Limit Order Book, Anonymity, and Market Liquidity:

Evidence from The Sydney Futures Exchange

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Abstract

This study examines the impact of the removal of broker mnemonics on the Sydney Futures Exchange. Early research finds that the decrease in transparency reduces liquidity in the market, while more recent research finds reduced transparency improves market quality. Results of this study indicate an improvement in liquidity after the removal of broker mnemonics. There is a significant increase in quoted depth and trading volume, and a significant decrease in quoted spreads in the 90 Day BAB, 3 Year Treasury Bond and 10 Year Treasury Bond Futures.

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1. Introduction

This paper examines the impact on market liquidity of the removal of broker mnemonics in an electronic limit order market. The majority of previous research examines the change in bid-ask spreads associated with changes in both pre- and post-trade anonymity. Simaan, Weaver and Whitcomb (2003) argue that anonymity reduces collusion among quote providers. A transparent market allows dealers to collude and post wider spreads, with anyone providing tighter spreads easily identified and subsequently reprimanded by other dealers. They document that Nasdaq dealer quotes on anonymous electronic communication networks (ECN's) are tighter than quotes posted on Nasdaq (a transparent dealer quotation system).

Foucault, Moinas and Theissen (2003) develop a theoretical model which predicts that anonymity leads to a narrowing of bid-ask spreads. By separating traders who supply liquidity into two classes, informed and uninformed, they argue that in a market setting that provides broker identification, informed traders supplying liquidity provide information regarding future price movements. In this environment, uninformed quote providers learn from the quotes provided by informed traders, and can thus quote more aggressively in front of the informed traders.

To protect themselves from this behaviour, Foucault, Moinas and Theissen (2003) argue that informed traders will occasionally set wider spreads than required to deceive uninformed quote setters. In a market that does not provide broker identification, informed traders will not engage in "bluffing" activities, and will thus always post competitive quotes. Foucault, Moinas and Theissen (2003) document a decline in bid-ask spreads and depth (after controlling for trading activity, volatility and price) on Euronext

Paris subsequent to the removal of pre-trade broker identification. They conclude that the removal of broker identifiers has an ambiguous effect on market liquidity.

Comerton-Forde, Frino and Mollica (2005) extend the analysis of Foucault, Moinas and Theissen (2003). In addition to examining Euronext Paris, they also examine the removal of broker identification on the Tokyo Stock Exchange, and the introduction of broker identification for limit orders on the Korea Stock Exchange, thus increasing the already high levels of pre-trade transparency. Their results indicate that a reduction in transparency leads to a decrease in both relative and effective bid-ask spreads, while both relative and effective spreads increase for the Korea Stock Exchange, supporting the notion that an increase in limit order anonymity improves liquidity.

On the 20 February, 2004, the Sydney Futures Exchange (herein SFE) removed the display of broker mnemonics on the limit order book for the three primary interest rate futures contracts. The primary motivation of this study is to examine the impact of the removal of these broker identifiers on market liquidity. In particular, this study will concentrate on changes in both quoted bid-ask spreads and *quoted depth* associated with the structural change. In addition, this is the first study (to our knowledge) that examines the impact of the removal of broker identifiers in a futures market.

Results of our analysis suggest that removal of broker mnemonics leads to an increase in market liquidity. There is a significant reduction in quoted bid-ask spreads, and significant increases in both quoted depth and trading activity. These results are confirmed after controlling for changes in volume and volatility, and are robust to the time period examined around the structural change.

The reminder of this paper is organized as follows. Section 2 discusses the institutional detail of the SFE, while Section 3 describes the data and method. Section 4 presents univariate and regression results, while the final section summarises the paper.

2. Institutional Details

The Sydney Futures Exchange (SFE) is the largest futures exchange in the Asia-Pacific region, and is ranked among the top ten futures and options exchanges worldwide by value of turnover.[1] The 90-day BAB futures was launched in 1979, and represents the first interest rate futures contract to be listed outside the United States. Day trading on the SFE commences at 8:30 a.m. and ends at 4:30 p.m. for interest-rate future contracts. Trading on the SFE is conducted via a fully automated trading system, the Sydney Computerised Market (SYCOM). SYCOM was originally launched on November 30, 1989, as an overnight trading system. On October 4, 1999, SFE abandoned floor trading in favour of electronic screen trading, and SYCOM was upgraded to an open-architecture design (SYCOM IV) in order to serve as the primary trading platform.

The three contracts examined in this study follow a quarterly expiration cycle (March, June, September and December). Trading in the nearest-to-delivery contract on the 90-day BAB cease at 12:00 noon on the second Friday of the delivery month. The settlement day for the 3-year and 10-year bond occurs one business day following the last permitted day of trading, which is the fifteenth day of the contract month.

The SFE's interest rates futures products are quoted as 100 minus the yield to maturity of the contracts, expressed in percent per annum. This is different to the United

[1] Aitken, Frino, Hill and Jarnecic (2004) and Frino, Harris, McInish and Tomas III (2004).

States markets. The remainder of this section outlines the pricing conventions of the three interest rates futures contracts examined in this chapter. The formula for computing the dollar value of the 90-day BAB given the quoted price is as follows:

$$Value\ of\ 90-day\ BAB = \frac{1{,}000{,}000 * 365}{365 + \left[\frac{(100 - Quoted\ Price) * 90}{100}\right]}$$

The dollar value of the 3-year and 10-year Bond contracts is given by the following formula:

$$Bond\ Value = 1000 * \left[\frac{c(1-v^n)}{i} + 100v^n\right]$$

where: $$i = \frac{100 - (Quoted\ Price)}{200}$$

$$v = \frac{1}{1+i}$$

$$c = \frac{coupon\ rate}{2}$$

On 16 March 2001, the SFE reduced the coupon rate of both the 3-year and 10-year bond futures contracts from 12 percent per annum to 6 percent per annum. The face value of the 90-day BAB, 3-year and 10-year bonds underlying the futures contracts are AUD 1 million for the BAB's and AUD 100,000 for the 3-year and 10-year bonds.

The decision to remove mnemonics (broker identifiers) for Australian Interest Rate Products is the outcome of an extensive consultation program undertaken with SFE Participants during 2003. The decision was made based on recommendations received from SFE Participants as well as feedback provided by various end-users.

3. Data and Research Design

This paper employs a unique dataset obtained from SFE to examine the price impact of trades executed on the Sydney Futures Exchange. The data is extracted from the electronic settlement system of SFE known as OM Secur. The data represents an electronic list of all transactions executed on the SFE platform. Each record contains fields which document the date, time, price, volume, contract code, buy or sell code, account identifier and broker identifier. The account and broker identifiers represent alphanumeric codes which identify trades that are attributable to the same account or trader and executed by the same broker, respectively. The dataset available for this paper describes transactions executed in the near contracts during the daytime trading session. We define the structural change as the event date when broker mnemonics were removed from the limit order book. The data extends from 1 August, 2003 to 31 August, 2004.

In order to explore the impact on the liquidity of the change from a non-anonymous market to an anonymous market, the prevailing quoted depth at the best bid and ask quotes is calculated as follows -

$$\text{Depth} = \text{Volume at the Best Ask} + \text{Volume at the Best Bid} \quad (1)$$

We also examine relative quoted bid-ask spreads and volatility, defined as follows -

$$\text{Relative Spread} = [\text{Best Ask} - \text{Best Bid}] / 0.01$$

Volatility = Log [High_Price / Low_Price]

where 0.01 is the minimum tick for each transaction, and the volatility is measured as the logarithm of the highest price traded divided by the lowest price traded each day (see Wiggins, 1992]. The volume variable is calculated as the average number of contracts traded each day.

Consistent with prior event studies in futures markets, we confine our analysis to daytime trading in the near term contract (see Bortoli et al, 2004 and Aitken et al., 2004). We apply a pre- and post- research design centered on the change in the transparency regime. The sampling procedure is designed to control for possible time to expiration effects in liquidity as the average time to maturity of the contracts for the days sampled in the pre-event period is approximately equal to that of the days sampled in the post-event period [Grammatikos and Saunders (1986)].

The final sample period consists of 218 trading days in the Bank Accepted Bills for the SFE, 218 trading days in the 3-year bond, and 256 trading days in the 10-year bond, consistent with 6 months observations before and after the event date for the markets. The data includes 39,211 transaction quotes in the BABs, 193,593 transactions quote in the 3-year bond, and 219,167 transactions in the 10-year bond for the SFE.

The increase in liquidity due to the intervention of mnemonics' removal is tested by examining the change in depth at the best quotes in the pre- and post-event samples. Depth, as well as the liquidity determinants described above, are sampled for each trade in the trading day and then averaged for each day. Averaging bid-ask spreads and depth to produce one observation for each day removes intraday variation across these

variables, which is not of interest in this study. The quoted, as apposed to proportional, bid-ask spread is employed in the present study since the analysis is confined to single futures contract series.[2] A *t*-test is used to examine whether the means of the variables in the pre- and post-event periods are significantly different.

Harris (1994) develops a model which identifies a number of variables that explain changes in depth, namely trading volume and price volatility. It is important to control for changes in these variables in order to ensure that any changes in depth observed in this study are attributable to the change in anonymity, and not merely to changes in market conditions which influence these variables. The models below are estimated using OLS to test the impact of brokers' removal on market depth, controlling for possible changes in known determinants;

$$PBAS_t = a + \beta_1 D_1 + \beta_2 VOLUME_2 + \beta_3 VOLATILITY_3 + \varepsilon$$

$$DEPTH_t = a + \beta_1 D_1 + \beta_2 VOLUME_2 + \beta_3 VOLATILITY_3 + \varepsilon$$

where the dependent variable $PBAS_t$ is the quoted spread divided by the minimum thick 0.01, and the dependent variable $DEPTH_t$ is the daily average limit order volume at the best buy and sell prices. $VOLUME_t$ is the log transformation of trading volume, consistent with Harris (1994). The variable D_t is again a dummy variable that takes the value of one after the structural change, zero otherwise. All *t*-statistics are adjusted for

[2] Spurious results may be generated by the proportional bid-ask spreads in time series futures data. If a contracts bid-ask spread remains constant over time and the contracts price is trending, the proportional bid-ask spread will change. A proportional bid-ask spread is employed to control for heterogeneity across stocks in cross sectional analysis of time series equities data [see for example McInish and Wood (1992) and Harris (1994)].

heteroskedasticity and autocorrelation using the procedure developed by Newey and West (1987).

4. Results

4.1 Univariate Results

Table 1 provides summary statistics and results from tests of the impact of anonymity on depth, using data from six months before and after the structural change. Panel A of Table 1 reports results for the depth at the best quotes. Consistent with Frino et al. (2005) and Foucault et al. (2003), Table 1 documents an increase in average depth across the contracts examined. Decreased transparency of the limit order book corresponds with an increase in depth of 903.5 contracts for the BABs, 943 contracts for the 3-year bonds, and 82.83 contracts for the 10-year bonds. Additionally, *t*-tests comparing the means in the pre- and post-event periods are significant at the 0.01 level, indicating that the increases in depth are statistically significant for all the three type of contracts.

Trading volume shows a similar pattern, with an increase of 8539 daily contracts for the 3-year bond, and an increase of 1341 daily contracts for 10-year bonds. The quoted bid-ask spread is significantly tighter for all three contracts. Volatility exhibits a significant decrease for the BABs and the 3-year bonds.

<INSERT TABLE 1>

4.2 Regression Analysis

Although changes in several factors that affect spreads are minimal, it is possible that these factors are driving the changes in spreads and depth documented in the univariate results. To control for the impact that these additional factors have on the spread, several regressions are estimated. Table 2 provides the results of regression analysis for both relative spread and depth. Results indicates that after controlling for variation in volume and volatility, spreads are significantly tighter after broker identification is removed (the anonymity dummy variable has a significantly negative coefficient).

Interesting results are found for the regressions with the depth as the dependent variable. The volume variable has a significantly positive coefficient, while the volatility variable has a significantly negative coefficient, while the dummy variable has a significantly positive coefficient (which is significant at all conventional levels), indicating that depth increased with the reduction in transparency. Overall, after controlling for factors that affect both spreads and depth, there is a significant increase in market liquidity under an anonymous market structure.

<INSERT TABLE 2>

To examine the sensitivity of results to the length of the event window, we re-estimate all statistics using data from three months before and after the structural change. The results are presented in Table 3. Univariate results are similar to those based on six-month data. Although the relative spread, depth, volume and volatility for the BABs are

insignificantly different from zero, there is a significant increase in depth of 859 contracts for the 3-year bonds, and 70.55 contracts for the 10-year bond. Volume exhibits an increase of 5130 contracts for the 3-year bonds, and an increase of 1229 contracts for the 10-year bond. Quoted bid-ask spreads are significantly tighter for both the 3-year and 10-year bonds.

<INSERT TABLE 3>

We also re-estimate all regressions separately for the three-month event window. Results are reported in Table 4. Results indicate that all coefficient estimates are consistent with the original findings. All dummy variables are significantly negative for bid-ask spread regressions, and significantly positive for depth regressions, indicating a significant increase in market liquidity. We thus conclude that our findings are robust to the length of the event window.

<INSERT TABLE 4>

6. Conclusion

This paper examines the impact of removing broker identifiers on market liquidity. Several studies show that a reduction in transparency leads to a reduction in bid-ask spreads and an overall improvement in market quality. On the 20 February, 2004, the SFE ceased displaying broker mnemonics on the limit order book. Results of our analysis indicate a significant reduction in quoted bid-ask spreads, and a significant

increase in both quoted depth and trading activity. These results are robust to changes in factors that affect spreads and depth, specifically volume and volatility. The results are also robust to the length of the event window around the structural change. The removal of broker identifiers has improved market liquidity.

TABLE 1

Descriptive Statistics

This table reports descriptive statistics including number of trades, proportional spread, daily depth, daily volume, and daily volatility for the Bank Accepted Bills, the 3-year bond, and the 10-year bond traded in the Sydney Future Exchange. Trades are included if they traded continuously for 6 months prior to and after the 20 February, 2004. The Proportional spread is calculated as the bid-ask spread over the minimum tick of $0.01. Volatility is calculated as the natural logarithm of the ratio of daily high to low securities prices. Volume is the average number of contracts traded per day. For each variable, the table reports the mean, and change in mean for the 6 months before and after the structural change. Statistical significance emanates from the test of whether the mean change is significantly different from zero.

Descriptive Statistics	90-day T-bill		3-year bond		10-year bond	
6 months data	Pre	Post	Pre	Post	Pre	Post
No of Trades						
Mean	154.28	137.93	706.75	687.41	798.15	824.20
Mean change	-16.35		-87.1400		26.0500	
Proportional spread (%)						
Mean	0.79	0.76	0.8030	0.7407	0.3350	0.2730
Mean change	-0.039 *		-0.0074 ***		-0.0620 ***	
Depth						
Mean	2881.5	3386.4	2623.4	3566.4	226.53	309.36
Mean change	504.9 ***		943 ***		82.8300 ***	
Average Daily Volume						
Mean	11198	11594	30508	32584	9678	11019
Mean change	396		8539 *		1341 **	
Daily volatility (%)						
Mean	0.04	0.03	0.06	0.05	0.0612	0.0632
Mean change	0.01 **		-0.01 **		0.0020	

*** *Sig at less than 0.01*
** *Sig at less than 0.05*
* *Sig at 0.1*

TABLE 2
Regressions Results
This table reports two sets of regression results for the Bank Accepted Bills, the 3-year bond, and the 10-year bond traded on the Sydney Future Exchange. Trades are included if they traded continuously for 6 months prior to and after the 20 February, 2004. In the first regression, the dependant variable is measured as the relative spread. In the second regression, the dependent variable is measured as the depth at the best quotes. The change dummy variable takes the value of one after the structural change, zero otherwise. The regressions include the natural logarithm of the volume and the percentage volatility, measured as the natural logarithm of the ratio of daily high to low securities prices. For each regression, coefficient estimates, statistical significance and adjusted R-squared values are reported.

Regressions	intercept	volume	volatility	change	R square
pbas 90-day T-bill	0.24**	0.0074	-12.93**	-1.046**	0.0463
pbas 3-year bond	0.82***	0.0085*	-36.45	-0.058***	0.0268
pbas 10-year bond	0.35***	0.0064	18.72	-0.056***	0.0392

Regressions	intercept	volume	volatility	change	R square
depth 90-day T-bill	-291***	0.0121	-58.46***	399.26***	0.2046
depth 3-year bond	484.78	0.003	-126.6*	1001.031***	0.2541
depth 10-year bond	36.63***	0.0038***	-16.43***	74.09***	0.2584

*** *Sig at less than 0.01*
** *Sig at less than 0.05*
* *Sig at 0.1*

TABLE 3
Sensitivity to Event Window

This table reports descriptive statistics including number of trades, proportional spread, daily depth, daily volume, and daily volatility for the Bank Accepted Bills, the 3-year bond and the 10-year bond traded in the Sydney Future Exchange. Trades are included if they traded continuously for 3 months prior to and after the 20 February, 2004. Trades are included if they traded continuously for 6 months prior to and after the 20 February, 2004. The Proportional spread is calculated as the bid-ask spread over the minimum tick of $0.01. Volatility is calculated as the natural logarithm of the ratio of daily high to low securities prices. Volume is the average number of contracts traded per day. For each variable, the table reports the mean, and change in mean for the 6 months before and after the structural change. Statistical significance emanates from the test of whether the mean change is significantly different from zero.

Descriptive Statistics	90-day T-bill		3-year bond		10-year bond	
6 months data	Pre	Post	Pre	Post	Pre	Post
No of Trades						
Mean	140.02	138.18	590.15	639.54	698.56	777.68
Mean change	-1.84		49.3900		79.1200	
Proportional spread (%)						
Mean	0.719	0.723	0.7560	0.7201	0.2890	0.2480
Mean change	0.004		-0.0359 *		-0.0410 *	
Depth						
Mean	2783.3	2807.3	2666.6	3525.7	233.01	303.56
Mean change	24		859.1 ***		70.5500 ***	
Average Daily Volume						
Mean	10416	10735	25598	30728	8796.00	10025.00
Mean change	319		5130 *		1229 *	
Daily volatility (%)						
Mean	0.03	0.028	0.05	0.047	0.0612	0.0632
Mean change	-0.002		-0.003		0.0020	

*** *Sig at less than 0.01*
** *Sig at less than 0.05*
* *Sig at 0.1*

TABLE 4

Sensitivity to Event Window – Regressions Results on three months basis

This table reports regression results for the Bank Accepted Bills, the 3-year bond, and the 10-year bond traded on the Sydney Future Exchange. Trades are included if they traded continuously for 3 months prior to and after the 20 February, 2004. In the first regression, the dependant variable is measured as the relative spread. In the second regression, the dependent variable is measured as the depth at the best quotes. The change dummy variable takes the value of one after the structural change, zero otherwise. The regressions include the natural logarithm of the volume and the percentage volatility, measured as the natural logarithm of the ratio of daily high to low securities prices. For each regression, coefficient estimates, statistical significance and adjusted R-squared values are reported.

Regressions	intercept	volume	volatility	change	R square
pbas 90-day T-bill	0.84***	0.0002	-13.63*	-1.042***	0.1602
pbas 3-year bond	0.45**	0.0001**	-66.078*	-1.024**	0.0046
pbas 10-year bond	0.30***	0.0006	24.75	-1.035***	0.0263

Regressions	intercept	volume	volatility	change	R square
depth 90-day T-bill near	22.07	-0.0001	-28.696*	17.97	0.1306
depth 3-year bond	133.73	0.0089***	-15.32*	745.72***	0.2334
depth 10-year bond	94.37	0.0045***	-16.01**	62.83***	0.5398

*** *Sig at less than 0.01*

** *Sig at less than 0.05*

* *Sig at 0.1*