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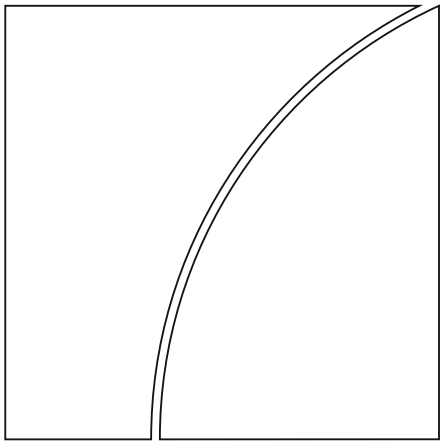

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De jure benchmark bonds

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Abstract

Benchmark bonds help to improve market efficiency. They seem to arise spontaneously in deep and liquid markets. Can governments help to create them where markets are too small? This paper examines three emerging markets in Asia where authorities have tried: they have designated specific bonds as benchmarks and fostered their liquidity. We identify exactly which bonds were the designated benchmarks. We then propose rank-order measures of liquidity and determine the extent to which these de jure benchmarks end up as de facto benchmarks in the sense of being the most liquid bonds in their maturity segments. We find that this occurs in close to 60% of months in our sample, covering a range of maturities for Indonesia, Malaysia and Thailand. We identify three factors that make success more likely: (a) choosing already liquid bonds; (b) choosing bonds that have previously served as de jure benchmarks; and (c) choosing bonds that will be issued during the month.

Keywords: benchmark bond, price discovery, market liquidity, informational public good, recycling, de jure, de facto, wannabe benchmark, probit model, inverse Mills ratio

JEL classifications: G10, G12, G14

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"You're not more punk because you wear leather jackets."
Dean Mackin, Australian radio announcer

1. Introduction

Benchmark bonds are the most liquid of bonds. By virtue of their liquidity, they serve as the focus of price discovery. What they discover they convey through prices to the market at large, thus supplying an informational public good. Indeed, to Dunne, Moore and Portes (2002), price discovery provides the defining characteristic of a benchmark bond. Referring to benchmarks in over-the-counter markets, Duffie, Dworczak and Zhu (2017) argue that a "benchmark can raise social surplus by increasing the volume of beneficial trade, facilitating more efficient matching between dealers and customers, and reducing search costs."

In the world's largest government bond markets, benchmarks seem to arise without government intervention. In the US Treasury market, for example, market convention has long established the on-the-run issues as the benchmarks. One possible reason for such a convention is a revelation mechanism proposed by Duffie, Dworczak and Zhu. Under certain conditions, this mechanism would lead low-cost dealers to name a benchmark. Dunn, Moore and Portes (2007) explain that once benchmarks are established, network externalities would reinforce their status. Pasquariello and Vega (2009) show that the strength of this status also depends on the degree of information heterogeneity in the market. To the extent that benchmarks form a yield curve, there are gains that accrue to the broader fixed-income market. Wooldridge (2001) points out that the presence of this yield curve makes it easier to price corporate bonds as well as certain derivative contracts.[1] Benchmark bonds also seem to be a source of market resilience in times of stress. Furfine and Remolona (2002), for example, find that during the global flight to liquidity in 1998 in the wake of the Russian sovereign default and the near collapse of the hedge fund Long-Term Capital Management, trading activity shifted to benchmark bonds and away from less liquid bonds.

When a benchmark fails to arise in a bond market, would it make sense for the government to step in and try to produce one? Many of the smaller bond markets of emerging market economies, for example, have not had the advantage of benchmark bonds. It turns out, however, that in some of these economies, governments have taken it upon themselves to designate benchmark bonds and to foster these bonds' liquidity. This liquidity is fostered through re-openings of bond issuance and market-making obligations imposed on primary dealers.

The question we ask in this paper is whether such policy intervention works. In other words, to what extent do these *de jure* benchmarks become *de facto* benchmarks? To us, the de jure benchmarks are very much like "wannabe" benchmarks. The Australian radio announcer, Dean Mackin, has said, "You're not more punk because you wear leather jackets." We see the government's designation

[1] Hence, the IMF and World Bank (2001) have recommended creating benchmarks in a range of maturities.

of a benchmark as analogous to Mackin's leather jackets. The designation alone may not lead to a real benchmark. In the end, the rise of real benchmarks will depend on the trading activity of market participants and market makers. We can then ask what factors tend to turn wannabe benchmarks into real benchmarks.[2]

We look at three government bond markets in emerging Asia, namely those in Indonesia, Malaysia and Thailand. These are markets that McCauley and Remolona (2000) would deem too small to be deep and liquid. These are also markets for which the authorities have designated de jure benchmark bonds in various chosen maturities. Importantly, in each of these markets, we are able to identify exactly which bonds were designated as de jure benchmarks, a total of 78 bonds. In looking at these bonds, we uncover a phenomenon that we have not seen in the literature nor in the more developed markets: a bond that is chosen as the de jure benchmark in its maturity segment is later "recycled" as the de jure benchmark in a shorter maturity. In our data, de jure bonds are recycled almost half the time.

We collect from Bloomberg daily data on 422 government bonds that were traded in these markets, including the de jure benchmarks. These are all the fixed-coupon local currency issues that are available for these markets. The sample period is from March 1999 to April 2017, a period that would have seen significant variation in liquidity within each market. The data consist of quoted prices, yields and bid-ask spreads. With the available data for the three countries, we measure bond-specific relative liquidity in various ways, specifically by rank-order methods. We are then able to determine the extent to which the de jure benchmark bonds end up becoming real benchmarks in the sense of being the most liquid bonds in their maturity segments. We find that this occurs in close to 60% of months in our sample. In Malaysia, the success rate is 78%. Estimates from a probit model identify three alternative factors that make success more likely: (a) choosing the bond that was already the most liquid one; (b) choosing a bond that had been a de jure benchmark in a different maturity in the past; and (c) choosing a bond that will be issued during the month. We also find that the predictability of the choices of de jure bonds does not improve the chances that those bonds will become de facto benchmarks.

In what follows, we start by characterising the de jure bonds and the recycling phenomenon. In Section 3, we then describe our data and explain how we use them to measure liquidity and compare liquidity across bonds. In Section 4, we determine which bonds have the most liquidity and whether these are the de jure bonds chosen by the government. In Section 5, we examine what factors tend to help de jure bonds succeed as real benchmarks. In Section 6, we analyse the predictability of the choice of de jure bonds and ask whether such predictability affects the probability of success of those bonds. Finally, in Section 7 we conclude and provide policy implications.

2. The de jure benchmarks

The government bond markets that we look at are those in Indonesia, Malaysia and Thailand. These are markets in emerging Asia that would presumably be too small to be deep and liquid and thus to produce benchmark bonds spontaneously. When

[2] When referring to benchmark bonds, we use the terms "de jure" and "wannabe" interchangeably and the terms "de facto" and "real" interchangeably.

McCauley and Remolona (2000) analysed the liquidity of a broad cross-section of government bond markets, they suggested that the minimum size for a deep and liquid market was about USD200 billion in terms of the amount outstanding. As shown in Table 1, none of the markets in our sample exceeded that threshold as of the end of 2017. The largest of the three markets was Malaysia, with USD167 billion, which amounted to 54% of the country's GDP. The smallest was Thailand, with USD136 billion, or 30% of GDP. While Indonesia's market was bigger than Thailand's in terms of absolute size, it was smaller in terms of the ratio to GDP. All three markets were dwarfed by the more developed markets of the United Kingdom (USD2,785 billion), Japan (USD9,471 billion) and the United States (USD17,584 billion).

Size of government bond markets

Nominal amount outstanding of government bonds in selected countries as of end-2017 Table 1

	Amount outstanding in USD billions	Ratio to GDP
Thailand	**136**	**0.30**
Indonesia	**156**	**0.15**
Malaysia	**167**	**0.54**
United Kingdom	2,785	1.06
Japan	9,471	1.94
United States	17,584	0.90

Sources: Salomon Smith Barney; national data.

It seems unlikely that the three emerging market economies in our sample would have developed benchmark bonds without government intervention. Indeed, such intervention did take place. The authorities in all three economies have designated specific bonds as benchmarks and have tried to foster their liquidity. The strategy of designating benchmark bonds is pursued in other emerging markets as well.[3]

Various official sources serve to identify the designated benchmark bonds or what we call *de jure* bonds. In Indonesia, the de jure bonds are announced by the Ministry of Finance. For Malaysia, the source is the central bank's website. In Thailand, the de jure benchmarks are announced by the Public Debt Management Office. Based on these sources, the authorities in Indonesia announced 27 specific de jure benchmarks between March 1999 and April 2017. In the same period, Malaysia announced 32 de jure benchmarks and Thailand announced 19. This gives us a total of 78 de jure bonds to analyse.

[3] For example, at the Banco de Mexico, Álvarez-Toca and Santaella-Castell (2014) advocate the creation of benchmarks. They state, "In a yield curve there is a wide set of securities issued at different maturities. Among the measures adopted to foster the government securities market is selecting only certain issues that will serve as benchmarks. This is done by increasing the outstanding amount in circulation through a re-opening process for the purpose of building a critical outstanding amount." Meanwhile, authorities in Chile support benchmarks with maturities of five, 10, 20 and 30 years using re-openings and additional benchmark issuance in exchange for non-benchmark securities (https://www.hacienda.cl/english/press-room/news/archive/ministry-of-finance-announces-issuance.html).

The choices of de jure benchmarks have always been associated with specific maturities. As shown in Table 2, Indonesia has tended to prefer four maturities for its de jure bonds, namely the 5-year, the 10-year, the 15-year and the 20-year maturities. Malaysia has also tended to choose four maturities for its de jure bonds, but at somewhat shorter maturities, namely the 3-year, the 5-year, the 7-year and the 10-year maturities. Thailand has tended to spread its de jure bonds across eight maturities, although there has been a slight preference for the 5-year, the 10-year and the 15-year maturities. What is common to the three jurisdictions are three maturities that tended to be chosen for de jure bonds, namely the 5-year, the 7-year and the 10-year maturities.[4]

Number of de jure bonds by maturity

De jure benchmark bonds as designated by national authorities: selected sample periods in selected markets

Table 2

	Maturities in years							
Countries	Three	Five	Seven	10	15	20	30	50
Indonesia 2009-2018		9	1	9	9	8	1	
Malaysia 2006-2018	14	14	9	13				
Thailand 2010-2017	3	7	4	5	5	4	4	2

Sources of data: For Indonesia, Ministry of Finance; for Malaysia, Bank Negara Malaysia; and for Thailand, Public Debt Management Office.

In the three jurisdictions in our sample, the authorities have often chosen de jure bonds in a surprising way. In particular, they would choose a de jure bond in a given maturity and later recycle the exact same bond as the de jure benchmark in a shorter maturity. As shown in Table 3, in Indonesia in 2011, bond FR0053 was the de jure government benchmark in the 10-year maturity. Five years later, the same bond became the de jure benchmark in the 5-year maturity. A similar recycling of roles happened to six other bonds in Indonesia. Table 3 also illustrates the phenomenon in Malaysia, where a recycling of de jure bonds took place four times. Similarly, Table 3 also illustrates the phenomenon in Thailand, where such recycling took place seven times. Indeed, a Thai de jure bond, identified as LB21DA, was recycled twice. If all de jure bonds in our sample were recycled once, there would be 39 instances of recycled bonds. Instead we find 18 such instances, meaning that de jure bonds were recycled 46% of the time.

The recycling phenomenon is surprising because, at least in in the more developed bond markets, the benchmarks tend to be newly issued bonds. As far as we know, benchmark bonds in well developed markets never repeat as benchmarks

[4] For a full list of the designated benchmarks, see Tables A1-A3 in the appendix.

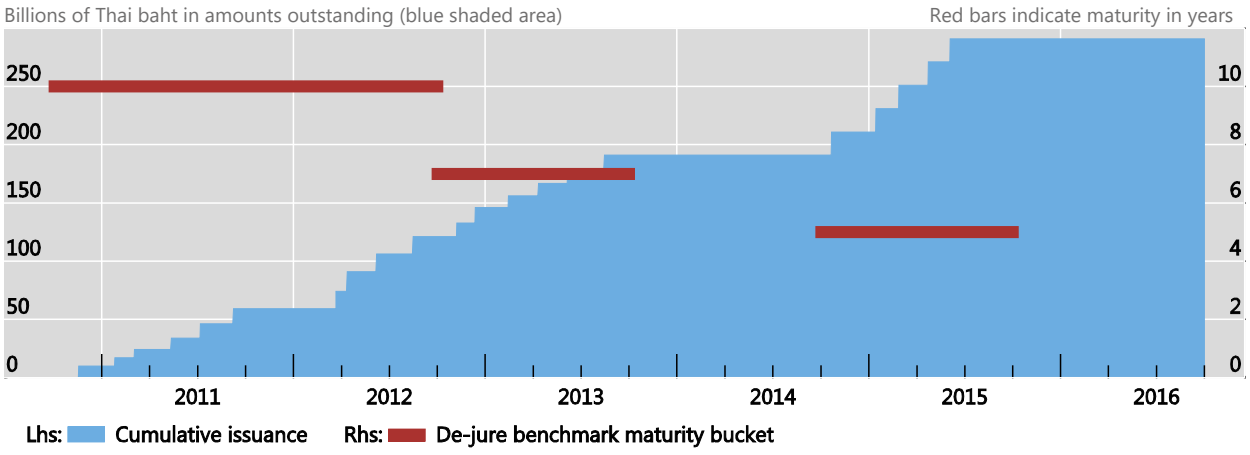
in shorter maturities. As mentioned above, in the US Treasury market, the benchmarks are always the "on-the-run" issues or the most recently issued bonds. In Japan, the benchmark is always a recently issued 10-year government bond, although not always the *most* recently issued one (Boudoukh and Whitelaw, 1991). One question we ask is whether a recycled de jure benchmark has a better chance of success than does a new de jure benchmark.

The life of the Thai de jure bond that was recycled twice illustrates the interaction between recycling and re-openings. As shown by red bars in Graph 1, the bond identified as LB21DA first received de jure benchmark status at the 10-year maturity as soon as it was issued in late 2010. It retained that status for two years even as its time to maturity shortened. In late 2012, it became the de jure benchmark for the 7-year maturity, a status it retained for about a year. It lost that de jure status when its time-to-maturity shortened to six years. However, it regained de jure benchmark status after a year, this time for the 5-year maturity, when its maturity had shortened to five years.

The recycling of de jure benchmark bonds Table 3

Bond ID	Initial year	Initial maturity	Recycled year	Recycled maturity
Indonesia				
FR0053	2011	10 years	2016	5 years
FR0056	2011	15 years	2016	10 years
FR0061	2012	10 years	2017	5 years
FR0059	2012	15 years	2017	10 years
FR0063	2013	10 years	2018	5 years
FR0064	2013	15 years	2018	10 years
FR0065	2013	20 years	2019	15 years
Malaysia				
MJ050004	2006	5 years	2007	3 years
MO060001	2006	10 years	2011	5 years
MJ0120005	2012	5 years	2015	3 years
MJ160004	2016	5 years	2018	3 years
Thailand				
LB196A	2010	10 years	2013	5 years
LB296A	2010	20 years	2014	15 years
LB21DA	2011	10 years	2013	7 years
"	"	"	2015	5 years
LB25DA	2011	15 years	2015	10 years
LB316A	2011	20 years	2017	15 years
LB176A	2012	5 years	2013	3 years

The life of a Thai de jure benchmark: LB21DA Graph 1



Notes: The blue shaded area indicates the cumulative issuance of bond LB21DA (lhs). Red lines indicate the period when LB21DA was designated a de jure benchmark bond and at what maturity (rhs).

Sources: Bank of Thailand; Thai Bond Management Association.

The blue region in Graph 1 displays the cumulative issuance of bond LB21DA, and illustrates another important aspect by which authorities have sought to foster the liquidity of wannabe benchmarks that we see in our sample. Each blue step represents a re-opening of the bond. This occurs 21 times, all during periods when the bond was a de jure benchmark. We will examine the importance of issuance in supporting benchmark behaviour in de jure benchmark bonds.

Another way by which the authorities try to foster the liquidity of de jure benchmarks is by requiring primary dealers to make markets in these securities. Primary dealers are market participants that are eligible to trade with the central bank, and they often have market obligations as well as special privileges. In the case of the Indonesian bond market, primary dealers have the obligation "to provide continuous two-way price quotations (bid and offer prices) for benchmark series of government securities…"[5] In the case of the Malaysian market, Bank Negara Malaysia requires primary dealers "to provide two-way price quotations for benchmark securities under all market conditions to ensure liquidity in the secondary market."[6] In the case of the Thai market, primary dealers are obliged to "[q]uote two-way firm prices for all benchmark bonds under normal market conditions, particularly after the private repurchase market has been in place."[7]

5 See Asian Development Bank (2017, p. 82).

6 See http://bondinfo.bnm.gov.my/portal/server.pt?open=514&objID=27247&parentname=CommunityPage&parentid=68&mode=2.

7 See Bank of Thailand (2002).

3. Measuring liquidity

We collect from Bloomberg daily data on 422 government bonds that were traded in these markets, including the de jure bonds, for a total of over 237,000 observations. These are all the fixed-coupon local currency issues that are available for these markets. In a sample spanning the period from March 1999 to April 2017, the data consist of quoted prices, yields and bid-ask spreads. Unfortunately, there are a significant number of missing observations. We are also unable to obtain data on trading activity. Nonetheless, the available data allow us to measure bond-specific relative liquidity in various ways and thus to compare liquidity across bonds. Indeed we are able to use to our advantage the fact that there are missing observations.

To compare liquidity we limit ourselves to sample periods and maturity buckets in which de jure benchmarks exist and there are a sufficient number of other bonds for comparison. In general, we consider wider buckets for longer maturities. We construct the bucket widths as shown in Table 4.

Definitions of maturity buckets

Selected countries, buckets are centred on time to maturity of de jure benchmark bond — Table 4

Countries	Maturities in years					
	Three	Five	Seven	10	15	20
Indonesia		+/- 1		+/- 2	+/- 2.5	+/- 2.5
Malaysia	+/- 1	+/- 1	+/- 1	+/- 2		
Thailand		+/- 1	+/- 1	+/- 2	+/- 2.5	+/- 2.5

Sources of data on maturity of de jure benchmark bonds: For Indonesia, Ministry of Finance; for Malaysia, Bank Negara Malaysia; and for Thailand, Public Debt Management Office.

The buckets are centred on the maturity of the de jure benchmark. Given that the remaining time to maturity for the de jure benchmark is not for a fixed maturity, but shortens over time, there are cases where the associated buckets overlap. In these cases, the demarcation between buckets is drawn at the midpoint of the remaining times to maturity of the two associated de jure benchmarks.

In limiting ourselves to sample periods and maturity buckets in which sufficient data are available, we are left with sample periods that start after 2005 and with only five maturity buckets for Thailand instead of eight.[8] We are then left with 252 bonds and 126,279 daily observations. With these data, we calculate bond-specific liquidity within each bucket at the monthly frequency, using the following three simple measures:

[8] Daily bond price data is scant for 30-year maturity bonds, and almost non-existent for 50-year bonds.

1) Average bid-ask spread, in which the bond with the narrower spread is considered more liquid;

2) Average yield to maturity, in which the bond with the lower average yield is considered more liquid, since greater liquidity would command a price premium that would be reflected in a lower yield; and

3) Number of days for which the above quotes are available, in which the bond with more days with quotes is considered more liquid.

In using as one measure of liquidity the number of days for which quotes are available, we take advantage of the fact that there are missing observations for some bonds for a significant number of days, since this is itself a proxy for liquidity.

For each of the three measures above, we rank the bonds from most liquid to least liquid. We then sum up the rank-orders and identify the bond with the lowest combined rank-order as the most liquid bond in its maturity bucket and therefore the de facto benchmark. In identifying the most liquid bond, the sum of the rank-orders sometimes leads to ties between two bonds. These ties are easily broken by carrying out the same analysis using standardised rank-orders. We resort to these non-parametric ways of measuring liquidity, because the data are too sparse to accommodate other methods.

With more complete data, it might be possible to identify the de facto benchmarks by examining their role in price discovery. Dunne, Moore and Portes (2002), for example, use Granger-causality and co-integration methods to identify benchmarks in the euro area government bond markets. One can also extract principal components from the price movements of bonds in a market, and identify as the benchmark the bond with the highest factor loading. These methods, however, do not work well with the data available to us. Hence, in this paper, we limit ourselves to measuring liquidity, which we recognise is a necessary but not sufficient condition for true benchmark status.

4. Does de jure become de facto?

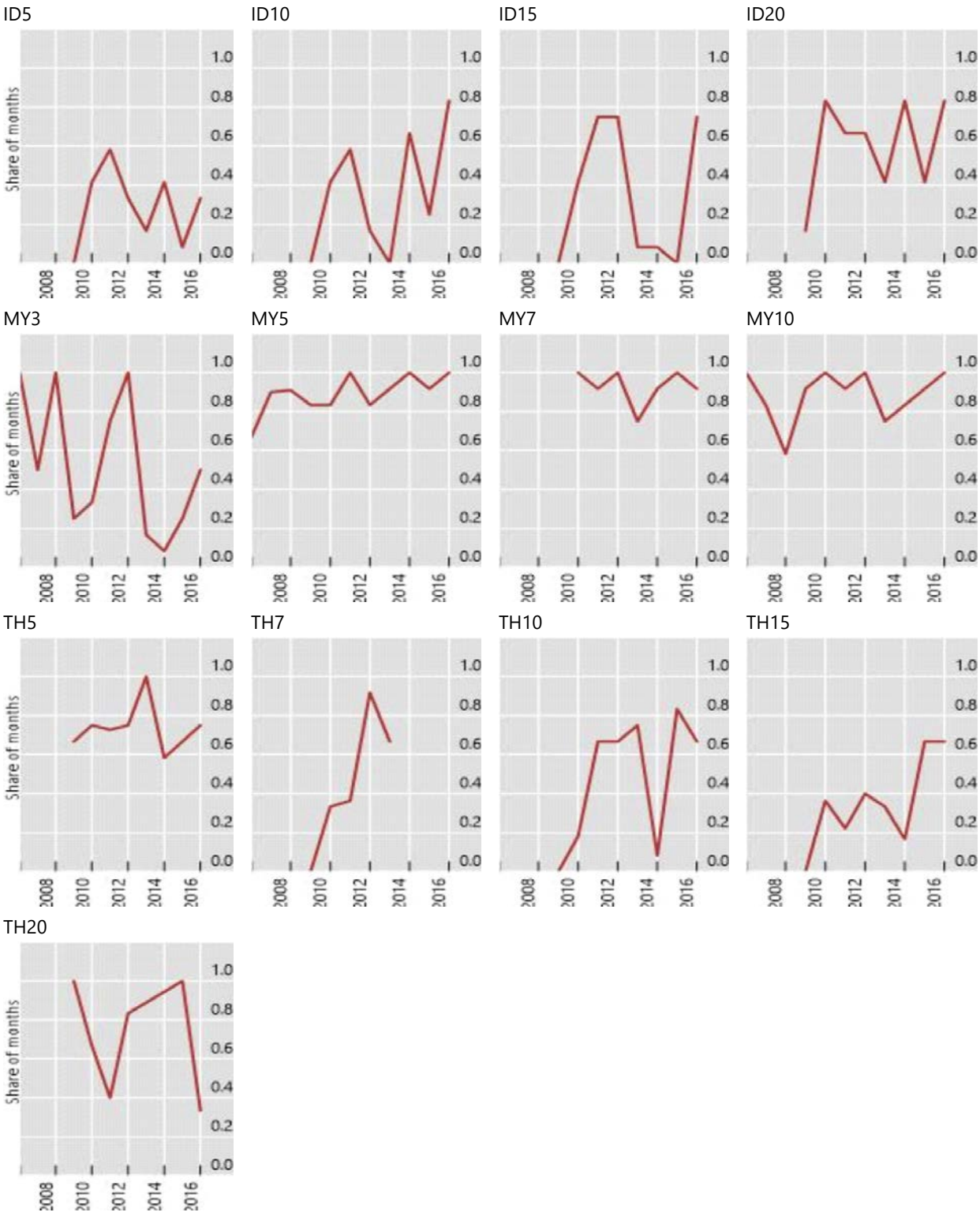
The question we ask in this section is simple. In determining the de facto benchmark, to what extent do market participants go along with the government's de jure choice? Our empirical version of this question is: does the de jure benchmark turn out to be the de facto benchmark in the sense of being the most liquid bond in its maturity bucket in a given month? It turns out that sometimes it does and sometimes it does not. To summarise results, we take the proportion of months in the year in which the de jure benchmark turns out to be also the de facto benchmark. We then graph that proportion for each market and maturity bucket over the years in which we are able to carry out the liquidity analysis.

The frequency with which a de jure benchmark becomes the de facto benchmark depends on the market and the maturity bucket. As shown in Graph 2, in Indonesia especially since 2010, the de jure benchmark for the 20-year maturity was more often than not also the de facto benchmark. This was not the case for the other maturities in Indonesia. In the case of Malaysia, the de jure benchmark was also the de facto benchmark most of the time. This was especially the case for the 5-year and 10-year maturities since 2006 and for the 7-year maturity since 2010. In the case of Thailand, the 5-year de jure benchmark was the most successful one across de jure maturities.

It was the de facto benchmark for its maturity in the majority of months since 2009. The 20-year de jure bond also saw some success but only until 2015. When it comes to maturity, the 5-year de jure bond seems to be the most successful one overall. As shown in Graph 3, carrying out the analysis using standardised rank orders does not change the qualitative results.

When we combine maturities and markets, de jure benchmarks become de facto benchmarks 59.6% of the time. When we compare markets, Malaysia wins the race. In that market, de jure benchmarks make it as de facto benchmarks 77.8% of the time. As shown in Graph 4, since 2006, a Malaysian de jure benchmark more often than not has become the de facto benchmark. In the case of Indonesia and Thailand, their de jure benchmarks had good years and bad years. The good and bad years in Indonesia do not coincide with those in Thailand, suggesting that the lack of success of their de jure benchmarks was likely due to market-specific factors rather than global or regional factors.

How often does de jure become de facto?[1] Graph 2



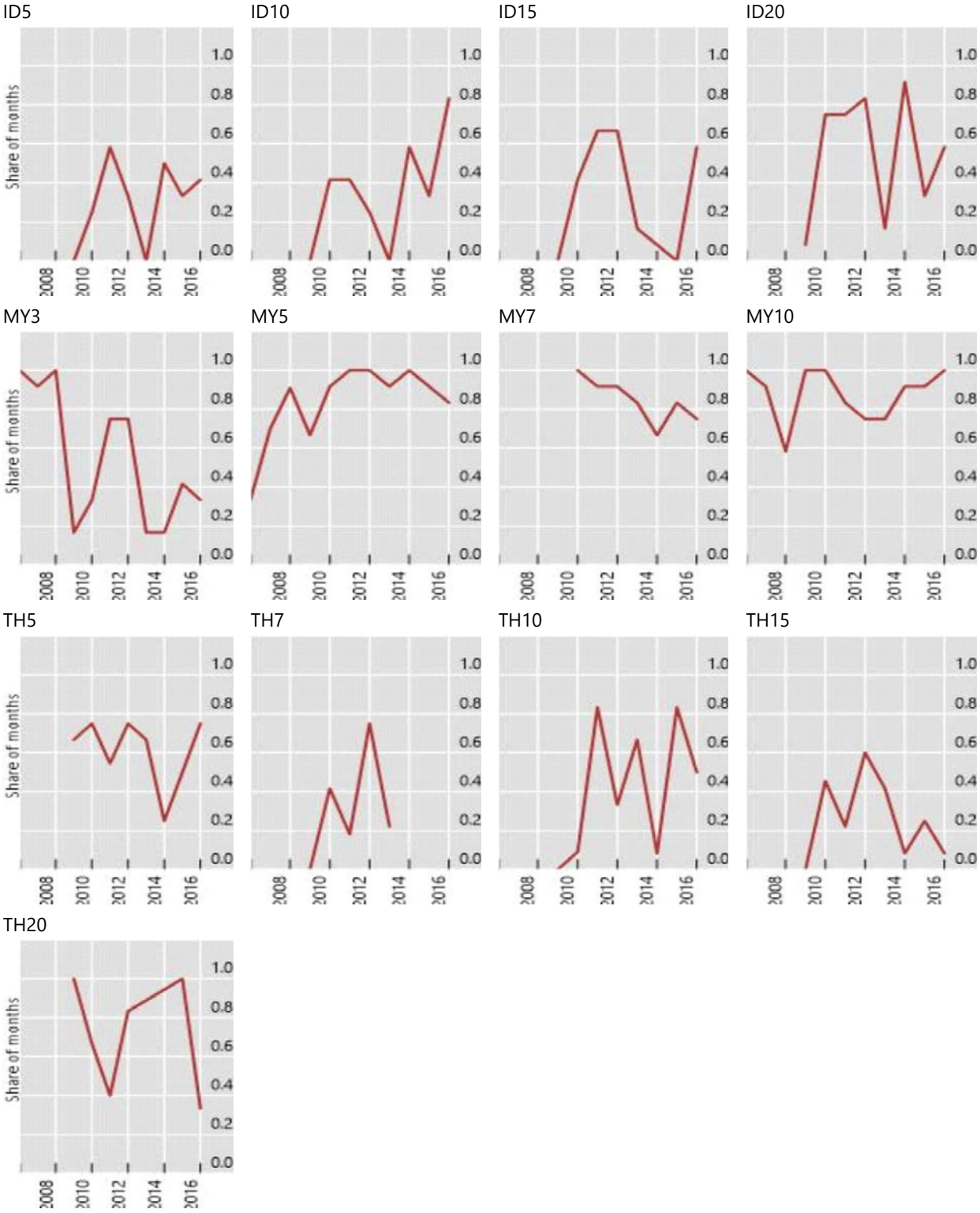
[1] Graph displays the share of months for which jure = de facto by year, maturity and market.

Source: Authors' calculations.

How often does de jure become de facto?[1]

By standardised rank orders

Graph 3

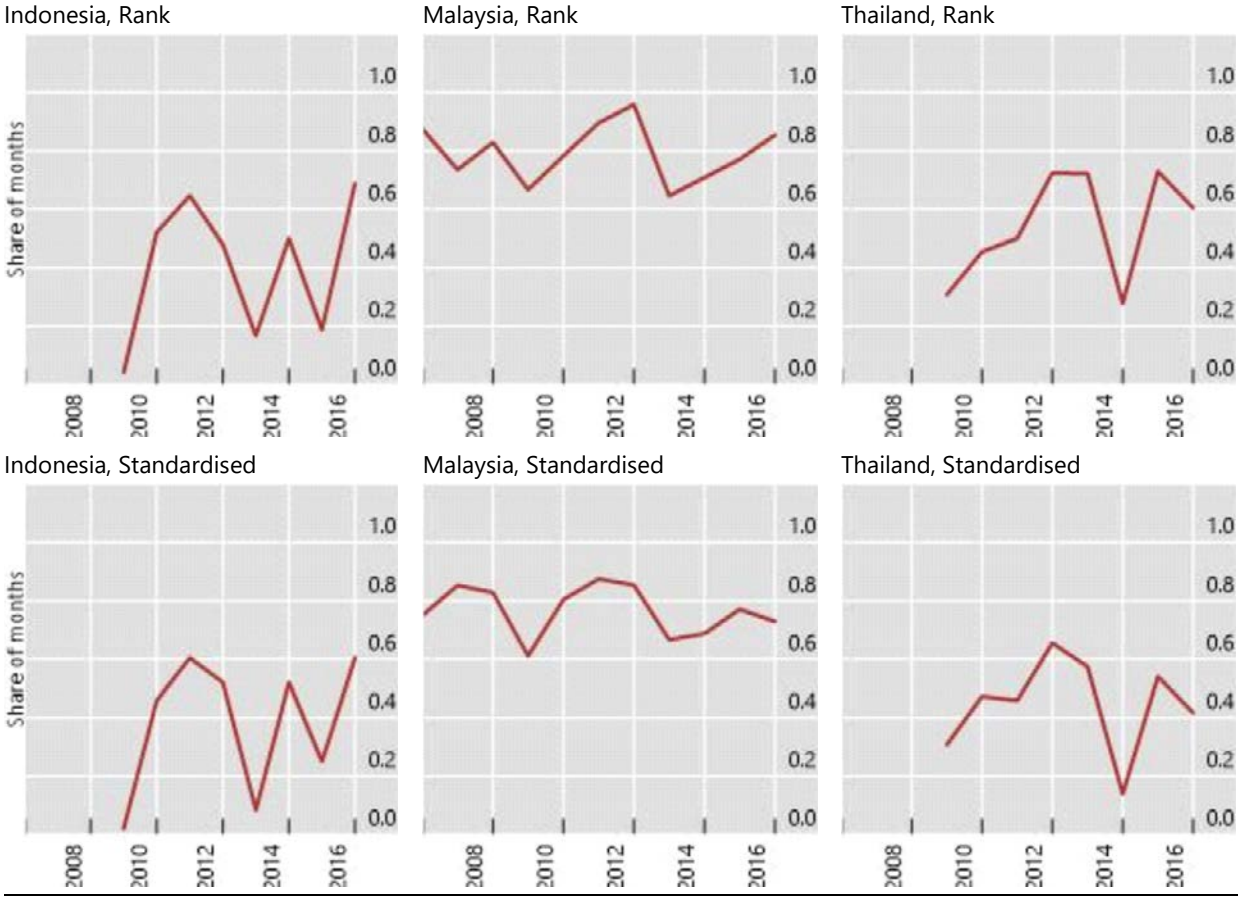


[1] Graph displays the share of months for which jure = de facto by year, maturity and market.

Source: Authors' calculations.

Does de jure become de facto?[1]

Summarising across maturities — Graph 4

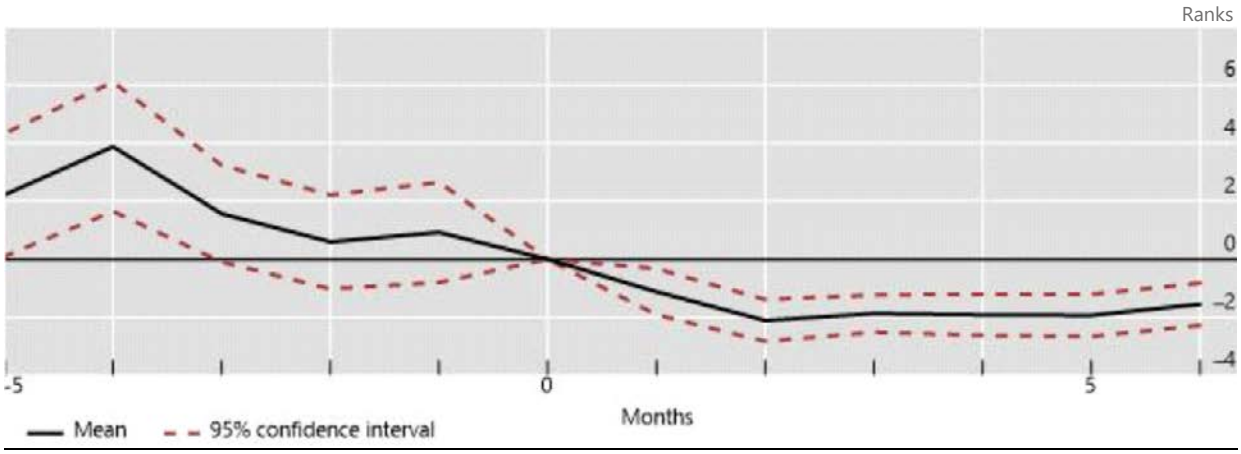


[1] Graph displays the share of months for which jure = de facto by year, combining maturities by market.

Source: Authors' calculations.

Does de jure benchmark status enhance a bond's liquidity at all even if the bond does not become the de facto benchmark? To answer this question, we consider all our de jure benchmarks together and track their liquidity in terms of our rank-order calculations relative to the month before a bond becomes a de jure benchmark. We report our calculations month-by-month before and after the bonds receive their de jure designation. It turns out that indeed there is an improvement in relative liquidity but this improvement is somewhat gradual. As shown in Graph 5, the improvement starts as early as four months before the designation and continues for two months after the designation. The overall improvement is equivalent on average to a rank-order change of four ranks. This is a large change, and it is highly statistically significant. This suggests that de jure status does help a bond's liquidity somehow. To some degree, market participants seem to heed their governments' call by trading the designated benchmark somewhat more actively than otherwise. Moreover, it appears that these participants are able to anticipate which bond will receive de jure benchmark status, since this improvement begins before the designation.

Do bond become more liquid after they become de jure benchmarks?[1] Graph 5



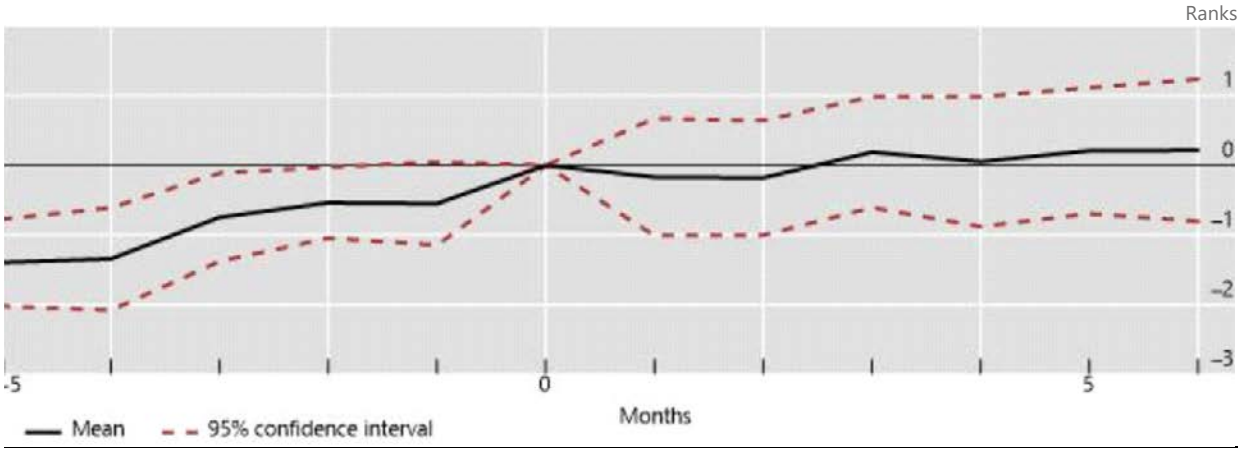
[1] Liquidity measured relative to month 0, defined as the final month before a bond becomes a de jure benchmark.

Source: Authors' calculations.

What happens when a bond loses its de jure benchmark status? As shown in Graph 6, there is a deterioration in the bond's relative liquidity as early as five months before the loss of status. The deterioration seems to end by the time the status is lost. Again, market participants apparently know when a new de jure benchmark will be chosen, although the effect is not as large or statistically significant as the discontinuity around the start of de jure status.

The result that liquidity anticipates de jure status suggests that predictability could be a factor in the creation of benchmarks. In the case of the US Treasury market, the issuance calendar makes the issuance of on-the-run securities predictable, and this raises the question of whether this predictability helps make them benchmark bonds. In the case of our three emerging bond markets, it is possible that the choice of a de jure bond is often preceded by a discussion with market participants, a discussion that may help the participants predict that choice. In section 6 we will seek to answer this question: does the predictability of de jure bond choice contribute to enhancing the liquidity of the chosen bond?

Do bond become less liquid after they lose their de jure status?[1] Graph 6



[1] Liquidity measured relative to month 0, defined as the final month for which a bind was a de jure benchmark.

Source: Authors' calculations.

5. When does de jure become de facto?

Why do some de jure benchmarks make it as de facto benchmarks, while others do not? To answer this question, we estimate a probit model:

$$Pr(\text{de jure} = \text{de facto}) = f(x\beta),$$

where a de jure bond that succeeds in a given month takes on the value of one and otherwise takes on the value of zero. For the vector of dependent variables x, we consider the following:

1) Whether the de jure bond was the de facto bond in the previous month;
2) Whether the bond was issued (or reopened) during the month;
3) Total accumulated issuance of the bond;
4) Whether the bond was a recycled de jure benchmark;
5) The number of months the bond had already served as a de jure benchmark;
6) How many other maturities there are with de jure benchmarks;
7) Yield distance from par; and
8) Fixed effects for each benchmark maturity in each country.

Our estimate of the probit model identifies three of the above factors as reliably important. As shown by the highly statistically significant coefficients reported in Table 5, the authorities would be well advised to choose as their de jure benchmark a bond with at least one of the following features: (a) it was already the de facto benchmark in the previous month; (b) it is a bond that will be issued or reopened during the month; and (c) it was a de jure benchmark in a different maturity in the past. The most important feature seems to be whether the bond was already the de

facto benchmark in the previous month. In terms of marginal effects, this feature increases the probability that a de jure bond will become the de facto benchmark by 29%. The second most important feature is whether the bond was previously a de jure benchmark. In this case, the marginal increase in the chances for success is 16%. Issuance during the month comes third, increasing the probability of success by 7%. The estimates suggest that market-specific factors also matter. Somewhat surprisingly, the stock of outstanding bonds of the same issue is generally statistically insignificant and often has the "wrong" sign, suggesting that it is the flow of new issuance that is important for bonds to act as benchmarks, rather than the overall stock of accumulated issuance.

The results are robust to how we locate issuance within the month. When we move the issuance date by 15 days (so that issuance is counted as being in a month if it is between the 15th of the previous month and the 15th of the current month), the qualitative results do not change (see Table A4).

The probability that a de jure bond will become the de facto benchmark

Estimates of a probit model in which a de jure bond that is the most liquid in a given month takes on the value one and zero otherwise

Table 5

Variable	Coefficient	T-statistic	Significance
De facto benchmark in previous month	1.09	12.41	***
Recycled de jure in another maturity	0.59	3.04	***
Issued or reopened during month	0.26	2.67	***
Months since becoming de jure	0.019	1.59	
Stock x ID	1.6E-15	0.50	
Stock x MY	-3.0E-05	-1.31	
Stock x TH	-3.1E-06	-1.52	*
Number of bonds in bin	-0.11	-4.48	***
Pseudo R^2=0.30	N=1222		

NB: ***, **, ***** indicate significance at the 10%, 5% and 1% level respectively.

6. Predictability of the choice of a de jure bond

How do the authorities actually decide on the de jure benchmark in a given maturity? Is this choice predictable? Does such predictability affect the chances that the bond will become the de facto benchmark?

6.1 Predicting the choices of de jure bonds

We start by addressing the question of how the authorities decide on which bonds to designate as de jure bonds. For this purpose, we estimate a second probit model, $Pr(\text{de jure} = 1) = f(x\beta)$, where the dependent variable is a dummy that takes on the value of one if the bond is a de jure benchmark in a given month, and zero otherwise. For the vector of dependent variables x, we consider the following:

1) Whether the de jure bond was the de facto bond in the previous month;
2) Whether the bond had previously been a de jure benchmark at a longer maturity;
3) Whether the bond was issued (or reopened) during the month;[9]
4) Total accumulated issuance of the bond;
5) The number of bonds in the bucket; and
6) Fixed effects for each benchmark maturity in each country.

We first estimate the model for all three countries together. Then, to allow for the possibility that the factors that determine predictability need not be the same across countries, we estimate the model separately for each country.

It turns out that the choices of de jure bonds are fairly predictable. As reported in Table 6, the pseudo R-squared for the probit model of all the countries together is 0.42. Also, whether we estimate the model for all three counties together or estimate it for each country separately makes little qualitative difference. Further, most variables influence the likelihood of a bond being the de jure benchmark similarly for each country. Being the most liquid bond in the previous month or being issued during the month increases the likelihood that a bond will be chosen a de jure benchmark, while having previously served as a de jure benchmark at a longer maturity or the presence of more bonds in the maturity bin reduces it. The only difference in effects across countries is that a larger stock of the issue outstanding increases the likelihood of the bond being a de jure benchmark for Indonesia and Thailand, but reduces it for Malaysia.

[9] Again, as a robustness check, we also consider total issuance in the second half of the previous month or first half of the current month, given that our assessment of liquidity is conducted at monthly frequency. Results are similar in this case.

The probability that a de jure bond will be chosen as a de jure benchmark Table 6

Variable	All	ID	MY	TH
De facto benchmark in previous month	0.73 *11.75* ***	0.44 *4.24* ***	1.25 *11.39* ***	0.57 *4.68* ***
Previously de jure in a longer maturity	-0.89 *-11.92* ***	-1.36 *-8.24* ***	-1.37 *-8.67* ***	-0.26 *-2.32* **
Issued or reopened during month	1.75 *22.72* ***	1.72 *18.58* ***	1.26 *5.57* ***	2.25 *13.10* ***
Stock x ID	2.7E-14 *12.59* ***	2.9E-14 *12.65* ***		
Stock x MY	-3.8E-05 *-3.14* ***		-3.9E-05 *-2.60* ***	
Stock x TH	3.6E-06 *3.53* ***			2.4E-06 *2.17* **
Number of bonds in bin	-0.11 *-7.90* ***	-0.10 *-5.90* ***	-0.14 *-4.40* ***	-0.13 *-2.66* ***
Pseudo R^2	0.42	0.42	0.45	0.32
Number of observations	3494	1798	905	791

NB: t-statistics are in italics. *, **, *** indicate significance at the 10%, 5% and 1% level, respectively.

6.2 Does predictability matter for a de jure bond's success?

It would seem reasonable that the more predictable the choice of a de jure bond is in a given maturity, the more likely it is that the chosen bond will become the de facto benchmark in that maturity. In the US Treasury market, for example, the issuance calendar tells market participants exactly which bonds will be on-the-run issues and thus which bonds will be the benchmarks. If an equivalent process were at work in our sample, then de jure benchmark choices that are more predictable should be more likely to become de facto benchmark bonds. In particular, the fact that the most important explanatory variable in explaining whether wannabe benchmarks become actual benchmarks is whether the bond was the most liquid in the previous month suggests that authorities could look like they are supporting the creation of benchmarks if they simply published a list of most liquid bonds as de jure

benchmarks. But if this was the case, then predictability would be a key explanatory variable for explaining the success of wannabe benchmarks.

To see whether this is indeed the case for our emerging market economies, we return to our original probit model but this time include the inverse Mills ratio as an additional explanatory variable.[10] We calculate the inverse Mills ratio from our estimates of the previous probit model. The ratio is calculated as the ratio of the probability density function to the cumulative distribution function.

As before, our probit model takes the form $Pr(\text{de jure} = \text{de facto}) = f(x\beta)$, where the dependent variable in a given month takes on the value of one if the de jure bond succeeds as a benchmark and otherwise takes on the value of zero. For the vector of independent variables x, we consider the following:

1) Whether the de jure bond was the de facto benchmark in the previous month;
2) Whether the bond was issued or reopened during the month;
3) Total accumulated issuance of the bond;
4) Whether the bond was a recycled de jure benchmark;
5) The number of months the bond had already served as a de jure benchmark;
6) How many bonds are in the bin;
7) Fixed effects for each benchmark maturity in each country; and
8) The inverse Mills ratio based on the estimates of the probit model for the choice of the de jure bonds.

We estimate the model for two sets of specifications, in parallel with our second probit model as reported in Table 6 above. One set includes all three countries together, while the other set considers each country individually. For the former, we use the inverse Mills ratio derived from the estimates reported in the column "All" in Table 6, while for the individual country estimation we use the country-specific estimates in the regression.

Our estimates reveal a surprising result. The predictability of the choice of the de jure bond is not important for whether the chosen bond becomes the de facto benchmark. As shown in the top row of Table 7, a high inverse Mills ratio is negatively correlated with the de jure bond becoming the de facto benchmark. This effect is statistically highly significant for the full sample, and marginally significant for both Malaysia and Thailand separately.

The inclusion of the inverse Mills ratio does change our results, however, albeit in predictable ways. Those variables that entered positively in the model to predict de jure choices (reported in Table 6) now have smaller estimated coefficients. These variables are (a) whether a bond was the de facto benchmark in the previous month

[10] The inverse Mills ratio is usually applied to take account of selection bias in the presence of a censored variable. A dependent variable that cannot take on negative values, for example, would lead to a concentration of observations just above zero. To correct for the bias, Heckman (1979) proposed a two-stage estimation procedure using the inverse Mills ratio. In the first stage, a probit model is estimated and the estimated parameters are used to calculate the inverse Mills ratio. In the second stage, this ratio is included as an additional explanatory variable.

or (b) whether the bond was issued during the month. The estimated coefficient on the former falls from 1.11 to 0.60, and on the latter from 0.26 to -0.85. Conversely, the variable about having previously been a de jure bond at another maturity was negatively associated with being chosen a de jure benchmark. Its estimated coefficient increases from 0.59 to 1.21 once the inverse Mills ratio is included.

The probability that a de jure bond will become the de facto benchmark

Accounting for the predictability of the de jure choice

Table 7

Variable	All	ID	MY	TH
Inverse Mills ratio	-1.35 *-4.89* ***	-0.49 *-1.02*	-1.01 *-1.78* *	-1.35 *-1.90* *
De facto benchmark in previous month	0.60 *4.54* ***	0.71 *3.99* ***	0.62 *1.60*	0.66 *3.01* ***
Recycled de jure in another maturity	1.21 *5.12* ***	0.89 *1.73* *	1.30 *2.26* **	0.74 *2.63* ***
Issued or reopened during month	-0.85 *-3.47* ***	0.14 *0.27*	-0.57 *-1.78* *	-1.38 *-1.93* *
Months since becoming de jure	0.023 *1.89* *	-0.045 *-1.71* *	0.045 *1.59*	0.063 *3.55* ***
Stock x ID	-1.5E-14 *-3.11* ***	3.2E-15 *0.40*		
Stock x MY	3.8E-07 *0.02*		-3.0E-05 *-0.78*	
Stock x TH	-5.8E-06 *-2.73* ***			-7.3E-06 *-2.78* ***
Number of bonds in bin	-0.046 *-1.65* *	-0.11 *-2.44* **	-0.12 *-2.04* **	-0.079 -1.06
Pseudo R^2	0.31	0.25	0.35	0.24
Number of observations	1222	400	457	365

NB: t-statistics are in italics. *, **, *** indicate significance at the 10%, 5% and 1% level respectively.

7. Conclusions

Because of their special role in price discovery, benchmark bonds supply an important informational public good to the bond market at large. Hence, if such bonds did not exist, it would make economic sense for the government to help create them. As it turns out, there are at least three governments that have made such an effort. These are the governments of Indonesia, Malaysia and Thailand. These governments have designated de jure benchmark bonds in various maturities in their bond markets and have fostered these bonds' liquidity. The governments have tried to foster to the liquidity of these wannabe bonds by re-opening issuance and by requiring primary dealers to make markets in them. This paper is about the extent to which such efforts have succeeded and what might make these efforts even more successful. In the end, it is market participants who will determine whether a bond will actually perform the role of a benchmark.

We started by identifying exactly which bonds have been designated by the governments as de jure benchmarks. With daily data on 422 bonds, including the de jure benchmarks, we measured bond-specific liquidity to ask whether the de jure benchmarks do end up possessing the superior liquidity that true benchmark bonds would have. Since the markets that are the focus of our study are still in the process of development, the available data are somewhat sparse. We proposed rank-order tools that can be used to assess benchmark status in spite of this. To assess liquidity, we combined rankings based on average yields, bid-ask spreads and the number of days for which quotes are available.

We found that in varying degrees the governments' efforts have succeeded. For the three markets together, the de jure benchmark ends up being the de facto benchmark about 60% of the time. In the case of Malaysia, the government's efforts have succeeded 78% of the time. We also found that the choices of de jure bonds tend to be anticipated, and once anticipated the chosen bonds tend to gain liquidity. The loss of de jure status also tends to be anticipated, and there is some deterioration in the liquidity of the bonds that are about to lose their de jure status.

What accounts for this variation in success? By estimating a probit model, we found that it helps to select certain bonds to serve as de jure benchmarks. Surprisingly, acting predictably in choosing these bonds, does not seem to help. The most important criterion for choosing de jure bonds is whether the bond is already the most liquid one in its maturity segment. If that criterion cannot be met, the second important criterion is whether the bond had already been a de jure benchmark in the past, followed by the criterion of whether the bond will be issued or re-opened frequently.

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Appendix

Specific de jure benchmark bonds for Indonesia — Table A1

Calendar year	Maturity					
	5 year	7 year	10 year	15 year	20 year	30 year
2009	FR0051	FR0030	FR0036	FR0044	FR0047	FR0050
2010	FR0027		FR0031	FR0040	FR0052	FR0050
2011	FR0055		FR0053	FR0056	FR0054	
2012	FR0060		FR0061	FR0059	FR0058	
2013	FR0066		FR0063	FR0064	FR0065	
2014	FR0069		FR0070	FR0071	FR0068	
2015	FR0069		FR0070	FR0071	FR0068	
2016	FR0053		FR0056	FR0073	FR0072	
2017	FR0061		FR0059	FR0074	FR0072	
2018	FR0063		FR0064	FR0065	FR0075	

Specific de jure benchmark bonds for Malaysia — Table A2

Calendar Year	Maturity			
	3 year	5 year	7 year	10 year
2006	MH060003	MJ050004		MO060001
2007				MN070002
	MJ050004	MJ070005		
2008	MN01001V	MJ080001		MS03002H
		MN04002W		MS04003H
2009	MH090001			
		MJ090004		MO090002
2010	MH090005	MJ100001	ML100002	
2011	MH110002	MO060001		MO110001
2012	MH120003	MJ120005	MK110005	MO120001
2013	MH130001	MI130002	ML120006	MN130003
			MK130006	
2014	MG140002	MJ140004	ML140003	MO140001
2015	MJ120005	MJ150003	ML150002	MO150001
2016	MH150005	MJ160004	ML160001	MO160003
2017		MI170001	ML170002	MO170004
	MH170005			
2018	MJ160004	MI180002	MK180001	MS130005

NB: The 3-year benchmark at the beginning of the sample is MV89001H.

Specific de jure benchmark bonds for Thailand

Table A3

Fiscal year	Maturity							
	3 year	5 year	7 year	10 year	15 year	20 year	30 year	50 year
2010		LB155A	LB16NA	LB196A	LB24DA	LB296A	LB406A	
2011	LB14NA	LB15DA	LB17OA	LB21DA	LB25DA	LB316A	LB416A	LB616A
2012	LB165A	LB176A	LB193A	LB21DA	LB27DA	LB326A	LB416A	LB616A
2013	LB176A	LB196A	LB21DA	LB236A	LB27DA	LB326A	LB416A	LB616A
2014		LB196A		LB236A	LB296A		LB446A	LB616A
2015		LB21DA		LB25DA	LB296A		LB446A	LB616A
2016		LB206A		LB25DA	LB296A	LB366A	LB446A	LB666A
2017		LB226A		LB26DA	LB316A	LB366A	LB466A	LB666A

The probability that a de jure bond will become the de facto benchmark

Robustness check: moving issuance by 15 days (so issuance is counted as being in a month if it is between the 15th of the previous month and the 15th of the current month)

Table A4

Variable	Coefficient	T-statistic	Significance
De facto in previous month	1.11	12.56	***
Recycled benchmark from another maturity	0.60	3.02	***
Issued or reopened during month	0.24	2.53	**
Months since becoming de jure	0.019	1.53	
Stock x ID	8.2E-16	0.25	
Stock x MY	-2.7E-05	-1.15	
Stock x TH	-3.1E-06	-1.53	
Number of bonds in bin	-0.11	-4.36	***
Pseudo R^2=0.30	N=1222		

NB: ***, **, ***** indicate significance at the 10%, 5% and 1% level, respectively. Includes fixed effects for each country/bin. Issuance dates adjusted by -15 days.

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