The Effect of Changes in Transparency and Short Informativeness Horizon of Undisclosed Limit Orders: Evidence from the Australian Securities Exchange

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Abstract

This paper examines the impact of the submission of Undisclosed Limit Orders and its short term information content compared to 'similar' orders (Disclosed Limit Orders and Marketable Orders) on the limit order book. Also, we further examine the impact of the removal of broker identifiers and investigate whether the abolishment of broker identifiers from trading screens on the Australian Securities Exchange affect the short term information content of various order types. Results indicate that aggressively submitted undisclosed orders compared to 'similar' disclosed limit orders lead to significant higher short term price movement. Results further indicate that the removal of broker identification did not provide consistent and robust evidence of any changes in the short term information content of large dollar volume orders. Thus, the information content and overall market anticipation, subsequent to the submission of undisclosed orders is unaffected by the removal of broker identification.

Keywords: Australian Securities Exchange, Market Microstructure, Transparency, Undisclosed Limit Orders, Broker Identification, Hidden Orders

1. Introduction

The ability for financial markets to process and adjust to voluminous orders is a fundamental element of a well functioning market. Large dollar volume orders pose a problem in themselves, in that information can be inferred from them by informed traders, acting quickly and heavily on new information not reflected in current prices.[1] This however, disadvantages traders (not insiders) who require a circumstantial large position to reveal their trading motivation to the market.[2]

The role of a limit order book for a fully order-driven market like the Australian Securities Exchange (ASX) is to provide a central trading platform for the submission, execution, cancellation, and amendment of orders simultaneously. Investors provide liquidity in an order-driven market through the submission of orders around (or at) the best bid and ask quotes, but are susceptible to a number of exposure risks. For any limit order trader various exposure risks include either; i) being front-run by other orders, ii) risk of non-execution, iii) revealing their trading intentions to the market and iv) trading with informed traders (D'hondt, De Winne and Francois-Heude 2003). To overcome the exposure of revealing limit orders in the order book (in this study, large dollar volume orders), many exchanges worldwide have introduced a Hidden Limit Order (HLO) type.[3] Hidden orders placed in the order book changes an important attribute of trading, allowing traders to protect their trading intention from other market participants (in particular, actions of herding or mimicking of trades). From an exchange point of view, the introduction of hidden orders allows greater flexibility for investors attracting hidden portions of depth into the order book. Pardo and Pascual (2003) document the use of hidden orders within the Spanish stock exchange and find that hidden orders are used as a tool to mitigate information asymmetry risk for liquidity suppliers. Anand and Weaver (2004) investigate hidden orders on the Toronto Stock Exchange (TSX) and finds hidden orders increase the inside depth of the order book.

The distinguishable feature of any hidden order is whereby a portion of the total order volume is hidden (undisclosed) within the order book. Most international markets enable investors to place hidden orders, but each exchange differs in terms of their rules of execution and disclosure limits (See for example, Comerton-Forde and Rydge (2006) for details about hidden order properties used within Asia-Pacific Stock exchanges).

The characteristic of a HLO on the ASX i.e. Undisclosed Limit Order (ULO), however differs from other recognised hidden orders (i.e. iceberg order type) implemented in many financial markets. The comparison between ULO to the iceberg order type reveals three striking differences. First, the ULO type does not sacrifice time priority in the order book, where the iceberg order type does. Second, after submission of a ULO a letter '/u' is placed in the quantity field in the order book, whereas the iceberg order exist as a single disclosed order with a specified quantity.

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[1] Herein high dollar volume orders represent orders with a dollar value in excess of $200,000.
[2] We recognise that traders have the strategy of splitting their order in smaller portion, but as result incur higher trading cost. Also traders have the option to submit market orders but again at a cost of trading at a higher/lower price then desired. Therefore the hidden order type provides a cost efficient way of submitting a large limit order at a desired priced and quantity.
[3] Hidden orders represent both type of orders - Iceberg and Undisclosed orders.

Third, once the ULO total dollar order quantity falls below $200,000, it simply exists as a DLO.[4] Whereas the iceberg order replenishes itself after each disclosed portion is executed.

In this paper, we differentiate from other studies by examining the short term additional impact of hidden orders surrounding broker anonymity in the ASX. Broker anonymity has been well documented in the literature, examining the subsequent effects on market quality. Foucault, Moinas and Thiessen (2007) examine the effect of broker anonymity in the Paris Euronext and finds quoted bid ask spreads decline and quoted depth decreased. Similarly, Comerton-forde and Tang (2008) examine market quality when the ASX changed to an anonymous regime and finds three improvement in market quality i) reduction in quoted spreads, ii) increase quoted depth and iii) greater order flow. The ASX removed broker identifier from orders on November 28, 2005, thus providing this paper with an excellent natural experiment to examine whether reducing pre-trade transparency has changed the preference (and information content) for hidden orders.

The decision to abolish order identifier on the ASX was to create an anonymous trading arena for traders and was inline with many international exchanges moving to opacity.[5] Broker identifiers provide valuable information in the limit order book; it explicitly offers free information in the trading process (O'Hara, 1995). The information content revealed through broker identifiers is another example of exposure risk that a limit order trader faces. Intuitively, the submission of a hidden order in the post anonymity period should serves as a 'double' concealment from exposure risk as firstly, as a broker your identity is hidden and secondly your order quantity is likewise hidden. The specific focus of this study is to assess the market response to the subsequent submission of hidden orders around the market reform of anonymity. The purpose is to untie whether this 'double' exposure protection confounded within hidden orders in an anonymous market adds to the short term informativeness of the ASX order book.

Specifically, we examine the information content for large dollar volume orders i.e. Undisclosed Limit Orders (ULOs), Disclosed Limit Orders (DLOs) and Market Orders (MOs). Distinctively we focus on the additional information content compounded within a hidden order (i.e. ULOs) when compared to a 'similar' order that is fully disclosed to the market. We analyse the difference in short term price return for a ULO to the same short term return of a 'matching' DLO and MO as to the extent of information confounded within each order type. Furthermore, we examine whether the removal of broker identifiers contributes to any changes in information content between matched orders on the ASX. We use order by order data provided by the Security Industry Research Centre of Asia-Pacific (SIRCA) to fully reconstruct the order book for the event period. Employing data from a period of six months prior to, and six months subsequent to the removal of broker identification, we match ULOs to 'similar' DLOs and MOs using all listed securities on the ASX.

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[4] The minimum dollar order value of an ULO is $200,000. See Aiken et al (2001) for the changes in undisclosed threshold limits over time on the ASX.

[5] Except for the Korean Stock Exchange, which moved from opacity to a transparent market by revealing broker identifiers on October 25, 1999.

The results indicate firstly, aggressively placed hidden orders do have a significant returns difference compared to similar DLOs within the first 10 minutes of submission. This result highlights the possible additional information contained within the hidden order type. Further examination of hidden orders around broker anonymity finds limited evidence that additional information is contained in broker identifiers for large dollar volume orders. Numerically, returns differences are negligible subsequent to the removal broker identifiers across all order directions and all order aggressiveness types. Finally, the results for comparable hidden orders information content, pre/post of anonymity also show inconclusive evidence of the value of broker identifiers. The result for the differences in returns for the hidden orders is all insignificant across all order directions and across all order aggressiveness types. We find that aggressively placed hidden orders explicitly show greater movement compared to similar order type but only due to the concealment of the order volume and not linked with broker identifiers. We conclude that broker identifier for all matched large dollar volume orders are irrelevant as the market perceive the same short term return with or without broker identifiers attached.

The paper is organised as follows. Section 2 presents the literature on the magnitude and statistics of hidden orders firstly on the ASX and secondly on international markets. Section 3 describes the data, the method and develops the hypotheses for this study. Section 4 discusses the empirical results and the final section, section 5 concludes the paper.

2. Literature Review

Several papers examine the use of HLOs focusing on the ASX. Aiken et al. (1996) finds in 1993 that a total of 6% of all submitted orders on the ASX were undisclosed, accounting for 28% of total volume. Aiken et al. (2001) finds that the use of hidden orders on the ASX reduces the option value of limit orders. Furthermore, their study finds the use of ULOs is negatively related to relative tick size and also trading activity, but positively related to volatility and order value. In terms of the information content of different order strategies, they find no evidence that ULOs are more frequently used by informed traders than DLOs. Another study by Aiken et al. (2003) finds the main determinants of the size of a ULO is confounded by both price volatility and liquidity levels. They suggest the appearance of an undisclosed order in stocks may provide a signal of the possibility of a new information event in the market. Allen et al. (2007) examine the price impact of submission of a ULO, and attempts to match these orders to similar DLOs and MOs. Their findings suggests that large orders have a significant price impact on the order book (for the first ten minutes), but comparing ULOs to similar DLOs and MOs, no significant permanent return differences is witnessed.

A number of papers have researched HLOs (iceberg order type) from many internationally recognised exchanges. First, Harris (1996) shows that 74% of all submitted orders for 300 stocks traded on the Paris Bourse are not fully disclosed when the size is greater than FF500,000. Degryse (1999) finds in the Brussels CATS system, that hidden orders account for over 16% of the order book. Furthermore, Hasbrouck and Saar (2002) find that approximately 3% of all hidden orders are

executed on the Island Electronic Communication Network (ECN). This small percentage of hidden order execution equates to almost 12% of all order execution. For stocks belonging to the CAC40 index, D'hondt De Winne and Francois-Heude (2003) find approximately 5% of all orders submitted contain a hidden component. Additionally, the hidden depth accounts for over 45% of the total depth available at the best 5 quotes. Finally, Anand and Weaver (2004) find that on the Toronto Stock Exchange (TSX), submitted hidden orders account for approximately 7% of submitted total volume. Literature on HLOs on international markets, as well as the ASX, reveals similar patterns, in the active use of HLOs which accounts for a relatively large component of total trading volume and liquidity. The market reform of the removal of broker identities in conjunction with hidden order type provides a further avenue of study previously not examined in literature.

3. Data Description

The order by order data was provided by the Security Industry Research Centre of Asia-Pacific (SIRCA) which allows for the full re-construction of the limit order book during the sample period. The dataset include every submitted order placed on all traded ASX securities from 30 May, 2005 to 26 May, 2006. For each order, the dataset comprises information on price, order quantity, timestamp (closest to the nearest hundredth second), direction i.e. either a buy or sell, prevailing best bid and ask at the time the order was submitted and an identifier differentiating how the order was submitted to the order book (either as an ULO, MO or DLO).[6] Since the ASX opens with a pre-auction opening (at 10am) and closes with a pre-close auction (at 4pm), the dataset capture normal trading activity from 10:30:00am to 15:30:00pm to avoid any potential bias from these daily opening/closing market phases. This comprehensive dataset capturing the entire order book allows for in depth examination of the information content of ULOs compared to different order placement types (i.e. DLOs and MOs). Furthermore we analyse information content of broker identifier subsequent to the move to an anonymous market by the ASX. The method for examining the informational content of ULOs stems from the methodology described by Allen et al. (2007).

The Allen et al. (2007) methodology examines the information content of ULOs based on various order aggressiveness categories. Instead of examining trades, order placement is considered to be more informative. Empirical studies such as Biais, Hilton and Spatt (1995), Pascual and Veredas (2003) and Ranaldo (2004) all consider order flow as informative at various levels of aggressive trading strategies. Coppejeans and Domowitz (2002) show that trades in the order book have different information content when compared to submitted orders and highlight the information content behind order cancellations. Walsh (1997) provides empirical evidence that suggest order flow data is more informative in terms of information content that trades on the ASX. Furthermore studies such as Harris and Panchapagesan (2005) and Kaniel and Liu (2006) also suggest the order book contributes to price discovery. Price submission reaction is likely to differ for various order types at various levels of aggressiveness; hence we examine orders based on their level of aggressiveness and order type. Three explicit types of order aggressiveness are examined in this paper;

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[6] We also have order number in the dataset, thus allowing us to identify how the order lives in the order book. This is important as we filter out multiple matches with the same order number.

1) Aggressive Limit Order (ALO) – orders submitted at or better than the best price on the same side of the book, but less than the best price on the opposite side;
2) Less Aggressive Limit Order (LALO) – orders submitted behind the best price, but within two ticks of the best price on the same side of the book;
3) Aggressive Limit Order Cancellation (ALOC) – orders cancelled while positioned at the best price of the order book.

This paper matches a submitted ULO to a 'similar' DLO and MO, where the only defining difference between the successful match is how they are submitted to the order book. A successful match of a DLO or MO must be 1) within 10 percent of dollar volume to the submitted ULO, 2) submitted within 30 days of the ULO but the matching order can not be within 10 minutes of the submitted ULO, 3) be in the same direction of the ULO i.e. the same side of the order book, 4) order is submitted in the same position of the order book as the ULO, 5) the order is within two ticks of the bid ask spread of the ULO and 6) the matching order is the same order category i.e. the matching order is either submitted (i.e. ALO, LALO) or deleted (i.e. ALOC) and is matched with the same order category as the ULO.[7] Additionally, we extend Allen et al. (2007) methodology by matching on stock code (i.e. the matching order DLO or MO is the same stock as the ULO) keeping the information content between orders firm specific. Finally, we match by event period, that is, the successful matched order is submitted in the same event period (*Pre* or *Post*) of the removal of broker identifiers. Any ULOs that does not satisfy all of the above criteria is deleted from the dataset.

For an additional test, we examine short term informativeness of ULOs around broker anonymity. We accumulate all short term returns for each period (i.e. *Pre* and *Post*) and test whether there are return difference solely within ULOs. We dont apply a matching procedure for this methodology as we do not need to control for difference in order type as each order type examined are all ULO.

Short term returns are calculated at 1, 2, 5, and 10 minutes intervals by capturing the price movement on the opposite side of the order book of the submitted order. The use of the opposite side quotes avoids the problem of capturing an increased supply of liquidity of new limit orders improving the original quote. This improvement does not necessarily reflect any new order information in the order book (Aiken et al. (2001)).

For buy orders the short term order return is:
$$\text{Return}_{buy} = \ln (\text{Prevailing Ask Price}_t / \text{Prevailing Ask Price}_0); \text{ and}$$

for sell orders the short term order return is:
$$\text{Return}_{sell} = \ln (\text{Prevailing Bid Price}_t / \text{Prevailing Bid Price}_0);$$

where $t = 1, 2, 5,$ and 10 minutes, captures the short term price impact from order submission. For market orders, the same side quote is used to calculate the short term return i.e. for a buy order the log of the prevailing bid price after 1, 2, 5 and 10

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[7] This matching criteria originates from Aiken et al (2001) in an attempt to measure the information content of ULOs compared to DLOs.

minutes are captured and divided by the log of the prevailing bid price from when the order was initially submitted (likewise for market sell orders ask prices are applied). Finally, the day close return calculated by the log of the closing price divided by the log of the midpoint of the prevailing bid and ask price at which the order was initially submitted.

Refining the matched orders dataset, any returns greater than 10% within the first 10 minutes are removed from the matched dataset. It is likely that any returns greater than 10% are subsequent to a specific firm announcement or unwarranted trading activity and improbably linked with the submission of the ULO. Also, we remove orders that have a current stock prevailing bid price below $1.50.[8] After filtering, this comprehensive dataset allows for the comparison between different levels of aggressiveness in order submission within the matched dataset.

3.1 Hypothesis Development

In an order driven market, like the ASX it is essential that limit orders are submitted to provide liquidity to the market. However, liquidity suppliers/demanders are faced with various types of exposure risk when submitting limit orders at their desired price and quantity. Informed trader covering their trading intention and large patient traders are the likely groups of market participants that use ULOs as their preferred order strategy taking advantage of hidden nature of the order type (Allen *et al.* (2007)). However, the submission of ULO is not what is hidden in the order book, but rather the order quantity is hidden.[9] We firstly hypothesised that the submission of a ULO contains additional information in terms of the short term price movement when compared to a matched DLO and MO. The question asked, does the use of ULO type suggest to the market the presence of informed traders or private information not captured in the current prices? We examine the additional information content behind the use of a hidden order, in particular whether the hidden component of this order type adds valuable information and uncertainty in the short horizon while keeping the level of pre-trade transparency constant. Therefore it is firstly hypothesised that:

> H_1: The difference between the mean price reaction between the ULO to either matching DLO or MO is significantly different from zero in the short term (first 10 minutes) when keeping the level pre-trade transparency constant (either transparent or opaque market).

We also test a directional hypothesis (i.e. buys and sells) on the possible information content within each order aggressiveness category.

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[8] There was no explicit reason why the prevailing bid price is used as a reference. Removing the matching stocks with prevailing bids below $1.50 removes only 3 percent of all matching orders from the dataset. Stocks belonging to prevailing bid price below $1.50 are majority illiquid stocks in the ASX, which exhibits strong deviations in returns in the short horizon. Also, we removed stocks with prevailing bid prices below $2.00; the results are similar to that of stocks with prevailing bid prices less that $1.50.

[9] The flagging of the symbol "/u" in the order book, highlights firstly the presence of a ULO order and secondly signals a limit order with a dollar volume of at least $200,000.

The removal of broker identifiers from trading screens has frequently been witnessed across a number of exchanges worldwide (for example, in Euronext Paris - April 23, 2001, Euronext Brussels - May 21, 2001 and Tokyo Stock Exchange - June 30, 2003). The question arises in this study whether the movement by the ASX to a less transparent market (i.e. a more opaque market) causes any changes in the information content between the matched orders in the short horizon.

Prior to broker anonymity traders could identify submission of orders of broker/s (specifically, the detail of who the broker is representing); this in turn gave other market participants an educated guess about whether it was likely to be informed. Since the abolition of broker identification from trading screens, the question arises whether the information content of hidden orders changes when the market can not infer which brokers are taking the positions. We do witness sufficient ULO trading in post anonymity, but why would a broker submit an ULO in the post anonymity period when the market can not infer who the broker is acting for. A number of possible reasons for the submission of ULO is 1) hide their private information they might possess; 2) concealing the total order value; 3) concealing their broker identity in the order book; and 4) is cost efficient / preferred order strategy. The reason could be a combination of the above, nonetheless we analyse whether a decrease in pre-trade transparency affects the short term price reaction between ULO and matching DLO and MO. Essentially, we examine the value of broker identifiers on the matched dataset, and the informativeness of the order book by concealing order size around anonymity. We hypothesised that:

> H_2: The difference between the mean price reaction between the ULO to matching DLO or MO is significantly different from 0, across quote direction and across the market reform of broker anonymity.

The use and availability of hidden orders are important for exchanges as they provide investors with the accessibility of taking large positions to trade without disclosing their entire order volume to the market. The removal of broker identifiers from trading screen invites us to examine whether the short term price reaction of a ULO differs subsequent to anonymity within the same order type. In the former case where each ULO has broker identifier attached allows us to exactly value broker identifiers placed on hidden orders on the ASX. It is finally hypothesised that:

> H_3: The difference between the mean price reaction between the ULO prior to the removal of broker identifiers to a ULO submitted after the removal of broker identifiers is significantly different from 0.

4. Results

Table 1 reports the number of matches that result from the matching criteria described in Section 3. Separate figures are reported for the pre-event period *Pre*, post-event period *Post,* across both trade directions of the submitted order i.e. buy/sell and across the different type of order type i.e. ALO, LALO and ALOC.[10] Table 2 presents summary statistics for the all orders that have matching orders across the entire

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[10] For Market Orders the only order type is ALO.

dataset.[11] In total, there are 5170 matched orders between ULOs and DLOs and MOs in the dataset. The results across volume, bid-ask spread, proportional bid-ask spread and daily average volume are comparable within the matched sample providing us an excellent framework.

INSERT TABLE 1
INSERT TABLE 2

Table 3 and Table 4 examine the difference in returns from placing a ULO compared to a 'similar' order disclosed in the order book.[12] The difference in returns captures the additional information content that the market perceives from submission of ULO. The purpose of introducing any kind of hidden order type for an exchange is to (i) protect large limit order traders from various risk exposure, (ii) to promote greater liquidity for the exchange and (iii) to reduce execution costs of trading. In particular, we examine how much more if any, information is contained in submitting a ULO than other disclosed order placement strategies.

Table 3 provides the results of the mean difference percentage returns for buy directed orders for the matched sample. Firstly, for the ALO type the result indicate strong statistical disparity between both matched orders (i.e. ULOs and DLOs). The positive mean return differences indicate on average a greater movement in the ask price after submission of a ULO compared to a DLO in the short term. We find that this significant difference is consistent *pre* and *post* of anonymity and also find over the long horizon (i.e. day close) return differences experience a price reversal. Initially, it is evident that aggressively placed buy ULO shows greater ask quote movement than similar DLO irrespective of whether broker identifiers are disclosed. This possibly signals to the market, either the presence of informed traders or a new information event not reflected in current price after the submission of ULO in the short interim. For the other order aggressiveness types (i.e. LALO, ALOC and MO) no significance returns differences can be attributed. The results for sell directed orders shown in Table 4 portrays identical results to that of the buy directed orders. The significant difference in returns is witnessed within the ALO type across both event periods. The significance negative values indicate there is greater decrease on average in the bid price after submission of a ULO compared to a DLO. Neither LALO, ALOC and MO show any evidence of returns difference for submitted sell orders.

INSERT TABLE 3
INSERT TABLE 4

The second hypothesis examines whether the change in pre-trade transparency has any effect on the short term information content between ULOs to DLOs and MOs. Table 5 presents results for buy directed orders across all order aggressive types. For the ALO order type, no conclusive evidence is revealed through a reduction in pre-

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[11] By matching orders we refer to matched order between ULO and DLO and between ULO and MO.

[12] Differences in firm size effect are negligible in this study. 75.9% of orders fall under the category of the top 20 actively traded ULO in the dataset. Anand and Weaver (2004) suggested that hidden limit orders occur in the most active stocks where the chance of non-execution is small. Since, the top 20 ULO stocks dominate the dataset which consequently are highly liquid stocks on the ASX, differences in firm capitalisation are not imperative.

trade transparency even though differences in returns are witnessed from hypothesis 1. The result of identifying the value of broker identifiers in conjunction with the hidden order type across the remaining order types is also insignificant. That is, the difference between the information content of ULOs compared to DLOs prior to, and after, the removal of broker identifiers is negligible. For instance, the change in mean return difference for aggressive matched orders at the 1-minute interval is -0.004%, at 2 minutes 0.011%, at 5 minutes -0.017% and 0.009% at the 10 minute interval. The only significance in returns (at the 10% significance level) is seen for market orders at the 5 and 10 minute interval. This result provides inconclusive evidence that the change in pre-trade transparency has influenced the short term return of the information content of marketable limit orders. Table 6 shows the result for sell directed orders portraying the link between transparency and information content for matched ULOs and DLOs/MOs. Similarly with buys orders, the sells orders results indicate no further changes in short term information content subsequent to order submission from the removal of broker identifiers. We initially suggest, that broker identifiers are irreverent on large dollar volume orders even though if the order quantity is hidden. It suggests that the market perceive that the same agents are trading these orders, thus the information content of broker identifiers are negligible around anonymity. Another possible explanation for this result could simply stem from the disclosure of the '/u' symbol in the order book, being more informative than the disclosure of broker identification. Hence, we find removing broker identifier does not add any additional information to the submission of ULOs when compared to the same order but submitted through a different placement strategy (i.e. DLOs or MOs).

INSERT TABLE 5
INSERT TABLE 6

The final hypothesis tests whether the same information content is attributable within hidden orders surrounding anonymity. Table 7 (Table 8) illustrate the results for buy (sell) directed orders across the various order aggressive types. We find no significance differences in returns with hidden orders across all order aggressiveness type. This result shows the value of broker identifiers is nonexistent and does not adds additional information on ULOs type. It is put forward that the market anticipants again; that the same agents are trading these hidden orders type in the market thus broker identifiers are irrelevant. For sells order (Table 8), the results are also inconclusive for all order aggressiveness types for the short term horizon. It is therefore concluded likewise, with buys, the evidence of broker anonymity revealing any additional information content within ULOs is nonexistent on the ASX. This result re-assures the main finding from hypothesis 1, that is that aggressively priced ULO indicates higher returns than similar DLO. That is only for the ALO type the significance is confined to the order placement type and that broker identifiers have no additional value for these orders.

INSERT TABLE 7
INSERT TABLE 8

5. Conclusion

This paper examines the information content of ULOs on the ASX, as well as assessing the removal of broker identifiers from trading and its effects on the information content between matched orders. The ASX hidden order type differs from the most common internationally recognised order type (i.e. iceberg orders), in that the order itself does not lose time priority, the undisclosed portion of the order executes before the disclosed portion and is symbolised in the order book by the letter "/u". The results from this paper demonstrate three key findings. First, the submission of an aggressive ULO leads to a greater price movement in the opposite quote comparable to a 'similar' DLO when keeping the level of pre-trade market transparency constant. Second, the removal of broker identification has no conclusive effect on the level of information content between the matched orders. This result is consistent across both order direction and across each order type. Third, no evidence is also shown that broker identifiers contain additional information within hidden orders for the first 10 minutes after order submission. An important implication of these findings is that after a reduction in pre-trade transparency for the ASX neither positively nor negatively affected the market anticipation of large sized orders even if the order quantity is hidden in the order book. It is evident that ULO type contains information that are placed at the top of the order book but value of broker identifier on these orders large dollar volume are negligible. Therefore, the double protection from exposure risk from the submission of HLO is confined to only the concealment of order quantity as we find the value of brokers identifiers is valueless, thus highlighting the informativeness of hidden orders in the ASX order book.

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TABLE 1
Number of Matches

This table reports the total number of matches that resulted between ULOs and DLOs and ULOs and MOs. Figures are reported for 6 months prior to the event date (*Pre*) and 6 months subsequent to the event date (*Post*) of anonymity across each order direction and order aggressive type.

Order Aggressive Type	Event Period	Order Direction	Number of Matches
DLO - ALO	PRE	SELL	848
		BUY	877
	POST	SELL	794
		BUY	939
DLO - LALO	PRE	SELL	134
		BUY	163
	POST	SELL	208
		BUY	234
DLO - ALOC	PRE	SELL	28
		BUY	38
	POST	SELL	46
		BUY	56
MO	PRE	SELL	219
		BUY	199
	POST	SELL	195
		BUY	192

TABLE 2
Summary Statistics for all Matched Orders

This table reports the summary statistics for all the orders that have been matched with ULOs. The matched order criteria is reported in section 3 of this paper. The summary statistics captures dollar volume correct to the nearest dollar, bid ask spread correct to 3 decimal place, proportional bid ask spread correct to 3 decimal place and daily volume correct to the nearest dollar across a number of a statistic measures which include mean, standard deviation, minimum and maximum for each order type, respectively.

	Mean	Standard Deviation	Minimum	Maximum	Number of Obs.
Panel A: Average Volume ('000) (per order)					
ULO	822	1028	200	12030	5170
DLO	902	1155	200	11700	4365
MO	423	369	200	4052	805
Panel B: Bid Ask Spread					
ULO	0.0135	0.0097	0.0010	0.1400	5170
DLO	0.0130	0.0096	0.0010	0.1500	4365
MO	0.0125	0.0072	0.0050	0.1000	805
Panel C: Proportional Bid Ask Spread					
ULO	0.0017	0.0022	0.0001	0.0488	5170
DLO	0.0017	0.0023	0.0001	0.0465	4365
MO	0.0012	0.0011	0.0001	0.0105	805
Panel D: Daily Average Volume ('000) (per day)					
ULO	777	314	249	2433	251 days
DLO	851	356	285	2182	251 days
MO	394	295	201	3090	221 days

TABLE 3
Buy Orders: Mean Difference Percentage Returns

This table summarizes the results across all order types (i.e. ALO, LALO, ALOC, MO) the mean return differences for the matched sample between ULOs to DLOs for buy directed orders. The *T-tests* examines the difference in the means for each matched order between ULO and DLO/MO is equal zero while keeping the level of transparency constant. Values in parentheses are t-values for the null hypothesis that the difference in mean is zero are correct to 2 decimal places. All returns differences are expressed as percentages and are correct to 3 decimal places. ***, ** and * denote statistical significance at the 1%, 5% and 10% significance level, respectively.

Buy Orders	Order Type	Time Interval				
		1 min	2 min	5 min	10 min	Day Close
$(ULOs - DLOs)_{PRE}$	*ALO*	**0.027**	**0.038**	**0.024**	**0.034**	-0.024
		(2.92*)**	**(3.78***)**	**(1.97**)**	**(2.34**)**	(-0.60)
	LALO	0.023	0.022	0.034	**0.065**	0.136
		(1.39)	(1.54)	(1.25)	**(2.10**)**	(1.45)
	ALOC	-0.018	-0.022	0.021	0.000	0.114
		(-0.37)	(-0.41)	(0.60)	(0.00)	(0.73)
$(ULOs - MOs)_{PRE}$	MO	0.017	0.022	-0.039	-0.032	0.042
		(1.36)	(1.35)	(-1.10)	(-1.46)	(0.54)
$(ULOs - DLOs)_{POST}$	*ALO*	**0.031**	**0.027**	**0.041**	**0.024**	**-0.112**
		(4.42*)**	**(3.31***)**	**(4.15***)**	**(2.07**)**	**(-2.49**)**
	LALO	0.001	-0.006	-0.008	0.002	0.071
		(0.11)	(-0.49)	(-0.53)	(0.08)	(0.83)
	ALOC	0.015	0.050	-0.008	0.057	0.256
		(0.36)	(0.95)	(-0.19)	(0.76)	(1.17)
$(ULOs - MOs)_{POST}$	MO	0.007	-0.003	0.034	0.034	-0.136
		(0.54)	(-0.25)	(1.58)	(1.49)	(-1.22)

TABLE 4
Sell Orders: Mean Difference Percentage Returns

This table summarizes the results across all order types (i.e. ALO, LALO, ALOC, MO) the mean return differences for the matched sample between ULOs to DLOs for sell directed orders. The *T-tests* examines the difference in the means for each matched order between ULO and DLO/MO is equal zero while keeping the level of transparency constant. Values in parentheses are t-values for the null hypothesis that the difference in mean is zero are correct to 2 decimal places. All returns differences are expressed as percentages and are correct to 3 decimal places. ***, ** and * denote statistical significance at the 1%, 5% and 10% significance level, respectively.

Sell Orders	Order Type	Time Interval				
		1 min	2 min	5 min	10 min	Day Close
$(ULOs - DLOs)_{PRE}$	*ALO*	**-0.023**	**-0.019**	**-0.033**	**-0.058**	**-0.083**
		(-3.40***)	**(-2.14**)**	**(-2.67***)**	**(-3.74***)**	**(-1.97**)**
	LALO	-0.009	-0.009	-0.004	-0.009	0.131
		(-1.11)	(-0.81)	(-0.25)	(-0.44)	(1.11)
	ALOC	0.003	-0.020	-0.030	-0.081	-0.052
		(0.05)	(-0.38)	(-0.41)	(-0.61)	(-0.25)
$(ULOs - MOs)_{PRE}$	MO	-0.010	-0.014	-0.022	-0.028	-0.104
		(-1.58)	(-1.58)	(-1.57)	(-1.60)	(-1.39)
$(ULOs - DLOs)_{POST}$	*ALO*	**-0.027**	**-0.036**	**-0.043**	**-0.029**	-0.030
		(-3.83***)	**(-4.51***)**	**(-4.40***)**	**(-2.16**)**	(-0.71)
	LALO	-0.009	-0.004	0.000	0.025	0.024
		(-0.70)	(-0.31)	(0.01)	(0.96)	(0.29)
	ALOC	0.010	0.032	-0.002	0.039	0.191
		(0.21)	(0.54)	(-0.04)	(0.67)	(1.38)
$(ULOs - MOs)_{POST}$	MO	-0.014	-0.019	-0.017	-0.021	-0.117
		(-1.22)	(-1.31)	(-0.94)	(-0.79)	(-1.10)

TABLE 5
Buys Mean Difference Percentage Returns: Pre and Post of Event Date

This table summarizes the results of buys mean price reaction for ULOs and corresponding matched DLOs/MO around the event date of the removal of broker identifiers. The difference in returns between the matched orders around *Pre* and *Post* removal of broker identifier is examined for each order aggressive type. *T-tests* examines whether the difference in the means for the matched sample between ULO and DLO between both event period (*Pre* and *Post*) is equal zero. Values in parentheses are t-values for the null hypothesis that the difference in mean is zero are correct to 2 decimal places. All returns differences are expressed as percentages and are correct to 3 decimal places. ***, ** and * denote statistical significance at the 1%, 5% and 10% significance level, respectively.

Buy Orders	Time Interval				
	1 min	2 min	5 min	10 min	Day Close
Panel A: Aggressive limit order cancellation					
$(ULOs - DLOs)_{PRE} - (ULOs - DLOs)_{POST}$	-0.033	-0.072	0.030	-0.057	-0.142
t-statistic	(-0.18)	(-0.70)	(1.17)	(-0.24)	(-0.48)
Panel B: Aggressive limit orders					
$(ULOs - DLOs)_{PRE} - (ULOs - DLOs)_{POST}$	-0.004	0.011	-0.017	0.009	0.088
t-statistic	(-0.36)	(0.83)	(-1.08)	(0.50)	(1.47)
Panel C: Less Aggressive limit Orders					
$(ULOs - DLOs)_{PRE} - (ULOs - DLOs)_{POST}$	0.022	0.029	0.042	0.063	0.065
t-statistic	(1.24)	(1.36)	(1.49)	(1.52)	(0.63)
Panel D: Market Orders					
$(ULOs - MOs)_{PRE} - (ULOs - MOs)_{POST}$	0.009	0.025	**-0.073**	**-0.066**	0.178
t-statistic	(0.50)	(1.24)	**(-1.83*)**	**(-1.95*)**	(1.30)

TABLE 6
Sells Mean Difference Percentage Returns: Pre and Post of Event Date

This table summarizes the results of sells mean price reaction for ULOs and corresponding matched DLOs/MOs around the event date of the removal of broker identifiers. The difference in returns between the matched orders around *Pre* and *Post* removal of broker identifier is examined for each order aggressive type. *T-tests* examines whether the difference in the means for the matched sample between ULO and DLO between both event period (*Pre* and *Post*) is equal zero. Values in parentheses are t-values for the null hypothesis that the difference in mean is zero are correct to 2 decimal places. All returns differences are expressed as percentages and are correct to 3 decimal places. ***, ** and * denote statistical significance of difference across order types at the 1%, 5% and 10% significance level, respectively.

Sell Orders	Time Interval				
	1 min	2 min	5 min	10 min	Day Close
Panel A: Aggressive limit order cancellation					
$(\text{ULOs} - \text{DLOs})_{\text{PRE}}$ - $(\text{ULOs} - \text{DLOs})_{\text{POST}}$	-0.007	-0.052	-0.028	-0.120	-0.243
t-statistic	(-0.26)	(-0.86)	(-0.74)	(-0.68)	(-1.01)
Panel B: Aggressive limit orders					
$(\text{ULOs} - \text{DLOs})_{\text{PRE}}$ - $(\text{ULOs} - \text{DLOs})_{\text{POST}}$	0.004	0.017	0.010	-0.029	-0.053
t-statistic	(0.39)	(1.43)	(0.64)	(-1.42)	(-0.88)
Panel C: Less Aggressive limit Orders					
$(\text{ULOs} - \text{DLOs})_{\text{PRE}}$ - $(\text{ULOs} - \text{DLOs})_{\text{POST}}$	-0.001	-0.004	-0.004	-0.035	0.107
t-statistic	(-0.15)	(-0.09)	(-0.18)	(-0.94)	(0.67)
Panel D: Market Orders					
$(\text{ULOs} - \text{MOs})_{\text{PRE}}$ - $(\text{ULOs} - \text{MOs})_{\text{POST}}$	0.004	0.005	-0.006	-0.008	0.012
t-statistic	(0.28)	(0.31)	(-0.31)	(-0.46)	(0.09)

TABLE 7
Buys Mean Difference Percentage Returns: Hidden Orders

This table summarizes the results of buys mean return difference for ULOs. The difference in returns between matched ULOs around *Pre* and *Post* removal of broker identifier is examined for each order aggressive type. *T-tests* examines whether the difference in the means for each matched ULO across both event period (*Pre* and *Post*) is equal zero. Values in parentheses are t-values for the null hypothesis that the difference in mean is zero are correct to 2 decimal places. All returns differences are expressed as percentages and are correct to 3 decimal places. ***, ** and * denote statistical significance at the 1%, 5% and 10% significance level, respectively.

Buy Orders	Time Interval				
	1 min	2 min	5 min	10 min	Day Close
Panel A: Aggressive limit order cancellation					
ULOs $_{PRE}$ - ULOs $_{POST}$	-0.005	-0.015	-0.034	-0.002	-0.017
t-statistic	(-0.22)	(-0.66)	(-1.35)	(-0.06)	(-0.15)
Panel B: Aggressive limit orders					
ULOs $_{PRE}$ - ULOs $_{POST}$	-0.001	0.002	-0.016	0.011	-0.017
t-statistic	(-0.05)	(0.24)	(-1.39)	(0.55)	(-0.39)
Panel C: Less Aggressive limit Orders					
ULOs $_{PRE}$ - ULOs $_{POST}$	0.003	0.021	0.019	0.014	0.040
t-statistic	(0.34)	(1.60)	(1.40)	(0.62)	(0.61)

TABLE 8
Sells Mean Difference Percentage Returns: Hidden Orders

This table summarizes the results of sells mean return difference for ULOs. The difference in returns between matched ULOs around *Pre* and *Post* removal of broker identifier is examined for each order aggressive type. *T-tests* examines whether the difference in the means for each matched ULO across both event period (*Pre* and *Post*) is equal zero. Values in parentheses are t-values for the null hypothesis that the difference in mean is zero are correct to 2 decimal places. All returns differences are expressed as percentages and are correct to 3 decimal places. ***, ** and * denote statistical significance at the 1%, 5% and 10% significance level, respectively.

Sell Orders	Time Interval				
	1 min	2 min	5 min	10 min	Day Close
Panel A: Aggressive limit order cancellation					
ULOs $_{PRE}$ - ULOs $_{POST}$	0.032	0.034	0.017	0.046	0.127
t-statistic	(1.54)	(1.30)	(0.60)	(1.35)	(1.42)
Panel B: Aggressive limit orders					
ULOs $_{PRE}$ - ULOs $_{POST}$	0.015	0.006	0.015	0.002	0.067
t-statistic	(1.51)	(1.19)	(1.26)	(0.12)	(1.51)
Panel C: Less Aggressive limit Orders					
ULOs $_{PRE}$ - ULOs $_{POST}$	0.017	0.010	0.011	-0.005	0.078
t-statistic	(1.40)	(0.54)	(0.55)	(-0.26)	(1.01)