Does broker anonymity hide informed traders?

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Abstract

This study investigates the extent to which broker anonymity in an electronic central limit order book impairs the ability of the market to detect informed trading in the lead up to takeover announcements. Our research represents the first study in this area to analyse the effects of broker anonymity in the context of significant information asymmetry, where one would expect anonymity to be of greatest importance. This article, therefore, extends prior research which only investigates the effects of broker anonymity averaged across all types of information environments. The results of this study indicate that informed traders are less detected, and therefore better off when broker identifiers are concealed. This finding has important policy implications for exchange officials deciding whether or not to reveal broker identifiers surrounding trades, especially considering that almost all prior research suggests that broker anonymity is correlated with improved liquidity in the form of lower bid-ask spreads.

1. Introduction

One of the most prominent market design issues considered by exchange officials of electronic order driven markets in recent years has been the decision regarding whether to reveal broker identifiers surrounding trades. Between 1999 and 2005 no fewer than seven exchanges made changes to their respective broker identification regimes and the high incidence of such changes has led to an equally high incidence of academic studies investigating the effect of the transparency change on market quality. Foucault, Moinas and Thiessen (2007) investigate the switch to pre-trade broker anonymity on the Paris Bourse in April 2001 and find that quoted bid-ask spreads decrease after the change and that spreads become less informative about future volatility. Comerton-Forde, Frino and Mollica (2005) examine the affects of broker identification changes on the Paris Bourse, the Tokyo Stock Exchange and the Korean Stock Exchange and find that improved market quality, in the form of reduced relative and effective bid-ask spreads, is correlated with pre-trade broker anonymity. Finally, Comerton-Forde and Tang (2008) document decreased bid-ask spreads, increased depth and greater order flow after the Australian Stock Exchange removed pre-trade broker identifiers and delayed the reporting of post-trade broker identifiers on 28 November 2005. Table A summarises the recent broker identification changes implemented by electronic exchanges and related academic studies.[1] The focus of such studies has been broad in nature, with an emphasis on the effects of the transparency change on general market quality indicators.

Despite the extensive literature on broker identification, few studies in this area have yet to examine how a change in broker anonymity affects market participants during periods of large information asymmetry. This is an important distinction since one would naturally expect that anonymity is more relevant during periods of high information asymmetry *vis-à-vis* periods when no information event is pending. Intuitively, broker anonymity impairs the ability of uninformed traders, followers and dealers to discern the advent of some significant price-sensitive announcement from

[1] Theoretical work by Foucault et al. (2007) and Rindi (2008), and a study conducted in an experimental market by Perotti and Rindi (2006) support these empirical results. The overwhelming consensus amongst published literature is that pre-trade or post-trade broker anonymity reduces bid-ask spreads.

the pool of liquidity-motivated trades.[2] The hidden nature of broker identifiers is not as problematic (beneficial) for uninformed (informed) traders when no information event is about to occur. Furthermore, the interpretation of market quality statistics can be fundamentally altered depending upon the level of informed trading across the period being analysed. For example, during periods when no information event is pending, tight bid-ask spreads represent lower transaction costs for uninformed traders, whereas tight bid-ask spreads before unanticipated material announcements with active informed traders, imply that liquidity providers are not adequately engaging in price protection. It is not possible to disentangle the two scenarios by examining, as previous studies have, market quality statistics averaged across all market conditions.

The purpose of this study is to investigate the extent to which broker anonymity hides the fact that informed traders are present in the market prior to a significant information event. To perform this analysis we investigate pre-announcement trading in a sample of 252 takeovers, announced between 28 November 2003 and 28 November 2007, corresponding to a time period two years either side of the aforementioned transparency change that occurred on the Australian Stock Exchange on 28 November 2005. As recognised by Cao, Chen and Griffin (2005), takeover announcements provide an ideal setting to test hypotheses related to information transmission in markets. The magnitude of potential returns provides a strong incentive for informed traders to trade and indeed it is well established that informed traders are active prior to takeover announcements (Keown and Pinkerton, 1981; Jarrel and Poulson, 1989; Meulbroek, 1992). Furthermore, unlike earnings announcements, the timing and occurrence of takeover announcements is completely unknown to uninformed traders. As such, if abnormal volume or price activity occurs before these announcements, it most likely coincides with trading by informed participants. This study, therefore, explicitly addresses the issue of broker anonymity effects in the context of large information asymmetry. This is important given the frequency of changes to broker transparency that have occurred in financial markets in recent years and the fact that almost all studies to date suggest that improved liquidity (in the form of smaller bid-ask spreads) is correlated with an anonymous

[2] This reasoning is in the same spirit as Pagano and Roell (1996). However, their paper concerns the effects of order book price and depth transparency rather than broker identifiers.

regime. Our results indicate that informed traders are better off after a switch to anonymity, a finding which needs to be considered together with previous studies when assessing the implications of broker anonymity changes on market quality.

This study benefits significantly from access to a unique data set provided by the Australian Stock Exchange which contains the broker counterparties to every trade executed on the exchange. Prior studies, including all those listed in Table A, which investigate changes in the transparency of broker identifiers have yet to utilise data of this nature, resorting instead to broad trade and quote level data. While this can be suitable, and indeed two of the hypotheses in this paper require only trade and quote level data, one could argue that the most natural observational unit for a study of broker identifier transparency is the individual broker. To the best of our knowledge, this is the first study of broker transparency to incorporate within its analysis, research directed at the level of the individual broker.

We use the data set provided by the Australian Stock Exchange to calculate the average permanent price impact of each broker's trades and the dispersion of this variable *across brokers*. The rationale for examining this metric is that, all other things being equal, the dispersion of permanent price impact across brokers provides an indication of the extent to which the market utilises the identifier to distinguish informed from uninformed trades. For example, all other things being equal, if the standard deviation of average permanent price impact across brokers is zero, then the market places no informational weight on the identifier. Clearly in the anonymous broker regime it is impossible for the market to extract any information from the broker identifier. We compare the dispersion of broker price impact before and after the change to determine if the identifier has incremental signalling value in the transparent period in the lead up to takeover announcements. If it contains value, then by definition, its absence suggests that the informed traders are less detectable after the change to anonymity.

To enhance this analysis we also investigate the extent to which liquidity suppliers adequately price protect themselves as well as the ability of the market to correctly interpret the information content of order imbalances in the forty days prior to takeover announcements. We choose to examine bid-ask spreads since it provides a

natural indication of whether informed traders are being detected by liquidity providers (Bagehot, 1971; Copeland and Galai, 1983; Glosten and Milgrom, 1985; Easley and O'Hara, 1987). Furthermore, we measure the strength of the order imbalance to price relationship in the days leading up the announcement as another indicator of how well informed traders can disguise their status.[3] Studies show that informed trading is likely to manifest itself as an imbalance between buyer and seller initiated trades (Easley, Kiefer, O'Hara and Paperman, 1996; Easley, Kiefer and O'Hara, 1997). Since we analyse periods where informed trading is likely to occur, the extent to which the market reacts to order imbalances during this time is another measure to assess the ability of informed traders to remain hidden from the market.

The results of this study indicate that the dispersion in the average permanent price impact across brokers is significantly lower after the change to broker anonymity with the standard deviation of average price impact across brokers dropping from 1.99% to 1.12% for trades of all sizes and from 4.15% to 1.30% for the largest trades. We also find that bid-ask spreads are significantly lower in the anonymous market setting. The magnitude of this reduction is material, in the order of 20 basis points even after controlling for firm size, volume and volatility. Additional tests indicate that the decrease is attributable to a reduction in the adverse selection component of the spread. With respect to the order imbalance-price relationship, results indicate that both before and after the switch to anonymity excessive buyer initiated days correspond to days of greater returns. However, this relationship is significantly weaker in the post period. Overall the results of this study suggest that informed traders remain less detected by the market and are therefore, better off after a switch to anonymity.

The rest of this paper is organised as follows. Section 2 outlines the theory underpinning the hypotheses of the paper. Section 3 describes the institutional detail and data used for this study. Section 4 provides the results of the analysis and Section 5 concludes.

[3] Another data-related advantage arises from the fact that the market being analysed is a centralised electronic limit order market. Therefore trade classification algorithms, such as the Lee and Ready (1991) algorithm commonly adopted in studies of U.S. markets, are not required to discern trade direction. Since all trades (excluding upstairs trading) must be executed at either the best prevailing bid or ask, it is possible to classify with certainty whether a trade is buyer or seller initiated. This facet of the data allows us to accurately calculate order imbalances for the firms in our sample.

2. Hypothesis Development

In this section we outline three hypotheses which allow us to test whether informed traders are more hidden after the removal of broker identifiers. The first hypothesis relates to permanent price impact, and how an investigation of this metric at the broker level reveals the extent to which the identifier is used to distinguish informed and uninformed traders. Secondly, we explain how bid-ask spreads reflect informed trading in an electronic market where all traders can provide liquidity. Thirdly, we discuss the price-order imbalance relationship and its connection with informed trading.

2.1. Dispersion in broker level permanent price impact

The price impact of a trade can be divided into two components: transitory and permanent (Kraus and Stoll, 1972). The transitory component measures the price impact associated with temporary liquidity constraints at the time of the trade. In contrast, the permanent component measures the longer lasting price impact of the trade. In this study we are interested in the permanent component because it can be used to ascertain the market's assessment of the information content of that order. Since broker identifiers are attached to all orders in the transparent regime, but not in the anonymous regime, a comparison of permanent price impacts across regimes provides some insight into the information content of the identifiers, if any.

Consider two brokers, one which is perceived by the market to execute trades from informed traders, broker *I* and another broker *U*, which executes trades from uninformed investors. In terms of real world examples, broker *I* could fit the description of an institutional broker and broker *U* could be a discount internet broker catering mainly for retail investors. All other things being equal, the trades executed by broker *I* will have a great permanent price impact than those of broker *U*. Now consider the case where the market cannot identify the broker behind each trade and thus cannot use the incremental signalling value it provides. In this case, all other things being equal, the trades of broker *I* and broker *U* should have the same perceived information content and thus the same permanent price impact. Therefore, in the transparent regime, *assuming the broker identifiers have some informational value*, the dispersion in the average permanent price impact across brokers should be higher than in the anonymous regime. On the other hand, if the broker identifiers have

no value then the dispersion should be similar across the regimes. By definition, if broker identifiers have informational value then the absence of these identifiers means that informed traders are more hidden after the change to anonymity. Therefore, an investigation of the dispersion in permanent price impact furthers the overall aim of this study – namely, whether the removal of broker identifiers hides informed traders.

H1: In the lead up to takeover announcements the dispersion in permanent price across brokers is narrower after the switch to anonymity.

Note this hypothesis does not require us to identify which broker identifiers are associated with informed trading and which ones are not.

2.2 Bid-ask spread

It is well established that the bid-ask spread incorporates the risk associated with trading with an informed trader (Bagehot, 1971). Therefore, the magnitude of the bid-ask spread should be an increasing function of the probability of informed trading in the market (Copeland and Galai, 1983; Glosten and Milgrom, 1985; Easley and O'Hara, 1987). However, this relationship breaks down when liquidity providers and dealers incorrectly assess the probability of informed trading or at the extreme, fail to discern the presence of informed traders whatsoever. For example, Fishe and Robe (2004) show that NASDAQ dealers did not widen bid-ask spreads in the presence of trading by those who had foreknowledge of the influential *Business Week* stock analysis column, 'Inside Wall Street'. Therefore, assuming informed traders are active in a market, one can examine bid-ask spreads to determine the extent to which other market participants have detected informed traders. Indeed, Garfinkel and Nimalendram (1997) use bid-ask spreads as a means to determine the extent to which traders are recognised as informed on the New York Stock Exchange compared to the NASDAQ.

The above reasoning applies when informed traders act as liquidity demanders in a market. However, in an electronic limit order book with no market makers such as the ASX, informed traders are also free to act as liquidity suppliers. In this situation we contend that the bid-ask spread is still a useful indicator of the extent to which participants are recognised as informed. Foucault et al. (2007) provide a model where

informed traders possess information about a stock's future volatility and act as liquidity suppliers. They compete for order flow with uninformed liquidity suppliers, who behave according to the participation rate of informed dealers in the market. Uninformed liquidity suppliers post orders after the initial round in which an informed dealer or pre-committed (uninformed dealer) acts first. For an anonymous market, when the participation rate of uninformed dealers is low, uninformed liquidity suppliers never assign a large enough probability of an information event even when the order book looks like it has been set by an informed dealer. As such uninformed participants always provide price improvement (i.e. reduce the spread) because they cannot tell the informed from the uninformed due to the hidden nature of the broker's identity. Similar reasoning leads the authors to conclude that, when the participation rate of informed dealers is large, spreads widen such that there is a positive correlation between bid-ask spreads and the participation rate of informed dealers. In a transparent market, uninformed dealers behave as if they have perfect information as to whether an order book is set by an informed dealer or otherwise.

Foucault et al. (2007) assume that uninformed traders are able to accurately assess the participation rate of informed dealers and act accordingly. In reality however, the behaviour of uninformed dealers is not determined by the participation rate of informed dealers, but rather the uninformed dealers' *beliefs* about the participation rate of informed dealers. The bid-ask spread is therefore an indicator of such beliefs and prior to significant information events the bid-ask spread is an appropriate measure of the extent to which uninformed liquidity suppliers can discern the presence of informed liquidity suppliers.

Whether informed traders demand or supply liquidity, we hypothesise that if informed traders are able to conceal their informed status as a result of broker anonymity, then other liquidity suppliers should factor in a lower adverse selection cost component into the spread.

H2: The bid-ask spread of target firms in the lead up to the takeover announcement is lower in the anonymous broker regime.

2.3 Order imbalance and returns

The third metric we use to determine the extent to which informed traders are detected is the relationship between order imbalances and returns. Order imbalance is a measure of excess buyer over seller initiated trading in a given period. Easley, Kiefer, O'Hara and Paperman (1996) formalise the intuition that this measure can be used to ascertain the extent of informed trading in markets. Cao, Chen and Griffin (2005) show that contemporaneous and lagged order imbalances are positively related to stock returns prior to takeover announcements, providing empirical evidence that order imbalances are a manifestation of information transmission in markets.

Before outlining our hypothesis, it is important to note the inferential differences between order balances in a specialist or dealer market compared to a completely order driven market. At the most basic level, order imbalances are equivalent in either market structure – order imbalances measure the difference between liquidity demanded by buyers over liquidity demanded by sellers of securities. The primary difference between the markets is that in order driven markets public traders, rather than dealers provide the liquidity. As such, there is an argument to suggest that the term order imbalance, in the context of order driven markets, is a misnomer and therefore uninformative, since 'for every buyer there is also a seller'. We do not take this view, but note the difference in interpretation of order imbalances in an order driven market *vis-à-vis* specialist or dealer markets.

In an order driven market, order imbalance represents the magnitude of excess buy *market* orders over sell *market* orders. This metric is not completely uncorrelated with the extent of informed trading in the market, since it can be argued that informed traders are more likely to use market orders, rather than limit orders, to rapidly utilise their information before others trade on the same information (Conroy and Winkler, 1981; Glosten, 1994; Seppi, 1997; Harris, 1998). This might be particularly the case in the period leading up to takeover announcements where it is likely that a larger group of individuals (employees of the target, the bidder and the corporate and legal advisors for both parties) possess the price sensitive information, compared to company specific announcements such as earnings reports. If market orders are in general correlated with informed trading during the periods analysed in this study, and broker anonymity impairs the discovery of informed traders then this can manifest

itself in two ways within the order imbalance-return relationship. Firstly, for a given return, if uninformed traders cannot discern which trades are informed then they are less likely to trade in the same direction as informed traders, reducing the level of order imbalance. Alternatively, for a given order imbalance, trades by informed individuals should incur a smaller permanent price impact if anonymity means that the market does not correctly interpret the information content of their trades. In either case, the correlation between order imbalance and returns should be weaker when informed traders are hidden due to broker anonymity.

H3: In the lead up to a takeover announcement, the relationship between order imbalances and returns for target firms is weaker in the anonymous broker regime.

3. Institutional detail and data

The Australian Stock Exchange operates a centralised electronic limit order book similar to other prominent exchanges in Europe (e.g. Euronext) and Asia (e.g. Tokyo Stock Exchange, Hong Kong Stock Exchange and Korea Stock Exchange). The market opens with a call auction and thereafter all trading is conducted via a continuous order driven auction, until the close of the day when another call auction is used to set the closing price. During normal trading, brokers submit orders with size and price conditions which are matched with an order(s) on the opposite side of the book, if possible, otherwise they remain in the limit order book. Orders with the most competitive price are executed first and where prices are the same, orders that were submitted first have precedence. Prior to 28 November 2005 brokers were able to see broker identifiers of other limit orders as well as the broker counter parties to a trade after a transaction occurred. Since the change to an anonymous regime, all pre-trade identifiers have been removed. In terms of post-trade information, participants can obtain, for a fee, a summary of each broker's transactions after the close of trading. The summary provides the total volume per broker per security traded on that day. Complete trade by trade broker counterparty information, formerly reported immediately after trade, is now only available three trading days after the initial transaction. In this study we investigate how this change in the disclosure of pre and post-trade broker identifiers allows informed traders to conceal themselves from other market participants. This research investigates the ability of the market to detect

informed trading in the forty days prior to takeover announcements announced two years either side of the transparency shift on 28 November 2005.

A list of merger and takeover announcements is obtained from Thomson DataStream and supplemented by another list obtained from Bloomberg. To ensure the cleanliness of the pre-announcement period, where a firm has been the subject of multiple takeover offers we only consider announcements for which there have been no others in the preceding year for that firm.

The intraday trade and quote data used in this study is obtained from two sources: the Securities Institute Research Centre of Asia-Pacific (SIRCA) and the internal database of the Australian Securities Exchange (ASX). Both data sets include the price, size and time of every trade for each firm in the sample. Trades that occur during the opening and closing call auctions are excluded from the sample. The SIRCA data set provides best quotes that prevailed immediately before each trade (required for the calculation of trade direction), while the ASX data provides the broker counterparties to each trade. The SIRCA data set covers a period that allows analysis of all takeover announcements made two years either side of the transparency change – 28 November 2003 to 28 November 2007.[4] This dataset is used to test *H2* and *H3*. The data set sourced internally from the ASX covers only one year either side of the change, 28 November 2004 to 28 November 2006. This data set is merged with the SIRCA data set and is used to test *H1*.

If a trade is executed at the prevailing ask price (or greater if the order walks up the book) then the trade is classified as buyer initiated. Seller-initiated trades are classified in a similar way. Unlike studies conducted in U.S. markets, trade classification via an algorithm, such as Lee and Ready (1991) is unnecessary since the structure of the ASX requires that trades are executed against existing standing limit orders. Therefore, there is less ambiguity with respect to whether a trade is buyer or seller initiated. Less than 2.4% of trades in the data appear not to execute at either the bid or ask. These are considered data errors and are deleted from the sample.

[4] The actual data set sourced from SIRCA spans a period slightly longer than four years, since we also require 150 days of trading data prior the announcement in order to calculate various benchmarks for volume and returns.

We are primarily interested in the 40 days prior to the announcement (hereafter, the 'pre-announcement period'). However, we also require intraday trading data up to 150 days prior to the announcement to ascertain benchmark metrics for the calculation of abnormal volume and returns. The benchmark period in our sample is from days t=-50 to t=-150, where t=0 is the day of the announcement. A firm is purged from the sample if it does not have at least twenty days of trading during the pre-announcement period or at least fifty days of trading during the benchmark period. For the main analysis, we also exclude nine firms whose pre-announcement period spans both the transparent and anonymous regimes. These firms are kept aside for an additional robustness test to ascertain whether the observed results are caused not by the switch to anonymity but by broader market trends. After all filters have been applied, this leaves a total of 252 takeover targets over the period 28 November 2003 to 28 November 2007. Ninety three announcements are made in the transparent broker regime, while 159 announcements are made in the anonymous broker regime. For the restricted ASX sample used to test *H1*, there are 178 takeover targets, 68 in the transparent regime and 110 in the anonymous regime.

Summary statistics of the target firms for the entire sample are presented in the Table 1. The statistics indicate that the nature of the takeover firms is not materially different between the two sample periods. The median value for market capitalisation of the firms (calculated by taking the average daily market capitalisation in the benchmark period) is very similar taking the values of $116.31 million in the transparent regime and $114.25 in the anonymous regime. This is important since firm size is highly correlated with a number of important metrics such as the level of informed trading (Hasbrouck, 1991), the bid-ask spread (Roll, 1984) and the magnitude of the stock price to volume relationship (Breen, Hodrick and Korajczyk, 2002). This makes it less likely that our results are driven by differences in the characteristics of the firms across the two regimes. The daily pre-announcement traded volume during both regimes is similar, with a median value of 27,037,000 shares in the transparent regime compared to 25,195,000 shares in the anonymous regime. Again, this is a reassuring statistic since overall trading activity is a known determinant of bid-ask spreads (Demsetz, 1968; McInish and Wood, 1992) and price impact (Breen, Hodrick and Korajczyk, 2002).

There is a difference in the ratio of to pre-announcement and post-announcement stock abnormal return before and after the structural change. The ratio between mean pre to post announcement abnormal returns is higher when broker identifiers are visible (0.89) compared to when they are anonymous (0.63). This result provides the first indication that informed traders are generally more hidden after the switch to an anonymous regime since less of the overall abnormal stock return occurs before the announcement is made. We investigate this issue with greater rigour in the following section by examining bid-ask spreads, the order imbalance to return relationship and the dispersion in permanent price impact using univariate and multivariate analyses.

4. Methodology and results

4.1.1 Dispersion in permanent price impact across brokers

In this section we calculate the dispersion in broker level permanent price impact and compare this metric between the two regimes. For each buyer-initiated market order in the sample[5], the permanent price impact is calculated as:

$$Permant\ Price\ Impact = \frac{Close\ Price - Trade\ Price}{Trade\ Price} \tag{1}$$

Since one determinant of price impact is the size of the trade, trades are divided into four categories based size. This is accomplished by first calculating each firm's median trade size during the pre-announcement period and then comparing the trade size to the median value:

$$Relative\,Trade\ Size = \frac{Trade\,Volume}{Median\,Trade\ Size} \tag{2}$$

Trade size groups are defined as follows: *Group 1* contains all trades where *Relative Trade Size (RTS)* < 1; *Group 2* contains all trades where $1 \leq RTS < 2$; *Group 3* contains all trades where $2 \leq RTS < 5$ and Group 4 contains all trades where $RTS \geq 5$.

[5] We focus only on buyer initiated orders in order to restrict the sample to trades which can be motivated by information. We make the assumption that seller initiated trades prior to a takeover sample are not informed trades.

The average permanent price per broker per trade size group is then calculated. Table 2 reports the standard deviation of permanent price impact across brokers per trade size group and also for all trades. The results indicate that the standard deviation of permanent price impact across brokers has experienced a significant reduction from 1.99% to 1.12%. Furthermore, across all groups the standard deviation of permanent price impact between brokers is lower after the change to anonymity. The results are significant at the 1% level for all groups except *Group 2* for which the F-statistic has a p-value of 0.04. The greater dispersion in permanent price impact across brokers in the transparent regimes suggests that broker identifiers have incremental signalling value when they are visible to the market in the lead up to takeover announcements.

The incremental signalling value appears to be greatest for the largest trade size group where the standard deviation of permanent price impact amongst brokers falls from 4.18% to 1.30%. This might be expected given the information uncertain nature of large trades. Barclay and Warner (1993) show that 'medium sized' trades rather than large trades are perceived by the market to contain the greatest information value. However, basic economic rationale predicts that to maximise returns those with information will trade the greatest amount possible, especially when there is significant competition amongst informed traders, as might be the case just before takeover announcements (Harris, 2003 p326). Given this uncertainty for large trades, it might be possible that the broker identifiers are used to distinguish those large trades which are based on information and those which are not. Indeed the results of this section suggest that this is the case. More generally, the fact that the broker identifiers appear to have informational value shows that informed traders are more concealed after the change to broker anonymity.

4.2.1 Bid-ask spread

Table 3 compares the magnitude of bid-ask spreads between the two broker identification regimes. Using univariate analysis, there is mixed evidence that spreads have declined, and therefore informed traders are less detected, after the switch to anonymity. We sample bid-ask spreads immediately before each trade for a given security in a given day and calculate both the daily mean and median percentage bid-ask spread. Table 3 reports summary statistics of these daily measures. Both median and mean percentage spreads are lower in the post period. The median (mean)

percentage bid ask spread decreases from 1.63% (1.71%) in the transparent regime to 1.56% (1.67%) in the anonymous regime. A one way t-test indicates that the daily median percentage bid-ask spread is significantly lower, at the five percent level, after the switch to anonymity, while the mean daily percentage bid-ask spread is not significantly different after the change. A non-parametric Wilcoxon two-sample rank sum test, however, indicates that both median and mean bid-ask spreads are significantly lower in the anonymous period. The z-statistic approximation to the Wilcoxon statistic is 6.30 and 4.60 for daily median bid ask spreads and daily mean bid-ask spreads respectively, both of which are significant at the one percent level.

To further investigate the robustness of our univariate results we also examine the change in the adverse selection component of the spread. We perform this analysis because the theory underpinning our hypothesis is that liquidity suppliers are less able to detect informed trading in an anonymous regime and therefore factor in a lower adverse selection component into the bid-ask spread. Statistics examining total bid-ask spreads might therefore be capturing changes in some other aspect of the spread (inventory holding or order processing) that is unrelated to adverse selection and as such uninformative about our hypothesis. We calculate the adverse selection cost component of the bid-ask spread using the method developed in Lin, Sanger and Booth (1995) and subsequently applied to an electronic limit order market in Brockman and Chung (1999). The adverse selection component is calculated by estimating the following regression for each firm over the entire 40 day pre-announcement period:

$$\Delta Q_{t+1} = \lambda z_t + e_{t+1} \qquad (3)$$

where Q is the natural log of the bid-ask spread midpoint, z is the natural log of the difference between the transaction price and the bid-ask spread midpoint and e is a normally distributed error term. The coefficient on z, λ, measures the adverse selection component of the bid-ask spread. Table 3 presents summary statistics of the adverse selection cost component, before and after a switch to broker anonymity. The results indicate that the adverse selection component decreases from 32.09% to 27.26% in the anonymous period. The adverse selection cost component is

significantly lower at conventional levels when assessed using a t-test or a Wilcoxon two sample rank sum test. The results suggest that informed traders are not as easily detected after the removal of broker identifiers since liquidity suppliers do not incorporate as large an adverse selection cost component into the bid-ask spread.

Finally, to ascertain the extent to which informed traders go undetected by liquidity suppliers in the market in a multivariate setting we estimate the following pooled cross-sectional regression:

$$PBAS_{jt} = \beta_0 + \beta_1 * D_{jt} + \beta_2 * Volume_{jt} + \beta_3 Volatility_{jt} + \sum_{i=1}^{3} \gamma_i * Size_{jti} \qquad (4)$$

PBAS is the median daily proportional bid-ask spread for firm *j* on day *t*, where as previously, the bid-ask spread is sampled immediately before each trade.[6] The dummy variable, *D*, takes the value 0 during the transparent regime and 1 during the anonymous regime. Volume, volatility and market capitalisation variables are also include in the regression specification as control variables (McInish and Wood, 1992). *Volume* is the firm's turnover for the day. *Volatility* is defined as the natural log of the day's price range divided by the closing price. To avoid contamination from the stock run up that occurs during the pre-announcement period, firm size is calculated by averaging the daily market capitalisation of the firm over the benchmark period. The firms are then ranked and placed into four groups based on quartile ranking. The quartile cut-off values are \$41.92 million (25th percentile), \$115.28 million (50th percentile), \$507.38 million (75th percentile) and \$15,944 million (100th percentile). In the regression, γ_i is equal to 1 if the firm is in size quartile *i* and 0 otherwise. The results of the regression are presented in Table 3. We report the results based on the entire pre-announcement period and for robustness, sub-groups of observations according to proximity to the announcement date.

The results indicate that after controlling for volatility, volume and firm market capitalisation, during the forty days leading up to the announcement bid-ask spreads are smaller in the anonymous broker regime. The coefficient on the anonymity

[6] We also estimate the equation using daily mean bid-ask spreads. The results are very similar and we therefore only report the results using daily median bid-ask spreads.

dummy variable is negative and significant and indicates that spreads are 21 basis points per trade lower when broker identifiers are hidden (Table 4, column 1). This suggests that liquidity suppliers are not price protecting as aggressively and that informed traders are therefore, more concealed after a switch to broker anonymity.

An analysis of the results based on the time to the announcement date indicates that this result is robust across the pre-announcement period. The magnitude of the coefficient on the dummy variable is greatest in the period furthest away, that is 40 to 31, days prior to the announcement (Table 4, column 5). The value of the coefficient is negative 39 basis points. In the final thirty days the results are reasonably consistent across the sub-periods, ranging between a 16 to 18 basis point reduction in bid-ask spreads (Table 4, column 2 to 4). This result indicates that in the anonymous market, despite the fact that there is less detection of informed trading as indicated by the negative coefficient on the dummy variable, the ability of informed traders to remain hidden is lower in the final thirty days leading up the announcement compared to the days -40 to -31. This might be because other indicators, unrelated to broker identifiers, such as rumours, volume or price run-ups reveal the presence of informed traders to the market and these indicators are more prevalent closer to the announcement date. Alternatively, it is possible to argue that there is negligible informed trading in the period -40 to -31 during the anonymous regime and the result in this period is driven not by a lack of detection, but a lack of informed trading whatsoever. To ensure the robustness of our results, we rerun the analysis with only a 30 day pre-announcement window. The coefficient on the broker anonymity dummy variable is negative, (-0.17) and significant at the one percent level. Therefore, our conclusions remain unchanged.

4.2.2 Additional Test

One argument that can be made against any research that investigates the effects of a one-off change to market structure is that the results may be driven by broader market trends over the sample period rather than being directly related to the structural change.[7] Applied specifically to this study, this argument questions whether the results of the preceding analysis are driven by the change in broker anonymity or,

[7] See Majois (2007) for a critique of natural experiments methodology.

alternatively, a secular decrease in bid-ask spreads between the transparent to anonymous regimes.

We attempt to minimise the influence of potential market trends by investigating nine firms whose forty day pre-announcement period straddles the change to an anonymous regime on 28 November 2005. These firms were excluded from the original analysis. The sample period of this subset of firms is 71 trading days from 10 October 2005 to 19 January 2006. The rationale for analysing this sample is that these firms span the shortest possible time frame for which there is still variation in the anonymity dummy variable (see equation 4), thereby minimising the effect of any gradual improvement in liquidity while still making it possible to estimate equation 4 via ordinary least squares regression. The results of the pooled cross-sectional regression are presented in Table 5.

While estimated on a small independent sample of firms, the results are remarkably similar to the main analysis. The coefficient on the anonymity change dummy variable indicates that this sample experiences a 22 basis point reduction in bid-ask spreads after a switch to broker anonymity compared to a 21 basis point reduction for the main sample. This result is significant at the 10% level. Given the proximity of the sub-sample sample to the anonymity switch, this indicates that the concealment effect of informed trades appears to have occurred immediately or very soon after the change.[8] The results of this robustness test suggest that broader improvements to market quality are not driving the results of the main analysis.

4.3.1 Order Imbalance and Returns

In this section we test the sensitivity of daily returns to contemporaneous order imbalances. The following pooled cross-sectional regression is estimated:

[8] In an additional test we estimate firm specific time series regressions rather than a pooled cross-sectional regression. While the small sample size of each regression (maximum number of observations is 40), reduces the precision of the parameter estimates, they are nevertheless unbiased. The results indicate that seven out of the nine firms have a negative value on the anonymity switch dummy variable.

$$R_{jt} = \beta_0 + \beta_1 * D_t + \beta_2 * OI_{jt} + \beta_3 * OI_{jt} * D_t + \sum_{i=1}^{3} \gamma_i * Size_{jti} + \sum_{m=1}^{4} \phi_m * Day_m + \sum_{k=1}^{5} \lambda_k R_{it-k} + \varepsilon \quad (5)$$

where R_{jt} and OI_{jt} represent the standardised beta-adjusted excess return[9] and standardised order imbalance respectively of firm j on day t, and D_t is a dummy variable which takes the value of 1 if the day falls on or after 28 November 2005 and zero otherwise. Included within the regression are dummy variables to control for the effect that firm size and day of the week might have on excess returns. Finally we also include five lags of the dependant variable to control for possible autocorrelation in excess returns. Following Cao, Chen and Griffin (2005) both excess returns and order imbalances are standardised by the mean and standard deviation of the variables over the benchmark period. Specifically, the dependant variable is the excess return standardized by the standard deviation of excess returns during the benchmark period. Order imbalance is calculated by first taking the difference between the number of buyer initiated market orders and the number of seller initiated market orders for a given day then dividing by the average volume over the benchmark period. The variable is then standardised using its mean and standard deviation during the benchmark period. The standardisation allows observations from different firms, with potentially divergent return and volume characteristics, to be more suitably combined in a pooled cross-sectional regression.

The results of the regression are presented in Table 6. The results indicate that in both regimes greater order imbalance leads to larger returns. The coefficient on OI_{jt} is positive and significant at 0.342 which indicates that when order imbalance is one standard deviation greater than its benchmark mean excess returns are 0.342 standard deviations greater than zero. This result is consistent with the notion that excess buying conveys positive information about the firm. However, as indicated by the coefficient on the interaction variable $OI_{jt}*D$, -0.144, this relationship is substantially weaker when broker identifiers are anonymous. During the anonymous broker regime *vis-à-vis* the transparent market, similar levels of order imbalance do not lead to as large a price movement in target firms prior to the takeover announcement. This

[9] Each firms' beta is calculated by estimating the market model of returns over the benchmark period.

might be because, for a given return, other traders do not trade as much in the same direction as informed traders or, for a given imbalance, there is a lower permanent price impact after buying (or both). In any case, it appears that the market does not respond as strongly to trading which suggests that a takeover announcement is imminent, after the removal of broker identifiers. In order to test the robustness of our results the same regression is estimated using total volume imbalance, rather than order imbalance (which disregards the magnitude of the trades). The results are similar to that using order imbalance and are presented in column 2 of Table 6.

4.3.2 Additional Test

As for the analysis of the bid-ask spreads, the regression of order imbalance and returns is re-estimated using the observations of those firms whose pre-announcement period straddles the change on 28 November 2005. The results are presented in columns 3 and 4 of Table 6. The coefficients on the variables of interest are similar to those in the main analysis. Excess returns are significantly positively related to order imbalance with a coefficient of 0.670 and also total volume imbalance which has a coefficient of 0.538. The coefficient on the interaction variable is negative at -0.126 and -0.120 for order imbalance and total volume imbalance respectively. This indicates that after the switch to anonymity the relationship between returns and imbalances is weaker, a finding which reconfirms *H3*. The results of this robustness test indicate that informed traders appear to be better hidden after the switch to anonymity and this finding is not driven by a secular change in the relationship between returns and imbalances over time.

5. Conclusion

In this study we present three pieces of evidence that show that, in the lead up to takeover announcements, informed traders are more concealed, and therefore, better off after broker identifiers were removed from the electronic trading screen at the Australian Stock Exchange on 28 November 2005. Firstly, we show that the dispersion in permanent price impact of trades across brokers is significantly lower after the change. This suggests that the market used the identifiers to help distinguish informed from uninformed trades during the transparent regime. Put differently, our results suggest that broker identifiers have informational value. The fact that they

have been removed indicates that informed traders are more concealed after the transparency change.

Secondly, we show that after the removal of broker identifiers bid ask spreads are significantly lower in the days leading up to a takeover announcement. This suggests that liquidity suppliers not engaging in as much price protection compared to when identifiers were revealed. Indeed, the adverse selection component of the spread falls significantly in the anonymous regime, from 32.09% to 27.26% suggestive of the fact that informed traders remain less detected by the market. Finally, an analysis of the relationship between returns and order imbalances shows that while there is a positive relationship between the two variables, the relationship is weaker in the anonymous broker regime. Again, this suggests that the market is not able to detect informed traders as readily when broker identifiers are concealed.

The results have interesting policy implications for exchange officials of electronic markets considering whether to reveal or hide the identities of brokers surrounding trades. Evidence from prior literature indicates that the concealment of identifiers is correlated with lower bid-ask spreads (Foucault et al., 2007; Comerton-Forde et al., 2005; Comerton-Forde and Tang, 2008). However, the results of this study indicate that bid-ask spreads remain lower, even when a significant information announcement is pending. Taken together the research suggests that the removal of broker identifiers has a mixed effect for uninformed traders. When no information event is pending uninformed traders enjoy improved liquidity. However, when information asymmetry is large, the ability of uninformed traders to detect and protect themselves from the informed is impaired. To resolve the issue as to whether broker identifiers should be revealed or not, research is required which analyses and quantifies the trade-off between these two competing factors. We leave this as a possible avenue for future investigation.

Table A

Exchange	Date of change	Academic Literature
Australian Stock Exchange	28 November 2005	Comerton-Forde and Tang (2008)
Paris Bourse	23 April 2001	Foucault, et al. (2003); Comerton-Forde et al. (2005)
Korea Stock Exchange	25 October 1999	Comerton-Forde et al. (2005)
Tokyo Stock Exchange	30 June 2003	Comerton-Forde et al. (2005)
Deutsche Borse	27 March 2003 to 10 April 2003	Hackmeister and Schierek (2006)
Brussels Stock Exchange	21 May 2001	Maher et al. (2007)
Borsa Italiana	2004	

Table 1 – Summary Statistics – This table reports summary statistics of the takeover targets in the sample. *Market capitalisation* is the average daily market capitalisation of the firm during the 'benchmark period' (days t = -150 to t = -50 where the announcement date is t = 0). *Daily trading volume* is the number of shares traded during the 'pre-announcement' period (days t = -40 to t = -1). *Pre-announcement abnormal return* is the simple return over the pre-announcement period. *Post-announcement abnormal return* is the return from days t = 0 to t = 2.

Panel A: All takeovers (n=252)	Mean	Median	Max	Min	Std Dev
Market capitalisation (pre-runup, $millions)	752.66	115.28	15944.63	2.12	1799.95
Daily trading volume ('000s shares)	774.27	256.01	11271.71	3.50	1392.41
Pre-announcement abnormal return (%)	6.61	4.68	121.30	-80.52	20.63
Post-announcement abnormal return (%)	9.28	5.12	79.37	-14.99	13.81

Panel B: Transparent Regime (n=94)	Mean	Median	Max	Min	Std Dev
Market capitalisation (pre-runup, $millions)	696.73	116.31	7405.2	6.52	1386.55
Daily trading volume ('000s shares)	714.69	270.37	8371.05	3.50	1233.53
Pre-announcement abnormal return (%)	7.26	3.12	121.30	-80.52	21.44
Post-announcement abnormal return (%)	8.11	2.56	79.37	-14.68	14.22

Panel C: Anonymous Regime (n=158)	Mean	Median	Max	Min	Std Dev
Market capitalisation (pre-runup, $millions)	785.38	114.25	15944.63	2.12	2006.11
Daily trading volume ('000s shares)	809.12	251.95	11271.71	4.11	1480.09
Pre-announcement abnormal return (%)	6.23	5.54	89.33	-50.49	20.20
Post-announcement abnormal return (%)	9.96	6.34	54.19	-14.99	13.56

Table 2 – Dispersion in Permanent Price Impact across Brokers – This table reports the standard deviation of permanent price impact across brokers according to the size of the trade. The trade size groups are defined as such: *Group 1* contains all trades where *Relative Trade Size (RTS)* < 1; *Group 2* contains all trades where $1 \leq RTS < 2$; *Group 3* contains all trades where $2 \leq RTS < 5$ and Group 4 contains all trades where $RTS \geq 5$ where *RTS* is defined as the size of the trade divided by the median trade size in the pre-announcement period. The table also reports the F-statistic of a one-way test of differences in standard deviation between the regimes.

	Transparent Regime		Anonymous Regime		Test of Differences	
	Std. deviation (%)	No. of observations	Std. deviation (%)	No. of observations	F statistic	p-value
All	1.99	77	1.12	79	1.78	0.00
Group 1	2.87	75	1.13	78	2.54	0.00
Group 2	2.39	74	1.61	77	1.48	0.04
Group 3	2.48	73	1.33	74	1.85	0.00
Group 4	4.15	68	1.30	76	3.19	0.00

Table 3 – Bid-Ask Spreads: Univariate Analysis – This table reports the average daily median and mean percentage bid-ask spread as well as the average adverse selection cost component of the spread. This table also reports tests of the hypothesis that the value in the transparent broker identifier regime is larger than the value in the anonymous broker identifier regime (one-tailed test). The difference is tested using a parametric t-test and a non-parametric Wilcoxon test.

	Transparent Regime	Anonymous Regime	T-test statistic	Wilcoxon statistic
Average daily median percentage bid-ask spread (%)	1.63	1.56	1.75**	6.30***
Average daily mean percentage bid-ask spread (%)	1.71	1.67	1.09	4.60***
Average pre-announcement adverse selection cost component (%)	32.09	27.26	2.65***	2.91***

*** indicates significance at the 1% level
** indicates significance at the 5% level

Table 4 – Bid-Ask Spreads: Multivariate Analysis – This table reports the coefficient values and t-statistics in brackets of a regression of daily median percentage bid ask spread on the following variables: *D* is a dummy variable which takes a value of 1 during the anonymous broker regime and 0 otherwise; *Volume* is the firm's turnover for the day; *Volatility* is defined as the natural log of the day's price range divided by the closing price. *Size 2nd Q* is a dummy variable which takes the value of 1 if the firm falls within the second quartile of firms by market capitalisation and 0 otherwise. *Size 3rd Q* and *Size 4th Q* are similarly defined. The regression is estimated using daily trading data from the forty days prior to 252 takeover announcements. The regression is also estimated using various sample subsets partitioned according to proximity to the announcement date.

	Days -40 to -1	Days -10 to -1	Days -20 to -11	Days -31 to -20	Days -40 to -31
Intercept	4.88	4.65	5.12	4.59	5.23
	(64.07)	(33.26)	(32.06)	(31.17)	(32.04)
D	-0.23	-0.18	-0.18	-0.16	-0.39
	(-7.57)	(-3.13)	(-2.22)	(-2.92)	(-6.05)
Volume	-20.94	-15.93	-33.67	-23.47	-21.38
	(-13.83)	(-5.55)	(-7.11)	(-6.91)	(-8.50)
Volatility	0.41	0.40	0.42	0.37	0.45
	(20.75)	(11.06)	(10.49)	(9.62)	(10.80)
Size 2nd Q	-1.51	-1.33	-1.72	-1.44	-1.53
	(-33.59)	(-16.01)	(-18.51)	(-17.18)	(-15.80)
Size 3rd Q	-2.18	-2.06	-2.41	-2.04	-2.22
	(-49.11)	(-24.78)	(-26.20)	(-24.46)	(-23.24)
Size 4th Q	-2.73	-2.59	-2.89	-2.60	-2.82
	(-60.54)	(-30.87)	(-30.87)	(-30.69)	(-29.08)
n	8676	2157	2203	2140	2176
Adj. R^2	41.46%	42.69%	42.06%	42.57%	39.68%

Table 5 – Additional Test for bid-ask spreads – This table reports the results of the same regression documented in Table 3. In this regression is estimated using a sample of nine firms whose pre-announcement period includes the date of the transparency change.

	Coefficient	T-stat
Intercept	5.16	16.11***
D	-0.22	-1.69*
Volatility	0.65	7.74***
Volume	-59.23	-5.32***
Size 2nd Q	-0.62	-2.70***
Size 3rd Q	-1.18	-7.78***
Size 4th Q	-1.80	-8.34***
n	291	
Adj. R^2	42.68%	

*** indicates significance at the 1% level
** indicates significance at the 5% level
* indicates significance at the 10% level

Table 6 – Order imbalance and returns – This table reports the coefficients and t-stats, in brackets, of the variables of interest from equation 3. The dependant variable is the beta-adjusted daily excess return standardised by the variable's standard deviation over the benchmark period. *D* is a dummy variable which takes a value of 1 during the anonymous broker regime and 0 otherwise. *OIjt* is the standardised daily order imbalance (column 1 and 3) or the total volume imbalance (column 2 and 4). The main sample comprises trade data of 252 takeover targets announced between 28 November 2003 and 28 November 2007. The robustness sample consists of nine takeover targets whose pre-announcement period includes the date of the change to an anonymous broker regime.

Variable	Order imbalance – Main sample	Volume imbalance – Main sample	Order imbalance – robustness sample	Volume imbalance – robustness sample
Intercept	0.151	0.122	-1.838	-0.239
	(0.43)	(0.35)	(-1.51)	(-0.21)
D	0.208	0.216	2.825	1.09
	(0.80)	(0.84)	(2.16)	(0.88)
OI_{jt}	0.342	0.428	0.670	0.538
	(26.09)	(25.77)	(12.21)	(14.72)
$OI_{jt} * D$	-0.144	-0.142	-0.126	-0.120
	(-9.00)	(-6.88)	(-1.70)	(-2.28)
n	7411	7411	274	274
Adjusted R^2	13.31%	14.27%	51.14%	56.22%

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