

## Online Appendix

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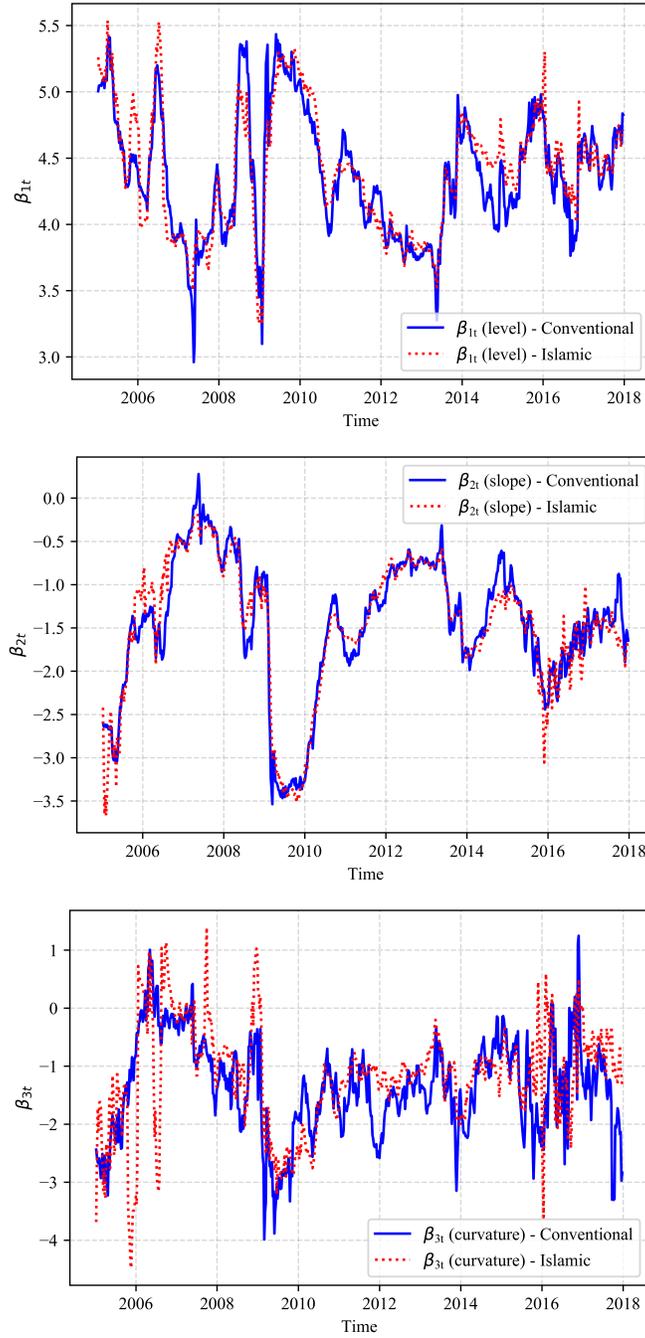
### Clientele Effect in Sovereign Bonds: Evidence From Malaysia

This online appendix reports the supplementary results and institutional background as described below:

- Online Appendix A: Supplementary Results of Nelson-Siegel Three-Factor Model
- Online Appendix B: Islamic Bonds (*Sukuk*) and Malaysian Bond Market
- Online Appendix C: List of Bond Instruments
- Online Appendix D: Data Cleaning and Sample Construction Process
- Online Appendix E: Islamic Bond (*Sukuk*) and Malaysian Bond Market

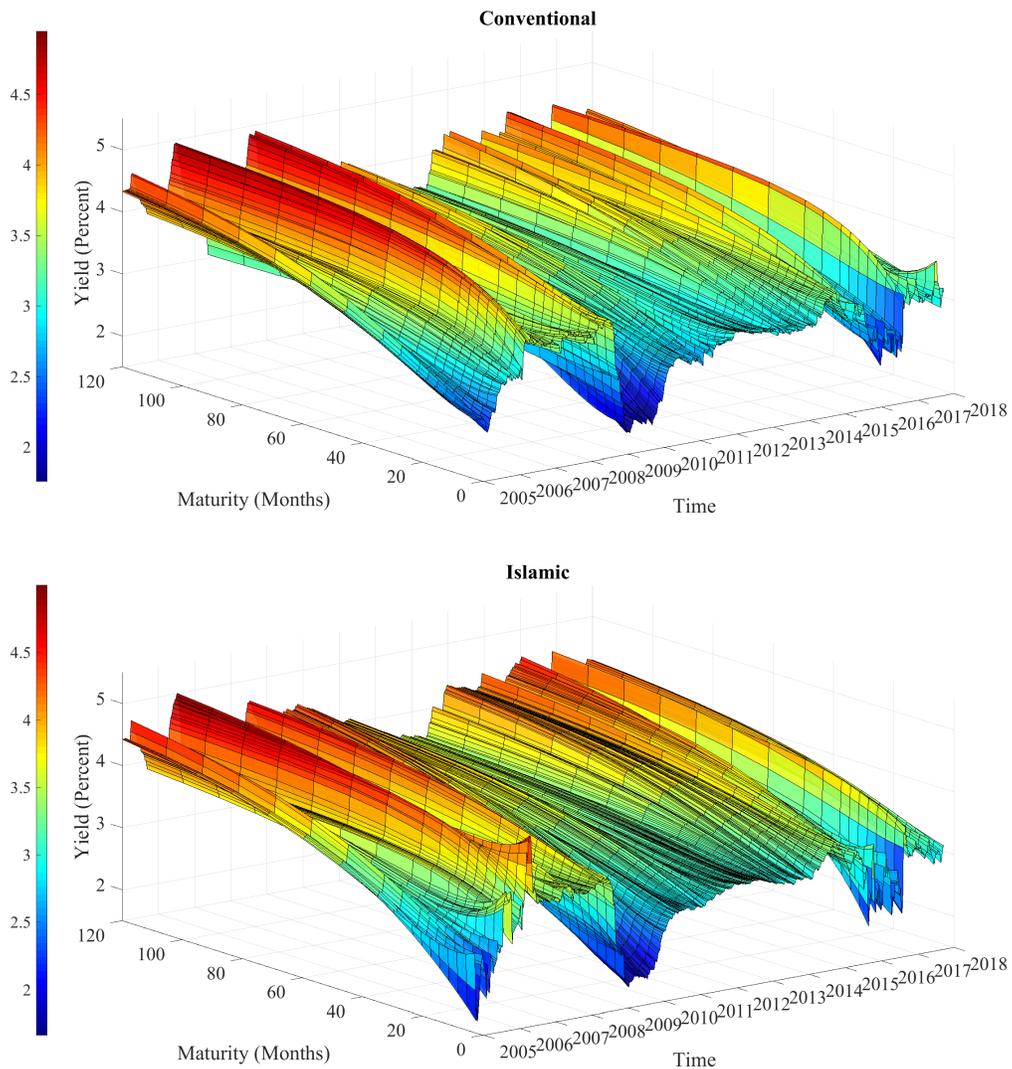
## A. Online Appendix: Supplementary Results of Nelson-Siegel Three-Factor Model

In this online appendix, we report some supplementary results of the Subsection 4.1 Nelson-Siegel analysis in the paper. In Figure IA-1, we plot the time-trend of the three estimated factors, based on which we compute the time series mean (median, 25th and 75th of  $\beta_{1t}$ ,  $\beta_{2t}$  and  $\beta_{3t}$  from Table 6 in the paper. In Figure IA-2, we show the fitted yield surfaces (i.e., the collection of the weekly yield curves) for both subsets of bonds. To clearly differentiate the yield surfaces, in Figure IA-3, we project the yield surface onto the “Yield-Time” panel (i.e., by shrinking the “Maturity” axis), which turns out as an area plot in Figure IA-3. Figure IA-4 takes the difference between the two area plots of the Islamic (*Sukuk*) and conventional sovereign bonds in Figure IA-3. We can see from Figure IA-4 that during the first half of our sample period, both bond subsets show a balanced pattern in terms of the yield spread. However, the Islamic sovereign bonds show consistently higher yields than their conventional counterparts during the second half of the sample period.



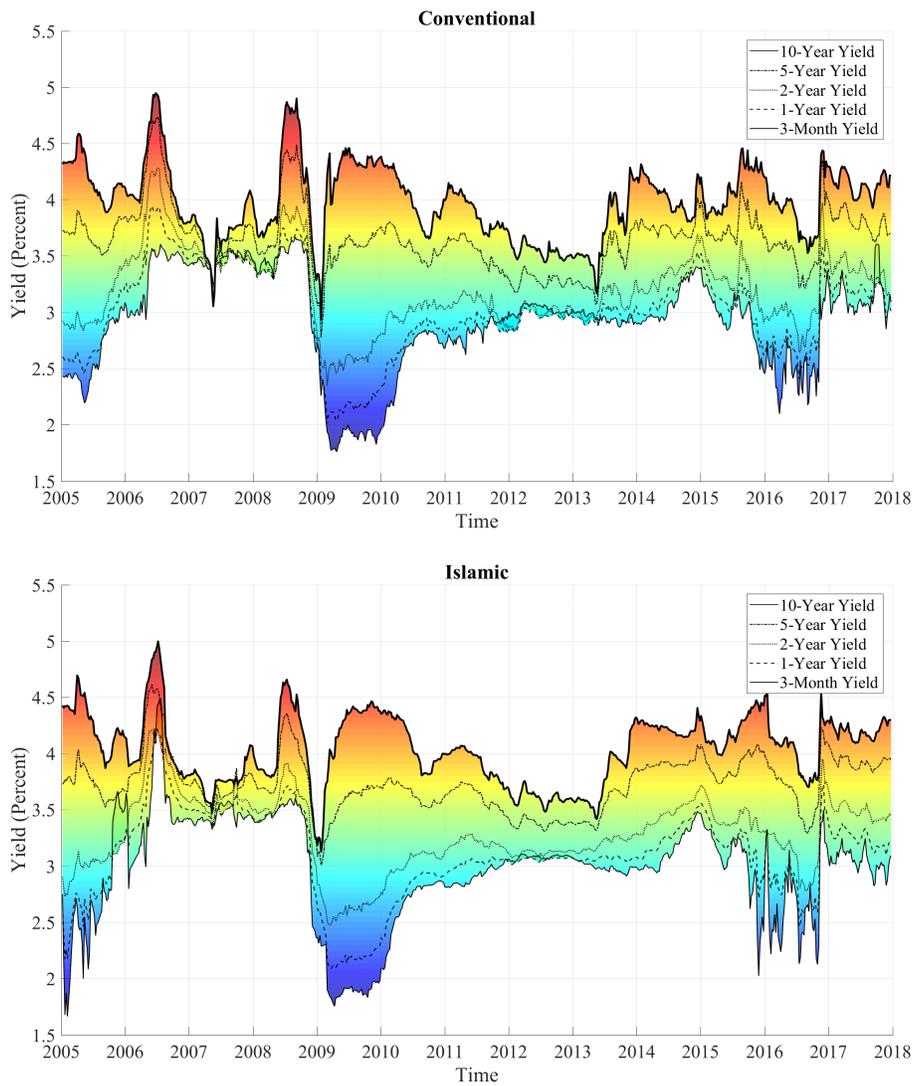
**Figure IA-1 Time-trend of the Estimated Nelson-Siegel Factors**

This figure shows the time-trend of the three estimated factors (i.e., level- $\widehat{\beta}_1$ , slope- $\widehat{\beta}_2$ , and curvature- $\widehat{\beta}_3$ ) from the Nelson-Siegel model. For each week, we regress the yields on the two factor loadings cross-sectionally. The factor loading is a function of the maturity. We then plot the time series of the three estimated factors. The dataset consists of 432,633 transactions and 37,686 bond-week observations for Malaysian sovereign bonds traded over the period January 2005 to December 2017. We report the time-trend of the estimated factors for both Islamic and conventional sovereign bonds.



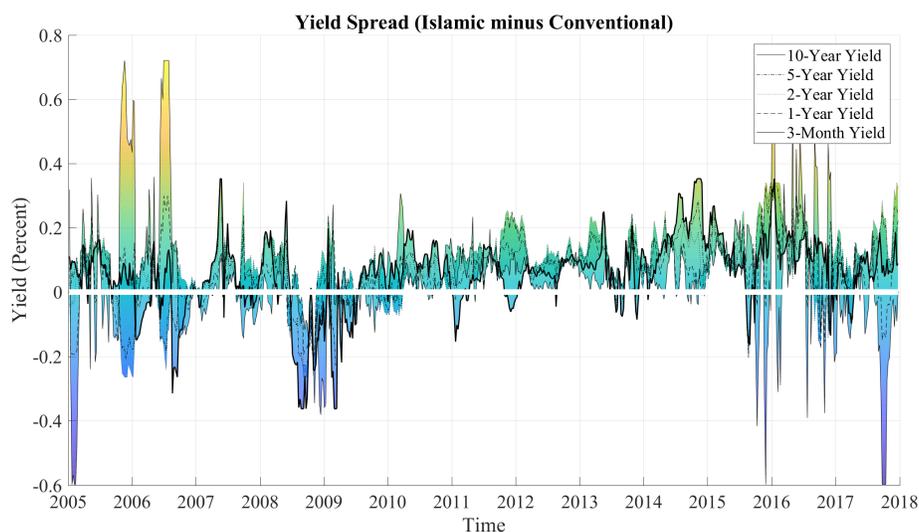
**Figure IA-2 Fitted Nelson-Siegel Fitted Yield Surfaces**

This graph shows the fitted yield surfaces using the Nelson-Siegel model over the sample period. For each week, we obtain the fitted yield curves by evaluating the Nelson-Siegel model at the value of the three estimated factors for that week (i.e.,  $\hat{\beta}_1$ ,  $\hat{\beta}_2$ , and  $\hat{\beta}_3$ ). After computing the fitted yield curves for all the weeks during the sample period, we plot the surface by shading the areas between the fitted yield curves. The dataset consists of 432,633 transactions and 37,686 bond-week observations (675 weeks) after aggregating Malaysian sovereign bonds traded over the period January 2005 to December 2017. We report the fitted yield surfaces for both Islamic and conventional sovereign bonds.



**Figure IA-3 Time-trend of the Fitted Yield Levels**

This figure shows a time-trend of the yield levels for Islamic and conventional bonds across all the maturities ranging from 3 months to 10 years, respectively. We pick 5 representative maturities: 3 months, 1 year, 2 years, 5 years, and 10 years. We first plot the time series of the yield levels for the 5 maturities, and then shade the areas between the time series plots of the yield levels. The dataset consists of 432,633 transactions and 37,686 bond-week observations (675 weeks) after aggregating Malaysian sovereign bonds traded over the period January 2005 to December 2017. We report the time-trend for both Islamic and conventional sovereign bonds.



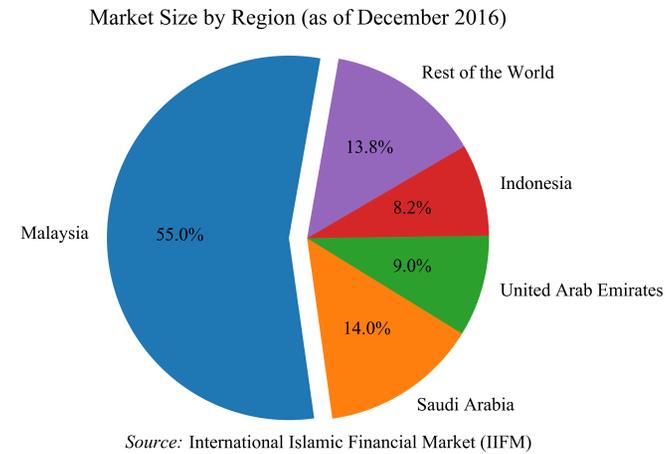
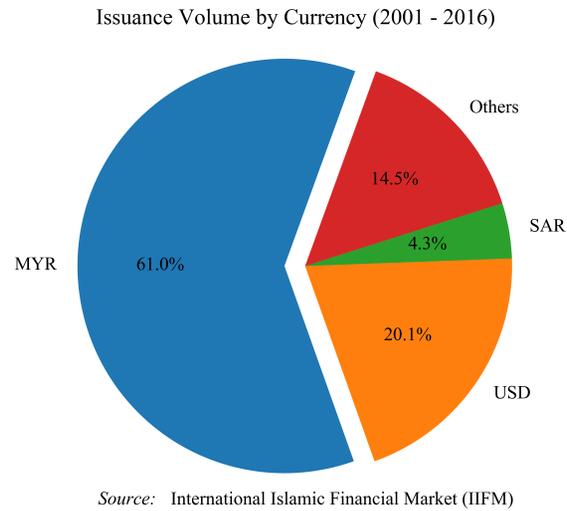
**Figure IA-4 Time-trend of the Fitted Yield Spreads**

This figure shows a time-trend of the yield spreads between Islamic and conventional bonds across all the maturities ranging from 3 months to 10 years. The yield spread is calculated by subtracting the yield level of *Sukuk* from that of conventional bonds. We pick 5 representative maturities: 3 months, 1 year, 3 years, 5 years and 10 years. We first plot the time series of the yield spreads for the 5 maturities, and then shade the areas between the time series plots of the yield spreads. The dataset consists of 432,633 transactions and 37,686 bond-week observations (675 weeks) after aggregating for Malaysian sovereign bonds traded over the period January 2005 to December 2017. We show the time-trend of the yield spreads, which is computed by subtracting the yield of *Sukuk* from that of conventional bonds.

## B. Online Appendix: Islamic Bond (*Sukuk*) and the Malaysian Bond Market

In contrast to conventional bonds, Islamic bonds have often been referred to as *Sukuk*, an Arabic term for financial certificates. The objective of Islamic and conventional bond issuance remains the same, i.e., to raise the necessary financing for projects. However, as an Islamic finance product, *Sukuk* must comply with certain underlying Shariah principles. That is, the funds raised by issuing *Sukuk* cannot be involved in non-Shariah compliant activities (e.g., gambling, alcohol, pork production, etc.) *Sukuk* are one of the most successful, visible, internationally-issued and accepted Islamic finance products. Malaysia issued the world's first *Sukuk* in 2000 and is currently the largest global issuer, with more than half of *Sukuk* issued worldwide being dominated in Malaysian ringgit (MYR). As shown in Figure IA-5, during the time period from 2001 through 2016, 61% of *Sukuk* issued was dominated in MYR.

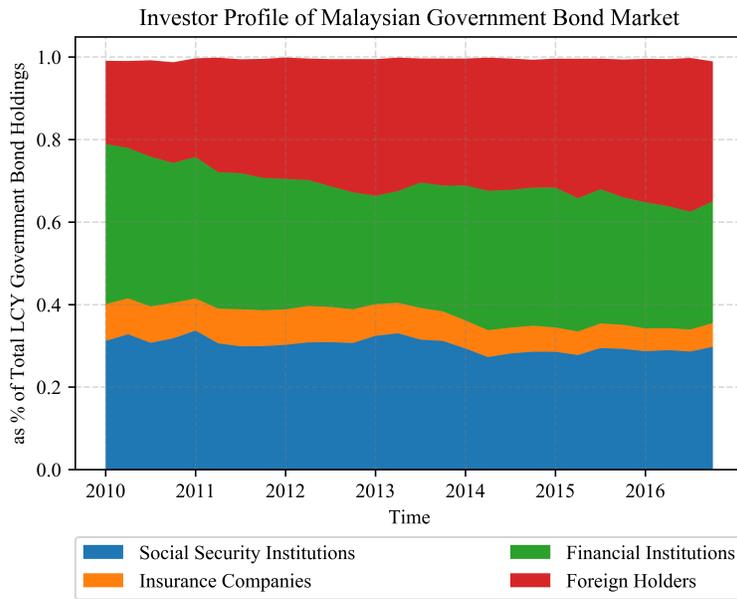
The Malaysian bond market is predominantly traded by institutional investors. Both Islamic and conventional bonds are open to foreign investors, who serve as important players in the Malaysian bond market. Figure IA-6 shows a significant increase in foreign holdings relative to the total amount outstanding in the Malaysian sovereign bond market. The foreign holdings are at the same level with the holdings of domestic financial and social security institutions.



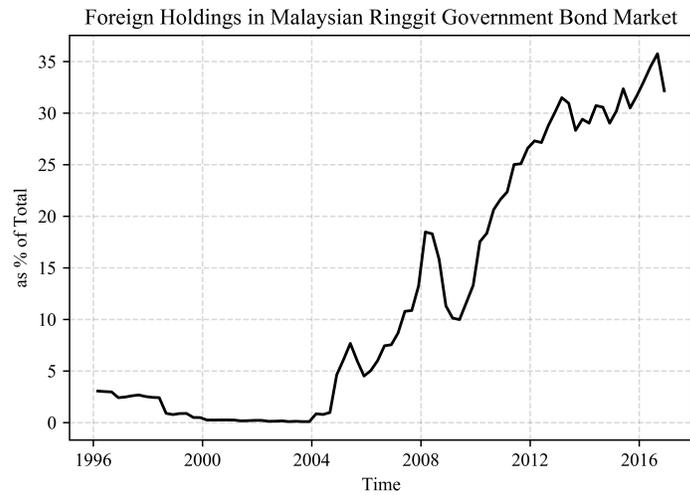
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**Figure IA-5** *Sukuk* Issuance by Currency and Market Size by Region

These two pie charts show the historical *Sukuk* issuance volume by currency and *Sukuk* outstanding by region, respectively. The period covers three years from 2001 through 2016.



Source: *AsianBondsOnline* and Bank Negara Malaysia (BNM)

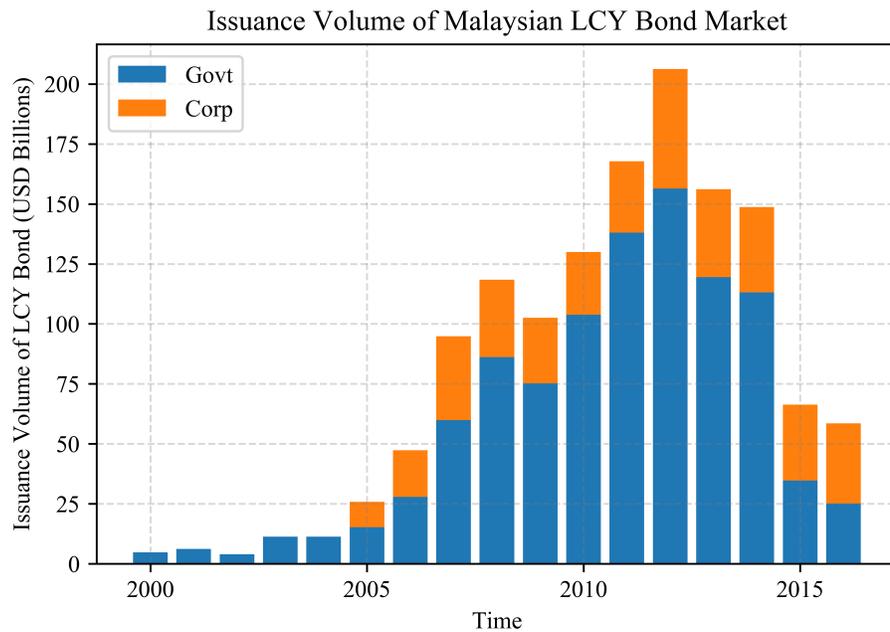


Source: *AsianBondsOnline* and Bank Negara Malaysia (BNM)

**Figure IA-6 Investor Profile and Foreign Holding**

The investor profile area plot shows the percentage of sovereign bond holdings by different institutional investors. The foreign holding plot shows the percentage in Malaysian sovereign bonds held by foreign investors relative to the total amount of bonds outstanding in Malaysian sovereign bond market.

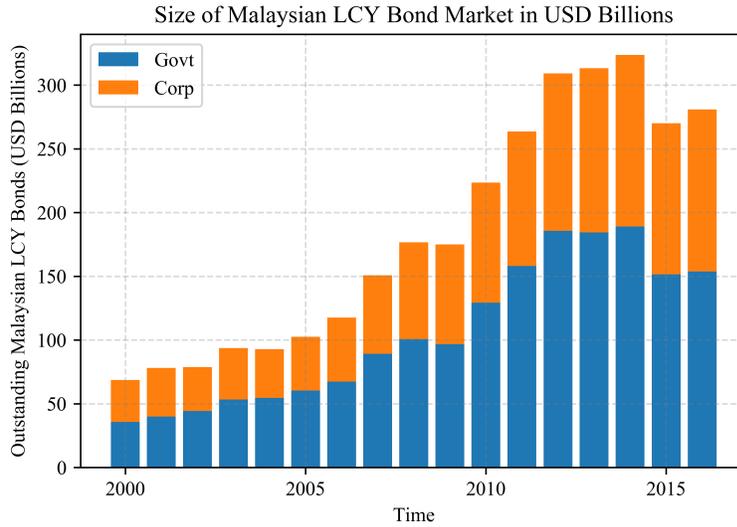
According to *AsianBondsOnline*, the Malaysian bond market is the third largest bond market in the Asia-Pacific region (ex-Japan). This is due to its increasing issuance volume, growing market size, and active trading activities. As can be seen from Figure IA-7, the issuance of Malaysian local currency (LCY) sovereign bonds increased steadily from USD4.75 billion in 2000 to USD156.46 billion in 2012. As of the end-March 2017, the total size of the Malaysian bond market was USD273 billion, peaking at USD329 billion in September 2014, which is close to 100% of the GDP of Malaysia. Figure IA-8 presents the yearly average of outstanding Malaysian LCY bonds in USD billions and a percentage of national GDP, respectively. As seen from Figure IA-9, Malaysia has progressively developed into an active Asian bond market since 2000. It witnessed its most dynamic year in 2011 with sovereign bond trading volumes reaching USD553.64 billion in total, and achieving an average turnover ratio of 0.83. The latter is a form of activity or liquidity measure, reflecting the frequency at which outstanding issues are traded in the market, i.e., the traded bond value divided by the outstanding bond value. In general, Malaysian sovereign bonds dominate the local currency bond market.



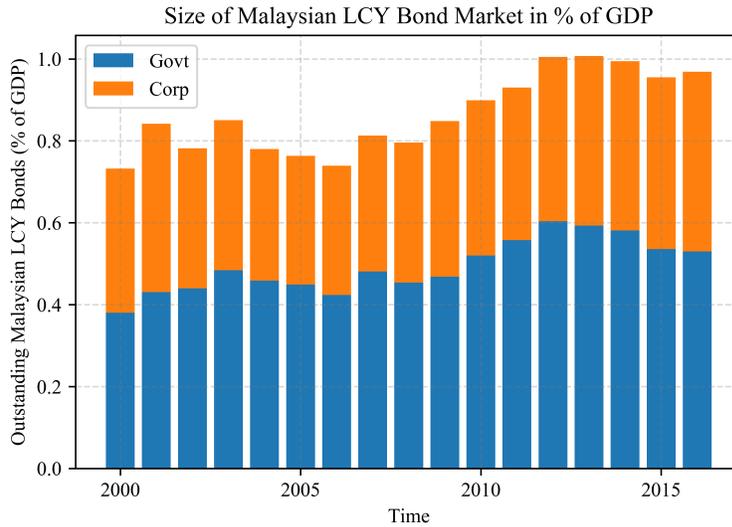
Source: *AsianBondsOnline*, Bank Negara Malaysia (BNM) and Bloomberg, L.P.

**Figure IA-7 Issuance Volume in Malaysian Bond Market**

This figure shows the total volume of Malaysian local currency (LCY) bond issuance, including both sovereign and corporate issuance, on a yearly basis. Sovereign bond issuance includes bonds issued by central governments, central banks, local governments, and quasi-government institutions. Corporate bond issuance includes bonds issued by both public and private companies, and financial institutions.



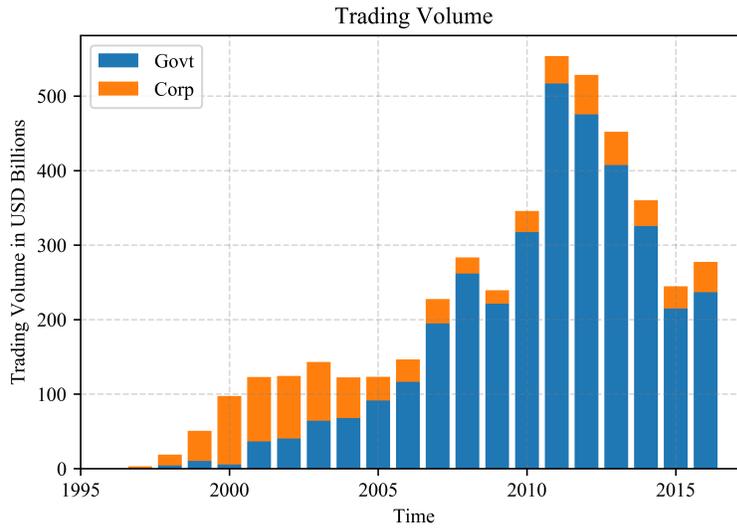
Source: AsianBondsOnline, Bank Negara Malaysia (BNM) and Bloomberg, L.P.



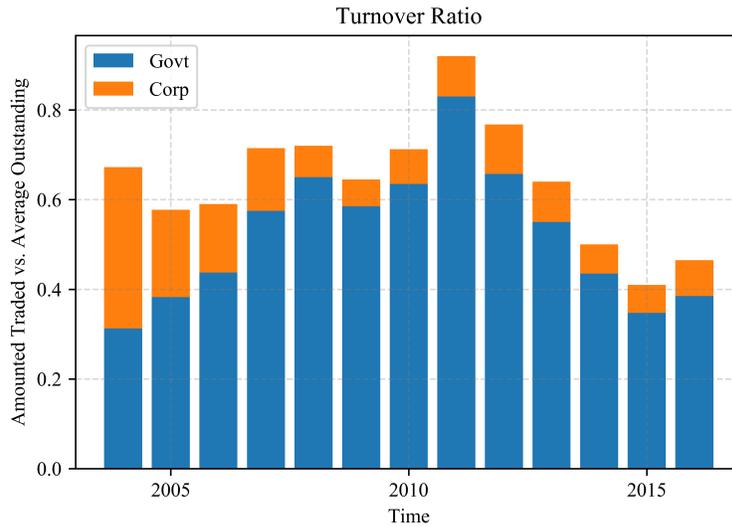
Source: AsianBondsOnline, Bank Negara Malaysia (BNM) and Bloomberg, L.P.

**Figure IA-8 Size of Malaysian Bond Market**

These two figures show the size of Malaysian local currency bond market in U.S. Dollar billions and in percent of national GDP, respectively. Sovereign bonds include obligations of the central governments, local governments, and the central bank. Corporate bonds comprise both public and private companies, including financial institutions. Financial institutions comprise both private and public-sector banks, and other financial institutions. Bonds are defined as long-term bonds and notes, Treasury bills, commercial paper, and other short-term notes.



Source: *AsianBondsOnline*, Bank Negara Malaysia (BNM) and Bloomberg, L.P.



Source: *AsianBondsOnline*, Bank Negara Malaysia (BNM) and Bloomberg, L.P.

**Figure IA-9 Trading Volume and Turnover of Malaysian Bond Market**

These two figures show the trading volumes in USD billions and turnover ratio in Malaysian bond market, respectively. Trading volume is the USD value of local currency sovereign and corporate bonds traded in the secondary markets. The turnover ratio indicates the frequency at which outstanding issues have been traded in the market. The turnover ratio is calculated as

$$turnover = \frac{\text{value of bonds traded}}{\text{average amount of bonds outstanding}}$$

Nevertheless, the Malaysian sovereign bond market is active in both Islamic and conventional bonds. According to the Malaysian International Islamic Financial Centre (MIFC), *Sukuk* bonds represent a substantial portion (around 50%) of sovereign new issuance. In Malaysia, Islamic sovereign bonds are similar to conventional sovereign bonds in terms of the effective cash flows, issuance structure and legal status. Table [IA-1](#) provides a comparison between two specific types of Islamic and conventional sovereign bonds. Malaysian Government Securities (MGS), which are conventional bond issues, and its Islamic principles variant, Government Investment Issue (GII), are both long-term bonds issued by the government of Malaysia. According to local financial institutions, there are no substantial tax differences between them. However, GII, which are capped at 10 years, have relatively shorter maturities than MGS, which are capped at 20 years. In addition, GII (MYR1000 million) also have a higher threshold for the minimal issuance amount than MGS (MYR500 million).

**Table IA-1 Bank Negara Malaysia Information Notes**

Bank Negara Malaysia Website gives the official information note about Islamic government bond and answers to some frequently asked questions. These documents list out the main features of Government Investment Issue (GII), which is a major form of Islamic government debt instruments. They cover a variety of aspects that people are interested in, such as Issuance, investor base, liquidity, return payment, redemption, tax treatment, regulatory treatment, legal status, and etc. A comprehensive understanding of these aspects is also quite critical for supporting our analysis and conclusion in this paper. The key information from these documents is summarized in the table below.

Although GII is defined by Bank Negara Malaysia (BNM) as “long-term non-interest-bearing Government securities based on Islamic principles issued by the Government of Malaysia for funding developmental expenditure,” the cash flow structure is indeed the same as that of MGS. One important concept in Islamic finance is the “sell and buy back” agreement, based on which “the Government will sell specified nominal value of its assets and subsequently will buy back the assets at its nominal value plus profit through a tender process.” The “profit” in GII is, economically, no different than the “interest” in MGS when viewed in terms of repaying money to investors. As a consequence, MGS and GII are two specific types of sovereign bond instruments.

<b>Features</b>	<b>Description</b>
Issuer	The Issuer of GII is Government of Malaysia, which is the same as its conventional counterpart – Malaysian Government Securities (MGS).
Mode of Issue	GII is issued through a variable-rate multiple-price auction format (English auction format), with Bank Negara Malaysia as issuance agent to the Government. The auction process of GII is quite similar to that of MGS.
Governing Law	The governing law for GII is the Government Funding Act 1983, and other applicable laws of Malaysia.
Investor Base	The subscription in primary market and trading in secondary market for GII are open to both Islamic and conventional participants.
Trading Lot and Liquidity	The trading lot in secondary market for GII is RM 10 million, which is about the same as MGS. Trading of GII in the secondary market is pretty active, as several Islamic and conventional Principal Dealers are consistently providing market making service and liquidity.
Mandatory Rating	Government debt securities are exempted from mandatory rating for domestic issuance.
Return payment	Both GII and MGS pay profit/interest to debtholders semi-annually, following Actual/Actual day count basis.
Redemption	Both GII and MGS are redeemed at par on maturity date.
Tax Treatment	Malaysia has no capital gains tax and stamp duty for issuance and transfer of government debt securities. Income tax for resident individuals, unit trust companies and listed closed-end fund companies, as well as withholding tax for non-resident investors, are exempted for interest/profit earnings from ringgit-denominated government debt securities.
Regulatory Treatment	With respect to regulation, GII and MGS are treated quite similarly. For example, both of them have 0% risk weight under the Risk-Weighted Capital Adequacy Framework and the Capital Adequacy Framework for Islamic Banks. Both of them are eligible collateral for Standing Facility. And also, they are excluded from Single Customer Credit Limit.
Legal Status	Both of GII and MGS are direct obligation of the Government. They represent the same certificate of indebtedness or liability of the Government.
Default Protection	There’s no difference in terms of investors’ protection against default. Legal treatment for non-payment/late payment of the return portion and the principal amount is the same for both Islamic and conventional government debt securities.

Source: GII Information Note 2013, Bank Negara Malaysia, <http://iimm.bnm.gov.my/index.php?ch=4>; GII FAQ 2013, Bank Negara Malaysia, <http://iimm.bnm.gov.my/index.php?ch=4>; Islamic Interbank Money Market FAQs, BNM, <http://iimm.bnm.gov.my/index.php?ch=1&pg=42>.

## C. Online Appendix: List of Bond Instruments

This table presents a list of instruments of all debt securities in Malaysia's local currency (LCY) market. Debt securities in Malaysia's local currency (LCY) market are classified by type of issuer—government, quasi-government and corporate. Lists of debt securities available in this market are provided below.

Instrument	Name	Definition	Conventional/ Islamic	Government/ Corporate
<i>BNB</i>	<i>Bank Negara Bills</i>	<i>Bank Negara Bills issued by Bank Negara Malaysia</i>	<i>Conventional</i>	<i>Government</i>
<i>BNMN-CB</i>	<i>Bank Negara Monetary Notes - Coupon Based</i>	<i>Bank Negara Monetary Notes (BNMN)—discounted or coupon-bearing government securities with maturities of 91-, 182-, 364-days and one to three years. BNMN are issued by BNM to manage liquidity in both conventional and Islamic markets, and have replaced BNM Bills and BNM Negotiable Notes beginning December 2006. BNMN are offered through competitive auction through principal dealers.</i>	<i>Conventional</i>	<i>Government</i>
<i>BNMN-DB</i>	<i>Bank Negara Monetary Notes - Discount Based</i>			
<i>BNMNF</i>	<i>Floating Rate Bank Negara Monetary Notes</i>	<i>BNMNF are instruments used for implementing monetary policy and in managing liquidity in the financial market. Floating rate BNMN issuance is conducted through competitive Dutch auction (uniform price) via the Principal Dealer network and the market participant will bid the tender based on spread.</i>	<i>Conventional</i>	<i>Government</i>
<i>BNNN</i>	<i>Bank Negara Negotiable Bills</i>	<i>Bank Negara Negotiable Bills - issued by Bank Negara Malaysia</i>	<i>Conventional</i>	<i>Government</i>
<i>KHA</i>	<i>Khazanah Bonds</i>	<i>Khazanah Bonds issued by Khazanah Nasional Berhad</i>	<i>Conventional</i>	<i>Government</i>
<i>MGS</i>	<i>Malaysian Government Securities</i>	<i>Malaysian Government Securities issued by the Government of Malaysia</i>	<i>Conventional</i>	<i>Government</i>
<i>MGSC</i>	<i>Malaysian Government Securities Callable</i>	<i>Since December 2006, Bank Negara Malaysia has introduced callable MGS which provides the Government with the option to redeem the issue at par by giving advance notice of five business days to bondholders. Typically, the issue will be called in whole on specific coupon date(s). However, these characteristics may vary in the future. Issuance of callable MGS allows the Government to better manage its cashflow as well as meet the diverse needs of investors. MGSC are issued via competitive auction by Bank Negara Malaysia on behalf of the Government. Successful bidders are determined according to the lowest yields offered and the coupon rate is fixed at the weighted average yield of successful bids.</i>	<i>Conventional</i>	<i>Government</i>
<i>MTB</i>	<i>Malaysian Treasury Bills</i>	<i>Short-term securities issued by the Government of Malaysia to raise short-term funds for Government's working capital. Bills are sold at discount through competitive auction, facilitated by Bank Negara Malaysia, with original maturities of 3-month, 6-month, and 1-year. The redemption will be made at par. Issued on a weekly basis and the auction will be held one day before the issue date. The successful bidders will be determined according to the most competitive yield offered. Normal auction day is Thursday and the result of successful bidders will be announced one day after. Tradable on yield basis (discounted rate) based of bands of remaining tenure (e.g., Band 4=68 to 91 days to maturity). The standard trading amount is RM5 million, and it is actively traded in the secondary market.</i>	<i>Conventional</i>	<i>Government</i>

BNMN-IDB	Bank Negara Monetary Notes - Islamic Discount Based	BNMN-i are Islamic securities issued by Bank Negara Malaysia replacing the existing Bank Negara Negotiable Notes (BNNN) for purposes of managing liquidity in the Islamic financial market. The instruments will be issued using Islamic principles which are deemed acceptable to Shariah requirement. The maturity of these issuances has also been lengthened from one year to three years. New issuances of BNMN-i may be issued either on a discounted or a coupon-bearing basis depending on investors' demand. Discount-based BNMN-i will be traded using the same market convention as the existing BNNN and Malaysian Islamic Treasury Bills (MITB) while the profit-based BNMN-i will adopt the market convention of Government Investment Issues (GII).	Islamic	Government
BNMN-IDM				
BNMN-IPB BNMN-IPI	Bank Negara Monetary Notes - Islamic Profit Based	the profit-based BNMN-i will adopt the market convention of Government Investment Issues (GII).	Islamic	Government
GII	Government Investment Issues	long-term non-interest-bearing Government securities based on Islamic principles issued by the Government of Malaysia for funding developmental expenditure. Similar with MGS, GII is issued through competitive auction by Bank Negara Malaysia on behalf of the Government. The GII issuance programme is pre-announced in the auction calendar with issuance size ranging from RM1 billion to RM3.5 billion and original maturities of 3-year, 7- year, 5-year and 10-year. GII is based on Bai' Al-Inah principles, part of the sell and buy back concept in Islamic finance. Under this principle, the Government will sell specified nominal value of its assets and subsequently will buy back the assets at its nominal value plus profit through a tender process. Profit rate is based on the weighted average yield of the successful bids of the auction. The nominal value of buying back the assets will be settled at a specified future date or maturity, while the profit rate will be distributed half yearly. The obligation of the Government to settle the purchase price is securitised in the form of GII and is issued to the investors. At maturity, the Government will redeem the GII and pay the nominal value of the securities to the GII holders. GII is one of the financial instruments that are actively traded in the Islamic Interbank Money Market.	Islamic	Government
MITB	Malaysian Islamic Treasury Bills	short-term securities issued by the Government of Malaysia based on Islamic principles. MITB are usually issued on a weekly basis with original maturities of 1-year. MITB auctions are held one day before the issue date. The successful bidders will be determined according to the most competitive yield offered. Both conventional and Islamic institutions can buy and trade MITB . structured based on Bai' Al-Inah principle, part of sell and buy back concept. Bank Negara Malaysia on behalf of the Government will sell the identified Government's assets on competitive tender basis, to form the underlying transaction of the deal. Allotment is based on highest price tendered (or lowest yield). Price is determined after profit element is imputed (discounting factor). The successful bidders will then pay cash to the Government. The bidders will subsequently sell back the assets to the Government at par based on credit term. The Government will issue MITB to bidders to represent the debt created. tradable on yield basis (discounted rate) based on bands of remaining tenure (e.g., Band 4= 68 to 91 days to maturity). The standard trading amount is RM5 million, and it is actively traded based on Bai ad-Dayn (debt trading) principle in the secondary market.	Islamic	Government

SBNMI	<i>Sukuk</i> Bank Negara Malaysia Ijarah	SBNMI are issued based on the Al-Ijarah or sale-and-lease-back concept, a structure that is widely used in the Middle East. A special-purpose vehicle (SPV) has been established to issue the <i>Sukuk</i> Ijarah.	Islamic	Government
SPK	<i>Sukuk</i> Perumahan Kerajaan	a Shariah compliance long-term profit-based Government securities issued based on Commodity Murabahah structure. SPK is issued by the Government of Malaysia under the Housing Loan Fund Act 1971 to refinance funding for housing loans to Government civil servants and to extend new Government housing loans. The funds were previously raised through loans but is now replaced with <i>Sukuk</i> issuances, consistent with the Government's continuous support in developing the Malaysian <i>Sukuk</i> market.	Islamic	Government
ABS	Asset-Backed Securities	Asset-Backed Securities - bonds issued pursuant to a securitisation transaction	Conventional	Corporate
ABSMTN	Asset-Backed Securities - medium-term notes	Asset-Backed Securities - medium-term notes issued pursuant to a securitisation transaction	Conventional	Corporate
BONDS	Corporate bonds	Corporate Bonds issued by corporations	Conventional	Corporate
CAGB	Cagamas Bonds	Cagamas Bonds issued by Cagamas Berhad	Conventional	Corporate
CAGN	Cagamas Notes	Cagamas Notes issued by Cagamas Berhad	Conventional	Corporate
CP	Commercial paper	Commercial papers (CP) —short-term revolving promissory notes with maturities from 1 month to 1 year. Issued by corporations	Conventional	Corporate
CP-CPN	Commercial paper	Commercial paper - coupon	Conventional	Corporate
MTN	Medium-term Notes	Medium-term notes (MTN) —have tenors from 1 to 5 years and may be issued both on conventional or Islamic principles, and by direct placement or tender.	Conventional	Corporate
ABS-IMTN	Asset-Backed Securities - Islamic medium-term notes	Asset-Backed Securities - Islamic medium-term notes issued pursuant to a securitisation transaction	Islamic	Corporate
CAGABAIS	Cagamas Bithaman Ajil Islamic Securities	Cagamas Bithaman Ajil Islamic Securities issued by Cagamas Berhad	Islamic	Corporate
IABS	Islamic Asset-Backed Securities	Islamic Asset-Backed Securities - <i>Sukuk</i> issued pursuant to a securitisation transaction	Islamic	Corporate
IBONDS	Islamic Corporate Bonds	<i>Sukuk</i> issued by corporations	Islamic	Corporate
ICP	Islamic Commercial Paper	Islamic Commercial Papers issued by corporations	Islamic	Corporate
ICP-CPN	Islamic Commercial Paper	Islamic Commercial Paper - coupon	Islamic	Corporate
IMTN	Islamic Medium-term Notes	Medium-term notes (MTN) —have tenors from 1 to 5 years and may be issued both on conventional or Islamic principles, and by direct placement or tender.	Islamic	Corporate

SAC	Sanadat ABBA Cagama	Sanadat ABBA Cagamas issued by Cagamas Berhad	Islamic	Corporate
SMC	Sanadat Mudharabah Cagamas	Sanadat Mudharabah Cagamas issued by Cagamas Berhad	Islamic	Corporate

*Source:* Bank Negara, Bond Info Hub and FAST websites

## D. Online Appendix: Data Cleaning and Sample Construction

To make our price/yield estimation as accurate as possible, we further restrict our sample to fixed-rate “straight” instruments without optionality, and drop suspicious data points by implementing the following six steps. Table IA-2 presents the number (share) of observations left after each step of filtering steps.

- *Removing errors*: We delete the observation if its instrument type, stock description, issuer and maturity date are all missing.
- *Removing missing yields*: The purpose of applying this filter is to make sure the price/yield information is available and accurate to the best of our knowledge.
- *Removing extreme values*: We omit outliers, which we define as price, yield and volume observations which below the 0.1th percentile or above the 99.9th percentile, considering all observations.
- *Removing duplicated reporting*: We remove duplicated reports of which the bond code, bond description, trade date, trade time, price, yield and amount are all identical. We believe these observations are real duplicates other than that these reports just randomly happened to be the same, because we could observe such cases repeatedly for some specific bonds
- *Price filtering*: We apply both price median filter and price reversal filter. The median filter eliminates any transaction where the price deviates by more than 10% from the daily median, or from a nine-day median centered at the trading day. The price reversal filter eliminates any transaction with an absolute price change deviating from the lead, lag and average lead/lag price change by at least 10%.
- *Six instruments*: The instruments in our database can be grouped into asset backed securities (ABS), corporate bonds, sovereign securities, commercial paper, Bank Negara Malaysia securities and medium-term notes. To exclude the impact of differential credit risks, we will focus only on the Malaysian sovereign bonds and restrict our sample to 6 types of security: BNB, BNMN-DB, BNMN-IDB, BNMN-IDM, GII, and MGS.

**Table IA-2 Data Cleaning and Sample Construction Process**

This table illustrates the data cleaning process and the number (Panel A) and the share (Panel B) of observations remaining after cleaning step for each year of data and the whole dataset. The initial number of observations is given as *before cleaning*, which equals to the total number of transactions in Malaysian bond market during the period of January 2005 through December 2017. *After removing errors*: Delete if instrument type, stock description, issuer and maturity date are all missing. *After removing missing yields*: The price information filter is applied to make sure the price/yield information is available and accurate to the best of our knowledge. In general, we remove the observations whose yield is not reported by Bank Negara Malaysia (BNM). *After removing extreme values*: We omit outliers, which we define as price, yield and volume observations which are below the 0.1th percentile or above the 99.9th percentile, considering all observations. *After removing duplicated-reporting*: We remove duplicated reports of which the bond code, bond description, trade date, trade time, price, yield and amount are all identical. *After price-filtering*: We apply both price median filter and price reversal filter. The median filter eliminates any transaction where the price deviates by more than 10% from the daily median, or from a nine-day median centered at the trading day. The reversal filter eliminates any transaction with an absolute price change deviating from the lead, lag and average lead/lag price change by at least 10%. *Six instruments*: The instruments in our database can be grouped into asset backed securities (ABS), corporate bonds, sovereign securities, commercial paper, Bank Negara Malaysia securities and medium-term notes. To exclude the impact of differential credit risks, we will focus only on the Malaysian sovereign bonds and restrict our sample to 6 types of security: BNB, BNMN-DB, BNMN-IDB, BNMN-IDM, GII, and MGS.

Panel A: Number of observations

year	before cleaning	errors	missing yields	after removing extreme values	duplicated-reporting	after price-filtering	six instruments
2005	39100	39100	29001	28818	28806	28806	22764
2006	41781	41781	30663	30557	30551	30551	26017
2007	40343	40343	26140	26013	26008	26008	23844
2008	37429	37429	34475	34095	34083	34083	27810
2009	34645	34645	33437	32646	32643	32643	25421
2010	43325	43325	42075	41970	41959	41959	33420
2011	51833	51833	50044	49887	49866	49866	40332
2012	56279	56279	54120	53938	53929	53929	40529
2013	55317	55317	53666	53495	53487	53487	39579
2014	52216	52216	50144	49989	48970	48970	35608
2015	56345	56345	54092	53876	52932	52932	39880
2016	67869	67869	57855	57627	57620	57617	43252
2017	52228	52228	48002	47888	46481	46481	34177
TOTAL	628710	628710	563714	560799	557335	557332	432633

Panel B: Share of observations

year	before cleaning	errors	missing yields	after removing extreme values	duplicated-reporting	after price-filtering	six instruments
2005	100.00%	100.00%	74.17%	73.70%	73.67%	73.67%	58.22%
2006	100.00%	100.00%	73.39%	73.14%	73.12%	73.12%	62.27%
2007	100.00%	100.00%	64.79%	64.48%	64.47%	64.47%	59.10%
2008	100.00%	100.00%	92.11%	91.09%	91.06%	91.06%	74.30%
2009	100.00%	100.00%	96.51%	94.23%	94.22%	94.22%	73.38%
2010	100.00%	100.00%	97.11%	96.87%	96.85%	96.85%	77.14%
2011	100.00%	100.00%	96.55%	96.25%	96.21%	96.21%	77.81%
2012	100.00%	100.00%	96.16%	95.84%	95.82%	95.82%	72.01%
2013	100.00%	100.00%	97.02%	96.71%	96.69%	96.69%	71.55%
2014	100.00%	100.00%	96.03%	95.74%	93.78%	93.78%	68.19%
2015	100.00%	100.00%	96.00%	95.62%	93.94%	93.94%	70.78%
2016	100.00%	100.00%	85.25%	84.91%	84.90%	84.89%	63.73%
2017	100.00%	100.00%	91.91%	91.69%	89.00%	89.00%	65.44%
TOTAL	100.00%	100.00%	89.66%	89.20%	88.65%	88.65%	68.81%

## E. Online Appendix: Islamic Bond (*Sukuk*) and Malaysian Bond Market

In contrast to conventional bonds, Islamic bonds have often been referred to as *Sukuk*, an Arabic term for financial certificates. The objective of Islamic and conventional bond issuance remains the same, i.e. to raise the necessary financing for projects. However, as an Islamic finance product, *Sukuk* must comply with certain underlying Shariah principles. That is, the funds raised by issuing *Sukuk* cannot be involved in non-Shariah compliant activities (e.g., gambling, alcohol, pork production, etc.) *Sukuk* are one of the most successful, visible, internationally-issued and accepted Islamic finance products. Malaysia issued the world's first *Sukuk* in 2000 and is currently the largest global issuer, with more than half of *Sukuk* issued worldwide being dominated in Malaysian ringgit (MYR).

The Malaysian bond market is predominantly traded by institutional investors. Both Islamic and conventional bonds are open to foreign investors, who serve as important players in the Malaysian bond market. The foreign holdings are at the same level with the holdings of domestic financial and social security institutions.

According to *AsianBondsOnline*, the Malaysian bond market is the third largest bond market in the Asia-Pacific region (ex-Japan). This is due to its increasing issuance volume, growing market size, and active trading activities. The issuance of Malaysian local currency (LCY) sovereign bonds increased steadily from USD4.75 billion in 2000 to USD156.46 billion in 2012. As of the end-March 2017, the total size of the Malaysian bond market was USD273 billion, peaking at USD329 billion in September 2014, which is close to 100% of the GDP of Malaysia. The yearly average of outstanding Malaysian LCY bonds in USD billions and a percentage of national GDP, respectively. Malaysia has progressively developed into an active Asian bond market since 2000. It witnessed its most dynamic year in 2011 with sovereign bond trading volumes reaching USD553.64 billion in total, and achieving an average turnover ratio of 0.83. The latter is a form of activity or liquidity measure, reflecting the frequency at which outstanding issues are traded in the market, i.e., the traded bond value divided by the outstanding bond value. In general, Malaysian sovereign bonds dominate the local currency bond market.

Nevertheless, the Malaysian sovereign bond market is active in both Islamic and conventional bonds. According to the Malaysian International Islamic Financial Centre (MIFC), *Sukuk* bonds represent a substantial portion (around 50%) of sovereign new issuance. In Malaysia, Islamic sovereign bonds are similar to conventional sovereign bonds in terms of the effective cash flows, issuance structure and legal status. Malaysian Government Securities (MGS), which are conventional bond issues, and its Islamic principles variant, Government Investment Issue (GII), are both long-term bonds issued by the government of Malaysia. According to local financial institutions, there are no substantial tax differences between them. However, GII, which are capped at 10 years, have relatively shorter maturities than MGS, which are capped at 20 years. In addition, GII (MYR1000 million) also have a higher threshold for the minimal issuance amount than MGS (MYR500 million).

Although GII is defined by Bank Negara Malaysia (BNM) as “long-term non-interest-bearing Government securities based on Islamic principles issued by the Government of Malaysia for funding developmental expenditure,” the cash flow structure is indeed the same as that of MGS. One important concept in Islamic finance is the “sell and buy back” agreement, based on which “the Government will sell specified nominal value of its assets and subsequently will buy back the assets at its nominal value plus profit through a tender process.” The “profit” in GII is, economically, no different than the “interest” in MGS when viewed in terms of repaying money to investors. As a consequence, MGS and GII are two specific types of sovereign bond instruments.

A more detailed description of the institutional background with graphs and tables can be found in Online Appendix [B](#).