.kemenkeu.go.id/.

The consistency of those results to the employment of bond prices' standard deviation as the dependent variable is then compared. Columns 3.2e to 3.2h of the similar table provide the latter specifications' statistical results. Due to having a greater variance or more heterogeneity that may cause an increase in the sensitivity, different results between these specifications (i.e., whether VOLY and VOLP is assigned as the dependent variable) might appear.

However, the results tend to be similar regarding the coefficients' signs and statistical significance. For example, in columns 3.2e and 3.2f, the VIX index and the ratio of short-term external debt to foreign reserves have a positive relationship with volatility. A 1-unit increase in the index is estimated to generate a hike in volatility by 0.086 and 0.037 points in the entire observation period and sub-period, respectively. In comparison, a 1-unit addition in the ratio could cause a rise in volatility by 21.1 and 15.6 points in the whole period and sub-period. Therefore, referring to these statistical findings, the VIX index and the ratio of short-term external debt to foreign reserves apparently have a decisive role in explaining the volatility that happened in Indonesia's local-currency bond market in both observable periods. However, their magnitude of influence is lessening due to the improvement of the country's rating status. In addition, the inflation rate expectation only influences volatility in the whole period, while the IDR tradable bonds to industrial output and the previous period's volatility only affect volatility in the sub-period.

Similar to columns 3.2c and 3.2d, columns 3.2g and 3.2h are the models with the inclusion of the interaction term. The employment of bond prices' standard deviation as the dependent variable presents a consistent result about a negative relationship between the interaction term and the volatility in the whole period and sub-period, with statistical significance only in the whole period. The finding emphasises the important contribution of foreign investors in diminishing the effect of the VIX index on the domestic bonds market from March 2004 to September 2019, a period that covers several important events in the global financial market (i.e. subprime mortgage crisis in 2008 and the eurozone debt crisis from 2010 to 2012).

Further, the first differences of the observable variables are utilised to address the stationarity issue, as explained in Equation 3.14. Thus, in these models, the changes in the bond yields' standard deviation, ΔVOLY, and the bond prices' standard deviation, ΔVOLP are estimated as a function of the change in the VIX index, the change in the share of foreign holdings, the change in the interaction term, and the changes in the control variables. Table 3.3 provides the statistical results of these models. Specifically, the outputs of the models with the inclusion of the change in the interaction term variable are shown in columns 3.3c, 3.3d, 3.3g, and 3.3h. Focusing more on the statistical significance and excluding a negative relationship between the changes in the previous period's volatility and the current volatility, the results tend to be similar to the specifications with the employment of the observable variables at the level at which the results are provided in Table 3.2.

Table 3.3: The OLS outputs – investigating volatility proxied by VOLY and VOLP variable, all variables of monthly dataset, at 1st difference

	ΔVOLY: Indonesia 10-year IDR bond yield, volatility$_t$				ΔVOLP: Indonesia 10-year IDR bond price, volatility$_t$			
	A whole period	Investment grade period	A whole period	Investment grade period	A whole period	Investment grade period	A whole period	Investment grade period
	(3.3a)	(3.3b)	(3.3c)	(3.3d)	(3.3e)	(3.3f)	(3.3g)	(3.3h)
ΔVIXI$_t$:ΔVIX index$_t$	0.028**	0.007***	0.070***	0.009	0.096***	0.045**	0.221***	0.074
	(2.391)	(2.797)	(2.930)	(0.186)	(2.762)	(2.471)	(2.892)	(0.216)
ΔFORH$_{t-1}$:ΔThe foreign holdings' share$_{t-1}$	-3.037*	0.095	-4.078	2.361	-12.772	4.073	-10.098	9.855
	(-1.877)	(0.096)	(-0.688)	(0.526)	(-1.643)	(0.585)	(-0.340)	(0.301)
ΔVIXI$_t$xFORH$_{t-2}$	-	-	-0.168***	-0.003	-	-	-0.497**	-0.077
	-	-	(-2.686)	(-0.028)	-	-	(-2.227)	(-0.086)
ΔFORH$_{t-1}$xVIXI$_t$	-	-	0.068	-0.143	-	-	-0.065	-0.364
	-	-	(0.222)	(-0.489)	-	-	(-0.043)	(-0.169)
ΔIDR tradable bonds over industrial output$_{t-1}$	0.034	-0.067	-0.002	-0.065	-0.074	-0.462	-0.159	-0.459
	(0.469)	(-1.493)	(-0.046)	(-1.449)	(-0.198)	(-1.544)	(-0.499)	(-1.508)
ΔInflation rate expectation$_{t-1}$	0.021**	0.027**	0.018*	0.028**	0.096**	0.164**	0.087*	0.163*
	(2.138)	(2.305)	(1.838)	(2.305)	(2.052)	(2.010)	(1.894)	(1.971)
ΔShort-term external debt over foreign reserves$_{t-1}$	3.862*	3.287**	2.075	3.143**	20.795**	22.039**	15.657*	21.497**
	(1.896)	(2.324)	(1.437)	(2.132)	(2.134)	(2.299)	(1.671)	(2.114)
ΔThe dependent variable$_{t-1}$	-0.549***	-0.378***	-0.551***	-0.373***	-0.520***	-0.395***	-0.522***	-0.393***
	(-4.726)	(-3.666)	(-5.734)	(-3.521)	(-5.440)	(-3.678)	(-5.509)	(-3.517)
Dummy variable: Investment grade period	-0.003	-	-0.009	-	-0.036	-	-0.047	-
	(-0.097)	-	(-0.355)	-	(-0.273)	-	(-0.371)	-
Constant	0.006	-0.001	0.012	-0.001	0.038	-0.012	0.046	-0.012
	(0.223)	(-0.093)	(0.503)	(-0.130)	(0.311)	(-0.204)	(0.404)	(-0.196)
Observations	185	94	185	94	185	94	185	94
Adjusted R^2	0.459	0.218	0.517	0.202	0.370	0.220	0.391	0.202

[1] ***, **, * denote significance at 1%, 5%, 10% respectively. [2] *t-statistics* in parentheses. [3] Dummy variable: no investment grade 0, investment grade 1 (Investment grade period). [4] VOLY and VOLP are the standard deviation of Indonesia 10-year bond yield and price, respectively. [5] A whole period: March 2004 to September 2019; Investment grade period: December 2011 to September 2019. [6] The multicollinearity test (VIF) are provided in Table 3.13. [7] The statistical results that use at level of the observable variables are displayed in Table 3.2.

The outputs provided in column 3.3a and 3.3b are differentiated by the observable period and employ the change of bond yields' standard deviation as the dependent variable. Consequently, in the second column, the dummy variable of the investment-grade status is not included. By comparing these outputs, the study finds that the changes in the VIX index, inflation rate expectation, and the ratio of short-term external debt to foreign reserves positively correlate with the changes in volatility. However, particularly for the VIX index, its influence is lessening in a period when Indonesia's credit rating had a better status. A negative coefficient sign of the dummy variable confirms that a better status of the investment grade could reduce the volatility, even though the coefficient is not statistically significant. These findings generally prove robust when the change in bond prices' standard deviation is used as the dependent variable. The statistical results provided in column 3.3e and 3.3f show the changes in the VIX index, inflation rate expectation, and a ratio of short-term external debt to foreign reserves also have positive correlations with the changes in volatility. In contrast, the change in the last period's volatility negatively correlates with the change in the current volatility of the bond yields. These results differ from the regression in levels where the relationship between the last period's volatility and the current volatility is positive.

In particular, for the whole observable period in column 3.3a, with a 90% confidence interval, a 1-unit increase in the change of the foreign holdings' share is associated with a decline in the change of the bond yields' volatility by 3.04 points. Hence, based on the finding, it seems that the contribution of foreign investors in developing the domestic bonds market is essential (i.e. lessening the volatility due to the spillover effect from the global financial market). It is also consistent with the output obtained from the ARCH specification (see Table 3.1 column 3.1i). The negative sign of the coefficient is also similar to column 3.3e with a greater impact. However, in the latter specification, it is not statistically significant.

Then the robustness of the finding of a negative relationship between the interaction term and the volatility at the level (i.e. Table 3.2 columns 3.2c and 3.2g) is tested. Columns 3.3c and 3.3g of Table 3.3 show the results. In these columns, the outputs appear to echo the previous findings of the negative relationship between the interaction term and the volatility from March 2004 to September 2019. A clearer explanation is displayed in the right panel in Figure 3.3. It demonstrates that the impact of an increase in the change of the VIX index on the change in Indonesia's bond market volatility slightly lessens when the change in the foreign holdings' share is growing. Considering the illustrative model explained in the previous section, the results highlight that the effect of the foreign holdings' share on the VIX index depends on the relative sensitivity of foreign and domestic investors to the bond yields (and bond prices) and VIX index.

3.6.4 Disaggregating foreign investors

Given the possibility of different preferences in managing investment portfolios, a more detailed bondholders' categorisation would benefit policymakers in responding to any unfavourable issues that may arise in the secondary market. Therefore, mainly, this study assesses the role of private foreign investors (e.g., investment banks, mutual funds, foundations, individuals, insurance companies, and pension funds) and official foreign investors (e.g. central banks and governments) in determining volatility in Indonesia's local currency bonds market. From February 2013 to September 2019, as illustrated in Figure 3.4, the average share of private foreign investors' holdings was about four times greater than official foreign investors' holdings (30.09% vs 7.23%).

The specification explained in Equation 3.12 is applied and replaces the foreign holdings' share variable with the private foreign holdings' share and the official foreign holdings' share. Table 3.4 shows the statistical results from the specifications. However, considering the data are only available from February 2013 to Septem-

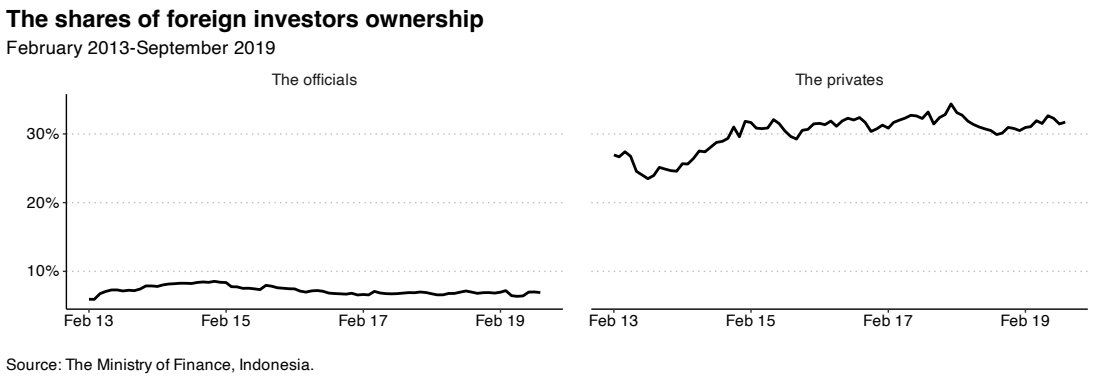


Figure 3.4: The shares of foreign holdings: the officials and the privates

ber 2019, the results can be compared to the previous findings that use all foreign holdings' shares in the models with the observation period from December 2011 to September 2019, when Indonesia already had investment-grade status. Likewise, the results are differentiated based on the dependent variable: bond yields' standard deviation or bond prices' standard deviation. In addition, the results of the multicollinearity test are presented in Table 3.14 in the Appendix section. As a rule of thumb, a high correlation between two or more explanatory variables is diagnosed if the variance inflation factors (VIF) number is more than 10. Hence, the VIF numbers of our variables of interest, VIX index and the share of each type of foreign investors' holdings, provided in columns 3.4b, 3.4d, 3.4f, and 3.4h are much greater than columns 3.4a, 3.4c, 3.4e, and 3.4g because the interaction term to the former models is included, and there is an inevitable correlation between the interaction term and its constituent variables

The outputs show that the employment of different types of foreign investors as an explanatory variable does not change the primary outcome from the previous specification presented in columns 3.2b and 3.2f of Table 3.2. The models also discover that the VIX index and the ratio of short-term external debt are critical in determining volatility because they have similar coefficients to the statistical outputs of the previous models, which are significantly positive. As presented in column 3.4a, a 1-unit increase in the index and the ratio could generate an upsurge in the volatility by 0.006 and 2.553 units, while in column 3.4e, a similar rise of

these regressors could cause addition in the volatility by 0.006 and 2.471 units. The impacts are not too different from the previous models, which are 0.006 and 2.753 units. These findings also proved robust to a different model where bond prices' standard deviations are used as the response variable. In columns, 3.4c and 3.4g, the results obtained from the OLS models reveal that their relationships with the volatility are significantly positive. The greater coefficients' numbers compared to columns 3.4a and 3.4e possibly because bond prices' standard deviations are greater than bond yields' standard deviation.

In addition, a relatively similar specification is implemented by using the first difference of the observable variables to address a stationarity issue. Table 3.5 presents the results from the latest specification. From columns, 3.5a, 3.5c, 3.5e, and 3.5g, the outputs conclude that the findings are consistent since the coefficients' sign of the changes in VIX index and short-term external debt to foreign reserves are significantly positive as well. The outputs suggest that, in the case of Indonesia's domestic bond market, the VIX index and the ratio of short-term external debt to foreign reserves are essential in determining the volatility from February 2013 to September 2019. As for other control variables, the relationships with the volatility are inconsistent compared to the employment of a more heterogeneous dependent variable or the usage of the first difference as the observable variables.

Furthermore, the statistical results of specifications with an inclusion of the interaction term are shown in columns 3.4b and 3.4f. Following the previous approach, the robustness of the findings in these columns is tested by using a different measure of volatility as the response variable, provided in columns 3.4d and 3.4h of Table 3.4, and addressing the stationarity issue, displayed in columns 3.5b, 3.5d, 3.5f, and 3.5h of Table 3.5.

Table 3.4: The OLS outputs – investigating volatility proxied by VOLY and VOLP variable, disaggregating foreign investors, at level

	Private foreign bondholders				Official foreign bondholders			
	VOLY: Indonesia 10-year IDR bond yield, volatility$_t$		VOLP: Indonesia 10-year IDR bond price, volatility$_t$		VOLY: Indonesia 10-year IDR bond yield, volatility$_t$		VOLP: Indonesia 10-year IDR bond price, volatility$_t$	
	(3.4a)	(3.4b)	(3.4c)	(3.4d)	(3.4e)	(3.4f)	(3.4g)	(3.4h)
VIXI$_t$: VIX index$_t$	0.006***	0.115**	0.032**	0.745**	0.006***	-0.074**	0.033***	-0.496**
	(2.696)	(2.286)	(2.433)	(2.129)	(2.932)	(-2.481)	(2.655)	(-2.262)
FNBP$_{t-1}$: Foreign private holdings' share	-0.049	4.781**	-0.157	31.422**	-	-	-	-
	(-0.100)	(2.163)	(-0.053)	(2.054)	-	-	-	-
FCBP$_{t-1}$: Foreign official holdings' share	-	-	-	-	-1.765	-17.733***	-11.521	-117.998***
	-	-	-	-	(-1.021)	(-3.005)	(-1.017)	(-2.764)
VIXI$_t$xFNBP$_{t-1}$	-	-0.349**	-	-2.281**	-	-	-	-
	-	(-2.192)	-	(-2.050)	-	-	-	-
VIXI$_t$xFCBP$_{t-1}$	-	-	-	-	-	1.110***	-	7.406**
	-	-	-	-	-	(2.694)	-	(2.427)
IDR tradable bonds over industrial output$_{t-1}$	-0.041*	-0.029	-0.288**	-0.209	-0.048**	-0.044**	-0.331**	-0.302**
	(-1.940)	(-1.444)	(-2.059)	(-1.566)	(-2.135)	(-1.994)	(-2.150)	(-2.008)
Inflation rate expectation$_{t-1}$	0.009	0.010	0.038	0.042	0.011*	0.012**	0.050	0.059
	(1.332)	(1.616)	(0.847)	(1.043)	(1.680)	(2.005)	(1.184)	(1.445)
Short-term external debt over foreign reserves$_{t-1}$	2.553***	2.047***	15.357***	11.885**	2.471***	2.943***	14.654***	17.603***
	(3.535)	(2.696)	(3.172)	(2.293)	(3.535)	(4.255)	(3.212)	(3.885)
The dependent variable$_{t-1}$	0.241**	0.231**	0.214**	0.212**	0.233**	0.191**	0.206**	0.167**
	(2.575)	(2.477)	(2.516)	(2.479)	(2.582)	(2.087)	(2.502)	(2.008)
Constant	0.090	-1.456**	0.836	-9.270*	0.219	1.330***	1.711	9.134***
	(0.603)	(-2.101)	(0.857)	(-1.924)	(1.082)	(3.110)	(1.244)	(3.017)
Observations	79	79	79	79	79	79	79	79
Adjusted R^2	0.408	0.437	0.326	0.359	0.416	0.439	0.335	0.362

[1] ***, **, * denote significance at 1%, 5%, 10% respectively. [2] *t-statistics* in parentheses. [3] VOLY and VOLP are the standard deviation of Indonesia 10-year bond yield and price, respectively.[4] The multicollinearity test (VIF) are provided in Table 3.14. [5] The statistical results that use the 1st difference of the observable variables are displayed in Table 3.5. [6] The estimation period is from February 2013 to September 2019.

Table 3.5: The OLS outputs – investigating volatility proxied by VOLY and VOLP variable, disaggregating foreign investors, at 1st difference

	Private foreign bondholders				Official foreign bondholders			
	ΔVOLY: Indonesia 10-year IDR bond yield, volatility$_t$		ΔVOLP: Indonesia 10-year IDR bond price, volatility$_t$		ΔVOLY: Indonesia 10-year IDR bond yield, volatility$_t$		ΔVOLP: Indonesia 10-year IDR bond price, volatility$_t$	
	(3.5a)	(3.5b)	(3.5c)	(3.5d)	(3.5e)	(3.5f)	(3.5g)	(3.5h)
$\Delta VIXI_t$:ΔVIX index$_t$	0.008***	0.073	0.051***	0.579*	0.008***	-0.066**	0.054***	-0.441**
	(3.450)	(1.357)	(3.213)	(1.704)	(3.270)	(-2.203)	(3.194)	(-2.202)
$\Delta FNBP_{t-1}$:ΔForeign private holdings' share$_{t-1}$	-1.612	7.630**	-8.673	49.452**	-	-	-	-
	(-1.367)	(2.246)	(-1.083)	(2.094)	-	-	-	-
$\Delta FCBP_{t-1}$:ΔForeign official holdings' share$_{t-1}$	-	-	-	-	6.069*	1.080	45.201**	-1.002
	-	-	-	-	(1.798)	(0.071)	(2.035)	(-0.010)
$\Delta VIXI_t$x$FNBP_{t-2}$	-	-0.206	-	-1.689	-	-	-	-
	-	(-1.206)	-	(-1.556)	-	-	-	-
$\Delta FNBP_{t-1}$x$VIXI_t$	-	-0.593***	-	-3.699**	-	-	-	-
	-	(-2.828)	-	(-2.525)	-	-	-	-
$\Delta VIXI_t$x$FCBP_{t-2}$	-	-	-	-	-	1.029**	-	6.847**
	-	-	-	-	-	(2.526)	-	(2.507)
$\Delta FCBP_{t-1}$x$VIXI_t$	-	-	-	-	-	0.341	-	3.135
	-	-	-	-	-	(0.330)	-	(0.461)
ΔIDR tradable bonds over industrial output$_{t-1}$	-0.038	-0.027	-0.258	-0.198	-0.035	-0.039	-0.203	-0.225
	(-0.796)	(-0.618)	(-0.836)	(-0.705)	(-0.739)	(-0.838)	(-0.645)	(-0.728)
ΔInflation rate expectation$_{t-1}$	0.025**	0.026**	0.144*	0.147**	0.027**	0.024**	0.154*	0.133**
	(2.125)	(2.282)	(1.860)	(2.042)	(2.217)	(2.233)	(1.953)	(2.003)
ΔShort-term external debt over foreign reserves$_{t-1}$	2.820**	1.785	18.408**	11.340	3.364**	3.268**	21.727**	21.065**
	(2.127)	(1.383)	(2.057)	(1.277)	(2.556)	(2.484)	(2.500)	(2.418)
ΔThe dependent variable$_{t-1}$	-0.358***	-0.331***	-0.363***	-0.330**	-0.316***	-0.319***	-0.327**	-0.330**
	(-2.968)	(-2.778)	(-2.818)	(-2.617)	(-2.733)	(-2.680)	(-2.625)	(-2.563)
Constant	0.001	-0.000	0.004	-0.003	-0.001	-0.001	-0.009	-0.010
	(0.101)	(-0.018)	(0.064)	(-0.041)	(-0.119)	(-0.129)	(-0.158)	(-0.159)
Observations	78	78	78	78	78	78	78	78
Adjusted R^2	0.206	0.238	0.196	0.230	0.211	0.222	0.213	0.224

[1] ***, **, * denote significance at 1%, 5%, 10% respectively. [2] *t-statistics* in parentheses. [3] VOLY and VOLP are the standard deviation of Indonesia 10-year bond yield and price, respectively. [5] The multicollinearity test (VIF) are provided in Table 3.15. [6] The statistical results that use at level of the observable variables are displayed in Table **??**. [7] The estimation period is from February 2013 to September 2019.

Regardless of the multicollinearity concerns, the finding obtained from the specification provided in column 3.4b presents a significantly negative relationship between the volatility and the interaction term of the VIX index and foreign private holdings' share. It suggests that the harmful impact of the VIX index on the volatility could be reduced as the share of foreign private holdings increases. On the contrary, column 3.4f shows a significantly positive relationship between the volatility and the interaction of the VIX index and foreign official holdings' shares. It appears that the private and official foreign investors have different roles in affecting the local currency government bond market in Indonesia, where more participation of the official foreign investors could have a less advantageous effect in reducing the volatility. However, in interpreting the results, a lower share of their holdings than the private foreign investors needs to be considered, as illustrated in Figure 3.4. In addition, Papaioannou et al. (2006) describes that central banks' portfolio managers also adopt a mean-variance portfolio policy. More specifically, it suggests that they prefer a bond with the lowest variance among different bonds with similar expected returns. Conversely, they would favour a bond with the highest expected return among different bonds that have a similar variance.

These statistical outcomes are consistent with the use of bond prices' standard deviation as the response variable exhibited in columns 3.4d and 3.4h. The interaction term coefficients' signs in those columns are significantly negative and positive, respectively, with a greater impact than the coefficients in columns 3.4b and 3.4f (2.28 vs 0.35 and 7.41 vs 1.11). Moreover, the interaction term coefficients' signs are similar to utilising the first difference of the observable variables in the models, as indicated by the results provided in Table 3.5. Columns 3.5b and 3.5d present information that the relationships between the changes in the interaction term and the volatility are negative. Meanwhile, in columns 3.5f and 3.5h, the relationships between those variables are positive.

In the previous section, columns 3.2d and 3.2h of Table 3.2 and columns 3.3d and 3.3h of Table 3.3 show that the employment of all foreign investors as an independent variable in the models cannot capture a significant relationship between the interaction term and the volatility. However, by focusing more on the interaction term, the disaggregation of foreign investors can provide more persuasive evidence about their roles in influencing the domestic bond market in Indonesia. Accordingly, it could be utilised by policymakers and researchers as a proxy to observe their behaviour in emerging markets.

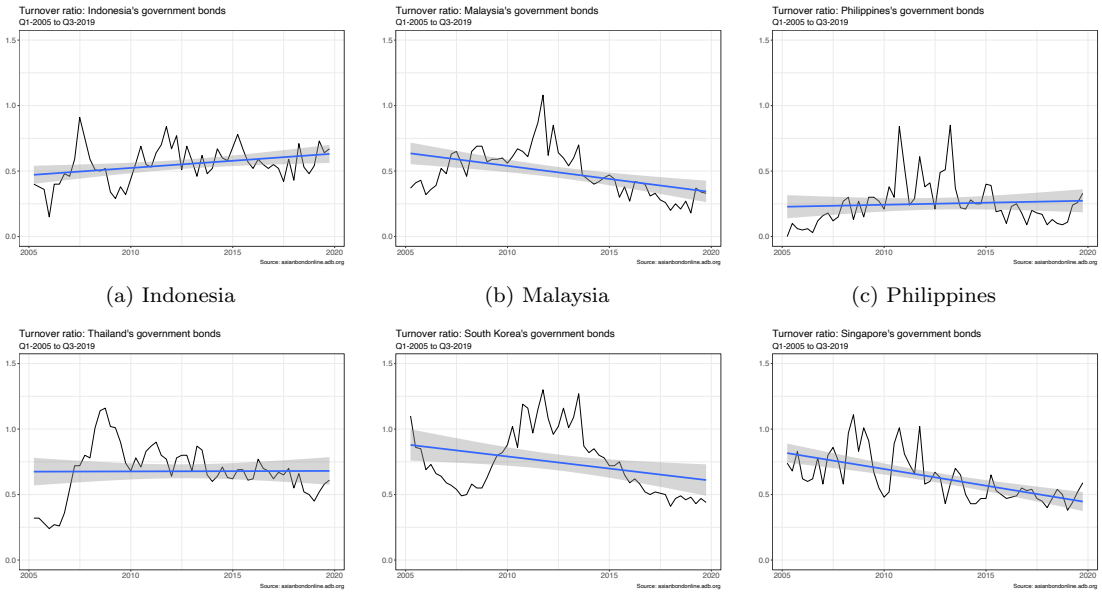
3.7 Discussions

Luengnaruemitchai and Ong (2005) mention that increasing foreign investors' participation in a domestic market could improve the market infrastructure and enhance the pricing mechanism. Besides, a greater number of foreign investors in the domestic market could assist domestic investors if they need an alternative funding source. Considering the share of foreign investors' ownership in Indonesia is the highest in emerging East Asia economies[14], then their contributions to developing the domestic bond market cannot be disregarded. Accordingly, the main objective of this sub-section is to investigate the contribution of foreign investors in improving the local-currency government bonds market liquidity in the secondary market, which is represented in the turnover ratio.

Deemed essential in examining a financial market's performance, market liquidity could be used as an indicator to measure the degree of easiness of finding a counterpart if an investor wants to sell or buy a financial instrument without sacrificing its price (sell much lower or buy much higher than the average market price). Intuitively, an illiquid market would be less attractive for the market players since

[14]Subject to data availability on asianbondsonline.adb.org: Indonesia 25.67% (Q4 2003-Q3 2019), South Korea 7.54% (Q4 2002-Q3 2019), Malaysia 13.00% (Q1 2008-Q3 2019), Philippines 4.91% (Q4 2016-Q3 2019), Thailand 9.20% (Q1 2003-Q3 2019).

they cannot adjust their portfolios immediately following any events that potentially could deteriorate their returns. Therefore, the assumption is the more liquid the transaction, the more developed the market. Consequently, a more established market would suffer less from unexpected turbulence (i.e., continuous and sudden capital outflow).



(a) Indonesia (b) Malaysia (c) Philippines

(d) Thailand (e) South Korea (f) Singapore

Figure 3.5: Turnover ratios in the domestic government bond markets.

Figure 3.5[15] shows the turnover ratio[16] in selected members of the Asian Development Bank from Q1-2005 to Q3-2019. During this period, most turnover ratio trends declined, except for Indonesia, the Philippines, and Thailand. In addition, at the end of the period, Indonesia's turnover ratio tends to have improved compared to other members.

Table 3.6 presents statistical outputs of a model to examine the role of foreign holdings' share in improving the domestic market liquidity, proxied by a ratio between total daily trading and total tradable Indonesian rupiah government bonds (turnover ratio). To address the stationarity issue in the models, the table is differentiated to models with observable variables at level (columns 3.6a and 3.6b)

[15]Source: Asian Development Bank

[16]The turnover ratio is measured by dividing the value of bonds traded by the average amount of bonds outstanding at the end of the previous and current quarters.

and at the first difference (columns 3.6c and 3.6d).

Table 3.6: The OLS outputs – determining the turnover ratio, selected variables of monthly dataset

Dependent variable:	Turnover ratio$_t$		ΔTurnover ratio$_t$	
	A whole period	Investment grade period	A whole period	Investment grade period
	(3.6a)	(3.6b)	(3.6c)	(3.6d)
VIXI$_t$: VIX index$_t$	-0.072	0.359*	-	-
	(-1.291)	(1.902)	-	-
FORH$_{t-1}$: The foreign holdings' share$_{t-1}$	64.330***	115.191***	-	-
	(7.703)	(4.062)	-	-
IDR tradable bonds over industrial output$_{t-1}$	-1.515	-2.023	-	-
	(-1.051)	(-1.208)	-	-
ΔVIXI$_t$:ΔVIX index$_t$	-	-	0.090	0.080
	-	-	(0.912)	(0.313)
ΔFORH$_{t-1}$:ΔThe foreign holdings' share$_{t-1}$	-	-	6.947	5.834
	-	-	(0.114)	(0.059)
ΔIDR tradable bonds over industrial output$_{t-1}$	-	-	8.637**	11.008**
	-	-	(2.393)	(2.404)
Dummy variable: Investment grade period	3.591*	-	-0.214	-
	(1.927)	-	(-0.201)	-
Constant	13.340***	-6.391	0.047	-0.208
	(4.926)	(-0.714)	(0.085)	(-0.218)
Observations	186	94	185	94
Adjusted R^2	0.620	0.142	0.009	0.008
Multicollinearity test: Variance Inflation Factors				
VIXI$_t$: VIX index$_t$	1.31	1.05	-	-
FORH$_{t-1}$: The foreign holdings' share$_{t-1}$	5.8	1.63	-	-
IDR tradable bonds over industrial output$_{t-1}$	4.46	1.62	-	-
ΔVIXI$_t$:ΔVIX index$_t$	-	-	1.02	1.02
ΔFORH$_{t-1}$:ΔThe foreign holdings' share$_{t-1}$	-	-	1.08	1.03
ΔIDR tradable bonds over industrial output$_{t-1}$	-	-	1.05	1.04
Dummy variable: Investment grade period	4.04	-	1.02	-

[1] ***, **, * denote significance at 1%, 5%, 10% respectively. [2] *t-statistics* in parentheses. [3] Dummy variable: no investment grade 0, investment grade 1 (Investment grade period). [4] A whole period: March 2004 to September 2019; Investment grade period: December 2011 to September 2019.

Column 3.6a and column 3.6b provide statistical evidence about the relationship between the share of foreign holdings and the turnover ratio in both observation periods. A 1-unit rise in the foreign holdings' share is associated with improved market liquidity by 64.33 units in the entire period. Moreover, their influence is increased in the sub-period to 115.19 units. The VIX index, in particular, only impacts the market liquidity in the sub-period. Higher volatility in the global financial market, as represented by the variable, could intensify more frequent transactions in the secondary market. From a market player's point of view, it is a good indicator since they could liquidate their portfolios and then reallocate them to other markets in an unfavourable market condition. Further, the outputs indicate that an investment-grade status is essential in increasing the liquidity that could benefit the development of the domestic bond market. However, when the specification employs the first difference of the observable variables, the findings

do not hold. In the latter specification, as displayed in column 3.6c and 3.5d, the change of the turnover ratio could only be influenced by the change of the ratio between the total of local currency tradable bonds and the industrial output.

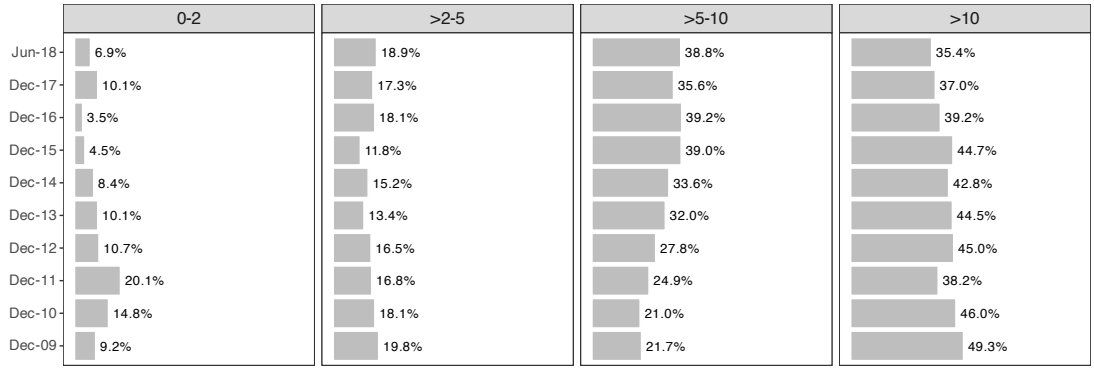


Figure 3.6: The composition of foreign investors' holdings, grouped by the bonds' term to maturity (in years)

In addition, it is also probably because of their policies in increasing the holdings in >5 years bonds, which could not be considered short-term bonds. Differentiated by the term of maturity of Indonesia's local currency government bonds, Figure 3.6 illustrates the composition of foreign investors' holdings from December 2009 to June 2018. In this period, it appears they had focused more on investing in the >5-10 years bonds than in 0-2 years, >2-5 years, and >10 years. As a result, the intermediate-term bonds' composition increased from 21.7% at the end of 2009 to 38.8% in the mid of 2018. Further, when the eurozone sovereign debt crisis emerged, they adjusted the short-term bonds' composition from 20.1% at the end of 2011 to 4.5% at the end of 2015. On the contrary, in the same period, they had raised the long-term bonds' composition from 38.2% to 44.7%. To sum up, foreign investors were more interested in investing in long- and intermediate-term bonds than in short-term ones, possibly because they considered Indonesia's government bonds to be either less risky or more promising than other countries. Further, Adam et al. (2014) explains that in the case of the Polish bond market, a stable base of foreign investors that hold the long-term asset is associated with a more resilient domestic market.

3.8 Conclusions

The study in this chapter follows work by Ebeke and Lu (2015) and implements an autoregressive method to determine volatility in Indonesia's domestic bonds market on a monthly data set from March 2004 to September 2019. However, in Indonesia's case, the results find that the autoregressive method is less persuasive in explaining volatility within a month since the method utilises end-of-month data. Therefore, modelling volatility using daily data could be a sensible approach due to rapid changes in the global risk appetite. Accordingly, this study measures the volatility by calculating the bond yields' standard deviation and using it as a response variable in the regression model. Moreover, bond prices' standard deviations are also utilised as the dependent variable, and the first differences of the observable variables are used in a relatively similar specification to check the robustness of the findings. Further, the utilisation of the daily data set from 1 March 2004 to 30 September 2019 to define volatility in Indonesia's bonds market and the implementation of the alternative approach are two attributes that this study proposes as novelties to the current literature.

The statistical results show that the volatility in Indonesia's local currency bond market is highly correlated with the 30-day future of the US's S&P index options, an underlying variable to measure the VIX index. In addition, the results also indicate that higher participation of foreign investors in the domestic bond markets, compensated by a lower share of the domestic investors' holdings, could be beneficial in lessening the impact. The latter result is somewhat different to Andritzky (2012), Peiris (2013), and Ebeke and Lu (2015). A plausible explanation behind their role in reducing the effect of the VIX index on volatility is the foreign investors' contribution to developing the domestic market by increasing its liquidity and their decision to invest more in intermediate-term and long-term bonds rather than short-term bonds. Eventually, a more developed local-currency bond market could recover quickly after being affected by the unfavourable condition in

the global financial market. Taking into account the theoretical model, it appears that even though foreign investors tend to be more sensitive to the VIX index than the domestic investor, it does not always mean that greater foreign investors' holdings would raise volatility in the domestic bonds market since the condition is also influenced by foreign investors' sensitivity on the bond yields.

Furthermore, different to official foreign investors, the study also finds that private foreign investors have an essential role in reducing the impact of the VIX index on the domestic bond market volatility, proxied by the bond yields' standard deviation. The result is robust to the employment of the bond prices' standard deviation as the response variable and the utilisation of the first difference of the observable variables in the models. Additionally, the disaggregation of foreign investors has revealed the different roles of each type of foreign investor in affecting the domestic bond market. Thus, the findings suggest a more profound study is needed to investigate different types of bondholders' behaviour in developing Indonesia's local-currency bond market, especially in lessening the impact of undesired spillover from the global market. The results provided in this chapter also unveil that the ratio of short-term external debt to foreign reserves positively correlates with volatility. It suggests that a domestic factor influences Indonesia's bond market volatility besides the global factor, especially the VIX index.

Therefore, considering the fact that the establishment of a local-currency bond market is essential for financing the budget deficit, the government needs to continuously enhance the strategies in managing the market, i.e. by developing tools to measure the potential risk, diversifying the instruments, sharpening a bond stabilisation framework to enter the market in a case it is getting worsening and preparing alternative plans if the cost of bonds issuance is considered too expensive and could be a burden for the state budget.

3.9 Appendix

3.9.1 Tables

Table 3.7: Description of variables

Code	Definition	Measurement unit	Data sources
IG10P	Mid price to maturity of Indonesia's local currency 10-year government bonds (constant maturity in approximate 10 years), end of the month.	In percentage	Bloomberg
IG10Y	Mid yield to maturity of Indonesia's local currency 10-year government bonds (constant maturity in approximate 10 years), end of the month.	In percentage	Bloomberg
VOLY	The local currency bond market volatility based on Indonesia's 10-year bond yield (IG10Y). The standard deviation of daily observation within a month in the monthly dataset; and within the last five days in the daily dataset.	A numerical	Author's calculation.
VOLP	The local currency bond market volatility based on Indonesia's 10-year bond price (IG10P). The standard deviation of daily observation within a month in the monthly dataset; and within the last five days in the daily dataset.	A numerical	Author's calculation.
FORH	All foreign investors' ownership in tradable Indonesian rupiah government bonds - the share over total tradable, end of the month.	A numerical	Indonesia MoF
VIXI	An index developed by the Chicago Board Options Exchange (CBOE) based on 30-day future S&P 500 index options, a proxy to capture global financial conditions, especially during financial anxiety. On average, within a month in the monthly dataset and within the last five days in the daily dataset.	Index	Bloomberg
TOID	A ratio between total Indonesia rupiah tradable bonds and the industrial output; a proxy to measure the debt of GDP, end of the month.	A numerical	Indonesia MoF, World Bank
IDIE	The average of expected inflation YoY according to Bloomberg's survey of domestic commercial banks' economists in Indonesia.	In percentage	Bloomberg
XDDV	A ratio between non-IDR government bonds mature less than 1 year and the foreign reserves. A proxy to measure a short-term external debt over the foreign reserves.	A numerical	Indonesia MoF, Bank Indonesia
TOVR	A ratio between total daily trading and total tradable IDR government bonds (turnover ratio). A proxy to measure liquidity in the secondary market.	In percentage	Indonesia MoF

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Table 3.7 – continued from previous page

Code	Definition	Measurement unit	Data sources
DMRT	A dummy variable to represent Indonesia's investment grade status, where 0 is the non-investment grade period (Mar-04 to Nov-11) and 1 is the investment grade period (Dec-11 to Sep-19)	A numerical	Author's calculation
RESSQ	The residuals (in absolute value) obtained from a regression where Indonesia's 10-year bond yield (IG10Y) as a function of the VIX index (VIXI), the share of the foreign holdings' share (FORH), the ratio of total IDR tradable bonds to industrial output (TOID), the ratio of total short-term external debt to foreign reserves (XDDV), and the dummy variable related to the investment grade status (DMRT).	A numerical	Author's calculation
RVOL	Realised volatility; calculated on a monthly basis by following Chatziantoniou et al. (2021)'s method. Basically, it is the square root of the realised variance after taking into account the number of trading days in each respective month	A numerical	Author's calculation

Table 3.8: Summary statistics of variables, Mar. 2004–Sep. 2019

	Mean	Std. Dev.	Min.	Max.	Var.	Skew.	Kurt.	No. Obs.
Indonesia 10-year IDR bond yield	8.92	2.33	5.15	17.26	5.45	0.79	3.28	187
Indonesia 10-year IDR bond price	100.45	10.93	61.47	124.77	119.57	-0.71	3.89	187
Indonesia 10-year IDR bond yield - volatility	0.20	0.23	0.02	2.31	0.05	5.53	45.71	187
Indonesia 10-year IDR bond price - volatility	1.19	0.98	0.13	7.93	0.96	3.08	17.63	187
Foreign holdings' share	0.26	0.12	0.02	0.41	0.02	-0.57	1.96	187
Foreign private holdings' share	0.30	0.03	0.23	0.34	6.84×10^{-4}	-1.08	3.09	80
Foreign official holdings' share	0.07	0.01	0.06	0.09	3.72×10^{-5}	0.50	2.58	80
VIX index	18.29	8.34	10.13	62.25	69.51	2.63	11.86	187
The ratio of IDR tradable bonds to industrial output	2.75	0.81	1.62	4.99	0.65	0.57	2.36	187
Inflation rate expectation	6.26	3.32	2.53	18.10	11.00	1.63	5.63	187
The ratio of short-term external debt to the foreign reserves	0.01	0.01	0.00	0.05	1.61×10^{-4}	1.30	3.60	187
The domestic bond market's turnover ratio	26.42	10.81	6.75	51.37	116.83	0.26	2.14	187
The absolute-residual of the main regression model	0.94	0.78	0.03	6.01	0.61	2.26	12.93	186
Realised volatility	4.83	5.36	0.35	42.16	28.72	3.65	19.87	187

Table 3.9: Cross-correlation table, at level: Mar. 2004–Sep. 2019

	IG10Y	IG10P	VOLY	VOLP	FORH	VIXI	TOID	IDIE	XDDV	TOVR	RESSQ	RVOL
IG10Y	1.00	-0.56	0.47	0.35	-0.78	0.32	-0.70	0.69	-0.40	-0.57	0.33	0.35
IG10P	-0.56	1.00	-0.45	-0.33	0.17	-0.13	0.14	-0.53	-0.22	0.05	-0.33	-0.41
VOLY	0.47	-0.45	1.00	0.95	-0.21	0.65	-0.28	0.29	-0.12	-0.13	0.49	0.71
VOLP	0.35	-0.33	0.95	1.00	-0.16	0.63	-0.26	0.22	-0.11	-0.09	0.39	0.67
FORH	-0.78	0.17	-0.21	-0.16	1.00	-0.15	0.87	-0.53	0.61	0.78	-0.13	-0.10
VIXI	0.32	-0.13	0.65	0.63	-0.15	1.00	-0.26	0.08	-0.29	-0.18	0.43	0.48
TOID	-0.70	0.14	-0.28	-0.26	0.87	-0.26	1.00	-0.61	0.74	0.66	-0.28	-0.16
IDIE	0.69	-0.53	0.29	0.22	-0.53	0.08	-0.61	1.00	-0.34	-0.44	0.26	0.25
XDDV	-0.40	-0.22	-0.12	-0.11	0.61	-0.29	0.74	-0.34	1.00	0.54	-0.31	-0.02
TOVR	-0.57	0.05	-0.13	-0.09	0.78	-0.18	0.66	-0.44	0.54	1.00	-0.05	-0.03
RESSQ	0.33	-0.33	0.49	0.39	-0.13	0.43	-0.28	0.26	-0.31	-0.05	1.00	0.33
RVOL	0.35	-0.41	0.71	0.67	-0.10	0.48	-0.16	0.25	-0.02	-0.03	0.33	1.00

Table 3.10: Cross-correlation table, at 1st difference: Mar. 2004–Sep. 2019

	ΔIG10Y	ΔIG10P	ΔVOLY	ΔVOLP	ΔFORH	ΔVIXI	ΔTOID	ΔIDIE	ΔXDDV	ΔTOVR	ΔRESSQ	ΔRVOL
ΔIG10Y	1.00	-0.74	0.38	0.27	-0.43	0.46	-0.28	0.15	0.05	0.04	0.53	0.33
ΔIG10P	-0.74	1.00	-0.34	-0.29	0.35	-0.33	0.23	-0.17	-0.07	-0.09	-0.27	-0.23
ΔVOLY	0.38	-0.34	1.00	0.95	-0.17	0.42	-0.05	0.02	0.02	0.21	0.28	0.50
ΔVOLP	0.27	-0.29	0.95	1.00	-0.17	0.35	-0.05	0.01	0.02	0.25	0.17	0.47
ΔFORH	-0.43	0.35	-0.17	-0.17	1.00	-0.31	0.21	0.02	-0.12	0.11	0.00	-0.11
ΔVIXI	0.46	-0.33	0.42	0.35	-0.31	1.00	-0.22	0.06	-0.04	0.04	0.34	0.21
ΔTOID	-0.28	0.23	-0.05	-0.05	0.21	-0.22	1.00	-0.11	0.07	-0.26	-0.12	-0.10
ΔIDIE	0.15	-0.17	0.02	0.01	0.02	0.06	-0.11	1.00	0.00	-0.03	-0.09	-0.05
ΔXDDV	0.05	-0.07	0.02	0.02	-0.12	-0.04	0.07	0.00	1.00	-0.06	-0.03	0.03
ΔTOVR	0.04	-0.09	0.21	0.25	0.11	0.04	-0.26	-0.03	-0.06	1.00	0.16	0.27
ΔRESSQ	0.53	-0.27	0.28	0.17	0.00	0.34	-0.12	-0.09	-0.03	0.16	1.00	0.14
ΔRVOL	0.33	-0.23	0.50	0.47	-0.11	0.21	-0.10	-0.05	0.03	0.27	0.14	1.00

Table 3.11: The unit root test at the level, Mar. 2004–Sep. 2019, monthly dataset

Variables	Obs.	Z(t)	p-val.	CV 1%	CV 5%	CV 10%
Indonesia 10-year IDR bond yield	186	-2.094	0.247	-3.48	-2.88	-2.57
Indonesia 10-year IDR bond price	186	-3.170	0.022	-3.48	-2.88	-2.57
Indonesia 10-year IDR bond yield - volatility	186	-8.776	0.000	-3.48	-2.88	-2.57
Indonesia 10-year IDR bond price - volatility	186	-9.459	0.000	-3.48	-2.88	-2.57
Foreign holdings' share	186	-1.893	0.336	-3.48	-2.88	-2.57
Foreign private holdings' share	79	-1.552	0.508	-3.54	-2.91	-2.59
Foreign official holdings' share	79	-2.346	0.157	-3.54	-2.91	-2.59
VIX index	186	-3.425	0.010	-3.48	-2.88	-2.57
IDR tradable bonds over industrial output	186	-0.516	0.889	-3.48	-2.88	-2.57
Inflation rate expectation	186	-2.019	0.278	-3.48	-2.88	-2.57
The short-term external debt over the foreign reserves	186	-1.996	0.288	-3.48	-2.88	-2.57
The domestic bond market's turnover ratio	186	-5.011	0.000	-3.48	-2.88	-2.57

Note: Disaggregation foreign investors into central banks/governments and non-central banks/government is only available from Feb. 2013 to Sep. 2019.

Table 3.12: The variance inflation factors of OLS outputs in Table 3.2 – investigating volatility proxied by VOLY and VOLP variable, all variables of monthly data set, at level

	VOLY: Indonesia 10-year IDR bond yields, volatility$_t$				VOLP: Indonesia 10-year IDR bond prices, volatility$_t$			
	A whole period	Investment grade period	A whole period	Investment grade period	A whole period	Investment grade period	A whole period	Investment grade period
	(3.12a)	(3.12b)	(3.12c)	(3.12d)	(3.12e)	(3.12f)	(3.12g)	(3.12h)
Multicollinearity test: Variance Inflation Factors								
VIXI$_t$: VIX index$_t$	2.10	1.17	10.83	146.55	1.85	1.15	9.76	147.16
FORH$_{t-1}$: The foreign holdings' share$_{t-1}$	6.18	1.82	18.69	33.29	6.10	1.85	18.76	33.32
VIXI$_t$xFORH$_{t-1}$	-	-	17.10	149.56	-	-	16.52	150.16
IDR tradable bonds over industrial output$_{t-1}$	6.88	5.21	6.90	5.27	7.02	5.20	7.04	5.27
Inflation rate expectation$_{t-1}$	1.72	3.16	1.72	3.24	1.65	3.03	1.65	3.11
Short-term external debt over foreign reserves$_{t-1}$	2.65	2.04	2.66	2.14	2.67	1.92	2.68	2.02
The dependent variable$_{t-1}$	1.84	1.63	2.00	1.64	1.60	1.43	1.68	1.44
Dummy variable: Investment grade period	4.51	-	4.59	-	4.44	-	4.55	-

[1] ***, **, * denote significance at 1%, 5%, 10% respectively. [2] *t-statistics* in parentheses. [3] Dummy variable: no investment grade 0, investment grade 1 (Investment grade period). [4] VOLY and VOLP are the standard deviation of Indonesia 10-year bond yield and price, respectively. [5] A whole period: March 2004 to September 2019; Investment grade period: December 2011 to September 2019.

Table 3.13: The variance inflation factors of OLS outputs in Table 3.3 – investigating volatility proxied by VOLY and VOLP variable, all variables of monthly dataset, at 1st difference

	ΔVOLY: Indonesia 10-year IDR bond yield, volatility$_t$				ΔVOLP: Indonesia 10-year IDR bond price, volatility$_t$			
	A whole period	Investment grade period	A whole period	Investment grade period	A whole period	Investment grade period	A whole period	Investment grade period
	(3.13a)	(3.13b)	(3.13c)	(3.13d)	(3.13e)	(3.13f)	(3.13g)	(3.13h)
Multicollinearity test: Variance Inflation Factors								
ΔVIXI$_t$:ΔVIX index$_t$	1.02	1.04	8.87	149.73	1.02	1.04	8.86	149.73
ΔFORH$_{t-1}$:ΔThe foreign holdings' share$_{t-1}$	1.13	1.09	5.28	22.47	1.13	1.08	5.18	22.51
ΔVIXI$_t$xFORH$_{t-2}$	-	-	9.01	149.94	-	-	9.01	149.94
ΔFORH$_{t-1}$xVIXI$_t$	-	-	5.57	22.75	-	-	5.35	22.82
ΔIDR tradable bonds over industrial output$_{t-1}$	1.07	1.09	1.1	1.10	1.07	1.10	1.1	1.11
ΔInflation rate expectation$_{t-1}$	1.01	1.07	1.02	1.10	1.01	1.07	1.02	1.10
ΔShort-term external debt over foreign reserves$_{t-1}$	1.03	1.06	1.04	1.12	1.03	1.06	1.04	1.11
ΔThe dependent variable$_{t-1}$	1.03	1.03	1.11	1.04	1.03	1.02	1.07	1.04
Dummy variable: Investment grade period	1.02	-	1.04	-	1.02	-	1.04	-

[1] ***, **, * denote significance at 1%, 5%, 10% respectively. [2] *t-statistics* in parentheses. [3] Dummy variable: no investment grade 0, investment grade 1 (Investment grade period). [4] VOLY and VOLP are the standard deviation of Indonesia 10-year bond yield and price, respectively. [5] A whole period: March 2004 to September 2019; Investment grade period: December 2011 to September 2019.

Table 3.14: The variance inflation factors of OLS outputs in Table 3.4 – investigating volatility proxied by VOLY and VOLP variable, disaggregating foreign investors, at level

	Private foreign bondholders				Official foreign bondholders			
	VOLY: Indonesia 10-year IDR bond yields, volatility$_t$		VOLP: Indonesia 10-year IDR bond prices, volatility$_t$		VOLY: Indonesia 10-year IDR bond yields, volatility$_t$		VOLP: Indonesia 10-year IDR bond prices, volatility$_t$	
	(3.14a)	(3.14b)	(3.14c)	(3.14d)	(3.14e)	(3.14f)	(3.14g)	(3.14h)
Multicollinearity test: Variance Inflation Factors								
VIXI$_t$: VIX index$_t$	1.09	444.88	1.07	443.89	1.08	284.64	1.06	283.21
FNBP$_{t-1}$: Foreign private holdings' share	3.39	57.10	3.39	57.04	-	-	-	-
FCBP$_{t-1}$: Foreign official holdings' share	-	-	-	-	1.76	40.42	1.77	40.16
VIXI$_t$xFNBP$_{t-1}$	-	519.27	-	518.46	-	-	-	-
VIXI$_t$xFCBP$_{t-1}$	-	-	-	-	-	351.40	-	349.11
IDR tradable bonds over industrial output$_{t-1}$	5.44	5.61	5.44	5.62	4.14	4.17	4.14	4.17
Inflation rate expectation$_{t-1}$	4.02	4.03	3.90	3.91	4.01	4.05	3.88	3.91
Short-term external debt over foreign reserves$_{t-1}$	2.24	2.35	2.17	2.30	1.60	1.72	1.53	1.64
The dependent variable$_{t-1}$	1.75	1.75	1.55	1.55	1.76	1.82	1.56	1.60

[1] ***, **, * denote significance at 1%, 5%, 10% respectively. [2] *t-statistics* in parentheses. [3] VOLY and VOLP are the standard deviation of Indonesia 10-year bond yield and price, respectively. [4] The estimation period is from February 2013 to September 2019.

Table 3.15: The variance inflation factors of OLS outputs in Table 3.5 – investigating volatility proxied by VOLY and VOLP variable, all variables of monthly dataset, at 1st difference

	ΔVOLY: Indonesia 10-year IDR bond yield, volatility$_t$				ΔVOLP: Indonesia 10-year IDR bond price, volatility$_t$			
	A whole period	Investment grade period	A whole period	Investment grade period	A whole period	Investment grade period	A whole period	Investment grade period
	(3.15a)	(3.15b)	(3.15c)	(3.15d)	(3.15e)	(3.15f)	(3.15g)	(3.15h)
Multicollinearity test: Variance Inflation Factors								
$\Delta VIXI_t$:ΔVIX index$_t$	1.05	358.59	1.05	357.96	1.07	223.46	1.07	223.31
$\Delta FNBP_{t-1}$:ΔForeign private holdings' share$_{t-1}$	1.19	21.46	1.18	21.55	-	-	-	-
$\Delta FCBP_{t-1}$:ΔForeign official holdings' share$_{t-1}$	-	-	-	-	1.11	41.74	1.11	41.84
$\Delta VIXI_t$x$FNBP_{t-2}$	-	360.73	-	360.11	-	-	-	-
$\Delta FNBP_{t-1}$x$VIXI_t$	-	22.15	-	22.23	-	-	-	-
$\Delta VIXI_t$x$FCBP_{t-2}$	-	-	-	-	-	222.98	-	222.84
$\Delta FCBP_{t-1}$x$VIXI_t$	-	-	-	-	-	42	-	42.08
ΔIDR tradable bonds over industrial output$_{t-1}$	1.16	1.19	1.16	1.19	1.16	1.18	1.16	1.18
ΔInflation rate expectation$_{t-1}$	1.08	1.09	1.08	1.08	1.07	1.09	1.07	1.08
ΔShort-term external debt over foreign reserves$_{t-1}$	1.07	1.17	1.07	1.16	1.03	1.04	1.03	1.03
ΔThe dependent variable$_{t-1}$	1.06	1.08	1.05	1.07	1.03	1.07	1.03	1.07

[1] ***, **, * denote significance at 1%, 5%, 10% respectively. [2] *t-statistics* in parentheses. [3] Dummy variable: no investment grade 0, investment grade 1 (Investment grade period). [4] VOLY and VOLP are the standard deviation of Indonesia 10-year bond yield and price, respectively. [5] A whole period: March 2004 to September 2019; Investment grade period: December 2011 to September 2019.

3.9.2 Figures

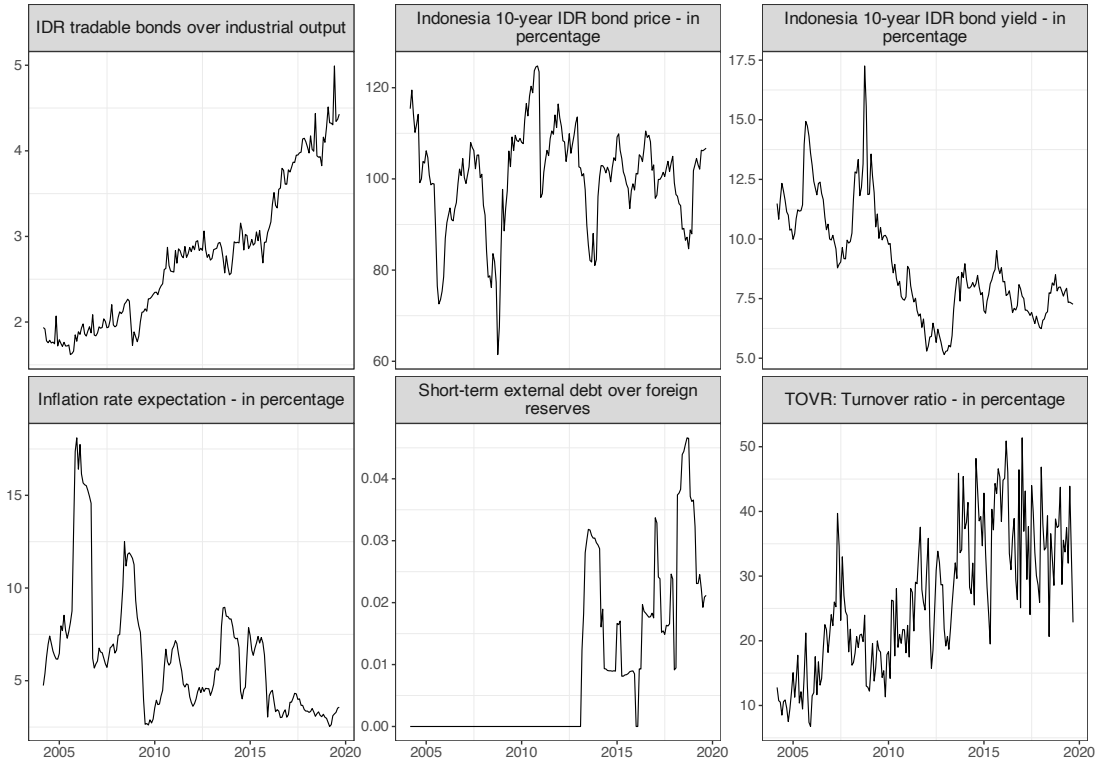


Figure 3.7: Other observable variables

Chapter 4

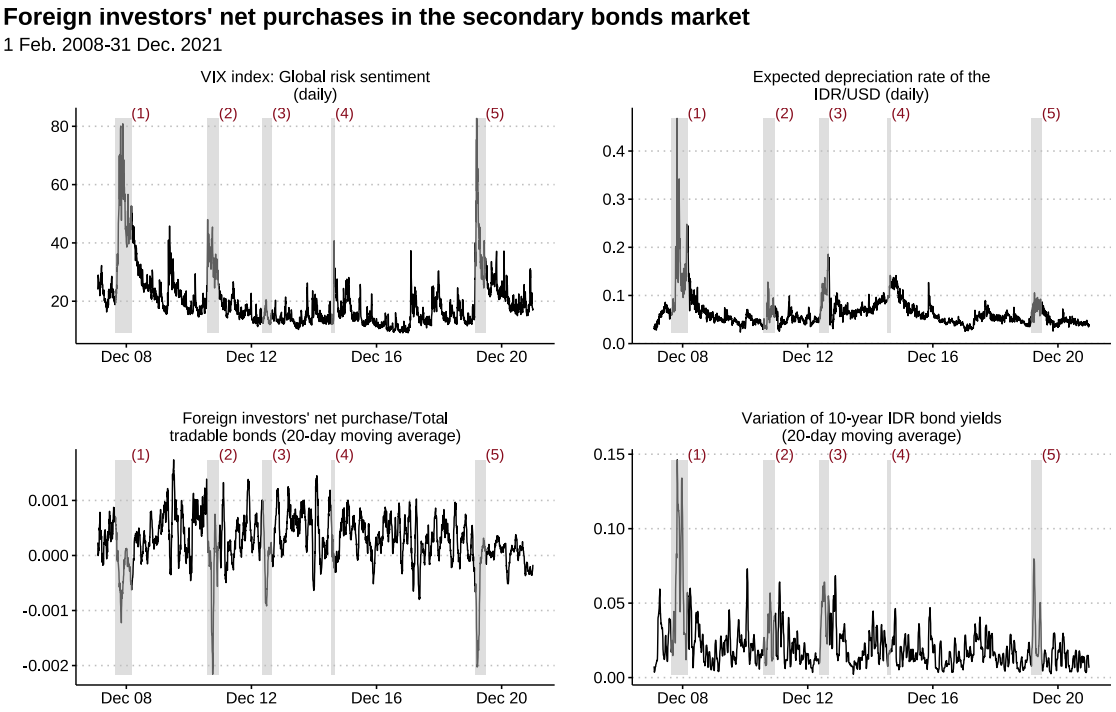
The daily trading behaviour of different types of investors

Contents

4.1 Introduction

The introduction of the J.P. Morgan Government Bond Index-Emerging Markets (GBI-EM) in June 2005 and the J.P. Morgan Corporate Emerging Markets Bond Index (CEMBI) in November 2007 had a critical role in supporting the development of emerging bond markets. Nevertheless, just like two sides of a coin that cannot be separated, the capital flow offers advantages and disadvantages that need to be managed carefully by policymakers in emerging countries. Specifically, the presence of foreign investors in the local-currency bond market, on the one hand, could deepen the market and act as alternative funding resources. However, on the other hand, their existence could also increase the volatility in the domestic market (Peiris, 2013; Ebeke and Lu, 2015). Further, it is also important to note that the foreign investor's behavioural pattern is heterogeneous across different types. For example, foreign investors' mutual funds might have more pressure from their end investors than the other institutions to react to short-term trends, while insurance companies & pension funds might have more flexibility in managing their portfolios because they tend to buy and hold the government bonds until maturity.

Prior literature has shown that the different types of foreign investors could behave differently to the changes of global risk and past return. Ng et al. (2019) explained that during the taper tantrum in 2013, mutual funds tended to reduce their ownership in emerging Asian bond markets, while insurance companies & pension funds behaved differently by increasing their ownership. Timmer (2018) found that the banks and the investment fund tended to respond pro-cyclically, meaning that these investors buy bonds when their returns have been high and sell when their returns have been low. On the contrary, the insurance companies & pension funds acted differently by buying bonds when their returns had been low and selling when their returns had been high.



Note: Data are obtained from the Indonesian Ministry of Finance and Bloomberg. Following Ahmed et. al. (2011)'s method, areas (1) to (5) refer to financial stress periods as follows (1) Subprime mortgage crisis, (2) Eurozone debt crisis, (3) Taper tantrum, (4) The PBoC's policies on its currency, and (5) Coronavirus pandemic.

Figure 4.1: Foreign investors' net purchases in the secondary bonds market and the performances of related variables.

As an emerging country, it is less likely that Indonesia could avoid any spillover from heightened uncertainty in the global market. In particular, as shown in Figure 4.1, several notable events influenced the global risk from 2008 to 2021. First, in 2008, the global financial market was shocked by the subprime mortgage crisis in the U.S., which led to the bankruptcy of Lehman Brothers. At the time of the collapse, the company was among the largest investment banks in the United States and held USD639 billion in assets and USD613 billion in liabilities. Hence, the circumstance is considered the largest bankruptcy filing in U.S. history. Further, although it peaked from 2010 to 2012, the European sovereign debt crisis had started a few years before with the collapse of Iceland's banking system in 2008 and the finding of misreporting in the previous Greek government budget deficit in 2009. These events then led to the inability of several countries (i.e., Greece, Spain, Ireland, Portugal, and Cyprus) to repay or refinance their debts. In addition, Standard & Poor's decision to downgrade Greece's credit rating to

junk status in April 2010 increased worries about the debt problem in Europe.

Another crisis during the observable period was the taper tantrum in 2013. Market players overreacted following the U.S. Federal Reserve's plan to reduce their bond purchases had increased worries about a decline in U.S. bond prices. As a result, bond investors sold their holdings, anticipating a future decline, leading to more depressed bond prices and increased bond yields. Additionally, on three consecutive occasions, the People's Bank of China (PBoC)'s decision to devalue the Chinese yuan renminbi against the U.S. dollar surprised currency markets globally in August 2015. The Chinese government argued that the decisions were carried out as part of the domestic reforms to be a more market-oriented economy. Lastly, the coronavirus pandemic, which started in 2020, had a greater impact on the financial market. Most governments worldwide have issued restrictions on people's mobility to control the spread, consequently affecting economic growth. A decrease in revenue, added with an additional budget to strengthen the health and socio-economic sectors, has pushed many governments to increase their debt.

Those five financial stress episodes significantly impacted the global risk appetite, as shown in the top-left panel of Figure 4.1. Mainly due to the subprime mortgage crisis and the coronavirus pandemic, the VIX index, as a proxy variable to measure global risk, increased to the highest level from 2008 to 2021. In similar episodes, the expected depreciation of the IDR over USD and the yield of Indonesia's 10-year bonds also responded negatively, showing that the domestic financial market could not run away from heightened volatility in the global financial market. Also, important to note that during those episodes, the foreign investors' net purchases declined significantly. As shown in the bottom-left of the figure, the most significant declines happened during the subprime mortgage crisis, the European sovereign debt crisis, the taper tantrum, and the coronavirus pandemic.

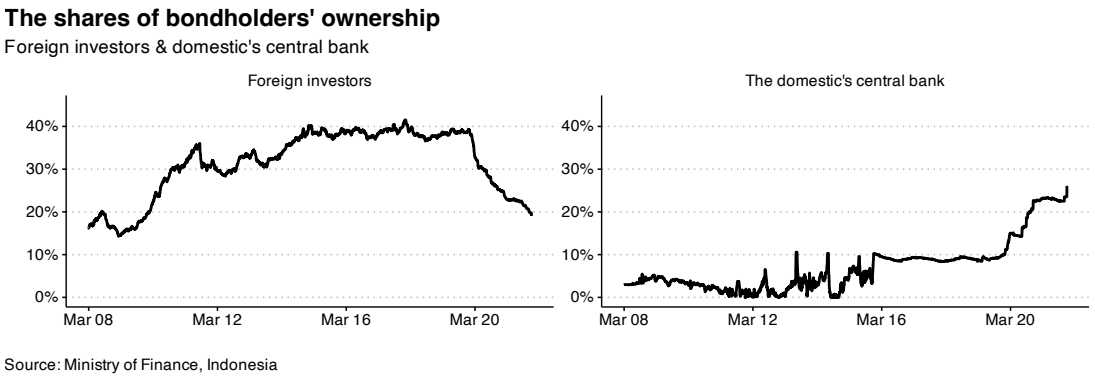


Figure 4.2: The shares of foreign investors and the domestic's central bank

Specifically, as shown in Figure 4.2, the shares of the foreign holdings in Indonesia's government bonds market declined dramatically due to the shock caused by the coronavirus pandemic, from the highest at 41.52% on 25 January 2018 to the lowest at 19.05% on 31 December 2021. The decline, among others, was caused by a relaxation in Indonesian regulation that allowed the central bank to buy government bonds with longer maturities (more than 1 year) in the primary market to finance the sudden increase in the budget deficit due to the pandemic. At the end of 2021, the total outstanding local-currency government bonds was IDR4,678.97 trillion, increased by 69.98% from the end of 2019, which was IDR2,75274 trillion. In a similar period, the foreign investors' holdings declined by 16.06% from IDR1,061.86 trillion to IDR891.34 trillion. Meanwhile, the central bank's holdings increased by 346.81% from IDR273.21 trillion to IDR1,220.73 trillion.

Considering a few studies that have discussed foreign investors' behaviour in the local-currency bond market and how their presence is important in developing the domestic markets, this study investigates their behaviour using Indonesia's bonds market as a case study. Prior literature mostly used quarterly or annual data sets; it would be valuable to use a more frequent data set to understand their behaviour. Hence, the main objective of this study is to investigate foreign investors' behaviour by looking at their net purchases (buying minus selling) in Indonesia's secondary local-currency bond market using daily data. Specifically, the study will assess the relative effects of the foreign investors' responses to global

and domestic factors compared with the domestic investors' responses.

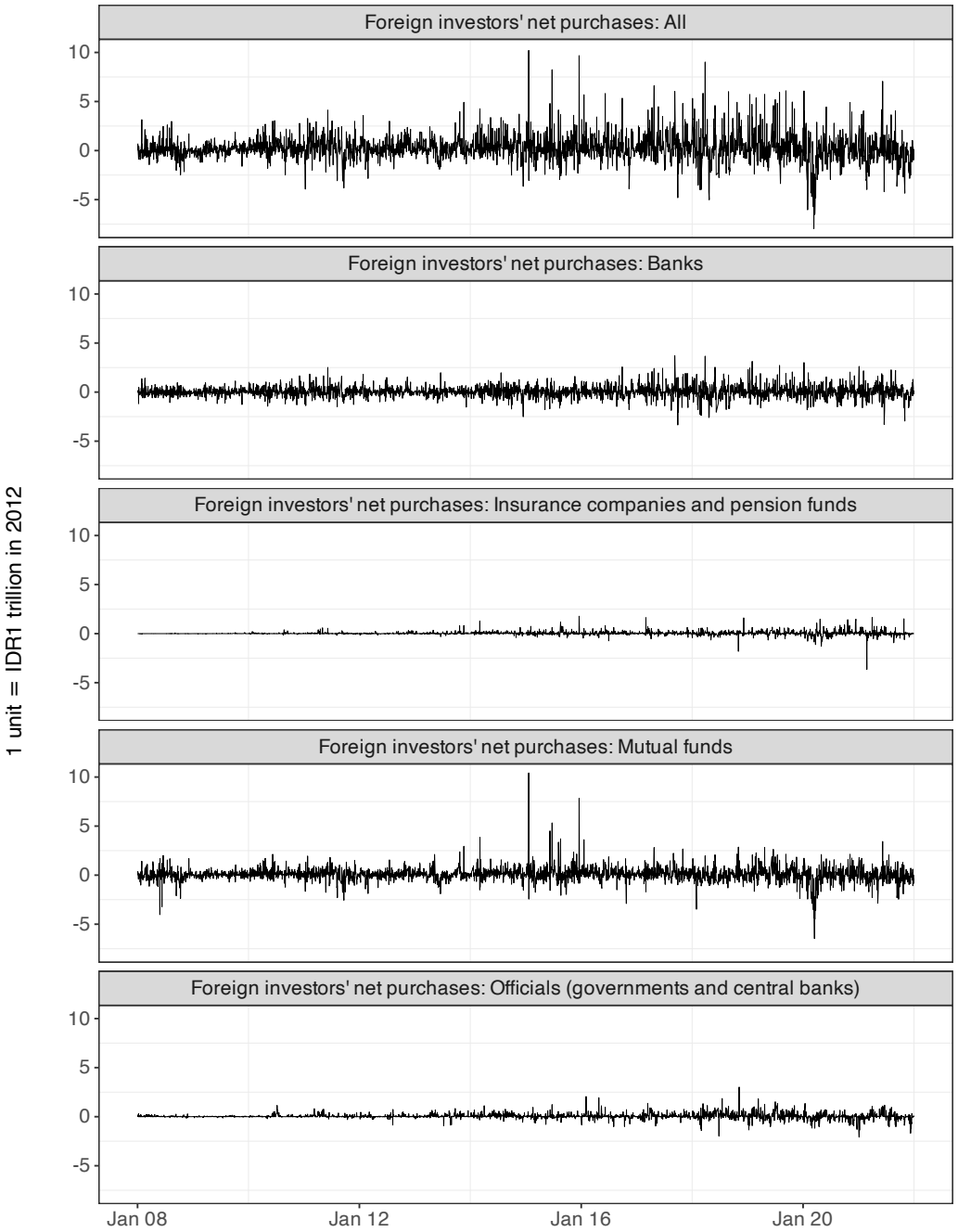


Figure 4.3: The net purchases of the foreign investors, in the real values (the nominal values are divided by the respective month's consumer price index).

The data set also allows this study to differentiate the foreign agents into several categories: banks, insurance companies & pension funds, mutual funds, and officials, which consist of governments and central banks, as presented in Figure 4.3. However, even though the data are available from 2 January 2008 to 31 December 2021 and can cover several financial stresses during the period, a significant decline in foreign investors' participation during the coronavirus pandemic is evident. Rather than model the pandemic effect, which represents a clear structural break, the main analysis of this study will focus on the period from 2008 to 2019. Since the study examines the relative effect, the coefficients of the independent variables obtained from the model will be the effects of those variables on foreign investors' demand relative to the effects on domestic investors' demand for the equivalent financial asset (since net sales by foreigners must equal net purchases by domestic investors, given that the data refer to secondary market transactions only).

Utilising the ARDL approach, the statistical outcomes show that foreign investors, as a whole, consider the VIX index, Indonesia's 12-month yields, the expectation of Indonesian rupiah depreciation, and average credit ratings and rating agency outlooks are essential in affecting their decisions. Consequently, in the long run, and compared with the domestic investors, they would purchase more Indonesian local-currency bonds with more stability in the global financial market, a higher domestic short-term asset return, a stronger local currency exchange rate in the future, and a lower probability of default. In the short run, their behaviour is only influenced by the changes in the VIX index, Indonesia's 12-month yields, the expectation of the local currency's depreciation, and the past return based on a longer maturity of Indonesia's government bonds.

Further, by focusing more on the different types of foreign investors, the statistical outputs also find that mutual funds and insurance companies & pension funds are the most sensitive to heightened uncertainty in the global financial market in the

long run. Meanwhile, in the short run, any changes in global risk appetite only influence the mutual funds and the banks. The disaggregation of the bondholders also reveals useful information regarding the role of domestic investors. In the short run, the statistical results show that domestic insurance companies & pension funds would purchase more Indonesian bonds than others when the VIX index increases.

The chapter is organised as follows. Section 2 reviews the literature on bondholders' roles in developing emerging market economies. Section 3 briefly describes the data. Then, section 4 explains the methodology and analyses the empirical results. Section 5 assesses the robustness of the main findings. In section 6, the findings are discussed. Finally, section 7 concludes.

4.2 Literature review

In the last decade, diminishing boundaries between financial markets and declining global interest rates have created new opportunities and increasing demand for securities issued by emerging economies. At the same time, the development in those economic environments has attracted researchers' interest and, consequently, contributed to the growing volume of research related to the development of bond markets in emerging markets. The present study is related to the literature on capital mobility, investment portfolio allocation, and foreign investors' contribution to the domestic financial market.

Burger and Warnock (2007) analyse the determinants of foreign investors' participation in 41 countries' local currency bond markets, covering developed and emerging economies. Specifically, they use the U.S. investors' bond portfolio allocation at the end of 2001 as a proxy to measure foreign investors' decisions to invest in those countries. Accordingly, in their regression model, the dependent variable is the ratio of the weight of each country in the U.S. bond portfolio to

its weight in the world bond market portfolio. As for the explanatory variables, the authors use capital account openness (Gwartney et al., 2003) divided by the average value of 2000 and 2001 (openness), detrended stock market value as of December 2001 (business cycle), and expected mean, variance, and skewness of bond returns for 48-months before December 2001. The empirical results find that the variance and skewness of the bond returns are consistently essential in influencing U.S. investors' decisions. The negative and positive relationships between those regressors and the response variable, respectively, suggest that U.S. investors prefer local-currency bond markets that yield returns with lower variance and higher skewness profile[1]. Meanwhile, the business cycle, openness, and the mean of the bond returns are not statistically significant in most specifications.

Raddatz and Schmukler (2012) study the responses of investors and managers of global mutual funds to shocks and crises in the global financial market that occurred between January 1996 and November 2010. In addition, they also investigate the impact of their responses on the capital flows in over 124 developed and developing countries. The injections (or redemption) of the investors to the funds, as a proxy to measure the investors' behaviour, are estimated as a function of lagged fund returns and the country of origin returns, and dummy variables representing country crisis and global crisis. While a fund's country portfolio allocations, as a proxy to capture portfolio managers' behaviour, are estimated as a function of lagged portfolio allocations, relative returns (i.e., the difference between net country returns and net fund returns), and a dummy variable that represents a country crisis. By employing 1,076 funds, which consist of equity and bond funds, and utilising ordinary least squares regressions, the study concludes that the investors' and fund managers' behaviour seems to be pro-cyclical. It means that they would reduce their investment and lower their portfolio al-

[1]"... The positive skewness of distribution indicates that an investor may expect frequent small losses and a few large gains from the investment. The positively skewed distributions of investment returns are generally more desirable by investors since there is some probability of gaining huge profits that can cover all the frequent small losses..." (Corporate Finance Institute, 2020)

locations, respectively, in countries that experience crises and during increasing uncertainty in the global financial market; and then increase the investments and allocations when the condition of the countries improves. In addition, considering that there is also evidence that their behaviour could amplify the crises across countries, relying more on mutual funds to stabilise the market will not necessarily solve the problem.

Adler et al. (2016) examine the role played by domestic investors in offsetting a decline in capital inflows due to the existence of global financial shocks. Specifically, they use the terms gross inflows (an accumulation of net foreign liabilities) to represent foreign investors' behaviour and gross outflows (an accumulation of net foreign assets) to represent domestic investors' behaviour. Their study focuses on 38 emerging market economies and uses a quarterly data set from Q1-1990 to Q2-2014. By utilising a panel vector autoregressive model and impulse response function, which consider all variables are endogenous, the study differentiates the shocks based on the U.S. and global macroeconomic variables (i.e., real GDP growth, the VIX index, 10-year bond yields, and a broad index of commodity prices). As the variable of interest, the capital flows are measured in percentage units of domestic GDP. The statistical outcomes show that, in particular, a one standard deviation shock to the VIX index (about 5.4 units) influences a decline in average gross inflows of about 1% of annual GDP over six quarters. However, a similar shock also leads to a decline in gross outflows with a relatively similar magnitude. The finding, then, could be interpreted that during a global turmoil, proxied by an increase in the VIX index, domestic investors compensate the foreign investors retrenching from the emerging economies by reducing external assets accumulation. In addition, in countries with high official reserves, the external assets repatriations executed by the domestic investor tend to be higher. As a result, their behaviour could mitigate the impact caused by the retrenchment.

Focusing more on the taper tantrum event that started in May 2013 that caused a

sudden increase in the global bond yields, Ng et al. (2019) study the role of several types of investors involved in that event. In particular, their study differentiates the investors based on their sensitivity to the shock (i.e., mutual funds; insurance, pension funds, and annuity) and domicile (i.e., local, regional, and global funds); then tests the hypothesis that financial institutions behave differently during the observable period: mutual funds' institutions reduce their ownership, while insurance, annuity, and pension funds' companies increase. Further, the study employs the Asia-Pacific government and corporate bonds[2] held by asset managers all over the world from 2011 to 2015, which are mainly obtained from Thomson Reuters eMAXX on a quarterly basis. By utilising a simple regression to estimate the investors' change of holdings as a function of various explanatory and control variables[3], they confirm the existence of the institutional fire sale hypothesis[4]. They find evidence that during the taper tantrum mutual funds' investors sold more emerging Asia government bonds in foreign currencies than in other periods. On the contrary, the other type of investors (i.e., insurance, annuity, and pension funds) act differently by buying more government bonds than in other periods. It appears that, during this specific event, the mutual funds' investors were buying more advanced Asia corporate bonds, different to other types of investors that were selling more advanced Asia corporate bonds; suggesting that during this specific event, the mutual funds' investors seek a safer place to reallocate their funds. Nevertheless, such behaviour cannot be found in the local-currency bond market. In addition, by differentiating the bondholders by their domicile and being more specific on the local-currency bond market, their study also explains that during the 2013 crisis, local funds would buy more emerging Asian and developed Asian corporate bonds, regional funds would buy more emerging Asia's

[2]The data set covers Australia, China Taipei, Hong Kong SAR, India, Indonesia, Japan, Korea, Malaysia, New Zealand, the Philippines, Singapore, Thailand, and Vietnam

[3]The global factor i.e., VIX index; and the country factors i.e., GDP growth, exchange rates, current account/GDP, and sovereign credit ratings.

[4]A condition when a particular type of bondholder (i.e., mutual funds) would receive such pressure from their end investors who want to withdraw their investment due to irrational fear during a higher uncertainty in the financial market.)

government bonds and sell developed Asian bonds (corporate and government), and global funds would sell emerging Asian bonds (corporate and government).

Furthermore, Timmer (2018) also explores the different investment behaviour of particular debt securities' holders, which are banks, investment funds, and insurance companies & pension funds. By using more granular security-by-security holdings data from Q4-2005 to Q4-2014 provided by the Deutsche Bundesbank, the study seeks to learn how their behaviour reacts to the changes in the returns. Therefore, in the model, his study estimates the changes in the nominal amount of the securities held by a particular holder as a function of the one-quarter lag of the return[5] and other control variables. Moreover, it is important to mention that even though the insurance companies & pension funds held a relatively smaller quantity of debt securities compared to banks and investment funds and conducted less frequent transactions than the other type of bondholders, the average volume of their selling and buying are larger than investment funds. In contrast, investment funds are the most active buyers and sellers in the secondary market, but with smaller amounts compared to banks and insurance companies & pension funds. The statistical results show that the behaviour of banks and investment funds is different to the behaviour of insurance companies & pension funds. A 10% increase in the last quarter's return could be followed by a 4.4% decrease in the initial amounts of the securities that are held by the insurance companies & pension funds. On the other hand, a similar situation could be followed by 1.2% and 3.5% increases in the initial amounts of the securities that are held by investment funds and banks, respectively. It means that different to other holders, the insurance companies & pension funds tend to act counter-cyclically by buying the securities when the returns decrease and then selling when they increase. A possible explanation is because of long-term liabilities give them more flexibility in managing their investment in the short term. Accordingly, their behaviour could

[5]The return is calculated by using the following formula: $Return_{s,t} = (Price_{s,t} - Price_{s,t-1} + Coupon_s)/Price_{s,t-1}$; where s denotes the security and t is time period on a quarterly basis.

stabilise the market as they would absorb the securities which are undervalued based on a certainty that the securities will return to their initial values when it comes to their maturities.

Park et al. (2019) investigate the determinants of investment decisions taken by foreign and domestic investors in developed and emerging bond markets. Instead of directly using the share of bondholders' holdings as the dependent variable, the authors estimate foreign and domestic investment bias scores[6] as a function of variables representing asset-risk return profile, currency risks, financial development, and macroeconomic stability. The scores are used to measure foreign and domestic investors' relative preference toward a particular bond market. In particular, if a country's foreign bias score is higher (lower) than zero, the bond market is overweighted (underweighted) by foreign investors. Using 41 countries' yearly data sets ranging from 2010 to 2015, they find that foreign investors consider bond markets with higher returns and lower volatility to be preferable. A 1% increase in monthly bond index returns, proxied by the mean of monthly return in the local bond market index during the past 12 months, and volatility, proxied by the standard deviation of monthly return on the local bond market index during the past 12 months, would raise and reduce the foreign bias by 0.025% and 0.032%, respectively. Moreover, when market developments are used to differentiate the observations, they emphasise those indicators in the emerging markets more than in the developed markets. As for the domestic investors, the statistical results show that, among the independent variables, they consider the aggregate value of outstanding bonds in a bond market as an essential factor. A 1% increase in the market size would reduce the domestic bias by 0.65% in combined markets and 0.76% in emerging markets. Further, due to the research limitations, they suggest employing different types of bondholders and higher frequency data sets for future

[6]Foreign $\text{bias}_{i,t} = \log\left(w^{\text{FI}}_{i,t}/w^{\text{M}}_{i,t}\right)$ and Domestic $\text{bias}_{i,t} = \log\left(w^{\text{DI}}_{i,t}/w^{\text{M}}_{i,t}\right)$, where $w^{\text{FI}}_{i,t}$ is the weights of market i in foreign investors' global portfolio, $w^{\text{DI}}_{i,t}$ is the weights of market i in domestic investors' global portfolio, and $w^{\text{M}}_{i,t}$ is the weights of market i in the world bond market portfolio, in time t.

work on investigating foreign and domestic investors' behaviour. Their suggestion is included in our considerations to conduct research on bondholders' behaviours in Indonesia's local-currency bond market.

4.3 Data

To study the behaviour of different types of bondholders in the Indonesian local-currency bond market, a daily data set on net purchases of bonds in the secondary market will be used. Data on net purchases by different domiciles of investors (foreign or domestic) from 2 January 2008 to 31 December 2021 have been provided by the Ministry of Finance of the Republic of Indonesia. By excluding any transactions that occurred on public holidays and during the weekends, the total of observations from 2008 to 2021 is reduced from 3,703 to 3,430. Since the main analysis will cover the period from 2008 to 2019, the number of observations is lessened from 3,430 to 2,935. For each domicile, the data are disaggregated by type of investor (i.e., banks, insurance companies & pension funds, mutual funds, officials (governments and officials)), but for confidentiality reasons not by the individual investor. The data are not disaggregated by bond maturity; therefore, they cover net purchases of bonds of all maturities. Because the data refer to transactions in the secondary market only, the sum of net purchases on each day is necessarily zero. Moreover, given that inflation has been significant over the period, all net purchases have been expressed in real terms by dividing by the consumer price index (reference base year is 2012) for the relevant month. Thus, 1 unit of the net purchases is equal to IDR1 trillion in 2012 (i.e., what IDR1 trillion would buy at 2012 prices).

The mean column in the summary statistics in Table 4.1 shows that from 2008 to 2021, foreign investors have consistently been net purchasers (0.25 units) and domestic investors net sellers (-0.25 units). Amongst foreigners, all types have

been net purchasers, whereas, amongst domestic investors, the net purchasers are only mutual funds and insurance companies & pension funds. On the other hand, the net sales by domestic investors have been mostly by commercial banks (-0.22 units). Turning to the standard deviation, all foreigners (1.27 units) is far greater than that for each type, whereas for domestic investors the standard deviation for banks is much higher (2.05 units for commercial banks and 1.70 for the central bank units). That suggests that net purchases by all types of foreign investors tend to be quite strongly positively correlated, whereas net purchases by domestic commercial banks are quite strongly negatively correlated with those of the central bank. In detail, the cross-correlation for all observable variables is shown in Table 4.10 of the Appendix section.

Table 4.1: Summary statistics (the net purchases and the total outstanding bonds are in the real value)

	Mean	Std. Dev.	Min.	Max.	Var.	Skew.	Kurt.
Dependent variables: the net purchases (buying minus selling) of the bondholders, 1 unit = IDR1 trillion in 2012							
Foreign: All	0.25	1.27	-7.96	10.21	1.61	0.58	10.28
Foreign: Mutual funds	0.09	0.71	-6.47	10.42	0.50	0.89	28.23
Foreign: Banks	0.03	0.57	-3.35	3.72	0.32	0.34	7.70
Foreign: Insurance comp. & Pension funds	0.03	0.19	-3.65	1.78	0.03	-1.35	72.21
Foreign: Officials	0.05	0.27	-2.09	3.01	0.07	0.69	17.23
Domestic: All	-0.25	1.27	-10.21	7.96	1.61	-0.58	10.28
Domestic: Mutual funds	0.04	0.36	-16.59	2.45	0.13	-27.32	1,267.88
Domestic: Banks	-0.22	2.05	-26.71	45.90	4.19	8.83	196.69
Domestic: Insurance comp. & Pension funds	0.05	0.21	-2.35	2.01	0.05	0.53	20.52
Domestic: Central bank	-0.08	1.70	-45.19	21.53	2.88	-15.84	385.58
Independent variables							
VIX index	20.09	9.64	9.14	82.69	92.91	2.43	11.07
U.S. treasury bill 12-month, yield (%)	0.71	0.80	0.04	3.17	0.64	1.22	3.07
Indonesia treasury bill 12-month, yield (%)	6.11	1.94	2.54	19.38	3.77	1.48	7.77
The expectation of Indonesian rupiah depreciation againts U.S. dollar in the next 12-month (%)	0.06	0.03	0.02	0.47	0.00	3.56	25.73
Indonesia's credit rating and outlook, on average	11.59	1.14	9.08	13.00	1.29	-0.74	2.61
Control variables							
Total outstanding bonds (1 unit = IDR1 quadrillion in 2012)	1.18	0.63	0.54	2.96	0.40	1.14	3.47
The return based on Indonesia's 5-year government bonds	0.07	0.02	0.00	0.26	0.00	1.21	8.76
Number of observations				3,430			

Note: Net purchases are calculated by a bondholder's buying with its selling.

The independent variables are chosen to reflect the theoretical model discussed in the previous section. To capture the global market risk and investors' sentiment, the measure used is the Chicago Board Options Exchange's Volatility Index (VIX index) which is derived from S&P 500 index options for the next 30 days. Also

included is the rate of return in the short term on the risk-free asset, proxied by the U.S. treasury bill with a constant maturity of 12 months (1 year), and in the Indonesian domestic market, proxied by Indonesia's treasury bill with a constant maturity of 12 months (1 year). The yield differential between those short-term bills would be important information for foreign investors to calculate the attractiveness of investing in the Indonesian market. Next, since foreign investors are more sensitive to the exchange rate risk, the expectation of Indonesian rupiah depreciation against the U.S. dollar in the next 12 months (1 year) is included. Given that besides as a data provider Bloomberg also acts as a global foreign exchange trading platform, they could compile the expected exchange rate between the Indonesian rupiah and the U.S. dollar in the next year (as proxied by non-deliverable forward rate 12-month) and the current spot rate daily[7]. Hence, the expected depreciation is calculated by using the difference between the expected exchange rate in the next 12 months at t and the current's spot rate at at t, then divided by the current's spot rate at t.

The last independent variable is the average ratings and outlooks assigned for Indonesia by the three credit rating agencies (i.e., Fitch, Moody's, and Standard and Poor's). This information is publicly available on Bank Indonesia's website[8]. Due to data availability, the only available information on their website is rating and outlook for the foreign currency long-term debt. However, it is assumed that the rating and outlook for the local-currency debt for all maturities would be not too different because the issuer is similar (the Indonesian government). The rating and outlook conversions into numbers are shown in Table 4.9 in the Appendix section. Two control variables are also included. The first is the total outstanding Indonesian tradable government bonds denominated in local currency. The second is the return on investing in Indonesia's 5-year bonds, calculated based on Timmer

[7]Source: https://www.bloomberg.com/company/press/bloomberg-launches-ndf-executable-streaming-on-fxgo/. The ticker for the expected exchange rate in the next year (12 months) is "IHN+12M BGN Curncy", while the spot rate is "IDR REGN Curncy".

[8]Bank Indonesia's Investor Relation Unit: https://www.bi.go.id/en/iru/economic-market-data/default.aspx

(2018).

Table 4.2: The unit root test at the level: ADF

Variables	Obs.	Z_t	p-val.	CV 1%	CV 5%	CV 10%
Dependent variables: the net purchases of the bondholders, 1 unit = IDR1 trillion in 2012						
Foreign: All	3,429	-41.26	0.00	-3.43	-2.86	-2.57
Foreign: Mutual funds	3,429	-46.85	0.00	-3.43	-2.86	-2.57
Foreign: Banks	3,429	-48.76	0.00	-3.43	-2.86	-2.57
Foreign: Insurance comp. & Pension funds	3,429	-44.31	0.00	-3.43	-2.86	-2.57
Foreign: Officials	3,429	-46.28	0.00	-3.43	-2.86	-2.57
Domestic: All	3,429	-41.26	0.00	-3.43	-2.86	-2.57
Domestic: Mutual funds	3,429	-46.55	0.00	-3.43	-2.86	-2.57
Domestic: Banks	3,429	-27.46	0.00	-3.43	-2.86	-2.57
Domestic: Insurance comp. & Pension funds	3,429	-44.76	0.00	-3.43	-2.86	-2.57
Domestic: Central bank	3,429	-14.55	0.00	-3.43	-2.86	-2.57
Independent variables						
VIX index	3,429	-6.36	0.00	-3.43	-2.86	-2.57
U.S. treasury bill 12-month, yield (%)	3,429	-3.18	0.02	-3.43	-2.86	-2.57
Indonesia treasury bill 12-month, yield (%)	3,429	-2.81	0.06	-3.43	-2.86	-2.57
The expectation of Indonesian rupiah depreciation againts U.S. dollar in the next 12-month (%)	3,429	-8.36	0.00	-3.43	-2.86	-2.57
Indonesia's credit rating and outlook, on average	3,429	-2.39	0.15	-3.43	-2.86	-2.57
Control variable						
Total outstanding bonds (1 unit = IDR1 quadrillion in 2012)	3,429	7.23	1.00	-3.43	-2.86	-2.57
The return based on Indonesia's 5-year government bonds (%)	3,429	-16.03	0.00	-3.43	-2.86	-2.57

Since time series variables are used on a daily frequency, there is a higher possibility that their means or variances change over time. Such non-stationarity could create a false relationship between the dependent and independent variables in the model. Therefore, to test the hypotheses explained in the theoretical model, it is necessary to check the stationarity of the observable variables as a pre-estimation test. Accordingly, the Augmented Dickey–Fuller (ADF) test is applied to those variables before employing the statistical specifications. To be considered stationary, the Z value of the variable obtained from the test should be less than or equal to critical values ($Z \leq Z_{CV}$). Alternatively, the null hypothesis is rejected that a variable has a unit root if the probability of the Z is less than or equal to 10%, 5%, or 1% level.

The results of the ADF test displayed in Table 4.2 show that almost all observable variables are stationary at the level, except the yield on twelve-month Indonesian treasury bills, the average of Indonesia's credit rating and outlook, and the total outstanding of the bonds. Those variables are not stationary at the 5% level.

However, the implementation of another unit root test, the KPSS test, yield different results. As shown in Tables 4.11 and 4.12 in the Appendix section, almost all the variables are non-stationary at the level, except for the net purchases of the foreign investors' banks and domestic investors' mutual funds. In 1st differences, almost all the variables are stationary, except ΔThe yield on the U.S. 12-month bill and ΔTotal outstanding.

To complement the unit root tests, other pre-estimation tests are also conducted. The first is a cross-correlation test among the observable variables to avoid a multicollinearity issue that might appear in the model. The results are shown in Table 4.10. As can be seen in the table, the correlations among independent variables (as explained in Table 4.1) are less than 0.70 is considered sufficient to address the issue.

Unless specified, the variables used in this study are mostly obtained from the Ministry of Finance of the Republic of Indonesia, Bank Indonesia, Statistics Indonesia, the International Monetary Funds, and Bloomberg terminal. The plots for the other observable variables are shown in Figure 4.6 in the Appendix section.

4.4 Empirical analysis

4.4.1 Working models

The main objective of this model is to investigate the behaviour of foreign investors in the secondary market of Indonesian government bonds by considering global and domestic factors. Further, to examine the long-run and short-run relationships in the observable variables, this study follows Shrestha and Bhatta (2018)'s suggestion to employ the autoregressive distributed lag (ARDL) model. Therefore, the restricted ARDL framework to determine the bondholders' behaviours is specified

as follows:

$$\Delta\omega_t \ = \alpha + \sum_{i=1}^{p} \gamma \Delta\Gamma_{t-i} + \xi\Psi_{t-1} + \epsilon_t \tag{4.1}$$

where ω is a dependent variable. In different ARDL models, the dependent variables will be the net purchases of the foreign investors as a whole, banks, insurance companies & pension funds, mutual funds, and officials. Γ and Ψ are vectors of the lags of the dependent variable and independent variables, which are the VIX index, the return on the U.S. treasury bill (with maturity in 1 year), the return on Indonesia's treasury bill (with maturity in 1 year), the expectation of exchange rate depreciation in the next 1 year, the volatility of the US$ exchange rate, and the average of sovereign credit ratings and outlooks; Δ is the first difference; γ is a vector of the short-run dynamic coefficients; ξ is a vector of the long-run dynamic coefficients, and ϵ_t is a white noise term. The control variables are the total outstanding tradable local-currency government bonds and the returns on investing in Indonesia's 5-year government bonds. Moreover, to measure the net purchases and the total outstanding of bonds in real value, these variables are divided by the consumer price index for that month.

Then, if the existence of cointegration among the observable variables is confirmed, the equations above can be converted into an error correction specification (ECM) as follows:

$$\Delta\omega_t \ = \beta + \sum_{i=1}^{p} \gamma \Delta\Gamma_{t-i} + \delta \mathrm{ECT}_{t-1} + \upsilon_t \tag{4.2}$$

where δ is the speed of adjustment, and ECT_{t-1} denotes how quickly variables converge to equilibrium. If the δ is negative and statistically significant, the long-run relationship can be concluded to be captured in the model.

In the ARDL models, the Akaike Information Criterion (AIC) determines the optimum number of lags. For the initial models, the maximum lags allowed to be chosen by the AIC are five lags, which represent five working days or equal to one week. As well, to address the endogeneity, for the initial points, the independent variables are lagged by 1, except for the total outstanding bonds. Then, to test the existence of cointegration among the variables, the ARDL bound test is applied. Suppose the F-statistic value is greater (smaller) than the upper (lower) bound critical values. In that case, the null hypothesis of no correlation is rejected (accepted) and can be concluded that the variables are in a long-run relationship. However, if the value lies between the upper and lower bounds, the long-run relationship is inconclusive. In that case, the error correction term (ECT) is examined. If the term is negative and significant, it can be concluded that a long-run relationship exists among the variables.

4.4.2 Statistical results

The disaggregation of foreign investors into mutual funds, banks, insurance companies & pension funds, and officials (governments and central banks) provides four different models. Tables 4.3 and 4.4 present the outcomes from those specifications, covering a period from 2 January 2008 to 31 December 2019. The F-statistics of the bound test in the specifications confirm the existence of long-run relationships between the response and explanatory variables. The error correction terms (ECTs) that are negative and statistically significant strengthen the relationships between them. In particular, the autocorrelation test results show that the null hypothesis of no serial correlation in all models is not rejected. As for the stability test, the post-estimation tests present evidence that all models fail to reject the null hypothesis of no structural break because their F-statistics are less than the critical values (10%: 1.22; 5%: 1.36; 1%: 1.63). The volatility of the US$ exchange rate has tried to be included in the model as one of the

independent variables. However the inclusion of the variable does not improve the model and the relationships between the variable and the dependent variable in all specifications are not statistically significant.

Table 4.3: Investigating the determinants of foreign investors' behaviour, 2 Jan. 2008 to 31 Dec. 2019, maximum lags allowed to be chosen by the AIC are 5 lags: **The long-run relationships**

	Dependent variable: The net purchases of the bondholders				
	All	Mutual funds	Banks	Insurance comp. & pension funds	Officials
The long-run	(4.3a)	(4.3b)	(4.3c)	(4.3d)	(4.3e)
VIX index$_{t-1}$	-0.009*	-0.005**	-0.001	-0.001	0.000
	(-1.693)	(-1.994)	(-0.272)	(-1.603)	(0.355)
UST bill 12-month$_{t-1}$	-0.106	-0.083**	-0.009	-0.020***	0.007
	(-1.453)	(-2.187)	(-0.307)	(-2.952)	(0.408)
Indonesia's bill 12-month$_{t-1}$	0.163***	0.070***	0.018	0.012***	0.028***
	(3.870)	(3.233)	(1.050)	(3.339)	(2.956)
Expectation of the IDR depreciation$_{t-1}$	-7.686***	-3.205***	-1.364*	-0.363**	-1.310***
	(-4.133)	(-3.377)	(-1.743)	(-2.264)	(-3.166)
Indonesia's rating and outlook$_{t-1}$	0.387***	0.197***	0.060	0.024**	0.086***
	(3.591)	(3.517)	(1.350)	(2.485)	(3.487)
Error correction term$_{t-1}$	-0.676***	-0.737***	-0.795***	-0.898***	-0.613***
	(-25.595)	(-20.881)	(-33.044)	(-48.786)	(-19.733)
Observations	2,929	2,929	2,929	2,929	2,929
Adjusted R^2	0.401	0.465	0.432	0.448	0.409
Root Mean Square Error	1.098	0.624	0.528	0.134	0.235
Long-run relationships	Yes	Yes	Yes	Yes	Yes
Autocorrelation	No	No – at 5%	No	No	No
Stability (no structural break)	Yes	Yes	Yes	Yes	Yes

[1]***, **, * denote significance at 1%, 5%, 10% respectively. *t-statistics* in parentheses. [2] The maximum lags allowed to be selected by the Akaike Information Criterion (AIC) are 5 lags, which represents 5 working days or equal to 1 week.

Column 4.3a informs, in the long-run, foreign investors would lessen their net purchases in the Indonesian government bonds market following heightened instability in the global financial market. A 1-unit point increase in the VIX index could drive foreign investors to reduce their net purchases on the local-currency bonds by 0.01 units more than the domestic investors, although the result is statistically weaker (at 10% level). Moreover, foreigners also consider the expectation of the domestic exchange rate as an important variable. A 1% increase of the variable would be followed by a decrease in their net purchases by 7.69 units more than the domestic investors. Those conditions indicate that, in general, foreign investors behave as risk-averse investors. On the other hand, foreign investors also seek a higher return. A positive relationship between the return on Indonesia's 12-month bill and their net purchases presents evidence of their return-seeker behaviour, under the assumption that the return on the risk-free asset does not change. It tends

to confirm Park et al. (2019)'s finding that explain a higher investment return is important to influence foreign investors' decision.

Finally, the model also provides evidence that foreign investors care about the Indonesian ability to meet their obligations in paying their debts. Moreover, although investors have the same information regarding Indonesia's macroeconomic conditions as the credit rating agencies, and therefore do not need to be influenced by their judgement, some funds may advertise themselves to their clients as only holding investment-grade bonds, as defined by the rating agencies. In this case the demand for Indonesian bonds from those funds can only be non-zero when the bonds are rated above the threshold. The positive relationship between the Indonesia's credit rating and outlook and their net purchases could be interpreted as meaning that a 1-unit upgrade in Indonesia's rating and outlook would encourage the foreigners to increase the net purchases by 0.39 units.

Table 4.3 shows that the differentiation of foreign investors based on their investment preferences has revealed other critical findings. It appears that each type behaves differently in response to changes in global and domestic factors. In the long run, the mutual funds are the most sensitive to uncertainty in the global market compared to other institutional investors. Column 4.3b presents evidence that the global risk has a greater effect on mutual funds' behaviour than other institutions. A 1-unit increase of the VIX index would lead them to reduce their net purchases by 0.01 unit more. In general, the results are consistent when different specifications are used. Specifically for the mutual funds, the consistency of the results obtained from different specifications is displayed in Table 4.15 of the Appendix section.

These results are quite similar to Ng et al. (2019)'s study on bonds denominated foreign currencies that finds that, during the taper tantrum in 2013, the mutual funds responded to heightened instability in the market by reducing their ownership of Emerging Asia's government bonds and increasing Developed Asia's

corporate bonds. A possible reason could be that the fund's manager received more pressure from their end investors, who acted irrationally during that period. According to their findings, the behaviour of mutual funds is different from that of insurance companies, annuity, and pension funds which behaved in the opposite way by increasing holdings in Emerging Asia's government bonds and reducing Developed Asia's corporate bonds.

By focusing more on government bonds denominated in local currency, the current specifications in this study find that other foreign institutions do not pay too much attention to intensifying volatility in the global financial market. It means that, in the long run, a higher VIX index is considered important only by the mutual funds to lessen their net purchases in Indonesian government bonds. Nevertheless, the differences in the period of observation (Q1 2011 to Q4 2015 vs 2 January 2008 to 31 December 2019), data availability (quarterly vs daily), coverage (15 Asia-Pacific countries (including Indonesia) vs only Indonesia), and currency denomination of the bonds (in U.S. dollar vs Indonesian rupiah), which might relate to the currency mismatch considered by foreign investors, could be some of the reasons of why the findings of Ng et al. (2019)'s study and this study are relatively different.

Additionally, even though the sign of the coefficients is negative, as expected in the theoretical framework, the insignificant relationships between the return on the risk-free asset and the net purchases of the banks and the officials show that an increase in the risk-free asset's interest rate is less likely to be followed by a decline in their net purchases. Next, the returns on Indonesia's 12-month bills are considered important by mutual funds, insurance companies & pension funds, and officials. The returns on the bill and their net purchases are positive and statistically significant. A possible reason could be because, after the global financial crisis, interest rates provided by the Indonesian financial market were consistently much higher than the global rates, as can be seen in Figure 4.4. From 2008 to 2021, the average spreads of the short-term rate in Indonesia and the euro area

and the U.S. are 6.12% and 5.77%, respectively. As expected, the highest spreads between Indonesia's short-term rate and the developed markets in euro area and the U.S. were found during the global crisis period, particularly in December 2008. In addition, the sovereign credit rating's upgrade to investment status on 15 December 2011 by Fitch has raised the attractiveness of the Indonesian domestic market since the probability of default in Indonesian debt, which is considered an essential variable by insurance companies & pension funds and the officials, has been reduced.

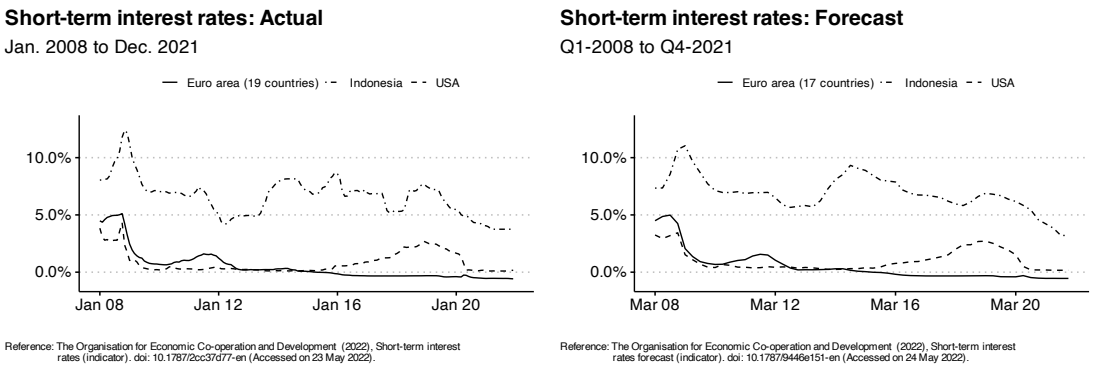


Figure 4.4: Short-term interest rates, based on three-month money market rates.

Another important variable is the exchange rate expectation between the Indonesian rupiah and the U.S. dollar. The results show that all institutions seem to agree that the exchange rate risk is essential in influencing their investment decisions. A 1% increase in the expectation of the Indonesian rupiah's depreciation in the next 12 months would lead them to lessen their net purchases by 0.36 units to 3.21 units more. Although the coefficient for the banks is statistically significant at 10% level, much weaker than the others.

Last of all, as displayed in Tables 4.3, the results show that an upgrade of Indonesia's credit ratings and outlooks would encourage the insurance companies & pension funds, the mutual funds, and the officials to increase their net purchases of Indonesian government bonds by 0.02 units, 0.20 units, and 0.09 units. A possible reason could be that their investment policies have required them to invest in a certain grade of the sovereign credit ratings.

Table 4.4: Investigating the determinants of foreign investors' behaviour, 2 Jan. 2008 to 31 Dec. 2019, maximum lags allowed to be chosen by the AIC are 5 lags: **The short-run relationships**

	Dependent variable: The net purchases of the bondholders				
	All	Mutual funds	Banks	Insurance comp. & pension funds	Officials
The short-run	(4.4a)	(4.4b)	(4.4c)	(4.4d)	(4.4e)
ΔDependent variable$_{t-1}$	-0.131***	-0.190***	-0.069***	-	-0.218***
	(-5.585)	(-5.850)	(-3.726)	-	(-7.376)
ΔDependent variable$_{t-2}$	-0.054***	-0.095***	-	-	-0.093***
	(-2.944)	(-3.263)	-	-	(-3.415)
ΔDependent variable$_{t-3}$	-	-0.077***	-	-	-0.051**
	-	(-3.088)	-	-	(-2.145)
ΔDependent variable$_{t-4}$	-	-0.052***	-	-	-0.044**
	-	(-2.839)	-	-	(-2.359)
ΔVIX index$_{t-1}$	-0.045***	-0.022***	-0.018***	0.001	-
	(-3.738)	(-3.278)	(-3.239)	(1.106)	-
ΔVIX index$_{t-2}$	-0.018	-0.024***	-	0.003**	-
	(-1.584)	(-3.805)	-	(2.251)	-
ΔUST bill 12-month$_{t-1}$	-0.959	-0.668*	-0.710**	-	-
	(-1.464)	(-1.791)	(-2.259)	-	-
ΔUST bill 12-month$_{t-2}$	-	-	-	-	-
	-	-	-	-	-
ΔUST bill 12-month$_{t-3}$	-	-	-	-	-
	-	-	-	-	-
ΔIndonesia's bill 12-month$_{t-1}$	0.195*	0.079	0.095*	-	-
	(1.702)	(1.233)	(1.701)	-	-
ΔIndonesia's bill 12-month$_{t-2}$	0.018	0.027	-	-	-
	(0.159)	(0.437)	-	-	-
ΔIndonesia's bill 12-month$_{t-3}$	-0.299***	-0.136**	-	-	-
	(-2.777)	(-2.240)	-	-	-
ΔExpect. of the IDR depreciation$_{t-1}$	-12.154***	-3.177**	-6.400***	-	-
	(-4.639)	(-2.173)	(-4.989)	-	-
ΔExpect. of the IDR depreciation$_{t-2}$	-4.749*	-	-3.174***	-	-
	(-1.813)	-	(-2.655)	-	-
ΔExpect. of the IDR depreciation$_{t-3}$	-	-	0.275	-	-
	-	-	(0.235)	-	-
ΔExpect. of the IDR depreciation$_{t-4}$	-	-	-2.251**	-	-
	-	-	(-2.017)	-	-
ΔExpect. of the IDR depreciation$_{t-5}$	-	-	-2.247**	-	-
	-	-	(-2.025)	-	-
ΔIndonesia's rating and outlook$_{t-1}$	-	1.146*	-	-	-
	-	(1.873)	-	-	-
Total tradable bonds$_t$	-0.293	-0.163	-0.053	0.015	-0.068*
	(-1.565)	(-1.541)	(-0.586)	(0.667)	(-1.705)
Domestic return$_{t-1}$	5.501**	4.669***	1.483	0.401	0.491
	(2.346)	(3.517)	(1.330)	(1.466)	(1.033)
Constant	-3.101***	-1.814***	-0.583	-0.285***	-0.605***
	(-3.620)	(-3.788)	(-1.411)	(-2.832)	(-3.418)
Observations	2,929	2,929	2,929	2,929	2,929
Adjusted R^2	0.401	0.465	0.432	0.448	0.409
Root Mean Square Error	1.098	0.624	0.528	0.134	0.235
Long-run relationships	Yes	Yes	Yes	Yes	Yes
Autocorrelation	No	No – at 5%	No	No	No
Stability (no structural break)	Yes	Yes	Yes	Yes	Yes

[1]***, **, * denote significance at 1%, 5%, 10% respectively. *t-statistics* in parentheses. [2] The maximum lags allowed to be selected by the Akaike Information Criterion (AIC) are 5 lags, which represents 5 working days or equal to 1 week.

In the short run, column 4.4a and 4.4b show consistent results with the long run, columns 4.3a and 4.3b. Specifically, regarding the sensitivity of the foreign investors' behaviour, as a whole, and the mutual funds in responding to the development in the global risk. The negative relationships of those variables with their net purchases could be interpreted that a rise in the changes of the VIX index would be followed by a greater decline in the changes of their net purchases compared to other bondholders. The results also highlight the finding in the long run that mutual funds are the most responsive to heightened uncertainty in the global financial market. On the other hand, column 4.4c provides information that the banks pay a lot of attention to the currency risk, as represented by the changes in the expectation of the IDR depreciation in the next 12 months. The negative signs of the coefficients in lags 1, 2, 4, and 5 that are statistically significant present evidence that an increase in the changes of the expected local-currency depreciation would push the banks to lessen their net purchases in the next few days. As for the insurance companies & pension funds and officials, their behaviour appears to be less sensitive than the others in the short run. Probably because of their preference to hold the bonds until the maturity dates, which allow them to have more flexibility in adjusting their portfolios.

In particular regarding the relationships between the past return and the foreigners' net purchases, column 4.4a shows that, as a whole, foreign investors acknowledge the importance of the previous domestic returns in determining their decisions. A positive and statistically significant sign could be interpreted that an increase in the past return by 1% could influence the foreign investors to add their net purchases by 5.50. Nevertheless, the results for different types of the foreign agents are not similar to Timmer (2018)'s findings. Table 4.4 cannot support his finding that the insurance companies & pension funds act counter-cyclically by buying the bonds when the returns decrease. By restricting the maximum lags to five, the statistical results find positive relationships between the past returns and the net purchases of this kind of institutions. Column 4.4d shows that an in-

crease in the past returns would encourage them to accumulate more Indonesian bonds, even though the results tend to be weaker, statistically. Instead, the results present more evidence that, among other institutional investors, the mutual funds are the most sensitive to the changes in the past returns in the short run, as shown in column 4.4b.

4.5 Robustness tests

In aiming to confirm the findings obtained from the main specifications, a robustness test is then conducted using an alternative variable to capture the global risk. Osina (2019) explains Bloomberg Financial Conditions Indices (available in three regions: the U.S., Euro-zone, and China) are better at capturing the latest condition in the global financial market than FRED Financial Stress Indices and the Euro-area Systemic Stress Composite Index. Specifically, Bloomberg's U.S. Financial Condition index that will be used as the alternative variable consists of ten variables representing the money market, bond market, and equity market[9]. Each market has an equal weight in contributing to the index (33.3%). The base of the index is a period from 1994 to June 2008 (before the crisis, which is considered as a normal period). Therefore, the index basically presents information about how the current financial condition deviates from normal levels (before the crisis). A positive value indicates favourable financial conditions, while a negative value indicates tighter financial conditions relative to the normal period. Thus, the direction of the alternative index is different with the VIX index. In particular, the correlation between Bloomberg's U.S. Financial Conditions index and the VIX index is quite high, -0.86.

[9]Money market: the U.S. TED spread (difference between LIBOR and US T-bill rate), Commercial paper/T-bill spread, LIBOR/OIS (overnight index swap rate) spread; bond market: Investment-grade corporate bonds/UST spread, municipal bonds/UST spread, swaps/UST spread, high-yield bonds/UST spread, and agency bonds (bonds issued by a department other than the U.S. Treasury)/UST spread; and equity market: S&P 500 shares prices and the VIX index

For this purpose, an ARDL approach will be utilised as the working model with a maximum restriction of the lags up to five that is also used in the main models. However, for the robustness test, the VIX index is substituted by the alternative index. To sum up, the independent variables that will be employed in this approach are Bloomberg's U.S. Financial Conditions index to capture the global risk, the yield on the UST 12-month bill, the yield on Indonesia's 12-month bill, the expectation of the Indonesian rupiah (IDR) depreciation in the next 12 months, and Indonesia's rating and outlook. As for the control variables, the model will use the total outstanding of the tradable government bonds denominated in the local currency and the returns in investing in Indonesia's 5-year bonds. Except for the total outstanding bonds, the other variables are lagged by one period to address the endogeneity issue that might appear in the specifications. Tables 4.5 and 4.6 provide the results.

Table 4.5: Robustness test: Investigating the determinants of foreign investors' behaviour, 2 Jan. 2008 to 31 Dec. 2019, maximum lags allowed to be chosen by the AIC are 5 lags: **The long-run relationships**

	Dependent variable: The net purchases of the bondholders				
	All	Mutual funds	Banks	Insurance comp. & pension funds	Officials
The long-run	(4.5a)	(4.5b)	(4.5c)	(4.5d)	(4.5e)
Bloomberg's the U.S. financial conditions index$_{t-1}$	0.069**	0.042**	-0.002	0.006**	0.002
	(2.198)	(2.555)	(-0.170)	(2.092)	(0.205)
UST bill 12-month$_{t-1}$	-0.108	-0.081**	-0.014	-0.019***	0.010
	(-1.492)	(-2.156)	(-0.474)	(-2.970)	(0.599)
Indonesia's bill 12-month$_{t-1}$	0.177***	0.075***	0.020	0.013***	0.027***
	(4.256)	(3.477)	(1.168)	(3.612)	(2.875)
Expectation of the IDR depreciation$_{t-1}$	-7.620***	-2.974***	-1.542**	-0.331**	-1.175***
	(-4.246)	(-3.184)	(-2.028)	(-2.152)	(-2.955)
Indonesia's rating and outlook$_{t-1}$	0.346***	0.166***	0.060	0.019*	0.083***
	(3.129)	(2.875)	(1.313)	(1.949)	(3.276)
Error correction term$_{t-1}$	-0.675***	-0.738***	-0.795***	-0.898***	-0.612***
	(-25.576)	(-20.839)	(-33.012)	(-48.767)	(-19.698)
Observations	2,929	2,929	2,929	2,929	2,929
Adjusted R^2	0.400	0.464	0.431	0.447	0.410
Root Mean Square Error	1.098	0.624	0.528	0.134	0.235
Long-run relationships	Yes	Yes	Yes	Yes	Yes
Autocorrelation	No	No – at 5%	No	No	No
Stability (no structural break)	Yes	Yes	Yes	Yes	Yes

[1]***, **, * denote significance at 1%, 5%, 10% respectively. *t-statistics* in parentheses. [2] The maximum lags allowed to be selected by the Akaike Information Criterion (AIC) are 5 lags, which represents 5 working days or equal to 1 week.

Column 4.5 shows that, in general, the relationships between the dependent variable and the independent variables are relatively similar to those in the main models. In the long run, the outputs find that the alternative variable also could capture the response of the foreign investors, as a whole, and the foreigners' mutual funds. The positive signs of the coefficients in columns 4.5a and 4.5b could be interpreted to mean that higher stability in the global financial market would induce those bondholders to increase their net purchases by 0.07 units and 0.04 units more than the others. Specifically, different from the main specification, it appears that the alternative variable could capture the relationship between the insurance companies & pension funds' behaviour and the global risk. A 1 unit increase in the index is associated with an additional net purchase of the foreigners' insurance companies & pension funds by 0.01 units.

Meanwhile, in the short run, the disaggregation of the foreign investors also strengthens the findings from the main specifications that use the VIX index to capture the global risk. Among the foreigners institutions, mutual funds are the most sensitive to the development of the global financial market, as represented by Bloomberg's U.S. Financial Conditions index. As shown in columns 4.6b, the positive and statistically significant signs highlight the mutual funds' behaviour in responding to changes in the stability of the global financial market. Besides the mutual funds, the statistical outputs presented in columns 4.6c also capture the banks' responses to the development in the global risk. Even though the coefficients are smaller than the mutual funds, the positive and statistically significant signs present evidence that higher stability in the global financial market would induce them to increase their net purchases in the Indonesian bonds market more than the other institutions.

Table 4.6: Robustness test: Investigating the determinants of foreign investors' behaviour, 2 Jan. 2008 to 31 Dec. 2019, maximum lags allowed to be chosen by the AIC are 5 lags: **The short-run relationships**

	Dependent variable: The net purchases of the bondholders				
	All	Mutual funds	Banks	Insurance comp. & pension funds	Officials
The short-run	(4.6a)	(4.6b)	(4.6c)	(4.6d)	(4.6e)
ΔDependent variable$_{t-1}$	-0.131***	-0.190***	-0.068***	-	-0.219***
	(-5.546)	(-5.818)	(-3.700)	-	(-7.413)
ΔDependent variable$_{t-2}$	-0.052***	-0.095***	-	-	-0.094***
	(-2.836)	(-3.247)	-	-	(-3.465)
ΔDependent variable$_{t-3}$	-	-0.077***	-	-	-0.053**
	-	(-3.093)	-	-	(-2.205)
ΔDependent variable$_{t-4}$	-	-0.051***	-	-	-0.045**
	-	(-2.796)	-	-	(-2.418)
ΔBloomberg's the U.S. financial conditions index$_{t-1}$	0.524***	0.277***	0.206**	-	0.048
	(3.056)	(2.837)	(2.490)	-	(1.615)
ΔBloomberg's the U.S. financial conditions index$_{t-2}$	-	0.176**	-	-	-
	-	(2.127)	-	-	-
ΔUST bill 12-month$_{t-1}$	-1.548**	-1.040**	-0.901**	-	-
	(-2.069)	(-2.442)	(-2.511)	-	-
ΔUST bill 12-month$_{t-2}$	-	-	-	-	-
	-	-	-	-	-
ΔUST bill 12-month$_{t-3}$	-	-	-	-	-
	-	-	-	-	-
ΔIndonesia's bill 12-month$_{t-1}$	0.195*	0.096	0.102*	-	-
	(1.699)	(1.472)	(1.821)	-	-
ΔIndonesia's bill 12-month$_{t-2}$	0.024	0.054	-	-	-
	(0.215)	(0.840)	-	-	-
ΔIndonesia's bill 12-month$_{t-3}$	-0.303***	-0.146**	-	-	-
	(-2.802)	(-2.366)	-	-	-
ΔExpect. of the IDR depreciation$_{t-1}$	-13.268***	-3.942***	-6.734***	-	-
	(-5.132)	(-2.682)	(-5.287)	-	-
ΔExpect. of the IDR depreciation$_{t-2}$	-6.133**	-2.671*	-3.131***	-	-
	(-2.445)	(-1.817)	(-2.608)	-	-
ΔExpect. of the IDR depreciation$_{t-3}$	-	-	0.345	-	-
	-	-	(0.295)	-	-
ΔExpect. of the IDR depreciation$_{t-4}$	-	-	-2.173*	-	-
	-	-	(-1.942)	-	-
ΔExpect. of the IDR depreciation$_{t-5}$	-	-	-2.176*	-	-
	-	-	(-1.957)	-	-
ΔIndonesia's rating and outlook$_{t-1}$	-	1.151*	-	-	-
	-	(1.879)	-	-	-
Total tradable bonds$_t$	-0.267	-0.141	-0.042	0.020	-0.069*
	(-1.436)	(-1.338)	(-0.470)	(0.877)	(-1.757)
Domestic return$_{t-1}$	4.653**	4.033***	1.213	0.275	0.493
	(2.012)	(3.063)	(1.100)	(1.032)	(1.051)
Constant	-2.893***	-1.627***	-0.577	-0.247**	-0.576***
	(-3.352)	(-3.327)	(-1.387)	(-2.458)	(-3.241)
Observations	2,929	2,929	2,929	2,929	2,929
Adjusted R^2	0.400	0.464	0.431	0.447	0.410
Root Mean Square Error	1.098	0.624	0.528	0.134	0.235
Long-run relationships	Yes	Yes	Yes	Yes	Yes
Autocorrelation	No	No – at 5%	No	No	No
Stability (no structural break)	Yes	Yes	Yes	Yes	Yes

[1]***, **, * denote significance at 1%, 5%, 10% respectively. *t-statistics* in parentheses. [2] The maximum lags allowed to be selected by the Akaike Information Criterion (AIC) are 5 lags, which represents 5 working days or equal to 1 week.

4.6 Discussions

4.6.1 The role of domestic investors

This section aims to find out which type of domestic investors could stabilise the volatility in the domestic bonds market by having more net purchases than the other bondholders when the VIX index increases. To this purpose, a relatively similar methodology to the previous models is employed, but the dependent variables are replaced with different types of domestic investors. The plots of the domestic investors' net purchases are shown in Figure 4.5.

By focusing more on the short-run relationships and considering the autocorrelation issues, Table 4.7 shows the changes of the VIX index have positive relationships with different types of domestic investors, even though for the specifications that employed the banks and the central bank, the results are statistically weaker (at 10%). However, further investigation, as presented in Table 4.13 in the Appendix section, reveals that the behaviour of the insurance companies & pension funds in stabilising the domestic market is consistent with the employment of different specifications. In general, the signs of the coefficients, which are statistically positive and significant, are associated with additional increases in their net purchases, compared to others, following intensifying volatility in the previous day.

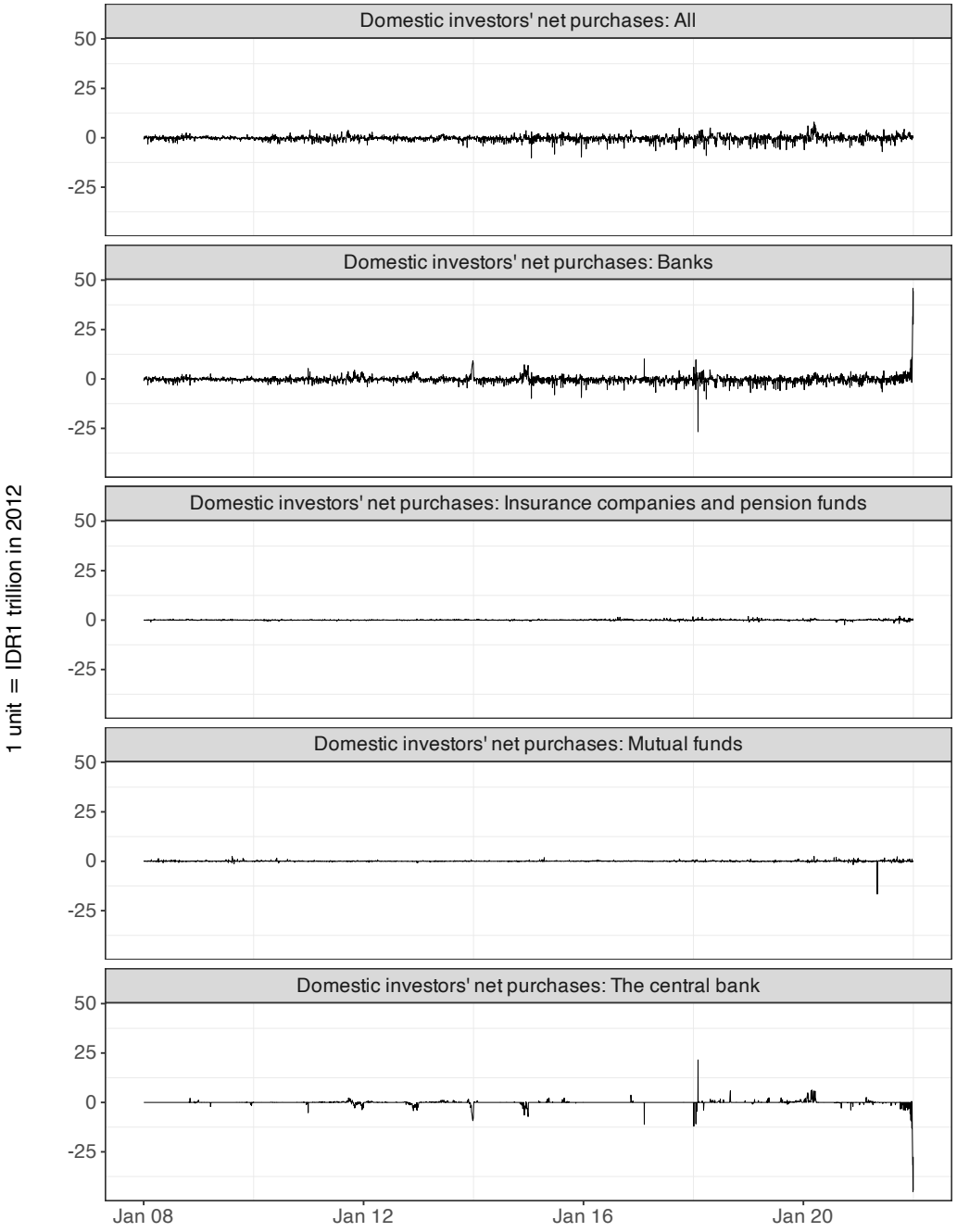


Figure 4.5: The net purchases of the domestic investors, in the real values (the nominal values are divided by the respective month's consumer price index).

The finding could strengthen the policies issued by the Indonesia's Financial Service Authority (FSA – "Otoritas Jasa Keuangan") a few years ago. In order to escalate domestic investors participation in the government bonds market, the FSA issued a regulation on 11 January 2016 to require non-bank financial institutions (NBFIs), e.g. insurance companies, financing institutions, pension funds, the social security agency for healthcare ("BPJS Kesehatan"), and the social security agency for employment ("BPJS Ketenagakerjaan") holding a certain proportion of government bonds instruments in their portfolio. According to the regulation, the minimum proportions must be fulfilled at the end of 31 December 2016 and 31 December 2017, depending on the type of institution.

The authority revised the regulation twice to widen the investment option on 14 November 2016 and 29 August 2017. Following the latest law, the NBFIs can invest in other instruments besides government bonds, which are bonds issued by Indonesia's state-owned enterprises and regionally owned enterprises; asset-backed securities, mutual funds, or other investments that use funds is aimed to finance infrastructure development. As a result, after the law was enacted, the ownership of pension funds & insurance companies in government bonds tradable domestic has increased 47% to IDR325.52 trillion at the end of 2016 and 57% to IDR348.86 trillion at the end of 2017, compared to IDR221.45 trillion at the end of 2015. In conclusion, it appears that the regulations have proved effective in supporting the government in maintaining the stability of the domestic bonds market.

Table 4.7: Investigating the determinants of domestic investors' behaviour, 2 Jan. 2008 to 31 Dec. 2019, maximum lags allowed to be chosen by the AIC are 5 lags: **The short-run relationships**

	Dependent variable: The net purchases of the bondholders				
	All	Mutual funds	Banks	Insurance comp. & pension funds	Officials
The short-run	(4.7a)	(4.7b)	(4.7c)	(4.7d)	(4.7e)
ΔDependent variable$_{t-1}$	-0.131***	-0.146***	-0.234***	-0.110***	-0.339***
	(-5.585)	(-4.959)	(-7.883)	(-4.638)	(-14.107)
ΔDependent variable$_{t-2}$	-0.054***	-0.054**	-0.146***	-0.040**	-0.173***
	(-2.944)	(-2.166)	(-5.334)	(-2.163)	(-7.635)
ΔDependent variable$_{t-3}$	-	-0.059***	-0.064***	-	-0.066***
	-	(-3.219)	(-2.669)	-	(-3.542)
ΔDependent variable$_{t-4}$	-	-	-0.035*	-	-
	-	-	(-1.887)	-	-
ΔVIX index$_{t-1}$	0.045***	0.005***	0.025*	0.007***	0.014*
	(3.738)	(2.814)	(1.754)	(4.023)	(1.960)
ΔVIX index$_{t-2}$	0.018	-	-	-	-
	(1.584)	-	-	-	-
ΔUST bill 12-month$_{t-1}$	0.959	0.248**	-	0.331***	-
	(1.464)	(2.422)	-	(3.209)	-
ΔUST bill 12-month$_{t-2}$	-	-	-	-0.159	-
	-	-	-	(-1.591)	-
ΔUST bill 12-month$_{t-3}$	-	-	-	0.141	-
	-	-	-	(1.426)	-
ΔIndonesia's bill 12-month$_{t-1}$	-0.195*	0.067***	-0.233*	-	0.017
	(-1.702)	(3.834)	(-1.676)	-	(0.231)
ΔIndonesia's bill 12-month$_{t-2}$	-0.018	-	-0.225	-	0.180**
	(-0.159)	-	(-1.639)	-	(2.477)
ΔIndonesia's bill 12-month$_{t-3}$	0.299***	-	0.224*	-	-
	(2.777)	-	(1.711)	-	-
ΔExpect. of the IDR depreciation$_{t-1}$	12.154***	-0.719*	10.201***	-	-
	(4.639)	(-1.806)	(3.217)	-	-
ΔExpect. of the IDR depreciation$_{t-2}$	4.749*	-	4.947	-	-
	(1.813)	-	(1.629)	-	-
ΔExpect. of the IDR depreciation$_{t-3}$	-	-	-	-	-
	-	-	-	-	-
ΔExpect. of the IDR depreciation$_{t-4}$	-	-	-	-	-
	-	-	-	-	-
ΔExpect. of the IDR depreciation$_{t-5}$	-	-	-	-	-
	-	-	-	-	-
ΔIndonesia's rating and outlook$_{t-1}$	-	0.290*	-	-	-
	-	(1.716)	-	-	-
Total tradable bonds$_t$	0.293	0.088***	0.123	0.057*	0.017
	(1.565)	(3.005)	(0.541)	(1.942)	(0.136)
Domestic return$_{t-1}$	-5.501**	0.064	-8.406***	-0.585*	3.058**
	(-2.346)	(0.181)	(-2.956)	(-1.658)	(1.984)
Constant	3.101***	0.493***	2.662**	0.311**	-0.347
	(3.620)	(3.744)	(2.566)	(2.379)	(-0.625)
Observations	2,929	2,929	2,929	2,929	2,929
Adjusted R^2	0.401	0.471	0.409	0.394	0.349
Root Mean Square Error	1.098	0.172	1.337	0.173	0.734
Long-run relationships	Yes	Yes	Yes	Yes	Yes
Autocorrelation	No	No	Yes	No	No
Stability (no structural break)	Yes	Yes	Yes	Yes	Yes

[1]***, **, * denote significance at 1%, 5%, 10% respectively. *t-statistics* in parentheses. [2] The maximum lags allowed to be selected by the Akaike Information Criterion (AIC) are 5 lags, which represents 5 working days or equal to 1 week.

4.6.2 The crisis periods

Viewing Indonesia's status as an emerging market, any sudden shock in the global financial market could be considered essential in influencing the domestic bonds market through the behaviour of foreign investors. Accordingly, the main objective

of this section is to underline the responds of foreign investors on the heightening uncertainty in the global financial market by including those events in the specifications as dummy variables. To summarise, a relatively similar specification will be employed with the addition of the dummy variables and the extension of the period of observation to 31 December 2021. Therefore, this model, it can cover the subprime mortgage crisis in 2008, eurozone sovereign debt crisis in 2011, the taper tantrum in 2013, the yuan devaluation in 2015, and coronavirus pandemic in 2020.

Ahmed et al. (2017)' study is followed to develop the dummy variables that represent the financial stress episodes from 2008 to 2018. To identify the stress episodes, they used a weekly dataset and relied on unusually large movements in at least two of the three following variables: increases in the VIX index (two standard deviations above the trend), depreciations in an aggregate index of emerging market economies (EMEs) against the U.S. dollar (4.5% or more relative to the maximum value over the last six months), and declines in the Morgan Stanley Capital International (MSCI) equity index for the EMEs (10% or more relative to the maximum value over the last six months). According to their methods, the subprime mortgage crisis started from 19 September 2008 to 27 February 2009, European crisis from 29 July 2011 to 16 December 2011, the taper tantrum from 10 May 2013 to 30 August 2013, and the yuan devaluation from 21 July 2015 to 4 September 2015. The coronavirus pandemic was not covered in their study because the COVID-19 virus was first identified in December 2019, then officially declared as a pandemic by the World Health Organisation (WHO) on 11 March 2020. To address this issue, this study employs a relatively similar methodology in its data set. The results show that the coronavirus pandemic started affecting Indonesia's financial markets from 28 February 2020 to 26 June 2020.

Table 4.8: Investigating the determinants of foreign investors' behaviour, 2 Jan. 2008 to 31 Dec. 2021, maximum lags allowed to be chosen by the AIC are 5 lags, including the crisis periods: **The short-run relationships of the control variables**

	Dependent variable: The net purchases of the bondholders				
	All	Mutual funds	Banks	Insurance comp. & pension funds	Officials
The short-run	(4.8a)	(4.8b)	(4.8c)	(4.8d)	(4.8e)
Total tradable bonds$_t$	-0.180***	-0.070**	-0.035	-0.012	-0.030**
	(-2.998)	(-2.056)	(-1.229)	(-1.253)	(-2.309)
Domestic return$_{t-1}$	4.832**	4.290***	1.360	0.570*	0.027
	(2.207)	(3.421)	(1.323)	(1.763)	(0.059)
Subprime crisis	-0.077	0.018	-0.027	0.002	-0.012
	(-0.501)	(0.204)	(-0.369)	(0.090)	(-0.343)
European crisis	-0.092	-0.027	-0.064	0.004	0.021
	(-0.669)	(-0.343)	(-0.984)	(0.169)	(0.708)
Taper tantrum	-0.143	-0.171**	0.082	-0.002	-0.006
	(-0.966)	(-2.001)	(1.156)	(-0.091)	(-0.197)
Yuan devaluation	-0.250	-0.108	-0.177*	0.080**	-0.005
	(-1.210)	(-0.912)	(-1.791)	(2.500)	(-0.113)
COVID-19 pandemic	-0.459***	-0.235**	-0.084	-0.055**	-0.017
	(-2.785)	(-2.484)	(-1.081)	(-2.156)	(-0.477)
Constant	-2.303***	-0.966***	-0.623**	-0.285***	-0.372***
	(-3.554)	(-2.622)	(-2.006)	(-2.941)	(-2.683)
Observations	3,424	3,424	3,424	3,424	3,424
Adjusted R^2	0.383	0.443	0.428	0.373	0.415
Root Mean Square Error	1.149	0.659	0.55	0.179	0.255
Long-run relationships	Yes	Yes	Yes	Yes	Yes
Autocorrelation	No	Yes	No	No	No
Stability (no structural break)	Yes	Yes	Yes	Yes	Yes

[1]***, **, * denote significance at 1%, 5%, 10% respectively. *t-statistics* in parentheses. [2] The maximum lags allowed to be selected by the Akaike Information Criterion (AIC) are 5 lags, which represents 10 working days or equal to 2 weeks. [3] The period of notable events are based on Ahmed et al. (2017), except for coronavirus pandemic that is calculated by the authors. Subprime crisis: 19 Sep. 2008-27 Sep. 2009; European crisis: 29 Jul. 2011-16 Dec. 2011; Taper tantrum: 10 May 2013-30 Aug. 2013; Yuan devaluation: 21 Jul. 2015-4 Sep. 2015; COVID-19 pandemic: 28 Feb. 2020-26 Jun. 2020.

For simplicity, Table 4.8 only shows the results from the relationships in the short run for the control variables and all types of foreign investors' net purchases. The long-run and short-run relationships for the variable of interest are shown in Table 4.14 in the Appendix section. In particular, the autocorrelation issue for the mutual funds' model, as displayed in column 4.8b could be addressed by increasing the maximum lags to 10, as shown in columns 4.15d and 4.15e of Table 4.15 in the Appendix section. The results show that the mutual funds reduced their net purchases during the taper tantrum and the coronavirus pandemic compared to other institutions. It highlights findings from the main specification that they tend to be more sensitive to global financial market conditions than the other bondholders.

Even though the results from this study are statistically weaker and focus more on the local-currency bonds, they are relatively similar to Ng et al. (2019)'s findings that the mutual funds sold more emerging Asia government bonds in foreign currencies during taper tantrums than other periods. Nevertheless, the statistical output tends to disagree with another result from their study, suggesting that the insurance companies & pension funds acted differently by buying more bonds. Even though it is not statistically significant, the negative sign of the coefficient shows that the insurance companies & pension funds tended to reduce their net purchases during the taper tantrum period. Moreover, as presented in column 4.8d, there are other evidences that during the yuan devaluation in 2015, these institutions added more net purchases, while during the coronavirus pandemic, they reduced net purchases. The differences between this study and Ng et al. (2019) could be because they used quarterly data sets in 13 countries, while this study uses daily data sets and only covers Indonesia's government bonds.

4.7 Conclusions

In this chapter, the empirical results are based on a theoretical model of the variables that influence foreigners' behaviour in Indonesia's government bonds market from 2008 to 2019. A daily data set is used for the main specification, unlike the Ng et al. (2019) and Timmer (2018) that use quarterly data sets. For the robustness test, an alternative measure of global risk is used. In addition, the observation period covers several notable events that influenced the uncertainty in the global financial market. An autoregressive distributed lag (ARDL) approach that captures the long-run and short-run relationships between the independent and dependent variables is utilised. Except for the exchange rate volatility that cannot be examined even further, the hypotheses provided in the theoretical model are consistent with the statistical outputs.

As a whole, foreign investors' behaviour, in the long run, is influenced by global risk appetite, the interest rate of the domestic asset, the expectation of local currency depreciation, and the probability of default. In the short run, their behaviour is influenced by changes in the VIX index, the interest rate on short-term domestic assets, and the expectation of local currency depreciation. Then, the disaggregation of the foreign investors reveals another finding that, compared to other financial institutions, mutual funds are the most sensitive to uncertainty in the global financial market, whether in the long run or short run of the main specification. This finding extends Ng et al. (2019)'s study that mentions the mutual funds decreased their ownership in the foreign currencies denominated government bonds during the taper tantrum.

However, this study tends to disagree with another finding of their study that shows, in a similar situation, the different behaviour of the insurance companies & pension funds. The statistical results show that, in Indonesia's case, such financial institutions behave similarly by reducing net purchases when the uncertainty in the global financial market is rising. The differentials could be because of the differentials in the period of observation, coverage of the study, frequency of the data set and denomination of the bonds, which might relate to the currency mismatch that is considered as well by foreign investors. Moreover, different from Timmer (2018)'s finding, there is no strong evidence that the insurance companies & pension funds behave counter-cyclically. Instead, although statistically weaker, a positive sign of the coefficient shows that they tend to increase net purchases when the return in the previous period increases. Additionally, this study finds that the mutual funds also consider the importance of past returns in influencing their decisions to invest in Indonesia's bonds market.

Finally, the results also present the important role of domestics insurance companies & pension funds in stabilising the domestic market. Accordingly, it is important for the Ministry of Finance, as the government bonds' issuer, and the

Financial Service Authority, as the non-bank financial industries sectors' regulator, to maintain coordination in managing the market's stability. Perhaps, designing a special type of local-currency bond that meets the insurance companies & pension funds' liabilities could be considered as another way to mitigate sudden volatility in the domestic market due to worsening conditions in the global financial market.

4.8 Appendix

4.8.1 Tables

Table 4.9: The ratings and outlook conversions

Rating scale	Fitch	Moody's	S&P	Status
21	AAA	Aaa	AAA	Investment grade
20	AA+	Aa1	AA+	
19	AA	Aa2	AA	
18	AA-	Aa3	AA-	
17	A+	A1	A+	
16	A	A2	A	
15	A-	A3	A-	
14	BBB+	Baa1	BBB+	
13	BBB	Baa2	BBB	
12	BBB-	Baa3	BBB-	
11	BB+	Ba1	BB+	Speculative grade
10	BB	Ba2	BB	
9	BB-	Ba3	BB-	
8	B+	B1	B+	
7	B	B2	B	
6	B-	B3	B-	
5	CCC+	Caa1	CCC+	
4	CCC	Caa2	CCC	
3	CCC-	Caa3	CCC-	
2	CC	Ca	CC	
1	C - WD	C	R/SD/D	
0.25	Outlook: Positive			
0.00	Outlook: Stable			
-0.25	Outlook: Negative			

Table 4.10: Cross-correlation

	FG_ALL	FG_MTF	FG_BNK	FG_INP	FG_OFF	DM_ALL	DM_MTF	DM_BNK	DM_INP	DM_CNB	VIXI	US1Y	ID1Y	EX1Y	RTOU	VOEX	TOTL	RTRN
FG_ALL	1.00	0.74	0.67	0.31	0.33	-1.00	0.01	-0.52	-0.16	-0.06	-0.22	0.04	0.01	-0.12	0.01	-0.11	-0.05	0.07
FG_MTF	0.74	1.00	0.21	0.14	0.10	-0.74	0.02	-0.39	-0.16	-0.05	-0.20	0.00	0.02	-0.07	-0.02	-0.11	-0.07	0.08
FG_BNK	0.67	0.21	1.00	0.06	0.04	-0.67	0.00	-0.36	-0.08	-0.04	-0.07	0.02	-0.01	-0.08	0.01	-0.03	0.00	0.03
FG_INP	0.31	0.14	0.06	1.00	0.08	-0.31	0.00	-0.15	-0.05	-0.03	-0.09	0.01	-0.01	-0.02	0.05	-0.02	0.01	0.00
FG_OFF	0.33	0.10	0.04	0.08	1.00	-0.33	0.00	-0.18	-0.04	-0.01	-0.11	0.09	0.03	-0.04	0.04	-0.04	-0.02	0.00
DM_ALL	-1.00	-0.74	-0.67	-0.31	-0.33	1.00	-0.01	0.52	0.16	0.06	0.22	-0.04	-0.01	0.12	-0.01	0.11	0.05	-0.07
DM_MTF	0.01	0.02	0.00	0.00	0.00	-0.01	1.00	-0.05	0.04	0.00	0.01	0.00	0.00	0.01	0.00	0.02	0.02	0.01
DM_BNK	-0.52	-0.39	-0.36	-0.15	-0.18	0.52	-0.05	1.00	-0.01	-0.79	0.07	-0.09	-0.05	0.03	0.00	0.01	0.07	-0.07
DM_INP	-0.16	-0.16	-0.08	-0.05	-0.04	0.16	0.04	-0.01	1.00	0.01	0.07	0.10	0.05	0.08	0.03	0.07	0.07	-0.05
DM_CNB	-0.06	-0.05	-0.04	-0.03	-0.01	0.06	0.00	-0.79	0.01	1.00	0.06	0.07	0.06	0.04	-0.02	0.05	-0.08	0.05
VIXI	-0.22	-0.20	-0.07	-0.09	-0.11	0.22	0.01	0.07	0.07	0.06	1.00	-0.09	0.43	0.51	-0.41	0.55	-0.14	0.42
US1Y	0.04	0.00	0.02	0.01	0.09	-0.04	0.00	-0.09	0.10	0.07	-0.09	1.00	0.33	-0.10	0.06	-0.04	0.11	0.14
ID1Y	0.01	0.02	-0.01	-0.01	0.03	-0.01	0.00	-0.05	0.05	0.06	0.43	0.33	1.00	0.66	-0.67	0.35	-0.50	0.74
EX1Y	-0.12	-0.07	-0.08	-0.02	-0.04	0.12	0.01	0.03	0.08	0.04	0.51	-0.10	0.66	1.00	-0.33	0.53	-0.27	0.38
RTOU	0.01	-0.02	0.01	0.05	0.04	-0.01	0.00	0.00	0.03	-0.02	-0.41	0.06	-0.67	-0.33	1.00	-0.03	0.78	-0.74
VOEX	-0.11	-0.11	-0.03	-0.02	-0.04	0.11	0.02	0.01	0.07	0.05	0.55	-0.04	0.35	0.53	-0.03	1.00	0.05	0.20
TOTL	-0.05	-0.07	0.00	0.01	-0.02	0.05	0.02	0.07	0.07	-0.08	-0.14	0.11	-0.50	-0.27	0.78	0.05	1.00	-0.48
RTRN	0.07	0.08	0.03	0.00	0.00	-0.07	0.01	-0.07	-0.05	0.05	0.42	0.14	0.74	0.38	-0.74	0.20	-0.48	1.00

Notes: [1] Foreign investors' all: FG_ALL; Foreign investors' mutual funds: FG_MTF; Foreign investors' banks: FG_BNK; Foreign investors' insurance companies and pension funds: FG_INP; Foreign investors' officials: FG_OFF; Domestic investors' all: DM_ALL; Domestic investors' mutual funds: DM_MTF; Domestic investors' banks: DM_BNK; Domestic investors' insurance companies and pension funds: DM_INP; Domestic investors' central bank: DM_CNB; VIX index: VIXI; the U.S. 12-months bill yields: US1Y; Indonesia's 12-months bill yields: ID1Y; the expectation of Indonesian rupiah depreciation against the U.S. dollar in the next 12 months: EX1Y; the average of Indonesia's credit ratings and outlooks: RTOU; the total outstanding of the tradable bonds: TOTL; the return of the Indonesian 5-year government bonds: RTRN. [2] All of the net purchases of foreign and domestic investors, and the total outstanding of the tradable bonds are in the real value (all of the variables are divided by the consumer price index in the respective month).

Table 4.11: Unit root test at level: KPSS

Variable	Lag 0	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7	Lag 8	Lag 9	Lag 10
Dependent variables: the net purchases of the bondholders, 1 unit = IDR1 trillion in 2012											
Foreign: All	1.34	1.00	0.83	0.73	0.66	0.61	0.58	0.54	0.52	0.49	0.47
Foreign: Mutual funds	1.30	1.07	0.91	0.81	0.74	0.68	0.63	0.59	0.55	0.52	0.50
Foreign: Banks	0.06	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Foreign: Insurance comp. & Pension funds	0.64	0.50	0.45	0.41	0.38	0.36	0.35	0.34	0.33	0.33	0.32
Foreign: Officials	0.71	0.58	0.49	0.43	0.39	0.37	0.34	0.32	0.31	0.30	0.28
Domestic: All	1.34	1.00	0.83	0.73	0.66	0.61	0.58	0.54	0.52	0.49	0.47
Domestic: Mutual funds	0.14	0.12	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.09
Domestic: Banks	1.24	0.83	0.63	0.53	0.47	0.43	0.40	0.38	0.36	0.34	0.33
Domestic: Insurance comp. & Pension funds	0.52	0.41	0.36	0.33	0.30	0.28	0.26	0.25	0.24	0.23	0.22
Domestic: Central bank	0.94	0.57	0.42	0.34	0.29	0.26	0.24	0.23	0.22	0.21	0.20
Independent variables											
VIX index	24.94	12.63	8.49	6.42	5.17	4.33	3.74	3.29	2.94	2.66	2.43
U.S. treasury bill 12-month, yield (%)	30.75	15.39	10.27	7.71	6.18	5.15	4.42	3.87	3.44	3.10	2.82
Indonesia treasury bill 12-month, yield (%)	25.36	12.72	8.50	6.39	5.12	4.28	3.67	3.22	2.87	2.58	2.35
The expectation of Indonesian rupiah depreciation againts U.S. dollar in the next 12-month (%)	6.49	3.32	2.25	1.71	1.38	1.17	1.01	0.89	0.80	0.73	0.67
Indonesia's credit rating and outlook, on average	45.63	22.84	15.23	11.43	9.15	7.63	6.54	5.73	5.09	4.59	4.17
Control variable											
Total outstanding bonds (1 unit = IDR1 quadrillion in 2012)	65.13	32.60	21.75	16.32	13.07	10.89	9.34	8.18	7.28	6.55	5.96
The return based on Indonesia's 5-year government bonds (%)	25.06	13.99	9.76	7.48	6.07	5.10	4.41	3.88	3.46	3.13	2.86

Note: Number of observations: 3,430. If the test statistic is greater than the critical value, then the null hypothesis of stationarity is rejected (it means that the variable is non-stationary). The critical values at 1% is 0.22, 2.5% is 0.18, 5% is 0.15, and 10% is 0.12. Therefore, according to the KPSS test, almost all the observable variables are non-staionary at the level, except "Foreign: Banks" and "Domestic: Mutual funds".

Table 4.12: Unit root test at 1st difference: KPSS

Variable	Lag 0	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7	Lag 8	Lag 9	Lag 10
Dependent variables: the net purchases of the bondholders, 1 unit = IDR1 trillion in 2012											
ΔForeign: All	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ΔForeign: Mutual funds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ΔForeign: Banks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ΔForeign: Insurance comp. & Pension funds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ΔForeign: Officials	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ΔDomestic: All	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ΔDomestic: Mutual funds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ΔDomestic: Banks	0.02	0.04	0.05	0.06	0.07	0.08	0.08	0.09	0.09	0.10	0.10
ΔDomestic: Insurance comp. & Pension funds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ΔDomestic: Central bank	0.05	0.09	0.12	0.12	0.14	0.13	0.14	0.14	0.14	0.14	0.14
Independent variables											
ΔVIX index	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
ΔU.S. treasury bill 12-month, yield (%)	0.47	0.45	0.43	0.42	0.40	0.39	0.39	0.38	0.38	0.38	0.37
ΔIndonesia treasury bill 12-month, yield (%)	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
ΔThe expectation of Indonesian rupiah depreciation againts U.S. dollar in the next 12-month (%)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
ΔIndonesia's credit rating and outlook, on average	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Control variable											
ΔTotal outstanding bonds (1 unit = IDR1 quadrillion in 2012)	0.28	0.29	0.30	0.32	0.33	0.33	0.33	0.34	0.35	0.36	0.35
ΔThe return based on Indonesia's 5-year government bonds (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01

Note: Number of observations: 3,429. If the test statistic is greater than the critical value, then the null hypothesis of stationarity is rejected (it means that the variable is non-stationary). The critical values at 1% is 0.22, 2.5% is 0.18, 5% is 0.15, and 10% is 0.12. Therefore, according to the KPSS test, almost all the observable variables are stationary at the 1st, except "ΔThe yield of the U.S. 12-month bill" and "ΔTotal outstanding".

Table 4.13: Investigating the determinants of domestic insurance companies & pension funds' behaviour: **The short-run relationships**

	Dependent variable: The net purchases of the bondholders the domestic investors' insurance companies & pension funds				
The short-run	(4.13a)	(4.13b)	(4.13c)	(4.13d)	(4.13e)
ΔDependent variable$_{t-1}$	-0.109***	-0.214***	-0.216***	-0.328***	-0.329***
	(-4.589)	(-7.748)	(-7.837)	(-9.151)	(-9.227)
ΔDependent variable$_{t-2}$	-0.040**	-0.167***	-0.169***	-0.286***	-0.287***
	(-2.142)	(-6.649)	(-6.720)	(-8.216)	(-8.278)
ΔDependent variable$_{t-3}$	-	-0.125***	-0.125***	-0.249***	-0.249***
	-	(-5.714)	(-5.766)	(-7.445)	(-7.495)
ΔDependent variable$_{t-4}$	-	-0.056***	-0.056***	-0.188***	-0.188***
	-	(-3.263)	(-3.293)	(-5.898)	(-5.934)
ΔDependent variable$_{t-5}$	-	-	-	-0.142***	-0.142***
	-	-	-	(-4.701)	(-4.726)
ΔDependent variable$_{t-6}$	-	-	-	-0.166***	-0.166***
	-	-	-	(-5.936)	(-5.958)
ΔDependent variable$_{t-7}$	-	-	-	-0.153***	-0.153***
	-	-	-	(-6.057)	(-6.072)
ΔDependent variable$_{t-8}$	-	-	-	-0.128***	-0.128***
	-	-	-	(-5.849)	(-5.861)
ΔDependent variable$_{t-9}$	-	-	-	-0.062***	-0.062***
	-	-	-	(-3.595)	(-3.601)
ΔVIX index$_{t-1}$	0.007***	0.006***	0.006***	0.007***	0.007***
	(3.924)	(3.326)	(3.432)	(3.699)	(3.780)
ΔVIX index$_{t-2}$	-	0.003	0.003*	0.004**	0.004**
	-	(1.565)	(1.647)	(2.110)	(2.167)
ΔVIX index$_{t-3}$	-	0.005***	0.005***	0.005***	0.005***
	-	(2.672)	(2.738)	(3.087)	(3.137)
ΔVIX index$_{t-4}$	-	-	-	0.002	0.002
	-	-	-	(1.241)	(1.278)
ΔVIX index$_{t-5}$	-	-	-	0.003*	0.003*
	-	-	-	(1.894)	(1.926)
ΔVIX index$_{t-6}$	-	-	-	0.005***	0.005***
	-	-	-	(3.043)	(3.072)
ΔUST bill 12-month$_{t-1}$	0.335***	0.273**	0.270**	0.296**	0.294**
	(3.246)	(2.361)	(2.338)	(2.560)	(2.541)
ΔUST bill 12-month$_{t-2}$	-0.153	-	-	-	-
	(-1.536)	-	-	-	-
ΔUST bill 12-month$_{t-3}$	0.147	-	-	-	-
	(1.480)	-	-	-	-
Total tradable bonds$_t$	0.056*	0.019*	0.021**	0.018*	0.020**
	(1.916)	(1.843)	(2.150)	(1.726)	(2.050)
Domestic return$_{t-1}$	-0.548	-0.706*	-0.703**	-0.531	-0.551
	(-1.512)	(-1.911)	(-1.988)	(-1.439)	(-1.562)
Subprime crisis	0.008	-0.011	-	0.002	-
	(0.350)	(-0.398)	-	(0.066)	-
European crisis	-0.027	-0.024	-	-0.020	-
	(-1.275)	(-0.986)	-	(-0.837)	-
Taper tantrum	0.011	0.011	-	0.007	-
	(0.496)	(0.440)	-	(0.280)	-
Yuan devaluation	0.001	0.005	-	0.001	-
	(0.019)	(0.151)	-	(0.040)	-
COVID-19 pandemic	-	0.025	0.033	0.026	0.031
	-	(0.868)	(1.217)	(0.922)	(1.127)
Constant	0.303**	0.168	0.186*	0.203*	0.212**
	(2.281)	(1.537)	(1.750)	(1.855)	(1.989)
Observations	2,929	3,424	3,424	3,419	3,419
Adjusted R^2	0.393	0.390	0.391	0.398	0.399
Root Mean Square Error	0.174	0.202	0.202	0.200	0.200
Long-run relationships	Yes	Yes	Yes	Yes	Yes
Autocorrelation	No	No – until lag 2	No – until lag 2	No	No
Stability (no structural break)	Yes	Yes	Yes	Yes	Yes
Maximum lags allowed	5	5	5	10	10
Observable period	2 Jan. 2008 - 31 Dec. 2019	2 Jan. 2008 - 31 Dec. 2021	2 Jan. 2008 - 31 Dec. 2021	2 Jan. 2008 - 31 Dec. 2021	2 Jan. 2008 - 31 Dec. 2021

[1]***, **, * denote significance at 1%, 5%, 10% respectively. *t-statistics* in parentheses. [2] The period of notable events are based on Ahmed et al. (2017), except for coronavirus pandemic that is calculated by the authors. Subprime crisis: 19 Sep. 2008-27 Sep. 2009; European crisis: 29 Jul. 2011-16 Dec. 2011; Taper tantrum: 10 May 2013-30 Aug. 2013; Yuan devaluation: 21 Jul. 2015-4 Sep. 2015; COVID-19 pandemic: 28 Feb. 2020-26 Jun. 2020.

Table 4.14: Investigating the determinants of foreign investors' behaviour, 2 Jan. 2008 to 31 Dec. 2021, maximum lags allowed to be chosen by the AIC are 5 lags, including the crisis periods: **The long-run and short-run relationships of the main variables**

	Dependent variable: The net purchases of the bondholders				
	All	Mutual funds	Banks	Insurance comp. & pension funds	Officials
The long-run	(4.14a)	(4.14b)	(4.14c)	(4.14d)	(4.14e)
VIX index$_{t-1}$	-0.014**	-0.013***	0.000	-0.001	-0.002
	(-2.210)	(-3.732)	(0.218)	(-0.922)	(-1.217)
UST bill 12-month$_{t-1}$	-0.135**	-0.087**	-0.023	-0.015*	-0.003
	(-2.214)	(-2.515)	(-0.972)	(-1.699)	(-0.224)
Indonesia's bill 12-month$_{t-1}$	0.149***	0.040	0.025	0.012	0.033***
	(2.937)	(1.396)	(1.324)	(1.619)	(2.808)
Expectation of the IDR depreciation$_{t-1}$	-5.772***	-1.062	-1.679**	-0.469	-0.939*
	(-2.689)	(-0.875)	(-2.008)	(-1.579)	(-1.950)
Indonesia's rating and outlook$_{t-1}$	0.308***	0.120***	0.061**	0.035***	0.056***
	(3.976)	(2.746)	(2.083)	(3.164)	(3.109)
Error correction term$_{t-1}$	-0.622***	-0.631***	-0.790***	-0.656***	-0.579***
	(-26.359)	(-20.693)	(-35.734)	(-24.318)	(-20.637)
The short-run	(4.14f)	(4.14g)	(4.14h)	(4.14i)	(4.14j)
ΔDependent variable$_{t-1}$	-0.153***	-0.254***	-0.062***	-0.099***	-0.262***
	(-7.107)	(-8.857)	(-3.643)	(-4.010)	(-9.724)
ΔDependent variable$_{t-2}$	-0.056***	-0.143***	-	-0.074***	-0.104***
	(-3.262)	(-5.504)	-	(-3.442)	(-4.148)
ΔDependent variable$_{t-3}$	-	-0.112***	-	-0.063***	-0.055**
	-	(-4.983)	-	(-3.698)	(-2.470)
ΔDependent variable$_{t-4}$	-	-0.060***	-	-	-0.045***
	-	(-3.536)	-	-	(-2.620)
ΔVIX index$_{t-1}$	-0.049***	-0.020***	-0.021***	-0.001	-
	(-4.650)	(-3.435)	(-4.250)	(-0.549)	-
ΔVIX index$_{t-2}$	-0.029***	-0.028***	-	0.003**	-
	(-2.763)	(-4.783)	-	(2.140)	-
ΔVIX index$_{t-3}$	-0.002	-	-	-	-
	(-0.230)	-	-	-	-
ΔVIX index$_{t-4}$	-0.011	-	-	-	-
	(-1.086)	-	-	-	-
ΔVIX index$_{t-5}$	-0.025**	-	-	-	-
	(-2.553)	-	-	-	-
ΔIndonesia's bill 12-month$_{t-1}$	0.188	0.113*	0.082	-	-0.046*
	(1.634)	(1.743)	(1.502)	-	(-1.957)
ΔIndonesia's bill 12-month$_{t-2}$	0.070	0.050	-	-	-
	(0.609)	(0.775)	-	-	-
ΔIndonesia's bill 12-month$_{t-3}$	-0.251**	-0.114*	-	-	-
	(-2.325)	(-1.869)	-	-	-
ΔExpect. of the IDR depreciation$_{t-1}$	-14.510***	-4.888***	-6.971***	-	-
	(-5.522)	(-3.255)	(-5.432)	-	-
ΔExpect. of the IDR depreciation$_{t-2}$	-7.169***	-3.514**	-3.948***	-	-
	(-2.732)	(-2.345)	(-3.299)	-	-
ΔExpect. of the IDR depreciation$_{t-3}$	-	-	0.262	-	-
	-	-	(0.224)	-	-
ΔExpect. of the IDR depreciation$_{t-4}$	-	-	-2.474**	-	-
	-	-	(-2.209)	-	-
ΔExpect. of the IDR depreciation$_{t-5}$	-	-	-2.347**	-	-
	-	-	(-2.118)	-	-
ΔIndonesia's rating and outlook$_{t-1}$	-	1.205*	-	-	-
	-	(1.871)	-	-	-
ΔUST bill 12-month$_{t-1}$	-	-	-0.577*	-	-
	-	-	(-1.832)	-	-
Observations	3,424	3,424	3,424	3,424	3,424
Adjusted R^2	0.383	0.443	0.428	0.373	0.415
Root Mean Square Error	1.149	0.659	0.55	0.179	0.255
Long-run relationships	Yes	Yes	Yes	Yes	Yes
Autocorrelation	No	Yes	No	No	No
Stability (no structural break)	Yes	Yes	Yes	Yes	Yes

[1]***, **, * denote significance at 1%, 5%, 10% respectively. *t-statistics* in parentheses. [2] The maximum lags allowed to be selected by the Akaike Information Criterion (AIC) are 5 lags, which represents 1 working days or equal to 2 weeks. [3] The period of notable events are based on Ahmed et al. (2017), except for coronavirus pandemic that is calculated by the authors. Subprime crisis: 19 Sep. 2008-27 Sep. 2009; European crisis: 29 Jul. 2011-16 Dec. 2011; Taper tantrum: 10 May 2013-30 Aug. 2013; Yuan devaluation: 21 Jul. 2015-4 Sep. 2015; COVID-19 pandemic: 26 Feb. 2020-24 Aug. 2020.

Table 4.15: Investigating the determinants of foreign mutual funds' behaviour: **The short-run relationships**

	Dependent variable: The net purchases of the bondholders the foreign investors' mutual funds				
The short-run	(4.15a)	(4.15b)	(4.15c)	(4.15d)	(4.15e)
ΔDependent variable$_{t-1}$	-0.180***	-0.254***	-0.260***	-0.355***	-0.363***
	(-5.503)	(-8.857)	(-9.116)	(-9.496)	(-9.814)
ΔDependent variable$_{t-2}$	-0.087***	-0.143***	-0.148***	-0.253***	-0.260***
	(-2.983)	(-5.504)	(-5.708)	(-6.975)	(-7.229)
ΔDependent variable$_{t-3}$	-0.071***	-0.112***	-0.115***	-0.230***	-0.236***
	(-2.850)	(-4.983)	(-5.152)	(-6.608)	(-6.828)
ΔDependent variable$_{t-4}$	-0.049***	-0.060***	-0.062***	-0.190***	-0.195***
	(-2.683)	(-3.536)	(-3.643)	(-5.733)	(-5.905)
ΔDependent variable$_{t-5}$	-	-	-	-0.145***	-0.149***
	-	-	-	(-4.640)	(-4.771)
ΔDependent variable$_{t-6}$	-	-	-	-0.104***	-0.107***
	-	-	-	(-3.598)	(-3.703)
ΔDependent variable$_{t-7}$	-	-	-	-0.075***	-0.077***
	-	-	-	(-2.882)	(-2.956)
ΔDependent variable$_{t-8}$	-	-	-	-0.083***	-0.084***
	-	-	-	(-3.666)	(-3.722)
ΔDependent variable$_{t-9}$	-	-	-	-0.058***	-0.059***
	-	-	-	(-3.416)	(-3.450)
ΔVIX index$_{t-1}$	-0.023***	-0.020***	-0.021***	-0.021***	-0.022***
	(-3.358)	(-3.435)	(-3.534)	(-3.549)	(-3.662)
ΔVIX index$_{t-2}$	-0.025***	-0.028***	-0.028***	-0.029***	-0.030***
	(-3.975)	(-4.783)	(-4.826)	(-4.944)	(-5.002)
ΔUST bill 12-month$_{t-1}$	-0.666*	-	-	-	-
	(-1.788)	-	-	-	-
ΔIndonesia's bill 12-month$_{t-1}$	0.070	0.113*	0.114*	0.155**	0.152**
	(1.089)	(1.743)	(1.753)	(2.270)	(2.235)
ΔIndonesia's bill 12-month$_{t-2}$	0.018	0.050	0.051	0.132*	0.130*
	(0.289)	(0.775)	(0.795)	(1.941)	(1.917)
ΔIndonesia's bill 12-month$_{t-3}$	-0.139**	-0.114*	-0.115*	-	-
	(-2.278)	(-1.869)	(-1.873)	-	-
ΔExpect. of the IDR depreciation$_{t-1}$	-3.253**	-4.888***	-4.645***	-6.531***	-6.250***
	(-2.220)	(-3.255)	(-3.103)	(-4.156)	(-3.995)
ΔExpect. of the IDR depreciation$_{t-2}$	-	-3.514**	-3.308**	-5.191***	-4.929***
	-	(-2.345)	(-2.212)	(-3.266)	(-3.111)
ΔExpect. of the IDR depreciation$_{t-3}$	-	-	-	-3.779**	-3.604**
	-	-	-	(-2.548)	(-2.434)
ΔExpect. of the IDR depreciation$_{t-4}$	-	-	-	-3.360**	-3.275**
	-	-	-	(-2.356)	(-2.298)
ΔExpect. of the IDR depreciation$_{t-5}$	-	-	-	-3.201**	-3.140**
	-	-	-	(-2.319)	(-2.276)
ΔExpect. of the IDR depreciation$_{t-6}$	-	-	-	-3.338**	-3.302**
	-	-	-	(-2.442)	(-2.417)
ΔExpect. of the IDR depreciation$_{t-7}$	-	-	-	-1.934	-1.884
	-	-	-	(-1.428)	(-1.391)
ΔExpect. of the IDR depreciation$_{t-8}$	-	-	-	-1.186	-1.159
	-	-	-	(-0.877)	(-0.859)
ΔExpect. of the IDR depreciation$_{t-9}$	-	-	-	-3.580***	-3.574***
	-	-	-	(-2.659)	(-2.656)
ΔIndonesia's rating and outlook$_{t-1}$	1.143*	1.205*	1.206*	1.246*	1.246*
	(1.869)	(1.871)	(1.873)	(1.943)	(1.943)
Total tradable bonds$_t$	-0.184*	-0.070**	-0.063*	-0.061*	-0.054*
	(-1.731)	(-2.056)	(-1.942)	(-1.789)	(-1.669)
Domestic return$_{t-1}$	3.836***	4.290***	4.687***	3.866***	4.189***
	(2.805)	(3.421)	(3.903)	(3.063)	(3.465)
Subprime crisis	-0.126	0.018	-	0.024	-
	(-1.462)	(0.204)	-	(0.269)	-
European crisis	-0.136*	-0.027	-	-0.024	-
	(-1.772)	(-0.343)	-	(-0.307)	-
Taper tantrum	-0.191**	-0.171**	-	-0.156*	-
	(-2.345)	(-2.001)	-	(-1.822)	-
Yuan devaluation	-0.098	-0.108	-	-0.126	-
	(-0.872)	(-0.912)	-	(-1.072)	-
COVID-19 pandemic	-	-0.235**	-0.243***	-0.165*	-0.174*
	-	(-2.484)	(-2.691)	(-1.743)	(-1.913)
Constant	-1.819***	-0.966***	-1.106***	-0.754**	-0.887**
	(-3.741)	(-2.622)	(-3.086)	(-2.014)	(-2.439)
Observations	2,929	3,424	3,424	3,419	3,419
Adjusted R^2	0.467	0.443	0.443	0.448	0.448
Root Mean Square Error	0.623	0.659	0.659	0.656	0.656
Long-run relationships	Yes	Yes	Yes	Yes	Yes
Autocorrelation	Yes	Yes	Yes	No	No
Stability (no structural break)	Yes	Yes	Yes	Yes	Yes
Maximum lags allowed	5	5	5	10	10
Observable period	2 Jan. 2008 - 31 Dec. 2019	2 Jan. 2008 - 31 Dec. 2021	2 Jan. 2008 - 31 Dec. 2021	2 Jan. 2008 - 31 Dec. 2021	2 Jan. 2008 - 31 Dec. 2021

[1]***, **, * denote significance at 1%, 5%, 10% respectively. *t-statistics* in parentheses. [2] The period of notable events are based on Ahmed et al. (2017), except for coronavirus pandemic that is calculated by the authors. Subprime crisis: 19 Sep. 2008-27 Sep. 2009; European crisis: 29 Jul. 2011-16 Dec. 2011; Taper tantrum: 10 May 2013-30 Aug. 2013; Yuan devaluation: 21 Jul. 2015-4 Sep. 2015; COVID-19 pandemic: 28 Feb. 2020-26 Jun. 2020.

4.8.2 Figures

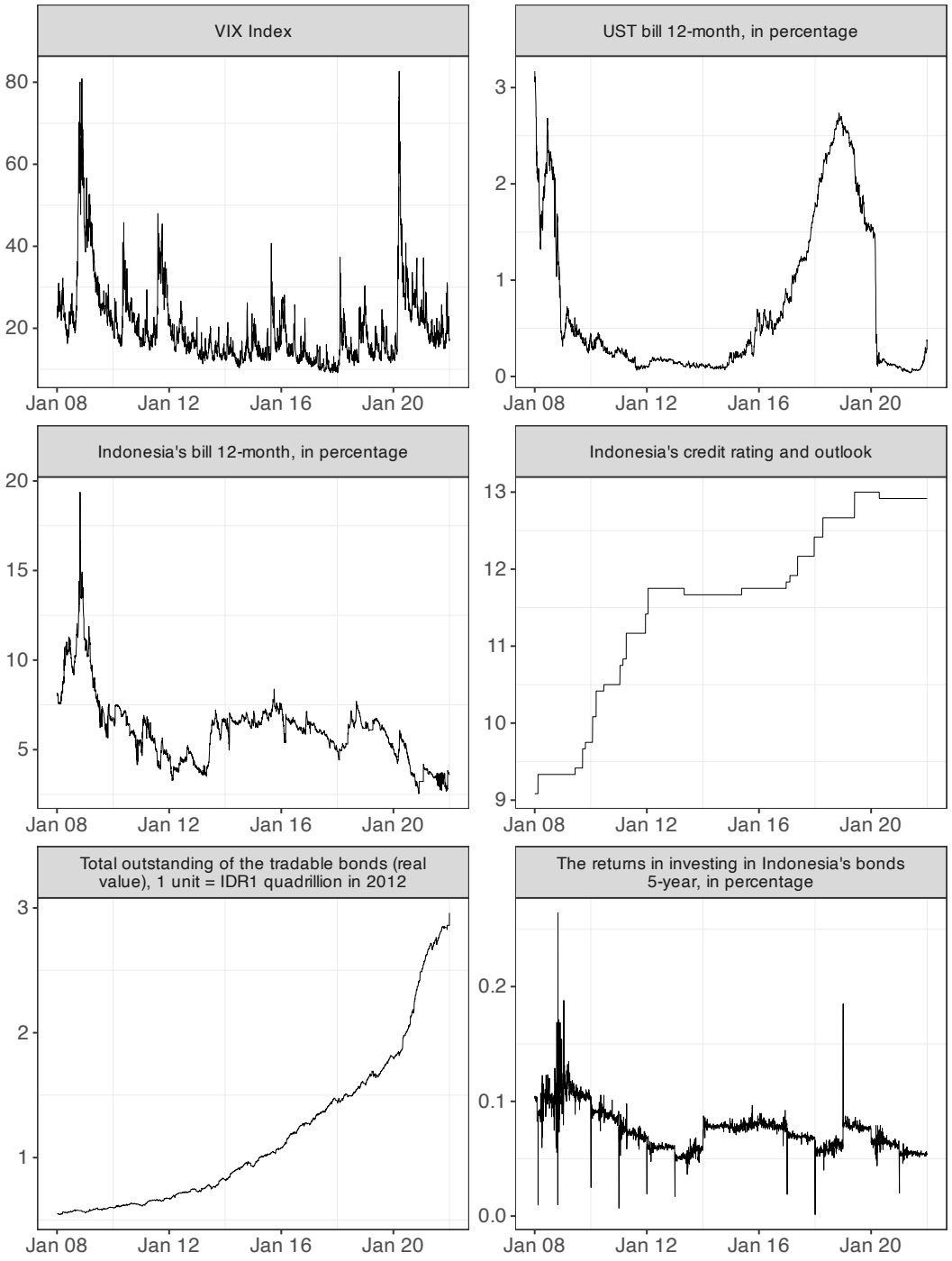


Figure 4.6: The independent variables included in the models.

Chapter 5

Conclusions

Observing a monthly data set from March 2004 to September 2019 and focusing more on Indonesia's local-currency government bonds market, this study aimed to explore the determinants of bond yields and investigate the market volatility. Foreign investors' behaviour was investigated using a daily data set from 2 January 2008 to 31 December 2019.

First, the results obtained from OLS and ARDL approaches show that a positive relationship between the VIX index, as a proxy to measure global risk, with the 10-year bond yields has highlighted that Indonesia's market could be exposed to the intensifying uncertainty in the global financial market. Further, this study finds that the effect of the VIX index in influencing Indonesian government bond yields was the greatest when the 2008 crisis exposed Indonesia's bonds market and Indonesia's credit rating was still below the investment-grade level. However, the impact was lessened in the sub-period when the turbulence in the global financial market was less frequent and Indonesia's credit rating had been upgraded to the investment grade. Accordingly, a higher level of investment grade can be interpreted as a reduced probability of default, which is related to the improvement in Indonesia's macroeconomic performance.

Those approaches also present inconsistent evidence about the role of foreign investors in lowering bond yields. A strong negative relationship between those variables can only be found in the whole period of observation, from March 2004 to September 2019, by implementing the OLS regression at the level of the observable variables and referring to the long-run relationship obtained from the ARDL specification. The result does not hold for the sub-periods and other frameworks (i.e., OLS regression on the first difference and the short-run relationship provided by ARDL specification).

The next chapter unveils that the autoregressive method used in the previous literature is less persuasive in explaining volatility within a month in Indonesia's bonds market. Perhaps, it is because the method utilises end-of-month data rather than employing more frequent data that is useful to capture the development in the financial market that changes rapidly. Therefore, in measuring the bond market volatility, this study employs daily data and calculates the bond yields' and bond prices' standard deviation within a month, then uses those variables as a response variable in different regression models.

Nevertheless, the outputs from OLS and ARCH/GARCH specifications present evidence that market volatility in Indonesia is highly correlated with the VIX index. Additionally, relatively different to the previous literature (Andritzky (2012), Peiris (2013), and Ebeke and Lu (2015)), the results show that the participation of foreign investors in Indonesia's bonds market, compensated by the lower share of the domestic investors, could be beneficial in lessening the impact caused by the increase in the global risk. A possible explanation is that the foreigners contribute to developing the domestic market by increasing the market liquidity and prefer to invest in intermediate- and long-term maturities. As a result, a more developed local-currency bond market tends to recover faster after being affected by unfavourable conditions in the global financial market than a less developed one. Further, between the officials and private investors, the outputs explain that

the latter type of foreign investors has a critical role in lessening the impact of the increase in global risk.

Lastly, the final chapter investigates foreign investors' behaviour by employing ARDL models that can capture long-run and short-run relationships on the daily trading data of different groups of investors. Trading in the secondary market is triggered by the differential sensitivity of different groups to the relevant explanatory variables. In Indonesia's case, foreigners' net purchases are influenced by the VIX index, the yield on Indonesia's 12-month bill, the expectation of local currency depreciation, and the probability of default. These findings are consistent with the theoretical model. Moreover, by disaggregating them into different types, the models suggest that foreign mutual funds are the most sensitive to the condition of the global financial market, as represented by the VIX index and the alternative variable.

In general, the findings in this chapter are relatively similar to Ng et al. (2019)'s study, which also explains that the mutual funds lessened their ownership in the government bonds denominated in foreign currencies during the taper tantrum. However, in Indonesia's case, the statistical outputs show that the insurance companies & pension funds behave similarly by decreasing net purchases when the uncertainty in the global financial market is rising, which is different to their findings. Also, the outcome from the ARDL models cannot find any convincing evidence that the insurance companies & pension funds act counter-cyclically, as described by Timmer (2018). On the contrary, even though statistically weaker, the results show that they tend to increase net purchases when the return in the previous period increases.

Further, considering that our models show the important role of domestic investors' insurance companies & pension funds in stabilising the domestic market, it is crucial for the Ministry of Finance, as the bonds' issuer, and the Financial Service Authority to maintain strong coordination. Additionally, designing gov-

ernment bonds that meet their needs could also be examined to increase their participation, eventually mitigating any risk that could jeopardise market stability. Nevertheless, in general, this study's findings suggest that foreign investors still need to develop the domestic market.

As for future research, it could be beneficial to conduct the VAR method then followed by IRF analysis to examine the effect of a shock in foreign holdings' share on the bond yields and extend the observation period to determine factors that could influence bond yields and market volatility. The main reason is that the part of this study related to those topics does not cover the period of the coronavirus pandemic when the Indonesian government took an extraordinary regulation by allowing the central bank to participate in buying bonds in the primary market. Also, to strengthen the results regarding the foreign investors' behaviour, it could be important to break down the net purchases by the maturities of the government bonds.

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