

WP/02/232

IMF Working Paper

Measuring Liquidity in Financial Markets

Abdourahmane Sarr and Tonny Lybek

IMF Working Paper

Monetary and Exchange Affairs Department

Measuring Liquidity in Financial Markets

Prepared by Abdourahmane Sarr and Tonny Lybek¹

Authorized for distribution by Arne B. Petersen

December 2002

Abstract

The views expressed in this Working Paper are those of the author(s) and do not necessarily represent those of the IMF or IMF policy. Working Papers describe research in progress by the author(s) and are published to elicit comments and to further debate.

This paper provides an overview of indicators that can be used to illustrate and analyze liquidity developments in financial markets. The measures include bid-ask spreads, turnover ratios, and price impact measures. They gauge different aspects of market liquidity, namely tightness (costs), immediacy, depth, breadth, and resiliency. These measures are applied in selected foreign exchange, money, and capital markets to illustrate their operational usefulness. A number of measures must be considered because there is no single theoretically correct and universally accepted measure to determine a market's degree of liquidity and because market-specific factors and peculiarities must be considered.

JEL Classification Numbers: G1 and G15

Keywords: Measuring liquidity, financial markets

Authors' E-Mail Addresses: asarr@imf.org; tlybek@imf.org

¹ Comments by Kai F. Barvell, Steen Byskov, Peter Dattels, Jennifer Elliott, Robert P. Flood, Mats E. W. Filipsson, Shyamala Gopinath, Peter Hayward, Lars Jessen, Jeppe F. Ladekarl, Gabriel Sensenbrenner, Quynh Anh Thai, Hung Q. Tran, and Mark Zelmer on a previous draft, as well as research assistance by Zeyneb Kantur, Hanan Morsy, and Plamen Yossifov are gratefully acknowledged.

Contents	Page
I. Introduction	4
II. Selected Liquidity Measures	8
A. Transaction Cost Measures	9
B. Volume-Based Measures	11
C. Price-Based Measures	14
D. Market-Impact Measures.....	17
Other econometric techniques	18
III. Application of Liquidity Measures	19
A. Foreign Exchange Markets.....	20
B. Money Markets	25
C. Bond Markets.....	29
D. Equity Markets.....	34
IV. Factors Affecting Asset and Market Liquidity.....	36
V. Liquidity During Periods of Stress	40
VI. Conclusion.....	41
References	60
Text Tables	
1. Average Bid-Offer Spreads of Spot and Forwards, October 11, 2001.....	22
2. Bid-Ask Spreads (basis points): Foreign Exchange Markets.....	24
3. Market Efficiency Coefficients: Foreign Exchange Markets.....	25
4. Bid-Ask Spreads: Money Markets	28
5. Market Efficiency Coefficients: Money Markets	29
6. Selected Liquidity Indicators for Government Securities Markets in G-10 Countries.....	32
7. Bid-Ask Spreads (Percent): Bond Markets	33
8. Market Efficiency Coefficients: Bond Markets.....	34
9. Liquidity Measures: Equity Markets.....	36
10. Market Efficiency Coefficients: Equity Markets.....	38
Figures	
1. Global Foreign Exchange Market Turnover, 1989–2001	21

Boxes

1. Illustration of Market Depth and Breadth	6
2. Liquidity Measures and Data Availability	20
3. Factors Affecting Asset and Market Liquidity	38

Appendices

I. Example of Data Request for FSAP Missions	42
II. Figures on Various Liquidity Measures in Selected Foreign Exchange Markets	43
III. Figures on Various Liquidity Measures in Selected Money Markets	46
IV. Figures on Various Liquidity Measures in Selected Government Bond Markets	50
V. Figures on Various Liquidity Measures in Selected Stock Markets	55

I. INTRODUCTION

Liquid markets are generally perceived as desirable because of the multiple benefits they offer, including improved allocation and information efficiency. They (i) allow a central bank to use indirect monetary instruments and generally contribute to a more stable monetary transmission mechanism; (ii) permit financial institutions to accept larger asset-liability mismatches, both regarding maturity and currency, thus fostering more efficient crisis management by individual institutions, and reducing the risk of the central bank having to act as lender of last resort for solvent but illiquid credit institutions; and (iii) render financial assets more attractive to investors, who can transact in them more easily.² The latter benefit, however, may not be true for investors collectively. As Keynes noted (1936, p. 160): “For the fact that each individual investor flatters himself that his commitment is “liquid” (though this cannot be true for all investors collectively) calms his nerves and makes him much more willing to run a risk.” Therefore, recent crises in financial markets, in particular, have triggered studies on how to better judge the state of market liquidity and ideally to better predict and prevent systemic liquidity crises.³

This paper has two main purposes. First, it provides an overview of the many different concepts related to *liquid* financial markets. Second, it identifies some simple quantitative indicators that *Financial Sector Assessment Program* (FSAP) missions of the International Monetary Fund (IMF) and the World Bank can use to illustrate the changing degree of liquidity in financial markets over time.⁴ Finally, the paper also briefly discusses the possibility of creating a composite measure of the “liquidity stance” in financial markets. This latter task was prompted by analysts, such as Borio (2000), who reports that in the run-up to financial crises, markets often appear artificially liquid, but during periods of stress, liquidity tends to evaporate.

The microeconomic concept of liquidity is multifaceted. Market participants perceive a financial asset as liquid, if they quickly can sell large amounts of the asset without adversely affecting its price. Liquid financial assets are thus characterized by having small transaction costs; easy trading and timely settlement; and large trades having only limited impact on the market price. Most of the existing literature gauging liquidity has focused on different

² International Accounting Standard No. 39 (effective January 1, 2001) encourages the use of fair-value accounting, which, in practice, often means mark-to-market valuation, and thus presumes liquid markets.

³ The stock market crises in October 1987 and 1989, the Asian crises in 1997, the Russian debt moratorium in August 1998, and problems at Long-Term Capital Management Fund (LTCM) led the Committee on the Global Financial System to conduct several studies discussing the importance of liquid financial markets, including *Market Liquidity: Research Findings and Selected Policy Implications* (BIS, 1999) and *Structural Aspects of Market Liquidity from a Financial Stability Perspective* (BIS, 2001c).

⁴ Dziobek et al. (2000), for instance, discuss how to establish a framework for a systemic liquidity policy.

dimensions of liquidity of individual financial assets.⁵ It is generally concluded (Baker, 1996, p. 1) that there: "...is no single unambiguous, theoretically correct or universally accepted definition of liquidity." Moreover, the importance of some of the characteristics of liquid markets may change over time. For instance, during periods of stability, the perception of an asset's liquidity may primarily reflect transaction costs. During periods of stress and significantly changing fundamentals, prompt price discovery and adjustment to a new equilibrium becomes much more important.

Liquid markets tend to exhibit five characteristics: (i) tightness; (ii) immediacy; (iii) depth; (iv) breadth; and (v) resiliency. *Tightness* refers to low transaction costs, such as the difference between buy and sell prices, like the bid-ask spreads in quote-driven markets, as well as implicit costs. *Immediacy* represents the speed with which orders can be executed and, in this context also, settled, and thus reflects, among other things, the efficiency of the trading, clearing, and settlement systems. *Depth* refers to the existence of abundant orders, either actual or easily uncovered of potential buyers and sellers, both above and below the price at which a security now trades. *Breadth* means that orders are both numerous and large in volume with minimal impact on prices. Box 1 illustrates the difference between depth and breadth. *Resiliency* is a characteristic of markets in which new orders flow quickly to correct order imbalances, which tend to move prices away from what is warranted by fundamentals. These terms reflect different dimensions of the extent to which an asset quickly and without significant costs can be transformed into legal tender.

These terms, however, are also to some extent overlapping. Most of the available data do not fully correspond to these dimensions, which complicates their measurement. In addition, a number of qualitative factors must be considered, since they affect the above-mentioned dimensions of liquidity. They range from the microstructure of the market, the central bank's implementation of its monetary policy, to risks in the payment and securities clearance and settlement systems.

Indeed, understanding the microstructure of the market is important, when proxies, like bid-ask spreads and turnover ratios, are used as liquidity indicators. A market can be a physical location, an electronic or other platform that allows *potential* buyers and sellers to interact. Most academics have a neoclassical phantom world in mind with a Walrasian auctioneer performing a price *tâtonnement* process ensuring instantaneous trading at market clearing prices. In short, prices are a sufficient statistic. In the practitioner's world, however, trading may take place in various platforms (for instance, dealer or auction markets) at nonmarket clearing prices because of factors such as market illiquidity.

In a dealer market, trading is *quote driven*. Dealers quote bid and ask prices and may take positions. Therefore, it is often argued that dealers provide liquidity, since they provide a

⁵ See, for instance, Baker (1996), Bernstein (1987), Hasbrouck and Schwartz (1988), and Kyle (1985) for a discussion of these concepts.

Box 1. Illustration of Market Depth and Breadth

Size of existing or easily uncovered bids				
Market:	1	2	3	4
Bid price	Thin and Shallow	Thin but Deep	Broad but Shallow	Broad and Deep
\$50	100	100	500	500
\$49	200	200	500	500
\$48	0	300	0	700
\$47	0	300	0	900
\$46	0	300	0	1500

Source: Garbade (1982, p. 421).

Markets 3 and 4 are *broader* compared to markets 1 and 2 because larger volumes of orders (1000 units instead of 300) can be satisfied with no price impact (\$49-50). Market 4 is also *broader* than market 2 because the price impact of larger volume orders occurs at greater volumes. In market 4, 1000 units can be sold at \$49-50 whereas in market 2, the price concession goes as far as \$46 to sell the same units.

Markets 2 and 4 are *deeper* compared to markets 1 and 3 because trade interests exist up to \$46.

The examples also show that *deep* markets can compensate for *broader* markets. Thus, because market 2 is deep, 1200 units can be sold by dividing the sale into smaller amounts. In the *broad but shallow* market 3, only 1000 units can be sold.

continuous market. However, since dealers usually try to square their positions or maintain a specified structural position toward the end of the day, they only “provide” liquidity by taking inventory positions as long they assume buyers and sellers will continue to emerge.⁶

In a pure auction market, potential buyers and sellers submit orders, and brokers or an electronic system will match them. Auction markets are thus *order* or *price driven* and may

⁶ A distinction is sometimes made between call markets and continuous markets. In a *call market*, trading takes place at specified times in an attempt to arrive at a single price when there are only few active transactors. It may also be used if trading is suspended during the day because of arrival of significant new information. It is generally contemplated that the call market mechanism may contribute to a more orderly market, although it may result in discretionary price shifts. In a *continuous market*, transactions can take place any time during opening hours.

be less continuous if there are few transactions. Market intermediaries in auction systems may also take inventory positions in order to facilitate liquidity (e.g., so-called specialists in widely traded securities). Most trading systems allow participants to submit limit-orders, which generally improve the liquidity. The intermediaries having direct access to the trading systems may cover their costs by charging a commission or they quote bid and ask prices to be paid by the ultimate buyers and sellers.

A distinction is also made between the *primary market*, where new issues are sold, and the *secondary market*, where those who have bought the issues at the primary market can resell them. The secondary market thus provides liquidity to those who have bought the securities.⁷ It is important to understand the reporting requirements of transactions in various markets before trading volumes can be used as a liquidity indicator.

While the paper focuses on measuring a financial market's liquidity, it is important to note that the concept of liquidity is also used to discuss other types of liquidity. A distinction can be made between: (i) asset liquidity; (ii) an asset's market liquidity; (iii) a financial market's liquidity; and (iv) the liquidity of a financial institution. An asset is liquid if it can easily be converted into legal tender, which per definition is fully liquid. Some financial claims, like demand deposits, are virtually perfectly liquid—as long as the credit institution is liquid—since they can be converted without cost or delay into money during normal circumstances, while the transformation of other claims into legal tender may involve brokers' commissions, settlement delays, etc. The emphasis here is on *transaction costs* and *immediacy*. The concept of an asset's market liquidity is broader. It is related to the *ease* with which, in the absence of new information altering an asset's fundamental price, *large volumes* of the asset can be disposed of *quickly* at a *reasonable price*.

A financial market's liquidity depends on the substitutability among the various assets traded in a particular market, and how liquid each of these assets are. If there are different issuers, particularly in the corporate bond markets and equities markets, credit risk can prevent substitutability and result in significant segmentation of the market. In spite of having the same issuer, individual assets may still have different characteristics, such as different maturities in the market for government securities, different voting rights for preference shares, etc. This aggregation problem renders difficult an attempt to apply measures to individual assets with the objective of measuring a market's liquidity.

Institutional liquidity, on the other hand, refers to how easily financial institutions can engage in financial transactions with a view to quickly cover mismatches between their assets and

⁷ It can be organized as an exchange or trading can take place over-the-counter (OTC). Sometimes the term *third market* is used where listed securities are traded OTC. The *fourth market* is where buyers and sellers, usually institutional investors, approach one another directly without any intermediaries. They do it to avoid fees and commissions, but instead they may encounter costs in their search for a counterpart.

liabilities, which may be measured by liquid asset ratios, etc., and to settle their obligations.⁸ The more liquid the assets in its portfolio are and the less liquid the liabilities are, the greater the flexibility in managing asset-liability mismatches and its ability to meet settlement obligations.⁹ Financial institutions' risk management systems increasingly rely on the assumption that their financial assets are liquid.

This paper identifies measures to gauge an asset's market liquidity with a view to assess if a financial market, or at a minimum some of its segments, can be characterized as liquid. With a few exemptions, such as Chordia et al. (2001), who study market liquidity, and Chordia et al. (2002), who analyze the correlation of liquidity measures between markets, most studies have investigated the liquidity of individual financial assets rather than a financial market's liquidity.

The rest of the paper is organized as follows. Section II classifies liquidity measures according to the dimension which they best measure. It also discusses factors that may affect their interpretation and ability to capture a given aspect of liquidity. Issues related to data availability to construct the measures are also briefly discussed. Section III applies the selected liquidity measures to the foreign exchange, money, and capital markets of a selected group of countries. Section IV lists some of the more important qualitative factors to consider when comparing the liquidity measures across markets and countries. Section V notes how liquidity measures during periods of stress may change. Section VI concludes the paper and briefly discusses how the measures presented could be used in the context of the FSAP.

II. SELECTED LIQUIDITY MEASURES

Liquidity measures can be classified into four categories: (i) transaction cost measures that capture *costs* of trading financial assets and trading frictions in secondary markets; (ii) volume-based measures that distinguish liquid markets by the volume of transactions compared to the price variability, primarily to measure *breadth* and *depth*; (iii) equilibrium price-based measures that try to capture orderly movements towards equilibrium prices to mainly measure *resiliency*; and (iv) market-impact measures that attempt to differentiate between price movements due the degree of liquidity from other factors, such as general market conditions or arrival of new information to measure both elements of *resiliency* and *speed of price discovery*. No single measure, however, unequivocally measures tightness, immediacy, depth, breadth, and resiliency.

⁸ Supervisors of financial institutions in low-income countries and emerging markets often require compliance with specific prudential ratios with a view to limiting liquidity risk, while supervisors in high-income countries increasingly rely on financial institutions' own risk-management systems (BIS, 2000).

⁹ Liquidity risk is, in this context, defined as the risk that a counterparty (or participant in a settlement system) will not settle an obligation for full value when due. Liquidity risk does not imply that a counterparty or participant is insolvent, since it may be able to settle the required debit obligations at some unspecified time thereafter.

A. Transaction Cost Measures

A distinction can be made between explicit transaction costs, which relate to expenses such as order processing costs and taxes associated with trades, and implicit transaction (execution) costs. Because bid-ask spreads may capture nearly all of these costs, they are the most commonly used measure of transaction (execution) costs.

In dealer markets, the bid-ask spreads may reflect: (i) order-processing costs; (ii) asymmetric information costs; (iii) inventory-carrying costs; and (iv) oligopolistic market structure costs.¹⁰ Immediacy, for instance, is fostered by the existence of dealers who stand ready to buy and sell specific quantities of a financial instrument at the quoted bid and ask prices. This service entails inventory-carrying costs—depending on the dealers squaring their positions toward the end of the day—which they must recover in addition to their order processing costs. But dealers also incur a risk by standing ready to trade based on asymmetric information. They must charge a premium to compensate for potential losses in providing a continuous market. Such costs are smaller, if there are numerous participants willing to trade with the dealers, and thus revealing their asymmetric information. In addition, since immediacy is bought at a price, the latter is influenced by competition. Thus, a few dealers with oligopolistic power may have higher discretionary fees for immediacy.

High transaction costs reduce the demand for trades and therefore the number of potentially active participants in a market.¹¹ This could also lead to more fragmented markets as many transactions may take place within the market makers' spreads and not necessarily around the equilibrium price, which results in a shallow market. High spreads, or commissions in auction markets, also encourage transactors to seek potential counterparts in a trade outside the market makers' markets; as such trades might be worth the search costs. That is, transactions will take place in the so-called fourth market. In contrast, when transactions costs are small, transactors would prefer to use dealers in auction mechanisms to trade rather than incur direct search costs, including through brokers. This results in transactions that are

¹⁰ Each one of these costs is affected by numerous factors. They range from the trading mechanisms and disclosure of traded prices and quantities, which may affect both the level of information as well as the extent of asymmetric information in the market; inventory costs associated with labor and capital costs; to the clearing and settlement systems which affect order-processing costs and risks (see Section IV).

¹¹ Lower transaction costs, which often are associated with more liquid markets, generally allow more decentralization, diversification, and result in more transactions. These aspects will typically allow more of the various participants' information to be disseminated via the price mechanism. Prices will adjust quicker, ideally also smoother, and, in principle, tend to reduce excessive volatility due to arrival of new information and thus become more resilient. In short, the price vector is to a larger extent a sufficient statistic. Accordingly, lower transaction costs will ideally result in a more efficient resource allocation. However, some may argue that lower transaction costs also increase volatility and overshooting triggered by myopic self-fulfilling expectations, spurious information, or rigidities. Such volatility could be remedied by, for instance, a Tobin tax or trading pauses in case of excessive price changes. It is outside the scope of this paper to further explore this dichotomy, which really depends on the perception of speculation being either stabilizing or destabilizing.

more likely to take place around the equilibrium price of an asset leading to a more unified and deep market.

The reduction in the number of market participants due to high transaction costs also affects breadth and resiliency. Since breadth implies having numerous participants, high transactions costs may lead to thin markets. Similarly, since large transaction costs may deter trades, they reduce resiliency by preventing orders from flowing in promptly to correct order imbalances that tend to move prices away from their fundamental level. In other words, the elasticity of order flows is generally much lower when transaction costs are high. The infrequency of trades is also likely to result in a market with substantial price discontinuities. The effects of high transactions costs go full circle, since a smaller number of participants reduce economies of scale on inventory costs with second round effects on market makers' spreads.

The bid-ask spread can be measured as the absolute difference between bid and ask prices or as a percentage spread (equations 1.1 and 1.2 below). The percentage spread allows taking into account the fact that a given spread would be less costly the higher the prices, and it is easier to compare across markets. Dealers' uncertainty about the equilibrium price also leads to adjustments in their bid and ask prices.

$$(1.1) \quad S = (P_A - P_B) \quad \text{where } P_A \text{ is the ask price and } P_B \text{ the bid price} \quad \text{or}$$

$$(1.2) \quad S = (P_A - P_B) / ((P_A + P_B) / 2)$$

The bid-ask spread of the market is generally calculated using the highest bid and lowest ask prices in the market for a reference period, or in practice the most recent quotation. However, if there are several bid and ask prices available from different dealers and particularly if they are not obligated to trade at the quoted prices, consideration should be given to ignoring the most extreme outliers. This market spread should be distinguished from individual dealers' spreads.

Other variants of the bid-ask spread can be calculated. Equations 1.1 and 1.2 above are calculated using quoted bid and ask prices. The bid-ask spread is sometimes calculated using weighted averages of actually executed trades over a period of time, since trades may not take place at quoted prices. In that case, the spread is called a *realized spread*.

In addition to the spread itself, the trade-size at which a dealer is committed to trade at quoted prices is also a useful indicator. All other things equal, the larger the trades that can be conducted at a quoted spread, the more depth and breadth the market has, but a large trade-size may also reduce the willingness to quote prices.¹²

¹² In Japan, for instance, it was found that the turnover increased significantly after the trade-size was reduced in the government securities markets.

Although not widespread, some of the high frequency databases now available occasionally include both bid and ask prices on a daily basis. However, both within the day, during the week and month, there may be patterns to take into account, thus monthly averages may not necessarily provide good indications of changes in the spread. Furthermore, on days when new important news are announced, the time it takes for the widened spread to reach “normal” levels can be an important indicator of resiliency.¹³ The financial asset with the shortest adjustment period is the most resilient.

B. Volume-Based Measures

Volume-based measures are most useful in measuring breadth (the existence of both numerous and large orders in volume with minimal transaction price impact). Markets that are deep tend to foster breadth since large orders can be divided into several smaller orders to minimize the impact on transaction prices.

Large numbers of trades are a valuable source of information for transactors and particularly dealers. They obtain information from order flows, and imbalances in this order flow give them information about the accuracy of their quoted prices. Changes in these quoted prices trigger balancing order flows, which would counter price movements that are not warranted by fundamentals (resiliency). This process allows dealers to have a continuous information source as to whether price changes are permanent or transitory. When markets lack breadth and depth, the absence of the continuous information source provided by numerous and frequent trades may result in price discontinuities and uncertainty about equilibrium prices. Even when there is uncertainty about equilibrium prices, but numerous orders from both the selling and buying sides of the market exist, transactors, and particularly dealers, may be able to execute orders without having to take risky inventory positions. Trading can also be enhanced if market makers can easily identify potential buyers and sellers, such as institutional investors with large portfolios.

Uncertainty about equilibrium prices may not, however, be a necessary outcome of a lack of breadth (orders are numerous and large in volume), and depth (wide range of orders), or higher transactions costs in a given market. Market participants may also infer equilibrium prices from the market of close substitutes, where price information is more complete. Thus, the existence of a deep and broad market for a close substitute may compensate for thinness, since they allow market makers to hedge position imbalances without waiting for balancing

¹³ Fleming and Remolona (1999), for instance, find an intraday trading pattern in the U.S. treasury market in the event of announcement of new information. Based on data from 250 trading days focusing on on-the-run issues, they find that “major macroeconomic announcements induces a sharp and nearly instantaneous price changes with a reduction in trading volume...” and “the bid-ask spread widens dramatically at announcement ...” The price volatility as well as the trading volume is highest early in the morning, as is the bid-ask spread, which apparently reflects that new information arrives during the night.

orders.¹⁴ However, many players have learned the hard way that assets perceived as being close substitutes may not turn out to be so in practice.

Trading volume is traditionally used to measure the existence of numerous market participants and transactions. The trading volume can be given more meaning by relating it to the outstanding volume of the asset being considered. The resulting turnover rate (equations 2.1 and 2.2 below) gives an indication of the number of times the outstanding volume of the asset changes hands.

$$(2.1) \quad V = \sum P_i \times Q_i \quad \text{where } V \text{ is dollar volume traded.}$$

P_i and Q_i are prices and quantities of the i trade during a specified period

$$(2.2) \quad Tn = V / (S * P) \quad \text{where } Tn \text{ is turnover rate.}$$

V is as defined in (2.1).
 S is the outstanding stock of the asset
 P is the average price of the i trades in (2.1).

While it is relatively easy to estimate turnover rates in exchange traded securities markets, it is more difficult to choose an appropriate basis against which to measure turnover rates in the typical OTC foreign exchange and money markets. In the latter cases, provided data are available, the absolute trading volume and the number of transactions, and thus the average trade size, may be better measures of the existence of numerous and large trades, that is, dimensions of market breadth.

Finally, the trading volume may shift significantly both during the day, week, and month depending on trading patterns, for instance around announcement of new information important for the pertinent asset. The volatility of the turnover should thus also be taken into consideration.

The Hui-Heubel Liquidity Ratio (equation 2.3 below), originally applied to the equity market, attempts to capture the other dimension of market breadth, which relates the volumes of trades to their impact on prices, and thus also to resiliency.

¹⁴ Garbade (1982, p. 500), for instance, notes that “[M]any investors, for example, view Treasury bills, short-term federal agency issues, bank CDs, and commercial paper as close substitutes.... However, ... yield premiums are fairly stable over short intervals of time, such as a few days and sometimes even weeks. Even though the markets in commercial paper, agency debts, and bank CDs are thinner than the market in Treasury bills, dealers in commercial paper, agency debt, and bank CDs do not suffer from a severe inability to estimate changes in equilibrium prices in their markets”.

The L_{HH} can be calculated as an average of the 5-day periods in a sample (e.g., 3 months) to smooth volatility. Subject to data availability, the ratio could also be calculated on a daily basis to capture very short-term price movements. The lower the L_{HH} , the higher the liquidity of the asset. To be specific about the dimension of liquidity being captured, we would say that the market has more breadth when the L_{HH} is low.

$$(2.3) \quad L_{hh} = \frac{[(P_{\max} - P_{\min}) / P_{\min}]}{[V / (S * \bar{P})]}$$

P_{\max} = highest daily price over last 5 days

P_{\min} = lowest daily price over last 5 days

V = total dollar volume traded last 5 days

S = number of instruments outstanding

\bar{P} = average closing price of the instrument over a 5-day period

The numerator in L_{HH} can simply be measured as the percentage change in the price of the asset over the 5 day period chosen. If those prices are not available, bid-ask prices could be used as a proxy to calculate the ratio, but then the information content also changes somewhat.

Conventional liquidity measures relate this price change to the simple volume traded in the denominator (V). The Hui-Heubel's liquidity ratio uses in the denominator the ratio of the traded volume to the outstanding volume of the asset (essentially the turnover rate).¹⁵ Depending on data availability, other measures of trading volume can be used in the denominator (e.g., number of securities traded). Liquidity ratios in general can also be expressed in terms of the value or number of units traded in the numerator to the percent change for a given period interval. In this case, the market has more breadth, the larger the number of trades to the percentage price change.

It can be argued that the impact of trading a large volume of an asset on price depends on whether the volume traded is a high proportion of the volume of the asset held in the market, which the Hui-Heubel measure would capture. Thus, if buyers or sellers suddenly want to trade a high proportion of the outstanding volume of an asset, a significant price change could occur because those trades may be indications that new information arrived in the market. The price movement should therefore not be assimilated with illiquidity. As a result, one of the criticisms of these liquidity ratios is the fact that the relationship between price movements and volumes is not proportional. In using the ratio to predict future relationships

¹⁵ The Hui-Heubel measure thus encompasses other volume based liquidity measures that capture price movements in relation to volumes traded only (e.g., conventional liquidity measures like the Martin-Index; see Baker, 1996, for a fuller discussion).

between the two variables, one may overestimate price changes on large volumes and underestimate them on small volumes. Furthermore, there is no distinction between transitory and permanent price changes.

C. Price-Based Measures

Bernstein (1987) noted that “measures of liquidity when no information is hitting a stock must be more relevant than measures of liquidity when new information leads to new equilibrium values...thus unrefined measures of liquidity may be nothing more than some kind of weighted average reflecting the frequency with which new information hits one stock as compared with another.” Ideally, there is thus a need for an underlying structural model to identify the equilibrium price, but given the difficulty in determining whether new information is indeed affecting the price of an instrument, Hasbrouck and Schwartz (1988) proposed the market efficiency coefficient to distinguish short-term from long-term price changes.

The Market-Efficiency Coefficient (MEC) exploits the fact that price movements are more continuous in liquid markets, even if new information is affecting equilibrium prices (equation 3.1 below). Thus for a given permanent price change, the transitory changes to that price should be minimal in resilient markets.

$$(3.1) \quad MEC = Var (R_t) / (T * Var (r_t))$$

$Var (R_t)$ = variance of the logarithm of long-period returns¹⁶

$Var (r_t)$ = variance of the logarithm of short-period returns

T = number of short periods in each longer period

The ratio would tend to be closer but slightly below one in more resilient markets, since a minimum of short term volatility should be expected. Indeed, prices of assets with low market resiliency may exhibit greater volatility (more transitory changes) between periods in which their equilibrium price is changing. Factors that foster excessive short-period volatility (overshooting) result in an MEC substantially below one. These factors include price rounding, spreads, and inaccurate price discovery. On the other hand, Bernstein (1987, p. 12) notes that factors such as market maker intervention, and inaccurate price determination

¹⁶ Logarithm returns are used to normalize variances and facilitate comparability, since returns and therefore variances could vary substantially between periods. The MEC can be calculated for sample periods (e.g., 30 days on a moving average basis).

Example: $[Var \ln(p_5/p_1)/T] / [Var \ln(p_5/p_4 * p_4/p_3 * p_3/p_2 * p_2/p_1)]$ where p_i denotes the price of the asset at period i and \ln denotes a logarithm to express price ratios as logarithm returns. Thus, for a sample period of 30 days, 5 day returns, daily returns, and their corresponding variances can be calculated to derive one MEC figure. Then, on a moving average basis (29 previous observations + 1 day, etc...) additional MEC values can be obtained for the available sample (e.g., one or several years).

involving partial adjustment to news, cause prices to adjust in relatively small, and positively correlated increments. This would dampen short-period price volatility relative to longer-period price volatility, and may cause the MECs to be above one.

Low price volatility, when a new equilibrium is being established, is also related to the concept of *orderly* markets.¹⁷ Orderly and resilient markets provide for greater price continuity, which is a desirable feature of liquid markets. It should however be noted that discontinuity in price movements in order to reach a new equilibrium price warranted by new information is a feature of information efficient markets.¹⁸ The MEC should not render an unfavorable verdict on liquidity and resiliency if it is calculated over a given period in which the equilibrium price changed discretely in response to new information and then stabilized quickly.

Indeed, it can be questioned if price continuity is synonymous to resiliency. Recall that resiliency is a characteristic of markets in which new orders flow quickly to correct order imbalances that tend to move prices away from what is warranted by fundamentals. In practice there may ex ante be quite a range of views, including by the central bank, on what is warranted by fundamentals, which ex post may turn out to be quite different. A dealer or day-trader, for example, wanting to square her positions toward the end of the day has a different time horizon than a transactor having a medium-term horizon in mind. Whatever the case may be, if market participants are mostly on one side of the market because of new fundamentals, the resulting order imbalance should lead to a price change. If pressures for a price change are countered by new orders flowing in, the phenomenon may produce more price continuity, but this price continuity should not be associated with market resiliency. It would rather be associated with an orderly market and possibly an information inefficient market. In this case, the MEC may be greater than one (as noted above), because the volatility over the long period could be higher than that of the shorter periods.

It is important to note that a market can become one sided and lead to a significant price change although unjustified by fundamentals. In this case, even if market makers are able to determine the equilibrium price of an asset based on fundamentals, cash and regulatory constraints (e.g., leverage limits) may prevent them from absorbing an order imbalance

¹⁷ Bernstein (1987, page 56): "An orderly market is one in which prices change smoothly rather than discontinuously. ... A fair market is one that helps to assure equilibrium prices by creating condition in which everyone has an equal opportunity to trade, both in terms of time and in terms of available information." Please note that lack of continuity may also be a feature of call auction markets where trading does not take place continuously.

¹⁸ For a discussion of information efficient markets see, for instance, Fama (1970 and 1991). A distinction is made between: (i) *weak efficiency*, where the market price includes all the information contained in historical prices; (ii) *semi-strong efficiency*, where the market price includes, in addition to information in historical prices, other published relevant information; and (iii) *strong efficiency*, where the market price reveals all pertinent information.

without a significant price change. Resiliency is thus lost, and liquidity evaporates in all its dimensions.¹⁹

The latter type of lost market liquidity should be distinguished from the one the paper has discussed so far. Wood and Wood (1985, p. 165-66) insightfully note that “even U.S. government securities are illiquid in the presence of widespread shortage of cash...General scramble for cash, or panic, leads to precipitate price falls...[in this case], nothing except cash is liquid.” They, like Keynes, also point out that liquidity perceived by an individual transactor is always greater than the liquidity if fully exploited by all transactors. If dealers are able to determine the equilibrium price of an asset, a single seller should not have difficulty selling that asset if she is acting more or less independently. On the other hand, if dealers are able to determine the correct price of an asset, but everyone else is selling, market liquidity is lacking. In the latter case, it is the perfectly liquid assets against which other assets’ liquidity are compared—namely cash—that is missing. Temporary injection of liquidity—cash—to support willingness to take open positions could in this case help market resiliency.²⁰

Trading systems in which trading in a financial instrument is stopped when order imbalances are high (so-called circuit breakers) tend to reduce price continuity. Circuit breakers do so by allowing prices to move discretely after the pause in trading. The pause in trading may be needed because the orderly movement of prices associated with price continuity, may prevent a discrete price movement to a new equilibrium price (Bernstein, 1987). Many market commentators, however, have mixed views on the merit of circuit breakers. However, the halting of trades may be needed to foster fair markets by allowing all market participants to attempt to determine whether fundamentally new information has altered an asset’s equilibrium price. In this case, one would say that the market has temporarily lost price continuity. However, when trading resumes at a new price among informed traders, the market may still be qualified as liquid by the definition given in the introduction of the paper. In other words, traders neutralizing small price deviations may no longer be around to help provide depth and breadth, but the market may still be liquid and resilient thanks to more informed traders, as the new information has already been absorbed. The MEC

¹⁹ Uncertainty about the value of an asset is part of the fundamentals, which should guide the estimated price, and may cause a one-sided market, although the estimated price may ex post turn out to be incorrect.

²⁰ Grossman and Miller (1988, p. 633) pointed out that during the stock market crash of 1987 “the Federal Reserve System was directly and indirectly encouraging banks to support dealer inventory positions... these infusions of buying power had pushed prices nearly back to their levels before the collapse and substantial market-making capacity was back in place.” Furthermore, the disaster at the World Trade Center (WTC) on September 11, 2001, affected a major telephone switch, and the primary and secondary sites of the largest clearer of government securities, which all were located close to the WTC. Discrepancies during the reconciliation of transactions in government securities increased significantly. The Federal Reserve Bank of New York injected additional liquidity (overnight lending reached a peak of US\$81 billion on September 14); settlement was extended from T+1 to T+5 in some cases; and opening hours of Fedwire were extended, which helped prevent systemic problems.

calculated over a long period covering a significant discrete price change may thus still be an appropriate measure of resiliency. However, it may not be true for all types of markets. Some argue that markets that are quote-driven generally provide more price continuity than markets that are order and call-driven, although it is debatable.

In addition to the MEC, vector auto regression econometric techniques, like impulse response functions, are also used to uncover the fact that the price discovery process is more timely and complete in liquid markets. Vector auto regression lags of price adjustments are shorter in liquid markets. As with other econometric techniques discussed below, operational ease argues against their use.

D. Market-Impact Measures

As noted above, liquidity ratios, such as the L_{HH} , generally do not distinguish between transitory price changes from permanent ones warranted by new information. When new information becomes available in the market, even small transaction volumes could be associated with large price movements. For instance, new information triggering a financial crisis may not result in large turnovers because transactors, as long as they are not cash constrained, may prefer to wait and see. To better capture the price movement mainly due to large volumes, i.e. breadth, the price movements due to significant new information should ideally be extracted.

A distinction is often made in the equity markets between systematic and unsystematic risk based on the capital asset pricing model (CAPM), which also provides an avenue to extract market movements (equation 4.1 and 4.2 below). The systematic effect relates to a risk that cannot be diversified because it affects all securities in a systematic fashion. The degree of this effect is called the "beta of the stock" to refer to the regression coefficient of a stock's return on that of the market. The higher the "beta," the higher the systematic risk of that stock. The unsystematic risk is the risk that is specific to the stock in question, once the market risk is removed. Hui and Heubel, using this approach, suggested calculating the Market-Adjusted Liquidity for equities.

$$(4.1) \quad R_i = \alpha + \beta R_m + u_i \quad \text{where}$$

R_i = daily return on the i th stock

R_m = daily market return (e.g., S&P index)

β = regression coefficient, represents systematic risk

u_i = regression residuals or specific risk.

The regression residual is then used to relate its variance to the volume traded:

$$(4.2) \quad u_i^2 = \gamma_1 + \gamma_2 V_i + e_i$$

u_i^2 = squared residuals from equation 4.1
 V_i = daily percentage change in dollar volume traded
 e_i = equation 4.2 residuals.

The market-adjusted liquidity uses the residual of a regression of the asset's return on the return of the market (thus purging it from its systematic risk) to determine the intrinsic liquidity of the asset.

The smaller γ_2 in equation 4.2 (above), the smaller is the impact of trading volume on the variability of the assets' price and therefore, the assets is more liquid. It should be noted that the lower the coefficient, the more breadth the market has. Note that the residuals of equation 4.1 could also have been used to calculate the L_{HH} discussed in the previous section.

It is also possible to distinguish between the market impact, that is the change in the zero-coupon yield curve, and the liquidity premium of government bonds. The main differences among government bonds are typically their maturity and their type (bullet bonds, serial bonds, etc.). Zero-coupon yield curves can be estimated to, ideally, better take into account the different timing of interest and principal.²¹ Based on these yield curves, it is possible to estimate the liquidity premium of a particular bond, as the difference between the market price of the bond and the estimated price using the zero-coupon yield curve. In practice, however, the spread between benchmark government bond and a government security with roughly the same duration, but traded less, is often used as a proxy for the liquidity premium. In the case of corporate bonds, the spread between the corporate bond and the benchmark government security reflects both the difference in credit risk and a liquidity premium.

Newer research using high frequency data and a combination of macroeconomic models and microstructure models, like order flows (Evans and Lyons, 2002) or news impact (Melvin and Yin, 2000), reportedly do produce exchange rate forecasts outperforming random walks. The difference in part reflects the market's liquidity (Galati and Ho, 2001). Foreign exchange markets are generally perceived as some of the most information efficient markets, in part because macroeconomic models using monthly data, rarely have outperformed random walk models.

Other econometric techniques

Other econometric techniques are used in some liquidity studies to separate the impact of anticipated trading volumes from those that are unanticipated and which may carry new information. The expected volumes are usually estimated by fitting an auto regressive moving average (ARMA) model of volumes traded. Actual volumes which deviate from the expected volumes as forecasted by the ARMA model are considered unexpected events, which are associated with new information flowing into the market. This distinction is used to explain the size of dealers' spreads. Thus, high expected volumes of trades reduce the dealers' spreads on account, for instance, of the economies of scale in their inventory costs discussed in section A. Unexpected volumes, however, will increase dealers' spreads by

²¹ See, for instance, Alonso et al. (1999) for an illustration of how to estimate liquidity premiums of individual government securities using a zero-coupon yield curve.

increasing the uncertainty premium associated with their trading on potentially asymmetric information.

More sophisticated econometric techniques are also used to take account of the fact that once price volatility starts, it will take some time for all market participants to come to agreement on equilibrium prices. This results in volatility persistence, which can be captured by autoregressive conditional heteroskedasticity (ARCH) and generalized autoregressive conditional heteroskedasticity (GARCH) type models. These models simply say that a given period volatility is dependent on the volatilities of previous periods.²²

Although more advanced econometric techniques have analytic appeal, they are not very operational. The computational burden may outweigh the benefits. Operationally, to make a statement about market breadth, it may be easier to analyze trading volumes and price volatility patterns over a long period using simple liquidity ratios such as the L_{HH} and turnover figures. In doing so, one should keep in mind that the inferences that would be made regarding statistical relationships between price volatility and volume would be less precise, although general trends could be uncovered. Price-based measures, which were discussed in the previous subsection, attempt to make a statement about the degree of an asset's liquidity by directly analyzing its price volatility. These measures avoid the issue of determining whether price movements are due to new information arriving in markets, thus they may actually be better measures of market resiliency.

III. APPLICATION OF LIQUIDITY MEASURES

This section analyzes various dimensions of liquidity in the foreign exchange, money, bond, and equity markets of a selected group of countries. While all measures cannot be applied in all markets because of lack of data (summarized in Box 2), several measures can be applied to compare the liquidity of different segments of a market, between markets, and between markets in different countries. Most of the data used in this section are publicly available information in the Bloomberg information system. The prices, however, are not firm, but merely indicative, and consequently we do not know how accurate they are. Additional data are typically available in central bank bulletins, publications issued by stock exchanges, dealer associations, etc.²³ Nevertheless, when these liquidity measures are used in the context of an FSAP, it is often necessary to request additional data from the authorities, particularly to ensure access to daily observations and volume figures.²⁴ Finally, there are several factors to keep in mind when applying the measures, as discussed in Section IV.

²² Campbell et al. (1997) provide an application of some of these techniques.

²³ The Japan Securities Dealers Association, for instance, issues an annual *Fact Book*, which provides useful information on the Japanese capital markets.

²⁴ See Appendix I for a stylized example of a data request to assess the liquidity in selected financial markets. In addition to the data, FSAP missions will ask market participants about their perception of market liquidity.

Box 2. Liquidity Measures and Data Availability

Measures	Typically OTC Markets		Typically Exchange Traded Markets ^{1/}	
	Foreign exchange Markets	Money Markets	Bond Markets	Equity Markets
Bid-ask spreads (mainly <i>tightness</i> supported by <i>breadth</i> and <i>depth</i>)	+++ data readily available	++ data available for selected instruments and maturities	+ data available for selected maturities or derivatives only	+ data available for individual securities and index derivatives only
Turnover ratios (mainly <i>breadth</i> supported by <i>depth</i> and <i>tightness</i>)	+ volume data rarely available, lack of denominator	+ data available for selected maturities, lack of denominator	+++ data often available for the market and individual securities	+++ data often available for the market and individual securities
Market-Efficiency Coefficient (MEC) (mainly <i>resiliency</i> supported by <i>faster price discovery</i> and <i>depth</i>)	+++ data readily available	+++ data available for selected maturities	++ data available for benchmarks and selected indexes	++ data available for individual securities and market indexes

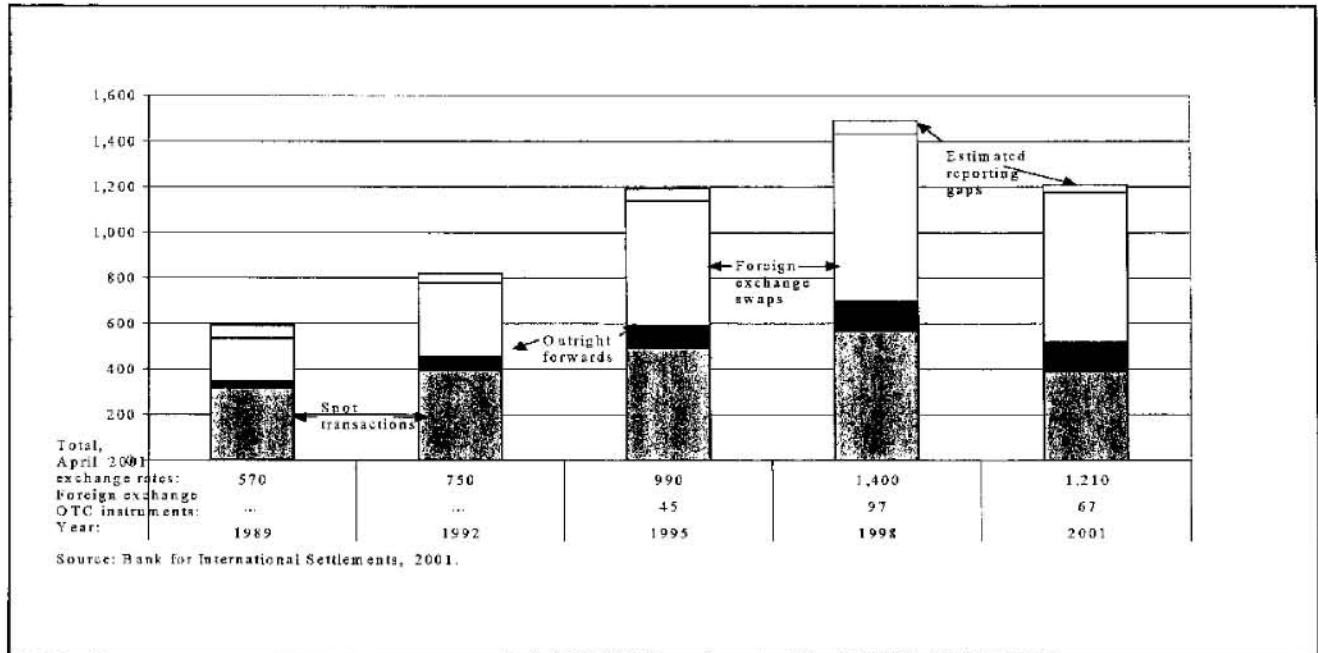
^{1/} In some securities markets, dealers account for a significant share of the turnover of listed securities. Bonds, for instance, are traded OTC in many markets.

A. Foreign Exchange Markets

Foreign exchange markets are generally perceived as some of the most liquid and information efficient markets, in part because it is a relatively homogeneous product and the daily turnover is significant. The Bank for International Settlements (BIS) conducts a survey in April every third year, and estimated that in 2001 the *daily average foreign exchange turnover* (i.e., spot, outright forwards, and foreign exchange swaps) in 48 countries, covering 2,772 banks, amounted to around US\$1,210 billion, while the daily average turnover in OTC instruments amounted to US\$67 billion (Figure 1). These figures are adjusted for double counting of local and cross-border interdealer transactions but include BIS' estimations for reporting gaps. They are also adjusted for exchange rate developments during the period from 1989 to 2001. The decline in turnover from the survey in 1998 to 2001 should, according to the BIS, be seen in context of the introduction of the euro; the increased use of electronic broking, particularly in the spot markets; the consolidation in the banking industry; and, according to anecdotal information, the reduced activity of hedge funds. Most of the trading takes place vis-à-vis the U.S. dollar.²⁵

²⁵ In 2001, euro-U.S. dollar trading accounted for about 30 percent of the turnover, Japanese yen-U.S. dollar for about 20 percent, and pound sterling-U.S. dollar for 11 percent.

Figure 1. Global Foreign Exchange Market Turnover, 1989–2001
Daily averages in April (billions of U.S. dollars)



Except for such surveys, relatively few central banks do regularly publish information about the turnover in their respective foreign exchange markets. In addition, the lack of a proper base for the outstanding value of foreign exchange (K) prevents the calculation of liquidity ratios such as the Hui-Heubel ratio— $(\% \Delta P) / (V/K)$.²⁶ As a result, most liquidity measures for the foreign exchange markets focuses on bid-ask spreads (Tables 1 and 2) and exchange rate volatility used in the MEC.

Table 2 shows the bid-ask spreads in basis points for a selected group of countries during the period 1996–2000. The data shows that Canada has the market with the lowest transactions costs as measured by the bid-ask spreads. The spread has also remained fairly unchanged throughout the sample period. In comparison to the other countries, the Canadian foreign exchange market with lower transaction costs can thus be characterized as more favorable to market depth. This, however, depends on the degree of the accuracy of the information source. Accordingly, country and market comparisons can be misleading.

²⁶ A proxy for K (i.e., market capitalization in the equity market) could, for instance, be: (i) the sum of exports, imports, and capital transactions, depending on the degree of capital account liberalization; or (ii) the level of central bank reserves, perhaps including short-term net foreign assets of the banking system. In an environment with free capital movements, the potential transactions are almost infinite. Regarding the turnover, the turnover at organized futures exchanges, which often is published, could be used as a proxy.

Table 1. Average Bid-Offer Spreads of Spot and Forwards, October 11, 2001^{1/}

	Currency	Spot	1-month	2-month	3-month	6-month	9-month	1-year
(percent of price, basis points)								
China	CNY	0	3	4	4	6	7	8
Hong Kong SAR	HKD	1	2	2	2	2	3	3
Indonesia	IDR	43	130	139	164	231	303	371
India	INR	4	27	30	30	40	54	67
Korea	KRW	3	9	9	9	9	9	9
Philippines	PHP	8	22	24	25	34	46	57
Singapore	SGD	5	8	8	9	10	12	14
Thailand	THB	16	26	32	35	42	57	77
Taiwan Province of China	TWD	3	10	12	12	14	15	16
Argentina	ARS	2	35	55	59	300	329	181
Brazil	BRL	6	20	29	36	40	46	44
Chile	CLP	5	9	13	18	25	36	47
Colombia	COP	7	25	35	47	83	104	121
Mexico	MXN	14	16	17	18	23	22	24
Peru	PEN	2	13	24	31	55	89	101
Venezuela	VEB	13	73	135	182	261	360	429
Czech Republic	CZK	5	7	7	7	9	10	11
Hungary	HUF	2	6	10	13	20	28	32
Poland	PLN	8	10	11	12	14	17	17
Slovakia	SKK	5	8	10	12	19	25	32
Israel	ILS	27	29	31	32	36	43	43
Saudi Arabia	SAR	2	3	4	5	6	8	8
Turkey	TRL	86	289	467	621	988	1255	1447
South Africa	ZAR	10	13	14	15	20	21	24

Source: *Currency Forward Liquidity Statistics* provided by SalomonSmithBarney.

1/ Bear in mind that the spreads on one particular day of one dealer is only indicative and may deviate significantly from the average spreads over a longer period based on quotations from several dealers.

Other countries show more variability in their bid-ask spreads during the sample period. There also seem to be some correlation around the Asian crises in late 1997 and the Russian crisis in August 1998. Countries such as Mexico and South Africa show declining spreads since 1998. Korea, on the other hand, shows deterioration after 1998. This deterioration probably reflects the effect of exchange rate flexibility since foreign exchange risk is part of the transaction costs implicit in the bid-ask spreads. This also helps explain the increase in bid-ask spreads in Malaysia during the 1998 period (Figure 1 in Appendix II).

However, while Malaysia's bid-ask spreads have decreased with the return to an exchange rate peg, the MEC values in Table 3 show that resiliency seems to have deteriorated.²⁷ This deterioration is consistent with the fact that the lower bid-ask spreads have become more volatile in the short run.

²⁷ In Table 3, the exchange rate used to calculate the MEC is the mid-point between the ask and bid exchange rates. This allows calculating the MEC even in periods of fixed exchange rates.

Table 2. Bid-Ask Spreads (basis points^{1/2}): Foreign Exchange Markets

	1986				1987				1988				1989				2000				
	Avg	Q1	Q2	Q3	Q4	Avg	Q1	Q2	Q3	Q4	Avg	Q1	Q2	Q3	Q4	Avg	Q1	Q2	Q3	Q4	
Canada	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Australia	0.07	0.07	0.06	0.06	0.06	0.07	0.07	0.06	0.06	0.06	0.09	0.10	0.09	0.08	0.09	0.08	0.08	0.08	0.09	0.09	0.11
Mexico	0.23	0.34	0.27	0.20	0.14	0.18	0.15	0.13	0.13	0.32	0.22	0.22	0.28	0.23	0.14	0.16	0.21	0.17	0.14	0.13	0.11
Korea	0.03	0.00	0.00	0.00	0.11	-0.02	0.00	0.00	0.00	-0.08	0.04	0.07	0.06	0.02	0.00	0.10	0.07	0.08	0.16	0.07	0.17
Singapore	0.08	0.08	0.09	0.08	0.09	0.07	0.07	0.06	0.06	0.08	0.12	0.16	0.13	0.10	0.09	0.05	0.06	0.05	0.05	0.05	0.04
Malaysia	0.06	0.08	0.05	0.05	0.06	0.08	0.04	0.04	0.11	0.15	0.36	0.48	0.40	0.46	0.07	0.08	0.11	0.04	0.04	0.13	0.02
South Africa	0.23	0.20	0.37	0.14	0.24	0.12	0.16	0.11	0.09	0.09	0.19	0.08	0.10	0.27	0.30	0.12	0.20	0.11	0.10	0.08	0.10
Indonesia	-0.03	0.01	0.01	-0.17	0.01	0.13	0.04	0.07	0.18	0.23	2.38	2.65	2.26	2.49	1.93	0.86	1.07	0.90	0.73	0.73	0.54
%AP	0.10	0.12	0.07	0.14	0.06	1.08	0.08	0.10	1.17	2.92	3.04	5.02	3.06	2.00	2.14	1.29	1.48	1.05	1.50	1.15	0.64
V	...	...	...	...	...	7.7E+03	8.3E+03	9.1E+03	8.0E+03	5.2E+03	1.3E+03	1.8E+03	1.4E+03	1.1E+03	8.8E+02	1.1E+03	8.7E+02	1.2E+03	1.3E+03	1.1E+03	1.4E+03
%APV	...	...	...	...	...	7.6E-04	1.2E-05	1.0E-04	2.2E-04	2.7E-03	2.1E-03	2.3E-03	1.8E-03	2.5E-03	1.8E-03	9.9E-04	9.0E-04	1.1E-03	1.2E-03	7.3E-04	5.7E-04

1/ Unless otherwise indicated
 %AP Absolute value of daily percent changes in the exchange rate
 V Value of monthly foreign exchange transactions
 %APV Liquidity Ratio (Ratio of percent changes to the value of transactions)

Source: Bloomberg.

Table 3. Market Efficiency Coefficients: Foreign Exchange Markets

	1996					1997					1998					1999					2000				
	Avg	Q1	Q2	Q3	Q4	Avg	Q1	Q2	Q3	Q4	Avg	Q1	Q2	Q3	Q4	Avg	Q1	Q2	Q3	Q4	Avg	Q1	Q2	Q3	Q4
Canada	0.74 (0.27)	0.77	0.65	0.66	0.91	0.90	0.92	0.89	0.92	0.86	0.86	1.05	0.69	0.78	0.92	0.91	1.27	0.82	0.62	0.94	0.86	0.70	1.07	0.98	0.67
Australia	0.77 (0.23)	0.71	0.66	0.87	0.81	0.73	0.67	0.63	0.84	0.76	0.79	0.61	0.50	1.10	0.92	0.99	1.44	0.96	0.84	0.75	0.71	0.71	0.64	0.87	0.64
Mexico	0.95 (0.39)	0.80	1.04	0.93	0.99	0.70	0.73	0.92	0.52	0.62	0.63	0.63	0.54	0.56	0.77	0.99	0.91	1.18	0.72	1.14	0.84	0.74	0.85	1.05	0.72
Korea	0.86 (0.41)	0.93	0.91	0.78	0.85	0.50	0.73	0.44	0.22	0.61	0.94	0.80	0.96	1.07	0.93	0.88	0.98	0.83	0.87	0.84	0.81	0.54	0.92	0.68	1.08
Singapore	0.64 (0.25)	0.30	0.91	0.66	0.59	0.63	0.51	0.66	0.76	0.60	0.88	0.84	0.99	0.71	0.97	0.74	0.53	0.97	0.54	0.91	1.01	0.77	1.15	1.07	1.05
Malaysia	0.71 (0.28)	0.43	0.67	0.67	0.96	0.95	0.83	0.70	1.02	1.25	0.91	1.10	0.68	0.69	0.77	0.35	0.22	0.35	0.50	0.31	0.22	0.19	0.23	0.18	0.28
Indonesia	0.71 (0.62)	0.61	0.65	0.49	1.04	0.88	0.54	0.70	1.02	1.22	1.03	0.89	0.95	1.14	1.15	0.91	0.64	0.81	0.89	1.20	0.74	0.63	0.98	0.88	0.48
South Africa	0.86 (0.36)	1.13	0.64	0.86	0.89	0.85	0.92	0.77	0.82	0.90	0.82	0.93	0.79	0.63	0.95	0.85	0.69	0.98	0.86	0.88	0.80	0.84	0.74	0.76	0.85

*Figures in parentheses are standard errors

Source: Bloomberg.

The MEC figures in Table 3 are mostly below one, as expected, with some cases of marked deterioration in resiliency such as Korea during 1997. The MEC for Korea averaged 0.50 in 1997, when the exchange rate moved from W 900 per US\$1 in August 1997 to over W1,600 per US\$1 by December 1997. This period was preceded by significant decreases in resiliency from the first to the third quarter of 1997, when the MEC reached its lowest value of 0.22 from 0.85 in the last quarter of 1996. The very low MEC suggests inadequate price discovery during this period leading to excessive short-term exchange rate volatility. The excessive short-term volatility, in turn, may reflect the lack of resiliency or orders quickly flowing in to correct imbalances that tend to move prices away from equilibrium, in part due to uncertainty regarding fundamentals.

Indonesia also experienced a sharp exchange rate adjustment in late 1997, but in contrast to Korea, the MEC values increased throughout 1997, from 0.54 in the first quarter to 1.22 in the last quarter. As noted earlier, large MEC values reflect dampening effects on short-term price movements (e.g., foreign exchange market intervention, or inaccurate price determination), which lead to correlated but low short-term price volatility. This results in longer-term volatility being larger than short-term volatility and thus MEC values larger than one. A large MEC may therefore be a leading indicator of an adjustment in the equilibrium price gradually taking place.

In sum, during the financial crises in 1997, in both Korea and Indonesia, significantly low or high MEC values seem to have preceded large exchange rate adjustments. This pattern can be contrasted with that observed in South Africa, where MEC values have consistently been around 0.80 and the exchange rate seems to have depreciated smoothly since 1995, which may in part reflect a freely floating exchange rate policy (Figure 1, Appendix II).

In Indonesia, the volume data of monthly foreign exchange transactions show that the value of foreign exchange transactions (V) has greatly decreased since 1997 (Figure 5 in Appendix II), but the conventional liquidity ratio ($|\% \Delta P|/V$) has improved significantly over the same period. This in part reflects reduced exchange rate volatility from 1997 to 2000 ($|\% \Delta P|$ and Figure 2 for Indonesia in Appendix II). This evidence suggests increased depth, which also is suggested by the bid-ask spreads that have decreased steadily from 1997 to 2000 (Figure 4 for Indonesia in Appendix II).

B. Money Markets

The money market consists of a number of different financial instruments with maturities up to one year. They typically include: (i) unsecured deposits/loans, which may be affected by credit risk; (ii) secured deposits/loans in form of repurchase agreements (where ownership changes) or with a collateral agreement (pledging); (iii) foreign exchange swaps; (iv) short-term central bank bills; (v) short-term government securities (treasury bills); and (vi) commercial paper. Derivatives, such as forward rate agreements (FRA), futures, and options may also be traded in the money market. Most of these instruments are standardized, but nonstandard instruments may be traded as well, like foreign exchange swaps with unusual maturities, etc. The central bank typically intervenes in the most "liquid" segments

of the money market with a view to influence the liquidity—reserve—conditions in the banking system or to observe an interest rate target in countries with well-developed financial markets and high degree of capital mobility. In addition to different instruments, there may also be different markets, for instance an electronic organized money market and an OTC market. Although arbitrage should reduce price differences among the various segments and markets to primarily reflect credit risk and the maturity structure, there may be significant market frictions.

Turnover figures are important, since they provide information about the composition of the money market and thus which segments better reveal the degree of liquidity in the money market. Central banks typically collect such information, but often daily information is not published. In small open economies without restrictions on capital movements, the foreign exchange market can indirectly be an important part of the money market. In the case of Denmark, for instance, foreign exchange swaps account for about 45 percent of the money market transactions. In addition to the absolute turnover, the volatility of the turnover is also important. It reflects a number of country specific issues, like averaging of required reserves, the location of the central government's deposits, and the functioning of the payment system.²⁸ In many countries, however, only money market rates and occasionally bid-ask spreads are readily available.

Table 4 shows quarterly averages of bid-ask spreads in Singapore, and Poland for overnight, 1-month, and 3-month maturities, respectively. The bid-ask spread varies from around 10 basis points to more than 100 basis points during periods of uncertainty, such as the fourth quarter of 1997 (the Asian crisis) and third quarter of 1998 (the Russian crisis), with Singapore relatively more affected by the Asian crisis than Poland by the Russian crisis. The volatility of the bid-ask spreads, which may be better inferred from the figures in Appendix III, shows that in Poland, the spread in selected segments of the interbank market is rather volatile, while in Singapore, the spreads have remained fairly constant after the effects of the Asian crises in 1997–98 were worn out.

In the United States, where the Federal Reserve Bank targets the Fed funds rate, the MEC shows that the long period Fed funds returns (5-day return) is less volatile than the daily returns, thus showing a low MEC (Table 5). According to Furfine (2001), who calculates intraday volatility, 76 percent of the change takes place during the day. The MECs are higher for longer maturities; but on average they are below one and they are generally also more

²⁸ In case the turnover observations are available with different frequency, the following approximation can be used to calculate annualized volatility:

$$\begin{aligned} \text{Annualized volatility} &= N \times \text{Periodic variance} \\ &\quad \text{where } N = \text{Number of periods in one year} \\ \text{Annualized volatility} &= 12 \times \text{Monthly variance} \\ &= 52 \times \text{Weekly variance} \\ &= 253 \times \text{Daily variance (253 to reflect number of business days per year)} \end{aligned}$$

Table 4. Bid-Ask Spreads: Money Markets

Maturity	1997					1998					1999					2000						
	Avg	Q1	Q2	Q3	Q4	Avg	Q1	Q2	Q3	Q4	Avg	Q1	Q2	Q3	Q4	Avg	Q1	Q2	Q3	Q4		
Singapore	Overnight	0.33 (1.00)	0.13	0.12	0.16	0.87	1.02 (1.36)	1.38	1.09	1.00	0.62	0.24 (0.11)	0.26	0.24	0.25	0.22	0.25 (0.04)	0.24	0.26	0.25	0.25	0.25
	1 Month	0.31 (0.43)	0.13	0.13	0.16	0.81	0.86 (0.90)	1.45	1.04	0.55	0.47	0.26 (0.05)	0.30	0.25	0.24	0.26	0.25 (0.02)	0.25	0.25	0.25	0.25	0.24
	3 Month	0.28 (0.38)	0.13	0.12	0.14	0.73	0.86 (0.63)	1.42	0.95	0.64	0.47	0.29 (0.07)	0.38	0.29	0.24	0.25	0.25 (0.02)	0.25	0.25	0.25	0.25	0.24
Poland	Overnight	0.93 (1.86)	0.46	0.84	1.09	1.32	0.64 (0.79)	0.70	0.50	0.67	0.69	0.70 (1.25)	0.35	0.20	0.37	1.92	1.21 (1.52)	1.49	1.26	1.26	1.26	0.86
	1 Month	0.84 (0.35)	0.62	0.61	1.12	0.98	0.73 (0.35)	1.06	0.62	0.71	0.50	0.58 (0.84)	0.33	0.17	0.20	1.66	0.42 (0.21)	0.54	0.34	0.34	0.34	0.43
	3 Month	0.88 (0.38)	0.74	0.65	1.37	1.14	1.02 (0.30)	1.15	0.84	1.01	1.05	0.80 (0.73)	0.64	0.28	0.42	1.92	0.53 (0.25)	0.78	0.52	0.44	0.44	0.39

*Figures in parentheses are standard errors
Source: Bloomberg

Table 5. Market Efficiency Coefficients: Money Markets

Maturity	1985				1986				1987				1988				1989				2000					
	Avg	Q1	Q2	Q4	Avg	Q1	Q2	Q4	Avg	Q1	Q2	Q4	Avg	Q1	Q2	Q4	Avg	Q1	Q2	Q4	Avg	Q1	Q2	Q4		
U.S.	Overnight	0.30	0.50	0.25	0.30	0.29	0.37	0.24	0.26	0.31	0.29	0.39	0.20	0.34	0.31	0.31	0.31	0.23	0.35	0.30	0.35	0.29	0.35	0.28	0.32	0.37
	1 Month	0.69	0.71	0.58	0.86	0.80	1.00	0.80	0.56	0.85	0.87	1.04	0.39	0.33	0.51	0.51	0.61	1.03	0.32	0.26	0.56	0.58	0.84	0.41	0.85	0.51
	3 Month	0.63	0.67	0.58	0.77	0.63	0.57	0.54	0.68	0.74	0.68	0.60	0.42	0.49	0.42	0.42	0.56	0.92	0.30	0.20	0.86	0.68	0.59	0.40	0.53	0.69
	12 Month	0.81	0.76	0.90	0.76	0.80	0.83	0.66	0.75	1.25	0.63	0.69	0.94	0.50	0.75	0.55	0.62	0.78	0.52	0.41	0.77	0.72	0.84	0.47	0.76	0.82
Australia	Overnight	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0.42	0.44	0.30	0.25	0.71
	1 Month	0.62	0.68	0.36	0.81	0.47	0.70	0.33	0.83	0.81	0.35	0.91	1.32	0.76	0.08	0.62	0.86	0.90	0.49	1.05	0.94	0.84	1.15	0.88	0.91	0.83
	3 Month	0.74	0.86	0.73	0.75	0.86	0.68	0.48	0.51	0.97	0.74	1.05	1.74	0.76	0.99	0.77	0.86	0.87	0.60	1.03	0.93	0.78	0.94	0.60	0.60	0.90
	12 Month	0.99	0.88	1.06	0.91	0.90	0.99	1.29	1.06	0.71	0.90	0.88	0.33	0.63	1.33	1.02	0.96	1.38	0.56	0.68	1.28	0.97	0.93	1.28	0.90	0.78
Canada	Overnight	0.67	0.87	0.65	0.61	0.47	0.50	0.57	0.46	0.44	0.57	0.89	0.44	0.61	0.77	0.77	0.72	0.89	0.88	0.65	0.50	0.31	0.37	0.22	0.27	0.36
	1 Month	0.80	1.11	0.66	0.88	0.83	0.92	0.78	0.88	1.17	0.82	0.79	1.02	0.67	0.68	0.82	0.89	0.76	1.05	0.88	0.87	0.63	0.71	0.77	0.52	0.32
	3 Month	0.76	0.91	0.63	0.85	0.74	0.90	0.79	0.88	1.28	0.64	0.73	0.97	0.60	0.71	0.68	0.96	0.78	1.15	0.89	1.02	0.63	0.61	0.55	0.52	0.68
	12 Month	0.65	0.86	0.72	0.59	0.55	0.82	0.78	0.68	1.01	0.80	0.81	0.95	0.56	0.56	0.39	0.78	0.66	0.89	0.84	0.74	0.64	0.57	0.75	0.69	0.53
Singapore	Overnight	0.90	0.81	0.99	1.08	0.87	0.97	0.76	0.84	1.24	1.06	0.88	0.65	0.74	0.60	0.72	0.56	0.69	0.81	0.46	0.37	0.27	0.53	0.41	0.34	0.20
	1 Month	0.80	1.11	0.66	0.88	0.83	0.92	0.78	0.88	1.17	0.82	0.79	1.02	0.67	0.68	0.82	0.89	0.76	1.05	0.88	0.87	0.63	0.71	0.77	0.52	0.32
	3 Month	0.76	0.91	0.63	0.85	0.74	0.90	0.79	0.88	1.28	0.64	0.73	0.97	0.60	0.71	0.68	0.96	0.78	1.15	0.89	1.02	0.63	0.61	0.55	0.52	0.68
	12 Month	0.65	0.86	0.72	0.59	0.55	0.82	0.78	0.68	1.01	0.80	0.81	0.95	0.56	0.56	0.39	0.78	0.66	0.89	0.84	0.74	0.64	0.57	0.75	0.69	0.53
Korea	Overnight	0.90	0.81	0.99	1.08	0.87	0.97	0.76	0.84	1.24	1.06	0.88	0.65	0.74	0.60	0.72	0.56	0.69	0.81	0.46	0.37	0.27	0.53	0.41	0.34	0.20
	1 Month	0.80	1.11	0.66	0.88	0.83	0.92	0.78	0.88	1.17	0.82	0.79	1.02	0.67	0.68	0.82	0.89	0.76	1.05	0.88	0.87	0.63	0.71	0.77	0.52	0.32
	3 Month	0.76	0.91	0.63	0.85	0.74	0.90	0.79	0.88	1.28	0.64	0.73	0.97	0.60	0.71	0.68	0.96	0.78	1.15	0.89	1.02	0.63	0.61	0.55	0.52	0.68
	12 Month	0.65	0.86	0.72	0.59	0.55	0.82	0.78	0.68	1.01	0.80	0.81	0.95	0.56	0.56	0.39	0.78	0.66	0.89	0.84	0.74	0.64	0.57	0.75	0.69	0.53
Peru	Overnight	0.90	0.81	0.99	1.08	0.87	0.97	0.76	0.84	1.24	1.06	0.88	0.65	0.74	0.60	0.72	0.56	0.69	0.81	0.46	0.37	0.27	0.53	0.41	0.34	0.20
	1 Month	0.80	1.11	0.66	0.88	0.83	0.92	0.78	0.88	1.17	0.82	0.79	1.02	0.67	0.68	0.82	0.89	0.76	1.05	0.88	0.87	0.63	0.71	0.77	0.52	0.32
	3 Month	0.76	0.91	0.63	0.85	0.74	0.90	0.79	0.88	1.28	0.64	0.73	0.97	0.60	0.71	0.68	0.96	0.78	1.15	0.89	1.02	0.63	0.61	0.55	0.52	0.68
	12 Month	0.65	0.86	0.72	0.59	0.55	0.82	0.78	0.68	1.01	0.80	0.81	0.95	0.56	0.56	0.39	0.78	0.66	0.89	0.84	0.74	0.64	0.57	0.75	0.69	0.53

* Figures in parentheses are standard errors
Source: Bloomberg

volatile than the MEC for the Fed funds rate. Higher interest rate volatility is sometimes used as an indicator of illiquid markets, but in the case of money markets, it should also be seen in context with the way the central bank intervenes.²⁹ Appendix III shows that the correlation among the different segments of the money market is far from obvious, although there appears to be some correlation using bid-ask spreads in the case of Singapore.

C. Bond Markets

The bond markets can be classified according to issuer, i.e., government securities, mortgage-backed bonds, and corporate bonds. The secondary market for government securities is generally perceived as being the most liquid of the various bond markets. Government securities often play a special role as collateral and benchmarks for pricing of other securities, and as safe haven because of limited credit risk and the fact that the outstanding amounts often are quite large. In recent years, some countries have concentrated their public debt on fewer maturities but larger issues of each maturity with a view to promote the liquidity—often in light of standardized derivatives—rather than tailor the securities to the preferences of specific investors. A few issuers—sometimes when creating benchmarks—occasionally guarantee to buy back at a discount, thus ensuring the securities remain liquid. Finally, a transparent and credible public debt policy is conducive to creating liquid public debt markets.

Turnover ratios vary significantly among countries. Inoue (1999) conducted in 1997 a survey among the G-10 countries, and found the turnover ratio varied from almost 34 in France to 2½ in the Netherlands. The different turnover ratios are, for instance, affected by prudential regulation that may limit the amount of securities truly being available for trading; the extent to which the central bank uses government securities to conduct open market operations; if intraday liquidity for the payment system is provided in form of repurchase agreements or in form of pledging; etc. In emerging markets, it is not unusual to have turnover ratios below one. Then, the number of trades per day becomes a useful indicator. In countries where dealers are required to report to the stock exchange or where securities are dematerialized and the central depository collects information on final ownership, turnover information is sometimes available, while it is much more difficult to attain such information in other countries, in part because dealers usually consider such information a business secret.

Bid-ask spreads for government securities are only available for individual securities and derivatives. In the United States, the spreads in derivative markets are often smaller than in the cash market according to Fleming (2001). They are occasionally used as a proxy for how

²⁹ Cohen (2000) found that in six out of nine large industrialized countries, using daily data for the period covering 1990–98, there was a significant positive relationship between the variance of the overnight rate and two or more longer interbank rates. Thus, targeting the overnight rate may also result in lower volatility for other rates. He also found that the transmission of volatility in overnight rates to longer maturities is smaller in countries without reserve requirements. In principle, averaging of required reserves should function as a buffer, but it also depends on how frequently the central bank intervenes. In case of required reserves, the volatility will typically increase toward the end of the maintenance period.

liquid the market for government securities really is, in part because the spread gives an indication of the hedging costs. Newly issued “on-the-run” benchmark securities typically have a lower spread than off-the-run securities, which are less traded. Accordingly, spreads are more useful as indicators of liquidity for different segments rather than for the whole market.

In the United States, the spreads of inter-dealer brokers are rather modest. The bid-ask spread for treasury bills has a median of 0.5 basis points with a range of 0–2 basis points (Fleming and Sarkar, 1999). According to Table 6, the yield-spread often increases with the maturity of the security, in part reflecting the inventory costs. On the other hand, long-term interest rates may be more stable than short-term interest rates, reflecting long-term expectations, and there may be higher turnover in longer securities, which contribute to a lower spread. Furthermore, the spread is often measured on the interest rate instead of the price. The same change in basis points of the interest spread is much larger than a similar change in the spread of the price because of the larger duration of longer bonds.³⁰ This may also help explain the fact that in Singapore the spreads are lower for longer securities (Table 7). The spreads in thinner emerging markets are typically larger.³¹ But it is important to acknowledge that the spread is only a proxy and does not include all the costs of a securities transaction and varies significantly across markets.

Table 8 shows the MEC for government securities with selected maturities in Australia, Canada, Singapore, and India during the period 1996–2000. There are significant differences between the different segments in each bond market and between countries, as also illustrated in the figures in Appendix IV.^{32 33}

³⁰ For interest bearing securities it is important to note a difference between return (which is used for equities) and the effective interest rate. The difference on the variance is illustrated by the following formula:

$$\text{Price volatility} = \frac{\text{Yield}}{\text{Volatility}} \times \frac{\text{Yield}}{(\text{decimal})} \times \frac{\text{Modified}}{\text{duration}}$$

³¹ Mohanty (2002) reports that spreads in the Philippines range from 25 to 50 basis points.

³² Volatility is occasionally used when spreads are not readily available, since they both reveal uncertainty. Figures in Appendix IV show interest rate volatility (not price volatility).

³³ Covariance of interest rate volatilities may be used to analyze international contagion. Dahlquist et al. (2000), for instance, analyze the volatility spillovers from the bond market in the United States and Germany into the Swedish bond market during the 1993–98 period. The Swedish bond market appears to more quickly incorporate news from Germany than from the United States.

Table 6. Selected Liquidity Indicators for Government Securities Markets in G-10 Countries ^{1/}

	Canada		Belgium		France		Germany		Japan		Netherlands		Sweden		Switzerland		U.K.		U.S.A.		
	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	
Spreads:																					
Fixed coupon, 2 years	2	...	n.a.	n.a.	4	n.a.	4	n.a.	4	n.a.	5	n.a.	4	n.a.	...	n.a.	3	n.a.	...	1.6	n.a.
5 years	5	13 ^{5/}	n.a.	n.a.	5	6	4	4	9 ^{2/}	11 ^{2/}	n.a.	n.a.	9	n.a.	...	n.a.	4	4	4	1.6	6.3
10 years	5	16 ^{3/}	5	7	10	6	4	5	7	7	n.a.	n.a.	15	n.a.	10	10	4	4	3.1	6.3	6.3
30 years	10	19 ^{5/}	n.a.	n.a.	24	10	10	10	16 ^{3/}	19 ^{3/}	n.a.	n.a.	27 ^{4/}	n.a.	25	n.a.	8	12	3.1	12.5	12.5
Index-linked, 10 years	25	...	...	n.a.	...	...	...	...	...	...	...	...	39	n.a.	...	...	15	...	6.3	n.a.	n.a.
Tick size ^{6/}																					
	0.1	1	1	1-2 ^{7/}	1	1-2 ^{7/}	1	1	3-4 ^{7/}	1	1	1	2-11 ^{7/}	1	1	1	3.1	3.1	0.8-3.1	0.8-3.1	0.8-3.1
Turnover indicators																					
Turnover rate (a/b)	21.9	4.1	4.1	33.8	n.a.	33.8	n.a.	n.a.	6.9	6.9	2.6	2.6	32.7	32.7	3.6	3.6	7.0	7.0	22.0	22.0	22.0
Yearly trading (U.S. million) (a)	6,243	947	947	18,634 ^{8/}	n.a.	18,634 ^{8/}	n.a.	n.a.	13,282	13,282	450 ^{8/}	450 ^{8/}	3,626	3,626	123 ^{8/}	123 ^{8/}	3,222	3,222	75,901	75,901	75,901
Outstanding (U.S. million) (b)	285	232	232	551	563	551	563	563	1,919	1,919	176	176	111	111	35	35	458	458	3,457	3,457	3,457
Average issue size (U.S. billion)	185	28	28	n.a.	n.a.	n.a.	n.a.	n.a.	18,453	18,453	...	...	1137	1137	90	90	3,294	3,294	27,928	27,928	27,928
Yearly trading volume in futures market (c)	33.7	33.8	33.8	n.a.	n.a.	n.a.	n.a.	n.a.	0.7	0.7	...	...	3.2	3.2	1.4	1.4	1.0	1.0	2.7	2.7	2.7
Cash futures ratio (a)/(c)																					
Market structure: Custromer ^{9/}	D	D ^{10/}	D ^{10/}	D ^{10/}	D ^{10/}	D ^{10/}	D ^{10/}	D ^{10/}	D ^{10/}	D ^{10/}	A and D	A and D	D	D	A and D	A and D	D	D	D	D	D
Interdealer ^{9/}	D	D	D	D	...	...	...	...	A and D	A and D	A	A	n.a.	n.a.	...	...	D	D	D	D	D
Memorandum items																					
Holdings of nonresidents (percent)	25.0	23.0	23.0	12.9	n.a.	12.9	n.a.	n.a.	10.0	10.0	24.0	24.0	19.5	19.5	n.a.	n.a.	14.4	14.4	36.9	36.9	36.9

Source: Reproduced after Inoue (1999).

1/ Excluding Italy.

2/ For 6-year bonds.

3/ For 20-year bonds.

4/ For 22-year bonds.

5/ The figure is the mid-point of a range.

6/ Tick size is shown in ten-thousandths of the face value of 100 currency units of each country. In many cases the tick size is the same for customers and interdealers.

7/ Some or all securities are quoted in yield terms with the tick size is converted.

8/ The figures may include trading other than outright transactions.

9/ D means dealer market and A means auction-agency market.

10/ Auction-agency markets exists.

Table 7. Bid-Ask Spreads (Percent): Bond Markets

Country	Maturity	1999					2000				
		Avg	Q1	Q2	Q3	Q4	Avg	Q1	Q2	Q3	Q4
Singapore	3 Month	0.05% (0.01)	0.05%	0.05%	0.05%	0.05%	0.06% (0.02)	0.05%	0.05%	0.05%	0.08%
	12 Month	0.05% (0.00)	0.05%	0.05%	0.05%	0.05%	0.05% (0.00)	0.05%	0.05%	0.05%	0.05%
	5 Year	0.01% (0.01)	0.01%	0.01%	0.01%	0.01%	0.01% (0.01)	0.01%	0.01%	0.01%	0.02%
	10 Year	0.01% (0.01)	0.01%	0.01%	0.01%	0.00%	0.01% (0.00)	0.01%	0.01%	0.01%	0.01%
Malaysia	3 Year	0.22% (0.13)	0.12%	0.12%	0.30%	0.31%	0.18% (0.11)	0.29%	0.20%	0.15%	0.12%
	5 Year	0.21% (0.13)	0.13%	0.20%	0.21%	0.29%	0.23% (0.10)	0.30%	0.23%	0.21%	0.19%
	10 Year	0.19% (0.23)	0.08%	0.10%	0.32%	0.24%	0.26% (0.08)	0.29%	0.30%	0.24%	0.20%

*Figures in parentheses are standard errors

Source: Bloomberg

Table 8. Market Efficiency Coefficients: Bond Markets

Country	Maturity	1987				1988				1989				1990						
		Avg	G1	G2	G3	Avg	G1	G2	G3	Avg	G1	G2	G3	Avg	G1	G2	G3			
Australia	3 Month	0.90 (0.02)	1.42	0.86	0.89	0.89	0.82	0.85	0.82	0.87	0.68	0.68	0.31	0.24	0.50	0.81	1.15	1.02	1.01	
	6 Month	0.88	1.50	0.89	0.82	0.79	0.88	0.86	0.83	0.87	0.48	0.48	0.28	0.28	0.77	1.08	0.98	1.21	0.89	1.14
	1 Year	0.88	0.74	0.71	0.64	0.72	0.85	0.76	1.28	0.83	0.86	0.44	0.39	0.26	0.38	0.88	0.73	0.61	0.62	0.80
	3 Year	0.83	0.56	0.55	0.69	0.77	0.81	0.80	1.25	0.88	0.81	0.76	0.81	0.80	1.14	0.87	0.84	1.15	0.73	0.71
	5 Year	0.81	0.52	0.47	0.72	0.73	0.86	0.86	1.01	0.87	0.85	0.70	0.80	0.75	0.89	0.80	0.82	1.09	0.82	0.67
	10 Year	0.73	0.06	0.52	0.79	0.71	0.83	0.78	0.78	0.85	0.74	0.98	0.88	0.94	0.75	0.75	0.87	0.89	0.71	0.74
Canada	3 Month	0.89	0.01	0.86	0.80	1.03	1.15	1.48	0.84	1.01	1.29	0.86	0.86	1.12	0.80	0.80	1.03	1.09	0.87	0.97
	6 Month	0.88	1.01	0.89	0.89	0.87	1.07	1.40	0.80	0.80	1.11	1.06	1.21	1.07	0.85	0.88	0.99	1.02	0.73	0.67
	1 Year	0.87	1.07	0.83	0.70	0.87	1.02	1.32	0.87	0.81	1.10	0.92	1.12	0.93	0.90	1.03	0.88	1.08	1.11	1.04
	3 Year	0.88	1.11	0.80	0.84	0.82	1.04	1.24	0.88	0.80	1.17	0.85	1.18	0.81	0.85	1.04	0.84	1.09	1.03	1.24
	5 Year	0.88	1.23	0.80	0.80	0.80	1.12	1.24	0.83	0.83	1.37	1.02	1.26	0.84	1.00	0.99	0.87	0.76	1.03	1.13
	10 Year	1.01	1.35	0.90	0.81	1.01	1.11	1.23	0.87	0.84	1.32	1.03	1.22	0.81	1.14	0.94	0.82	0.62	0.67	0.87
Singapore	3 Month	0.84	0.77	1.11	1.14	0.71	1.07	1.25	0.68	1.03	1.07	1.01	1.14	1.13	1.22	0.88	1.41	1.08	0.77	0.61
	6 Month	0.86	0.86	0.98	1.58	0.68	0.89	0.80	0.85	1.05	0.84	0.72	0.78	0.36	0.86	1.07	1.37	1.43	0.89	0.61
	1 Year	0.86	0.86	0.98	1.58	0.68	0.89	0.80	0.85	1.05	0.84	0.72	0.78	0.36	0.86	1.07	1.37	1.43	0.89	0.61
	3 Year	0.86	0.86	0.98	1.58	0.68	0.89	0.80	0.85	1.05	0.84	0.72	0.78	0.36	0.86	1.07	1.37	1.43	0.89	0.61
	5 Year	0.86	0.86	0.98	1.58	0.68	0.89	0.80	0.85	1.05	0.84	0.72	0.78	0.36	0.86	1.07	1.37	1.43	0.89	0.61
	10 Year	0.86	0.86	0.98	1.58	0.68	0.89	0.80	0.85	1.05	0.84	0.72	0.78	0.36	0.86	1.07	1.37	1.43	0.89	0.61
India	2 Year	0.73	0.38	1.00	0.47	0.51	0.60	0.53	0.45	0.52	0.87	0.87	0.97	0.72	0.85	0.88	0.83	1.20	0.91	1.08
	3 Year	0.73	0.45	1.20	0.52	0.48	0.60	1.01	0.51	0.52	0.19	0.63	0.55	0.66	1.40	0.84	0.88	1.23	0.83	0.85
	5 Year	0.73	0.45	1.20	0.52	0.48	0.60	1.01	0.51	0.52	0.19	0.63	0.55	0.66	1.40	0.84	0.88	1.23	0.83	0.85

*figures in parentheses are standard errors
Source: Bloomberg

D. Equity Markets

The use of stock market indexes is useful, but they remain a proxy for the stock market, since they only cover the most important stocks.³⁴ Table 9 shows liquidity measures for equity markets in the United States (Nasdaq), Mexico (Mexbol), Korea (KOSPI), Malaysia (KLCT) and Indonesia (JCI). To visualize trends in the liquidity measures, the data in Tables 9 and 10 should be reviewed in conjunction with the associated charts labeled Figures 1–10 for each country in Appendix V, referred to in parentheses below.

The U.S. data—that is, the Nasdaq—reveal that the volatility of the equity price index as measured by the absolute value of the daily percent changes ($|\% \Delta P|$, Figure 2) has increased over 1996–2000. However, conventional liquidity ratios relating price changes to the number of units traded ($|\% \Delta P|/N$, Figure 5) and the value of transactions ($|\% \Delta P|/V$, Figure 8), have not changed over the period. This reflects the increase in both the number of units traded (N , Figure 4) and the turnover (V , Figure 7), as price variability increased during the same period. The relative constancy of the conventional liquidity ratios in the face of increased price volatility can be interpreted as an increase in market depth. Thus, more transactions and their associated volume can be traded with minimal impact on average prices.³⁵

This increased depth contrasts with the trend of the more refined liquidity ratio relating price impact to the turnover rate ($|\% \Delta P|/(V/K)$ and Figure 10). This measure shows an upward trend in the face of increased turnover rate (V/K). This upward trend suggests evidence of reduced breadth indicating that large value trades impact on prices.

Finally, the market efficiency coefficient, Figure 3, has decreased from 1.12 to 0.82 over 1996–2000 suggesting improved resiliency. The improvement hypothesis relies on the fact that values of the MEC greater than 1 result from aspects of market operations that tend to stabilize prices inefficiently while factors that induce excessive short term volatility lead to an MEC substantially below 1 (see the discussion of the MEC in Section II. C). Thus, since the transition of the MEC from 1.12 to 0.82 did not result from the average of extreme MEC values, resiliency may have improved.

For Mexico, the volatility of the equity price index ($|\% \Delta P|$, Figure 2) has also increased over 1996–2000, but in contrast to the U.S., the conventional liquidity ratios ($|\% \Delta P|/N$, Figure 5 and $|\% \Delta P|/V$, Figure 8), have slightly increased. This is because the number of units traded

³⁴ Shah and Thomas (1998), for instance, discuss the impact of including illiquid securities in a market index.

³⁵ Care should be taken when analyzing volumes of transactions. Atkins and Dyl (1997) and Dyl and Anderson (2002), for instance, find that the volume at NASDAQ, which is a dealer market, may over report trades by public investors. When stocks are moved from NASDAQ to New York Stock Exchange (NYSE), which is an auction market, reported trading volume typically drops by about 38 percent (Dyl and Anderson, 2002) or previously 50 percent (Atkins and Dyl (1997).

Table 9. Liquidity Measures: Equity Markets^{1/}

	$|\% \Delta P|$	$|\% \Delta P|/N$	$|\% \Delta P|/V$	$|\% \Delta P|/T_n$	MEC	N	V	$T_n=V/K$	K
U.S									
1996	0.74	1.44E-03	1.43E-09	...	1.12	5.2E+02	1.30E+04	...	...
1997	0.88	1.41E-03	1.39E-09	8.69E-02	0.85	6.3E+02	1.82E+04	1.1E+01	1.74E+06
1998	1.22	1.73E-03	1.72E-09	1.05E-01	0.99	7.2E+02	2.25E+04	1.2E+01	1.98E+06
1999	1.40	1.51E-03	1.51E-09	1.04E-01	0.85	9.7E+02	4.24E+04	1.4E+01	3.12E+06
2000	2.43	1.49E-03	1.48E-09	1.60E-01	0.82	1.6E+03	8.04E+04	1.5E+01	5.40E+06
Mexico									
1996	0.92	1.33E-02	8.89E-01	3.62E-05	1.10	8.5E+01	1.08E+03	2.4E-03	4.32E+05
1997	1.08	1.47E-02	6.88E-01	3.78E-05	1.08	7.4E+01	1.55E+03	2.7E-03	5.64E+05
1998	1.62	2.82E-02	1.58E+00	1.02E-04	1.07	6.0E+01	1.09E+03	2.0E-03	5.56E+05
1999	1.46	2.35E-02	1.21E+00	7.42E-05	1.03	6.8E+01	1.31E+03	1.8E-03	7.39E+05
2000	1.71	2.42E-02	1.14E+00	8.55E-05	1.04	8.0E+01	1.57E+03	1.5E-03	1.04E+06
Korea									
1996	0.87	3.57E-02	1.96E-03	4.47E+00	1.09	2.7E+01	4.83E+05	2.5E-01	1.46E+08
1997	1.50	2.76E-02	2.90E-03	2.92E+00	1.21	4.2E+01	5.51E+05	5.2E-01	1.15E+08
1998	2.18	2.76E-02	4.06E-03	4.55E+00	1.06	1.0E+02	6.91E+05	2.5E-01	7.93E+07
1999	1.93	7.55E-03	6.74E-04	4.64E+00	0.97	2.8E+02	3.48E+06	2.4E-01	4.10E+08
2000	2.20	7.75E-03	9.29E-04	2.23E+00	0.83	3.1E+02	2.60E+06	1.0E+00	2.53E+08
Malaysia									
1996	0.59	1.21E-02	3.15E-01	1.85E+02	0.88	5.2E+01	1.84E+03	3E-03	3.95E+05
1997	1.53	1.81E-02	1.42E+00	3.63E+02	1.12	9.0E+01	1.65E+03	4.9E-03	3.25E+05
1998	2.37	2.90E-02	6.78E+00	1.09E+03	1.03	8.7E+01	4.68E+02	2.4E-03	1.83E+05
1999	1.26	1.70E-02	2.49E+00	6.19E+02	1.03	9.7E+01	8.70E+02	2.6E-03	2.72E+05
2000	1.05	2.05E-02	1.92E+00	6.33E+02	1.20	7.0E+01	7.15E+02	2.5E-03	3.45E+05
Indonesia									
1996	0.72	5.93E-03	3.59E-03	7.04E+05	1.09	1.2E+02	2.02E+02	1.0E-06	1.96E+08
1997	1.28	4.04E-03	3.33E-03	6.52E+05	1.26	3.2E+02	3.85E+02	2.0E-06	1.96E+08
1998	2.20	5.87E-03	5.44E-03	1.15E+06	1.07	3.7E+02	4.03E+02	1.9E-06	2.12E+08
1999	1.59	2.09E-03	2.65E-03	4.60E+05	1.13	7.6E+02	6.00E+02	3.5E-06	1.73E+08
2000	1.14	1.98E-03	2.19E-03	5.23E+05	1.03	5.8E+02	5.22E+02	2.2E-06	2.39E+08

Source: Bloomberg.

1/ All figures are averages of daily values

$|\% \Delta P|$ Absolute value of daily percent changes in the index

N Number of securities transacted daily

V Value of daily transactions

K Daily Market capitalization

$T_n=V/K$ Turnover rate

$|\% \Delta P|/N$ Liquidity Ratio (Ratio of price changes to the number of units traded)

$|\% \Delta P|/V$ Liquidity Ratio (Ratio of price changes to the value of trades)

$|\% \Delta P|/T_n$ Liquidity Ratio (Ratio of price changes to the turnover rate: 5 day moving average)

MEC Market Efficiency Coefficient

(N, Figure 4) and the turnover (V, Figure 7) have not experienced the same increase as in the U.S. The increase in price volatility with a relative constancy in the number of units traded, therefore, suggests a reduction in market depth. Trends in the Mexican liquidity ratio relating price impact to the turnover rate ($|\% \Delta P|/(V/K)$ and Figure 10) suggest that market breadth has decreased. Decreasing turnover rates have been associated with increasing price impact over 1996–2000, suggesting that large trades impact prices. Furthermore, the MEC values for Mexico (Figure 3) have consistently been above one, though on a slightly declining trend, reflecting inefficiency and lack of resiliency as discussed earlier.

The Korea equity market is an interesting case for which liquidity conditions seem to have improved in all dimensions over 1996–2000. Conventional liquidity ratios ($|\% \Delta P|/N$ and Figure 5) and ($|\% \Delta P|/V$ and Figure 8), have all declined despite increased volatility in the equity price index ($|\% \Delta P|$, Figure 2) during the period. This reflects increases in both the number of units traded (N, Figure 4) and the turnover (V, Figure 7). As in the U.S. case, this suggests increased market depth since numerous trades can be executed with minimum average price impact.

Market depth has also helped the increasing turnover rate (V/K, Figure 9) has been associated with a declining price impact ($|\% \Delta P|/(V/K)$). This latter observation suggests that the increase in depth, has helped breadth to reduce the impact of large trades. As illustrated in the introduction of the paper (see Box 1), depth can compensate for the lack of breadth, since large transaction volumes can be executed in the market in smaller batches. This compensating effect does not seem to have occurred in the U.S. case, discussed above, where the increased market depth did not coincide with a reduction in overall breadth.

Finally, the MEC values for Korea (Figure 3) also show a transition from 1.09 in 1996 to 0.83 in 2000 reflecting increased efficiency and resiliency. Table 10 also shows a reduction in the standard deviation of the Korea MEC indicating that the value of 0.83 is not the result of averages of extreme MEC values.

IV. FACTORS AFFECTING ASSET AND MARKET LIQUIDITY

The measures discussed in Sections II and III to assess tightness, immediacy, depth, breadth, and resiliency are affected by a number of market specific factors, which make them difficult to compare across countries and even across markets in the same country. These factors mainly affect transaction costs, either directly or indirectly in the form of externalities, such as transparency and risks, for instance, by influencing the information content in prices. Although some of these factors may have a predominant role in some of the markets, they may have ramifications on other markets as well. The more important ones are briefly mentioned in this section and summarized in Box 3 (below).

Table 10. Market Efficiency Coefficients: Equity Markets

	1996				1997				1998				1999				2000								
	Avg	Q1	Q2	Q3	Q4	Avg	Q1	Q2	Q3	Q4	Avg	Q1	Q2	Q3	Q4	Avg	Q1	Q2	Q3	Q4					
U.S.	1.12 (0.30)	1.00	1.33	1.02	1.05	0.85	0.75	1.05	0.83	0.75	0.99	1.04	0.82	1.01	1.11	0.85	0.70	0.83	0.92	0.92	0.82	0.72	0.94	0.98	0.64
Australia	0.85 (0.27)	0.82	1.06	0.95	0.55	0.86	0.81	0.69	0.81	1.12	0.97	0.75	0.99	1.17	0.98	0.83	0.86	0.77	0.73	0.95	0.91	0.75	0.83	1.23	0.84
Mexico	1.10 (0.33)	0.88	1.33	0.92	1.28	1.08	1.24	0.89	1.17	1.00	1.07	1.23	0.88	1.13	1.01	1.03	1.08	0.93	1.22	0.91	1.04	1.02	1.09	1.13	0.91
Korea	1.09 (0.34)	1.04	0.92	1.33	1.05	1.21	1.15	1.22	1.54	0.93	1.06	1.14	0.99	1.04	1.06	0.97	1.02	0.90	0.95	1.02	0.83	0.68	0.88	1.04	0.75
Singapore	1.05 (0.32)	0.79	0.94	1.34	1.13	1.25	1.17	1.38	1.10	1.36	1.06	1.18	1.13	0.91	1.04	1.12	0.85	1.03	1.32	1.24	1.04	0.58	1.22	1.58	0.75
Malaysia	0.88 (0.20)	0.82	0.80	0.85	1.04	1.12	0.88	1.16	1.16	1.24	1.08	1.18	1.08	0.85	1.00	1.03	0.92	1.03	1.04	1.14	1.20	1.52	0.90	1.03	1.37
Indonesia	1.09 (0.39)	0.95	0.91	1.34	1.14	1.26	1.11	1.43	1.33	1.16	1.07	1.14	0.69	1.25	1.18	1.13	1.07	1.28	1.03	1.23	1.03	0.95	1.15	0.87	1.17

*Figures in parentheses are standard errors

U.S. : Nasdaq, CCMP index
 Mexico : MEXPROI index
 Korea : KOSPI index
 Singapore : STI index
 Malaysia : KLCI index
 Indonesia : JCI index

Source: Bloomberg.

Box 3. Factors Affecting Asset and Market Liquidity

Macro Structure: Affecting the number and types of market participants as well as their expectations.

1. Vulnerabilities:

Internal vulnerabilities: fiscal imbalances, public debt policies, financial sector vulnerabilities, etc.

External vulnerabilities: current account imbalances, capital controls, etc.

2. Monetary policy:

Operational target(s) of the central bank.

Design of monetary instruments: averaging of required reserves, standing facilities, lender-of-last resort.

Central bank's day-to-day management of liquidity—reserves—in the banking system: coordination with government, frequency of interventions, etc.

Banking system's ability to recycle liquidity within the banking system: structure of the banking system, credit risk, etc.

3. Legislative framework: Bankruptcy legislation, cross border transactions, etc.

Institutional Micro Structure:

1. Product design: credit risk, maturity, substitutability, and use of derivatives.

2. Market participants:

Issuers: types of issuers, their issuing policies, legislative requirements to issuers (securities legislation, etc.), share of issue actually available for trading, etc.

Buyers: types of potential participants (capital controls), their heterogeneity, prudential regulation affecting behavior (e.g., liquidity requirements creating a captive market for government securities, hedging requirements and practices (e.g., value-at-risk (VAR) models, delta-hedging) etc.

3. Trading systems:

Market structure:

a. *periodic trading* at discrete intervals (call trading) or *continuous trading* during a specified period.

b. *dealer markets/market makers* (generally quote driven) or *agency/auction markets* (generally order-matching or order driven).

c. *electronic trading* or *floor trading*.

Trading system: licensing of dealers and brokers, capital requirements, cross-listings, etc.

Trading rules: tick-size; limit orders; bloc trading; short-selling; stop-loss orders; stop-buy orders; stop-loss rules; rules for margin transactions; circuit breakers; etc.

Trading transparency: availability of pre-trade and post-trade information to dealers and cash customers.

4. Clearing and settlement of transactions:

Payment systems: risks (legal risks, finality, payment-versus-payment (PVP)), costs, and convenience.

Clearing and settlement of financial instruments: risks (finality (T+3 or less), delivery-versus-payment (DVP)), costs, and convenience.

5. Regulatory and accounting framework:

Different financial instruments: their use as collateral (repo, pledging), etc.

Accounting framework: historical cost or fair-value accounting (mark-to-market may affect willingness to trade).

Taxation: withholding taxes, capital gains taxation, special transaction taxes, etc.

The institutional macro structure and macroeconomic policies constitute the framework affecting financial markets' ability to equilibrate supply and demand at low costs, even under stressful conditions without unduly inducing price swings. The legislative framework, including capital controls, governs the types and number of market participants.

Monetary policy is particularly important since it anchors financial markets. The operational targets of monetary policy, design of monetary policy instruments (averaging of required reserves, etc.), the central bank's day-to-day operations (robustness of liquidity forecasts, frequency of interventions, etc.) as well as the money market's ability to recycle reserve

money influence not just the money market, but also affect the foreign exchange markets as well as the market for government securities.

The design of the trading systems can affect the degree of liquidity in the market place, while the optimal design depends on a number of specific factors.³⁶ A distinction is sometimes made between: (i) periodic trading at discrete intervals and continuous trading; (ii) dealer markets and agency/auction markets, as previously noted; and (iii) floor and electronic trading. Assuming the flow of new information arrives continuously, there will be more volatility having discrete trading, while volatility will be higher with continuous trading if there are relatively few trades having a relatively large impact on the price. Foreign exchange markets, money markets, and the market for treasury bills are often dealer markets, while bonds and equities are more often traded at an exchange, although these securities also often are traded OTC. Floor trading is increasingly being substituted by electronic trading, which tends to be less expensive, more transparent, and operationally more efficient.³⁷ There are a number of other design features of various trading systems that may affect the liquidity of the financial instruments, including tick-size,³⁸ use of limit orders,³⁹ rules for bloc trading, stop loss rules, rules for short-selling, etc.

Prudential regulation may be an important factor affecting the activity in the various markets. A case in point is the fact that banks in some countries are subject to liquid asset requirements that forces them to buy government securities, which creates a captive market and thus reduces the incentives to trade them.⁴⁰ Moreover, accounting rules—although mark-to-market valuation is increasingly used—can impede trading activity since realization of losses or gains may influence certain participants' behavior. Furthermore, the design of the payment systems and settlement of securities can help reduce costs and risks and ensure prompt settlement of transaction, which contribute to greater liquidity in financial markets.⁴¹

³⁶ For an overview of micro structure of markets, see, for instance, O'Hara (2000 and 1995) and Dattels (1997).

³⁷ Regarding improved transparency, Shah (2000) reports that the spread in the Indian interbank money market in 1998 was significantly reduced when India's National Stock Exchange began to polling dealers in the OTC money market and computed reference rates.

³⁸ MacKinnon (1999) found that a reduction of the tick-size at the Toronto Stock Exchange increased liquidity in form of higher turnover.

³⁹ Ahn et al. (2001) investigate how limit orders provide liquidity in order driven markets, using the Stock Exchange of Hong Kong as an example.

⁴⁰ Liquid asset requirements frequently serve monetary policy objectives rather than prudential objectives.

⁴¹ The rules may themselves contribute to the turnover of certain financial assets. For instance, if the central bank use repurchase agreements to provide intraday liquidity in a real-time gross settlement system, where the change of ownership of the security may be recorded as a sale, instead of providing daylight credit against

V. LIQUIDITY DURING PERIODS OF STRESS

Financial markets appear to behave quite differently during periods of stress compared to periods characterized by stability. With a continuous flow of new information, the spread as well as turnover is fairly constant and the price adjusts smoothly. During periods of stress, the positive correlation between volumes and volatility found in many empirical studies (Karpoff, 1987; Bessembinder and Seguin, 1993; among others) may no longer exist. The liquidity measures may reveal conflicting information, making them difficult to interpret. Breedon (2000), for instance, distinguishes between two types of stress events. First, high volatility and high turnover, which generally is good for market makers, since they can increase the spread, but easily unload their positions and read incoming trades and quotes with relatively little risk thus allowing higher effective spreads. Cohen and Shin (2002), analyzing the U. S. treasury securities market, find that during periods of high price volatility, positive effects of past order flows on current prices are reinforced. Secondly, stress may happen during periods of high volatility and low turnover, which is bad for market makers, since they cannot easily unload their positions. The reaction being to increase the spread or not quote at all. After the initial Indonesian crisis in 1997, the rupiah market went through such a period, as discussed in Section III. A.^{42 43} Moreover, transaction costs, which may be important during normal circumstances, may become minute compared to expected losses or gains of a trade during periods of stress. In short, illiquidity is a symptom rather than a cause.

Furthermore, the market structure may also change during periods of stress. O'Hara (2000), for instance, notes that during periods of stress there seems to be a tendency to move from electronic matching systems to dealer systems in the foreign exchange markets. Finally, stress in one market may quickly affect other markets and even other countries, although appropriately designed clearing and settlement systems can help reduce systemic risk.

pledged securities, where ownership is not changed. See BIS (2001b and d) for good practices for designing payment systems and securities settlement systems with a view to reduce systemic risk and ensure efficiency.

⁴² Galati (2000) looks at the relationship between trading volumes, volatility, and bid-ask spreads in selected foreign exchange markets using daily observations of the Colombian peso, the Mexican peso, the Brazilian real, the Indian rupee, the Indonesian rupiah, the Israeli new sheqel, and the South African rand vis-à-vis the U.S. dollar covering the period January 1998 to June 1999, thus including the Russian crisis in August 1998. He confirms the positive correlation between volumes and volatility with the exception of the Mexican peso and the real, bearing in mind the turbulence during the pertinent period. He suggests that the relationship may actually be negative during periods of stress.

⁴³ Manganelli (2002) analyzes a sample of ten stocks at the New York Stock Exchange during the period January 1998 to June 1999, and finds that the perceived positive correlations between volume and price are only correct for frequently traded stocks. Impulse-response functions indicate that more frequently traded stocks are faster to reach their full information equilibrium, thus suggesting positive correlation between turnover and resiliency.

In view of the many factors affecting liquidity during periods of stress, liquidity measures based on trading volume and bid-ask spreads may need to be seen in context while the MEC may still reflect resiliency.

VI. CONCLUSION

Market liquidity is a multifaceted concept. Many of the various dimensions of the characteristics of market liquidity—tightness, immediacy, depth, breadth, and resiliency—can be covered by traditional liquidity measures, such as bid-ask spreads, turnover ratios, and selected price-based indicators (summarized in Box 2). However, these indicators are not complete, and they may send mixing signals, particularly during a crisis. Furthermore, they must be seen in context with numerous market specific factors (summarized in Box 3). This makes weighting and normalization of the various measures with a view to create one single measure to reveal the “liquidity stance” very challenging, if not impossible.

In addition to asking various market participants about the liquidity in different markets, an FSAP team also will usually analyze the more objective liquidity measures, such as bid-ask spreads, trading volumes, liquidity ratios, and market efficient coefficients. Changes in these indicators over time are particularly enlightening. If the underlying fundamentals causing these changes are not fully understood, the various liquidity measures can indeed become leading indicators. This appeared to be the case when the MEC was applied to selected foreign exchange markets. Although selected liquidity measures do contribute useful objective information, this paper also showed the practical difficulties, not least the lack of reliable data and the amount of time needed to prepare and analyze available data.

Illiquid markets are a symptom rather than a cause of inadequate market functioning, although they may amplify financial crises. The only sustainable solution to foster liquid financial markets is to pursue sound and transparent economic policies with appropriately designed trading, clearing, and settlement systems, as well as appropriate intervention policies of the central bank, which can help contain systemic risk.

EXAMPLE OF DATA REQUEST FOR AN FSAP MISSIONS

Markets: Describe the number and nature of financial markets (provide copy of pertinent rules and regulations) and list the instruments traded.

Foreign exchange market: local currency versus U.S. dollar (spot, forwards, and derivatives, if any).

Money market

- CDs with different maturities
- Repos (including and excluding repos for intraday liquidity to support an RTGS system)
- Treasury bills with up to one year maturity in local and foreign exchange
- Central bank bills with maturity up to one year in local and foreign exchange
- Commercial paper, if any
- Derivatives, futures, options, FRA, etc.

Government securities market:

- Notes (1-, 2-, and 5-year), both benchmarks and off-the-runs/indexes if available
- Bonds (10-, 15-, and 30-year), both benchmarks and off-the-runs/indexes if available
- Futures and other derivatives, if available

Equities: the number of listed companies and total market capitalization

- Ten most traded equities
- Derivatives, futures on indexes, etc.

Data: provide data on respective markets the last three years, if available.

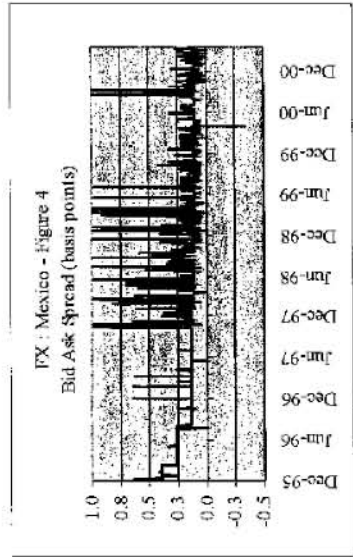
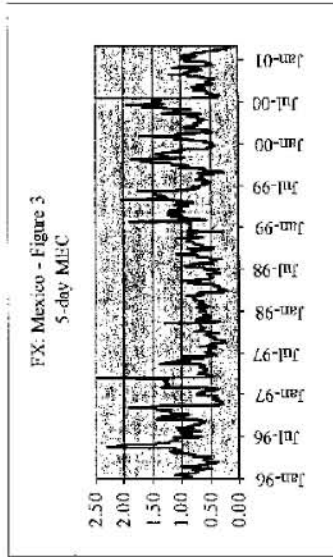
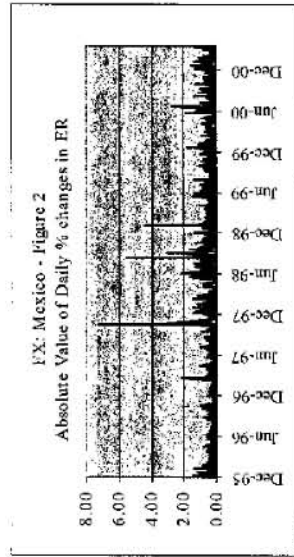
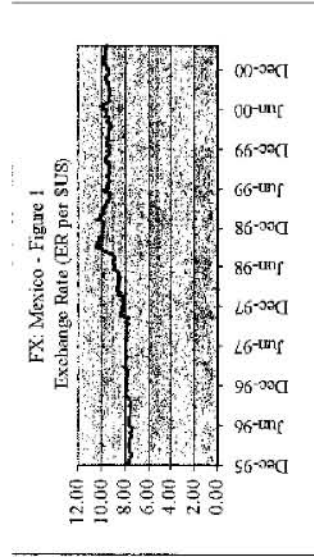
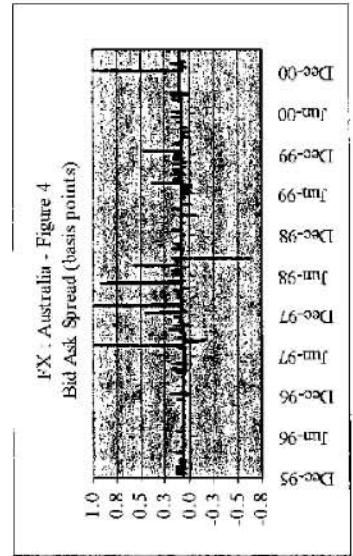
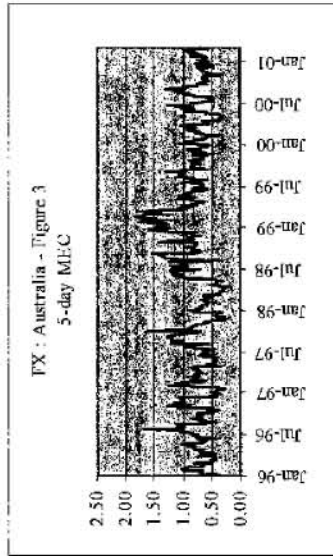
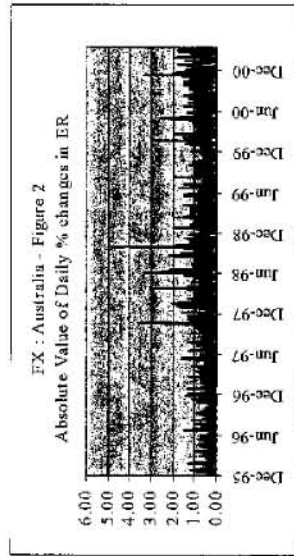
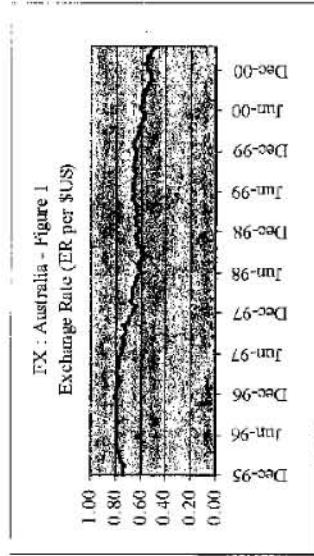
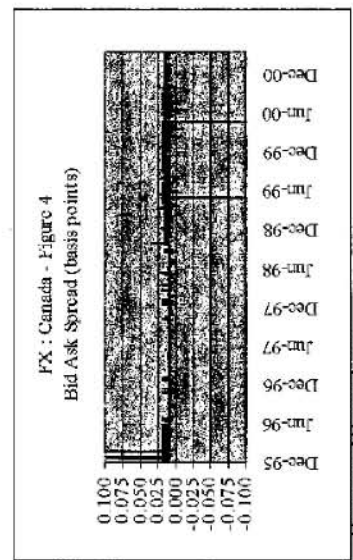
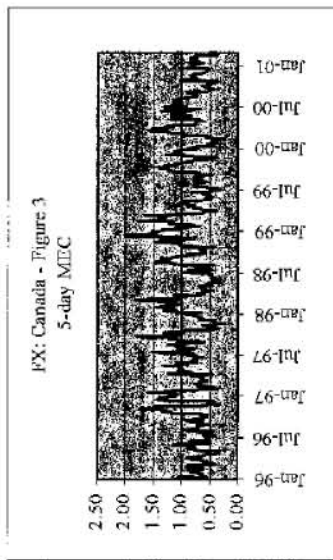
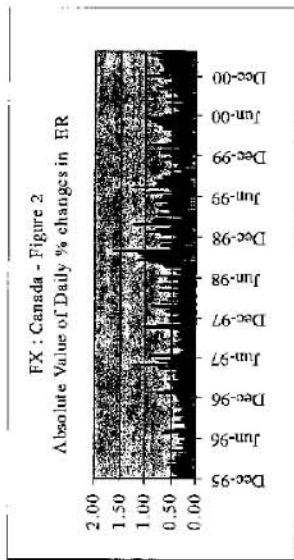
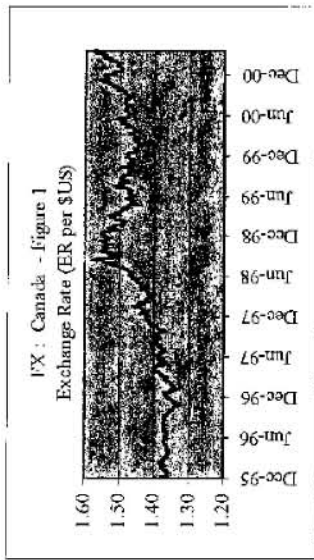
Frequency: Daily

Price: Bid and ask prices/interest rates if available
Minimum and maximum prices/interest rates during the day (or period of observation) if relevant
Average prices/interest rates, where relevant
Closing prices/interest rates, where relevant
Market indicators (market index if available)

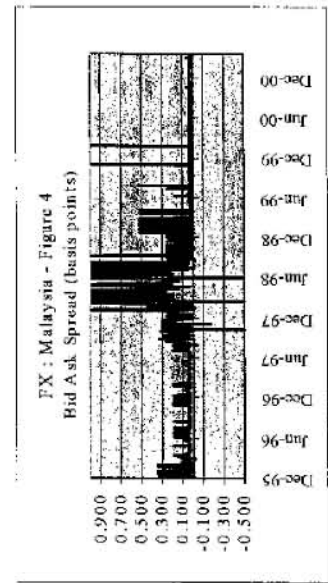
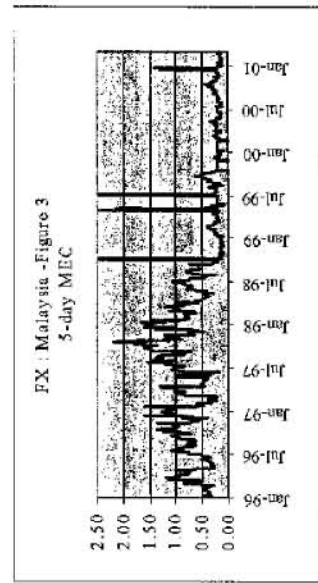
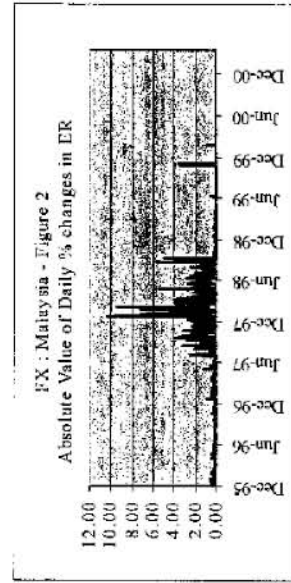
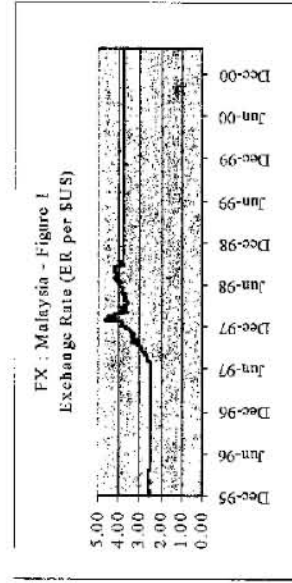
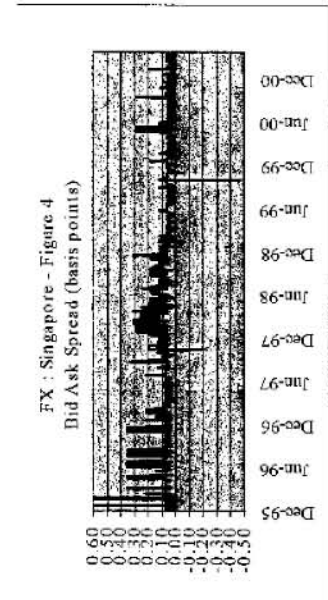
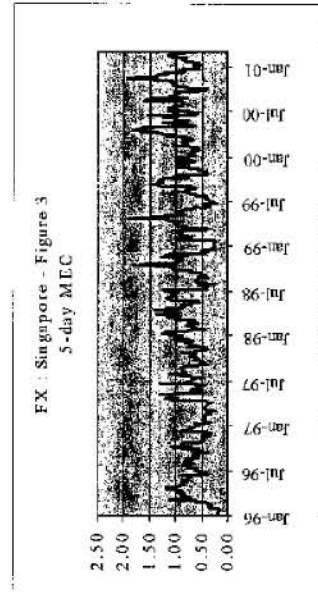
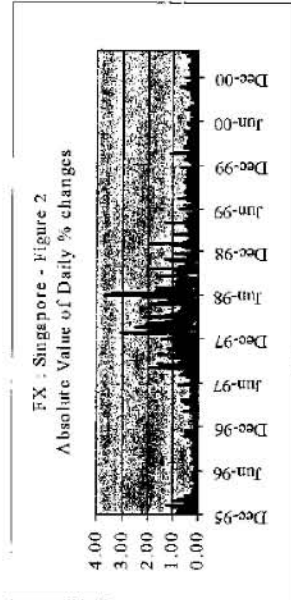
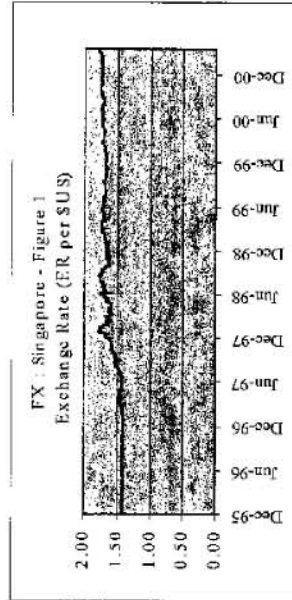
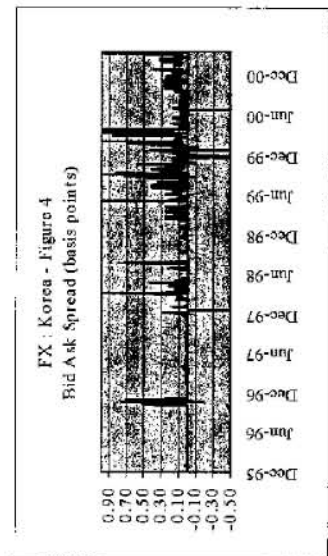
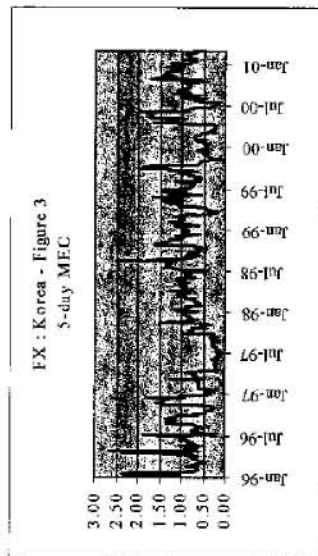
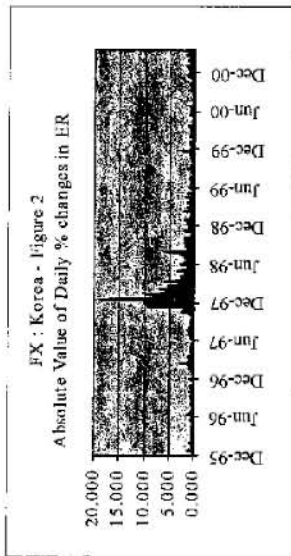
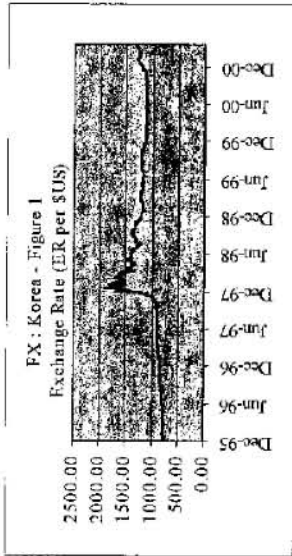
Turnover: Turnover during period (value per day or month)
Average number of trades during day

Outstanding value: Value at market price of pertinent most traded issues
Value at market price of total market

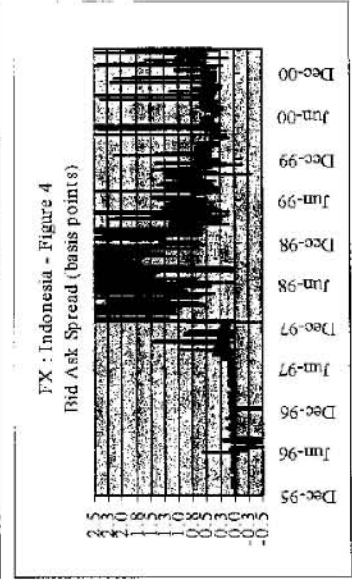
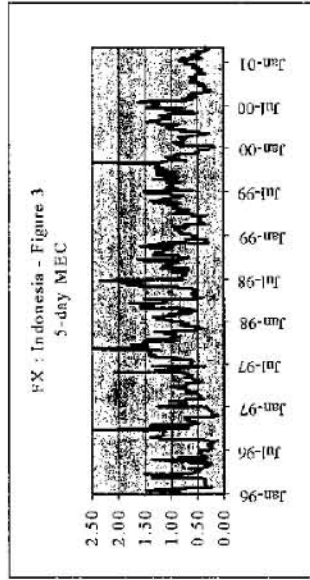
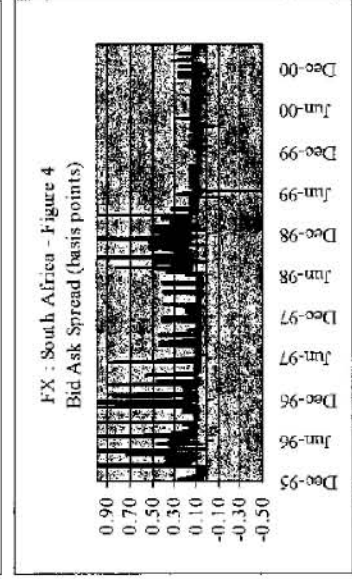
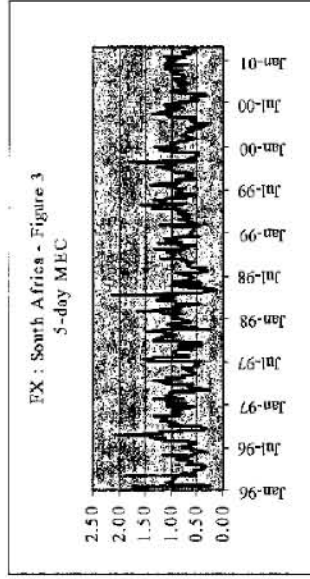
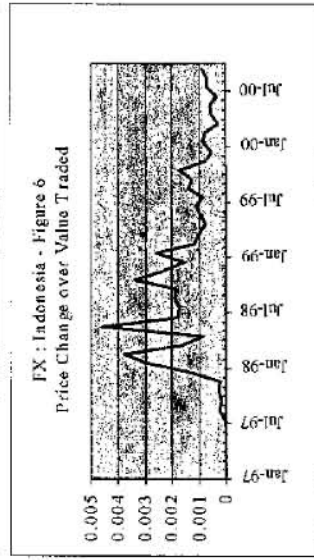
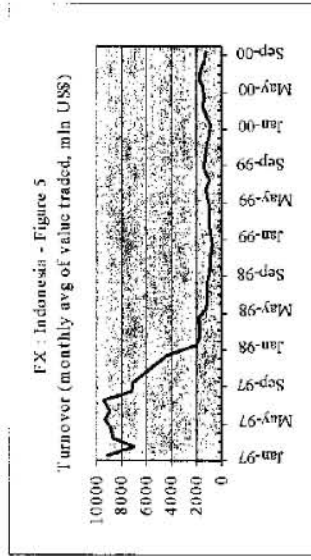
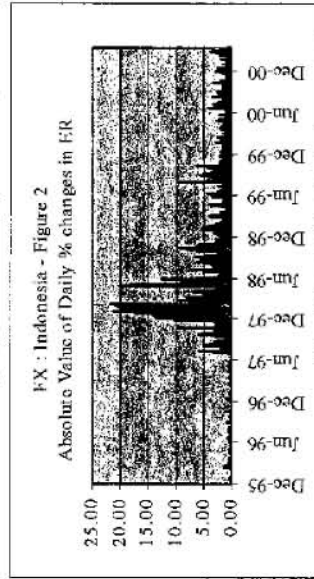
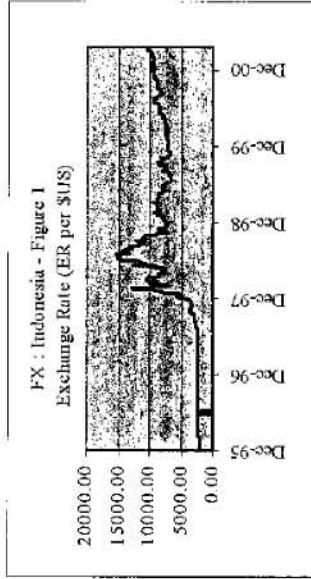
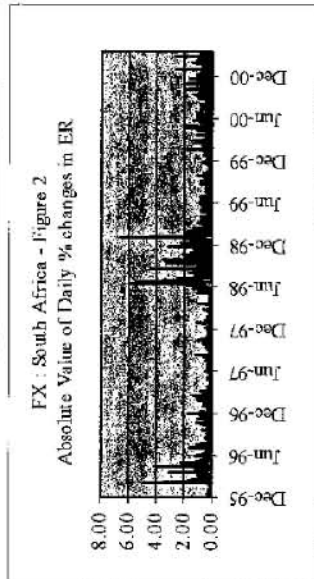
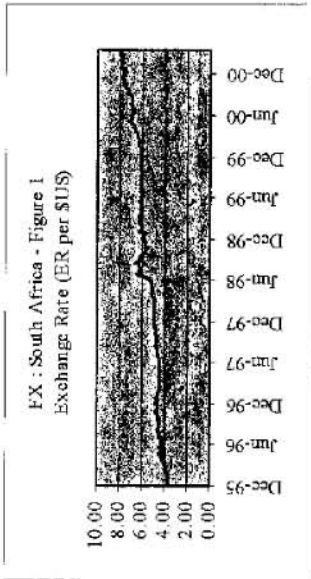
FIGURES ON VARIOUS LIQUIDITY MEASURES IN SELECTED FOREIGN EXCHANGE MARKETS



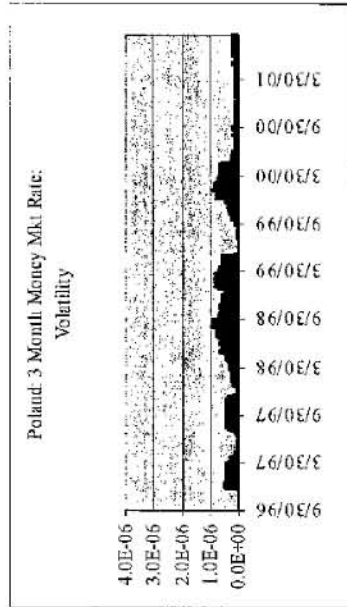
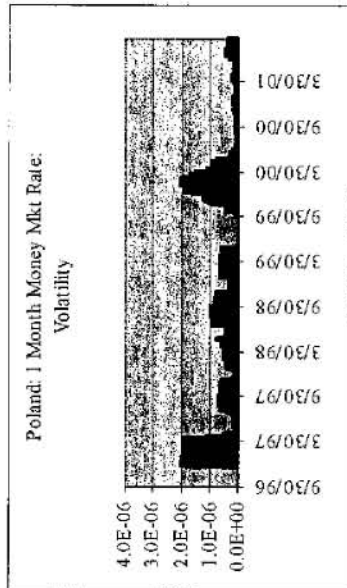
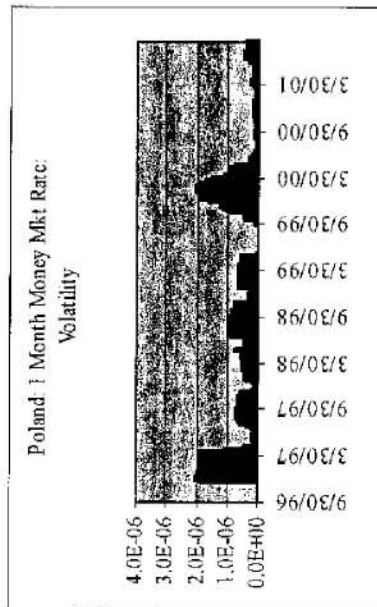
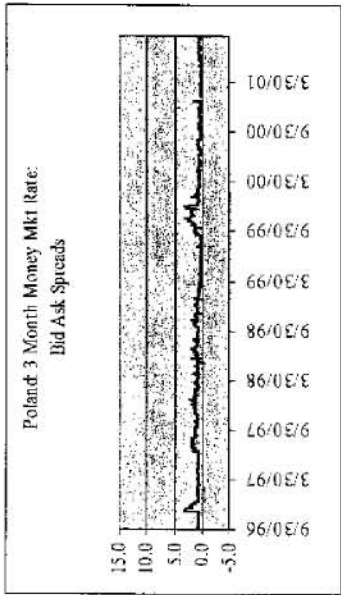
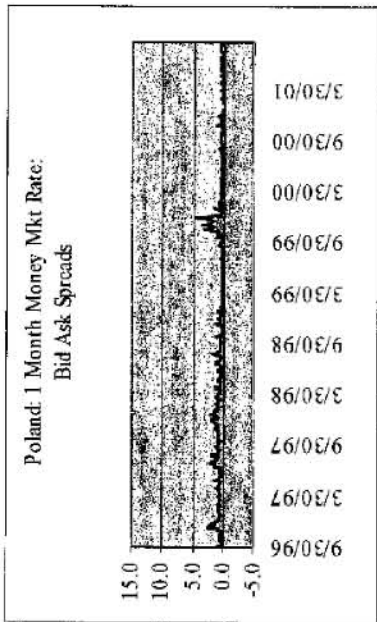
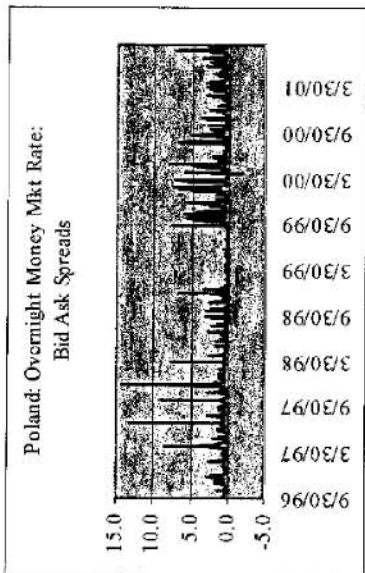
FIGURES ON VARIOUS LIQUIDITY MEASURES IN SELECTED FOREIGN EXCHANGE MARKETS



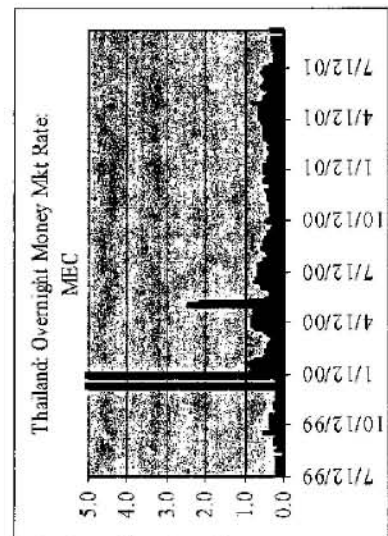
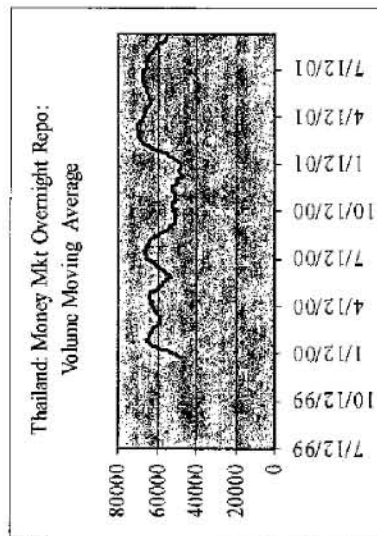
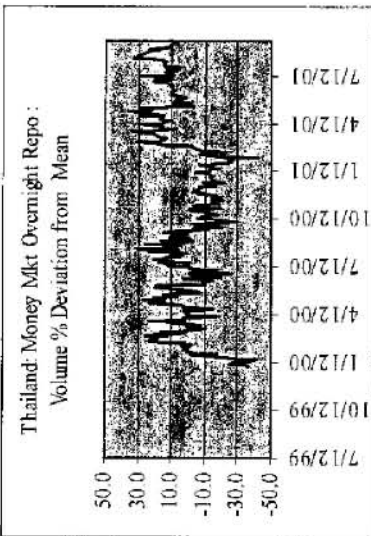
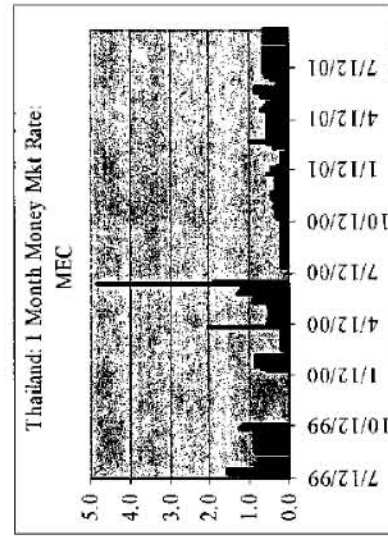
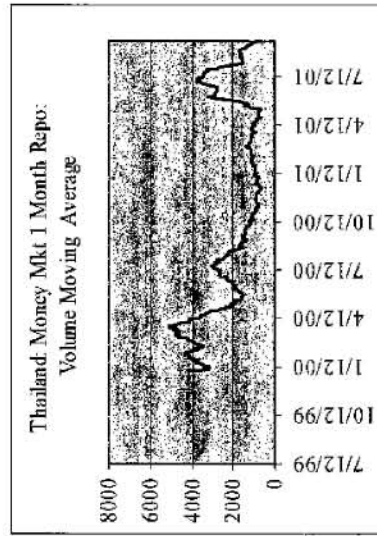
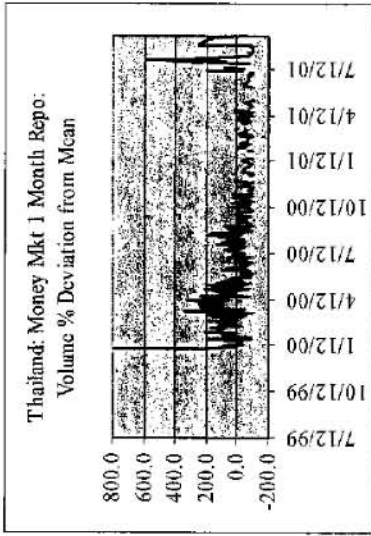
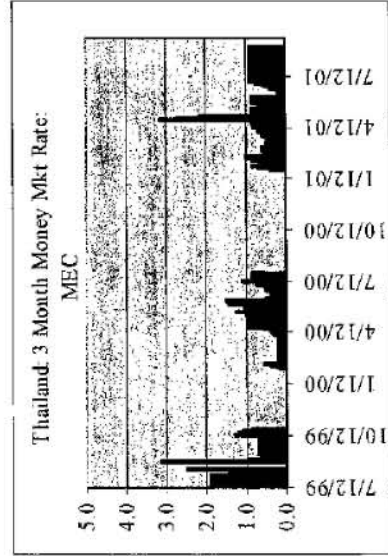
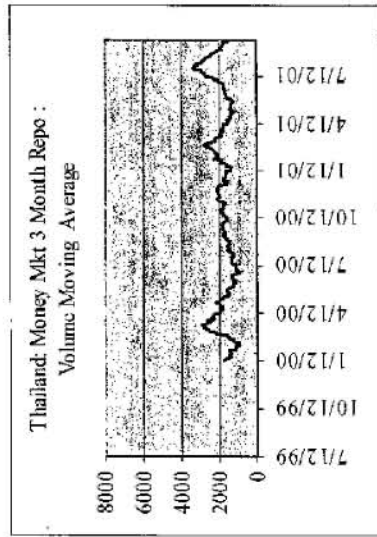
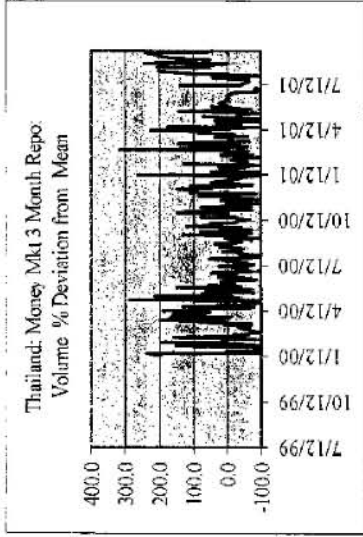
FIGURES ON VARIOUS LIQUIDITY MEASURES IN SELECTED FOREIGN EXCHANGE MARKETS

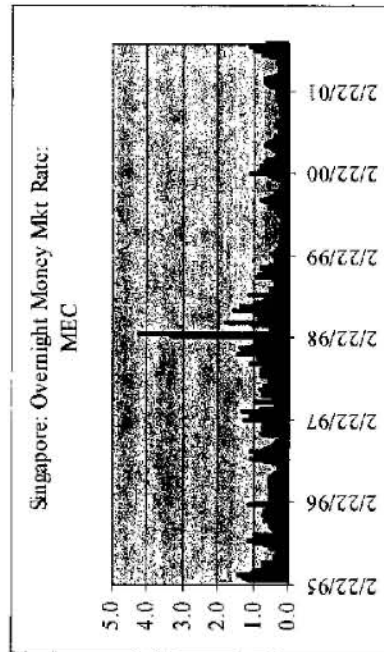
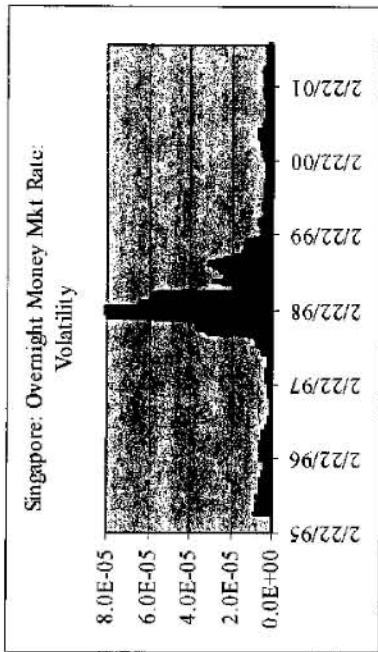
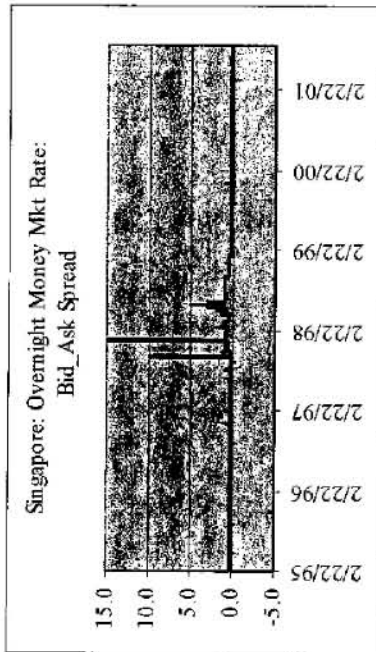
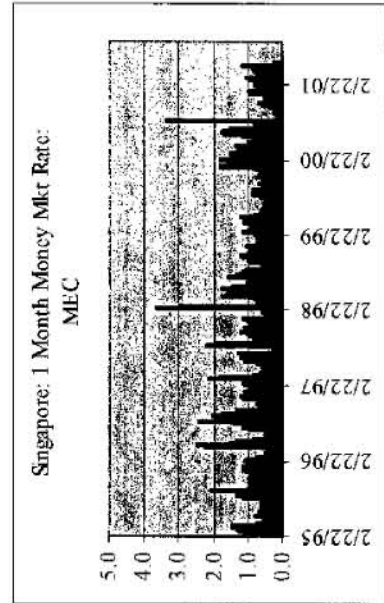
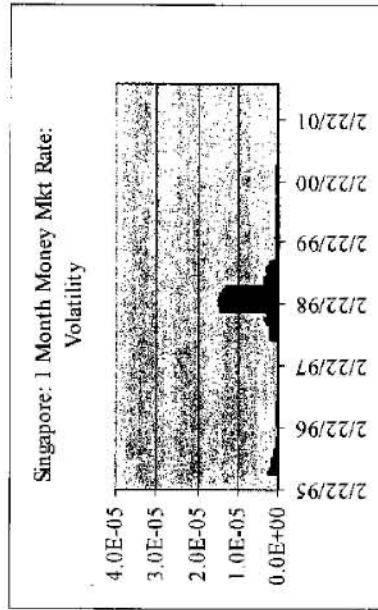
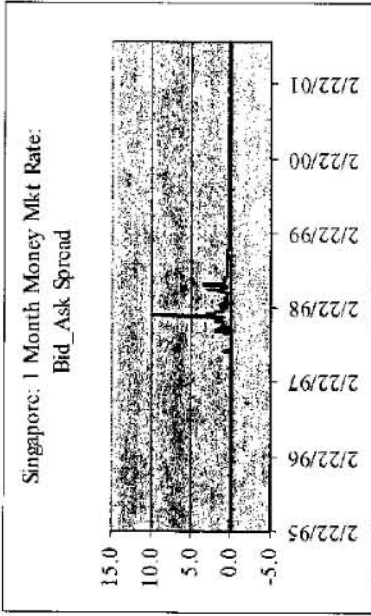


FIGURES ON VARIOUS LIQUIDITY MEASURES IN SELECTED MONEY MARKETS

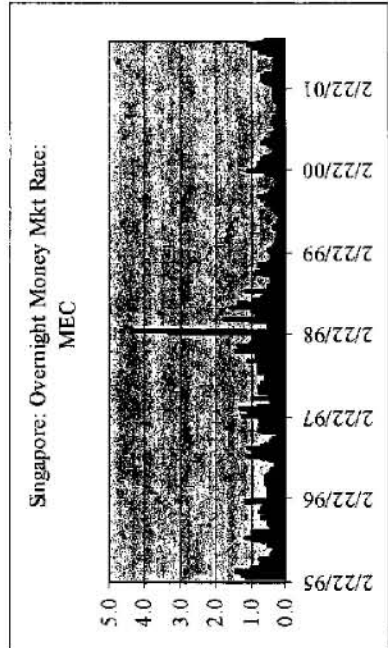
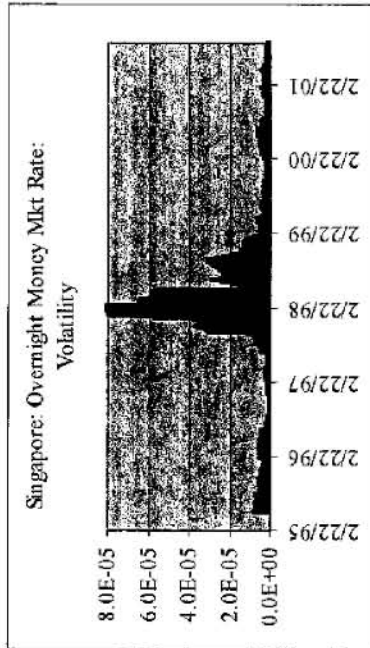
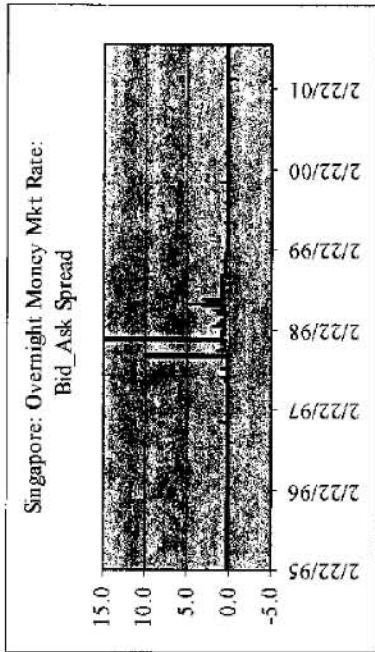
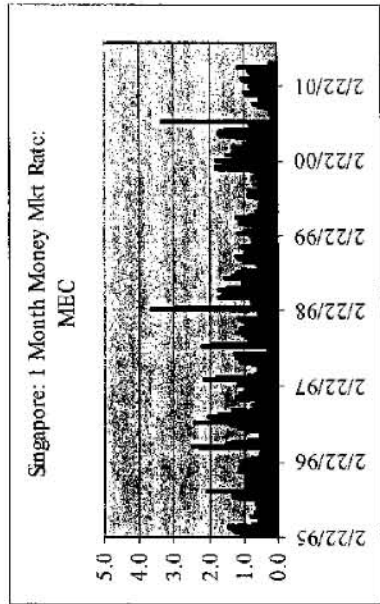
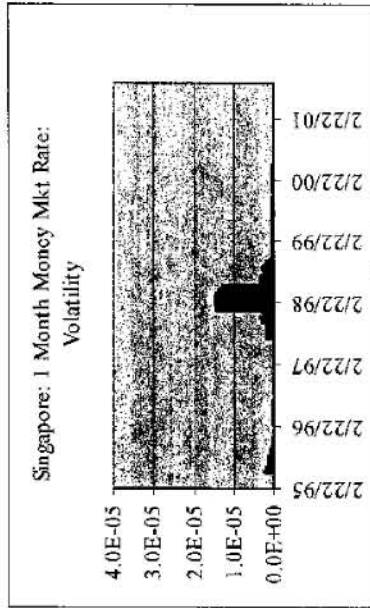
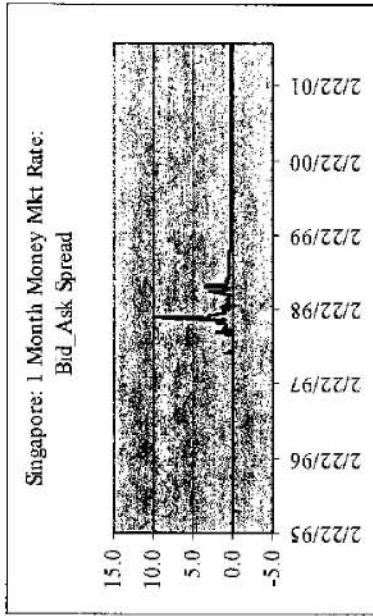


Source: Bloomberg.



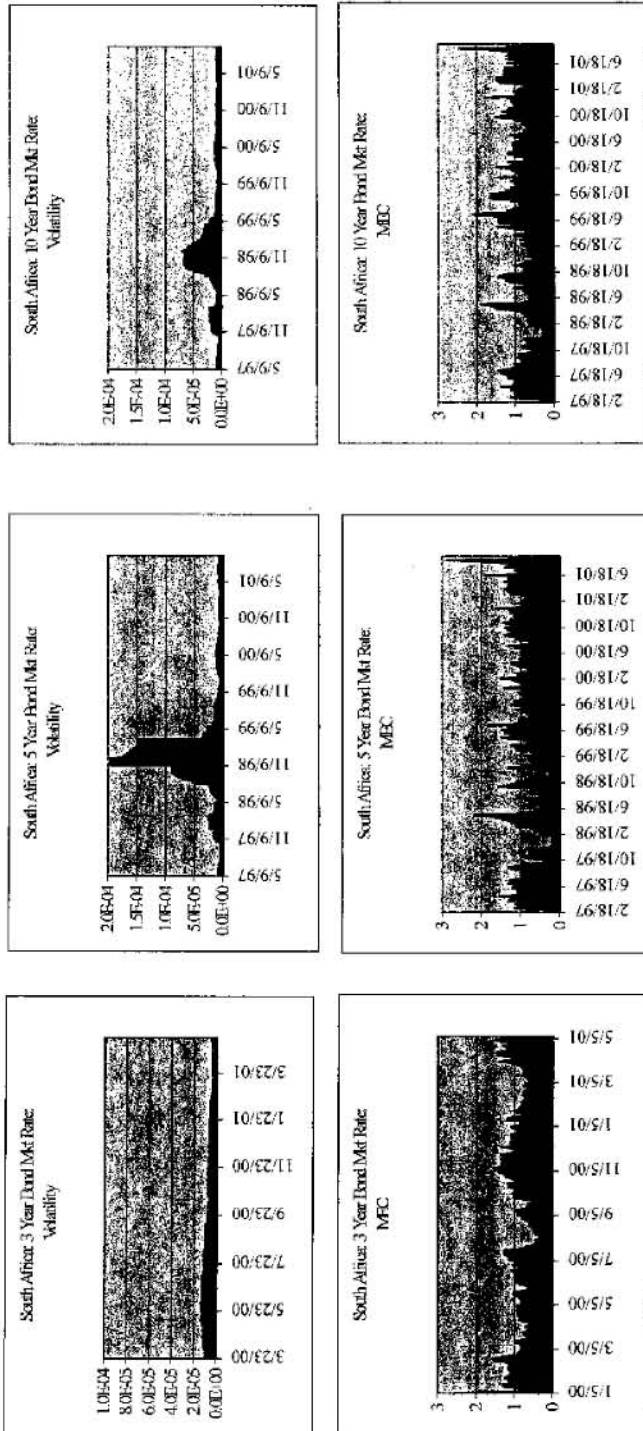


Source: Bloomberg.

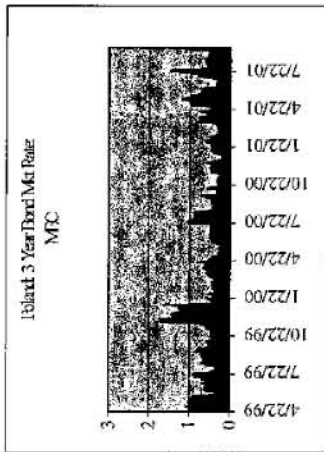
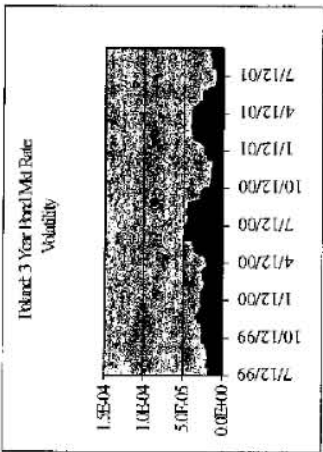
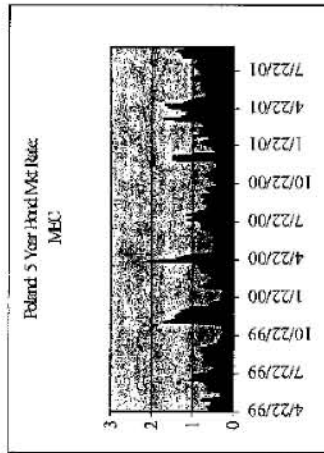
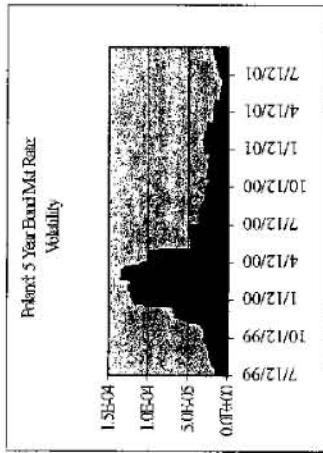
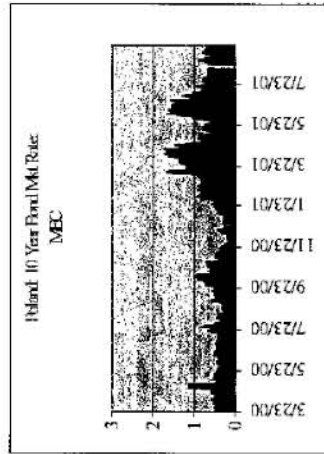
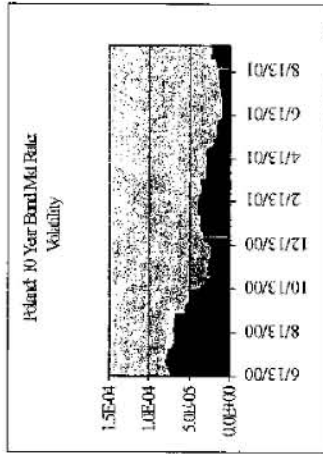


Source: Bloomberg.

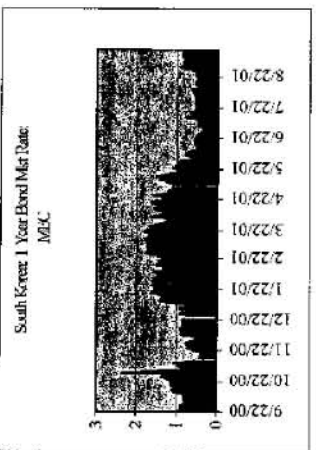
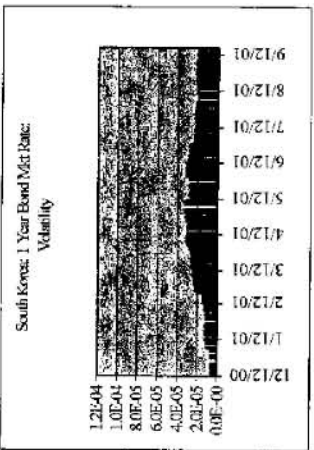
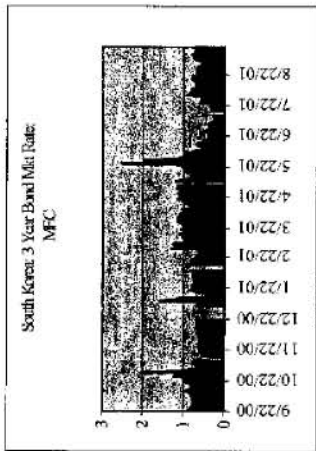
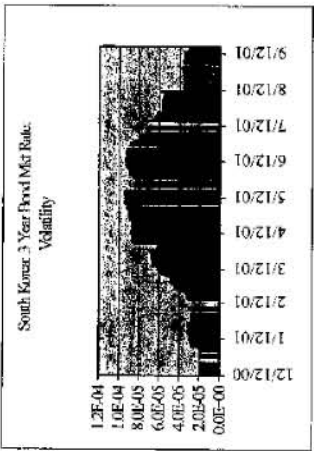
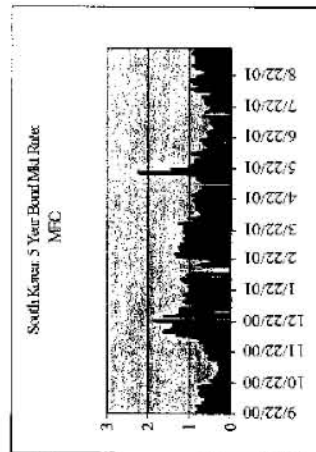
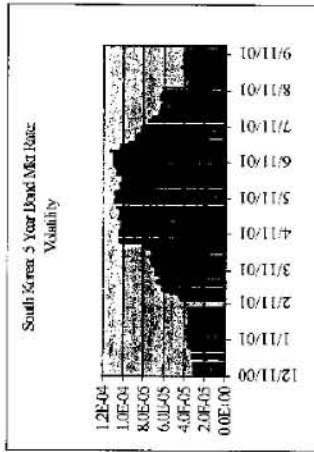
FIGURES ON VARIOUS LIQUIDITY MEASURES IN SELECTED GOVERNMENT BOND MARKETS



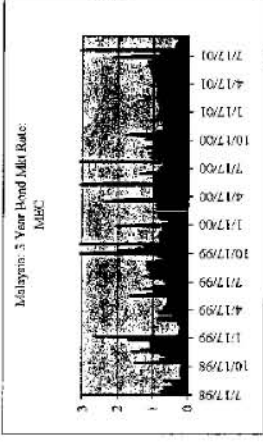
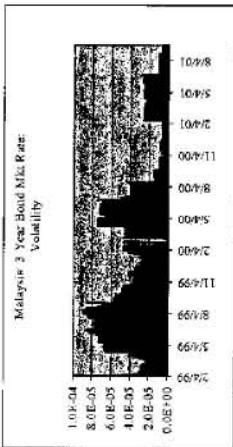
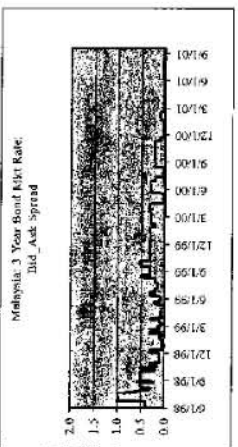
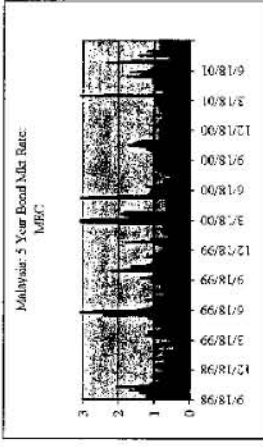
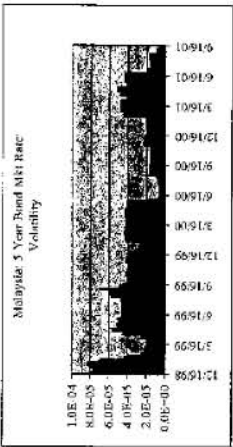
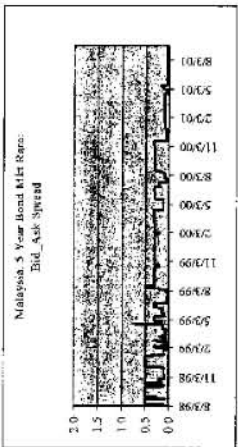
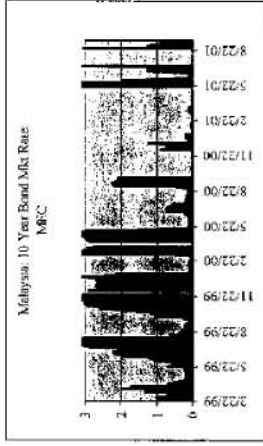
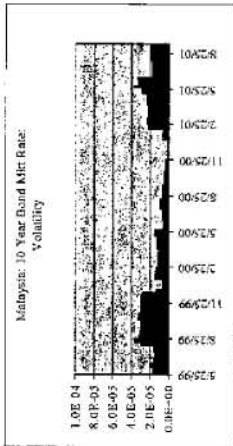
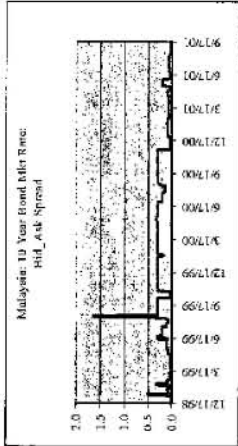
Source: Bloomberg.



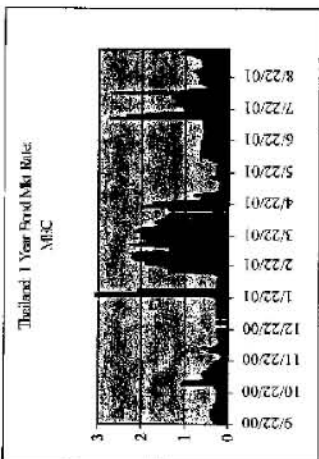
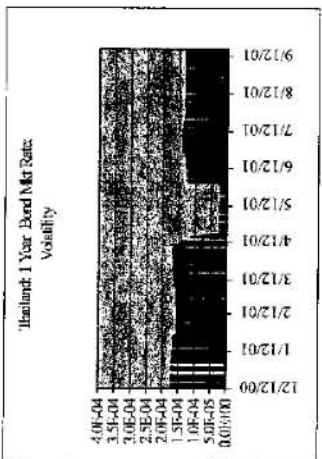
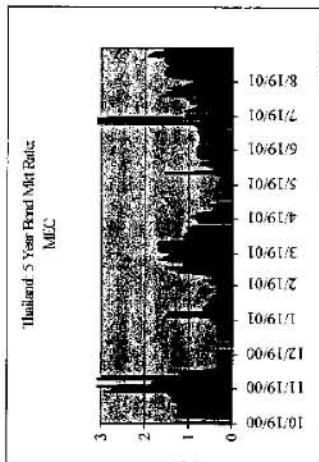
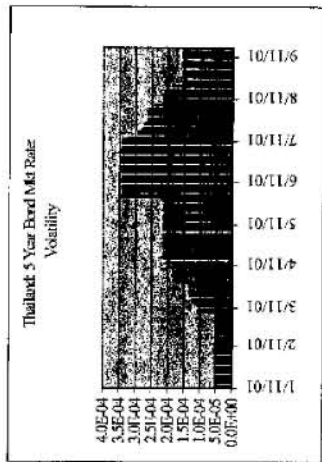
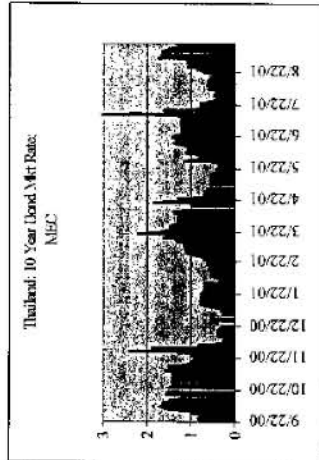
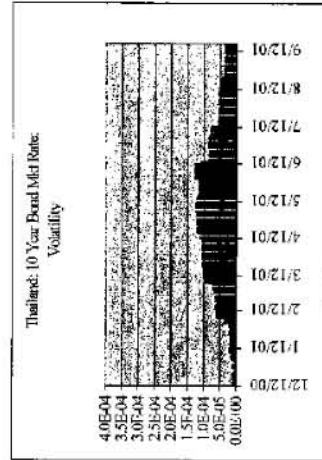
Source: Bloomberg.



Source: Bloomberg

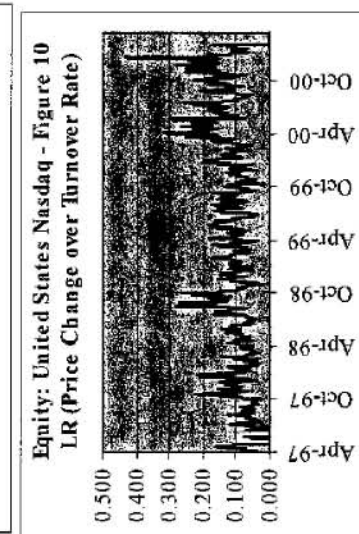
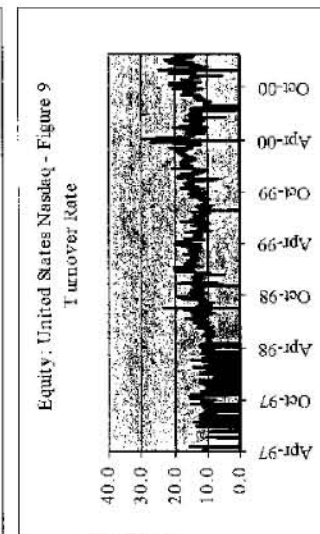
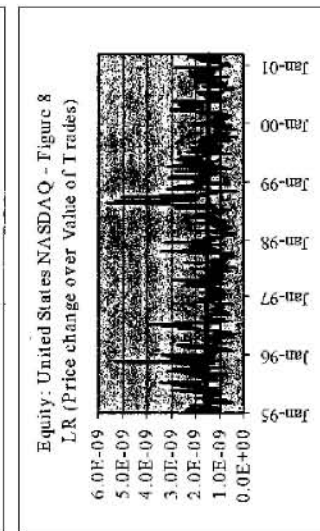
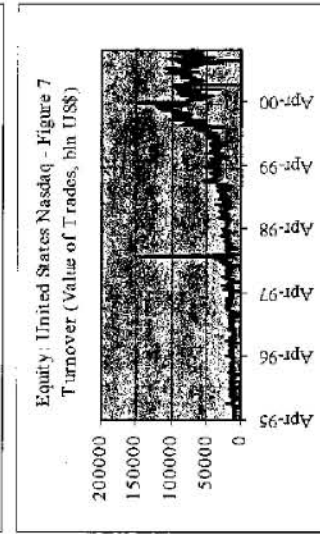
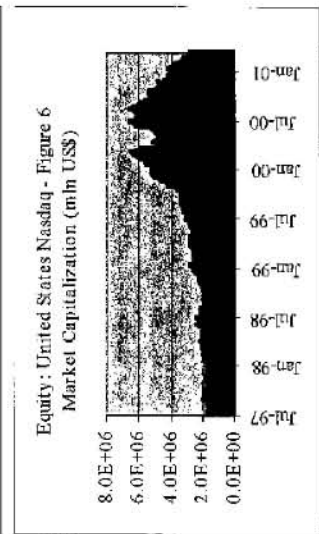
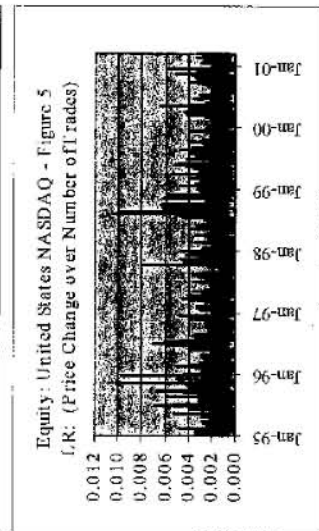
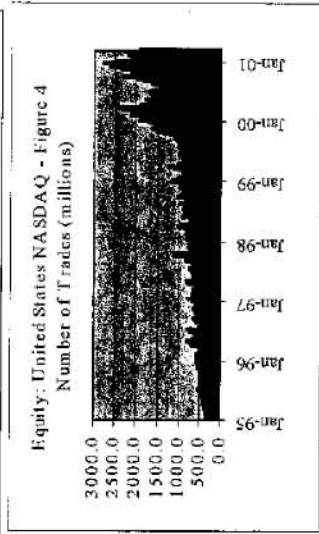
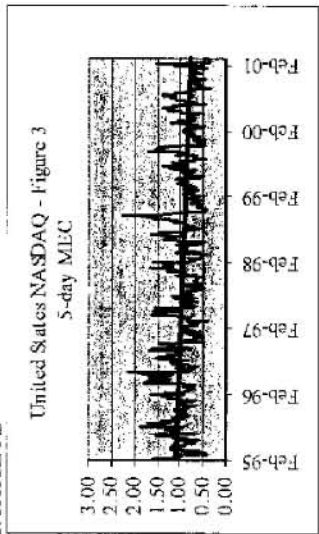
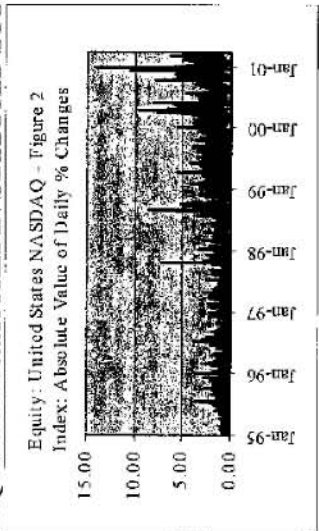
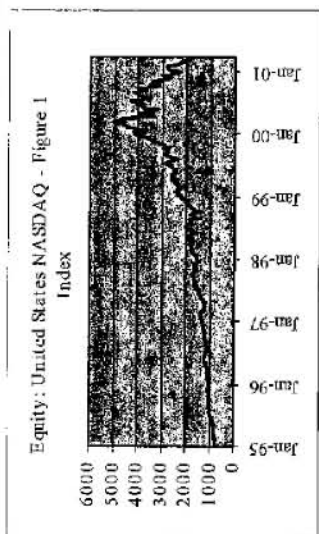


Source: Bloomberg.

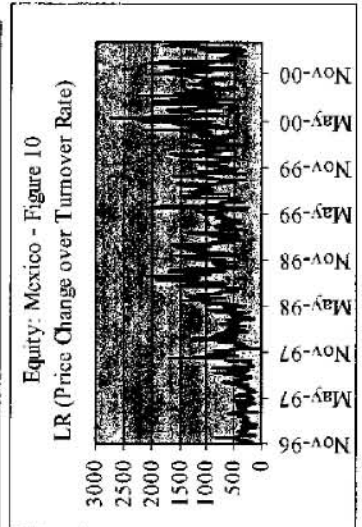
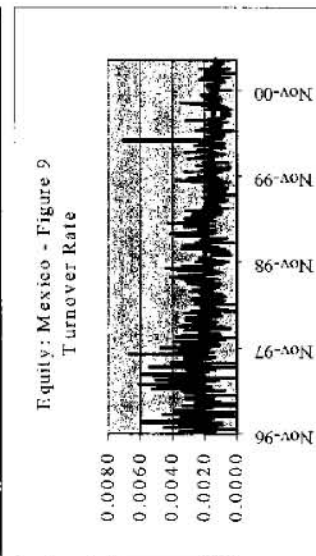
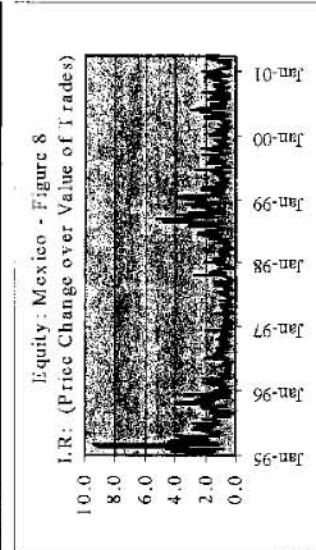
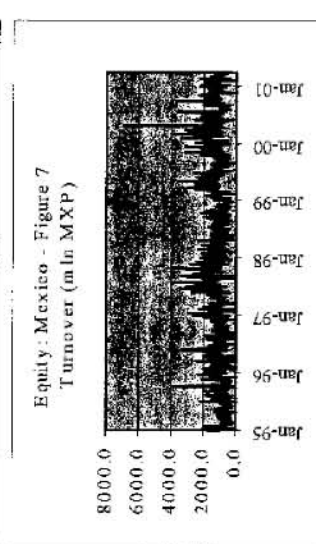
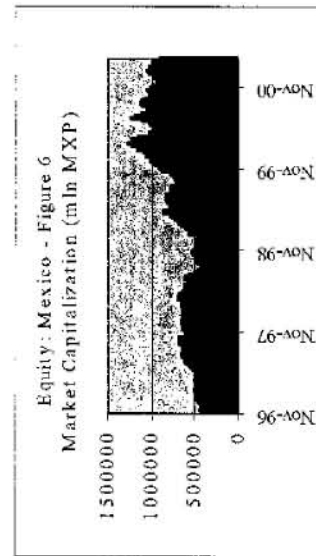
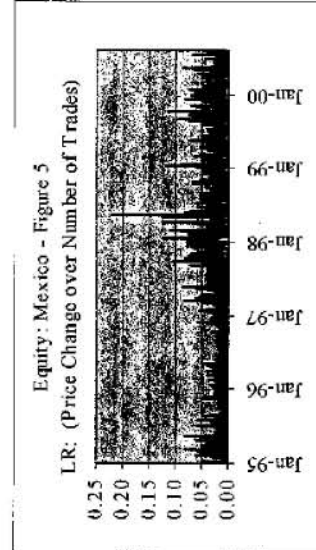
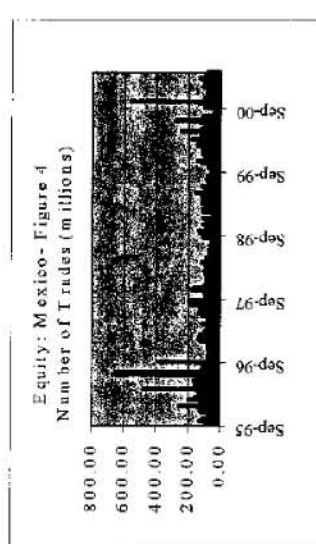
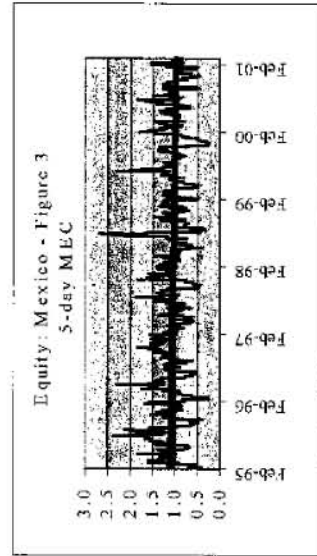
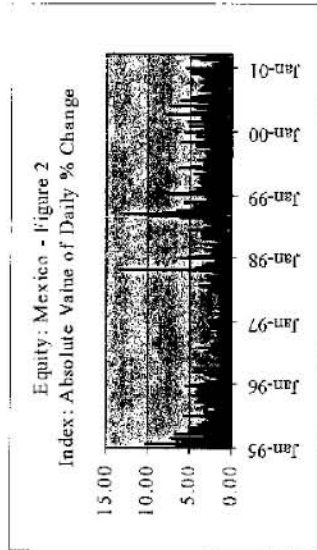
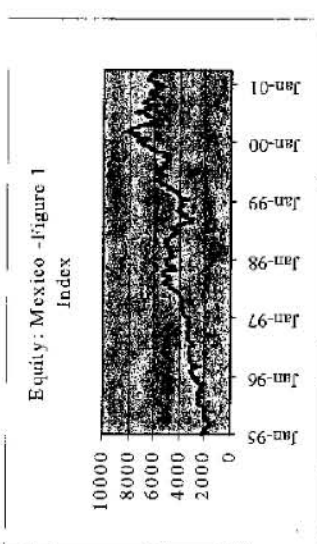


Source: Bloomberg.

FIGURES ON VARIOUS LIQUIDITY MEASURES IN SELECTED STOCK MARKETS

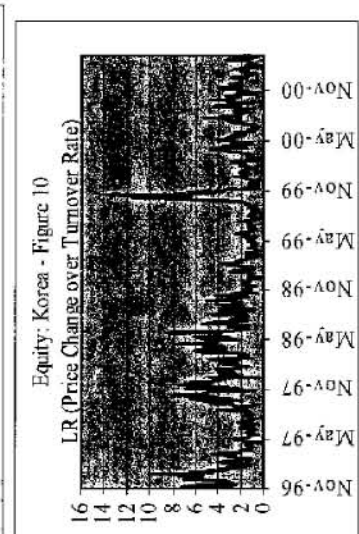
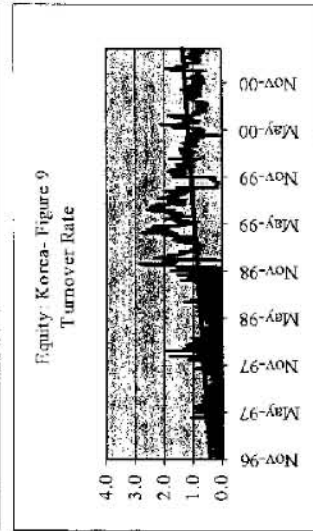
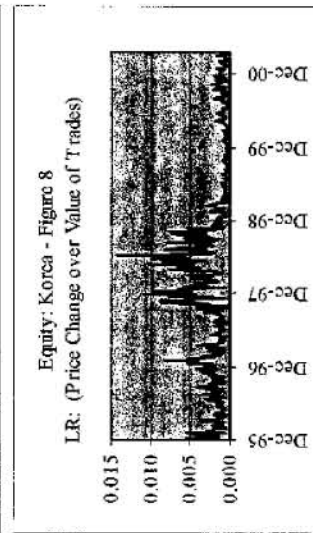
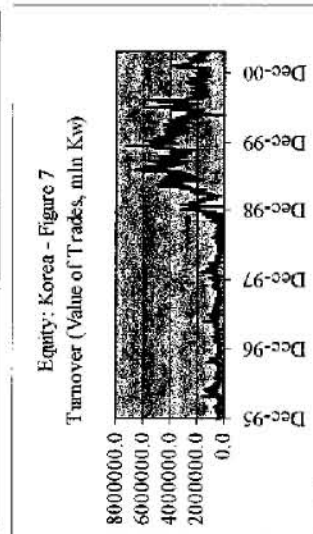
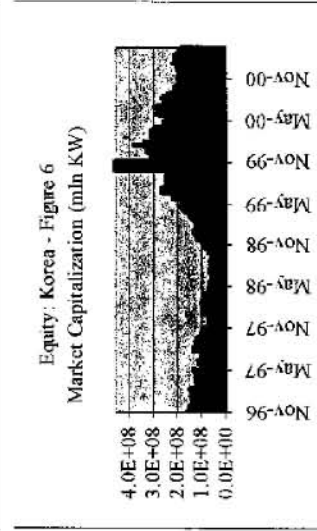
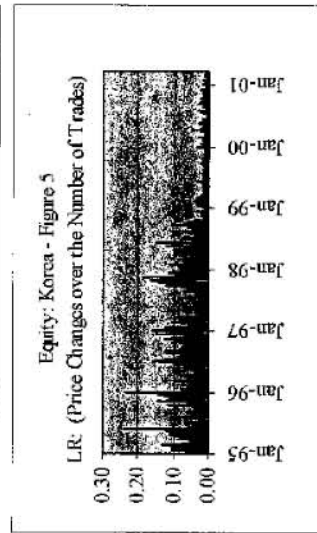
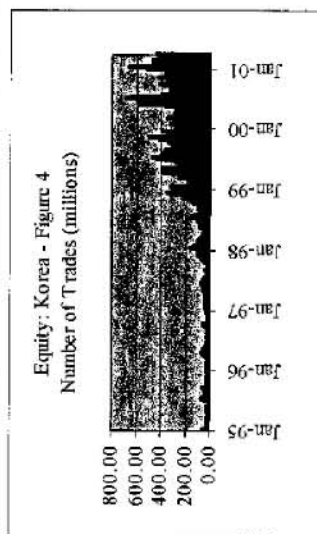
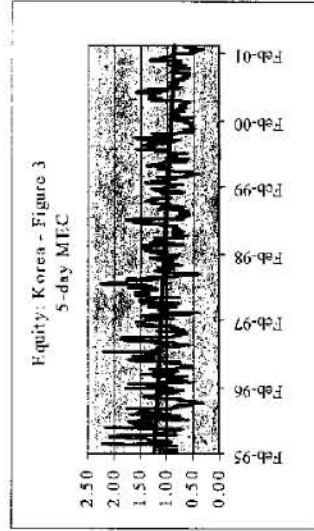
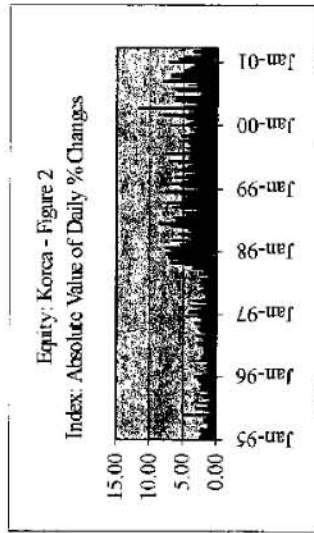
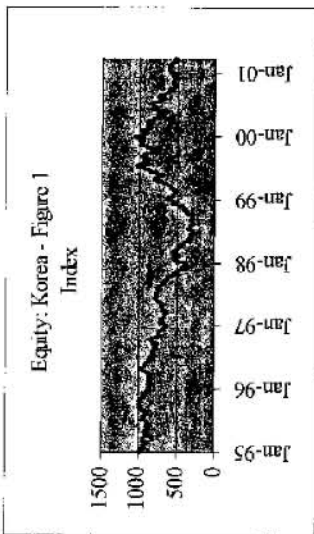


FIGURES ON VARIOUS LIQUIDITY MEASURES IN SELECTED STOCK MARKETS

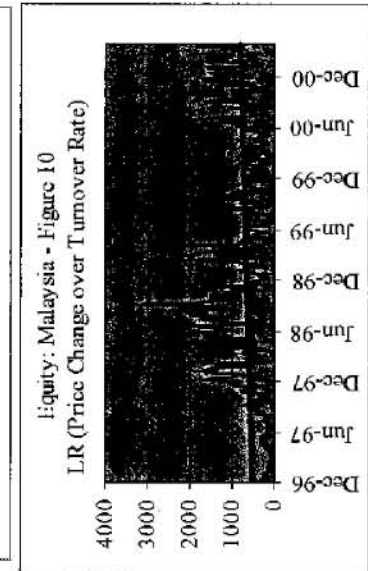
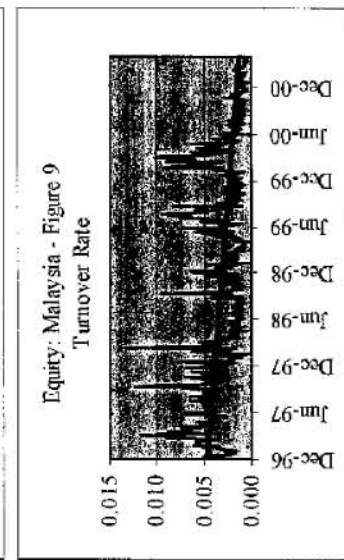
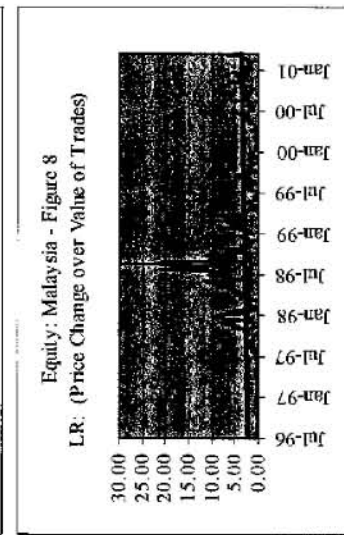
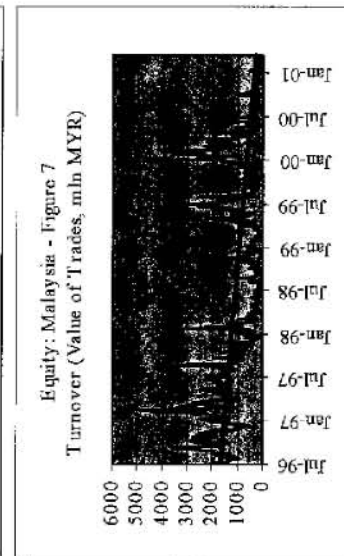
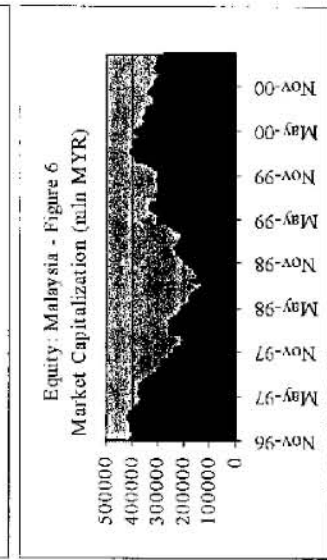
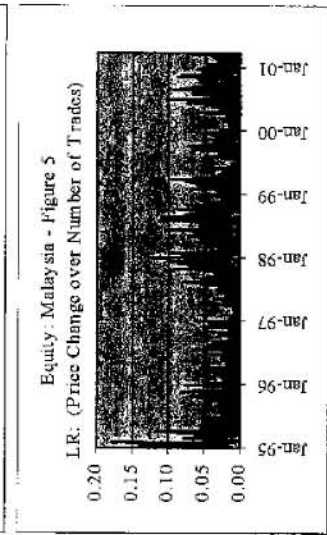
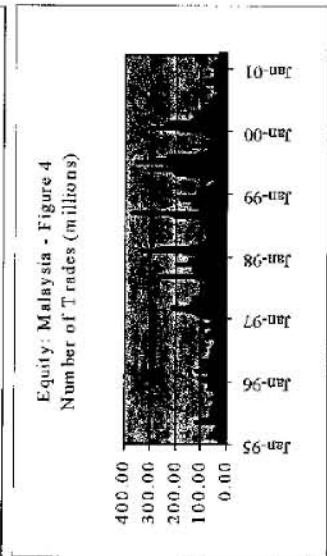
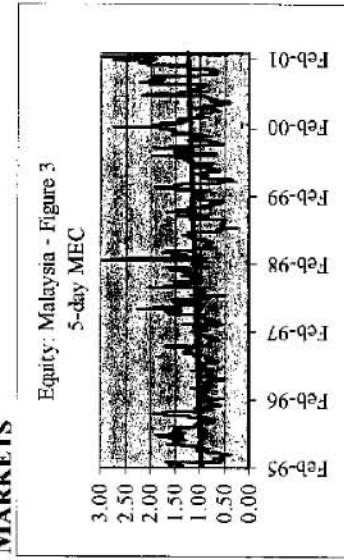
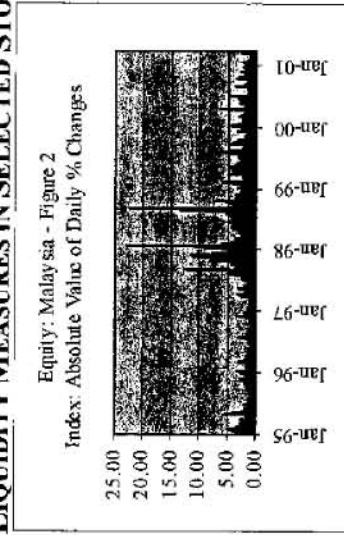
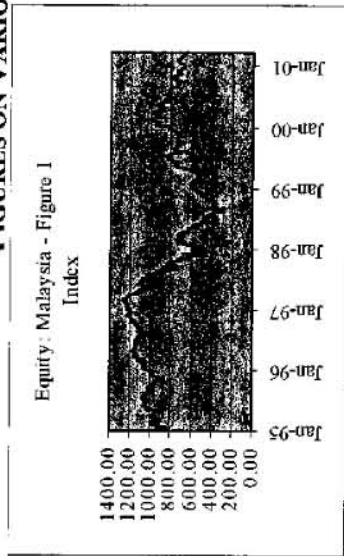


Source: Bloomberg.

FIGURES ON VARIOUS LIQUIDITY MEASURES IN SELECTED STOCK MARKETS

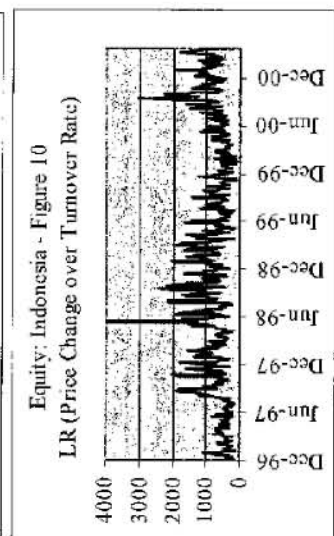
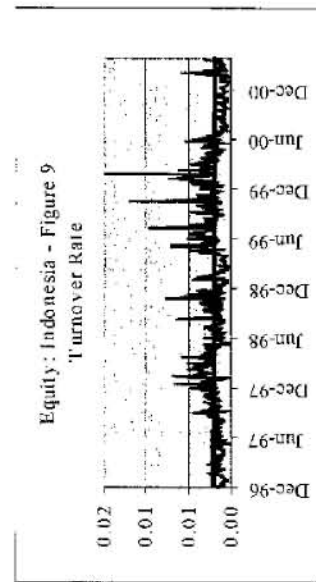
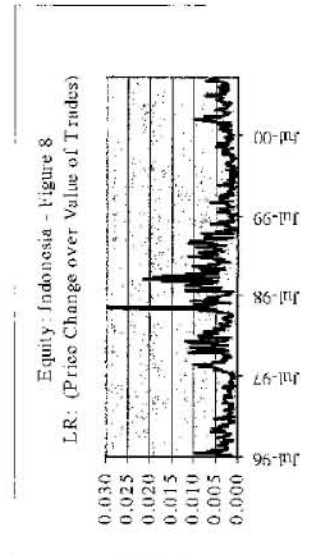
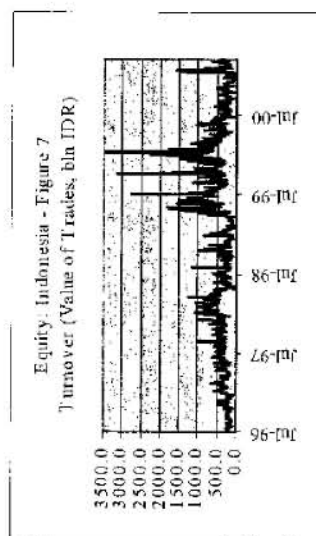
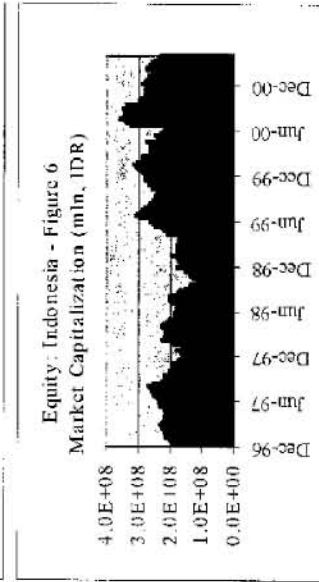
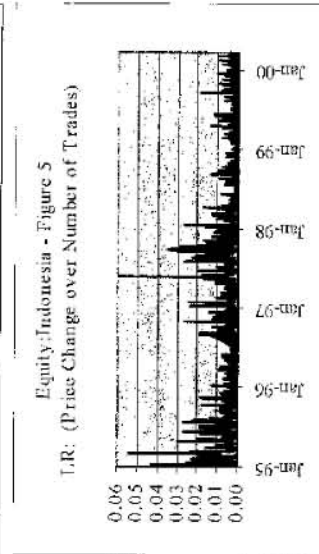
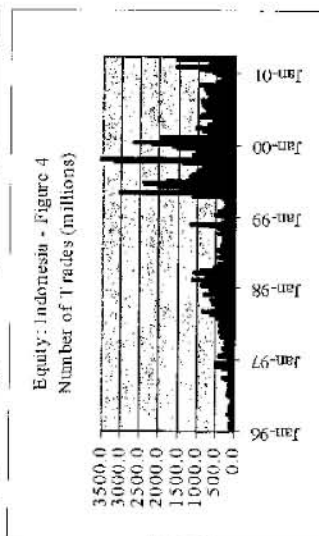
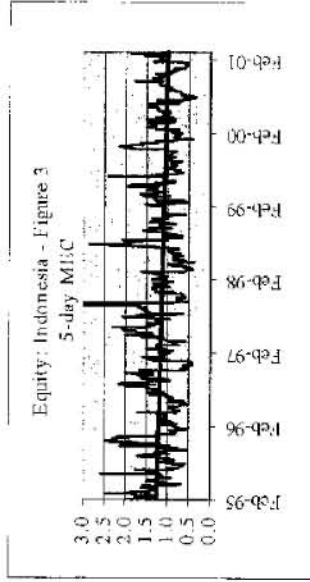
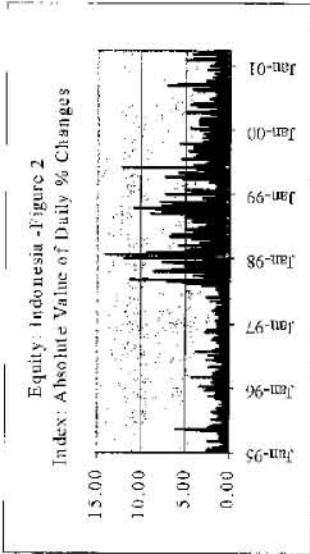
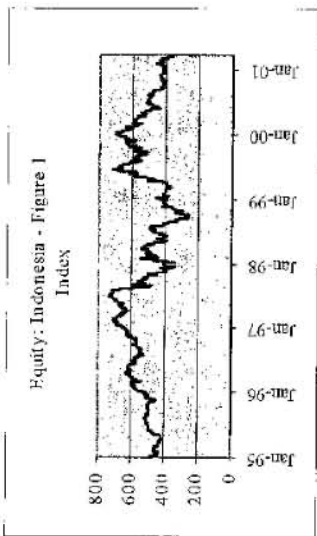


FIGURES ON VARIOUS LIQUIDITY MEASURES IN SELECTED STOCK MARKETS



Source: Bloomberg.

FIGURES ON VARIOUS LIQUIDITY MEASURES IN SELECTED STOCK MARKETS



REFERENCES

- Ahn, Hee-Joon, Kee-Hong Bae, and Karlok Chan, 2001, "Limit Orders, Depth, and Volatility: Evidence from The Stock Exchange of Hong Kong," *The Journal of Finance*, Vol. 56, No. 2 (April), pp. 767–88.
- Alonso, Francisco, Roberto Blanco, Ana del Rio, and Alicia Sanchis, 1999, "Estimating Liquidity Premia in The Spanish Government Securities Market," Documento de Trabajo No. 0017, Banco de España (Madrid).
- Atkins, Allen B., and Edward A. Dyl, 1997, "Market Structure and Reported Trading Volume: NASDAQ Versus The NYSE," *Journal of Financial Research*, Vol. 20, No. 3 (Fall), pp. 291–304.
- Bank for International Settlements, 1999, *Market Liquidity: Research Findings and Selected Policy Implications*, Committee on the Global Financial System (Basel).
- _____, 2000, *Sound Practices for Managing Liquidity in Banking Organizations*, Basel Committee on Banking Supervision, Basel (February).
- _____, 2001a, *Core Principles for Systemically Important Payment Systems*, Committee on Payments and Settlement Systems, Basel (January).
- _____, 2001b, *Central Bank Survey of Foreign Exchange and Derivatives Market Activity in April 2001: Preliminary Global Data*, Press Release No. 31, 2001E.
- _____, 2001c, *Structural Aspects of Market Liquidity from a Financial Stability Perspective*, A discussion note by the Committee on the Global Financial System, Basel (March).
- _____, and International Organization of Securities Commissions, 2001d, *Recommendations for Securities Settlement Systems*, Committee on Payments and Settlement Systems and Technical Committee on Payments and Settlement Systems, Basel (November).
- Baker, K., 1996 "Trading Location and Liquidity: An Analysis of U.S. Dealer and Agency Markets for Common Stocks," *Financial Markets, Institutions, and Instruments*, Vol. 5, No. 4.
- Bernard, Henri, and Joseph Bisignano, 2000, "Information, Liquidity and Risk in The International Interbank Market: Implicit Guarantees and Private Credit Market Failure," BIS Working Paper No. 86 (Basel: Bank for International Settlements).
- Bernstein, Peter, L., 1987, "Liquidity, Stock Markets, and Market Makers," *Financial Management* (Summer), pp. 54–62.

- Bessembinder, Hendrik, and Paul J. Seguin, 1993, "Price Volatility, Trading Volume, and Market Depth: Evidence from Futures Markets," *Journal of Financial and Quantitative Analysis*, Vol. 28, No. 1 (March), pp. 21–39.
- Borio, Claudio, 2000, "Market Liquidity and Stress: Selected Issues and Policy Implications," special feature in *BIS Quarterly Review* (November) (Basel: Bank for International Settlements).
- Breedon, Francis, 2000, "Market Liquidity under Stress: Observations from the FX Market," *BIS Papers No. 2* (Basel: Bank for International Settlements).
- Campbell, John Y., Andrew W. Lo, and A. Craig MacKinlay, 1997, *The Econometrics of Financial Markets* (Princeton, New Jersey: Princeton University Press).
- Chordia, Tarun, Asani Sarkar, and Avanidhar Subrahmanyam, 2002, "An Empirical Analysis of Stock and Bond Market Liquidity" (unpublished).
- Chordia, Tarun, Richard Roll, and Avanidhar Subrahmanyam, 2001, "Market Liquidity and Trading Activity," *The Journal of Finance*, Vol. 56, No. 2 (April), pp. 501–30.
- Cohen, Benjamin H., and Hyun Song Shin, 2002, "Positive Feedback Trading under Stress: Evidence from the US Treasury Securities Market," in *Risk Measurement and Systemic Risk* issued by Committee on the Global Financial System (Basel: Bank for International Settlements).
- _____, 1999, "Monetary Policy Procedures and Volatility Transmission along the Yield Curve," discussion note for the Committee on the Global Financial System (Basel: Bank for International Settlements).
- Dahlquist, Magnus, Peter Hördahl, and Peter Selling, 2000, "Measuring International Volatility Spillovers," *BIS Conference Paper* (Basel: Bank for International Settlements).
- Dattels, Peter, 1997, "Microstructure of Government Securities Markets," in *Coordinating Public Debt and Monetary Management*, ed. by V. Sundararajan, Peter Dattels, and Hans Blommestein (Washington: International Monetary Fund), pp. 209–82.
- Dupont, Y. Dominique "The Effects of Transaction Costs on Depth and Spread" *BIS Papers No. 2* (Basel: Bank for International Settlements).
- Dyl, Edward A., and Anne M. Anderson, 2002, "Market Structure and Trading Volume" (unpublished).

- Dziobek, Claudia, J. Kim Hobbs, and David Marston, 2000, "Toward a Framework for Systemic Liquidity Policy," IMF Working Paper WP/00/34 (Washington: International Monetary Fund).
- Evans, Martin D. D., and Richard K. Lyons, 2002, "Order Flow and Exchange Rate Dynamics," *Journal of Political Economy*, Vol. 110, No. 1, pp. 170–80.
- Fama, Eugene T., 1970 "Efficient Capital Markets: A Review of Theory and Empirical Work," *The Journal of Finance*, Vol. 25, pp. 383–417.
- _____, 1991 "Efficient Capital Markets: II," *The Journal of Finance*, Vol. 46, No. 5 (December), pp. 1575–1617.
- Fleming, Michael J., and Asani Sarkar, 1999, "Liquidity in U.S. Spot and Futures Markets," in Committee on the Global Financial System's report "Market Liquidity: Research Findings and Selected Policy Implications" (May) (Basel: Bank for International Settlements).
- _____, and Eli M. Remolona, 1999, "Price Formation and Liquidity in the U.S. Treasury Market: The Response to Public Information," *The Journal of Finance*, Vol. 54, No. 5 (October), pp. 1901–15.
- Furfine, Craig, 2002, "The Interbank Market During a Crisis," BIS Working Paper No. 99 (Basel: Bank for International Settlements).
- Galati, Gabriele, 2000, "Trading Volumes, Volatility and Spreads in Foreign Exchange Markets: Evidence from Emerging Markets," BIS Working Paper No. 93 (Basel: Bank for International Settlements).
- _____, and Corrinne Ho, 2001, "Macroeconomic News and The Euro/dollar Exchange Rate," BIS Working Paper No. 105 (Basel: Bank for International Settlements).
- Garbade, Kenneth, 1982, *Securities Markets* (New York: McGraw-Hill).
- Grossman, S. J., and M. Miller, 1988 "Liquidity and Market Structure," *The Journal of Finance* (July), pp. 617–33.
- Hasbrouck, J. and Robert A. Schwartz, 1998, "Liquidity and Execution Costs in Equity Markets," *Journal of Portfolio Management*, Vol. 14, No. 3 (Spring), pp. 10–16.
- Inoue, Hirotaka, 1999, *The Structure of Government Securities Markets in the G-10 Countries: Summary of Questionnaire Results*, Committee on The Global Financial System (Basel: Bank for International Settlements).

- Karpoff, Jonathan M., 1987, "The Relation between Price Changes and Trading Volume: A Survey," *Journal of Financial and Quantitative Analysis*, Vol. 22, No. 1 (March), pp. 109–26.
- Keynes, John Maynard, 1936, *The General Theory of Employment, Interest, and Money*, First Harbinger Edition, New York, 1964.
- Kyle, Albert S., "Continuous Auctions and Insider Trading," *Econometrica*, Vol. 53, No. 6 (November), pp. 1315–35.
- Manganelli, Simone, 2002, "Duration, Volume and Volatility Impact of Trades," Working Paper No. 125 (Frankfurt: European Central Bank).
- Melvin, Michael, and Xixi Yin, 2000, "Public Information Arrival, Exchange Rate Volatility, and Quote Frequency," *The Economic Journal*, No. 110 (July), pp. 644–61.
- Mishkin, F. S., 1991, "Anatomy of a Financial Crisis," NBER Working Paper No. 3934 (Cambridge, Massachusetts: National Bureau of Economic Research).
- Mohanty, S. M., 2002, "Improving Liquidity in Government Bond Markets: What Can Be Done?" BIS Papers No. 11 (Basel: Bank for International Settlements).
- O'Hara, Maureen, 1995, *Market Microstructure Theory* (Cambridge, Massachusetts: Blackwell Publishers).
- _____, 2000, "Overview: Market Structure Issues in Market Liquidity," *BIS Papers No. 2* (Basel: Bank for International Settlements).
- Shah, Ajay, and Susan Thomas, 1998, "Market Microstructure Consideration in Index Construction" (unpublished).
- Shen, P., and R. Starr, 1998, "Liquidity of the Treasury Bill Market and the Term Structure of Interest Rates," *Journal of Economics and Business*, Vol. 50, pp. 401–17.
- Muranaga, J., and T. Shimizu, 1999, "Expectations and Market Microstructure When Liquidity is Lost," BIS, Committee on Global Financial System. "Market Liquidity: Research Findings and Selected Policy Implications" (Basel).
- Wood, J. H., and Norma L. Wood, 1985, *Financial Markets* (New York: Harcourt Brace Jovanovich).