Key Determinants of Liquidity in the Thai Bond Market

Akkharaphol Chabchitrchaidol and Sakkapop Panyanukul[1]
Bank of Thailand

August 2005

The views expressed herein are those of the authors and not necessarily those of the Bank of Thailand.

Abstract

The Thai bond market has seen significant growth in the years following the Asian financial crisis in 1997. Authorities have recognized the importance and the need for deep and liquid bond markets and the role it plays in enhancing financial market resilience during times of stress. Markets for government securities also play an important role in providing a basis for a robust and efficient financial system as a whole. While steps have been taken to ensure that basic infrastructure in the bond market has been put in place, the lack of liquidity in the bond market has remained a major obstacle to market development. Not surprisingly, this lack of liquidity has made investors reluctant to trade bonds actively, with a large number of market players holding government bonds to maturity, in order not to incur daily mark-to-market losses.

This paper identifies and analyzes the key determinants of liquidity in the Thai bond market, measured by bid-ask spreads on government bonds. We draw upon these determinants to find ways to improve liquidity in the secondary market. The paper attempts to determine what policy actions the government and central bank can take to ensure that these key determinants are achieved, providing recommendations for authorities' role in creating an environment which best facilitates a liquid secondary market.

---

[1] Mr. Akkharaphol Chabchitrchaidol is a Senior Economist with the International Economics Department, Monetary Policy Group, and Mr. Sakkapop Panyanukul is a Senior Analyst with the Financial Markets Office, Financial Markets Operations Group, Bank of Thailand.

This paper represents a joint collaborative effort between the Bank of Thailand and the Bank for International Settlements (Asian Representative Office) in improving research on bond markets in Thailand. The authors are grateful to Titanun Mallikamas for his useful advice and comments from the beginning of this project. Thanks go to Robert McCauley, Eli Remolona, and Amporn Sangmanee, who have acted as advisors on this project. Special thanks are due to Corinne Ho for her helpful and extensive comments and suggestions, as well as to participants at a Seminar at the HKIMR and the BOT. Any errors or omissions are solely the authors'.

1. Introduction

The Thai bond market has seen significant growth in the years following the Asian financial crisis in 1997. The authorities have recognized the importance and the need for deep and liquid bond markets and the role these markets play in enhancing financial market resilience during times of stress. Markets for government securities also play an important role in providing a basis for a robust and efficient financial system as a whole. While steps have been taken to ensure basic bond market infrastructure has been put in place, the lack of liquidity has remained a major obstacle to market development. Market participants have realized that market liquidity cannot be taken for granted, even in normal times, with the market having been subject to periods where a sell-off in bonds has had an adverse effect on liquidity.

This paper identifies and analyzes the key determinants of liquidity in the Thai bond market as measured by bid-ask spreads. We draw upon the results of this analysis to find ways to improve liquidity in the secondary market. The paper also considers what policy actions the government and central bank can take to ensure that these key determinants are achieved, providing recommendations for the authorities' role in creating an environment which best facilitates a liquid secondary market.

The following section gives a brief overview of the structure of the bond market in Thailand, from prior to the Asian financial crisis of 1997 to the present day. Section 3 discusses how to measure and interpret bond market liquidity, in particular, the use of bid-ask spreads as a proxy for market liquidity. Section 4 discusses the theoretical and empirical framework used in the study, as well as the rationale behind it. Section 5 then summarizes the empirical results from our estimations. Section 6 draws some implications for policy, both for the Ministry of Finance in its capacity as an issuer of bonds, as well as for the Bank of Thailand in its role in safeguarding stability in the Thai financial system.

2. Overview of the Thai Bond Market

2.1 Background of Thailand's Bond Market

Thailand's Bond Market Prior to 1997

Prior to the economic crisis in 1997, the function of financial intermediation fell almost entirely on commercial banks. Funds were mobilized mainly through deposits through the banking sector. Direct financing through the domestic bond market – both for the public and private sector – was relatively scarce, leading to small and underdeveloped markets in government and corporate bonds.

The underdevelopment of Thailand's bond market can be attributed to the nine consecutive years of fiscal surplus between 1988 and 1996, which in turn meant that the Thai government had little incentive or need to issue any regular or substantial amount of government bonds. The resulting limited supply of government bonds inhibited the development of a risk-free benchmark, against which private issuers could price their

bonds. This in turn contributed to difficulties in development of the corporate bond market.

With the benefit of hindsight, one recognizes that the lack of a proper bond market – and the resulting imbalance from over-reliance on bank lending – was one factor that contributed to and perpetuated the 1997 financial and economic crisis. The crisis resulted from the practice of borrowing and rolling over short-term US Dollar loans from foreign banks to finance longer-term investments with revenues in Thai Baht. This dual-mismatch became problematic once creditors lost confidence in the Thai economy and refused to continue lending. With limited financing alternative to bank loans, businesses in Thailand faced a severe liquidity crunch as the banking sector curtailed their lending operations amid rising NPL ratios and increasing recapitalization needs. This intensified the economic slowdown as the normal and channels of funding were unable to function effectively.

Thailand's Bond Market After 1997

Recognizing the imbalance in the Thai financial system, the authorities have made a great deal of effort to try to redress this problem. Efforts to develop the domestic bond market were given an extra boost partly due to the need to fiscalize the cost of post-crisis financial sector restructuring, as well as the need to find an alternate funding source to reduce the reliance on bank intermediation and external financing.

The bond market has grown rapidly since 1997. Figure 1 shows the ratios of domestic bonds outstanding to stock market capitalization, bank loans, and GDP. All three ratios have been on an increasing trend. Domestic bond market capitalization surpassed stock market capitalization during 2000 – 2002, as indicated in the dotted circle. Figure 1 also shows that although bank loans still dominate the bulk of financing in the country, the share of bond financing has increased steadily.

Despite the considerable growth in term of size, the ratio of the Thai bond market to GDP, at about 40%, still remains small compared to those in industrial countries – which generally have debt market to GDP ratios above 100%. Local bond markets in the EMEAP[2] economies (excluding Japan) are equivalent to about 50 percent of GDP (Jiang and McCauley, 2003). Emerging countries with debt markets comparable in size to industrial countries include Malaysia and Korea. On average, the ratio of bonds outstanding to GDP is about one third for emerging countries.

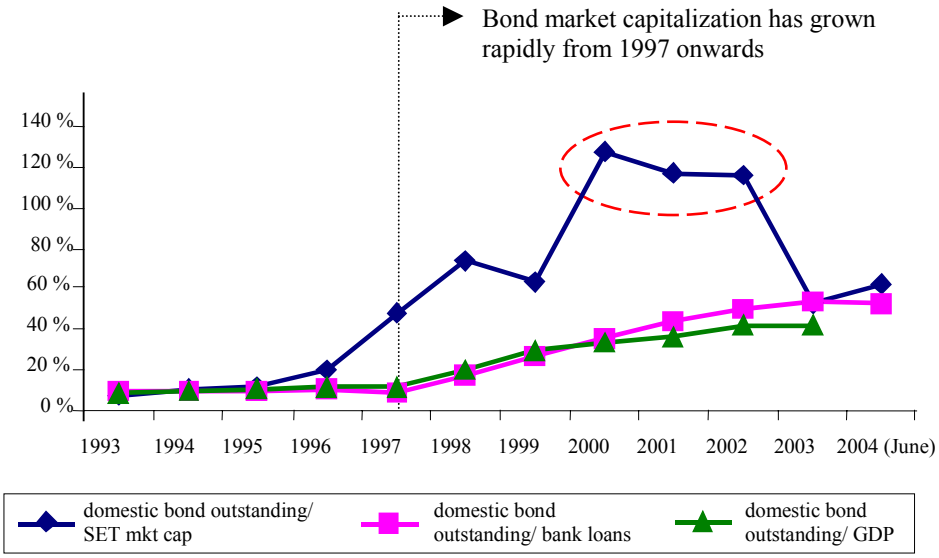
In 1998, the "Domestic Bond Market Development Committee" chaired by the Director General of the Ministry of Finance, was established to promote the development of the domestic bond market. As of January 2005, this committee is chaired by the Finance Minister and comprises high-level representatives from both public and private sector agencies. The aim of this committee is to find ways to enhance funding sources and investment alternatives, which would lead to a better distribution among bank

[2] EMEAP economies include Australia, China, Hong Kong SAR, Indonesia, Japan, Korea, Malaysia, New Zealand, the Philippines, Singapore, and Thailand)

financing, equity financing through stock market, and debt financing through the domestic bond market.

Moreover, for the past few years, development of the local and regional bond market has been given the unprecedented emphasis by various international fora including the Asia Corporation Dialogue (ACD), APEC, ASEAN+3 (Asian Bond Markets Initiative – ABMI), and EMEAP (Asian Bond Fund – ABF).

Figure 1. Bond market capitalization relative to the stock market, bank loan and GDP



Source: BOT

2.2 Thai Bond Market Profile

Figures 2 and 3 show a breakdown of the types of bonds outstanding in the Thai bond market. The Thai bond market is currently dominated by public debt securities, which account for more than two-thirds of the total outstanding bonds in the market. Though the corporate bond market has grown since the crisis, its development is still being handicapped by the lack of quality issuers and of a reliable benchmark yield curve. This issuer characteristic differs from many bond markets in other Asian countries (with exception of Hong Kong) where corporate issues account for a large portion of domestic debt issuance.

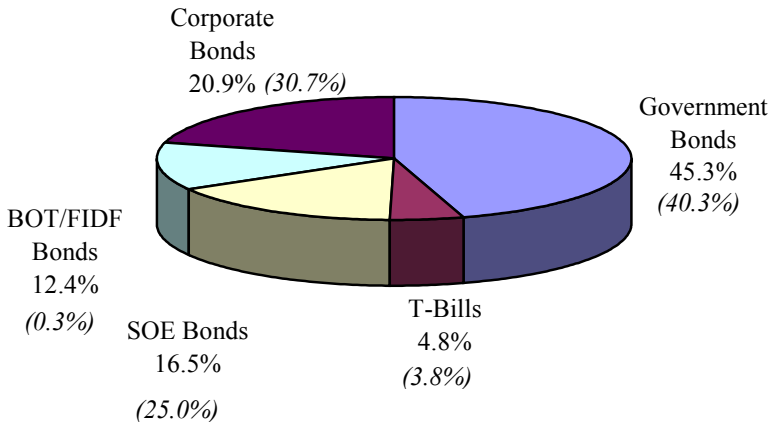
Figure 2. Outstanding values of domestic bonds

Unit: billion Baht

	2000	**2001**	**2002**	**2003**	**2004 (Jun)**
Government Bonds	658.7	706.4 *(7.24%)*	1,114.6 *(57.79%)*	1,132.2 *(1.58%)*	1,159.1 *(2.38%)*
T-Bills	62.0	110.0 *(77.42%)*	134.0 *(21.82%)*	127.0 *(-5.22%)*	123.0 *(-3.15%)*
State enterprise Bonds	408.8	416.1 *(1.79%)*	395.7 *(-4.90%)*	412.2 *(4.17%)*	421.3 *(2.21%)*
BOT/FIDF Bonds	4.1	112.3 *(2,639.02%)*	112.3 *(0.00%)*	239.3 *(113.09%)*	318.0 *(32.89%)*
Corporate Bonds	501.2	538.1 *(7.36%)*	543.4 *(0.98%)*	607.3 *(11.76%)*	535.2 *(-11.87%)*
Total	1,634.8	1,882.9 *(15.18%)*	2,300.0 *(22.15%)*	2,518.0 *(9.48%)*	2,556.6 *(1.53%)*

Source: ThaiBDC
Note: Number in parentheses represents y-o-y percentage change in outstanding value.

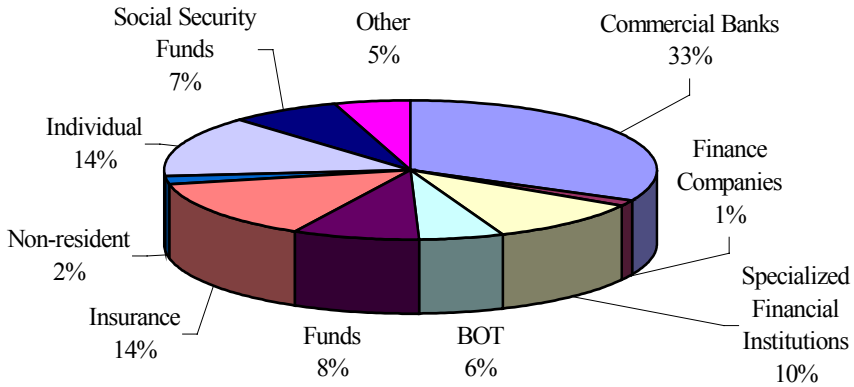
Figure 3. Bond outstanding by instruments as of June 2004



Source: ThaiBDC
Note: Number in parentheses represents corresponding figures in 2000.

The Bank of Thailand acts as a fiscal agent and registrar of government securities as well as collects and disseminates data on bond holders. Commercial banks are the largest holders of government bonds (see Figure 4. below for a profile of holders of government securities); however, they have reduced their investment in the bond market in the past few years, given their inclination to increase credit extension to the private sector. Insurance firms, another significant player in the government bond market, are mainly buy-and-hold investors, reducing the amount of *free-floating* bonds in the market available for trading. They tend to hold long-term bonds, which they match to their liabilities.

Figure 4. Profile of Government Securities Holders as of September 2004



Source: BOT

Both government and corporate bonds are traded over-the counter (OTC), with institutional investors – including banks, mutual funds, provident funds, the Government Pension Funds and insurance companies – as the main investors in bonds. In 2004, some corporate bond issues have been listed in a newly established exchange market to allow access by retail and individual investors. Going forward, authorities are promoting the establishment of an electronic trading platform (ETP) for all types of bonds to facilitate trade and reduce transaction costs in bond trading.

The majority of trading takes place between institutional investors, with two thirds of trading accounted for by inter-dealer trading (Currently, 46 dealers have been granted a license, comprising local and foreign banks as well as securities companies). Categorized by type of security, government bonds are the most actively traded securities, accounting for approximately 80-90 % of total trade. Dealers (financial institutions holding debt securities license granted by the Securities and Exchange Commission) are required to report all bond transactions to Thai Bond Dealing Centre[3]. Thai BDC monitors, compiles and disseminates prices to the public at the end of day. Prices disseminated by Thai BDC are used as market reference.

Even though the daily trading volume in the secondary market has increased since 2001, average daily trading volume of Government Bonds has shrunk in the past 2 years. This seems to have come about as activity in the secondary market has more recently focused on shorter-term instruments such as T-bills and Central Bank Bonds (both of which have a maturity of less than 1 year).

Figure 5. Daily trading volume in the secondary market

Unit: million Baht

	2001	**2002**	**2003**	**2004 (Jan – Sep)**
1. Government Bonds	3,725	4,805	4,674	4,193
2. Treasury Bills	1,426	2,861	2,343	3,474
3. State Enterprise Bonds	571	463	411	449
4. BOT Bonds / FIDF	379	259	2,257	3,190
5. Corporate Bonds	371	368	867	521
Total	6,472	8,755	10,553	11,827

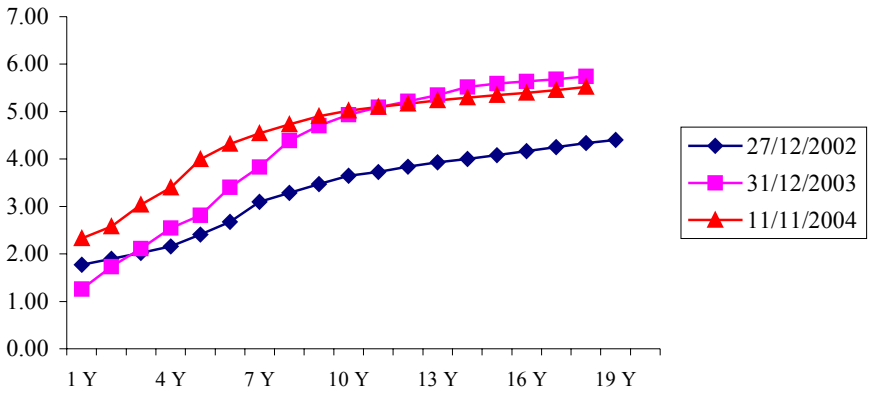
Source: ThaiBDC

The ThaiBDC has developed a government yield curve that extends out to 19 years, using government bond issues across all maturities (ranging from 1-20 years, with

[3] The Thai Bond Dealing Centre (Thai BDC) was established in 1998 under the Securities and Exchange Commission (SEC) Act B.E. 2535 as an organized secondary market for bonds. The primary roles of the Thai BDC are to disseminate information on the bond market as well as facilitate the operation of the secondary market for bond trading.

average duration of about 5 years). This yield curve is derived from bidding yields quoted daily by primary dealers[4] selected by the Bank of Thailand, for transactions with a value of 20 million Thai baht. Figure 6 gives an indication of the Thai Government bond yield curve, with snapshots at various points in time over the past three years.

Figure 6. Government bond yield curve.



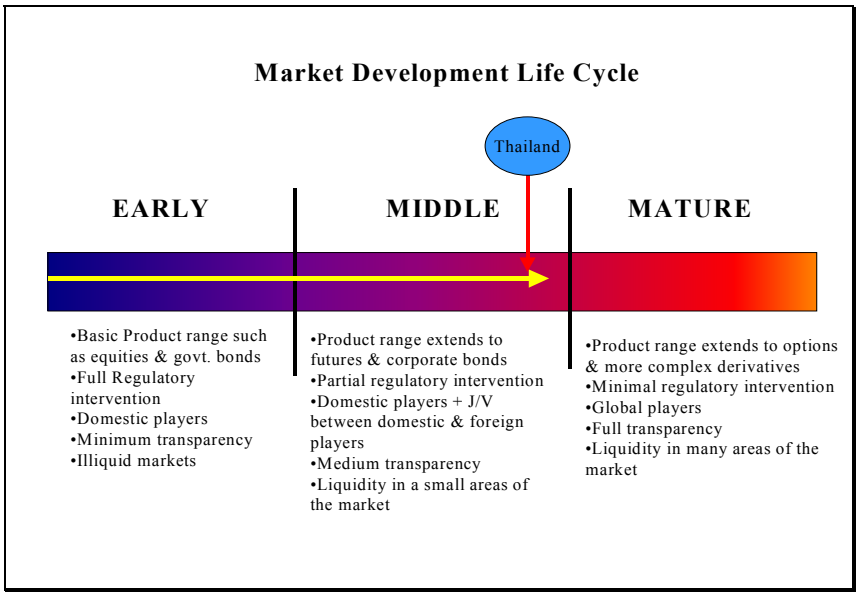
Source: ThaiBDC

Since the crisis, the Thai capital market - and the bond market in particular - has developed and broadened substantially. The authorities have put a great deal of effort in developing the domestic bond market. Figure 7 gives an indication of the market development life cycle. Despite recent advancement, it appears that the Thai bond market is still in an intermediate phase of development, with further development required to increase its effectiveness. In particular, liquidity in the secondary market remains poor. The market's yearly turnover ratio is just above 1, which is low compared to more developed markets.

At this juncture, enhancing liquidity in the secondary market is one of the most important steps that need to be taken to allow the Thai bond market to develop to a more mature stage. Using empirical analysis, this paper will analyze and suggest various measures in enhancing liquidity in Thailand's domestic bond market.

[4] As of end-2004, there are 9 primary dealers comprising both foreign and local banks.

Figure 7. Thailand's market development life cycle



3. Determinants and Measuring Market Liquidity

There is a great deal of literature on why bond market liquidity is important and on the various determinants of liquidity, with somewhat varying conclusions from market to market. Borio (2000) describes the increasing interest in liquidity as following naturally from the increased need for an efficient financial system. In particular, liquidity is an important factor underpinning the smooth functioning of the financial system and conditioning the daily activities of economic agents, including pricing, trading and risk management.

There are many ways in which liquidity can be defined and measured. The Committee on the Global Financial System (CGFS, 1999) broadly defines a liquid market as a market where participants can rapidly execute large-volume transactions with a small impact on prices. However, the concept of liquidity can be further elaborated in a number of dimensions. These include:

(1) tightness, or how far transaction prices diverge from mid-market prices; this can generally be measured by the bid-ask spread; the lower the spread, the higher the liquidity;

(2) depth, denoting either the volume of trades possible without affecting prevailing market prices or the amount of orders on the order-books of market-makers at a given time;

(3) resiliency, referring to the speed with which price fluctuations resulting from trades are dissipated, or the speed with which imbalances in order flows are adjusted; and

(4) immediacy, referring to the time that passes between the placing of a market order and its execution (Upper, 2001).

Determinants of market liquidity

The Committee on the Global Financial System (CGFS, 1999), looks at the importance of liquidity for central banks and central bank policy and comes up with a list of factors bearing on market liquidity, ranging from product design, market microstructure – including trade execution systems, transactions costs, and transparency of markets – to market participants' behavior, including the degree of heterogeneity of market participants in their views and risk profiles, as well as the effect of self-fulfilling expectations.

Theory suggests a number of micro - determinants which should have an effect on bond market liquidity. The CGFS divides these factors into three broad categories: product design, market microstructure, and the behavior of market participants. Mares (2002) supports the view that the level of market fragmentation – in particular the degree of substitutability of instruments and the outstanding amount of fungible assets in the market – plays an important role in determining liquidity. Other factors that affect liquidity include holdings by government accounts and other investors who do not trade actively, the amounts outstanding of benchmark issues, taxes, arrangements for repurchase, as well as clearing and settlement practices.

Macroeconomic factors may also play a role in determining market liquidity (Mohanty, 2002). In particular, the size of an economy tends to correlate positively with the size of the bond market – with a small market limiting the feasible range of marketable instruments and their effective tradability. In addition, economies of scale may also play a role, with a minimum turnover required in order for market-makers to function smoothly and cost-effectively. Mohanty refers to the European experience, which seems to suggest that bond markets became deeper after the adoption of a common market and currency. McCauley and Remolona (2000) suggest that debt markets require a minimum aggregate threshold size (roughly 100-200 billion USD in mature markets in industrial countries) in order to maintain liquidity.

Borio (2000), however, points out that the factors determining liquidity, or their degree of significance, can differ substantially during periods of market stress. Past periods of market turbulence seem to indicate that counterparty risks and cash liquidity constraints have important negative effects on bond trading. Consequently, arrangements for dealing with counterparty risk as well as the performance of risk management systems also have important effects on the dynamics of market liquidity. While keeping this in mind, this paper will focus on the determinants of liquidity under more normal circumstances in a developing bond market.

Measuring market liquidity

A number of approaches have been taken to measure bond market liquidity in various studies. D'Souza and Gaa (2004) suggest a number of measures for liquidity, including bid-ask spreads, volatility, trading volume and frequency, as well as quote size and frequency. While trading volume is an intuitive and widely cited measure of market liquidity, one drawback is that it is also associated with price volatility, which tends to be negatively related to market liquidity. This becomes especially apparent during times when the market is under stress. In addition, trading volume has no direct relation with any of the four dimensions of liquidity mentioned earlier. For example, large trades may still occur even when liquidity is poor but traders have a need to trade, such as for hedging purposes.

Trade frequency, or the number of trades observed per unit of time, is another indirect measure for liquidity. However, as with trading volume, while higher trading frequency may reflect a more liquid market, it may also be associated with increased price volatility, which is in turn associated with reduced liquidity.

A more commonly used measure for market liquidity is the bid-ask spread, or the difference between the best bid and offer prices. Not only is data for this measure easily available, bid-ask spreads reflect the tightness aspect of liquidity in the bond market. In practice, a market that has very low transaction costs is characterized as liquid; in this sense, the bid-ask-spread is a relatively direct measure of market liquidity. The bid-ask spread directly measures the cost of executing a "small"[5] trade, and being a major part of trading costs, it is commonly used as an indicator of the quality of market functioning.

In his study of liquidity in the U.S. Treasury Market, Fleming (2001) identifies the bid-ask spread as one of the most appropriate liquidity indicators due to its high degree of correlation with other measures, such as price impact and benchmark/non-benchmark yield spreads. D'Souza et al (2003) also find evidence that bid-ask spreads are one of the most appropriate indicators of liquidity, consistently exhibiting the expected relationship with price volatility and other liquidity measures.

However, Fleming (2001) suggests that a drawback of the bid-ask spread is that bid and offer quotes are only good for limited quantities and periods of time. The spread therefore only measures the cost of executing a single trade of limited size. Despite its drawbacks, the bid-ask spread remains the most commonly used and most appropriate measure of market liquidity.

---

[5] A "small" trade can be defined as the minimum quote size specific to each market. In the case of Thailand, this quote size is set at 20 million baht.

4. Theoretical Framework and Statistical Methodology

4.1 Basic Model and Rationale

A standard approach to study the impact on liquidity is to estimate an equation of bid-ask spreads (BAS), controlling for the effect of trading volumes and yield volatility (VOL(X)).

The basic least squares equation to be estimated is as follows:

$$BAS_t = \alpha + \beta_1 VOL(X) + \beta_2 \sqrt{Volume} + \beta_3 (Dummy) + \varepsilon_t \quad (1)$$

Volatility is expected to have a positive relation with bid-ask spreads (a negative impact on liquidity). Intuitively, an increase in volatility poses higher risks, which need to be compensated directly through a higher bid-ask spread.

Trading volume is also an intuitive and widely cited measure of market liquidity, and is expected to have a negative relationship with bid-ask spreads. In other words, when there is a high degree of liquidity, resulting from a high level of demand for trades, the spread between bid and offer prices will narrow. The opposite occurs when sellers and buyers are more reluctant to trade. Buyers are likely to bid lower prices, as they would require a higher return to compensate for the increased risk resulting from the lack of liquidity, namely the liquidity risk premium. On the other hand, sellers are likely to set a higher offer price for the same reason. The result is a bid-ask spread that is wider than in times of normal liquidity. In our estimation, trading volume enters our estimation as a square root in order to scale down the impact of volume on bid-ask spreads. At high levels of trading volume, any marginal increments in trading have a much smaller, limited effect on bid-ask spreads.

Higher volume or lower volatility is expected to be associated with lower bid-ask spreads, an indication of better market liquidity. While this association can be explained intuitively, it is also supported by market microstructure theory, which will be discussed in greater detail below.

Market microstructure theory also provides support for these associations. Formal studies have identified 3 main factors that may affect liquidity in financial markets (Upper, 2001). These include order processing costs, inventory control considerations, and adverse selection problems.

Order processing costs include exchange fees and taxes as well as costs of handling transactions. However, given that these costs should be fairly constant in the short-run, they are unlikely to determine short-term changes in liquidity.

Inventory control considerations arise mainly from uncertainty about order flows as well as uncertainty about future prices and valuation of the portfolio, leading to uncertainty in the size of the inventory that dealers need to keep on-hand. The inventory cost component needs to compensate dealers for holding less than fully diversified

portfolios (Krinsky and Lee, 1996). High volatility increases the risk of holding inventory by these dealers, leading them to quote larger bid-ask spreads to compensate for such risks. On the other hand, increased trading in the market, according to this theory, should lead to lower bid-ask spreads as inventory risk for dealers is reduced, suggesting a positive relation between volatility and spreads and a negative relation between trading volume and spreads, consistent with our intuitive predictions above.

Adverse selection problems arise when a group of investors – known in the literature as the "informed" traders - have private information on the value of an asset not currently reflected in prices. "Informed" traders will want to trade only if the current ask price they face is below - or the bid price above - the fundamental value of the asset.

The adverse selection theory introduces two sets of hypotheses. Under the first hypothesis, higher trading volume signals the presence of "informed" traders and results in increased spreads (Easely and O'hara, 1992). In this case, increased trading volume signals to all market players that an information event has occurred. Since the "uniformed" market participants (particularly, dealers) will always make a loss from dealing with "informed" traders, he has to recoup these losses from other investors by charging a larger bid-ask spread for his trades, leading the dealer to widen the spread in response to this unusually high number of trades. Under this hypothesis, a higher trading volume will lead to higher spreads.

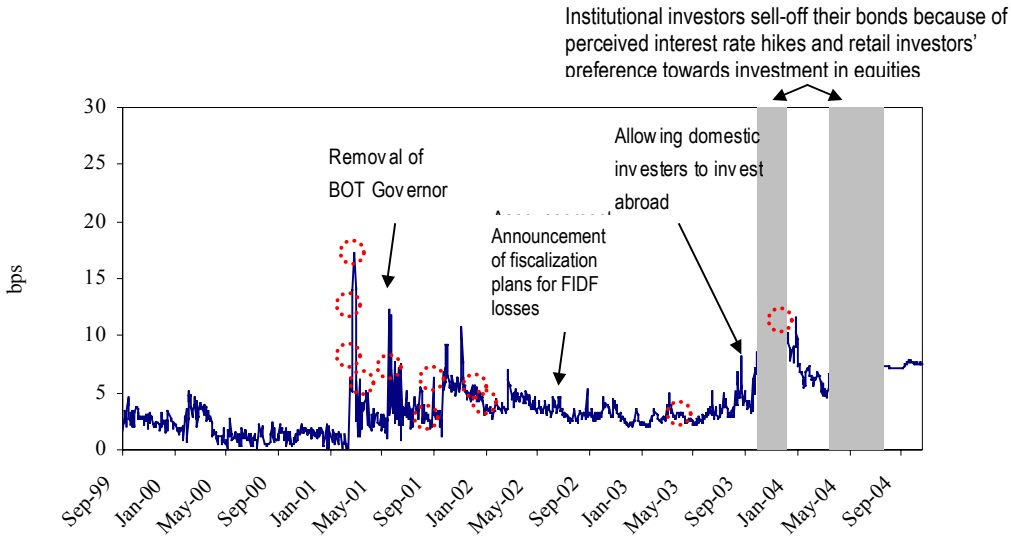
Under the second hypothesis, higher trading volume reflects an increase in liquidity trading (by the "uniformed"), therefore signaling higher overall market liquidity (Harris and Raviv, 1993). Under this scenario, dealers will interpret that a volume shock is due to a change in the demands of "liquidity" traders (such as through mutual fund redemption, for example), and would not be expected to decrease liquidity and have little to no effect on bid-ask spreads.

Existing models of adverse selection of this type, however, have mainly look at liquidity in equity markets, partly due to fact that data is more easily available due to the nature of exchange-traded equity markets. Existing models are based on the assumption that some investors have superior information on the payoff of the asset, which is unlikely to be the case for government bonds, where cash flows are perfectly known. (Lee et al, 1993). While it is unclear which of these two scenarios are more appropriate in our case, it is clear that both volatility and trading volume are two of the main factors which will play a role in determining spreads - and hence, liquidity – and are therefore included in our model.

In addition, we have included a dummy variable in our model to take into account of an apparent structural increase in bid-ask spreads since mid 2001. We interpret this break as being associated with an increase in policy uncertainty. In May 2001, the removal of Bank of Thailand Governor M.R. Chatu Mongkol Sonakul, who established inflation targeting explicitly as the central bank's main policy objective, raised concerns of the new Governor's willingness to adhere to this framework. At the time, markets expected the new Governor (M.R. Pridiyathorn Devakula) to be more biased towards exchange rate stability, possibly at the expense of price stability. This was seen as

leading to greater uncertainty about interest rate policy, which would have an effect on government bond yields. After this episode, several other events may have exerted an influence to the same effect. These include uncertainty of supply issuance to fiscalize losses incurred by the Financial Institutions Development Fund (FIDF) through financial system restructuring, which persists to the present day.[6] Another event that negatively affected liquidity is the massive sell-off of mutual funds invested in fixed income markets in late 2003. A chronology of events affecting the average bid-ask spreads in the bond market in the period between September 1999 – October 2004 is summarized in figure 8 below.

Figure 8. Events affecting the bid-ask spread (September 1999 – October 2004)



Note: Auction dates where bid-to-cover ratios are less than one are denoted by the dotted circles
Source: ThaiBDC, BOT

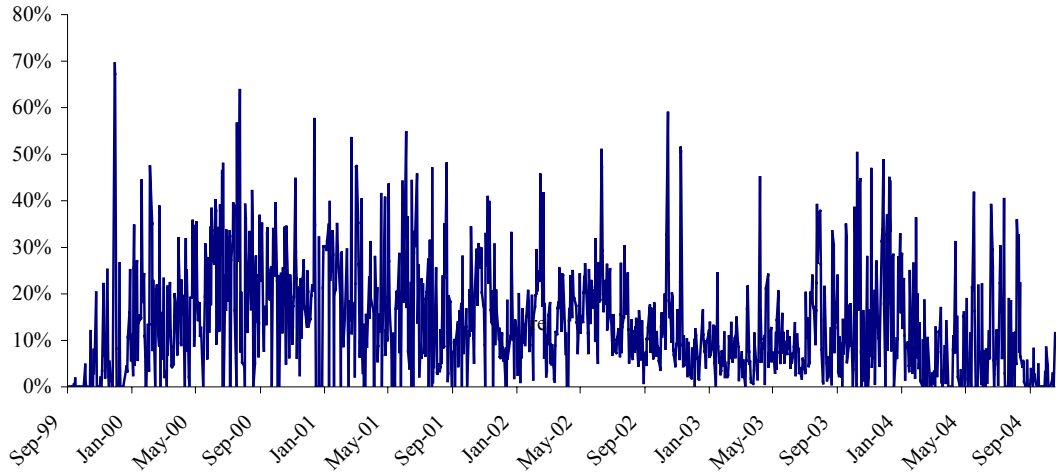
4.2 Data Source

This study covers the period from September 1999 to October 2004. September 1999 is the earliest date in which information on Thai bond trading started to be systematically compiled by the Thai Bond Dealing Centre (ThaiBDC). Data used for the study include daily data on bid-ask spread (end-day *indicative* averages) of government bonds with maturity of more than one year, data on trading volume (daily traded amount), and derived data on volatility (based upon end-day quoted yields). We conduct analysis on the most highly traded bond during our sample period, the LB08DA issue.

[6] The FIDF incurred over 1.4 trillion baht of losses in its restructuring of the financial sector after the 1997 crisis. Of this, 655 billion baht has been fiscalized through issuance of loan bonds, which are tradable by institutional investor (approx. 47% of total losses), as well as 395 billion baht of saving bonds (28%), targeted at retail investors. It is still unclear how the remaining 25% of losses currently held by the FIDF will be fiscalized, over what time frame, and in what form.

The LB08DA issue is a Government bond that was first issued on 8 December 1998, with a 10-year maturity. The outstanding amount for this government bond is at 50 billion baht, which is the largest outstanding amount of all tradable government bonds. The selected individual issue (LB08DA) represents a large proportion of trading volume in the market contributing to an average 20% of total trading volume over our study's time period. This is illustrated in Figure 9.

Figure 9. Trading of LB08DA as a proportion to all Government Bonds



Source: ThaiBDC

The ThaiBDC began to construct a ThaiBDC Government Bond Yield curve in 1998, based on actual executed yields on all government loan bonds. However, since 1999, this yield curve has been adjusted and is now based on average bid yields of government loan bonds, based indicatively quoted by the Bank of Thailand's 9 primary dealers for government bonds. These primary dealers are required to send quotes of both bid yields and offer yields for trades with a minimum size of 20 million baht to the ThaiBDC at the end of each working day (16.00 hours). The Government Bond Yield Curve is constructed and published daily on the ThaiBDC's website.

Trading volume comprises daily data on outright transactions compiled by the ThaiBDC. Data is required to submitted to the ThaiBDC from dealers within 15 minutes after a trade is executed. Most trades in the debt securities market are executed in the Over-the-Counter (OTC) market, which operates daily from 9.00 hours to 16.00 hours.

4.3 How Data Enters the Estimation

Bid-ask spreads are calculated as the difference between the bid and ask yields compiled by the ThaiBDC, and are measured in basis points. The data enters the

estimation as is. Data on trading volume, measured in millions of baht, are also compiled by the ThaiBDC and enter into the estimation as is.

There are different ways to calculate volatility. The simple approach is as follows. We generate a data series for volatility (VOL(X)) based on a rolling daily standard deviation of yield changes over a period of X observations (working days) measured in per cent.

$$VOL(x)_t = \sqrt{\frac{1}{x}\sum_{i=1}^{x}(YLD_{t-(i-1)} - \overline{YLD_t})^2}$$

where x = window width (in # of days) (2)

YLD_t = bond yield at date t

$\overline{YLD_t}$ = average bond yield over the x days to date t

In the first step of our study, we model yield volatility using varying values of X, ranging from 1 week (5 working days) to 6 months (126 working days). Given that there are various ways to calculate yield volatility, we proceed later in our estimations to model yield volatility more explicitly to take into account other factors which play a role in determining volatility.

As mentioned earlier, we include a dummy variable to allow for an apparent structural widening of bid-ask spreads that we believe to have started around the time of the change of Bank of Thailand Governor in May 2001. The dummy is set to zero before this date, and 1 thereafter, to capture the effect on markets from the perceived change in policy direction as well as other various effects on the bid-ask spread that cannot be captured by trading and volatility variables.

We first estimate the bid-ask spread equation for the most traded bond, the LB08DA issue. We then repeat the procedure at the aggregate level. Data at the aggregate level are generated using a similar process, using an average of data on all Thai Government bonds with maturity of more than one year, while we use the ten year interpolated yield (THY10) as a proxy for market yields, as the majority of government bonds in the past have been issued with maturities around 10 years. Details of how these data are generated can be found in Annex 1.

Tables 1-7 provide summary statistics for the bid-ask spread, trading volume, volatility and Thai bond yield over a five-year period (1999 – 2004). Figures 12-16 plot the time series for these data.

5. Empirical Results

5.1 Empirical Results using Least Squares Estimation

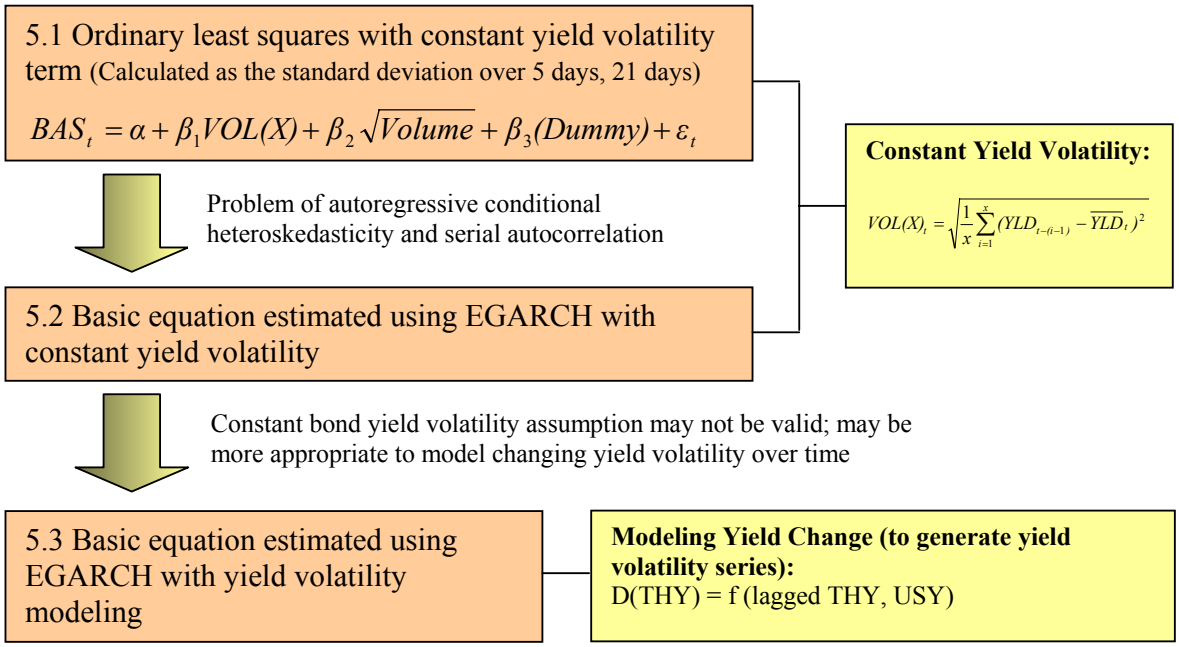
In our initial estimation of equation (1), BAS for the LB08DA issue was regressed on a constant, the issue's volatility, its trading volume, as well as a dummy variable using OLS.

Results indicate that all explanatory variables are highly significant. Trading volume is negatively related with spreads, while volatility as well as the dummy have a positive impact on BAS, as expected (Table 8). However, the Durbin-Watson statistic indicates serial correlation in the error term. Adding a lagged term for the BAS to account for this persistence improves the Durbin Watson statistic and a slight improvement in goodness-of-fit.

However, further investigation using an ARCH LM test for autoregressive conditional heteroskedasticity (ARCH) in the residuals results indicates heteroskedasticity in our data, possibly leading to inefficient estimators. When OLS is applied to heteroskedastic models, it is no longer a minimum variance estimator. The variances and standard errors are understated. Serial correlation in this case will also lead to biased estimators.

In this case, an EGARCH specification may be preferred to OLS. This process of refining our empirical model, covered in sections 5.1 – 5.3, is summarized in figure 10 below:

Figure 10. Refining the empirical model



5.2 Empirical Results using EGARCH Estimation

A variation of equation (1) was estimated using an EGARCH process in place of least squares, while keeping the same explanatory variables. The distinctive feature of using an EGARCH estimation is that it recognizes that variance of the error term is not constant, and therefore attempts to keep track of the fluctuations in variance through time by including past values in the explanation of future variances.

Given the characteristics of a financial variable, it has been suggested that it may be more appropriate not to restrict our specification of the variance of the error term. Using an EGARCH model allows greater flexibility in modeling volatility of the error term through asymmetric shocks to volatility.

Under the EGARCH(1,1) model, the variance equation is given by

$$\log(\sigma_t^2) = \omega + \beta \log(\sigma_{t-1}^2) + \gamma \frac{\mu_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \alpha \left[\frac{|\mu_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right]$$

The functional form of the EGARCH model has several advantages compared to that of the simple GARCH model. The exponential form that is used for the conditional variance σ^2_t guarantees that σ_t is always positive. This permits a wide range of variance effects that are not restricted by non-negativity constraints on the parameters - since we model the $\log(\sigma_t^2)$, then even if the parameters are negative, σ_t^2 will be positive. In addition, the EGARCH model takes into account the "leverage effects", whereby BAS levels may be correlated with changes in volatility of the BAS (depending on the direction of change).

In addition to the existing explanatory variables, a 1-day lag of the BAS was added in order to take into account the persistence of the BAS. The BAS, as with many financial variables, tends to exhibit a high degree of persistence based on recent past values. Table 8 summarizes regression results on the LB08DA bond using various specifications, which will be interpreted in section 6. Estimation using EGARCH yields better fit than our original OLS specification, as indicated in our final estimation (row 8.5).

5.3 Modeling Volatility

However, given the nature of bond yield volatility which is unlikely to remain constant over extended periods, our previous representation of yield volatility (as the sample of standard deviation over a number of days) may not be valid; it may be more appropriate to model yield volatility in such a way that allows it to change over time. Using an EGARCH model to estimate yield volatility allows for the variance of the error term to change continuously with the passage of time.

We begin with a basic estimation of volatility by estimating the historical yield of the LB08DA issue (denoted THY08) based on lagged values of itself. $D(THY08_t)$ is the

difference of yield on LB08DA from the previous day, using end-of-day quoted yields. In addition, given the market's perception that Thai and US interest rates tend to move together, they closely monitor movements in the US Treasury market in their pricing and trading decisions. We therefore introduced lagged interpolated yields of 10 year US Treasuries, which is considered a benchmark tenor in the US market, as an additional explanatory variable.[7]

We estimate the change in yield using the following specification, with results shown in table 9:

$$D(THY08)_t = \alpha + \beta_1(D(THY08_{t-1})) + \beta_2(D(THY08_{t-2})) + \beta_3(D(USY10_{t-1})) + \varepsilon_t \quad (3)$$

We use this specification (yield-change equation (3)) to generate a new series for yield volatility (VOLEG08), which we plug back into our main regression equation (1) in place of our original data series for yield volatility, VOL(X). This results in much improved estimates for our main equation (see table 8), which is free from the statistical problems faced in earlier regressions. Coefficients from our estimation have the expected signs, while the Durbin-Watson statistic is much improved at 1.8387, allaying our concerns of serial correlation. We proceed to discuss results in the next section based on this model EGARCH model for BAS and the above EGARCH model for volatility.

5.4 The Final Equation

The process above leads us to a final equation as follows:

$$\begin{aligned} BAS_t &= 0.0010 + (0.00170***)Dummy_t - (0.000043*)\sqrt{Volume}_t \\ &+ (0.02033**)Volatility_t + (0.94154***)BAS_{t-1} - (0.66378***)MA(1) \end{aligned} \quad (4)$$

where the yield change equation is modeled as follows:

$$\begin{aligned} D(THY08_t) &= -0.00264 + (0.32152***)(\mathrm{D}(\mathrm{THY08}_{t-1})) - (0.04956*)(D(THY08_{t-2})) \\ &+ (0.12357***)(D(USY10_{t-1})) \end{aligned} \quad (5)$$

Significance levels: *(10%), **(5%), ***(1%)

Results from equation (5) are used to generated a new yield volatility series, which was used in estimating equation (4).

Our final equation (equation (4)) sees a marginal improvement in goodness of fit, compared to earlier specifications. All explanatory variables in equation (4) are significant and have the expected signs. Results also suggest that there is a high degree of persistence in the bid-ask spread; in other words, 94% of the previous day's bid-ask spread contributes to the present-day's bid ask spread.

---

[7] A 1-day lag for US yields is used in order to account for time difference between trading days between the US and Thai markets

As theory suggests, equation (4) shows a positive relationship between yield volatility and bid-ask spread. In this case, a 1 percent increase in volatility results in a 2.0 bps increase in the bid-ask spread. Results also show a significant, negative relationship between volume and bid-ask spread, although at much smaller magnitude. In addition, the dummy variable has a small and positive impact on bid ask spreads.

Equation (5) suggests that movements in Thai Bond yields arises mainly from past yields changes in the Thai market as well as a spillover effect from yield changes in the US Bond Market. In particular, a 1 basis point change in the previous day's yield results in a 0.32 basis point change in present yields, while a 1 basis point change in the previous day's yield in US yields results in 0.12 basis point change in present yields.

Aggregate level regression

In order to test if these results are robust in the government bond market overall, we repeat the above methodology for the market as a whole. We calculate average bid-ask spreads for the whole market for government bonds with maturity over one year. Trading volume is calculated as the aggregate of all outright trades of government bonds. Volatility is calculated using the same methodology as for the LB08DA issue, but using interpolated 10-year Thai government bond yields (THY10). Details of these calculations and the methodology can be found in Annex 1.

Tables 10 summarizes regression results on the aggregate level using various specifications, while Table 11 shows the regression results of volatility modeling. Using the same processes as those of LB08DA leads us to the a final equation as follows:

$$\begin{aligned} BAS_t &= 0.00056 + (0.00120***)Dummy_t - (0.00001)\sqrt{Volume}_t \\ &+ (0.04204)Volatility_t + (0.97755***)BAS_{t-1} - (0.16280***)MA(1) \end{aligned} \tag{6}$$

where the yield change equation is modeled as follows:

$$\begin{aligned} D(THY10)_t &= -0.00136 + (0.39925***)(D(THY10_{t-1})) + (0.00729)(D(THY10_{t-2})) \\ &+ (0.13598***)(D(USY10_{t-1})) \end{aligned} \tag{7}$$

Significance levels: *(10%), **(5%), ***(1%)

Results from equation (7) are used to generated a new yield volatility series, which was used in estimating equation (6).

The regression results at aggregate level (equation (6)) yield broadly similar results to the LB08DA estimation in equation (4), in terms of sign and magnitude. However, both volume and volatility are no longer significant at the aggregate level. This is so because the estimation using data at the individual issue level is likely to better show sensitivity and responsiveness to market factors and conditions, and does not suffer the drawbacks of loss information through aggregation or averaging level variables.

6. Implications for Policy

6.1 Dummy Variable

Our dummy variable has remained consistently significant throughout our regressions. As a proxy for structural changes that occurred during our sample time period, we interpret its significance to mean that actions and announcements by authorities play an important role in determining spreads, with market uncertainty of public policy – such as how fiscalization of FIDF losses will occur, widening bid-ask spreads. With this in mind, authorities involved can help to reduce bid-ask spreads by ensuring that any potentially sensitive announcements are effectively communicated with market stakeholders. In addition, authorities should clearly announce plans regarding auctions and new issuances, and strictly commit to these plans if possible, in order to ensure smooth market movements and avoid market confusion.

6.2 Volatility

Our results suggest that a rise in the volatility of bond yields leads to a larger bid-ask spread. In this sense, volatility relates to both movements in Thai government bond yields as well as US Treasury yields.

On the policy side, the fact that volatility has an impact on bid ask spreads, and hence liquidity, mean that ways to safeguard against excessive volatility should be encouraged. One way to do so is to create a vibrant derivatives market which would allow effective hedging of interest rate risks, as well as credit risks. Other tools for risk management in the bond market that may be helpful include the development of a more active and well-functioning private repurchase market as well as short-selling transactions. Mares (2002) highlights the role of a highly liquid futures market to generate liquidity for the cash market – not only for bonds deliverable against futures contracts, but also for the rest of the yield curve. In addition, Mares finds that if a dealer can properly and rapidly hedge any bond, he will be more likely to enter into transactions on any of these bonds.

Market liquidity can further be boosted by permitting market participants to short-sell a security and at the same time enabling them to borrow the shorted securities temporarily from its owner with a contractual obligation to redeliver at a later date, possibly through the private repo market (Mohanty (2002)). Mohanty finds a general consensus among numerous central banks that short selling can have an important stabilizing influence on bond markets, as market volatility was generally higher when participants were unable to make short sales. In this regard, many industrial countries have relaxed restrictions on domestic and cross-border securities transactions in the 1990's, such as allowing short-sale transactions. Several countries have also developed a "when-issued" market[8] as a first step in introducing a short selling facility.

---

[8] A "when-issued" market refers to the market for forthcoming "on-the-run" securities (most recently issued note or bond of a given initial maturity)

The development of a private repurchase market is also an important step in improving market infrastructure. The private repo market could provide a link between money market and bond market. The private repo is also a tool for market participants to hedge their position and manage liquidity (both bond and cash positions) more effectively. The liquidity in the secondary bond market will be substantially improved once the well-functioning private market is put in place.

Another way to reduce volatility is through widening of investor and market participants. A greater variety and diverse set of participants will make the market more resilient to shocks, such as the recent sell-off by mutual funds, or to unanticipated changes in interest rates, as well as enable smooth dissipation of market shocks. An increase in market participants will also diversify players' risk profiles, reducing the chances of a one-way market. Heterogeneity of market participants in terms of transactions needs, risk assessments, and investment horizons enhances market liquidity, as flows received by diverse players will offset each other instead of adding to each other (Mares 2002). One way to increase competition is to allow the entry of foreign banks and securities firms into the finance sector to create a level playing field (Shih (1996)). Shih cites Taiwan's capital market as a model of development whereby foreign banks and securities firms were allowed entry into the local financial sector. A large investor base also generates incentives for financial innovation, leading to greater market dynamism and lower transaction costs.

It is worth noting that authorities in Thailand have to date taken numerous measures to reduce yield volatility in the bond market, with plans to establish a futures market in 2005.[9] The Bank of Thailand has also actively encouraged development of a private repurchase market, and has recently allowed financial institutions to undertake short-sale transactions in the past few years. Details of these and other measures can be found in Annex 2.

6.3 Trading Volume

Trading volume itself is likely to be affected by various factors. We run a simple cross section regression of annualized trading volume in 2004 against "free float" issues, time to maturity, and an auction dummy (equal to 1 if there is an auction in that particular issue, and zero otherwise). The main factors which have an impact on trading volume in the market for Thai Government bonds include whether or not an issue is auctioned in any particular year as well as the size of outstanding bonds in the market for each issue.

6.3.1 Issue Size

We find that issue size has an important and significant contribution to trading volumes in the market for Thai Government bonds. In the following analysis, we

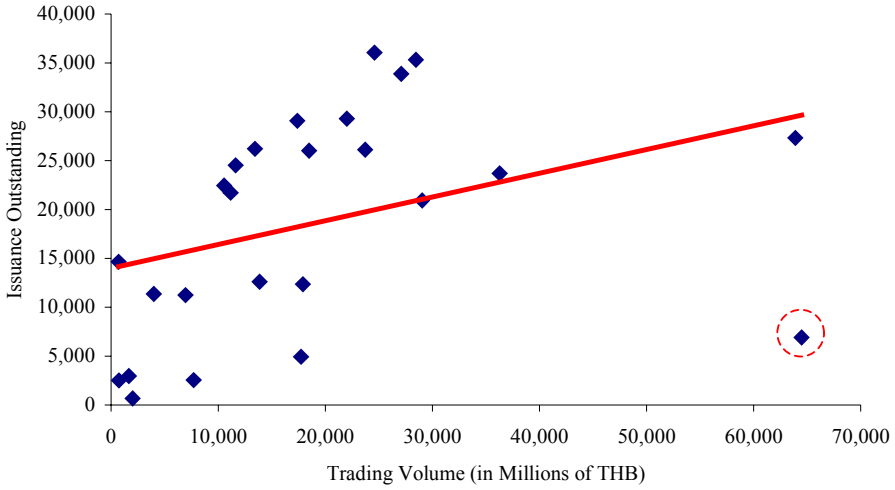
---

[9] In May 2003, the Derivatives Bill was passed in Parliament and was enacted in January 2004. The Stock Exchange of Thailand is expected to launch the SET index futures as one of the first products under this new Bill by the middle of 2005. This will be followed by cash-settled interest rate derivatives contracts (Government bond futures contract) as a next step.

consider the actual tradable amount of bonds (free float) available in the secondary market. We exclude from the formal issue size the amount of bonds held by the Bank of Thailand as well as insurance companies. These bonds are mostly "buy-and-hold" and are not traded in the secondary market.

Results (table 12) suggest that the amount of free-floating bonds has a positive relation to the amount of trading volume in the secondary market for each individual issue. In particular, there is almost a one-to-one effect of free-float outstanding to trading; in other words, a 1 unit increase in "free-float" outstanding bonds available for trade results in a significant 0.97 units increase in trading volume for that issue. This relation is plotted in figure 11, below.

Figure 11. The relationship between trading volume and issuance outstanding of the government bond in 2004



Note: Dotted circle refers to the LB09NC issue (5-year government bond) which was only recently auctioned in November 2004; annualized trading volume for this issue will therefore be noticeably larger than other issues.
Source: ThaiBDC, BOT

This has clear implications for policy. In order to increase the amount of outstanding bonds of particular issues to improve liquidity for these issues, the government may consider taking a series of steps, starting with a *bond buy-back program* for various issues that have a small outstanding size. These can then together be *reissued* in more sizeable auctions at tenors which are favored by the market. In other words, debt of different maturities can be *"lumped together"* to create fewer maturities, as suggested by McCauley and Remolona (2000). This may include reopening of issues.

A second way to enhance liquidity is through more frequent and systematic issuance in the primary market. This re-issuance will also increase trading volume in the market through the effect of new auctions as mentioned above, leading to the related improvement in liquidity. McCauley and Remolona (2000) suggest a few methods of

creating size, for governments worried about generating too much public debt or in a stage of fiscal surplus. The first, as mentioned above, is through *"lumping"* together different types of debt. This puts emphasis on gross issuance in specific securities by concentrating issuance in fewer maturities and by buying back illiquid issues. This debt can then be reissued to consolidate maturities to develop a benchmark. They also find that preferred maturities in industrial countries are at 2, 5, 10, and 30 years. Inoue (1999) also find concentration on a few important maturities to avoid market fragmentation to be preferable to large number of maturities with small issue sizes, with industrial countries generally concentrating on issuance of four to seven maturities. For governments with fiscal surplus – and corresponding shrinking debt levels, authorities may consider *"overfunding"*, with extra proceeds from borrowing channeled to alternative choices for investment. Mohanty (2002) reports the use of bond conversion, outright repurchase (also know as "coupon pass") and reverse auctions to buy back less liquid securities and replacing them with new liquid instruments in Canada and Singapore.

It is worth noting that developing benchmarks through the methods mentioned above are important not only for developing a risk-free yield curve but also for reducing the servicing cost to government. Goldstein and Folkerts-Landau (1994) find that savings to the government from selling benchmark issues are estimated to be in the order of 5-15 basis points in developed countries.

6.3.2 Bond Holding

The significance of "free-float" issues in the market on trading also implies that there are policy implications for bond holding by institutions, including the central bank. While the Bank of Thailand already does its best to ensure that its bond holding has minimal impact on market liquidity, it still holds a sizeable portion of bonds in the market.

In this regard, the Bank of Thailand may consider means to free up these bonds if needed by market participants to support liquidity, such as through a bond lending facility to support the market making function of primary dealers, for instance. This can be done in addition to the currently existing Securities Position Adjustment Facility (SPAf), which has been in implementation since the beginning of 2004.[10] In other words, this would effectively be an enhancement of the current SPAf in terms of lending amount, number of issues available for borrowing, and more flexible terms of lending (i.e. longer borrowing horizon).

Encouraging repurchase transactions (repos) in general should help contribute to secondary market liquidity by allowing market participants to borrow against their securities portfolios, generally below the unsecured borrowing rate. In particular, encouraging interbank-repos in government bonds would help promote liquidity.

---

[10] The SPAf allows 9 primary dealers for outright transactions to borrow 4 issues of benchmark bonds to support their market making functions.

Another main buy-and-hold player in the bond market are insurance companies, who also have a substantial holding of government bonds in their portfolios. These companies should be encouraged to lend out their bonds to more active players in the secondary market.

6.3.3 Auctions

In the case of Thailand, auctions for government bonds are conducted using an American auction procedure, and is open to dealers as well as end investors in the primary market. Given the relatively small demand compared to each issue size, large issues are auctioned in smaller lots over a number of weeks. In addition, to increase the outstanding size of any particular issue, the government, from time to time, auctions additional bonds of the same issue, which has the same effect as "reopening" of bond issues.

Using a dummy variable indicating whether or not a particular issue is auctioned or reopened in that year, we find that the fact that there is an auction (or reopening) has a positive impact on trading volume in that year. This may be due to the fact that new issuances are clearly priced at auction, while older issues may lack price transparency due to lack of trading, leading to preference for newer issues. In addition, most auctions are allotted to dealers (mainly primary dealers), which then are sold to end-investors, most of whom are institutional investors. This contributes to greater activity in the secondary market and increased trading volumes. Estimation results in table 12 show that for issues that had an auction taking place in 2004, trading volume for that particular issue increases significantly by 27,095 million THB.

Aside from frequency of auctions, authorities must make sure that they choose an auction technique that improves the price discovery process, given the informational asymmetries between sellers and buyers.

The Bank of Thailand's measures in developing the Thai bond market are summarized in ANNEX 2.

7. References

1. Borio, Claudio (2000): "Market liquidity and stress: selected issues and policy implications", *BIS Quarterly Review*, November 2000

2. Chabchitrchaidol, Akkharaphol and Orawan Permpoon (2002): "Development of the Thai Bond Market", *BIS Papers No 11* - The Development of Bond Markets in Emerging Economies, June-July 2002

3. Chordia, Tarun, Asani Sarkar, and Avanidhar Subrahmanyam (2003), "An Empirical Analysis of Stock and Bond Market Liquidity", *Federal Reserve Bank of New York Staff Reports*, No. 164, March 2003

4. Committee on the Global Financial System (1999), "Market Liquidity: Research Findings and Selected Policy Implications", Bank for International Settlements

5. D'Souza, Chris and Charles Gaa (2004), "The Effect of Economic News on Bond Market Liquidity", *Bank of Canada Working Paper* 2004-16, May 2004

6. D'Souza, C., C. Gaa, and J. Yang (2003), "An Empirical Analysis of Liquidity and Order Flow in the Brokered Interdealer Market for Government of Canada Bonds", *Bank of Canada Working Paper,* No. 2003-28.

7. Fleming, M. (2001), "Measuring Treasury Market Liquidity", *Federal Reserve Bank of New York Staff Report,* No. 133.

8. Fleming, Michael J. and Eli M. Remolona (1997), "What Moves the Bond Market?", *Federal Reserve Bank of New York, Research Paper* No. 9706, February 1997

9. Goldstein, M and D Folkerts-Landau (1994), "International Capital Markets: Developments Prospects, and Policy Issues", *International Monetary Fund*

10. Jiang, Guorong, Nancy Tang and Eve Law (2002), "Electronic Trading in Hong Kong and its Impact on Market Functioning", *BIS Papers* No. 12, August 2002

11. Jiang, G., and R. McCauley (2004), "Asian Local Currency Bond Markets", *BIS note*, April 2004

12. Inoue, H. (1999), "The Structure of Government Securities Markets in G10 Countries: Summary of Questionnaire Results", *Report of a Study Group established by the Committee on the Global Financial System*, May 1999

13. Jovanovic, Boyan and Peter L. Rousseau (2001), "Liquidity Effects in the Bond Market", *NBER Working Paper Series*, Working Paper 8597, November 2001

14. Krinsky, Itzhak and Jason Lee (1996), "Earnings Announcements and the Components of the Bid-Ask Spread", *The Journal of Finance*, Vol. LI, No. 4, September 1996

15. Lee, Charles M. C., Belinda Mucklow, Mark J. Ready (1993), "Spreads, Depths, and the Impact of Earnings Information: An Intraday Analysis", *The Review of Financial Studies*, Vol. 6, No. 2 (1993), 345-374

16. Mares, Arnaud (2002), "Market Liquidity and the Role of Public Policy", *BIS Papers* No. 12, August 2002

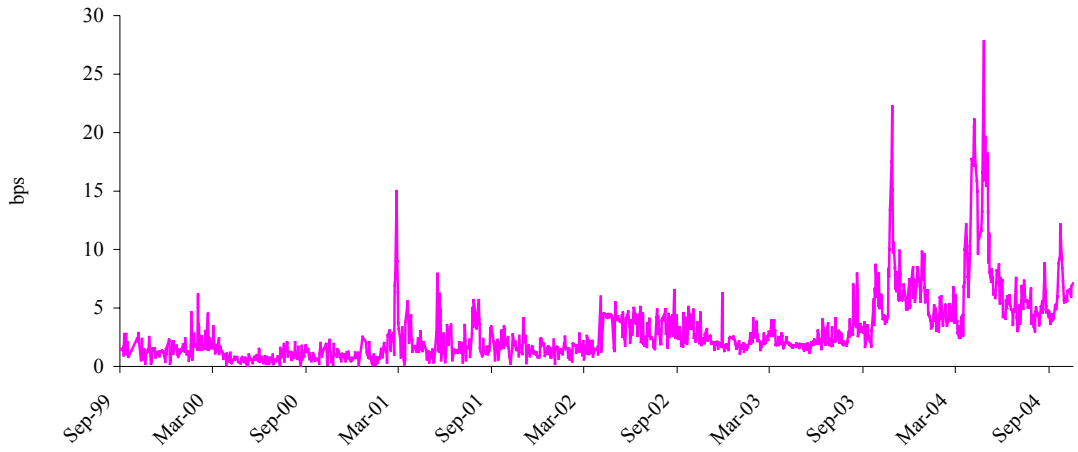
17. McCauley, Robert and Eli Remolona (2000), "Size and Liquidity of Government Bond Markets", *BIS Quarterly Review*, November 2000

18. Mohanty, M S (2002), "Improving liquidity in government bond markets: what can be done?", *BIS Papers No 11 - The Development of Bond Markets in Emerging Economies*, June-July 2002

19. Shih, Y C (1996): "The Changing Financial System in Taiwan", *BIS Policy Papers*, No. 1, December 1996

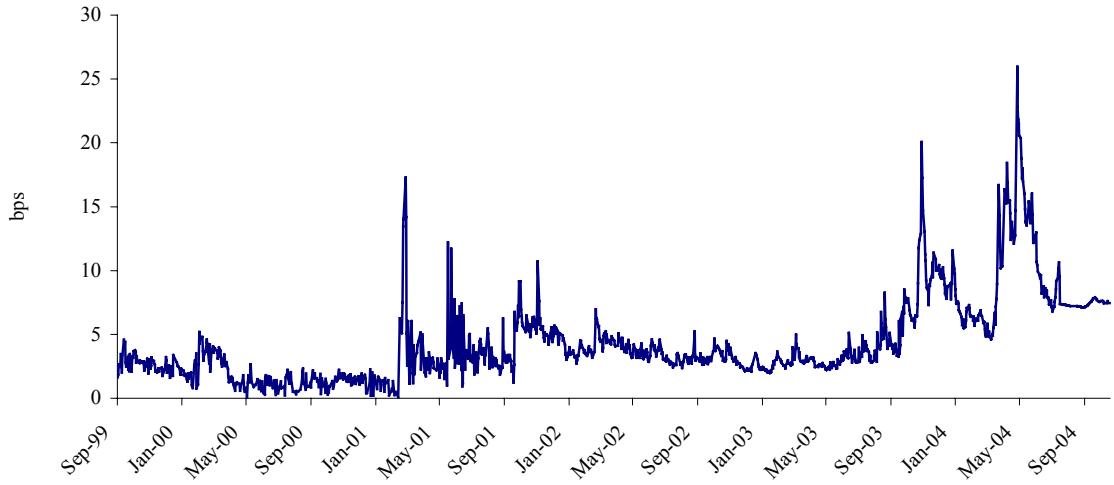
20. Upper, Christian (2001), "How safe was the "Safe Haven"?: Financial Market Liquidity During the 1998 Turbulences", *BIS Papers* No. 2, 2001

Figure 12: Bid Ask Spread – LB08DA



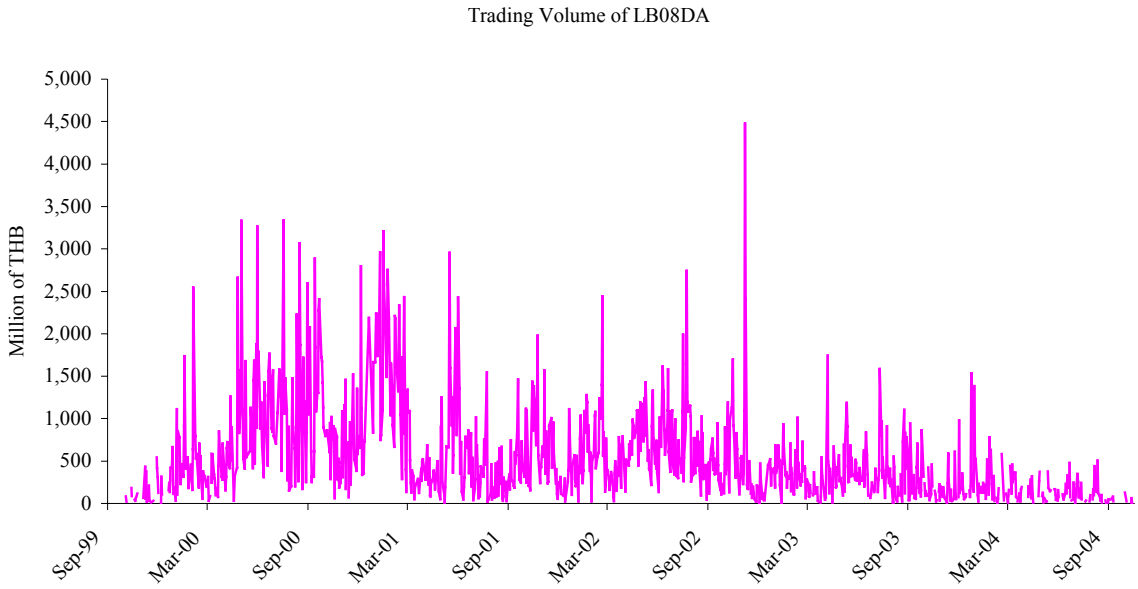
Source: ThaiBDC

Figure 12A: Bid Ask Spread - Aggregate



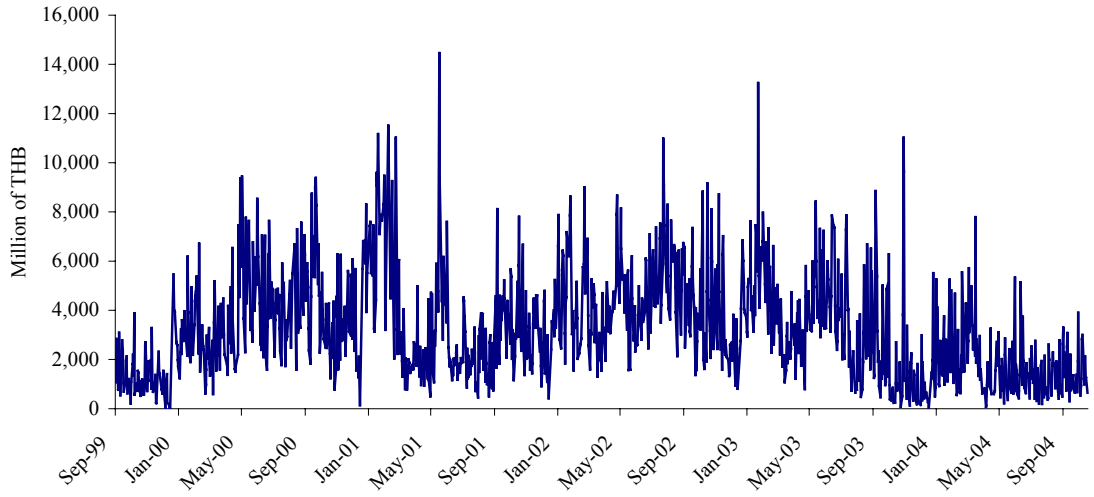
Source: ThaiBDC

Figure 13: Trading Volume – LB08DA



Source: ThaiBDC

Figure 13A: Trading Volume - Aggregate

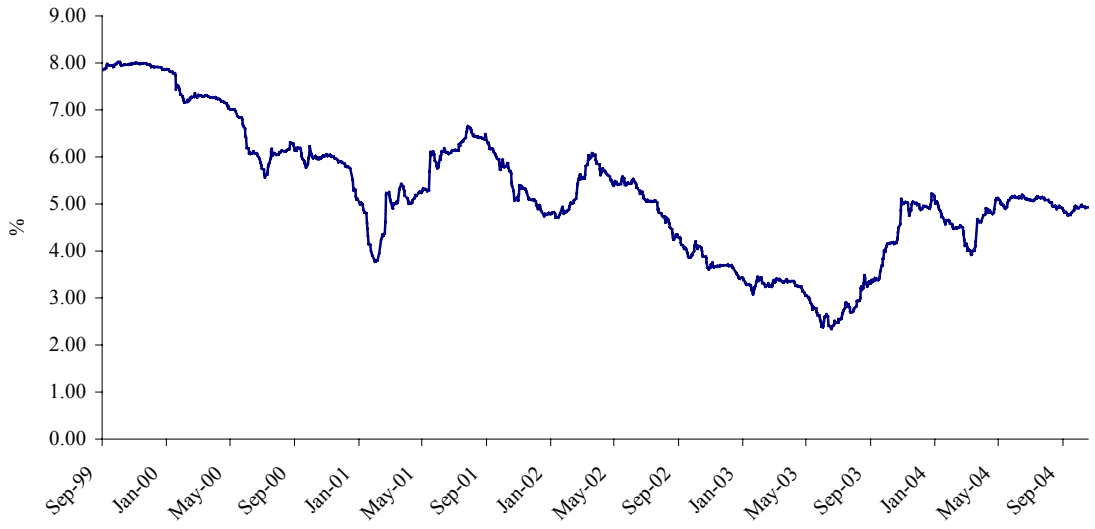


Source: ThaiBDC

Figure 14: Historical Yields of LB08DA

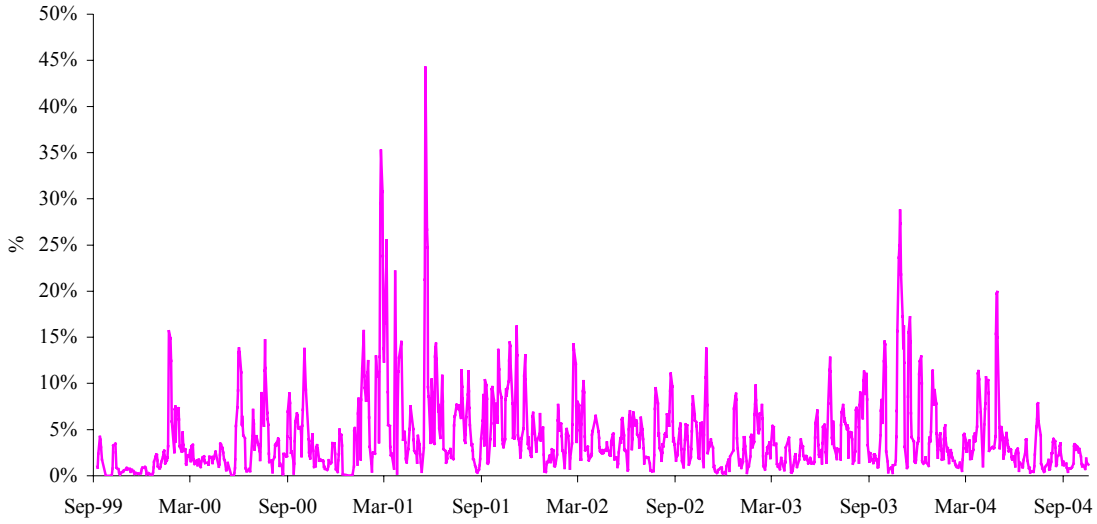
Source: ThaiBDC

Figure 14A: 10-Year Interpolated Thai Government Bond Yield



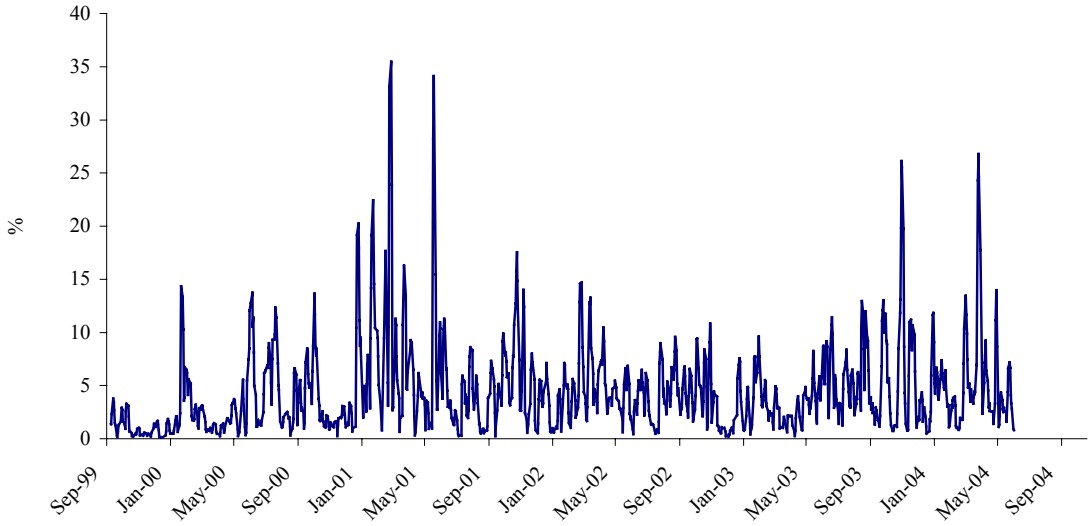
Source: ThaiBDC

Figure 15: Yield Volatility: Daily Standard Deviation of LB08DA Yield Movements in the past 5 days



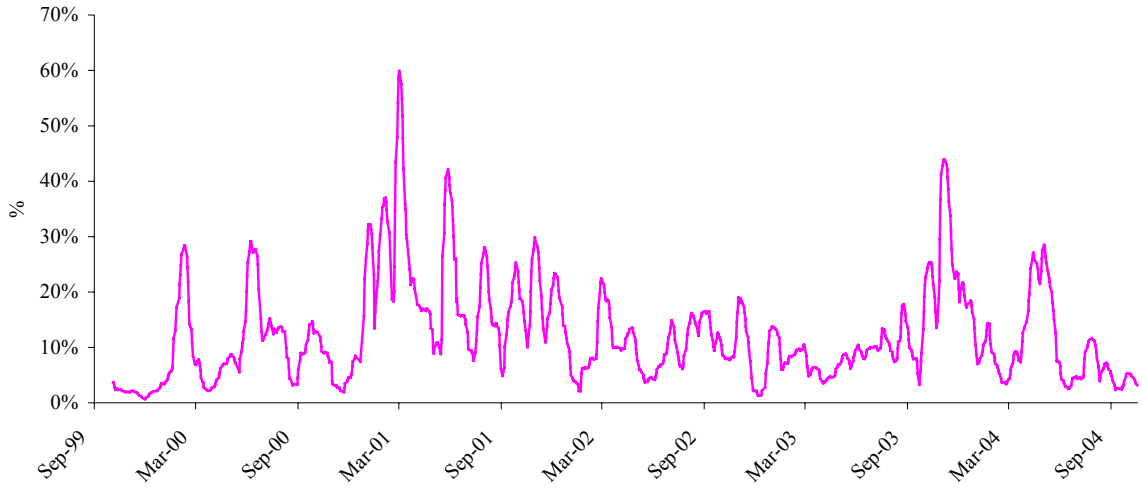
Source: ThaiBDC

Figure 15A: Yield Volatility: Daily Standard Deviation of Yield Movements (THY10) in the past 5 days



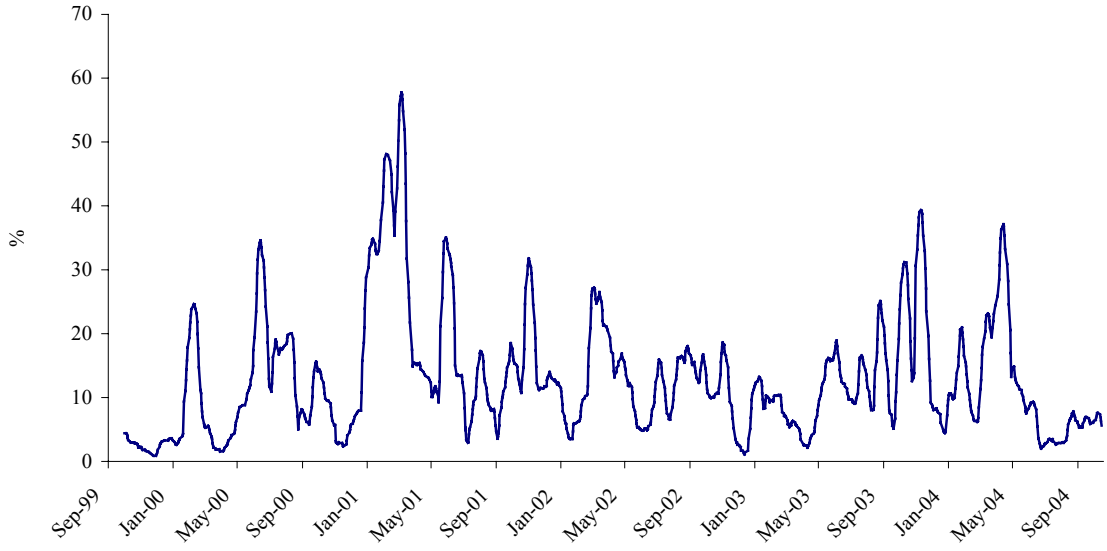
Source: ThaiBDC

Figure 16: Yield Volatility: Daily Standard Deviation of LB08DA Yield Movements in the past 21 days



Source: ThaiBDC

Figure 16A: Yield Volatility: Daily Standard Deviation of Yield Movements (THY10) in the past 21 days



Source: ThaiBDC

Table 1: Summary Statistics (LB08DA) 1999-2004

99-04	Average	Maximum	Minimum	Standard Deviation
BAS (bps)	3.12	30.00	0.25	2.92
Trading Volume (millions of THB)	500.64	4,474.18	0.67	524.34
VOL5 (%)	4.37	38.29	0.12	4.27
VOL21 (%)	12.31	56.76	0.67	8.96
LB08DA Yield (%)	4.01	7.88	1.60	1.63

Table 1A: Summary Statistics (Aggregate level) 1999-2004

99-04	Average	Maximum	Minimum	Standard Deviation
BAS (bps)	4.38	25.96	0.06	3.38
Trading Volume (millions of THB)	3,306.93	14,455.30	4.97	2,154.78
VOL5 (%)	4.42	35.46	0.57	4.18
VOL21 (%)	13.04	57.76	0.86	9.71
THY10 (%)	5.19	8.02	2.35	1.37

Table 2: Summary Statistics (LB08DA) 1999

1999	Average	Maximum	Minimum	Standard Deviation
BAS (bps)	1.10	2.00	0.50	0.47
Trading Volume (millions of THB)	118.86	432.32	8.79	133.64
VOL5 (%)	0.91	4.21	0.21	0.95
VOL21 (%)	1.97	3.58	0.67	0.77
LB08DA Yield (%)	7.85	7.88	7.82	0.02

Table 2A: Summary Statistics (Aggregate level) 1999

1999	Average	Maximum	Minimum	Standard Deviation
BAS (bps)	2.72	4.57	1.61	0.61
Trading Volume (millions of THB)	1,271.51	3,867.93	4.97	842.04
VOL5 (%)	1.08	3.77	0.09	0.91
VOL21 (%)	2.38	4.38	0.86	0.93
THY10 (%)	7.96	8.02	7.85	0.04

Table 3: Summary Statistics (LB08DA) 2000

2000	Average	Maximum	Minimum	Standard Deviation
BAS (bps)	0.99	5.00	0.25	0.67
Trading Volume (millions of THB)	820.85	3,336.38	31.76	685.01
VOL5 (%)	3.26	13.78	0.12	2.76
VOL21 (%)	9.39	28.88	1.88	6.99
LB08DA Yield (%)	6.30	7.81	5.15	0.85

Table 3A: Summary Statistics (Aggregate level) 2000

2000	Average	Maximum	Minimum	Standard Deviation
BAS (bps)	1.68	5.18	0.06	1.00
Trading Volume (millions of THB)	3,868.99	9,432.70	139.21	1,868.56
VOL5 (%)	3.30	14.34	0.24	3.10
VOL21 (%)	10.65	34.62	1.52	7.98
THY10 (%)	6.58	7.90	5.57	0.69

Table 4: Summary Statistics (LB08DA) 2001

2001	Average	Maximum	Minimum	Standard Deviation
BAS (bps)	1.76	10.00	0.50	1.24
Trading Volume (millions of THB)	647.11	2,952.35	12.79	585.42
VOL5 (%)	7.59	38.29	0.35	6.01
VOL21 (%)	21.95	56.76	4.84	10.64
LB08DA Yield (%)	5.03	6.29	3.44	0.72

Table 4A: Summary Statistics (Aggregate level) 2001

2001	Average	Maximum	Minimum	Standard Deviation
BAS (bps)	3.91	17.28	0.08	2.50
Trading Volume (millions of THB)	3,490.36	14,455.30	417.01	2,367.51
VOL5 (%)	6.07	35.46	0.25	5.71
VOL21 (%)	20.41	57.76	2.95	13.02
THY10 (%)	5.53	6.66	3.77	0.67

Table 5: Summary Statistics (LB08DA) 2002

2002	Average	Maximum	Minimum	Standard Deviation
BAS (bps)	3.08	8.50	0.50	1.81
Trading Volume (millions of THB)	632.26	4,474.18	2.64	512.09
VOL5 (%)	3.73	13.77	0.22	2.62
VOL21 (%)	10.20	22.41	1.27	4.93
LB08DA Yield (%)	3.80	4.83	2.66	0.66

Table 5A: Summary Statistics (Aggregate level) 2002

2002	Average	Maximum	Minimum	Standard Deviation
BAS (bps)	3.53	6.98	2.10	0.79
Trading Volume (millions of THB)	4,393.35	10,977.25	806.94	1,862.78
VOL5 (%)	4.15	14.70	0.20	2.87
VOL21 (%)	12.08	27.20	1.08	6.00
THY10 (%)	4.79	6.08	3.61	0.72

Table 6: Summary Statistics (LB08DA) 2003

2003	Average	Maximum	Minimum	Standard Deviation
BAS (bps)	3.54	25.00	1.00	2.82
Trading Volume (millions of THB)	317.27	1,741.15	0.67	268.09
VOL5 (%)	4.64	28.73	0.31	4.66
VOL21 (%)	12.46	43.95	2.78	8.71
LB08DA Yield (%)	2.32	3.91	1.60	0.46

Table 6A: Summary Statistics (Aggregate level) 2003

2003	Average	Maximum	Minimum	Standard Deviation
BAS (bps)	4.72	20.07	1.98	3.06
Trading Volume (millions of THB)	3,357.31	13,239.29	73.50	2,241.77
VOL5 (%)	4.68	26.12	0.28	3.89
VOL21 (%)	13.31	39.35	1.64	8.20
THY10 (%)	3.46	5.10	2.35	0.75

Table 7: Summary Statistics (LB08DA) 2004

2004	Average	Maximum	Minimum	Standard Deviation
BAS (bps)	6.42	30.00	2.50	3.94
Trading Volume (millions of THB)	169.63	1,533.00	2.10	206.03
VOL5 (%)	3.29	19.72	0.35	3.06
VOL21 (%)	9.74	28.49	2.35	6.86
LB08DA Yield (%)	2.97	3.51	2.18	0.41

Table 7A: Summary Statistics (Aggregate level) 2004

2004	Average	Maximum	Minimum	Standard Deviation
BAS (bps)	9.14	25.96	4.60	3.89
Trading Volume (millions of THB)	1,801.57	7,778.66	79.80	1,278.62
VOL5 (%)	5.31	26.80	0.69	4.65
VOL21 (%)	10.74	37.16	2.01	8.07
THY10 (%)	4.85	5.22	3.92	0.30

Table 8: Regression Results on BAS (individual, LB08DA issue)

Specification *(Expected sign)*	**Constant**	**Dummy** *(+)*	**Trading volume (Square Root)** *(-)*	**Volatility** *(+)*	**Lagged BAS**	**MA(1)**	**Durbin Watson/ R^2**
8.1 LS with VOL(21)	0.01411***	0.02682***	-0.00069***	0.04274***	-	-	0.8018/ 0.2479
8.2 LS with VOL(21) and lagged term	0.00561**	0.01036***	-0.00026***	0.01387*	0.61697***	-	2.3212/ 0.5337
8.3 EGARCH (1,1) with VOL(21)	0.00115	0.00147***	0.00000	-0.00163	0.94971***	0.69222***	1.7677/ 0.5843
8.4 EGARCH (1,1) with VOL(5)	0.00123*	0.00141***	0.00000**	0.00010	0.94770***	-0.70209***	1.7492/ 0.5843
8.5 EGARCH (1,1) with modeled volatility (VOLEG08)	0.0010	0.00170***	-0.00004*	0.02033**	0.94154***	-0.66378***	1.8387/ 0.5956

Significance levels: *(10%), **(5%), ***(1%)

Table 9: Yield change equation using EGARCH (individual, LB08DA issue) (VOLEG08)

Specification	Constant	D(THY08(-1))	D(THY08(-2))	D(USY10(-1))	Durbin Watson/ R^2
EGARCH(1,1)	-0.00264	0.32152***	-0.04956*	0.12357***	1.9868/ 0.1161

Significance levels: *(10%), **(5%), ***(1%)

Results from this equation are used to generate a yield volatility series which is plugged into main equation (4).

Table 10: Regression Results on Average BAS (aggregate of all tradable government bonds)

Specification *(Expected sign)*	**Constant**	**Dummy** *(+)*	**Trading volume (Square Root)** *(-)*	**Volatility** *(+)*	**Lagged BAS**	**MA(1)**	**Durbin Watson/ R^2**
10.1 LS with VOL(21)	0.04513***	0.03175***	-0.00061***	0.07789***	-	-	0.3423/ 0.3452
10.2 LS with VOL(21) and lagged term	0.00340*	0.00297***	0.00004	0.00484	0.91107***	-	2.3928/ 0.8828
10.3 EGARCH (1,1) with VOL(21)	0.00017	0.00097*	0.00000	0.03389	0.98264***	-0.20021***	2.1576/ 0.8874
10.4 EGARCH (1,1) with VOL(5)	0.00059	0.00133***	0.00000	-0.00986**	0.97666***	-0.16085***	2.2308/ 0.8868
8.5 EGARCH (1,1) with modeled volatility (VOLEG)	0.00056	0.00120***	-0.00001	0.04204	0.97755***	-0.16280***	2.1692/ 0.8916

Significance levels: *(10%), **(5%), ***(1%)

Table 11: Yield change equation using EGARCH (Aggregate level)

Specification	Constant	D(THY10(-1))	D(THY10(-2))	D(USY10(-1))	Durbin Watson/ R^2
EGARCH(1,1)	-0.00136	0.39925***	0.00729	0.13598***	2.1443/ 0.1538

Significance levels: *(10%), **(5%), ***(1%)

Results from this equation are used to generate a yield volatility series which is plugged into main equation (6).

Table 12: Effect of Outstanding Issuance on Trading Volume (TRADE)[+]

Specification	Constant	Outstanding[++]	Dummy for Issuance	Time to Maturity (TTM)	Durbin Watson/ R^2
LS	-7432.120	0.967100**	27095.42***	237.0885	2.0903/ 0.5072

Significance levels: *(10%), **(5%), ***(1%)

[+] **TRADE** refers to the annualized trading volume of each individual issue in 2004

[++] **Outstanding** refers to the free float amount of 25 issues of government loan bonds as of November 2004 excluding holding by Bank of Thailand as well as insurance companies, who generally buy and hold to maturity.

ANNEX 1

At the aggregate level, we calculate average bid asks spread data as average of Bid-Ask spreads of each issue (based upon indicative yields of government bonds traded each day), as follows:

$$BAS_t = \frac{\sum_{i=1}^{n} BAS_{it}}{n} \tag{8}$$

where n is the number of individual government bond issues available at time *t*.

Trading volume is calculated as the aggregate of all outright trades of government bonds at time t, as follows:

$$TRADE_t = \sum_{i=1}^{n} TRADE_{it} \tag{9}$$

Yield volatility is calculated based on the various methods discussed in the text, which include equation (2), where YLD is the 10-year interpolated yield, and volatility modeled from equation (5).

ANNEX 2

Measures Undertaken by the Bank of Thailand to Develop the Thai Bond Market

	Government	**Corporate**
Primary Market	• Coordinate with MOF to push forward - issuance of benchmark bond to establish benchmark yield curve - advance announcement of government securities auction schedule - issuance of Savings Bonds as an alternative investment for retail investors - the adoption of non-competitive bidding auction system (NCB) (June 2002) - the approval of the Baht Bonds issuance by International Financial Institutions i.e. WB, ADB, IFC, JBIC (April 2004). • Developed an electronic bidding platform (e-bidding) for auctions of government securities	
Reference Rate	• Assigned Primary Dealers (Outright) to submit the end of day indicative government bond yields to construct government bond yield curve (September 1999) • Assigned PD to submit two-way quotations for Benchmark government bonds through the Thai Bond Dealing Center (TBDC) website (January 2004)	• In an attempt to promote term lending in the interbank market, an interbank lending with term between 1 day - 1 year was no longer be included in the calculation of Single Lending Limit (SLL), and in addition, FIDF fee which is usually collected on bank's borrowing base was exepmpted. • Set up a quoting system for Bangkok Interbank Offer Rate (BIBOR), to begin in January 2005
Liquidity Management / Hedging Instrument	• Closed the morning session of the central bank repo market to promote Private Repo transactions among market participants. • Amendment of central bank Repo practices, such as raising transaction fees or raising minimum transaction value, to discourage activities through this channel • Developed electronic trading platform for central bank Bilateral Repo	• Amendment of central bank regulation - to allow commercial banks to borrow from corporates (such as public company) via Private Repo market - to allow financial institutions to use corporate debt securities as collateral in Private Repo transaction

	Government	Corporate
	transactions (e- BRP) and outright transactions (e-Outright) to enhance efficiency in monetary operations • Introduced last resort window for benchmark government securities - Securities Position Adjustment Facilities (SPAf)	Private Repo transaction • work closely with TBDC in the preparation of Private Repo Code of Conduct and encourage Primary Dealers to sign Master Agreement with other market participants • listed corporate bonds on SET (November 2003)
Primary Dealers	• Appointed financial institutions as primary dealers for 1) Bilateral repo transactions - to enhance the efficiency in conducting monetary operations by absorbing the liquidity at the significant amount from the Bank of Thailand and transmitting those liquidity to other market participants. 2) Outright transactions - to facilitate the bond market development as well as to ensure the successful outcome of government securities auctions in the primary market	
Information / Disclosure	• Cooperation with TBDC in the development of internet-based information dissemination system (e.g. bond auction calendar, auction results, market prices etc.) to promote price transparency and price discovery process	
Broad based Investors / Issuers		• Provide the market with extensive training courses with an objective to familiarize and educate local investors (financial institutions and end investors) with new financial products and developments • Encourage the diversification of issuer base as well as investor base, to include offshore players (non-resident or NR), for example, allowing non-resident to issue debt securities in Thai Baht (Baht Bond) and allowing qualified local institutional investors to invest in foreign securities.
Clearing & Settlement	• Introduced BAHTNET II system for clearing and settlement of the government securities which features the Delivery Versus Payment (DVP) ,greatly reduce the settlement risk in government bond trading (December 2001)	• Approved the plan (5-year plan from 2002 – 2007) to integrate the clearing and settlement system of the government securities and corporate bonds.
Tax	• Get cabinet approval of NR investors' tax exemption for investing in government bond (August 2004)	• Collaborate with the Revenue Department to provide the taxation structure conducive to the domestic bond market development