Liquidity of the Hong Kong stock market since the Asian financial crisis

Jim Wong and Laurence Fung,[1]
Market Research Division, Research Department
Hong Kong Monetary Authority

Abstract

This paper looks into how the liquidity of the Hong Kong stock market has evolved since the Asian financial crisis, and examines the determinants of changes in liquidity. Various conventional liquidity indicators are constructed for the study period from 1997 to June 2001. They show that, having deteriorated during the Asian financial crisis and the Russian crisis, market liquidity has mostly recovered to the pre-crisis level in the more recent period. However, these conventional liquidity indicators have the drawback of not being able to capture fully the dynamics of liquidity. Thus, a GARCH model is developed for five selected stocks to relate the sensitivity of their price movements to net order flows, using a unique set of 30-second tick-by-tick data of the Hong Kong Stock Exchange. Empirical results from our model illustrate clearly a sharp deterioration of market liquidity during the crises, followed by an apparent recovery in the post-crisis period. Based on a simple OLS regression estimation, we also analyse the determinants of the time-variation of market liquidity. It is found that financial crises exerted their influence on local liquidity mainly through their effect on domestic interest rates and price volatility, while global liquidity and risk conditions also played a significant role.

1. Introduction

The liquidity of financial markets stood out as a critical issue in both the Asian financial crisis and the Russia/Long-Term Capital Management (LTCM) crisis. Being one of the most liquid markets in the world, the Hong Kong stock market often served as a hedging tool for emerging markets in the region in periods of heightened uncertainty. As a result, Hong Kong's stock market is extremely sensitive to external factors. The turbulence in the 1997 and 1998 financial crises had placed tremendous pressure on liquidity and the efficient functioning of Hong Kong's stock market, and tested Hong Kong's ability as an international financial centre in withstanding the shocks.

Numerous studies on the dynamics and determinants of market liquidity have been initiated by policymakers and academics. While some studies indicated that the liquidity conditions in Hong Kong's markets have generally improved from the lows reached during the region-specific shocks,[2] local market sentiment remains fragile. Market sources suggested that market participants remained concerned about liquidity, as investors and traders have become more risk averse, and various players have withdrawn from active trading.

Liquidity of the stock market is a good barometer for the proper functioning of a market as it measures the degree of easiness with which stocks can be traded. A mature stock market should be an efficient discounting mechanism and an effective exchange for channelling invested capital to the real economy. From a financial stability perspective, it is important to monitor liquidity during normal times

---

[1] The views expressed in this paper are solely our own and not necessarily those of the Hong Kong Monetary Authority (HKMA). We are grateful to Stefan Gerlach and Grace Lau of the HKMA, Prof Win-lin Chou of the Chinese University of Hong Kong and internal seminar participants for useful comments, and to Polly Lai for excellent secretarial assistance. All remaining errors are ours.

[2] BIS (2001).

and at times of stress, and to promote structural changes that will enhance the liquidity of the stock markets.

To facilitate this process, this paper examines mainly two issues: (i) it looks into how the liquidity of Hong Kong stock market has evolved since the Asian financial crisis, and (ii) it examines the determinants of changes in liquidity. For the first issue, various conventional indicators are constructed to gauge market liquidity during the study period (covering 1997 to June 2001), by assessing mainly market depth. In particular, the paper assesses whether liquidity conditions have recovered to the pre-crisis level. To supplement the conventional liquidity indicators, using a unique set of 30-second tick-by-tick data of the Hong Kong Stock Exchange, a regression model which relates the sensitivity of stock prices to the prevailing order book conditions is built to examine the changes in market depth during the period. For the second issue, results of the above regression analysis are utilised to construct a model to assess the determinants of liquidity. It is found that financial crises exerted their influence on local liquidity mainly through their effect on domestic interest rates and price volatility, while global liquidity and risk conditions also had a significant impact on domestic liquidity.

2. Definitions and measures of liquidity

Market liquidity is difficult to define, given its multifaceted nature. Broadly speaking, there are mainly three possible dimensions of market liquidity: tightness, depth and resiliency. Tightness measures how far the bid or ask prices diverge from the mid-market prices. It is important to market players as it measures the costs incurred. Of the various indicators, the bid-ask spread is one of the most frequently used. Depth refers to the volume of trades possible without moving prevailing market prices. Conventionally, it can be measured either by the order amount on the order books, or by the fluctuation in bid-ask spreads as a result of market impact from order executions. The greater the relative imbalance of buy or sell orders, the farther the market price must diverge from the standard bid or ask prices to clear the imbalance. The relative sensitivity of market prices to a unit of imbalance of order flows may also reflect the relative depth of the market. Resiliency measures the speed with which price fluctuations resulting from trades reconverge, or the speed with which imbalances in order flows are dissipated.[3] Market resiliency gives us a picture of potential market depth, which cannot be observed from prevailing order flows.[4] There is no clear-cut approach to measure resiliency, and one approach is to examine the speed with which the bid-ask spread and order volume are restored to normal market conditions after trades.[5]

Other measures of market liquidity include price volatility,[6] the number and volume of trades, trade frequency and turnover ratio. Among these, price volatility is the most widely used measure, and is closely related to the market depth indicators (it is in fact sometimes treated as one of the depth indicators).

Given the trading system in Hong Kong, where the spread varies predeterminedly according to a set of price ranges for all stocks, market tightness cannot be readily measured from changes in the observed bid-ask spreads.[7] In this paper, we therefore focus mainly on the depth dimension of market liquidity as well as the price volatility indicators.

3 Another commonly used concept is immediacy, which is defined as the time necessary to execute a trade of a certain size within a certain price range. Because immediacy incorporates elements of all three of the above dimensions, it is not considered as a separate dimension.

4 Engle and Lange (1997).

5 Muranaga and Shimizu in BIS (1999a).

6 If one assumes a constant level of "true" (ie fundamentals-based) prices, then volatility in observed prices could reflect the bid-ask spread, the market impact of trades, and/or the degree of resiliency. Cohen in BIS (1999a) uses this concept to examine the liquidity of short-term money markets. Specifically, he investigates the linkages between the volatility of various short-term interest rates under different monetary policy operating regimes for nine developed countries.

7 A brief note on the trading system in Hong Kong is given in Annex A.

3. Variations of market liquidity since the Asian financial crisis

3.1 Conventional liquidity indicators

To assess how market liquidity in Hong Kong's stock market interacted and evolved, the following market-wide indicators measuring market depth and volatility, as discussed in Section 2, are constructed based on the daily closing trading statistics of the 33 constituent stocks of the Hang Seng Index (HSI). As these 33 stocks accounted for almost 80% of Hong Kong's stock market capitalisation during the study period (see below), their aggregate liquidity condition should be representative of the overall market.

3.1.1 The indicators

a. Market depth

Traditionally, market depth is measured by a variety of trading activity variables. One measure is the average turnover in a given time interval (such as a day or a week), which is an indicator for normal order flow. A more sophisticated measure of market depth would be to measure the effective supply and demand, which is the sum of actual trades by market participants and potential trades as a result of portfolio adjustments.[8] Other proxies for market depth are the size of trades that market-makers can accommodate[9] and the volume per trade. In this paper, trading volume and turnover value are used to reflect the market depth and they are constructed also as a ratio to both interday and intraday volatility.[10]

b. Price volatility

A widely used measure for price volatility is the interday price volatility, which is readily available from the daily closing price. However, as this volatility measure is not able to reflect within-day price fluctuations, the intraday price volatility is also considered.

To summarise, the following indicators are constructed for the market-wide analysis:

Market depth measures:

Volume:	Total number of shares traded during the day
Value:	Total turnover value (in Hong Kong dollars) during the day
Depth I (III):	Trading volume (or value) per unit of interday volatility
Depth II (IV):	Trading volume (or value) per unit of intraday volatility

Volatility measures:

Interday volatility:	Defined as the square of the daily percentage changes in closing prices, market capitalisation-weighted
Intraday volatility	Defined as (Day High–Day Low)/[(Day High+Day Low)/2]*100%

8 Though there are few examples of research to-date in this area, partly because information on order flows is difficult to obtain, Muranaga and Shimizu in BIS (1999a) investigate the dynamics of market depth by constructing simulated markets. Muranaga studies market impact by examining high-frequency data on transactions involving individual stocks listed on the Tokyo Stock Exchange.

9 BIS (1999a).

10 Trading volumes and values by themselves are inadequate measures for market depth. For example, an absence of transactions or low turnover does not necessarily imply the market is illiquid, as investors may wait for their "best" bid-ask quote to trade. On the other hand, high turnover may not mean the market is deep enough if stock price variation is high, which may lead to a widening of spreads. They should therefore be measured against the prevailing price volatility.

3.1.2 Study period

The analysis in this section covers the entire period from January 1997 to June 2001. To facilitate comparative analysis of liquidity during the normal and crisis periods, the study period is further divided into the following five sub-periods:

Pre-crisis period:	January 1997-19 October 1997
Asian financial crisis period:	20 October 1997-April 1998
Russia/LTCM crisis period:	May 1998-28 September 1998
Post-crisis period:[11]	29 September 1998-end December 2000
Recent period:	Jan 2001-June 2001

The above division of crisis periods follows largely that of the report of the Committee on the Global Financial System,[12] but some modifications are made to reflect Hong Kong's unique situations. Specifically, while the beginning of the Asian financial crisis is defined as 2 July 1997 in the BIS study, when the Thai government devalued the Thai baht, we define the start of the crisis as 20 October 1997, as the financial market turbulence in Hong Kong only clearly emerged after that day, with the pressure on the Hong Kong dollar and the equity market intensifying.

As for the Russia/LTCM crisis period, it is worth noting that the Russian crisis[13] started on 17 August 1998 when the Russian government effectively defaulted on its sovereign debt and devalued its currency, which largely coincided with the Hong Kong government's operations in the stock market, from 14 August to 28 August, to restore financial market stability.[14] As a result, large turnovers were recorded during this period, along with the rise in stock prices, as shown in Chart 1. Due to this, throughout this paper, other than in Charts 1 to 3, where no exclusions were made, the Russia/LTCM crisis period is defined to exclude the period from 14 August to 28 August, in order to eliminate the distortion caused by the government operation.

3.1.3 Empirical results and analysis

The conventional liquidity indicators for different periods are summarised in Table 1 and Charts 1 to 3. As shown in Table 1, market liquidity by all measures deteriorated sharply in the Asian financial crisis, and most of them fell further through the Russia/LTCM crisis. During the crisis periods, the fall in depth was dramatic. For instance, during the Asian financial crisis, market depth measured as the ratio of trading volume to intraday volatility fell by 28%, while in terms of trading value to intraday volatility, it dropped by 43% from the pre-crisis level, reflecting a much shallower market. The sharp falls in depth and rising price volatility all pointed to a rapid evaporation of liquidity in the market during the crisis.

During the post-crisis period, there were distinct trends of a pickup in market liquidity, with market depth improving, and volatility significantly reduced. By the first half of 2001, most market liquidity indicators appeared to have returned to their pre-crisis levels, with some even surpassing them.

---

11 The post-crisis period is further divided into three sub-periods based on the tightening and easing of interest rate policy by the US Federal Reserve. Period I from 29 September 1998 to 29 June 1999 refers to the round of US interest rate cuts after the financial crises; period II from 30 June 1999 to 15 May 2000 refers to the round of US interest rate hikes; and period III from 16 May 2000 to end-December 2000 refers to the sustained high interest rate era.

12 BIS (1999b).

13 The financial trouble regarding Long-Term Capital Management (LTCM) started in early July, but only intensified after massive losses by the company were reported after the Russian default in August. The US Federal Reserve was involved to recapitalise the company on 23 September 1998 in order to prevent a domino effect on other financial institutions.

14 It was estimated that the Hong Kong government purchased HK$ 118 billion worth of stocks in its attempt to restore financial market stability.

3.2 Sensitivity of stock prices to order imbalances

However, the above analysis suffers from a major deficiency in the use of daily closing data to measure market liquidity, which is changing constantly throughout a trading day. In particular, large and more frequent intraday variations are likely to occur in times of market turbulence. Thus, for an indicator to fully reflect liquidity conditions, statistics capturing changes during the day are needed.

Moreover, most of the conventional indicators characterise the depth of a market as the trade volume or the trade value cleared by a one unit change in prices (also known as liquidity ratios). It is, however, argued that prices change in response to the net disequilibrium in buys and sells, not to total trading volume.[15] Furthermore, the use of liquidity ratios as a measure of market liquidity has its limitations. And they seldom distinguish the sources of price volatility (or price changes). Grossman and Miller (1988) point out that liquidity ratios fail to answer the critical question of how a sudden arrival of a larger than average order would affect price movements. A market's liquidity conditions should thus be measured by its ability to absorb order imbalances without large price changes.

3.2.1 Previous research

Numerous studies have focused on order imbalances and their relationship with market liquidity and other market variables. Chordia et al (2001a) outline two reasons why order imbalances should be more important to stock returns and liquidity than trading volume. First, they argue that "order imbalances sometimes signal private information, which should reduce liquidity at least temporarily and could also move the market price permanently". Second, a large order imbalance exacerbates the inventory risk faced by market-makers, who may respond by widening the bid-ask spread in order to compensate for taking the risk, which in turn further worsens liquidity conditions. Following the same lines of reasoning, a number of studies have emerged to analyse order imbalances. For example, Brown et al (1997) study the interaction between imbalance of bid and ask orders and stock returns in the Australian market. They find that imbalance in terms of number of orders can explain current returns, while imbalance in terms of dollar value can explain both current and future returns. Chordia et al (2001a) examine the relation between S&P 500 returns and order imbalances. They find that there is a strong contemporaneous association between stock returns and order imbalance, and that a contemporaneous order imbalance exerts significant impacts on market returns. These empirical studies indicate that order imbalances affect price movements. Their relationship may thus provide a better measure of market liquidity than the conventional liquidity ratios, such as the ratio of trading volume to price volatility.

However, many of the earlier studies measure the order imbalance based on traded (executed) buy and sell volumes. Furthermore, previous studies often use the number, instead of size, of orders and transactions as a measure of order imbalance, motivated by findings by Jones et al (1994) that the number of transactions is a major determinant of price volatility. The use of traded (executed) buy and sell volumes may be partly driven by the more readily available transaction data from the authorised exchanges. However, with the rising importance of order-driven market structures and the information available from electronic limit order books, attention has rapidly shifted to liquidity provisions in an order-driven market.

The attention to limit orders as the main source of liquidity has been documented by Demsetz (1968). Basically, limit orders can be perceived as a supply of liquidity. Limit orders represent ex ante precommitments to provide liquidity to market orders which may arrive sometime in the future. Thus, following the traditional reasoning regarding liquidity, a liquid limit order market can be characterised as having a large volume of buy and sell limit orders, waiting to be executed at their corresponding bid and ask prices, if and when market orders arrive. To go further, a deep limit order market can be viewed as the ability of a market to absorb a large pool of limit orders without significant impacts on price movements, and the ability to restore the limit order book after a market order is submitted and executed.

As for Hong Kong, a number of empirical studies of its stock market regarding the issue of limit order and order-driven mechanism have been conducted over the past few years. Chan and Hwang (1998) study the impact of tick size on market quality. Ahn and Cheung (1999) and Brockman and Chung

---

[15] Kempf and Korn (1997), Engle and Lange (1997).

(1998) study the liquidity pattern of the Hong Kong stock market. Brockman and Chung (1999) investigate the intertemporal and cross-sectional depth pattern in an electronic, order-driven environment and find an inverted U-shaped pattern at the weekly, daily and trading session level. They also demonstrate that market depth at cross-sectional, corporate level is negatively related to information asymmetry. Brockman and Chung (2001) find commonality in spreads and depth across all sizes of firms. Ahn et al (2000) investigate the relation between market depth and transitory volatility. However, few have investigated the dynamic relation between price movements and order imbalance as a measure of market depth.

3.2.2 The model

To supplement the conventional market depth indicators, and to remedy some of their drawbacks, using a unique set of 30-second tick-by-tick data of the Hong Kong Stock Exchange, the following model is built to examine the general relationship between the changes in stock prices and the net position of order books:

$$\Delta \ln(P_t) = \alpha + \beta \ln(BSI_t) + \varepsilon_t \tag{1}$$

where P_t is the share price at time t, BSI_t is the net buying/selling pressure at time t, and ε is the error term. α is the constant term, while the parameter β measures the short-term sensitivity of the changes in stock prices to the contemporaneous order imbalance.

In the equation, $\Delta \ln(P_t)$ is thus the change in share price at time t over time t–1, while BSI_t is the net position of the order book, which is derived by subtracting the total selling orders (of the first five selling queues) at each 30-second tick from the total buying orders (of the first five buying queues),[16] as follows:

BSI_t = the net buying/selling pressure at time t

$$= \sum_{i=1}^{5}(BuyingQueue_i) - \sum_{i=1}^{5}(SellingQueue_i) \text{ in number of shares, at time } t$$

As order imbalance is likely to have a lagged impact on stock prices, lagged variables of $\Delta \ln(BSI_t)$ are introduced into the model. Furthermore, as the 30-second changes of stock prices are likely to exhibit serial correlation, lagged variables of $\Delta \ln(P_t)$ are included in the right-hand side to control for autocorrelation in short-term stock price fluctuations. The basic model (1) is thus extended to be as follows:

$$\Delta \ln(P_t) = \alpha + \beta \ln(BSI_t) + \sum_{i=0}^{m} \gamma_i \Delta \ln(BSI_{t-i}) + \sum_{j=1}^{n} \theta_j \Delta \ln(P_{t-j}) + \varepsilon_t \tag{2}$$

where m and n are the lag lengths for $\Delta \ln(BSI_t)$ and $\Delta \ln(P_t)$ respectively.

The lag structure of the $\Delta \ln(BSI_t)$ and the $\Delta \ln(P_t)$ variables in the right-hand side is then determined with reference to the Akaike Information Criterion (AIC). The proper lag structure is found to be $m = 8$ and $n = 12$.

Unit root test is performed on the dependent and explanatory variables to check for stationarity. Like many other time series of high-frequency financial data, our data also exhibit the autoregressive conditional heteroscedasticity (ARCH) effects. To capture these, our model is estimated under the GARCH estimation procedure, instead of the traditional Ordinary Least Square (OLS) estimation.

Five constituent stocks from the Hang Seng Index are selected for the analysis. Together, they account for 25% of the total Hong Kong stock market capitalisation.[17] Our analysis will focus on the

---

16 Our micro, stock-level study utilises the intraday Bid and Ask Record obtained from the Stock Exchange of Hong Kong. For each 30-second tick, the intraday Bid and Ask Record contains information on limit-order prices and order quantities, including the nominal price of a stock, as well as the number of shares quoted in the first five queues for both buying and selling orders at their respective bid and ask prices.

17 These stocks are Hang Seng Bank and Bank of East Asia from the finance sector, Cheung Kong Holdings and Sun Hung Kai Properties from the property sector and Hutchison Whampoa from the commerce and industry sector.

coefficient β, which measures the depth of the market. β should have a positive sign. A higher coefficient indicates lower liquidity and vice versa.

3.2.3 Study period

Similar to Section 3.1.2, the models are estimated for the period from 1997 to June 2001, which is divided into five sub-periods. However, as 30-second tick-by-tick data are collected, which involved a huge amount of data per day and substantial downloading and processing efforts, only data for the key months (instead of working out the data for the entire study period) are collected for the analysis. Specifically, the following months during each of the sub-periods are included in this section's analysis:

Pre-crisis period:	May-August 1997
Asian financial crisis period:	20 October 1997-November 1997
Russia/LTCM crisis period:	May 1998-13 August 1998
Post-crisis period:[18]	November 1998-October 2000
Recent period:	Jan-June 2001

3.2.4 Empirical results and analysis

GARCH estimation results of five selected stocks are summarised in Tables 2 to 6 and Charts 4 to 8. As shown in the tables, the estimated parameter β in all cases has the expected positive sign and is statistically significant. The positive relationship between the *BSI* variable and changes in stock prices shows that a net buying pressure drives up stock prices, whereas a net selling pressure pulls down stock values. The magnitude of the estimated value for β measures the sensitivity of changes in stock prices to the net buying/selling pressure, which in turn reflects liquidity conditions of the stock market.

As shown in the charts, the estimated parameter β for all stocks rose during crisis periods from the pre-crisis period. These results demonstrate the worsening of market liquidity during crises. While the worsening of liquidity conditions during the Asian financial crisis seemed to be more severe than during the Russian crisis for three of the five selected stocks, it appeared to be less severe for the other two stocks. As for the post-crisis period, the estimated parameter β declined in general, as the market calmed down and cuts in interest rates improved the liquidity condition from the Russian crisis period. Market liquidity then fluctuated within a narrow range, and for most of the selected stocks it has returned to the pre-crisis level in the recent period.

4. Determinants of market liquidity

Knowledge about what factors determine market liquidity is essential to the understanding of how financial crises exert their impact on market liquidity. Existing market microstructure theories on market liquidity are represented by the "inventory control" and "asymmetric information" models.[19] In general, these models suggest that the willingness of market-makers and investors to trade and invest, which determines market liquidity, is largely dependent on cost and risk factors. Market liquidity is expected to be negatively correlated with the cost and risk level. Thus a decrease in interest rates

---

[18] Similar to Section 3.1.2, the post-crisis period is further divided into three sub-periods based on the interest rate policy of the US Federal Reserve. However, the exact months included in this section are different from that of Section 3.1.2, with only data for key months collected. In this section, period I from November 1998 to March 1999 refers to the round of US interest rate cuts after the financial crises; period II from July 1999 to December 1999 refers to the round of US interest rate hikes; and period III from June 2000 to October 2000 refers to the sustained high interest rate era.

[19] Under the "inventory control" models, bid-ask spread is negatively related to trading volume, but positively related to price volatility. The "asymmetric information" models argue that the widening of bid-ask spread compensates market participants for taking the adverse selection risk, the risk of trading with other market participants with superior information. Contrary to the "inventory control" models, unusually high trading volume is positively related to the bid-ask spread under the "asymmetric information" models.

may stimulate trading interest and enhance market liquidity, while a volatile market would influence liquidity through an increase in inventory and short-term speculative risks.

4.1 Previous research

Based on the theoretical framework, a number of studies have attempted to explain market liquidity by cost and volatility. While based on 30 stocks in the Dow Jones Industrial Average, Hasbrouck and Seppi (2001) do not find conclusive evidence of economically significant common factors in explaining their liquidity proxies. Using data of 240 shares traded in the New York Stock Exchange, and focusing on four traditional proxies of liquidity, Huberman and Halka (2001) show that the temporal variations in their liquidity proxies are positively correlated with return and negatively correlated with volatility. Using a similar set of data, Chordia et al (2000) find quoted spreads, depths and trading activity respond to short-term interest rates, the term spread, equity market returns and recent market volatility. In a recent study, using daily closing data, Chordia et al (2001b) show that lagged market returns, lagged interest rates, the lagged bid-ask spread and lagged volume are strong predictors of the bid-ask spread and volume changes in both the stock and bond markets in the United States.

4.2 The model

To facilitate our regression analysis on the determinants of market liquidity, we utilise the same GARCH model in equation (2) and estimate the model on a monthly basis for the same selected periods as in Section 3.2.3 to obtain a series of monthly estimations of β. Charts 9 to 13 present the monthly movements of estimated β values for the five selected stocks.

For the examination of the determinants of stock market liquidity in Hong Kong, a model is specified to relate β (representing market liquidity) to cost and risk variables. In addition, given Hong Kong's role as a financial centre, the liquidity of the Hong Kong stock market should be affected by fund flows and the global liquidity trend. Market liquidity is therefore a function of the following factors:

$$\beta_t = f(I_t, ID_t, VHK_t, VUSA_t, MLUSA_t, D_{1t}, D_{2t}) \qquad (3)$$

where the dependent variable β_t is the liquidity level in the Hong Kong market at time t, which is proxied by the $\hat{\beta}$ presented in Charts 9 to 13. I_t is the Hong Kong three-month interbank rate (monthly average), representing the cost of investing and trading stocks. ID_t is the interest rate differential between the Hong Kong overnight interbank offered rates and the London interbank offered rates. Other things being equal, a positive ID_t should attract capital into Hong Kong and is positive to liquidity conditions. VHK_t is the intraday volatility of HSI while $VUSA_t$ is the intraday volatility of US stocks, measured by the volatility of the Dow Jones Industrial Average and the Nasdaq Composite Index, market capitalisation-weighted.[20] These two variables represent the domestic and global risk factors respectively. $MLUSA_t$ is the liquidity level of the US market, specified as the ratio of daily turnover of US stocks to the price volatility of the Dow Jones Industrial Average and the Nasdaq Composite Index, market capitalisation-weighted, which is used as a proxy to global liquidity. D_{1t} and D_{2t} are the dummy variables for the Asian financial crisis and the Russian crisis, respectively.

4.3 Empirical results and analysis[21]

OLS technique is used to perform the estimation for equation (3). Models of various specifications (with different combinations of the above explanatory variables) are estimated. The results are summarised in Table 7; it is found that:

---

[20] Defined as (day high–day low)/[(day high+day low)/2] * 100%.

[21] One should note that the variance of the disturbance term in the regression estimations is expected to be large, as the estimation error of the dependent variables β is incorporated in the disturbance term as well. Even though this should cause no problem for the estimation, as long as we model the disturbance term correctly, one should interpret the estimation results and the significance of the estimated parameters with caution.

(i) As expected, domestic interest rates (I_t) is significant and has the correct sign for five stocks in 12 estimations.[22] This indicates that a rise in domestic interest rates would lead to a deterioration of local market liquidity.

(ii) ID_t is found to be highly correlated to I_t (correlation coefficient of 0.80), as the differential between Hong Kong and US interest rates is largely determined by the fluctuation in Hong Kong rates, particularly during the crisis periods. If both of them are included in the regression equation, their estimated coefficients yield wrong signs due to multicollinearity. Furthermore, if only ID_t appears in the model, the estimated coefficient for ID_t consistently has a positive sign. This suggests that the inclusion of ID_t in the model fails to capture the impact of an expected influx of funds (which should yield a negative sign for the coefficient) and has instead reflected mainly the movement of local interest rates. As a result, ID_t was therefore dropped from all the models.

(iii) In line with the "inventory control" models, local market volatility (VHK_t) and overseas market volatility ($VUSA_t$) have the expected positive sign and are significant for four stocks in 14 estimations[23] and four stocks in 13 estimations[24] respectively. This indicates that an increase in volatility in either local or global stock markets would lead to a fall in market liquidity, and vice versa. However, when both local and overseas market volatility are included in the model, Hong Kong share price volatility is statistically significant in most cases, while that of the United States is insignificant (regressions 1 and 4) due to multicollinearity.

(iv) The variable $MLUSA_t$ is significant and has a correct sign for three out of the five stocks in 16 estimations,[25] suggesting that a deterioration of global liquidity conditions may have a negative impact on local market liquidity. It also indicates that $MLUSA_t$ is rather stock-specific.

(v) Naturally, D_{1t} and D_{2t} appear to be very powerful in explaining the sharp rise in β during the crises (regressions 7 to 12). However, whenever D_{1t} and D_{2t} are included in the regressions, other independent variables such as I_t and $VUSA_t$ become insignificant. An examination of the relationship between I_t and $VUSA_t$ separately with D_{1t} and D_{2t} shows that the two variables are highly correlated with the dummy variables. This seems to indicate that the impact of the crises on liquidity conditions might largely be effected through the interest rate and risk levels. As we are more interested in the impact of I_t and $VUSA_t$, the D_{1t} and D_{2t} are excluded from some of the models.

5. Conclusion

In this paper we studied the evolution of the Hong Kong stock market's liquidity since the Asian financial crisis and tried to explain the time-variation of market liquidity. Using a unique set of 30-second tick-by-tick data from the Hong Kong Stock Exchange, empirical results from our GARCH model for five selected stocks, which relates the sensitivity of their price movements to net order flows, confirm the sharp deterioration of market liquidity during the crisis periods. Furthermore, they also illustrate that, in the more recent period, the liquidity of most of the selected stocks has returned to the pre-crisis level.

[22] Regressions 3 and 6 for Cheung Kong Holdings, Hang Seng Bank, Sun Hung Kai Properties and Bank of East Asia, and Regressions 3, 6, 9 and 12 for the Hutchison Whampoa Limited.

[23] Regressions 1, 2, 4 and 5 for Cheung Kong Holdings, Hang Seng Bank, and Hutchison Whampoa Limited, and Regressions 2 and 5 for Bank of East Asia.

[24] Regressions 3 and 6 for Cheung Kong Holdings, Hang Seng Bank and Hutchison Whampoa Limited, and Regressions 3, 4, 6, 7, 9, 10 and 12 for Sun Hung Kai Properties.

[25] Regressions 5, 10, 11 and 12 for Cheung Kong Holdings, and Regressions 4, 5, 6, 10, 11 and 12 for Hang Seng Bank and Bank of East Asia.

This paper also establishes the correlation of stock market liquidity with cost and risk factors. The findings are consistent with the "inventory control" models, which predict that market depth is negatively correlated with price volatility. Largely in line with empirical studies of US market liquidity, which show that liquidity is correlated with lagged short-term interest rates, lagged market returns and market volatility, our OLS regression analysis also shows that financial crises exert their influence on local liquidity mainly through their effect on domestic interest rates and price volatility. Furthermore, given Hong Kong's role as a financial centre, our results indicate that, to a significant extent, global liquidity and risk conditions have an impact on domestic market liquidity as well.

Annex A
The Hong Kong stock market's bid and ask system

The trading system of the Exchange is an order-driven system, and is fully centralised and computerised, via terminals in the trading hall of the Exchange and terminals of the Exchange's members. Investors initiate buying and selling transactions by placing orders through brokers. These orders are consolidated into the Exchange's electronic limit-order book and executed (with some specific exceptions) through an automated trading system. Information regarding the limit-order book is disseminated on a real-time basis and available to all market participants through an electronic screen. The electronic screen displays the best five bid-ask prices, along with the broker identities and the numbers of shares intended to be bought and sold at each of the bid-ask queues. Orders are executed in strict price and time priority. The spreads vary according to a set of predetermined price ranges for all stocks (Table A1). A stock would have different dollar spreads if its price appreciates or drops to the next level of price range, and it would have different % spreads (as a % of the value of the stock) when prices move even within the price ranges.

Table A1

Spread table of stock trading on the Hong Kong stock exchange

	Price range (HK$)			Spread (HK$)	Spread as a % of price		
From	0.01	to	0.25	0.001	10	-	0.4
Over	0.25	to	0.50	0.005	2	-	1
Over	0.50	to	2.00	0.010	2	-	0.5
Over	2.00	to	5.00	0.025	1.25	-	0.5
Over	5.00	to	30.00	0.050	1	-	0.17
Over	30.00	to	50.00	0.100	0.33	-	0.2
Over	50.00	to	100.00	0.250	0.5	-	0.25
Over	100.00	to	200.00	0.500	0.5	-	0.25
Over	200.00	to	1,000.00	1.000	0.5	-	0.1
Over	1,000.00	to	9,995.00	2.500	0.25	-	0

Tables

Table 1

Liquidity indicators[1] of the Hong Kong stock market: pre-crisis, crises and post-crisis

	Pre-crisis[2]	Asian financial crisis[3]	Russia/LTCM crisis[4]	Post-crisis[5]	2001 H1[6]
Depth					
Volume (m shares)	175.2	243.9	189.7	188.1	232.6
Volume/intraday volatility	103.7	74.6	65.9	89.2	140.1
Volume/interday volatility	59.4	15.8	26.4	36.2	104.8
Value (HK$ bn)	5.1	5.7	3.6	3.7	4.8
Value/intraday volatility	3.0	1.7	1.2	1.7	2.9
Value/interday volatility	1.7	0.4	0.5	0.7	2.2
Volatility					
Intraday volatility	1.7	3.3	2.9	2.1	1.7
Interday volatility	3.0	15.4	7.2	5.2	2.2

[1] Weighted by market capitalisation of the 33 constituent stocks of the Hang Seng Index. [2] January 1997 to 19 October 1997. [3] 20 October 1997 to April 1998. [4] May 1998 to 28 September 1998, but excluding 14 August to 28 August 1998. [5] 29 September 1998 to 29 June 1999. [6] January 2001 to June 2001.

Sources: Bloomberg; HKMA staff estimates.

Table 2

Estimation results for Cheung Kong Holdings

$$\text{Model: } \Delta\ln(P_t) = \alpha + \beta\ln(BSI_t) + \sum_{i=0}^{8}\gamma_i\Delta\ln(BSI_{t-i}) + \sum_{j=1}^{12}\theta_j\Delta\ln(P_{t-j}) + \varepsilon_t$$

(Pre-crisis from 1997:05 to 1997:08, Asian crisis from 1997:10:20 to 1997:11, Russian crisis from 1998:05 to 1998:08:13, post-crisis I from 1998:11 to 1999:03, post-crisis II from 1999:07 to 1999:12, post-crisis III from 2000:06 to 2000:10 and recent period from 2001:01 to 2001:06)

	Pre-crisis	**Asian crisis**	**Russian crisis**	**Post-crisis**			**Recent period**
				I	**II**	**III**	
$\hat{\beta}$	0.9* (6.3)	3.5* (2.4)	1.3* (4.6)	1.4* (4.4)	1.0* (4.8)	1.1* (2.9)	2.2* (6.8)
$\hat{\gamma}_0$	14.2* (27.1)	22.0* (7.7)	9.6* (12.2)	25.7* (30.2)	3.7* (7.2)	10.5* (11.2)	24.4* (25.6)
$\hat{\gamma}_1$	2.2 (0.9)	19.2* (2.3)	9.4* (10.3)	14.0* (11.3)	4.7* (4.3)	4.7* (3.3)	10.8* (6.9)
$\hat{\gamma}_2$	0.5* (2.2)	16.0 (1.8)	7.2* (8.1)	16.6 (11.8)	7.0* (6.3)	2.0 (1.3)	13.5* (7.7)
$\hat{\gamma}_3$	2.1 (0.9)	15.8 (1.9)	5.7* (5.4)	9.3* (7.0)	5.1* (4.0)	1.0 (0.7)	9.9* (5.6)
$\hat{\gamma}_4$	6.6* (3.2)	9.3 (1.0)	5.0* (5.0)	9.0* (7.0)	5.0* (4.3)	2.5 (1.3)	6.2* (3.8)
$\hat{\gamma}_5$	3.7 (1.4)	5.9 (0.6)	3.7* (4.0)	4.3* (3.0)	5.0* (4.9)	–0.8 (–0.4)	1.4 (0.8)
$\hat{\gamma}_6$	5.9* (2.9)	2.5 (0.2)	5.5* (5.3)	5.1* (4.3)	2.6* (2.5)	0.6* (0.3)	2.4 (1.3)
$\hat{\gamma}_7$	0.9 (0.4)	4.0 (0.4)	2.2 (1.9)	3.0* (2.2)	2.9* (2.1)	–0.4 (–0.2)	3.2 (1.5)
$\hat{\gamma}_8$	2.2 (0.9)	4.2 (0.4)	2.0* (2.1)	2.6* (2.1)	1.0 (0.9)	1.3 (0.9)	3.2 (1.6)
$\bar{R}^2$	0.057	0.0099	0.0094	0.028	0.018	0.054	0.020
SSR	0.053	0.15	0.088	0.14	0.094	0.099	0.087
N	38,507	14,083	34,765	48,388	58,681	49,342	55,920

Notes: t-statistics in parentheses.

* Denotes significance at the 5% level. The $\ln(BSI_t)$ and $\Delta\ln(BSI_{t-i})$ variables are divided by 10,000. $\bar{R}^2$ is the adjusted R^2. SSR is the sum of squared residual. N is the number of observations.

Source: HKMA staff estimates.

Table 3

Estimation results for Hang Seng Bank

$$\text{Model: } \Delta\ln(P_t) = \alpha + \beta\ln(BSI_t) + \sum_{i=0}^{8}\gamma_i\Delta\ln(BSI_{t-i}) + \sum_{j=1}^{12}\theta_j\Delta\ln(P_{t-j}) + \varepsilon_t$$

(Pre-crisis from 1997:05 to 1997:08, Asian crisis from 1997:10:20 to 1997:11, Russian crisis from 1998:05 to 1998:08:13, post-crisis I from 1998:11 to 1999:03, post-crisis II from 1999:07 to 1999:12, post-crisis III from 2000:06 to 2000:10 and recent period from 2001:01 to 2001:06)

	Pre-crisis	**Asian crisis**	**Russian crisis**	**Post-crisis**			**Recent period**
				I	**II**	**III**	
$\hat{\beta}$	1.7* (4.7)	3.2* (3.7)	2.0* (5.8)	1.0* (2.0)	0.7* (4.2)	0.8* (4.2)	1.5* (9.3)
$\hat{\gamma}_0$	15.6* (33.9)	0.5 (0.04)	17.6* (17.5)	13.3* (11.9)	3.4* (10.5)	6.3* (10.5)	29.1* (37.2)
$\hat{\gamma}_1$	4.9* (2.9)	7.4* (2.0)	9.4* (6.5)	9.3* (6.2)	3.2* (3.7)	8.3* (9.9)	14.3* (10.3)
$\hat{\gamma}_2$	8.3* (4.5)	4.4 (1.4)	10.5* (7.9)	7.1* (5.3)	2.2* (2.5)	5.3* (5.3)	9.6* (7.4)
$\hat{\gamma}_3$	6.3* (3.9)	7.7* (2.4)	10.7* (6.7)	2.5 (1.3)	3.3* (4.0)	7.1* (7.8)	9.9* (6.3)
$\hat{\gamma}_4$	8.5* (4.4)	4.0 (1.4)	6.4* (4.5)	4.7* (2.7)	2.4* (2.3)	2.0 (1.7)	7.0* (4.9)
$\hat{\gamma}_5$	4.8* (2.5)	10.7* (4.1)	9.6* (6.8)	5.0* (2.5)	0.0 (0.03)	1.8 (1.9)	4.8* (3.4)
$\hat{\gamma}_6$	5.6* (2.7)	7.3* (2.8)	10.9* (6.8)	4.0* (2.3)	3.2* (3.1)	3.8* (4.0)	4.6* (3.0)
$\hat{\gamma}_7$	3.2 (1.4)	2.5 (1.0)	7.9* (4.7)	1.3 (0.7)	2.0* (2.1)	3.2* (3.1)	6.9* (5.3)
$\hat{\gamma}_8$	3.1 (1.5)	4.8 (1.8)	3.1 (1.7)	–0.3 (–0.2)	0.9 (1.0)	2.4* (2.2)	2.9 (1.8)
$\overline{R}^2$	0.038	0.0091	0.0019	0.013	0.014	0.024	0.033
SSR	0.095	0.16	0.082	0.10	0.065	0.067	0.094
N	38,526	14,071	31,144	48,218	58,729	47,807	56,381

Notes: t-statistics in parentheses.

* denotes significance at the 5% level. The $\ln(BSI_t)$ and $\Delta\ln(BSI_{t-i})$ variables are divided by 10,000. $\overline{R}^2$ is the adjusted R^2. SSR is the sum of squared residual. *N* is the number of observations.

Source: HKMA staff estimates.

Table 4

Estimation results for Hutchison Whampoa Limited

Model: $\Delta \ln(P_t) = \alpha + \beta \ln(BSI_t) + \sum_{i=0}^{8} \gamma_i \Delta \ln(BSI_{t-i}) + \sum_{j=1}^{12} \theta_j \Delta \ln(P_{t-j}) + \varepsilon_t$

(Pre-crisis from 1997:05 to 1997:08, Asian crisis from 1997:10:20 to 1997:11, Russian crisis from 1998:05 to 1998:08:13, post-crisis I from 1998:11 to 1999:03, post-crisis II from 1999:07 to 1999:12, post-crisis III from 2000:06 to 2000:10 and recent period from 2001:01 to 2001:06)

	Pre-crisis	**Asian crisis**	**Russian crisis**	**Post-crisis**			**Recent period**
				I	**II**	**III**	
$\hat{\beta}$	1.5* (2.5)	11.2* (9.4)	2.1* (4.1)	1.5* (4.4)	0.6* (2.3)	1.8* (3.5)	1.6* (7.0)
$\hat{\gamma}_0$	31.0* (24.1)	–3.7* (–2.0)	10.3* (11.2)	31.5* (48.2)	–3.6* (–8.4)	24.7* (15.5)	31.9* (50.3)
$\hat{\gamma}_1$	18.6* (6.0)	7.8 (1.1)	9.7* (7.7)	19.2* (11.2)	10.7* (10.3)	18.4* (6.6)	10.6* (8.8)
$\hat{\gamma}_2$	17.8* (6.0)	16.0* (2.4)	10.7* (9.1)	14.9* (8.8)	7.0* (6.4)	31.8* (12.5)	9.2* (7.9)
$\hat{\gamma}_3$	8.3* (2.6)	6.8 (0.9)	7.5* (5.9)	11.2* (5.8)	5.2* (4.2)	24.6* (9.4)	0.9 (0.8)
$\hat{\gamma}_4$	15.5* (5.4)	–2.8 (–0.44)	8.1* (6.8)	12.0* (7.2)	2.4* (2.2)	29.4* (11.5)	8.1* (7.3)
$\hat{\gamma}_5$	9.2* (3.2)	–0.5 (–0.08)	9.6* (8.3)	8.6* (4.3)	4.8* (3.6)	6.0* (2.2)	9.3* (6.7)
$\hat{\gamma}_6$	12.0* (4.4)	–0.7 (–0.1)	5.4* (4.7)	6.6* (3.2)	4.4* (3.5)	16.2* (5.5)	11.7* (8.7)
$\hat{\gamma}_7$	7.3* (2.4)	1.3 (0.2)	4.9* (4.1)	10.1* (5.6)	2.3 (1.8)	15.4* (5.8)	9.9* (7.2)
$\hat{\gamma}_8$	8.2* (2.5)	–4.4 (–0.7)	–0.6 (–0.5)	9.7* (5.3)	3.8* (2.6)	6.9* (2.3)	6.5* (4.5)
$\bar{R}^2$	0.075	0.0036	0.0020	0.014	0.025	0.077	0.044
SSR	0.078	0.14	0.090	0.13	0.11	0.14	0.098
N	38,517	14,077	34,760	48,386	58,723	49,316	56,379

Notes: t-statistics in parentheses.

* denotes significance at the 5% level. The $\ln(BSI_t)$ and $\Delta\ln(BSI_{t-i})$ variables are divided by 10,000. $\bar{R}^2$ is the adjusted R^2. SSR is the Sum of Squared Residual. N is the number of observations.

Source: HKMA staff estimates.

Table 5

Estimation results for Sun Hung Kai Properties

$$\text{Model: } \Delta\ln(P_t) = \alpha + \beta\ln(BSI_t) + \sum_{i=0}^{8}\gamma_i\Delta\ln(BSI_{t-i}) + \sum_{j=1}^{12}\theta_j\Delta\ln(P_{t-j}) + \varepsilon_t$$

(Pre-crisis from 1997:05 to 1997:08, Asian crisis from 1997:10:20 to 1997:11, Russian crisis from 1998:05 to 1998:08:13, post-crisis I from 1998:11 to 1999:03, post-crisis II from 1999:07 to 1999:12, post-crisis III from 2000:06 to 2000:10 and recent period from 2001:01 to 2001:06)

	Pre-crisis	Asian crisis	Russian crisis	Post-crisis			Recent period
				I	II	III	
$\hat{\beta}$	1.6* (4.6)	4.5* (2.6)	2.6* (6.4)	1.2* (4.6)	2.7* (10.8)	1.5* (6.7)	2.9* (10.5)
$\hat{\gamma}_0$	13.2* (16.8)	8.0* (10.6)	14.6* (15.0)	13.2* (19.2)	14.4* (28.7)	24.2* (38.6)	15.9* (44.3)
$\hat{\gamma}_1$	5.2* (3.1)	5.6 (1.4)	8.9* (7.4)	9.5* (10.6)	12.6* (12.2)	18.4* (23.7)	20.7* (19.5)
$\hat{\gamma}_2$	6.9* (4.7)	10.9* (2.6)	4.9* (3.2)	11.3* (11.7)	12.3* (8.0)	14.9* (19.3)	16.9* (12.8)
$\hat{\gamma}_3$	4.9* (3.3)	1.0 (0.2)	5.4* (3.3)	6.2* (6.0)	6.7* (4.3)	5.9* (5.2)	14.4* (11.4)
$\hat{\gamma}_4$	5.3* (3.7)	3.4 (0.7)	8.1* (5.1)	–1.9 (–1.8)	4.3* (2.4)	4.0* (3.4)	9.7* (8.4)
$\hat{\gamma}_5$	3.1* (2.0)	3.5 (0.7)	6.3* (4.0)	2.1* (2.1)	5.9* (3.8)	1.2 (1.0)	6.6* (5.3)
$\hat{\gamma}_6$	4.1* (2.5)	–1.8 (–0.2)	0.4 (0.3)	–0.4 (–0.3)	3.9* (2.1)	2.5* (2.2)	4.9* (3.5)
$\hat{\gamma}_7$	2.4 (1.4)	–3.3 (–0.5)	4.5* (2.9)	1.4 (1.5)	0.4 (0.2)	3.1* (2.5)	7.9* (5.4)
$\hat{\gamma}_8$	5.0 (3.4)	–3.0 (–0.4)	–2.3 (–1.4)	–4.3* (–6.1)	5.2* (2.9)	1.6 (1.4)	2.6 (1.9)
$\overline{R}^2$	0.020	0.0076	0.0034	0.016	0.017	0.0052	0.012
SSR	0.058	0.14	0.083	0.12	0.11	0.12	0.10
N	38,524	14,075	34,751	48,203	58,718	49,325	55,429

Notes: t-statistics in parentheses.

* denotes significance at the 5% level. The $\ln(BSI_t)$ and $\Delta\ln(BSI_{t-i})$ variables are divided by 10,000. $\overline{R}^2$ is the adjusted R^2. SSR is the sum of squared residual. N is the number of observations.

Source: HKMA staff estimates.

Table 6

Estimation results for Bank of East Asia

Model: $\Delta\ln(P_t) = \alpha + \beta\ln(BSI_t) + \sum_{i=0}^{8}\gamma_i\Delta\ln(BSI_{t-i}) + \sum_{j=1}^{12}\theta_j\Delta\ln(P_{t-j}) + \varepsilon_t$

(Pre-crisis from 1997:05 to 1997:08, Asian crisis from 1997:10:20 to 1997:11, Russian crisis from 1998:05 to 1998:08:13, post-crisis I from 1998:11 to 1999:03, post-crisis II from 1999:07 to 1999:12, post-crisis III from 2000:06 to 2000:10 and recent period from 2001:01 to 2001:06)

	Pre-crisis	Asian crisis	Russian crisis	Post-crisis			Recent period
				I	II	III	
$\hat{\beta}$	2.3* (6.3)	12.5* (3.5)	2.9* (7.8)	1.0* (3.2)	1.2* (4.5)	1.0* (5.7)	1.5* (6.6)
$\hat{\gamma}_0$	14.2* (27.1)	–2.0 (–0.8)	39.5* (29.3)	6.0* (5.1)	8.3* (13.7)	3.0* (5.4)	17.6* (20.0)
$\hat{\gamma}_1$	2.2 (0.9)	–2.3 (–0.2)	15.7* (6.8)	2.0 (1.2)	3.3* (2.3)	1.5 (1.9)	13.4* (10.5)
$\hat{\gamma}_2$	0.5* (2.2)	14.9 (1.5)	8.7* (3.6)	1.4 (0.8)	4.1* (3.1)	1.6 (1.9)	12.7* (9.1)
$\hat{\gamma}_3$	2.1 (0.9)	17.6 (1.7)	2.2 (0.9)	1.6 (1.0)	7.8* (7.1)	1.0 (1.2)	12.9* (9.3)
$\hat{\gamma}_4$	6.6* (3.2)	–0.4 (–0.04)	16.1* (7.4)	6.1* (3.5)	2.4* (2.0)	2.0* (2.2)	7.3* (4.9)
$\hat{\gamma}_5$	3.7 (1.4)	–9.5 (–0.8)	21.0* (9.6)	5.5* (3.2)	4.0* (3.2)	0.3 (0.4)	9.6* (6.5)
$\hat{\gamma}_6$	5.9* (2.9)	4.9 (0.4)	–10.4* (–4.8)	4.0* (2.3)	1.3 (0.9)	1.7* (2.1)	2.5* (2.1)
$\hat{\gamma}_7$	0.9 (0.4)	–9.9 (–1.0)	–1.9 (–1.0)	4.9* (3.0)	–3.4* (–2.6)	0.4 (0.5)	7.5* (5.5)
$\hat{\gamma}_8$	2.2 (0.9)	–5.4 (–0.5)	14.2* (6.3)	2.1 (1.3)	2.2 (1.6)	2.5* (3.1)	1.1 (0.8)
$\bar{R}^2$	0.057	0.0088	0.00059	0.0040	0.0097	0.024	0.021
SSR	0.053	0.080	0.14	0.13	0.091	0.087	0.10
N	38,507	14,064	34,767	48,369	58,706	49,319	56,377

Notes: t-statistics in parentheses.

* denotes significance at the 5% level. The $\ln(BSI_t)$ and $\Delta\ln(BSI_{t-i})$ variables are divided by 10,000. $\bar{R}^2$ is the adjusted R^2. SSR is the sum of squared residual. N is the number of observations.

Source: HKMA staff estimates.

Table 7

Determinants of market liquidity

$$\beta_t = f(I_t, ID_t, VHK_t, VUSA_t, MLUSA_t, D_{1t}, D_{2t})$$

	Regression no	**Constant**	***I_t*** **(x 10⁻⁴)**	***VHK_t*** **(x 10⁻⁴)**	***VUSA_t*** **(x 10⁻⁴)**	***MLUSA_t*** **(x 10⁻⁴)**	***D_1t*** **(x 10⁻⁴)**	***D_2t*** **(x 10⁻⁴)**	$\bar{R}^2$	**N**
Cheung Kong Holdings	1	–0.0002 (–1.3)	–0.4 (–1.6)	2.7* (4.3)	1.1 (1.7)	–	–	–	0.72	32
	2	0.00001 (0.1)	–0.6* (–2.4)	3.3* (6.0)	–	–	–	–	0.70	32
	3	–0.0006* (–2.1)	0.6* (2.4)	–	2.7* (2.8)	–	–	–	0.56	32
	4	–0.000006 (–0.0)	–0.6* (–2.0)	2.8* (4.6)	1.1 (1.7)	–0.1 (–1.8)	–	–	0.75	32
	5	0.0002 (1.6)	–0.8* (–3.0)	3.3* (5.2)	–	–0.1* (–2.2)	–	–	0.73	32
	6	–0.0004 (–1.4)	0.6* (2.0)	–	2.7* (2.8)	–0.1 (–1.5)	–	–	0.56	32
	7	0.0001 (0.9)	–0.2 (–0.7)	0.5 (0.7)	0.7 1.1)	–	11.7* (3.4)	0.8 (0.7)	0.81	32
	8	0.0003* (2.5)	–0.3 (–1.1)	0.7 (0.9)	–	–	12.7* (3.9)	1.1 (0.9)	0.80	32
	9	0.0002 (1.0)	–0.05 (–0.3)	–	0.7 (1.3)	–	13.4* (5.7)	1.0 (0.9)	0.81	32
	10	0.0003 (1.8)	–0.3 (–1.1)	0.6 (0.9)	0.6 (1.1)	–0.1* (–2.2)	11.4* (3.6)	0.6 (0.5)	0.83	32
	11	0.0005* (3.5)	–0.4 (–1.6)	0.8 (1.1)	–	–0.1* (–2.3)	12.4* (4.0)	0.9 (0.8)	0.83	32
	12	0.0003 (1.9)	–0.1 (–0.8)	–	0.7 (1.3)	–0.1* (–2.2)	13.4* (6.1)	0.9 (0.8)	0.83	32

Notes: t-statistics in parentheses.

* denotes significance at the 5% level. – denotes corresponding variable not included in the respective model. Estimation period as specified in Section 3.2.3 of the paper. Standard errors are obtained by the heteroscedasticity consistent estimator of White (1980) when necessary. Data are monthly averages. $\bar{R}^2$ is the adjusted R^2. N is the number of observations.

Source: HKMA staff estimates.

Table 7 (cont)

	Regression no	Constant	I_t (x 10^{-4})	VHK_t (x 10^{-4})	$VUSA_t$ (x 10^{-4})	$MLUSA_t$ (x 10^{-4})	D_{1t} (x 10^{-4})	D_{2t} (x 10^{-4})	$\overline{R}^2$	N
Hang Seng Bank	1	–0.0002	–0.05	1.4*	0.6	–	–	–	0.69	32
		(–1.8)	(–0.2)	(3.2)	(1.3)					
	2	–0.00008	–0.2	1.8*	–	–	–	–	0.68	32
		(–1.3)	(–0.8)	(4.5)						
	3	–0.0004*	0.5*	–	1.4*	–	–	–	0.59	32
		(–2.6)	(3.4)		(2.5)					
	4	–0.00002	–0.2	1.5*	0.6	–0.1*	–	–	0.74	32
		(–0.2)	(–0.9)	(3.6)	(1.3)	(–2.5)				
	5	0.00008	–0.3	1.8*	–	–0.1*	–	–	0.73	32
		(0.9)	(–1.5)	(5.0)		(–2.5)				
	6	–0.0003	0.5*	–	1.4*	–0.1*	–	–	0.62	32
		(–1.4)	(2.8)		(2.5)	(–2.5)				
	7	0.0001	–0.01	–0.04	0.2	–	9.3*	2.2*	0.78	32
		(1.1)	(–0.1)	(–0.1)	(0.4)		(3.7)	(2.5)		
	8	0.0002*	–0.04	0.003	–	–	9.6*	2.3*	0.79	32
		(2.1)	(–0.2)	(0.0)			(4.1)	(2.6)		
	9	0.0001	–0.02	–	0.2	–	9.2*	2.2*	0.79	32
		(1.1)	(–0.1)		(0.5)		(5.4)	(2.6)		
	10	0.0003*	–0.1	0.05	0.1	–0.1*	9.0*	2.0*	0.83	32
		(2.3)	(–0.6)	(0.1)	(0.4)	(–2.9)	(4.1)	(2.6)		
	11	0.0003*	–0.1	0.08	–	–0.1*	9.3*	2.1*	0.84	32
		(3.6)	(–0.8)	(0.2)		(–3.0)	(4.5)	(2.7)		
	12	0.0003*	–0.1	–	0.2	–0.1*	9.2*	2.0*	0.84	32
		(2.4)	(–0.8)		(0.4)	(–3.0)	(6.2)	(2.7)		

Notes: t-statistics in parentheses.

* denotes significance at the 5% level. – denotes corresponding variable not included in the respective model. Estimation period as specified in Section 3.2.3 of the paper. Standard errors are obtained by the heteroscedasticity consistent estimator of White (1980) when necessary. Data are monthly averages. $\overline{R}^2$ is the adjusted R^2. N is the number of observations.

Source: HKMA staff estimates.

Table 7 (cont)

	Regression no	Constant	I_t (x 10^{-4})	VHK_t (x 10^{-4})	$VUSA_t$ (x 10^{-4})	$MLUSA_t$ (x 10^{-4})	D_{1t} (x 10^{-4})	D_{2t} (x 10^{-4})	$\bar{R}^2$	N
Hutchison Whampoa	1	–0.0005*	1.39	2.0*	1.1	–	–	–	0.80	32
		(–3.3)	(1.0)	(3.1)	(1.6)					
	2	–0.0003*	0.1	2.6*	–	–	–	–	0.79	32
		(–3.1)	(0.4)	(4.1)						
	3	–0.0008*	1.1*	–	2.0*	–	–	–	0.74	32
		(–3.3)	(4.7)		(2.7)					
	4	–0.0006*	0.3	2.0*	1.1	0.05	–	–	0.79	32
		(–3.0)	(1.1)	(3.0)	(1.6)	(0.5)				
	5	–0.0004*	0.1	2.6*	–	0.04	–	–	0.78	32
		(–2.5)	(0.5)	(4.5)		(0.5)				
	6	–0.0009*	1.2*	–	2.2*	0.06	–	–	0.73	32
		(–3.2)	(4.7)		(2.7)	(0.8)				
	7	–0.0001	0.5	–0.2	0.6	–	12.3*	1.2	0.86	32
		(–0.7)	(2.0)	(–0.2)	(0.9)		(3.4)	(0.9)		
	8	–0.000009	0.4	–0.05	–	–	13.2*	1.4	0.86	32
		(–0.1)	(1.8)	(–0.1)			(3.8)	(1.1)		
	9	–0.0001	0.5*	–	0.5	–	11.7*	1.1	0.86	32
		(–0.8)	(2.6)		(0.9)		(4.8)	(0.9)		
	10	–0.0002	0.6	–0.2	0.6	0.05	12.4*	1.3	0.85	32
		(–1.0)	(2.0)	(–0.3)	(0.9)	(0.7)	(3.4)	(1.0)		
	11	–0.00007	0.5	–0.09	–	0.05	13.3*	1.5	0.85	32
		(–0.4)	(1.8)	(1.8)		(0.7)	(3.8)	(1.2)		
	12	–0.0002	0.5*	–	0.5	0.05	11.7*	1.2	0.86	32
		(–1.0)	(2.7)		(0.9)	(0.7)	(4.8)	(1.0)		

Notes: t-statistics in parentheses.

* denotes significance at the 5% level. – denotes corresponding variable not included in the respective model. Estimation period as specified in Section 3.2.3 of the paper. Standard errors are obtained by the heteroscedasticity consistent estimator of White (1980) when necessary. Data are monthly averages. $\bar{R}^2$ is the adjusted R^2. N is the number of observations.

Source: HKMA staff estimates.

Table 7 (cont)

	Regression no	Constant	I_t (x 10^{-4})	VHK_t (x 10^{-4})	$VUSA_t$ (x 10^{-4})	$MLUSA_t$ (x 10^{-4})	D_{1t} (x 10^{-4})	D_{2t} (x 10^{-4})	$\overline{R}^2$	N
Sun Hung Kai Properties	1	–0.0002 (–1.0)	0.3 (0.5)	0.06 (0.1)	1.9 (2.5)	–	–	–	0.40	32
	2	0.00008 (0.5)	–0.03 (–0.1)	1.0 (1.2)	–	–	–	–	0.26	32
	3	–0.0003* (–2.3)	0.3* (2.8)	–	1.9* (3.5)	–	–	–	0.42	32
	4	–0.0002 (–0.8)	0.3 (0.5)	0.07 (0.1)	1.8* (2.5)	–0.03 (–0.7)	–	–	0.38	32
	5	0.0001 (0.8)	–0.06 (–0.1)	1.0 (1.2)	–	–0.04 (–0.8)	–	–	0.24	32
	6	–0.0002 (–1.4)	0.3* (2.3)	–	1.9* (3.4)	–0.03 (–0.4)	–	–	0.41	32
	7	0.00003 (0.2)	–0.06 (–0.2)	–0.1 (–0.1)	1.6* (2.8)	–	4.0* (2.2)	4.3* (3.2)	0.58	32
	8	0.0004* (3.8)	–0.3 (–1.0)	0.2 (0.3)	–	–	6.5* (2.5)	4.9* (2.3)	0.47	32
	9	0.00003 (0.2)	–0.08 (–0.4)	–	1.6* (2.8)	–	3.7 (1.6)	4.2* (3.7)	0.59	32
	10	0.00005 (0.3)	–0.07 (–0.3)	–0.1 (–0.1)	1.6* (2.7)	–0.01 (–0.2)	4.0 (1.1)	4.3* (3.4)	0.56	32
	11	0.0004* (3.3)	–0.3 (–1.1)	0.3 (0.3)	–	–0.02 (–0.4)	6.4* (2.4)	4.9* (2.2)	0.45	32
	12	0.00005 (0.2)	–0.1 (–0.5)	–	1.6* (2.7)	–0.02* (–0.4)	3.7 (1.8)	4.2* (2.5)	0.58	32

Notes: t-statistics in parentheses.

* denotes significance at the 5% level. – denotes corresponding variable not included in the respective model. Estimation period as specified in Section 3.2.3 of the paper. Standard errors are obtained by the heteroscedasticity consistent estimator of White (1980) when necessary. Data are monthly averages. $\overline{R}^2$ is the adjusted R^2. N is the number of observations.

Source: HKMA staff estimates.

	Regression no	Constant	I_t (x 10^{-4})	VHK_t (x 10^{-4})	$VUSA_t$ (x 10^{-4})	$MLUSA_t$ (x 10^{-4})	D_{1t} (x 10^{-4})	D_{2t} (x 10^{-4})	$\overline{R}^2$	N
Bank of East Asia	1	–0.0001 (–1.0)	0.1 (0.4)	0.9 (1.4)	0.8 (1.2)	–	–	–	0.42	32
	2	–0.000007 (–0.1)	–0.03 (–0.1)	1.3* (2.4)	–	–	–	–	0.42	32
	3	–0.0003* (–2.3)	0.5* (3.4)	–	1.3 (1.7)	–	–	–	0.41	32
	4	0.0001 (0.8)	–0.08 (–0.3)	1.0 (1.7)	0.7 (1.2)	–0.2* (–3.0)	–	–	0.55	32
	5	0.0003* (2.2)	–0.2 (–0.9)	1.4* (2.8)	–	–0.2* (–3.0)	–	–	0.54	32
	6	–0.00002 (–0.2)	0.3* (2.3)	–	1.3 (1.9)	–0.2* (–3.6)	–	–	0.52	32
	7	–0.0002 (–0.7)	0.3 (0.9)	0.4 (0.4)	0.8 (1.1)	–	1.4 (0.3)	–1.2 (–0.8)	0.41	32
	8	0.00001 (0.1)	0.2 (0.5)	0.6 (0.6)	–	–	2.6 (0.6)	–0.9 (–0.6)	0.41	32
	9	–0.0001 (–0.7)	0.4 (1.6)	–	0.8 (0.9)	–	2.8 (1.0)	–1.1 (–0.9)	0.43	32
	10	0.0001 (0.5)	0.1 (0.4)	0.6 (0.7)	0.7 (1.1)	–0.2* (–3.1)	1.0 (0.3)	–1.5 (–1.2)	0.56	32
	11	0.0003 (1.8)	–0.0005 (–0.0)	0.7 (0.9)	–	–0.2* (–3.1)	2.1 (0.6)	–1.3 (–1.0)	0.55	32
	12	0.0001 (0.6)	0.3 (1.3)	–	0.8 (1.3)	–0.2* (–3.1)	2.8 (1.1)	–1.3 (–1.0)	0.57	32

Table 7 (cont)

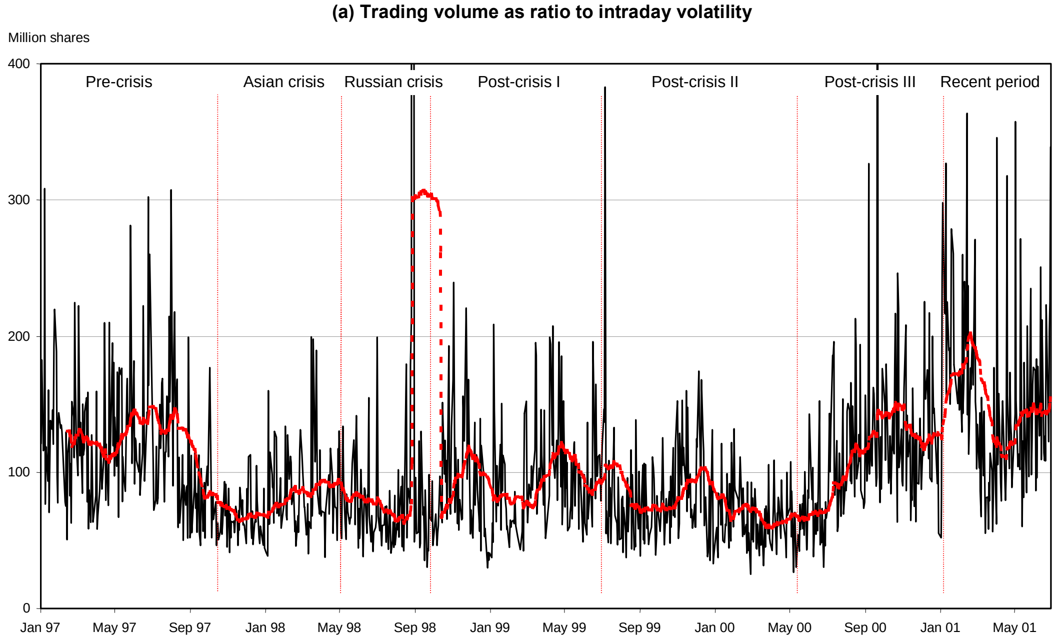
Notes: t-statistics in parentheses.

* denotes significance at the 5% level. – denotes corresponding variable not included in the respective model. Estimation period as specified in Section 3.2.3 of the paper. Standard errors are obtained by the heteroscedasticity consistent estimator of White (1980) when necessary. Data are monthly averages. $\overline{R}^2$ is the adjusted R^2. N is the number of observations.

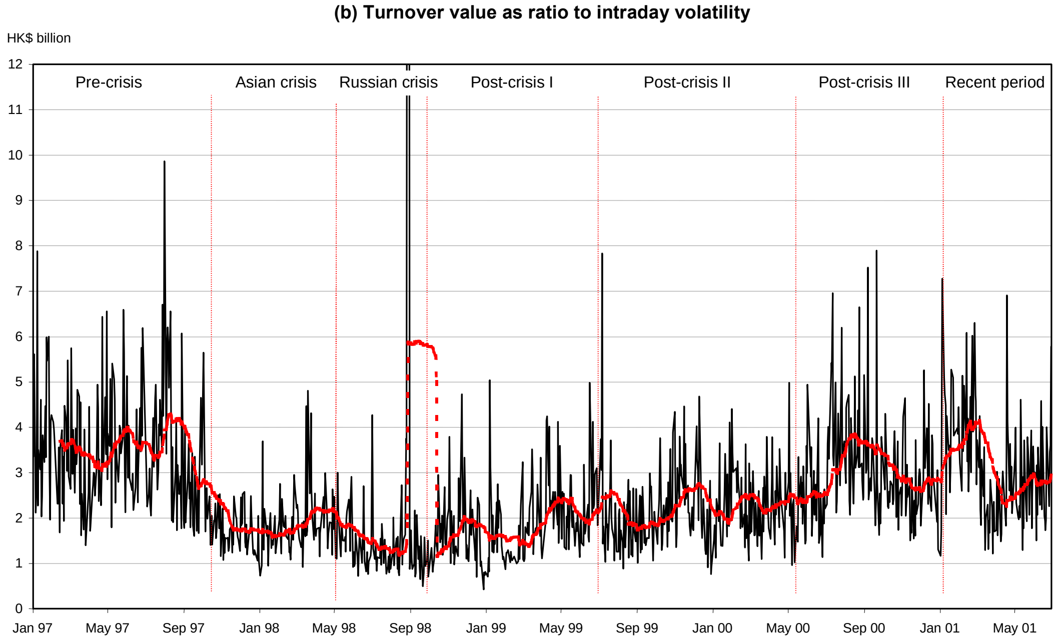
Source: HKMA staff estimates.

Chart 1

Market depth indicators of the Hong Kong stock market



Note: ----- line is a 30-day moving average.

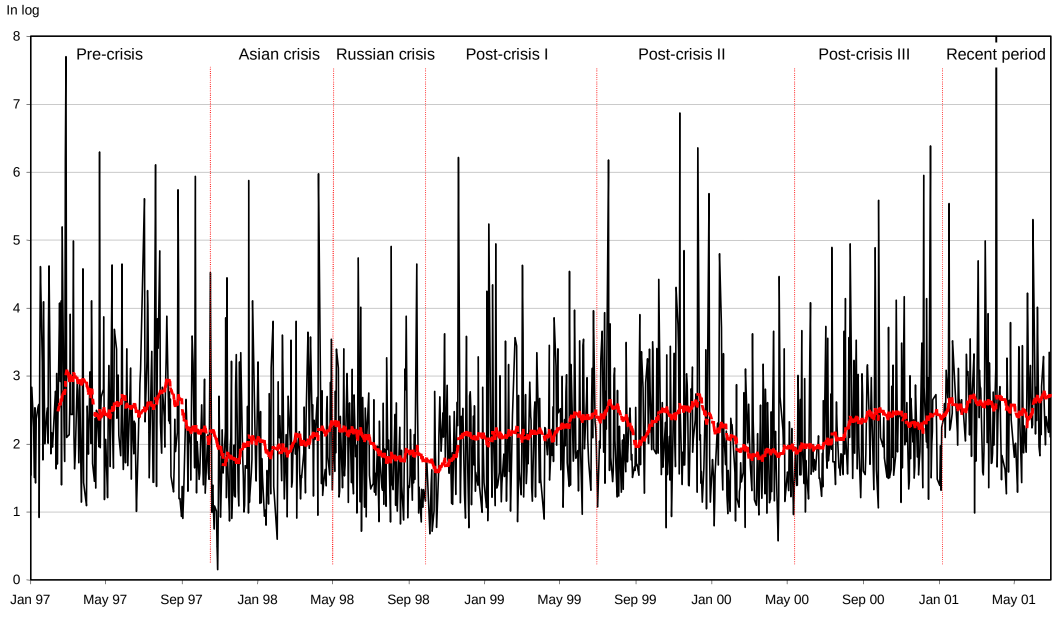


Note: ----- line is a 30-day moving average.

Chart 2

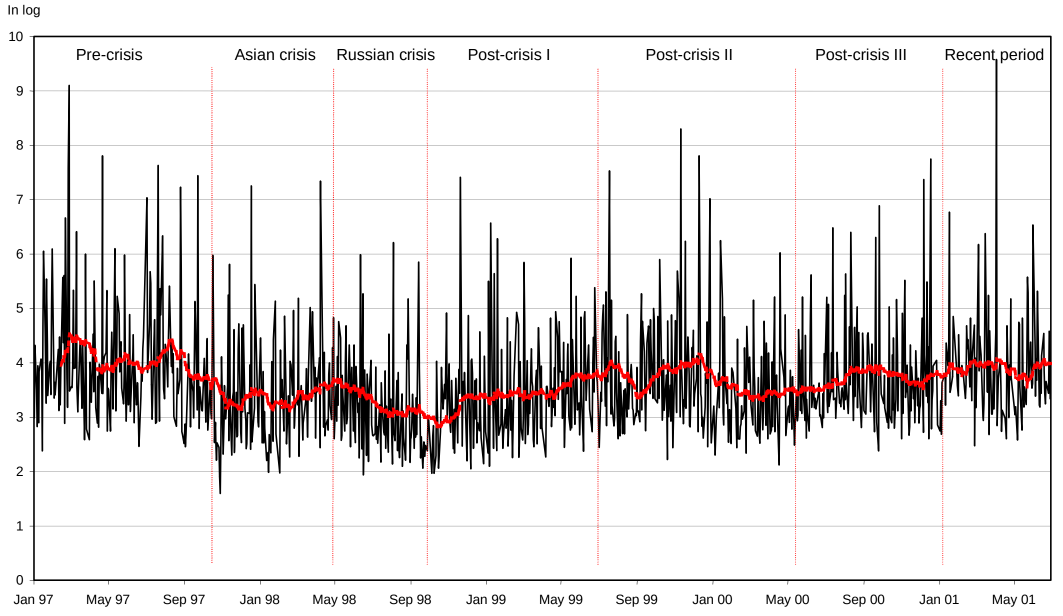
Market depth indicators of the Hong Kong stock market

(a) Trading volume as ratio to interday volatility



Note: ----- line is a 30-day moving average.

(b) Turnover value as ratio to interday volatility

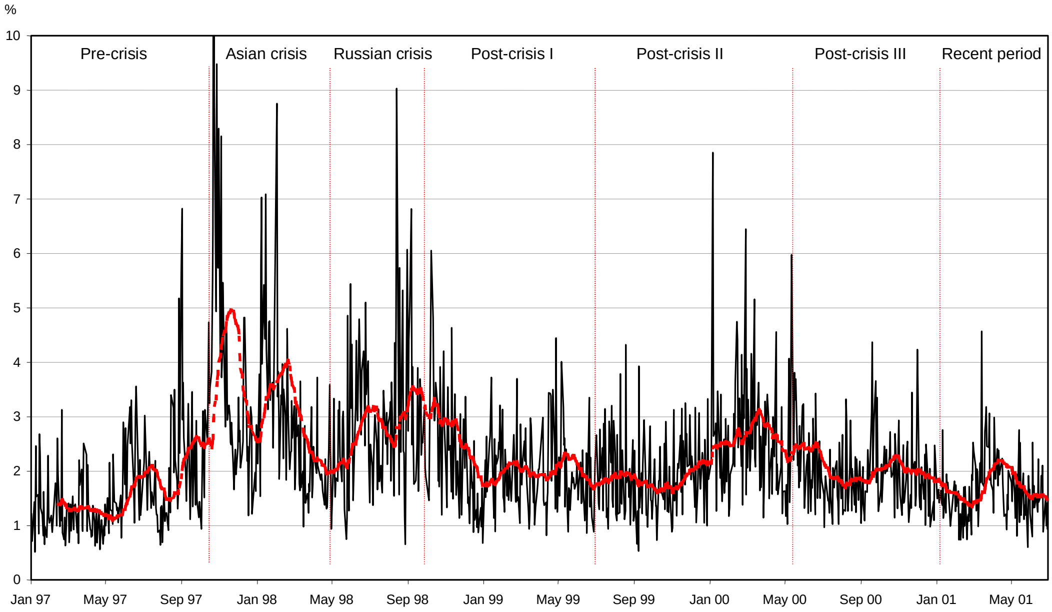


Note: ----- line is a 30-day moving average.

Chart 3

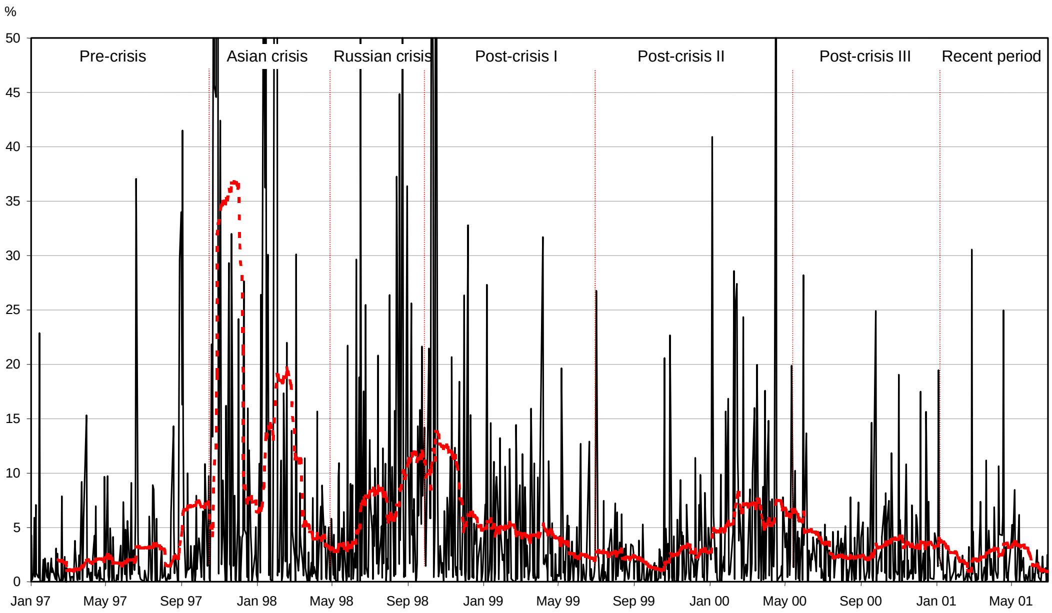
Price volatility of the Hong Kong stock market

(a) Intraday price volatility



Note: ----- line is a 30-day moving average.

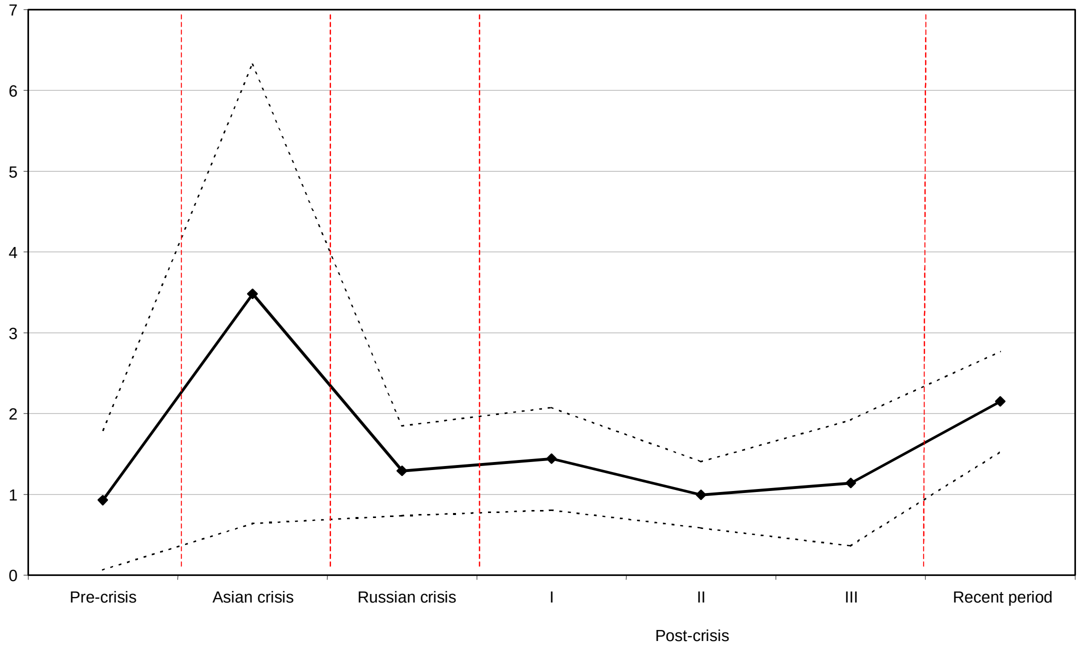
(b) Interday price volatility



Note: ----- line is a 30-day moving average.

Chart 4

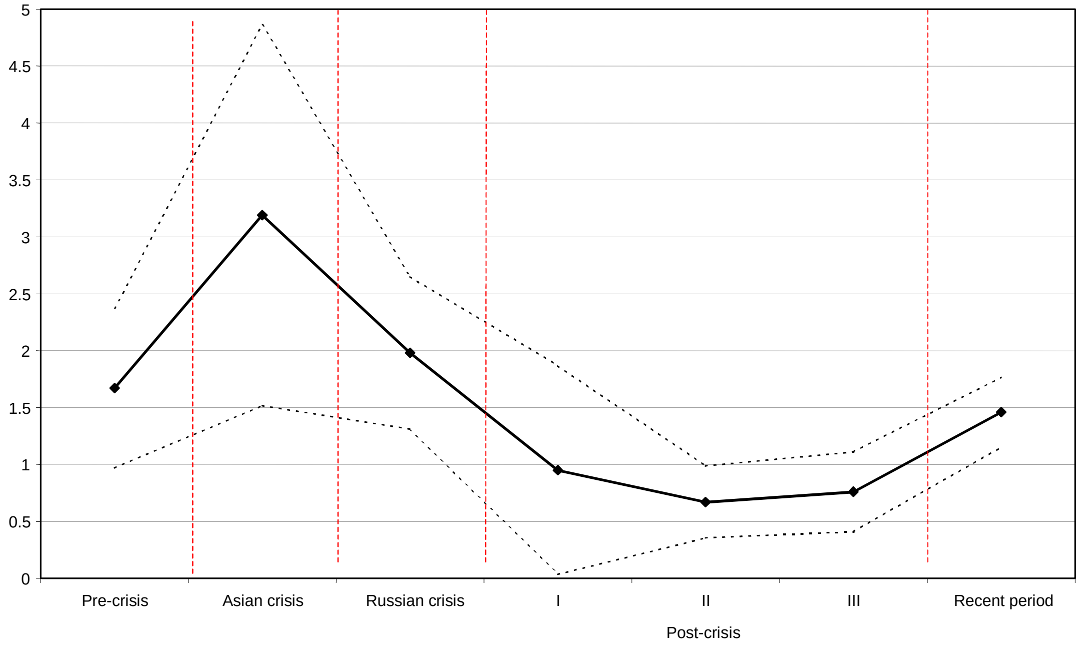
Estimated β coefficient for Cheung Kong Holdings



Note: ----- lines represent confidence interval of 95%.

Chart 5

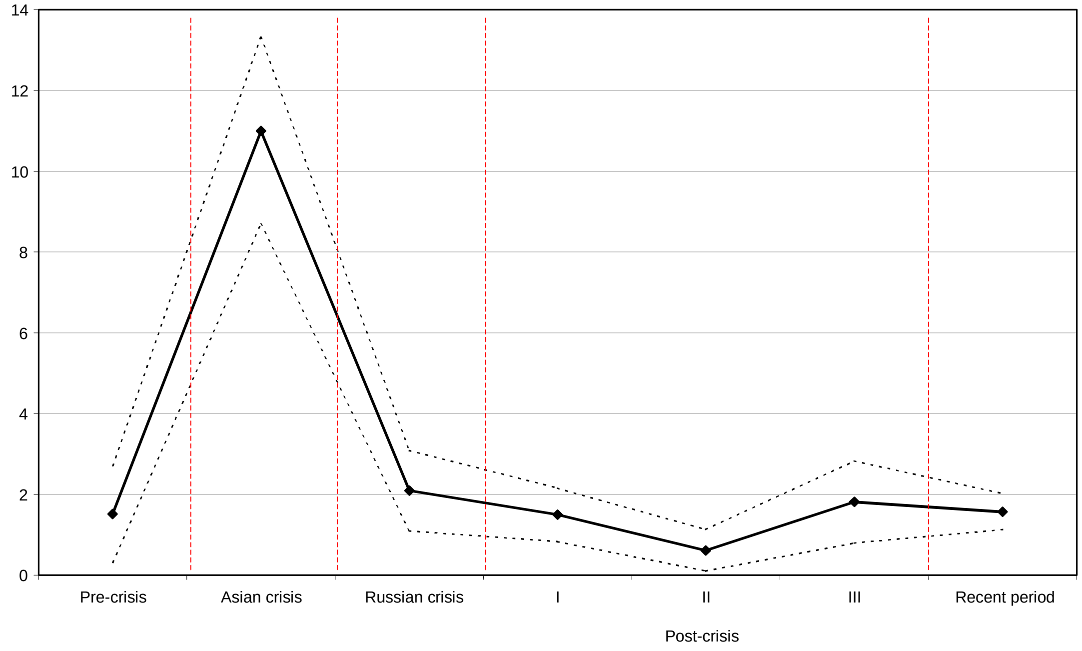
Estimated β coefficient for Hang Seng Bank



Note: ----- lines represent confidence interval of 95%.

Chart 6

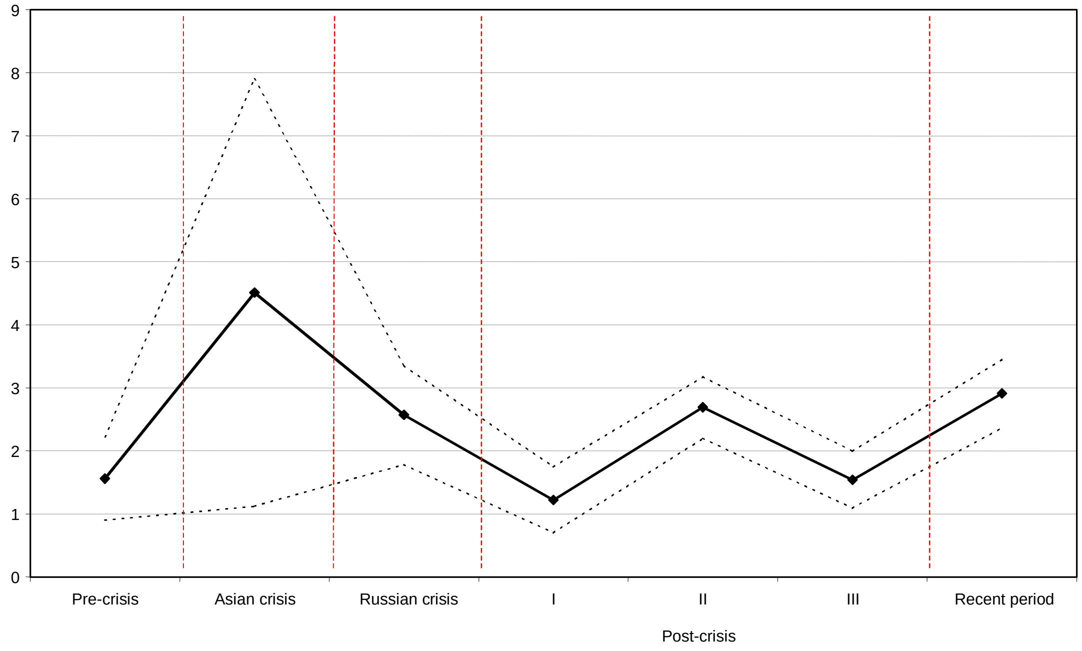
Estimated β coefficient for Hutchison Whampoa Limited



Note: ----- lines represent confidence interval of 95%.

Chart 7

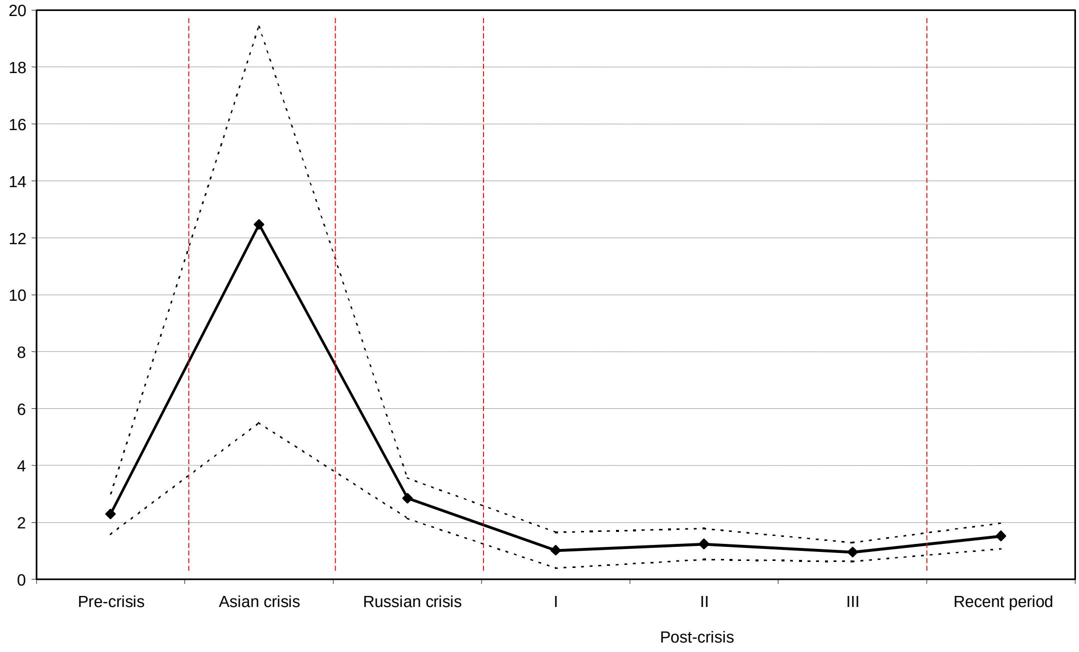
Estimated β coefficient for Sun Hung Kai Properties



Note: ----- lines represent confidence interval of 95%.

Chart 8

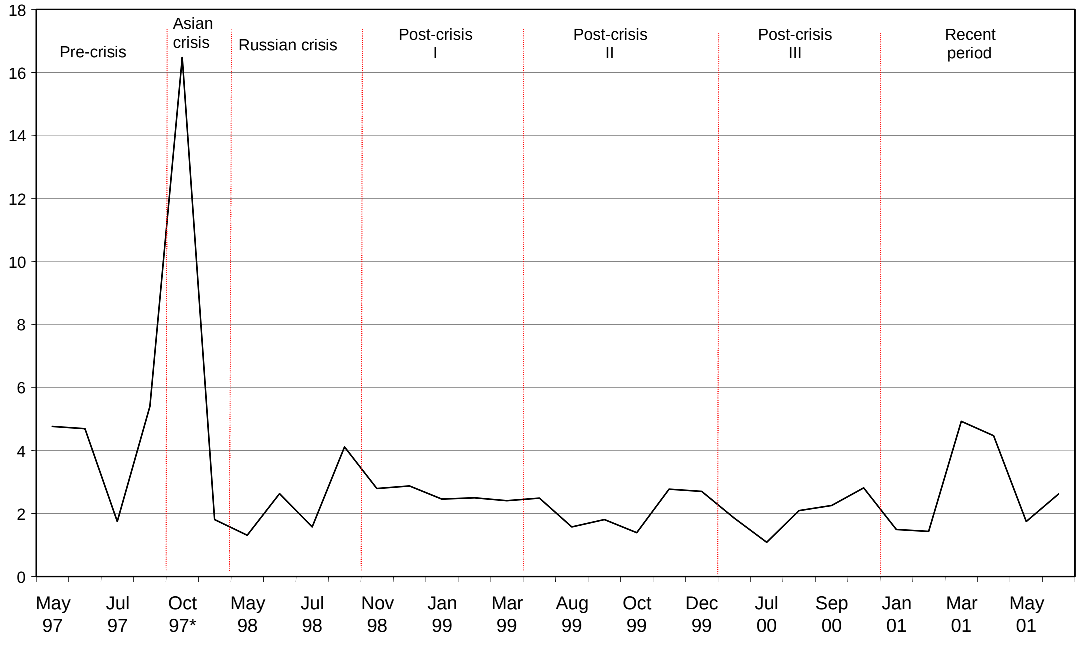
Estimated β coefficient for Bank of East Asia



Note: ----- lines represent confidence interval of 95%.

Chart 9

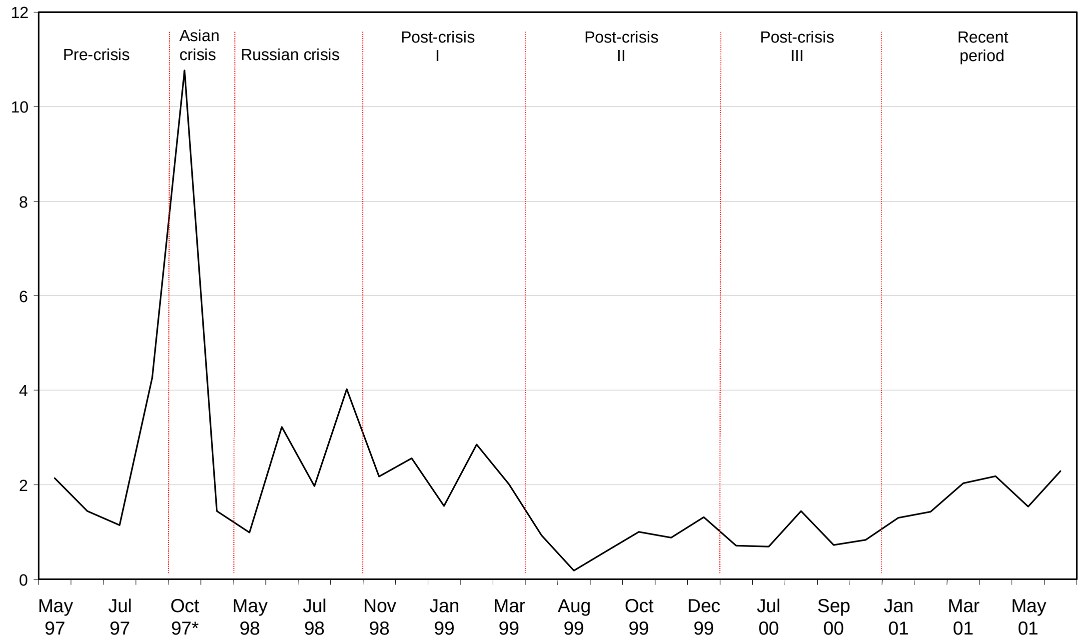
Monthly movement of estimated β coefficient for Cheung Kong Holdings



Note: All estimated βs are significant at the 5% level.

Chart 10

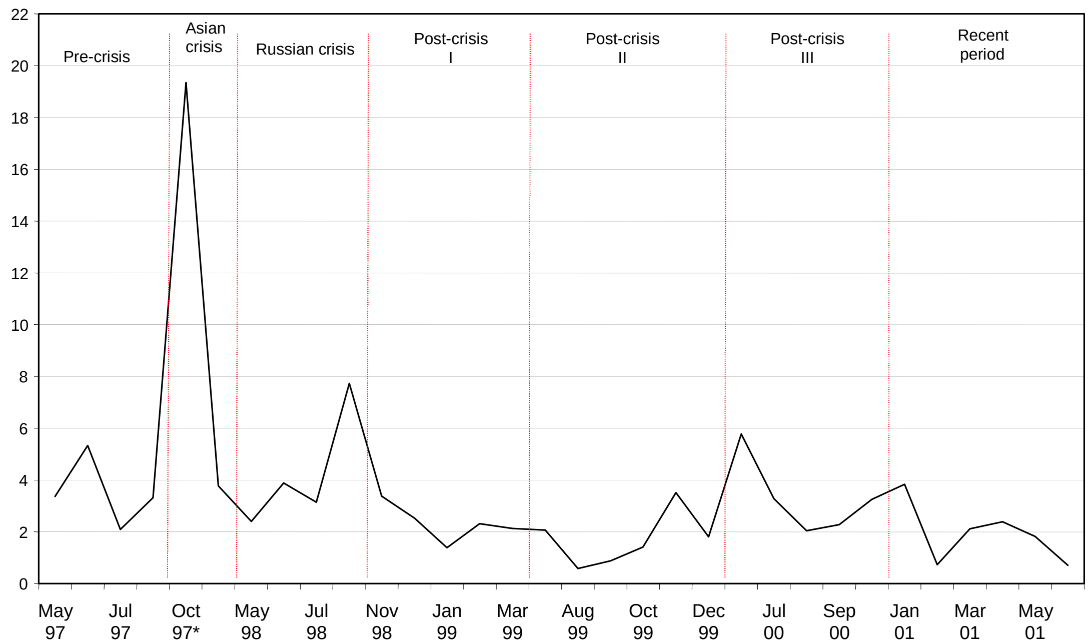
Monthly movement of estimated β coefficient for Hang Seng Bank



Note: All estimated βs are significant at the 5% level.

Chart 11

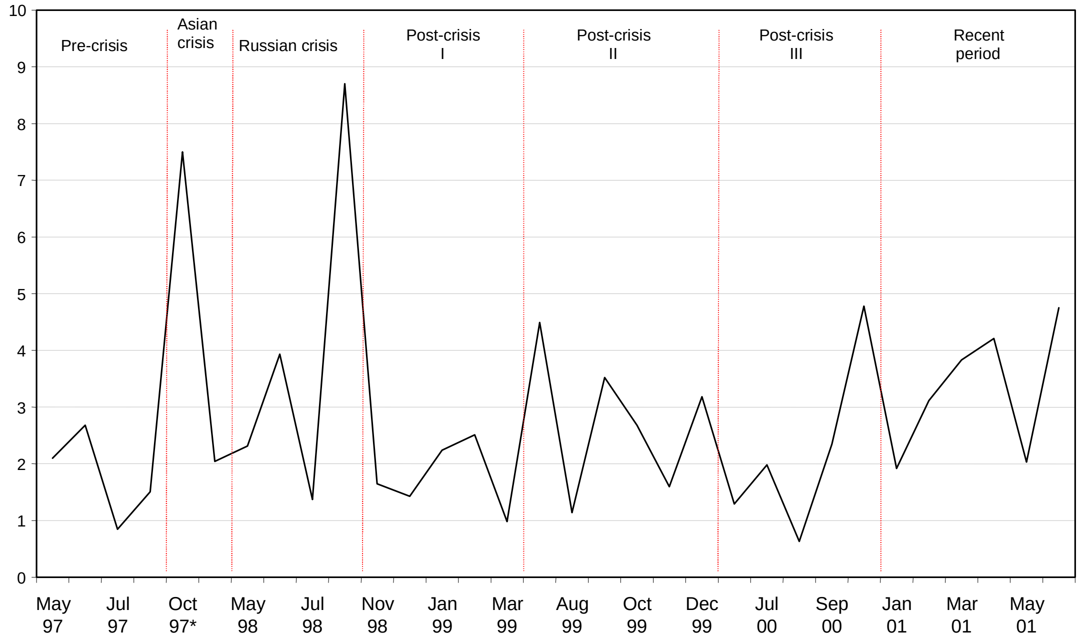
Monthly movement of estimated β coefficient for Hutchison Whampoa Ltd



Note: All estimated βs are significant at the 5% level.

Chart 12

Monthly movement of estimated β coefficient for Sun Hung Kai Properties



Note: All estimated βs are significant at the 5% level.

Chart 13

Monthly movement of estimated β coefficient for Bank of East Asia

Note: All estimated βs are significant at the 5% level.

References

Amihud, Y and H Mendelson (1980): "Dealership market: market-making with inventory", *Journal of Financial Economics* 8, 31-53.

Ahn, H J and Y L Cheung (1999): "The intraday patterns of the spread and depth in a market without market makers: the stock exchange of Hong Kong", *Pacific-Basin Finance Journal* 7, 539-56.

Ahn, H J, K H Bae and K Chan (2000): "Limited orders, depth, and volatility: evidence from the stock exchange of Hong Kong", *Journal of Finance*, forthcoming.

Bank for International Settlements (1999a): *Market liquidity: research findings and selected policy implications*, report of a study group established by the Committee on the Global Financial System of the central banks of the Group of Ten countries, May.

——— (1999b): *A review of financial market events in autumn 1998*, Committee on the Global Financial System, October.

——— (2001): *Structural aspects of market liquidity from a financial stability perspective*, discussion note prepared by the Committee on the Global Financial System for the March 2001 meeting of the Financial Stability Forum (FSF), June.

Brockman, P and D Y Chung (1998): "Inter- and intra-day liquidity patterns on the stock exchange of Hong Kong", *Journal of International Financial Markets, Institutions and Money* 8, 279-300.

——— (1999): "An analysis of depth behavior in an electronic, order-driven environment", *Journal of Banking and Finance* 23, 1861-86.

——— (2001): "Commonality in liquidity: evidence from an order-driven market structure", *The Journal of Financial Research*, forthcoming.

Brown, P, D Walsh and A Yuen (1997): "The interaction between order imbalance and stock price", *Pacific-Basin Finance Journal* 5, 539-57.

Chan, K and W Fong (2000): "Trade size, order imbalance, and the volatility-volume relation", *Journal of Financial Economics* 57, 247-73.

Chan, K C and C Y Hwang (1998): "The impact of tick size on market quality: an empirical investigation of the stock exchange of Hong Kong", Hong Kong University of Science and Technology, *Working Paper Series.*

Chordia, T, R Roll and A Subrahmanyam (2000): "Market liquidity and trading activity", Emory University and University of California, Los Angeles, *Working Paper Series*.

——— (2001a): "Order imbalance, liquidity, and market returns", *Journal of Financial Economics*, forthcoming.

Chordia, T, A Sarkar and A Subrahmanyam (2001b): "Common determinants of bond and stock market liquidity: the impact of financial crises, monetary policy, and mutual fund flows", Emory University, Federal Reserve Bank of New York and University of California, Los Angeles, *Working Paper Series*.

Demsetz, H (1968): "The costs of transacting", *Quarterly Journal of Economics* 82, 33-53.

Easley, D and M O'Hara (1992): "Time and the process of security price adjustment", *Journal of Finance* 47, 577-605.

Engle, Robert F and Joe Lange (1997): "Measuring, forecasting and explaining time varying liquidity in the stock market", *National Bureau of Economic Research Working Paper* 6129*.*

Grossman, S and M Miller (1988): "Liquidity and market structure", National Bureau of Economic Research, *Working Paper* 2641.

Hasbrouck, J and D J Seppi (2001): "Common factors in prices, order flows and liquidity", *Journal of Financial Economics* 59, 383-411.

Ho, T and H R Stoll (1980): "On dealer markets under competition", *Journal of Finance* 35, 2, 259-67.

——— (1981): "Optimal dealer pricing under transactions and return uncertainty", *Journal of Financial Economics* 9, 47-73.

Huberman, G and D Halka (2001): “Systematic liquidity”, *The Journal of Financial Research* 24, 2, 161-78.

Jones, C, G Kaul and M Lipson (1994): “Transactions, volume, and volatility”, *Review of Financial Studies* 7, 631-51.

Kempf, A and O Korn (1997): “Market depth and order size”, University of Mannheim, *Working Paper Series*.

Kyle, A (1985): “Continuous auctions and insider trading”, *Econometric* 53, 6, 1315-35.

O’Hara, M (1995): *Market microstructure theory*, Blackwell, Cambridge MA & Oxford.

O’Hara, M and G Oldfield (1986): “The microeconomics of market marking”, *Journal of Financial and Quantitative Analysis*, 21, 361-76, December.

Roll, R (1984): “A simple measure of the bid-ask spread in an efficient market”, *Journal of Finance* 39, 1127-39.

Stoll, H (1989): “Inferring the components of the bid-ask spread”, *Journal of Finance* 44, 115-34.

Upper, Christian (2000): “How safe was the ‘safe haven’? Financial market liquidity during the 1998 turbulences”, Deutsche Bundesbank, *Discussion paper* 1/00, February.

White, H (1980): “A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity”, *Econometrica* 48, 817-38.