Transactions in Futures Markets: Informed or Uninformed?

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Abstract

Using a proprietary data set from the Sydney Futures Exchange, this paper reconciles an inconsistency in futures microstructure literature. Berkman, Brailsford and Frino (2005) document that single trades in futures markets contain information, while Frino and Oetomo (2005) find trade packages in futures markets do not contain information. This paper resolves the methodological differences in Berkman, Brailsford and Frino (2005) and Frino and Oetomo (2005) and examines slippage incurred by individual trades and trade packages. We find that institutional transactions in futures markets do not contain information.

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1. INTRODUCTION

The market impact cost of a trade, or *slippage* as it is known in futures markets, is the difference between the price following the execution of a trade and the price that would have prevailed had the trade not executed (Domowitz, Glen and Madhavan, 2001). Slippage is an implicit cost of trading in futures markets and consists of two components; a temporary liquidity effect and a permanent information effect.[1]

Kraus and Stoll's (1972) seminal price impact study examines large buyer-and seller-initiated trades in equity markets. They find that block purchases generate a permanent price effect, while block sales generate both temporary and permanent price effects. The asymmetrical results for block purchases and sales presented in Kraus and Stoll (1972) are confirmed by numerous equity market studies including Holthausen, Leftwich and Mayers (1987, 1990) and Ball and Finn (1989).

Chan and Lakonishok (1993) examine individual trades *known* to be placed by institutions.[2] They confirm results in prior equity market studies, finding institutional purchases have permanent price effects, and institutional sales exhibit partial price reversals post-execution. Chan and Lakonishok (1993) attribute this asymmetry to restrictions placed on short-selling in equity markets.[3] In an extension of their earlier study, Chan and Lakonishok (1995) acknowledge it is "misleading" to examine price

[1] Scholes (1972) and Kraus and Stoll (1972) both originally discuss the components of market impact costs in equity markets.
[2] Their data set contains both trade direction (buy or sell) and the identity of the initiating institution.
[3] There are no restrictions on short selling in futures markets, implying purchases and sales should behave symmetrically. Frino and Oetomo (2005) find slippage is symmetrical for purchases and sales in futures markets.

behaviour surrounding individual trades, as institutions break-up large orders into sequences of smaller trades to minimise market impact costs. [4] Using the same data set and a similar research design to Chan and Lakonishok (1993), Chan and Lakonishok (1995) examine market impact costs incurred by trade packages. They obtain results consistent with their study of individual trades; purchases have a permanent price effect and sales exhibit a partial price reversal.[5]

Contrasting with equity markets, there is inconsistent evidence in futures microstructure literature. Berkman, Brailsford and Frino (2005) examine slippage incurred by single trades on the London International Financial Futures and Options Exchange (LIFFE). They find purchases and sales have a small, significant information effect. Frino and Oetomo (2005) examine slippage incurred by trade packages on the Sydney Futures Exchange (SFE) and find buy and sell trade packages incur only temporary liquidity effects; there is no information contained in these transactions.

There are three possible reasons for the discrepancy in Berkman et al. (2005) and Frino and Oetomo (2005). First, Berkman et al. (2005) examine slippage for single trades, while Frino and Oetomo (2005) examine slippage for trade packages. Second, Berkman et al. (2005) employ the quote rule to determine buyer-and seller-*initiated* trades while

[4] This is supported by the stealth-trading hypothesis presented in Barclay and Warner (1993). They postulate that informed traders are likely to break-up large orders into a small number of medium-sized trades to realise profits, as large trades reveal their information and numerous small trades are costly. Barclay and Warner (1993) provide empirical evidence to support their hypothesis, finding medium-sized trades generate the majority of the cumulate price change in pre-takeover announcement periods. Charkravarty (2001) extends Barclay and Warner (1993) and finds that institutions are driving this price change; they trade medium-sized trades to hide their information.

[5] A trade package is defined as consecutive purchases (sales) by an institution in one stock, ending when the institution stays out of the market for more than 5 days.

Frino and Oetomo (2005) have a proprietary data set and examine slippage on the buy and sell side of each transaction. Further, Berkman et al. (2005) use intra-day benchmarks to measure slippage, while Frino and Oetomo (2005) use daily benchmarks. Third, Berkman et al. (2005) use a sample of LIFFE stock index futures over two time periods; 20 March 2000 to 26 May 2000 and 28 August 2000 to 26 September 2000. Frino and Oetomo (2005) use a sample of SFE stock index and interest rate futures for the period 1 July 2000 to 30 June 2003.

This study aims to reconcile the methodological differences in Berkman et al. (2005) and Frino and Oetomo (2005) to determine if institutional transactions in futures markets contain information. Our analysis uses the same market, sample period and research design to directly compare slippage incurred by individual institutional trades and trade packages (consisting of the same individual trades). The primary motivation of this paper is to resolve the ambiguity surrounding the information content of institutional transactions in futures markets.

Transactions in futures markets have a low probability of containing information, as informed trades in interest rate contracts require leakage from a central bank (Frino and Oetomo, 2005) and stock index futures diversify away stock-specific information (Subrahmanyam, 1991). Berkman et al. (2005) find that overall, individual trades in futures markets are informed. However, if institutional investors execute large orders through a series of smaller trades, their consecutive purchases (sales) generate upward (downward) price pressure in the market over a period of time. This price pressure will

continue until the institutional investor exits the market, and any price continuation or reversal will not occur until after the order is executed in its entirety. When a single trade is part of a large order exerting price pressure in the market over a period of time, it will appear to have a permanent price effect regardless of whether the trade contains information.[6]

This study examines slippage for individual trades known ex post to belong to trade packages. It is expected these trades will appear to contain information; however, this information is the result of price pressure exerted in the market by institutions. Once these individual trades are grouped into institutional orders and examined as a package of trades, the information effect is expected to disappear. Analysing trade packages allows construction of a proxy for an institution's ex ante order, and should remove any bias obtained when examining single trades.

The remainder of this article is organised as follows. The data and method are presented next, and following these are the results, robustness tests and conclusions. Institutional detail and additional results are provided in the Appendix.

2. DATA AND METHOD

This study utilises a proprietary data set from the Sydney Futures Exchange (SFE) containing all transactions from January 1, 2001 to 31 December, 2005 in the four major

[6] A permanent price effect is measured as the return from a pre-trade to post-trade benchmark. If a single "buy" trade is part of a larger institutional purchase order, the post-trade benchmark is biased upward due to price pressure exerted by the order. The converse applies to single "sell" trades. In either situation, results are biased toward finding a permanent price effect.

contracts traded on the exchange. These contracts are 90 Day Bank Accepted Bill futures (BABs), 3 Year Bond futures, 10 Year Bond futures, and SPI 200 index futures.[7] The data contains date, time (to the nearest second), price, trade direction and volume fields, as well as an alphanumeric account code to identify the institution behind each trade.

The sample is restricted to trades in the near and deferred contracts during daytime trading hours. Trades occurring within 10 days of expiration of the near contract are excluded from analysis, as these trades are likely to form part of rollover strategies (Frino and MacKenzie, 2002).[8] Also excluded are trades by locals, trade packages greater than 10,000 contracts, one-trade packages and trade packages that take longer than twenty one days to execute.[9]

Sequences of individual trades for each contract are packaged into orders if they are executed (i) from the same account, (ii) in the same direction (eg. buy trades), and (iii) successively without a one-day trading break. These criteria are consistent with Frino and Oetomo (2005) and imply that an institution's order is complete when they (i) begin trading in the opposite direction, or (ii) stay out of the market in that contract for more than one trading day.

[7] Institutional detail is provided in Appendix A1.
[8] Frino and MacKenzie (2002) find increased activity, declining spreads and lower market impact costs in the period prior to contract maturity. These trades are removed from our sample in order to remove any bias associated with rolling over contracts. This is consistent with Frino and Oetomo (2005).
[9] These sample restrictions are consistent with Frino and Oetomo (2005). Locals are excluded in order to proxy for institutional trades.

To ensure consistency, slippage is calculated similarly for single trades and trade packages. Further, the analysis of slippage incurred by individual trades is conducted using trades that are known ex post to belong to a trade package.[10] The measures of slippage and its components employed in Frino and Oetomo (2005) are used in this study, and are analogous to the slippage measures in Berkman et al. (2005). *Slippage* captures the total price impact of a trade, and can be decomposed into temporary and permanent price effects. *Liquidity* captures any temporary price effects (price reversal), and *information* captures permanent price effects (price continuation).

$$Slippage_{i,j} = \frac{(Price_i - OpeningPrice_i)}{MinTick_j} \quad (1)$$

$$Liquidity_{i,j} = \frac{(ClosingPrice_i - Price_i)}{MinTick_j} \quad (2)$$

$$Information_{i,j} = \frac{(ClosingPrice_i - OpeningPrice_i)}{MinTick_j} \quad (3)$$

For each individual trade, *Opening Price* is the opening price on the day of the trade, *Closing Price* is the closing price on the day of the trade, and *Price* is the trade price. For each trade package *Opening Price* is the opening price on the first day of the package, *Closing Price* is the closing price on the last day of the package, and *Price* is the volume-weighted average price (VWAP) of the trade package.[11] For both individual trades and trade packages, $MinTick_j$ is the minimum tick for contract j.[12]

[10] In order to correctly test the proposed hypothesis, it is necessary to examine individual trades that are part of institutional orders.

[11] Additional pre-trade and post-trade benchmarks are used to test the robustness of slippage estimates in this study. For individual trades, the additional pre-trade benchmark is the closing price one day prior to the trade, and the additional post-trade benchmark is the closing price one day after the trade. For trade packages, the additional pre-trade benchmark is the closing price one day prior to the first day of the

Individual trades and trade packages are sorted into quartiles based on volume. Trades with the same volume are always in the same group, resulting in four groups approximately equal in size. Group 1 includes the smallest trades and group 4 includes the largest trades. A difference of means test is conducted at the 5% level to determine if the average total, temporary and permanent price effects are significantly different from zero.[13]

Table I presents descriptive statistics for the stock index and interest rate futures contracts examined in this study. Panel A reports statistics for individual trades, and Panel B reports statistics for trade packages. For individual trades, there are 153,940 buy trades and 156,133 sell trades in 90 Day BAB futures; 455,320 buy trades and 471,320 sell trades in 3 Year Bond futures; 460,085 buy trades and 464,067 sell trades in 10 Year Bond futures; and 1,629,367 buy trades and 1,586,000 sell trades in SPI 200 stock index futures. For trade packages, there are 25,228 buy and 24,905 sell packages in 90 Day BAB futures, 78,400 buy and 80,609 sell packages in 3 Year Bond futures, 73,072 buy and 74,265 sell packages in 10 Year Bond futures, and 266,575 buy and 259,322 sell packages in SPI 200 stock index futures.

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package, and the additional post-trade benchmark is the closing price one day after the package is complete. The results are quantitatively similar to the results presented in this paper and are available upon request.

[12] Appendix A1 contains the minimum tick for each contract examined. Slippage is measured in minimum ticks (points), consistent with futures market research.

[13] This study utilises a large sample, so it is necessary to adjust the critical level for t values to evade Lindley's paradox. This adjustment is also used by Frino and Oetomo (2005). The new critical value is calculated using the following formula:

$$t^* = \sqrt{[c^{\frac{2}{T}} T^{\frac{1}{T}} - 1](T - k)}$$

where t^* is the new critical t value; c is the ratio between the Bayesian probabilities of the null and alternative hypotheses; T is the sample size and k is the number of regressors in the model. Johnstone (2005) provides further explanation and derivation of this adjustment.

< INSERT TABLE I HERE >

Panel A of Table I reports characteristics of individual trades for all contracts. The average volume for individual trades ranges from a minimum of 3.89 contracts for SPI 200 futures, and a maximum of 55.49 contracts for 90 Day BAB futures. The characteristics of trade packages are reported in Panel B of Table I. The average number of hours taken to execute a package ranges from 0.88 hours for SPI 200 futures to 3.03 hours for 90 Day BAB futures. The average number of trades in a package ranges from 5.83 trades for 3 Year Bond futures to 6.81 trades for 10 Year Bond futures, and the average package volume ranges from 23.97 contracts for SPI 200 futures to 336.61 contracts for 90 Day BAB futures.

3. RESULTS

Table II reports total, temporary and permanent price effects for individual trades. Panel A reports these effects for 90 Day BAB futures, Panel B reports 3 Year Bond futures, and Panels C and D report 10 Year Bond futures and SPI 200 futures respectively. To ensure consistency with Berkman et al. (2005), total, temporary and permanent price effects are also reported by aggregating all single trades for each contract. For single trades, the overall total, temporary and permanent price effects are significant for purchases and sales across all contracts, confirming results in Berkman et al. (2005).

Across all four contracts, slippage is largest for medium-sized trades (groups 2 and 3). This is consistent with Barclay and Warner (1993) and Chakravarty (2001). The largest slippage for individual trades is reported in Panel D, where purchases of SPI 200 futures in size group 2 incur slippage of 0.73 ticks.

< INSERT TABLE II HERE >

There is inconsistent evidence of a significant liquidity effect across size groups and contracts in Table II. The sign of the liquidity effect variable for both purchases and sales is consistent with a price reversal in all contracts; however, this price reversal is not statistically significant for all contracts across all groups. The SPI 200 futures contract is the only contract with a consistently significant price reversal for purchases and sales.

Individual trades in the largest size group (group 4) are the only trades that do not contain information. The slippage for these trades is unequivocally a liquidity cost. However, trades in the remaining size groups have significant information content. Even with significant partial price reversals, there is strong evidence of significant price continuation in these trades. When small-and medium-sized trades that belong to a trade package are examined individually, these trades are shown to contain information.

The asymmetry between the complete price reversal of large single trades and the significant price continuation of small-and medium-sized single trades is initially puzzling. Closer examination of trades in the largest size group provides a possible

explanation. Chan and Lakonishok (1995) postulate any price reversal or continuation associated with a trade package will not occur until after the last trade of the package. As only the largest trades in Table II exhibit a complete price reversal, it is possible these trades on average the last trade in a package, and the price reversal is a result of the completion of the package. It is intuitive that large trades are on average the last trade, as executing larger trades at the beginning of a trade package will exacerbate slippage for remaining trades, and if an opportunity arises in the market for an institution to successfully complete their order they will execute one larger trade instead of numerous smaller ones.

Further examination of the data supports this theory. A difference of means test at the 5% level shows that the volume of the last trade in a package is significantly greater than the volume of other trades in the package (and is 50 per cent larger for the 10 Year Bond futures contract). This holds across all contracts. As large trades in this sample are on average the last trade in a package, any observed price reversal is the reversal associated with the completion of a package.[14]

< INSERT TABLE III HERE >

Total, temporary and permanent price effects for trade packages are reported for each size group and the entire sample of trade packages in Table III. For all contracts, slippage reported in Table III increases monotonically as trade package size increases. This is

[14] Appendix 2 reports the results of the difference of means testing for each contract.

consistent with Frino and Oetomo (2005).[15] Further, slippage for all contracts is significant for large trade packages, and for SPI 200 futures and 3 Year Bond futures slippage is also significant for some medium-sized packages. In the largest size group (group 4), trade packages of SPI 200 futures incur the most slippage, with buy packages incurring average slippage of 1.02 ticks. The least slippage is incurred by sell packages of 90 Day BAB futures, which incur average slippage of 0.18 ticks.

Consistent with Frino and Oetomo (2005), there is a significant liquidity effect for orders in the largest size category across all contracts, and there is further evidence of a liquidity effect for medium-sized trade packages of SPI 200 futures. Most importantly, Table III documents that regardless of size category, no information is contained in trade packages. The price impact incurred when trading packages of futures contracts is entirely a liquidity effect, as every size group that incurs significant slippage is accompanied by a significant price reversal. There is no significant information effect. Frino and Oetomo (2005) also report slippage incurred when trading futures contracts is attributable to a liquidity effect.

Overall, trade packages incur significant slippage and liquidity effects for all contracts except purchase orders of 3 Year Bond futures and purchase orders of 10 Year Bond futures. Otherwise, aggregate slippage and liquidity results for trade packages are consistent with those reported for individual trades in Table II. However, even when

[15] The magnitude of slippage in this study is less than the slippage reported in Frino and Oetomo (2005) for all contracts except purchase orders of SPI 200 futures. This reflects an increase in liquidity of SFE contracts between the end of the sample period of Frino and Oetomo (2005) and the current study.

aggregated, trade packages still contain no information. This provides further evidence that institutional trade packages in futures markets do not contain information.

This study documents that institutional trade packages in futures markets do not contain information. However, when trades that belong to these packages are analysed individually, small-and medium-sized trades are associated with permanent price effects. These individual trades do not actually contain information. They *appear* to contain information due to price pressure exerted through execution of the remaining trades in the package. The only trade in the package not susceptible to this effect is the last trade, as it is after the last trade that any price reversal or continuation begins. This article also documents that the last trade in a package is on average the largest trade, which explains the price reversal observed for single trades in group 4. The evidence presented in Tables II and III is consistent with the central hypothesis of this study. Examining slippage incurred by single trades that belong to institutional orders is biased towards concluding that these trades are information-motivated.

4. ROBUSTNESS TESTS

Several robustness tests are conducted to confirm results presented in Section 3. The first robustness test assesses trade packaging criteria. Previously, trades executed by the same institution with no more than a one-day trading gap were included in the same trade package. As a test of this criterion, trades executed by the same institution on the same day are aggregated to form a trade package. No trade package extends beyond one day

trading session. Results obtained by aggregating trades occurring on the same day are reported in Table IV.

< INSERT TABLE IV HERE >

In all panels of Table IV, slippage increases monotonically with trade package size. Packages in groups 3 and 4 have significant slippage and a significant liquidity effect. Irrespective of size, no trade packages contain information. The trade packaging criteria for this study appears robust, as these results are quantitatively similar to results in Table III.

The second robustness test involves recalculating Equations 1 to 3 using principal-weighted instead of arithmetic means. Chan and Lakonishok (1993, 1995) use principal-weighted and arithmetic means in their analysis of price impact in equity markets. They find similar results for both measures, with returns using principal-weighted often slightly higher than returns using arithmetic means. Tables V and VI report results using principal-weighted for single trades and trade packages respectively.

< INSERT TABLE V HERE >

< INSERT TABLE VI HERE >

The total, temporary and permanent price effects measured in Tables V and VI are similar to values reported in Tables II and III. In Table V, slippage for individual trades is

greatest for medium-sized trades (groups 2 and 3). Further, small and medium-sized trades contain information, where as large trades (group 4) do not. This is consistent with earlier results. For trade packages in Table VI, slippage increases with package size and trade packages of all sizes contain no information. Across all panels, slippage for the largest size group measured using a principal-weighted mean is greater than slippage measured using an arithmetic mean. This implies that in group 4, extremely large trade packages have a greater influence on the mean than smaller packages, providing further evidence that the largest trade packages incur the most slippage.

To determine if results hold for large block transactions, total, temporary and permanent price effects are calculated for the largest 5 per cent of trade packages, and are reported in Table VII. All contracts in Table VII have significant total and temporary price effects, and insignificant information effects. Average slippage for the largest 5 per cent of packages in Table VII is always greater than average slippage for the largest group of packages in Table III (group 4). This confirms that the largest trade packages incur the most slippage, and results hold for large block trades.

< INSERT TABLE VII HERE >

The results for single trades and trade packages presented in this study are robust to various sensitivity checks. Results remain relatively unchanged when trade package criteria changes, price effects are principal-weighted, and large block transactions occur.

5. CONCLUSIONS

This paper examines slippage incurred by individual trades and trade packages to resolve an inconsistency in futures microstructure literature. Berkman et al. (2005) find that single trades in futures markets contain information. Frino and Oetomo (2005) find that when single trades are grouped into packages there is no information and slippage is entirely a liquidity effect.

The results for single trades in this study are consistent with Berkman et al. (2005). There is an overall significant information effect for single trades. An additional finding in this study is that slippage incurred by small-and medium-sized single trades is attributable to an information effect, and only the largest trades display a significant price reversal. Contrasting with single trades, there is no significant information effect for trade packages. Slippage is entirely a liquidity effect for all trade packages irrespective of size. This holds across all contracts and is consistent with Frino and Oetomo (2005). All results in this study are robust to various sensitivity checks.

There is no apparent size effect for slippage incurred by single trades, with small-and medium-sized trades incurring the most slippage. As shown in the Appendix, the largest single trades in our sample are on average the last trade in a package. Any price reversal observed for large single trades is the price reversal associated with the completion of a package.

The results for single trades and trade packages in this study appear to conflict each other, as conclusions based on single trades indicate trades are informed, and conclusions based on trade packages indicate trades are uninformed. In fact, results for single trades and trade packages support each other. Institutions generate price pressure in the market when executing a trade package. The price pressure exerted on single trades belonging to trade packages causes an *apparent* information effect; however, the information effect disappears when these trades are analysed as packages. There is no information contained in institutional transactions in futures markets, any slippage incurred by transactions is attributable to a liquidity effect.

This paper has important implications for future research. A prospective study documenting slippage incurred by single trades in futures markets must account for the inherent bias in analysing single trades. Any information documented in single trades is potentially spurious, as slippage in futures markets is unambiguously a liquidity effect.

APPENDIX 1. INSTITUTIONAL DETAIL

The Sydney Futures Exchange (SFE) is the tenth largest financial futures and options exchange in the world by volume turnover and is the second largest in the Asia-Pacific region. On July 25, 2006 the SFE merged with the Australian Stock Exchange (ASX) to create the ninth largest listed exchange worldwide. The SFE now operates as a wholly owned subsidiary of the ASX.

This study examines slippage for the four most liquid contracts on the SFE: 90-Day Bank Accepted Bill futures, 3 Year Bond futures, 10 Year Bond futures and SPI 200 stock index futures. The SPI 200 futures contract is written on the S&P/ASX 200; the benchmark Australian equity market index. The SFE SPI 200 futures contract is ranked in the top ten equity index contracts by volume turnover in the Asia-Pacific region.

Traders on the SFE utilise a fully automated trading system, the Sydney Computerised Market (SYCOM). In 1999, the SFE moved from floor to electronic trading and SYCOM moved from being an overnight trading facility to serving as the primary trading platform. Additional details for each contract are provided in Table A1.

<INSERT TABLE A1 >

APPENDIX 2. ADDITIONAL ANALYSIS OF LARGE INDIVIDUAL TRADES

Table A2. reports the mean volume of the last trade in a package and the mean volume of all remaining trades in a package for each contract examined in this study. A difference

of means test is conducted to determine if the last trade in a package is significantly larger than other trades in a package. Table A2. supports the hypothesis that the last trade in a trade package is on average the largest, as mean volume of last trades are significantly larger than mean volumes of other trades in a package.

< INSERT TABLE A2 >

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Table I
Descriptive statistics

		90 Day BAB Futures		3-year bond Futures		10-year bond Futures		SPI200 Futures	
		Buy	*Sell*	*Buy*	*Sell*	*Buy*	*Sell*	*Buy*	*Sell*
Panel A: Single Trades									
Volume traded	Mean	55.61213	52.18	55.41	54.76	17.57	17.47	3.95	3.89
	Median	15.00	13.00	19.00	19.00	5.00	5.00	2.00	2.00
	Std dev	102.3667	97.00	132.00	133.78	57.48	56.21	12.60	10.90
Number		153578	156,133	455,991	471,320	460,085	464,067	1,629,367	1,586,000
Panel B: Trade Packages									
Volume traded	Mean	336.61	332.20	322.41	327.85	118.37	117.98	23.98	23.97
	Median	184.00	181.00	159.00	160.00	47.00	46.00	10.00	10.00
	Std dev	515.15	520.52	535.33	555.50	246.55	244.67	74.22	74.30
No. of trades	Mean	6.10	6.27	5.83	5.86	6.81	6.75	6.12	6.12
	Median	4.00	4.00	4.00	4.00	4.00	4.00	3.00	3.00
	Std dev	9.36	9.77	8.07	8.33	11.62	11.65	13.42	13.09
No. of hours	Mean	2.80	3.03	1.60	1.64	1.53	1.54	0.91	0.88
	Median	0.09	0.10	0.02	0.02	0.04	0.04	0.01	0.01
	Std dev	8.39	8.74	5.73	5.69	5.41	5.46	4.24	4.10
Number		25,228	24,905	78,400	80,609	73,072	74,265	266,575	259,322

Note: Table I reports descriptive statistics for all four contracts examined in this study. These contracts are 90 Day BAB futures, 3 Year Bond futures, 10 Year Bond futures and SPI 200 futures. Panel A reports statistics for individual trades, and Panel B reports statistics for trade packages. The mean, median and standard deviation is reported for volume traded, no. of trades and no. of hours. In Panel A, volume traded is the average individual trade volume. In Panel B, volume traded is the average total volume of trade packages. No. of trades is the average number of trades it takes to execute a trade package. No. of hours is the average number of hours it takes to execute a trade package. The number of single buy and sell trades in this study are not equal as the allocated volume is used instead of the reported transaction volume.

Table II
Total, temporary and permanent price effects for individual trades

		Slippage		Liquidity		Information	
Size	*No. contracts*	*Buy*	*Sell*	*Buy*	*Sell*	*Buy*	*Sell*
Panel A: 90 Day BABs							
1	1-4	0.372*	-0.304*	-0.076*	0.174*	0.296*	-0.130*
2	5-15	0.420*	-0.513*	-0.102*	0.027	0.318*	-0.486*
3	16-66	0.330*	-0.480*	-0.136*	0.015	0.195*	-0.465*
4	67-3000	0.090*	-0.104*	-0.101*	0.076*	-0.011	-0.028
	All Trades	0.302*	-0.348*	-0.103*	0.076*	0.199*	-0.270*
Panel B: 3 Year Bonds							
1	1-5	0.085*	-0.366*	-0.008	0.082*	0.077*	-0.285*
2	6-19	0.173*	-0.437*	-0.037*	0.093*	0.136*	-0.345*
3	20-56	0.069*	-0.274*	0.000	0.047*	0.068*	-0.227*
4	57-2000	0.028	-0.056*	-0.030*	0.087*	-0.002	0.031
	All Trades	0.088*	-0.282*	-0.017*	0.076*	0.067*	-0.206*
Panel C: 10 Year Bonds							
1	1-1	0.200*	-0.525*	-0.026	0.080*	0.174*	-0.445*
2	2-5	0.441*	-0.716*	-0.186*	0.099*	0.255*	-0.617*
3	6-16	0.206*	-0.397*	-0.038	0.030	0.168*	-0.366*
4	17-6500	0.082*	-0.114*	-0.117*	0.091*	-0.035	-0.023
	All Trades	0.227*	-0.440*	-0.088*	0.077*	0.139*	-0.363*
Panel D: SPI 200							
1	1-1	0.655*	-0.257*	-0.384*	0.205*	0.272*	-0.052
2	2-2	0.728*	-0.492*	-0.471*	0.182*	0.257*	-0.311*
3	3-5	0.693*	-0.532*	-0.453*	0.257*	0.240*	-0.275*
4	5-4500	0.492*	-0.355*	-0.355*	0.299*	0.137	-0.056
	All Trades	0.646*	-0.371*	-0.407*	0.229*	0.239*	-0.142*

***** Significantly different from zero at the 5% level

Note: Table II reports the total, temporary and permanent price effects for individual trades. Panel A reports these for 90 Day BAB futures, Panel B reports 3 Year Bond futures, Panel C reports 10 Year Bond futures and Panel D reports SPI 200 futures. *Slippage* is the return from the opening price on the day of the trade to the trade price. *Liquidity* is the return from the trade price to the closing price on the day of the trade. *Information* is the return from the opening price on the day of the trade to the closing price on the day of the trade. All returns are measured in ticks. Buy and sell single trades are assigned to quartiles based on their volume, and then trades with the same volume are allocated to the same group, resulting in four groups of approximately equal size. Groups 1and 4 represent the smallest and largest groups respectively. A *t*-test adjusted for sample size is used to test the deviation of mean values from zero.

Table III
Total, temporary and permanent price effects for trade packages

		Slippage		Liquidity		Information	
Size	*No. contracts*	*Buy*	*Sell*	*Buy*	*Sell*	*Buy*	*Sell*
Panel A: 90 Day BABs							
1	2-67	0.024	-0.013	-0.068	0.102	-0.043	0.089
2	68-185	0.058	-0.071	-0.072	0.011	-0.014	-0.060
3	186-400	0.084	-0.127	-0.051	0.060	0.033	-0.067
4	401-9000	0.228*	-0.218*	-0.139*	0.094*	0.090	-0.124
	All Packages	0.098*	-0.105*	-0.082*	0.066*	0.016	-0.039
Panel B: 3 Year Bonds							
1	2-65	-0.113*	0.001	0.026	0.062	-0.087	0.062
2	66-160	-0.090	-0.022	0.058	0.005	-0.032	-0.017
3	161-354	0.013	-0.131*	0.020	0.076	0.032	-0.055
4	355-10000	0.197*	-0.184*	-0.081*	0.110*	0.116	-0.073
	All Packages	0.000	-0.084*	0.006	0.064*	0.007	0.020
Panel C: 10 Year Bonds							
1	2-16	-0.074	-0.039	0.001	-0.027	-0.073	-0.067
2	17-47	0.073	-0.142	-0.027	0.058	0.046	-0.084
3	48-113	0.086	-0.148	-0.080	0.056	0.006	-0.092
4	114-7000	0.221*	-0.245*	-0.197*	0.200*	0.024	-0.046
	All Packages	0.076	-0.145*	-0.075*	0.071*	0.001	-0.072
Panel D: SPI 200							
1	2-5	0.131	0.032	-0.030	-0.093	0.100	-0.061
2	6-10	0.266	-0.235	-0.024	0.353*	0.242	0.118
3	11-21	0.674*	-0.325*	-0.610*	0.351*	0.064	0.026
4	22-6000	1.020*	-0.661*	-0.669*	0.566*	0.351	-0.095
	All Packages	0.497*	-0.272*	-0.312*	0.262*	0.185	-0.010

***** Significantly different from zero at the 5% level

Note: Table III reports the total, temporary and permanent price effects for trade packages. Panel A reports these for 90 Day BAB futures, Panel B reports 3 Year Bond futures, Panel C reports 10 Year Bond futures and Panel D reports SPI 200 futures. *Slippage* is the return from the opening price on the day the package commences to the volume-weighted average price of the package. *Liquidity* is the return from the volume-weighted average price of the package to the closing price on the last day of the package. *Information* is the return from the opening price on the first day of the package to the closing price on the last day of the package. All returns are measured in ticks. Buy and sell single packages are assigned to quartiles based on their total volume, and then packages with the same volume are allocated to the same group, resulting in four groups of approximately equal size. Groups 1and 4 represent the smallest and largest groups respectively. A *t*-test adjusted for sample size is used to test the deviation of mean values from zero.

Table IV
Total, temporary and permanent price effects for trade packages:
Trades aggregated on the same day

		Slippage		Liquidity		Information	
Size	*No. contracts*	*Buy*	*Sell*	*Buy*	*Sell*	*Buy*	*Sell*
Panel A: 90 Day BABs							
1	2-67	0.075	-0.092	-0.082	0.077	-0.007	-0.015
2	68-185	0.091	-0.095	-0.071	0.022	0.020	-0.073
3	186-400	0.102	-0.135	-0.034	0.050	0.068	-0.085
4	401-9000	0.209*	-0.228*	-0.112*	0.089*	0.097	-0.138
Panel B: 3 Year Bonds							
1	2-65	-0.048	-0.049	-0.011	0.085*	-0.058	0.036
2	66-160	0.072	-0.068	-0.007	0.007	0.066	-0.061
3	161-354	0.127*	-0.159*	-0.024	0.042	0.102	-0.118
4	355-10000	0.140*	-0.246*	-0.156	0.135*	-0.016	-0.112
Panel C: 10 Year Bonds							
1	2-16	-0.041	0.054	-0.052	-0.034	-0.093	0.019
2	17-47	-0.019	-0.030	-0.036	0.038	-0.055	0.008
3	48-113	0.049	-0.154	-0.096	-0.026	-0.047	-0.180
4	114-7000	0.253*	-0.342*	-0.282*	0.240*	-0.029	-0.103
Panel D: SPI 200							
1	2-5	0.060	0.057	-0.045	-0.063	0.016	-0.006
2	6-10	0.234	-0.189	-0.068	0.298*	0.167	0.109
3	11-21	0.607*	-0.303*	-0.588*	0.293*	0.020	-0.009
4	22-6000	0.934*	-0.590*	-0.723*	0.397*	0.212	-0.193

***** Significantly different from zero at the 5% level

Note: Table IV reports the total, temporary and permanent price effects for trade packages formed by aggregating trades occurring on the same day. Panel A reports these effects for 90 Day BAB futures, Panel B reports 3 Year Bond futures, Panel C reports 10 Year Bond futures and Panel D reports SPI 200 futures. *Slippage* is the return from the opening price on the day the package commences to the volume-weighted average price of the package. *Liquidity* is the return from the volume-weighted average price of the package to the closing price on the last day of the package. *Information* is the return from the opening price on the first day of the package to the closing price on the last day of the package. All returns are measured in ticks. Buy and sell packages are assigned to quartiles based on their total volume, and then packages with the same volume are allocated to the same group, resulting in four groups of approximately equal size. Groups 1and 4 represent the smallest and largest groups respectively. A *t*-test adjusted for sample size is used to test the deviation of mean values from zero.

Table V
Total, temporary and permanent price effects for individual trades: Principal-weighted means

		Slippage		Liquidity		Information	
Size	*No. contracts*	*Buy*	*Sell*	*Buy*	*Sell*	*Buy*	*Sell*
Panel A: 90 Day BABs							
1	1-4	0.311*	-0.344*	-0.085*	0.153*	0.227*	-0.191*
2	5-15	0.401*	-0.507*	-0.098*	0.025	0.304*	-0.481*
3	16-66	0.278*	-0.446*	-0.140*	0.023	0.139*	-0.423*
4	67-3000	0.062	-0.010	-0.078*	0.077*	-0.016	0.067
Panel B: 3 Year Bonds							
1	1-5	0.077*	-0.306*	0.007	0.091*	0.083*	-0.216*
2	6-19	0.167*	-0.407*	-0.031	0.092*	0.136*	-0.315*
3	20-56	0.058*	-0.271*	0.000	0.044*	0.058*	-0.227*
4	57-2000	0.031	-0.054*	-0.008	0.047*	0.024	-0.007
Panel C: 10 Year Bonds							
1	1-1	0.200*	-0.525*	-0.026	0.080*	0.174*	-0.446*
2	2-5	0.419*	-0.686*	-0.166*	0.097*	0.253*	-0.589*
3	6-16	0.193*	-0.375*	-0.032	0.029	0.160*	-0.347*
4	17-6500	0.149*	-0.187*	-0.117*	0.157*	0.032	-0.029
Panel D: SPI 200							
1	1-1	0.655*	-0.257*	-0.384*	0.205*	0.272*	-0.052
2	2-2	0.728*	-0.492*	-0.471*	0.182*	0.257*	-0.311*
3	3-5	0.693*	-0.539*	-0.453*	0.270*	0.240*	-0.269*
4	5-4500	0.492*	-0.233*	-0.355*	0.362*	0.137	0.130

***** Significantly different from zero at the 5% level

Note: Table V reports the total, temporary and permanent price effects for individual trades. Panel A reports these for 90 Day BAB futures, Panel B reports 3 Year Bond futures, Panel C reports 10 Year Bond futures and Panel D reports SPI 200 futures. Numbers reported are principal-weighted means. *Slippage* is the return from the opening price on the day of the trade to the trade price. *Liquidity* is the return from the trade price to the closing price on the day of the trade. *Information* is the return from the opening price on the day of the trade to the closing price on the day of the trade. All returns are measured in ticks. Buy and sell single trades are assigned to quartiles based on their volume, and then trades with the same volume are allocated to the same group, resulting in four groups of approximately equal size. Groups 1and 4 represent the smallest and largest groups respectively. A *t*-test adjusted for sample size is used to test the deviation of mean values from zero.

Table VI
Total, temporary and permanent price effects for trade packages:
Principal-weighted means

		Slippage		Liquidity		Information	
Size	*No. contracts*	*Buy*	*Sell*	*Buy*	*Sell*	*Buy*	*Sell*
Panel A: 90 Day BABs							
1	2-67	-0.060	-0.070	-0.095	0.007	-0.155	-0.063
2	68-185	0.053	-0.068	-0.070	0.007	-0.017	-0.061
3	186-400	0.088	-0.124	-0.049	0.066	0.039	-0.058
4	401-9000	0.191*	-0.255*	-0.126*	0.108*	0.066	-0.147
Panel B: 3 Year Bonds							
1	2-65	-0.109*	-0.002	0.036	0.077	-0.073	0.075
2	66-160	-0.090	-0.020	-0.001	0.003	-0.091	-0.017
3	161-354	0.023	-0.132*	0.020	0.084*	0.043	-0.047
4	355-10000	0.210*	-0.276*	-0.118*	0.177*	0.093	-0.098
Panel C: 10 Year Bonds							
1	2-16	-0.035	-0.043	0.001	-0.047	-0.034	-0.090
2	17-47	0.086	-0.120	-0.019	0.061	0.067	-0.059
3	48-113	0.099	-0.173	-0.074	0.065	0.024	-0.108
4	114-7000	0.358*	-0.299*	-0.275*	0.315*	0.083	0.016
Panel D: SPI 200							
1	2-5	0.131	0.105	-0.030	-0.100	0.100	0.005
2	6-10	0.266	-0.183	-0.024	0.087	0.242	-0.096
3	11-21	0.674*	-0.304*	-0.610*	0.130	0.064	-0.173
4	22-6000	1.090*	-0.721*	-0.784*	0.420*	0.306	-0.302

* Significantly different from zero at the 5% level

Note: Table VI reports the total, temporary and permanent price effects for trade packages. Panel A reports these for 90 Day BAB futures, Panel B reports 3 Year Bond futures, Panel C reports 10 Year Bond futures and Panel D reports SPI 200 futures. Numbers reported are principal-weighted means. *Slippage* is the return from the opening price on the day the package commences to the volume-weighted average price of the package. *Liquidity* is the return from the volume-weighted average price of the package to the closing price on the last day of the package. *Information* is the return from the opening price on the first day of the package to the closing price on the last day of the package. All returns are measured in ticks. Buy and sell single packages are assigned to quartiles based on their total volume, and then packages with the same volume are allocated to the same group, resulting in four groups of approximately equal size. Groups 1and 4 represent the smallest and largest groups respectively. A *t*-test adjusted for sample size is used to test the deviation of mean values from zero.

Table VII
Total, temporary and permanent price effects for the largest 5 per cent of trade packages

	Slippage		Liquidity		Information	
	Buy	*Sell*	*Buy*	*Sell*	*Buy*	*Sell*
90 Day BABs	0.382*	-0.322*	-0.197*	0.152*	0.185	-0.170
3 Year Bonds	0.282*	-0.231*	-0.156*	0.179*	0.126	-0.052
10 Year Bonds	0.301*	-0.289*	-0.320*	0.141*	-0.019	-0.148
SPI 200	1.195*	-0.807*	-0.897*	0.520*	0.298	-0.286

* Significantly different from zero at the 5% level

Note: Table VII reports the total, temporary and permanent price effects for the largest 5 per cent of trade packages. Panel A reports these effects for 90 Day BAB futures, Panel B reports 3 Year Bond futures, Panel C reports 10 Year Bond futures and Panel D reports SPI 200 futures. *Slippage* is the return from the opening price on the day the package commences to the volume-weighted average price of the package. *Liquidity* is the return from the volume-weighted average price of the package to the closing price on the last day of the package. *Information* is the return from the opening price on the first day of the package to the closing price on the last day of the package. All returns are measured in ticks. Buy and sell packages are assigned to quartiles based on their total volume, and then packages with the same volume are allocated to the same group, resulting in four groups of approximately equal size. Groups 1and 4 represent the smallest and largest groups respectively. A *t*-test adjusted for sample size is used to test the deviation of mean values from zero.

TABLE A1
Contract Specifications

	SPI 200	90 Day BABs	3 Year Bonds	10 Year Bonds
Futures type	Stock index	Interest rate	Interest rate	Interest rate
Settlement month	March/June/September/ December up to 6 quarters ahead.	March/June/September/December up to 20 quarters ahead.	March/June/September/December up to two quarter months ahead.	March/June/September/December up to two quarter months ahead.
Minimum price movement	One index point	0.01% (100 minus annual percentage yield quoted to two decimal places)	0.01% (100 minus annual percentage yield quoted to two decimal places)**	0.005% (For quotation purposes the yield is deducted from an index of 100)
Trading hours (US daylight savings time)*	5.10pm – 7.00am and 9.50am – 4.30pm	5.08pm – 7.00am and 8.28am – 4.30pm	5.10pm – 7.00am and 8.30am – 4.30pm	5.12pm – 7.00am and 8.32am – 4.30pm
Trading hours (US non-daylight savings time)*	5.10pm – 8.00am and 9.50am – 4.30pm	5.08pm – 7.30am and 8.28am – 4.30pm	5.10pm – 7.30am and 8.30am – 4.30pm	5.12pm – 7.30am and 8.32am – 4.30pm

Source: Sydney Futures Exchange Contract Specifications available from www.sfe.com.au
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* All times are Sydney times unless otherwise indicated and US daylight saving begins first Sunday in April and ends last Sunday in October.
**The SFE has just introduced new minimum tick requirements for 3 Year Bonds. The minimum tick reported here is the one relevant to the sample period for this study. There were no minimum tick changes for any contracts during the sample period for this study.

Table A2.
Trade package volume comparison: Last trade vs. Other trades

	90 Day BAB futures	3 Year Bond futures	10 Year Bond futures	SPI 200 futures
Mean volume of last trade in package	68.591	71.280	24.570	6.351
Mean volume of all other trades in package	52.283	52.398	16.059	6.321
Difference	16.680	18.880	8.511	0.166
t-statistic	31.65**	50.50**	39.54**	2.57*

* Significantly different from zero at the 5% level
** Significantly different from zero at the 1% level

Note: Table A2. documents mean volumes for both the last trade in a package and all other trades in a package (excluding the last trade). The *t*-statistic tests the statistical significance of a difference between mean volumes.