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**Editor’s introduction: optimal debt and aspects of risk and liquidity**

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This book is divided into three sections: these are first developing country debt, second volatility and risk, and third liquidity. Each of these areas has important unresolved issues regarding financial markets in general, and futures markets in particular. Moreover, in each case the futures markets aspects of these issues appear to have received relatively less attention than their spot market counterparts. Indeed, there are reasons to expect futures markets to behave differently compared with spot markets, because of important asymmetries between spot and futures markets, and within futures markets. An example of the first type of asymmetry is that futures markets operate on margin, whereas spot market transactions typically require payment in full. An example of the second type of asymmetry is that within futures markets, delivery if possible, is only at seller’s option.

The papers included in this volume have been selected because each provides new insights into an open question in the area of, or pertinent to futures markets. These papers discuss the following issues:

- Debt in excess of the optimal as a warning signal of impending financial crises¹
• trading characteristics of Chinese futures markets
• recent contributions to the literature on performance of agricultural futures markets
• Fourier analysis of intraday data, which avoids homogenisation
• realized volatility in a thin currency futures market
• forecasting and profits in currency futures
• traders’ perceptions of the price path in the presence of order imbalance
• simultaneous relationships between liquidity, volume and volatility in US electricity futures markets.

**Optimal debt in East Asia 1994-96**

Conventional indicators of macroeconomic performance, such as inflation rate, ratio of budget deficit to GDP and ratio of current account deficit to GDP, failed to anticipate the Asian crises of 1997-98. The same is true also of the reports of sovereign credit rating agencies. Yet some researchers have wondered whether there was information in the market, if only one knew how to identify and extract it, which could be used to predict the onset of such an event. In chapter 2 Stein and Lim provide an answer to this question. The information is that the exchange rates of some Asian countries were misaligned, and for some Asian countries the ratio of debt to net worth, relative to net risk-adjusted returns, was excessive. These two pieces of information suggested that a currency and/or debt crisis was likely if a random shock were to occur.
The analysis in chapter 2 is based on Stein’s (1995) theory of the Natural Real Exchange Rate (NATREX) and the stochastic optimal control theory of foreign debt of Fleming and Stein (2001), which was used by Stein and Paladino (2001) to analyse foreign debt of *inter alia* African, South American, Asian and Eastern European countries. These two theories recently have been brought together in Stein (2006). Stein’s (1995) NATREX is an equilibrium medium and long term real exchange rate, which assumes internal balance (e.g. capacity utilization is at its long run mean) and external balance (e.g. equality between domestic and foreign real interest rates, and no speculative capital flows).

The NATREX is expressed as $R[Z(t)]$, where $R$ is the real exchange rate, and is quoted as units of foreign currency per unit of domestic currency (raise is an appreciation of domestic currency), $Z$ represents fundamentals and other exogenous variables and $t$ is time. The actual real exchange rate at time $t$ is $R(t)$, and the difference between the actual and equilibrium rates is

$$\Phi_t = R(t) - R[Z(t)] \quad (1)$$

where $\Phi_t$ is a measure of misalignment of the actual rate relative to NATREX. If $\Phi_t > 0$ this indicates overvaluation of the domestic currency, and suggests that depreciation or possibly a currency crisis is probable. Conversely, if $\Phi_t < 0$ this indicates undervaluation of the domestic currency, and suggests that inflationary pressure will likely follow in the presence of a pegged nominal rate. Stein (2006, p. 11) suggests that a difference between the actual real rate and NATREX may be due to interest differentials, cyclical factors and/or speculative capital flows.
The optimal debt ratio $f^*$, of Stein and Lim in chapter 2 is that which maximizes a HARA (hyperbolic absolute risk aversion) expected utility function of discounted consumption, subject to the constraints that consumption and net worth ($X$) are always positive. In this model, which is based on Fleming and Stein (2001) and summarized in Stein (2006, pp. 20-24, 28-37), the current external debt ($L_t$) is expressed as a ratio ($f_t$) of net worth, which is defined as capital ($K$) minus debt$^3$. Thus

$$X_t = K_t - L_t$$  \hspace{1cm} (2)

$$f_t = L_t / X_t$$  \hspace{1cm} (3)

A measure of excess debt is the difference between the current debt ratio and that which is optimal

$$\Psi_t = f_t - f^*$$  \hspace{1cm} (4)

The optimal debt ratio can be expected to vary \textit{inter alia} with the mean net rate of return adjusted for risk $(b - r)/\sigma$, where $b = Y/K$ is the productivity of capital ($Y = GDP$), $r$ is the real rate of interest and $\sigma^2 = \text{var} (b - r)$. In this model there are two stochastic variables, $Y$ and $r$, which are both assumed to follow Brownian motion.

The implications of this analysis are threefold. First, if the domestic currency is overvalued relative to NATREX ($\Phi_t > 0$) this acts as a warning signal that a devaluation, or possibly a currency crisis, is likely. Second, if the current debt ratio exceeds the optimal ($\Psi > 0$) this acts as a warning signal that a debt crisis is likely if a random shock occurs. Third, there may be interaction between a misaligned exchange rate and excess debt, which can increase the probability of a currency and/or debt crisis. For example, if mean net returns fall due to a decline in domestic productivity, capital outflow may occur, which can lead to
devaluation. This devaluation will likely make it more difficult for the domestic economy to service external debt, which, if denominated in US dollars, implies a shock to the real rate of interest, and can lead to default⁴.

In chapter 2 Stein and Lim estimate the NATREX for five Asian economies (Indonesia, Korea, Malaysia, the Philippines and Thailand) for the period 1982-2000. They find that

- Thailand had prolonged exchange rate misalignment 1990-96.
- There was minor misalignment for Korea 1995-97.
- There was no misalignment for Indonesia, Malaysia or the Philippines.

The authors then estimate the time paths of the ratio of external debt to GDP and net return on investment (b – r) for these five economies. They argue that if returns are falling but the debt ratio is not declining, then the probability of default increases. This is because it becomes more difficult to service the debt without reducing consumption. Stein and Lim found inter alia that both Thailand and Korea exhibited warning signals of excess debt: there was a rise in the debt/GDP ratio, and a fall in relative returns 1994-96 in both cases. The authors then compare the forecasts of the NATREX and excess debt models, and their interaction, with the events in east Asia 1997-98.

**Volatility and risk**

Volatility, in the view of Poon and Granger (2003, pp. 481, 492), is a latent variable, and, unlike price, cannot be observed, but needs to be estimated, if inferences about volatility
are to be drawn. This would appear to contrast, to some extent, with the view of Andersen, Bollerslev, Diebold and Labys (2003) (henceforth ABDL), who, in proposing their concept of realized volatility, claim that empirically, they are “treating volatility as observed rather than latent” (ABDL, p. 581), although realized volatility (RV) still needs to be estimated. In any case, volatility is not identical with risk: while a sample standard deviation can be employed as an estimate of volatility, an inference about risk requires that this estimate be attached to a statistical distribution, either theoretical or empirical. Poon and Granger (2003) agree that volatility can be interpreted as uncertainty, although they believe that in such cases there is usually an implicit assumption about the distribution of returns (Poon and Granger, 2003, p. 480).

This section of the Introduction deals with five papers which address a range of issues in the areas of volatility and risk. Chapter 3 deals with the trading characteristics of instruments for managing and taking risk on China’s futures exchanges, while chapter 4 surveys recent contributions to the literature on these instruments in agricultural economics. Chapter 5 discusses the application of Fourier analysis to intraday data, which are not evenly spaced in time, to avoid problems from homogenizing and synchronizing the data. Chapter 6 discusses the distributional properties of realized volatilities estimated from intraday data for a thinly traded currency futures market, while chapter 7 is concerned with the development of a model to produce risk-adjusted returns with data from a leading currency futures market.
A developed cash market and a system of warehouse receipts, both important foundations for the support of futures markets in agricultural commodities, were late developments in China. Nevertheless, the China Zhengzhou Commodity Exchange (CZCE), acting on advice from the Chicago Board of Trade, opened a wholesale market in 1990, and futures trading began on CZCE in May 1993. By the end of 1993 there were more than 30 futures exchanges operating in China, although this number was reduced by Chinese regulatory authorities to 14 by the end of 1995, and to three in 1998, namely CZCE, (known as Zhengzhou Commodity Exchange, ZCE since 1998), Dalian Commodity Exchange and Shanghai Futures Exchange (Peck, 2001, pp. 445, 452-54). Futures trading on these three exchanges, which is all electronic, centred on commodities, especially mungbeans at ZCE, soybeans at Dalian and copper at Shanghai. Trading activity on China’s futures exchanges reached a peak in 1995 of 667 million contracts (see chapter 3) or approximately ten trillion yuan (Peck, 2001, p. 454), and thereafter declined until around 2000, from which time there has been a revival. New futures contracts, mostly listed since 2000, have played an important part in the recovery in trading volumes on China’s futures exchanges in 2005 and 2006. These commodities include especially strong gluten wheat, white sugar and cotton on ZCE, corn, soybean oil and meal on Dalian, and aluminium, rubber and fuel oil on Shanghai. Of the commodities which previously were strong performers on these exchanges, mungbeans have faded into oblivion at ZCE, although soybeans were a strong performer at Dalian in 2005, as was copper at Shanghai in the same year (http://english.czce.com.cn  www.dce.cn  www.shfe.com.cn all accessed August 18, 2006).
In a previous paper Peck was able to point to the speculative interest and activity by commercials on ZCE prior to 1998. This was in contrast to trading in wheat futures in Kazakhstan, which was in decline. The comparative success of ZCE, which was the most successful of the Chinese exchanges up to that date, Peck attributed in no small part to the managerial ability of the exchange officials (Peck, 2000, p. 54).

In chapter 3 Peck discusses trading patterns and aspects of the performance of Chinese futures exchanges which have received little attention in the literature. Trading on China’s futures exchanges typically reaches a maximum some five to seven months prior to maturity. This is true of soybeans at Dalian, of wheat at Zhengzhou, and of copper at Shanghai (the peak for aluminium at Shanghai is three to four months prior to maturity). Moreover, open interest follows the same course. This is in contrast to trading volume in the US, the UK, continental Europe and most other places, where the most active future is typically two to three months from maturity. Peck refers to a study which claims that the Chinese characteristic is due to the rules of Chinese exchanges, which require greater margins and smaller position limits in the month prior to delivery. Peck also seeks evidence of seasonality in Chinese trading patterns, and finds some surprising contrasts compared with US exchanges, especially for grains.

In chapter 3 Peck also reviews the literature on performance of China’s futures markets, including studies of the links between futures and cash prices in China, and between Chinese and US futures prices, for commodities which are traded in both countries. She
finds contrasting results for soybeans at Dalian and wheat at Zhengzhou, and seeks reasons for these contrasts.

*Futures market performance: a survey*

Previous surveys of the literature on futures markets were published by Gray and Rutledge (1971) and Goss and Yamey (1976, 1978). Those surveys, however, preceded many important developments in futures markets, such as the dominance of financial futures, the consolidation of clearing and/or ownership among major exchanges, the almost universal switch to screen trading and the significant increase in the importance of hedge funds and other managed funds. In chapter 4, Garcia, Leuthold and Egelkraut provide a survey of the literature on selected topics, with emphasis on agricultural futures markets, in which they not only review the contributions to the extant literature, but they also make suggestions for future research.

Issues emphasized in the review in chapter 4 include risk management, price relationships, informational efficiency, electronic trading and liquidity. In the discussion of risk management the reader’s attention will be drawn to factors which may cause actual hedge ratios to diverge from those which are optimal, such as the distinction between maximum utility and minimum risk. In the discussion of price relationships the reader may be surprised to find that the issue of whether the convenience yield can explain backwardation in the presence of scarce stocks, is still unresolved. The reader will note the asymmetry between backwardation (limited only by expectations, in the view of Keynes, 1930, pp.
142-44) and contango, which is constrained by storage costs, and she may like to consider the interpretation of these price spreads for non-storables, such as live cattle and electricity.

Chapter 4 reviews an extensive literature on weak-form and semi-strong form tests of the efficient market hypothesis for agricultural commodities, and the issue of informational efficiency may appear to be closed. Yet where is the literature on strong form tests in futures markets? Strong form efficiency means that all information, including private information, is impounded in price, and Ito, Lyons and Melvin (1998) inferred that the higher lunch-time variance in the Japanese Yen/USD and DM/USD spot rates, when the Tokyo foreign exchange market is open, is due to private information.

Lyons (2001, pp. 87-88, 271) describes how dealers in spot foreign currencies impound private information into prices, and it would seem that the data for strong form tests in futures are potentially available in intraday order flow and price information. [A trader with private information is termed an “informed trader”, and is to be distinguished from an “insider” who is an employee of a corporation and who possesses private information about that corporation (see Grossman, 1986, p. S130)].

The section on prices in chapter 4 includes a discussion of volatility, where the authors remind us of the direct relationship between seasonality and volatility, which is important for agricultural markets, and of the need for volatility forecasts (see later). The review in chapter 4 concludes with a discussion of factors which impact price discovery and the trading environment, such as electronic trading and liquidity. While evidence, from
agricultural markets, is scarce on the effect of electronic trading on price discovery, Anderson and Varhid (2001) find inter alia, with Sydney stock index data, that futures returns lead stock returns before the switch to screen trading, and afterward this lead increases. While the review in chapter 4 emphasizes the neglect of the time dimension and forecasts of liquidity, discussion of the liquidity topic will be delayed until the introductions of chapters 8 and 9, both of which deal with liquidity.

Fourier analysis with high frequency data

Not all information relevant to the determination of asset prices is publicly known. Some information is private, as for example, when a foreign exchange dealer receives an order for central bank intervention, or even a private client order, before the information is known to other market participants. Dealers can learn about this private information, not from direct access to the pieces of information held by the parties which initiate the transactions, but by observing the order flow. Moreover, because order flow is predictive of future price changes, dealers can be expected to respond to this information, for example, by taking market positions, either of a speculative or a risk management nature, or by adjusting the bid-ask spread (Lyons, 2001, pp. 4-8, 13-14, 21-27). The microstructure approach takes these processes, which will impact on price, into account.

High frequency data have been found to be more revealing of some microstructure processes, such as order flow, than low frequency data. Intraday data, however, are not evenly spaced in time, and the implementation of conditional volatility models requires that
data are homogenized, for example, by linear interpolation, which can induce bias in volatility estimates, or by previous tick, which tends to introduce spurious autocorrelation among estimated returns (Barrucci and Renò, 2002, pp. 371-78). Similarly, standard correlation measures can not be applied to data which are produced by non-synchronous trading, and if the data are synchronized by interpolation this can introduce bias.

Recently, a method has been developed, based on Fourier analysis, which permits correlation statistics to be obtained, or volatility to be estimated, without incurring the penalties imposed by attempts to homogenize and synchronize the data (see Malliavin and Mancino, 2002). In contrast, the Fourier method can be applied directly to raw data, and is based on integration of the time series, rather than interpolation. The Fourier integrals can be obtained through integration by parts, and these will permit the volatility to be reconstructed (e.g. Barrucci and Renò, 2002) or the correlation statistics to be obtained (e.g. Precup and Iori, 2005). For example, if $S_i(t)$ is the price of asset $i$ at time $t$ and $p_i(t) = \ln S_i(t)$, the Fourier coefficients of $dp_i$ are:

$$a_0(dp_i) = \frac{1}{2\Pi} \int_0^{2\Pi} dp_i(t)$$  \hspace{1cm} (5)

$$a_k(dp_i) = \frac{1}{2\Pi} \int_0^{2\Pi} \cos(kt)dp_i(t)$$  \hspace{1cm} (6)

$$b_k(dp_i) = \frac{1}{\Pi} \int_0^{2\Pi} \sin(kt)dp_i(t) \hspace{1cm} k \geq 1$$  \hspace{1cm} (7)

where the time window for asset prices $[0,T]$ is normalized to $[0,2\Pi]$. It has been shown that the Fourier coefficients of the volatility $\sigma^2(t)$ can be computed from the Fourier
coefficients of the \( d_{pi} \) (Malliavin and Mancino, 2002, pp. 49-61). A similar procedure will yield the Fourier correlation matrix \( \rho_{ij} \) for two assets \( i, j \) (Precup and Iori, 2005).

The Fourier method has been employed by Barrucci and Renò (2002, pp. 371-78), who estimated the volatility of a diffusion process with high frequency data, and found \textit{inter alia} that the Fourier volatility estimator has smaller bias and smaller variance than volatility estimates provided by cumulative squared intraday returns. The authors also found that a GARCH(1,1) model provided superior forecasts when volatilities obtained by the Fourier method were employed, as compared with volatilities computed by cumulative squared intraday returns. The Fourier method also has been employed by Precup and Iori (2005), who estimated correlation coefficients for two pairs of stocks on New York Stock Exchange with intraday data, and found that the Fourier estimates were more stable and more robust to variations in trading rates, than estimates provided by the Pearson method and an extension to the Pearson method to allow for “covolatility weighting”. In chapter 5 Mattiusi and Iori employ the Fourier method to analyse volatilities and correlation of returns with intraday data from Chicago Mercantile Exchange (CME) on futures contracts for S&P500 Index, US dollar/Japanese Yen and US dollar/Australian dollar, for the period April to December 1997, which includes the onset of the Asian crisis.

\textit{Realized volatility in thin markets}

Representation of the behaviour of intra-sample volatility requires that the model proposed is able to account for key stylised facts, including that
• Daily returns are leptokurtic
• Time series of returns exhibit volatility clustering
• Returns are negatively skewed (e.g. Franses and van Dijk, 2000, pp. 5-17; Poon and Granger, 2003, p. 481).

Nevertheless, Poon and Granger (2003, p. 479) hold the view that the success of a volatility model is to be measured in terms of its post-sample forecasting power. ABDL (p. 580) argue that since “standard” volatility models (e.g. GARCH models) cannot fully utilize the information in intraday data, a new approach was necessary. To address this perceived deficiency they proposed their realized volatility (RV) approach. They note first that while raw returns are leptokurtic, returns standardized by RV are approximately normal. Second, they note that while distributions of RV are positively skewed, logarithms of RV are approximately normal (ABDL, p. 581).

Post-sample VAR volatility forecasts based on RV for one and ten day horizons appear to outperform rival forecasts by models based on absolute returns, autoregressive models and GARCH type models (ABDL, pp. 603-12). In the ranking of volatility models by Poon and Granger (2003, pp. 508-35), according to their ability to forecast post-sample, and evaluated by a range of criteria, RV forecasts are ranked highly. Implied volatility forecasts derived from option pricing models also are highly ranked by Poon and Granger (2003). In option pricing models, such as Black-Scholes, the option price is a function of asset price, strike price, risk-free rate of interest, time to maturity and volatility. Since the first five variables are observable, the implied volatility can be obtained by inverting the
pricing model. Option price data also can be employed to find implied forward volatility between two non-overlapping maturities (e.g. Egelkraut and Garcia, 2006). Implied volatility is a market expectation of average volatility until expiration, and Poon and Granger (2003, pp. 486-89, 499) point out that a test of forecasting performance of an implied volatility model is a joint test of option market performance and validity of the option pricing model.

The distributional results, for returns standardized by RV and log realized volatilities, obtained by ABDL (pp. 581, 598-600) refer to large samples of spot foreign currency data (3045 days intra-sample, 596 days post-sample, with 30 minute returns derived from several million quotes at an average of approximately 4,500 per day (ABDL, pp. 591-93 and n. 17). In chapter 6 Schieck explores the extent to which these properties hold for the more thinly traded US dollar/Australian dollar futures contract at the Chicago Mercantile Exchange. Schieck calculates realized volatilities for ten-minute returns for the near future with maturities from March 1997 to December 1999.

*Forecasting and profits in currency futures*

Meese and Rogoff (1983) found that traditional economic models of exchange rates, such as the monetary model, could not outperform a random walk, in post-sample forecasts of the spot rate for the period 1976-1981, for three key exchange rates against the US dollar. Among the reasons suggested for this relative lack of success were simultaneous equations bias and misspecification (Meese and Rogoff, 1983, pp. 12-13, 17-19). This criticism was
re-emphasized by Isard (1987), Meese (1990) and others. Perceived deficiencies of traditional models included undue reliance on single equation methods, inadequate representation of expectations and insufficient attention to capital flows (Isard, 1987, pp. 1, 3, 15-16; Meese, 1990, p. 117).

In a world where models which could outperform a random walk were extremely rare, Goss and Avsar (1996) developed a simultaneous model of the Australian dollar/US dollar (AUD/USD) rate which forecasts the spot rate out of sample with a per cent root mean square error (RMSE) one quarter that of a random walk, albeit with only ten post-sample months of forecasting in a thin market (Goss and Avsar, 1996, pp. 171-72). Goss and Avsar (2000) developed a simultaneous model of the US dollar/Deutschemark (USD/DM) futures market, which was the most active currency futures market on the Chicago Mercantile Exchange prior to the introduction of the Euro, and this model outperforms a random walk in 34 months of post-sample forecasts of the spot rate with percent RMSE less than one fifth that of a random walk (Goss and Avsar, 2000, pp. 77-79).

It has not been shown, however, that the model of Goss and Avsar (2000) could be employed to produce risk-adjusted profits. Moreover, that model assumed an exogenous risk premium, an assumption which is unduly restrictive, because the risk premium is likely to vary *inter alia* with the time-varying volatility of the market under review. In chapter 7 Goss and Avsar re-develop and re-estimate their model of the USD/DM spot and futures markets (endogenization of the risk premium requires re-specification of the error terms, and re-estimation of the mean and variance equations). The re-specified model contains
functional relationships for short hedgers, long hedgers, net short speculators in futures, and for traders with unhedged spot positions. Conditional variances of the hedging and speculation equations are modelled as EGARCH (p, q) processes (Nelson, 1991) to capture the likely asymmetrical financial innovations.

The re-developed model again significantly outperforms a random walk in post-sample forecasts, and as the foundation for a simulated trading program in DM futures, it produces significant risk-adjusted profits for a holding period of seven days, while the average profits are positive but not significant if the positions are held for one month. This result may be interpreted as evidence against informational efficiency in the very short term. While this outcome may appear inconsistent with the concept of rational expectations, which is employed to represent expectations in this model, the authors provide two lines of reconciliation to this apparent conflict. The first is the presence of a significant risk premium (since the efficient market hypothesis is a joint hypothesis, embodying the assumptions of risk neutrality and rational expectations). The second avenue of reconciliation is the evidently greater power of the hypothesis tests based on post-sample forecasts, compared with those based on intra-sample tests of significance of estimated coefficients.
Liquidity

Order imbalance and liquidity relationships

Liquidity can be defined as the ability to buy or sell the desired quantity of a security at the market price, in a short period of time. Liquidity has value, so that more liquid securities tend to have higher prices than less liquid securities, other things being equal (Amihud, Mendelson and Pedersen, 2006, pp. 1-9, 49-51). The issue of determination of liquidity is important in the economics of futures markets, because the cost of liquidity is a major cost of transacting (Ding, 1999, p. 308; Wang, Yau and Baptiste, 1997, p. 759). Liquidity also has value to exchanges, in the sense that an exchange which trades a given security with greater liquidity than rival exchanges, can expect to attract volume at expense of rivals. Previous research has identified two key variables in the determination of liquidity, namely volume and volatility, and several studies have investigated the relationships between cost of liquidity and volume, between volume and volatility, as well as between cost of liquidity and volatility (e.g. Fleming, 1997; Wang et al, 1997; Hartmann, 1999; Bollerslev and Melvin, 1994; Goss and Avsar, 1998).

While no ideal measure of liquidity has been proposed, the bid-ask spread is a popular measure, although as Fleming (2003, p. 85) has emphasized, this measure represents the cost of executing a small trade, and is valid for only a short time period. This measure of cost of liquidity has been supplemented by measures of market depth, such as quote size (the quantity of securities to which the bid or offer refers) or trade size (the quantity of
securities traded). Fleming (2003, p. 85) argues that such measures tend to underestimate market depth, because they do not indicate the quantity of securities which could have been traded at the quoted price. Distinctions have been drawn between “nominal” and effective” bid-ask spreads, where the effective spread is the difference between the prices of a dealer’s buy (sell) and sell (buy) orders for a security, which may be separated in time (e.g. Grossman and Miller, 1988, p. 628; Smith and Whaley, 1994, pp. 438-39; Ding, 1999, p. 309).

Futures markets do not have official market makers, like some equities markets, such as the New York Stock Exchange, where “specialists” declare simultaneously the bid and offer prices at which they are willing to trade (provide “immediacy”: see Grossman and Miller, 1988, p. 628). In futures markets with open outcry, such as the Chicago Mercantile Exchange (CME), bid and offer quotes are provided, possibly by different persons, possibly separated in time (some futures contracts at CME now utilize electronic and open outcry side-by-side trading). In futures markets with screen trading, such as London International Financial Futures Exchange, bid and offer prices are matched by computer to effect transactions.

Previous research has distinguished four components of the bid-ask spread, each of which is influenced inter alia by volume and/or volatility:

1. Dealer’s inventory cost, which represents essentially the dealer’s risk from holding inventory, is a direct function of volatility, and varies inversely with volume
2. Asymmetric information cost, which gives rise to a compensation to the dealer from dealing with better informed traders. This component may vary directly with volume if the dealer perceives that orders are being placed by traders with private information, and is likely a direct function of volatility if increased volatility generates information driven orders.

3. Unit direct costs of order execution, which are likely to be negatively related to volume, due to the presence of fixed costs in the short run (Grossman and Miller, 1988, p. 629) and economies of scale in the long run\(^5\) (Ding, 1999, p. 313, and Hartmann, 1999, pp. 803-4).

4. Market power of the dealer, is likely to decrease with competition among dealers, and hence to be negatively related to volume (Fleming, 1997; Wang \textit{et al}, 1994; Glosten, 1987; McInish and Wood, 1992; Hartman, 1999). This component could be measured by the difference between dealer’s price and marginal cost or by the number of dealers trading in the pits (Wang \textit{et al}, 1997, p. 762). In a market with official market makers, Lyons (2001, p. 40) points out that the market maker’s monopoly power is limited by the limit order book, because in matching a market order, the market maker’s bid or ask quotes must be compared with the order book.

Previous research has studied the relationship between pairs of the three variables, liquidity, volume and volatility. In the cost-of-liquidity-volume relationship, an increase in volume will reduce the cost of order execution due to spreading fixed costs (short run) and economies of scale (long run), as discussed above. Moreover, an increase in volume will make it easier for a dealer to sell from inventory, thus reducing inventory cost, and also will
likely reduce the dealer’s monopoly power if more dealers are active. These three influences will tend to reduce the bid-ask spread. In contrast, if the dealer believes that new orders are driven by private information, then asymmetric information cost will increase, which will widen the bid-ask spread. While in theory the sign of this relationship is ambiguous, an increase in volume is generally thought to reduce the cost of liquidity, and empirically the relationship usually has been found to be negative (Hartmann, 1999, p. 805; Wang et al, 1997; pp. 761-62, 765-73; McInish and Wood, 1992, pp. 753-54; Copeland and Galai, 1983, p. 1463; Goss and Avsar, 1998, pp. 106-108).

Some authors have argued that in theory volume varies directly with volatility, while others regard the sign of this relationship as ambiguous. In the model of Epps and Epps (1976), for example, volatility (as measured by the conditional variance of price changes) varies directly with volume, through increased disagreement between buyers and sellers following the arrival of new information. In comparison, in the model of Tauchen and Pitts (1983) price variability and volume are directly related, given the number of traders. An increase in the number of traders, however, reduces the variance of price changes through a reduction in the differences between traders. Hence in the model of Tauchen and Pitts (1983) the sign of the volume-volatility relationship is indeterminate (Tauchen and Pitts, 1983, pp. 487-90). From the liquidity viewpoint, an increase in volatility contains information, which will likely lead to increased volume as traders respond to this information. To the extent that dealers perceive new orders are being placed by traders with private information, there will be an increase in asymmetric information cost, and an increase in the bid-ask spread, which will tend to reduce volume. Moreover, increased
volatility represents increased uncertainty, which will increase the dealer’s inventory risk, which also will tend to increase the bid-ask spread. Hence the sign of the volume-volatility relationship is ambiguous (see French and Roll, 1986; Ito, Lyons and Melvin, 1998; McInish and Wood, 1992, p. 754; Wang et al, 1994, p. 838, n. 1). Empirically, the sign of this relationship is typically found to be positive (see e.g. Clark, 1973, pp. 143-45; Wang et al, 1997, pp. 765-73; Fleming, 1997, p. 18; Goss and Avsar, 2006, pp. 44-45). Volume can also impact upon volatility (see Bessembinder and Seguin, 1993, pp. 23, 30-33).

The relationship between cost of liquidity and volatility is positive. Increased volatility contains new information, and to the extent that dealers perceive that the resulting orders are driven by private information, there will be an increase in asymmetric information cost, and hence in the bid-ask spread. Moreover, increased volatility also implies increased uncertainty, which will raise the dealer’s inventory cost, which also will raise the bid-ask spread (see McInish and Wood, 1992, p. 764; Fleming, 1997, pp. 21-23; Bollerslev and Melvin, 1994, pp. 356, 370-71; Wang et al, 1994, p. 838).

Dealers will know public information, and while they will not know the private information possessed by informed traders, they can learn about private information from (signed) order flow (negative for sales). Indeed, dealers can use order flow to forecast price movements. Moreover, because dealers hold inventory, a client order can result in disequilibrium in the dealer’s portfolio. A dealer can be expected to respond to the arrival of private information, as revealed by order flow, by undertaking risk management and/or speculative trading activity (Lyons, 2001, pp. 4-8, 13-14, 21-27). Pennings et al, (1998) studied the
price path due to order imbalance, as a measure of market depth (i.e. the number of contracts needed to change price by one tick, Kyle, 1985, p. 1319), and found evidence of a non-linear price path. In chapter 8 Marsh, Pennings and Garcia survey the perceptions of the price path due to order imbalance, of more than 400 traders at Chicago Board of Trade (CBOT) and CME. The nature of this price path is critical to the cost of liquidity, and the authors argue that perceptions drive the behaviour of traders. Marsh, Pennings and Garcia find considerable heterogeneity in traders’ perceptions of the price path due to small and large order imbalances, and the question is whether the variation in perceptions is related to characteristics of the traders themselves (e.g. scalping or spreading), or to aspects of market microstructure. The authors present evidence that the answer is to be found in microstructure, and they study characteristics such as the extent to which trading is open outcry or electronic, whether contracts traded are agricultural or financial, and whether there are differences in traders’ perceptions, between contracts within these groups.

Previous research on relationships between the variables cost of liquidity, volume and volatility has employed almost exclusively, single equation methods (Wang et al, 1997, is a rare exception). Nevertheless, in practice, these relationships are determined simultaneously, and this should be taken into account in empirical research. This is especially true of relationships between pairs of the three variables liquidity, volume and volatility, because if these relationships are estimated as regression functions, each equation will contain an endogenous regressor. The residuals and the regressors, therefore, will be contemporaneously correlated, so that ordinary least squares estimates will be biased and inconsistent. Furthermore, the residuals of these equations are likely to exhibit time
varying volatility and volatility clustering, i.e. heteroskedasticity, so that inferences drawn from conventional hypothesis tests likely will be invalid. Indeed, the necessity for a simultaneous approach to the analysis of liquidity is suggested in Andersen and Bollerslev (1998, p. 220). Although Wang et al, (1997) develop a two equation model to analyse the simultaneous determination of cost of liquidity and volume, this model does not endogenize volatility.

While liquidity in futures markets has received some attention in previous research, liquidity in electricity futures markets has virtually been ignored. This is unfortunate because competitive electricity markets are in an early stage of development, and an understanding of liquidity in these markets will be of increased importance as deregulation of electricity markets proceeds in Europe, North America, Asia and Oceania. Indeed, given the substantial volatility and price spikes observed in US markets, it is clear that effective risk management tools are essential in deregulated electricity markets (see Stoft, 2000; Avsar and Goss, 2001, pp. 480-81). In chapter 9 Avsar and Goss develop and estimate a three equation simultaneous model of the relationships between each pair of the variables cost of liquidity, volume and volatility. This model is estimated by three stage least squares with data from California-Oregon Border electricity futures contracts, which was one of the first two electricity futures contracts introduced in the US, and the most active during the sample period from April 1996 to December 1999. Three stage least squares (3SLS) is an appropriate estimator for this model, given the characteristics of liquidity relationships described above, and the likely covariation of the residuals of the individual equations. Single equation estimates of these relationships are provided for comparison, and to
estimate the ARCH-in-mean terms for the simultaneous model, and they also act as starting values for the 3SLS estimates. The reader will observe notable differences between the systems estimates and the single equation estimates for the reasons discussed above.
Endnotes

1 Although this paper (chapter 2 by Stein and Lim) does not employ futures market data, it is pertinent to futures markets, first because reform of East Asian financial architecture is an important policy issue for major international institutions (see Woo, Sachs and Schwab, 2000, pp. 4-11), and futures markets can be expected to play a role in any revised financial arrangements in East Asia. Second, it has been shown that activity in East Asian derivatives markets increased during the Asian crisis (see Zhang, 2004, pp. 159-73, 211-20).

2 Goldstein, Kaminsky and Reinhart (2000, p. 19) define a currency crisis as follows: “A currency crisis is defined as a situation in which an attack on the currency leads to substantial reserve losses, or to a sharp depreciation of the currency – if the speculative attack is ultimately successful – or to both”. This definition is helpful for the present discussion.

A debt crisis in the sense of Stein (2006, p. 226) occurs “….. if the attempt to service the debt requires a drastic decline in consumption”. Stein (2006, p. 227) argues, however, that a drastic reduction in consumption is unlikely, and that default is the likely outcome of such a situation.

Goldstein, Kaminsky and Reinhart (2000, p. 20) also define the events which they believe mark the beginning of a banking crisis. Although banking crises do not play an
explicit role in the model of Stein and Lim in chapter 2, they are nevertheless relevant, because as Goldstein, Kaminsky and Reinhart (2000, pp. 2, 13) argue, a banking crisis may precede a currency crisis, for example by leading to a loss of international reserves.

3 Stein (2006, chapter 1) can be accessed at www.oup.co.uk search <Jerome Stein> download “sample”.

4 An alternative warning system of banking and currency crises, which involves 24 indicators, is developed by Goldstein, Kaminsky and Reinhart (2000, pp. 21-43, 55-71).

5 The merger between the Chicago Mercantile Exchange and the Chicago Board of Trade announced 17 October, 2006 (see www.cme.com; www.bot.com; The Economist, October 21, 2006, p. 78) is consistent with the hypothesis of economies of scale of order execution, and with the view, expressed in Goss and Avsar (1998, pp. 105-109) that there are increasing returns to liquidity. Indeed, paragraph two of the merger announcement refers to the combined company as providing “…. One of the world’s most liquid market places, with average daily trading volume approaching 9 million contracts per day” (www.cme.com).
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