The Impact of Naked Short-sales on Returns, Volatility and Liquidity: Evidence from the Australian Securities Exchange

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Abstract

This paper examines the impact of *naked* short-sales on returns, volatility and liquidity in a unique market setting where *naked* short-sales are restricted to certain securities on an approved list, which is revised over time. Results indicate that allowing *naked* short-sales is not consistent with Miller's (1977) overvaluation theory. *Naked* short-sales do not lead to more efficient prices and lead to an increase in the volatility of stock returns. We also provide evidence that *naked* short-sales deteriorate liquidity via wider bid-ask spreads, decreased order-depth and reduced trading volumes. These results are consistent with the concern of policy makers who have recently moved toward curbing *naked* short-sales.

Keywords: Australian Securities Exchange, Market microstructure, Short-sales constraints, *Naked* short-sales

JEL classification: G10, G14

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1. Introduction

On July 9, 2008, the Securities and Exchange Commission (SEC) announced an emergency order to immediately curb *naked* short-sales on nineteen financial firms.[1] The move aims to stop unlawful stock price manipulation through *naked* short-sales, which have been held responsible for the struggling performances of financial firms including large mortgage lenders, Fannie Mae and Freddie Mac.[2] The actions of the SEC suggest that there is substantial concern among market participants over the use of *naked* short-sales. However, while markets in the United States are moving towards banning *naked* short-sales, there is little or no evidence regarding the impact of *naked* short-sales on equity markets. Evidence regarding the impact of *naked* short-sales would be of great value to market regulators and participants given the recent short-sales bans imposed around the world.[3] Previous empirical studies examine changes to either covered short-sales (see Chang, Chang and Yu, 2007), or changes to short-sale constraints that effect both *naked* and covered short-sales (see Boehme, Danielsen and Sorescu, 2006).

In this paper, we bridge this gap in the literature by directly examining the impact of *naked* short-sales on returns, volatility and liquidity. This opportunity is provided by a unique regulatory feature on the Australian Securities Exchange (ASX) which allows *naked* short-sales for certain securities on an approved short-sale list (hereafter, referred to

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1 The emergency order took effect on July 21, 2008 and ended August 12, 2008. On September 22, 2008 the SEC extended this regulation to all forms of short-sales on a list of 799 financial stocks. A further 190 stocks were added to this list before the ban ended on October 9, 2008.

2 A *naked* short-sale is where the participant, either proprietary or on behalf of a client, enters an order in the market and do not have in place arrangements for delivery of the securities. The other form of a short-sale, covered short-sale differs in that arrangements are in place, at the time of sale, for delivery of the securities.

3 Widespread changes to short selling regulation around the world have lead to a tightening of short-sale constraints in: Australia which banned all forms of short selling on all stocks; Taiwan which tightened restrictions on short selling of its largest stocks; The Netherlands, where regulators banned *naked* short selling for financial stocks; United States where the SEC banned all forms of short selling on financial stocks; United Kingdom where the FSA banned all forms of short selling on financial stocks; Germany where market regulators imposed a ban on short-selling of shares in 11 financial-sector companies; and Canada where regulators banned short selling on financial stocks.

as ‘the list’), that is revised over time.[4] The addition of a security to ‘the list’ represents a shift from covered to *naked* short-sales, thus allowing an isolation of the impact of allowing *naked* short-sales. This shift to *naked* short-sales circumvents a significant cost associated with covered short-sales- the fee charged by the stock lender.[5] In addition to the direct cost, there are several risks associated with covered short-sales, including the risk that the short position will be involuntarily closed due a to recall of the stock loan. Together, the cost and risk represents a short-sale constraint which is removed when *naked* short-sales are permitted.

Differences between the behaviour of *naked* and covered short sellers may lead to the impact of allowing *naked* short-sales on returns and volatility to differ from that of covered short-sales. *Naked* short-sales are often associated with market manipulation, to the extent that *naked* short-sellers may engage in the downward manipulation of stock prices; we may expect an increase in stock return volatility. However, the shorter term strategy of *naked* short-sales compared to covered short-sales may result in changes to volatility at the intraday level, rather than daily. Subsequently, while previous studies examine the impact of short-sales constraints on volatility using daily measures (see Ho, 1996 and Chang et al., 2007); we examine *both* daily and intraday volatility. Volatility measured over shorter periods, such as 15-min intervals and trade-based, contain less fundamental news and are more reflective of transitory price changes due to market structure differences or order imbalances (Bennett and Wei, 2006).

The current literature on short-sale constraints focus on the effect of such restrictions on asset prices and return volatility. As far as we are aware, there has been little or no

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4 Securities are added or removed from the list based on market capitalisation, shares issued and liquidity. See Section 3 for further details.

5 The Australian Securities Lending Association Limited estimate that these costs can range between 25 and 400 basis points, representing a significant barrier to covered short-sales.

documented empirical or theoretical work on how short-sale constraints affect liquidity.[6] *Naked* short-sale constraints may affect the mix of passive and active strategies of short sellers which could in turn affect liquidity measures such as bid-ask spreads and order-depth. Therefore, we bridge a gap in the literature by not only providing the first evidence of the impact of *naked* short-sales on returns and volatility, but also by examining the impact of short-sales constraints on liquidity.

The remainder of this study is organised as follows. Section 2 reviews the literature on short-sales constraints. Section 3 describes the institutional details for short-sales on the ASX and the data sample selection. Section 4 reports the empirical analysis of the impact of *naked* short-sales on returns, liquidity and volatility. Section 5 provides a summary of our main results and conclusions.

2. Literature review

The empirical literature on short-sales emanates from the seminal work of Miller (1977) and focuses on how short-sales constraints affect stock prices and returns. In Miller's (1977) model, short-sale constrained securities become overpriced because pessimists are restricted from acting on their beliefs, and therefore, value is determined by the most optimistic investors. Diamond and Verrecchia (1987) model the effects of short-sale constraints and speed of adjustment, to private information, of prices. An important implication of the model is short-sales constraints may not bias prices upwards if investors are rational. Rather, the model predicts short-sale constraints will reduce the speed of adjustment to negative information, which is consistent with subsequent empirical work (see Isaka, 2007).

Consistent with Miller (1977), empirical evidence, which rely on proxies of short-sale constraints, uniformly indicates that relaxing short-sales constraints leads to

[6] Diether, Lee and Werner (2009), examine the impact of short-sale price tests on market quality.

overvaluation.[7] Chang et al. (2007), offer the only direct examination (without the need for a proxy) of the relationship between *covered* short-sale constraints and stock price overvaluation on the Hong Kong Stock Exchange (HKEx). Consistent with Miller (1977), significant negative cumulative abnormal returns are reported after stocks are added to the list of designated securities for short-sales. In this paper, we add to the existing literature by examining whether relaxing *naked* short-sale constraints is consistent with Miller's (1977) theory.

An implication of these studies is that short sellers move prices towards fundamental values. Diamond and Verrecchia (1987) point out that since short sellers do not have the use of sale proceeds, market participant's never short for liquidity reasons, which would imply relatively few uninformed short sellers, all else equal. Consistently, empirical studies document that heavily shorted stocks under-perform, suggesting short sellers are informed (see Aitken, Frino, McCorry and Swan, 1998, Diether, Lee, and Werner, 2008 and Boehmer, Jones and Zhang, 2008).

The relationship between short-sales and stock return volatility is a contentious issue that has received limited academic attention. Scheinkman and Xiong (2003) develop a behavioural model with heterogeneous investors who show overconfidence to their private information. Contrary to the common belief that short-sales constraints de-stabilise the market, Scheinkman and Xiong (2003) predict a significant decrease in trading volume and price volatility when short-sales constraints are lifted. This is consistent with Diether, Lee, and Werner (2008), who document that short sellers tend to be contrarian traders which should have a stabilising effect on the market. Empirically, Ho (1996) documents the daily volatility of stock returns is increased when short-sales constraints are imposed.

[7] Examples of proxies include Figlewski (1981) and Senchack and Starks (1990) who use changes in short interest, Chen, Hong and Stein (2002) employ declines in breadth of ownership, Danielsen and Sorescu (2001) utilise option introductions, Ofek and Richardson (2003) use stock option lockups, Jones and Lamont (2002) employ the cost of short selling and Haruvy and Noussair (2006) use experimental markets.

However, more recently and using a different measure of short-sales constraints, Chang et al. (2007) find the volatility of stock returns increases when short-sales constraints are lifted.[8] Diether, Lee and Werner (2009) examine the effects of a temporary suspension of short-sales price-tests in the United States. Consistently, they document relaxing short-sales constraints leads to higher intraday volatility while daily volatility is unaffected. In this paper, we examine the relationship between *naked* short-sales and return volatility using daily, intraday and trade-by-trade based volatility measures.

Evidence regarding short-sales constraints and liquidity is area that has yet to be explored. Diether, Lee and Werner (2009) is the only exception and document that short-sale constraints have a limited effect on market liquidity. While short-sale activity increased, Diether, Lee and Werner (2009) find that the restriction results in only slightly wider spreads. In this paper, we examine the impact of changes in short-sale constraints on liquidity. In doing so, we provide the first evidence regarding the impact of *naked* short-sales and add to the existing literature on short-sales constraints.

<Insert Table 1>

3. Institutional settings and Data

Short-sales in Australia are governed by both Section 1020b of the Corporations Act 2001 and Section 19 of the ASX Market Rules. Section 19.3 of the market rules restricts *naked* short-sales to a group of securities listed on the approved short-sale products ('the list'). [9] The requirements for a stock to be included in 'the list' are:

(i) Greater than 50 million shares on issue;

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[8] Ho (1996) utilises an event where the Stock Exchange of Singapore suspended trading for three days from December 2, 1985 to December 4, 1985. When trading was resumed on December 5, 1985, contracts could only be done on an immediate delivery basis (i.e., delivery and settlement within 24 hours) which implies that short selling was severely restricted. Chang et al. (2007) analyse events where stocks are added to an approved short-sale list on the HKEx.

[9] On September 22, 2008, the ASX imposed a ban on all forms of short selling. The list is therefore no longer reported.

(ii) Market capitalisation exceeding $100 million; and

(iii) Possess "sufficient liquidity".[10]

Historical versions of 'the list' are obtained from the ASX to compile a sample of 317 additions over the period January 1, 2000 to December 31, 2007.[11] The final sample of 317 excludes events where, either return and/or turnover data are not available for at least 180-trading-days in the pre- and post-event periods, or there was a reversal of the short-sale constraint in the post-event period. The Reuters intra-day data used are provided by the Securities Industry Research Centre of Asia Pacific (SIRCA). The original data consist of trade level variables for all stocks listed on the ASX from January 1, 2000 to September 28, 2008. Each transaction is matched with its corresponding liquidity-related variables such as prevailing bid-ask quotes and quoted depth

<Insert Table 1>

Although we focus on the effect of short-sales constraints, it is well known that a short position can be replicated using derivates such as options or more recently, contracts for difference (CFD).[12] Even though it is debatable as to whether derivatives reduce short-sale constraints in an economically meaningful way,[13] it is important to note that stocks in our sample may have exchange traded options (ETO's) listed. However, only a small portion of our sample will have ETO's or CFD's listed over them. On the Australian Options Market (AOM), at any point in time there are only around 70 stocks that have options

[10] The ASX considers 7.5% volume based liquidity in the preceding three months as "sufficient liquidity" for the purposes of the rules. ASX may also form the opinion that a lower of higher level of volume based liquidity is sufficient in particular circumstances. The ASX may also form the opinion that prior to a new listing that sufficient liquidity will be available.

[11] Prior to September 22, 2008, the ASX reported 'the list' on its website daily containing all securities approved for *naked* short-sales. The approved list comprised 444 securities as at December 31, 2007.

[12] Figlewski and Webb (1993) find that constrained investors will buy puts and write calls as a substitute for short selling.

[13] Mayhew and Mihov (2005) is part of an emerging wave of studies which document options do not reduce short-sale constraints in an economically meaningful way. Other studies include: Mayhew and Mihov (2004), Ofek, Richardson, and Whitelaw (2004), Lakonishok, Lee, and Poteshman (2004), Brunnermeier and Nagel (2004), Lamont and Stein (2004), Battalio and Schultz (2006), Danielsen, Van Ness, and Warr (2007) and Bris et al. (2007).

listed over them. Further, the effect of options being listed over sample stocks should only be to minimise the impact of changes to 'the list' and may reduce the magnitude of our results.

4. Empirical analysis

Table 1, reports the 317 events which are clustered around 32 event dates each with a varying number of stocks. The spread of 32 event dates (clusters) over our sample period minimises potential confounding effects of other concurrent events. To further minimise this possibility and to ensure each cluster is weighted equally, we take the cross-sectional average of all events in each cluster and examine the cross-sectional average for each cluster.

4.1 Impact on Stock Returns

Miller's (1977) overvaluation theory suggests that when short-sale constraints are removed (a stock is added to 'the list'), any overvaluation should be reversed (e.g. negative abnormal returns). If restricting *naked* short-sales is a short-sale constraint, then lifting *naked* short-sale constraints should be associated with negative abnormal returns. To test this conjecture, we investigate cumulative abnormal returns (CARs) around the effective date for additions to 'the list'. Effective dates are used as they represent the actual removal or addition of short-sale constraints.[14]

Cumulative abnormal returns (CARs) are calculated using the market-adjusted model and the market model, defined as:

$$CAR_i^a(t_1,t_2) = \sum_{t=t1}^{t2} (R_{it} - R_{Mt}), \quad (1)$$

$$CAR_i^m(t_1,t_2) = \sum_{t=t1}^{t2} \left[R_{it} - \left(\hat{\alpha}_i + \hat{\beta}_i R_{Mt} \right) \right], \quad (2)$$

[14] Effective dates are also used by Danielson and Sorescu (2001) and Chang et al. (2007).

where R_{it} is stock i's return on day t, and R_{Mt} is the return on the S&P/ASX All Ordinaries index[15] on date t. The coefficients $\hat{\alpha}_i$ and $\hat{\beta}_i$ are estimates of the intercept and slope coefficients in the OLS market model when stock i's daily return, R_{it}, is regressed on the daily market return, R_{Mt}, in a 220-day estimation window beginning 60 trading days before the event day 0 (-280, -61). [16]

Following Chang et al. 2007, significance testing of the CARs is conducted using a bootstrap procedure. This method is preferred over the usual event study *t*-tests as the stocks added to 'the list' tend to be of similar market capitalisation and liquidity. Thus the returns could have a common component that would not be taken into account under either the market model or the market-adjusted model. These conditions may induce cross-sectional correlations among the CARs of individual stocks. To ensure that our significance tests are not influenced by these potential misspecifications, we perform bootstrap tests with actual security returns data to generate the empirical distribution for various CARs under the null hypothesis specific to our model. These empirical distributions are used to gauge the significance (to obtain the empirical p-values) of the respective CARs. The procedure is as follows:

1. Identify number of clusters and number of stocks in each cluster.
2. Assign each cluster a random event date during sample period January 1, 2000 to September 28, 2008.
3. On this date, form "pool" of eligible stocks (size and turnover).[17]

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15 S&P/ASX All Ordinaries index represents the 500 largest companies in the Australian equities market.

16 Brown and Warner (1985) find that the market model and market-adjusted model perform well under a number of circumstances and perform better than more complex methods.

17 Specifically, we use the largest and smallest size percentiles and the highest and lowest annual turnover of the actual firms in the cluster as the upper and lower bounds and then include all the listed stocks whose size and annual turnover at that time fall between the bounds in the pool. Chang et al. (2007) highlight that because the chosen stocks for each cluster share a common event date, and because they are similar in terms of size and turnover to the stocks in the actual cluster, the abnormal returns, if any, of the chosen stocks would preserve the cross-sectional correlation as it exists in the actual cluster.

4. Randomly select from pool the exact number of stocks in cluster.
5. Combine clusters together to form a simulated sample.
6. Calculate CARs for simulated sample.
7. Repeat for 1000 samples, to generate empirical approximation of distribution of CARs.
8. Generate one-tailed empirical p-value values by calculating the percentage of CARs observed in the empirical distribution based on 1,000 runs that is less than the average CAR values observed for the actual sample.

Table 2 reports CARs calculated using the market-adjusted and market-model around events dates (the effective date is denoted day 0) for 10, 30 and 60 trading days before and after each event. The direction of the results varies greatly between the market-adjusted and market-model. For the market-model, across all pre- and post-event windows, the CARs are negative but highly insignificant. For the market-adjusted model, across pre- and post-event windows, the CARs vary in sign but are all highly insignificant. The negative but insignificant CARs observed when *naked* short-sales are allowed using the market-model occurs because stocks added to 'the list' have most likely experienced strong positive returns which ultimately lead to their addition to 'the list'. Therefore, the estimation window (-280, -61) for the market-model may lead to misleading CARs in the post-event period due to the positive intercept term in the market-model caused by the strong positive returns in the estimation window. The simulation method controls for common component in treatment stocks (stocks added to 'the list') that is not controlled for by the market return.

These results suggest that removing *naked* short-sales constraints is not consistent with Miller's (1977) overvaluation theory. *Naked* short-sales do not appear to conform with the idea that short-sales add to the pricing efficiency of stock prices. This may suggest covered short-sales are sufficient to keep price in line with fundamental value and allowing *naked*-short-sales does not add to the efficiency of prices.

4.2 Impact on Volatility and Liquidity

To test for significant changes in volatility and liquidity we first select 90-trading days prior (subsequent) to the addition of a stock to 'the list' as the pre-event period (post-event period).[18] The decision to include in 'the list' stocks that are relatively large and actively traded reflects the ASX's attempt to avoid the claimed adverse influence of *naked*-short-sales on smaller and less liquid stocks. This arises due to stocks being added to 'the list' based on size and liquidity. It must be acknowledged that this decision may result in a certain degree of endogeneity in our analysis as the addition of stock may result from past performance. To address this concern and to control for market-wide changes in trading activity and liquidity we construct a market capitalisation and dollar volume matched sample of control stocks that are not on 'the list'.[19] It must be noted care must be taken when interpreting the results of our analysis as the control sample consists of stocks that are smaller and less liquid than the treatment sample.

To test whether measures changed significantly for treatment stocks relative to control stocks, we firstly compute the difference between the Pre and Post averages for each variable (labelled Diff) in both the treatment and control sample. We then take the difference of the difference between the treatment and control sample (labelled Diff-Diff). Statistical significance of the differences is conducted using the Wilcoxon rank sum test.

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[18] This study is also conducted using 60-trading days and 120-trading days as the pre- (and post) period interval. The results are qualitatively similar and available upon request.

[19] The control sample is constructed by firstly creating a pool of stocks which are not on 'the list'. From this pool we select a control stock for each treatment stock on the same date by requiring the market capitalisation of the control stock to be within 10% of the treatment stock and then finding the stock which minimises the difference between the trading value ($) of the treatment and control stock on the last trading day before the event. Previous studies that match based on size and trading activity include Mayhew, Sarin and Shastri (1995) and Bennet and Wei (2006).

To control for other possible confounding factors we conduct regression analysis. Ordinary Least Squares (OLS) is used to estimate the parameters of the cross-sectional pooled regressions specified as follows:

$$Liquidity_i = \beta_o + \beta_1 Volume_i + \beta_2 Volatility_i + \beta_3 Period_i + \beta_4 Group_i + \beta_5 Shortable_i + \varepsilon_i \quad (3)$$

$$Volatility_i = \beta_o + \beta_1 Volume_i + \beta_2 Period_i + \beta_3 Group_i + \beta_4 Shortable_i + \varepsilon_i \quad (4)$$

where *L*iquidity$_i$ or Volatility$_i$ is the cross-sectional average measure of interest in each interval for both the Pre and Post period and for the treatment and control sample. *Shortable$_i$* is a dummy variable equal to one if the stock is eligible for *naked* short-sales, and zero otherwise. *Period$_i$* is a control dummy variable equal to one if the observation lies in the post-event period, and zero in the pre-event period. *Group$_i$* is a control dummy variable equal to one if the observation belongs to the treatment sample, and zero if the control sample. Prior studies document trading volume and return volatility are important variables that affect liquidity.[20] Similarly, trading volume is an important variable that effects return volatility.[21] To control for these factors, *Volume$_i$* is included as a control variable in each regression, while *Volatility$_i$* is included in the regressions on liquidity.

4.2.1 Return Volatility

There are a range of volatility estimators to choose from that are extensively used by finance professionals and academic researchers. To test for the impact of *naked* short-sales on volatility, we use a variety of trade-by-trade, 15-minute interval and daily measures.[22] Daily measures include: (i) Classic;[23] (ii) G-K estimator;[24] and (iii) high-low, computed as

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[20] A previous study that controls for volume and volatility when using liquidity as a dependant variable includes Mayhew, Sarin and Shastri (1995).

[21] A previous study that controls for volume when using volatility as a dependant variable includes Corwin and Lipson (2000).

[22] We calculate returns based on both trade prices and quote mid-points to control for bid-ask bounce. Returns are also computed using open-open and close-close intervals. The results are qualitatively similar and available from the author.

[23] $VOLATILITY_{CLASSICAL,daily} = \left[\ln \left(C_t / C_{t-1} \right) \right]^2$

log of daily high on daily low. Interval (15-minute) measures include: (i) Sum ret^2, calculated as the sum of the squared interval returns; and (ii) high-low, computed as log of interval high on interval low. Trade-by-trade volatility is measured by, Std dev ret, computed as standard deviation of trade to trade returns.

4.2.1.1 Return Volatility-Univariate Results

Table 3 reports Univariate Pre- and Post-event return volatility for both the treatment and control sample. Across all measures, volatility increases for the treatment sample in the Post-event period as represented by the positive values in the treatment Diff column. Over the same period, volatility for control stocks decreases across all measures. Most importantly the difference in difference (Diff-Diff) column, which reports the difference between the 'Diff' for the treatment and control sample, is positive across all measures and significant across all but one measure. These results suggest *naked*-short-sales lead to elevated levels of stock return volatility at both the intraday and daily level.

<Insert table 3>

4.2.1.2 Return Volatility-Multivariate Results

Table 4 reports results of the pooled cross-sectional regressions of various volatility measures against three dummy variables ($Period_i$, $Group_i$ and $Shortable_i$) and a $Volume_i$ control variable. The key variable, $Shortable_i$, captures the marginal impact of allowing *naked* short-sales on stock return volatility. Results are homogenous across all volatility measures with the coefficient, $Shortable_i$ positive and statistically significant at the 5% level. Consistent with univariate analysis, the results imply the impact of *naked* short-sales, after controlling for changes in volume, is to increase the volatility of stock

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[24] G-K estimator was developed by Garman Klass (1980) and is estimated as: $VOLATILITY_{G-K,daily} = 0.511(a-b)^2 - 0.019\left[x(a+b)-2ab\right] - 0.383x^2$

where x = ln (Close/Open), a = ln (High/Open) and b = ln (Low/Open).

returns. These results are robust to various measures of volatility and across daily and intraday periods.

<Insert table 4>

An increase in the volatility of stock returns when *naked* short-sale constraints are removed is consistent with Chang et al. (2007) who find the volatility of daily stock returns increases when *covered* short-sales constraints are removed. Similarly Diether, Lee and Werner (2009) document relaxing short-sales constraints (removal of price-tests) leads to higher intraday volatility while daily volatility is unaffected. It appears relaxing short-sales constraints, regardless of the type of constraint, leads to increased levels of stock return volatility.

4.2.2 Liquidity

To examine the impact on liquidity of the change in *naked* short-sales constraints, four measures are examined. The first is the average relative bid-ask spread, calculated as the quoted bid-ask spread (difference between best-ask and best-bid immediately prior to each trade), divided by the midpoint of the best-bid and best-ask immediately prior to each trade. Relative bid-ask spreads are used as they control for stock price variation both over time and across stocks. Harris (1994) suggests order depth is a vital component of liquidity not captured by bid-ask spreads. Subsequently we compute two measures of limit order order-depth: (i) order-depth (best), computed as the volume at the best-bid and best-ask immediately prior to each trade; and (ii) order-depth (best-five), computed as the volume at the first five price levels on the bid and ask schedule immediately prior to each trade. Our final measure of liquidity, price impact, is calculated by firstly classifying each trade as either buyer- or seller-initiated using the Lee and Ready (1991) algorithm. Price Impact is measured as: [25]

If buyer initiated: $PI_i = ((vwap_i - prev\_mid_i) / prev\_mid_i) * 100$

If seller initiated: $PI_i = \left|((vwap_i - prev\_mid_i) / prev\_mid_i) * 100\right|$

As part of our analysis of liquidity we also examine various daily trading activity measures including: (i) Volume, measured as total volume traded; (ii) Number of trades, measured as total number of trades; and (ii) Turnover Value, measured as the dollar value of traded volume.

4.2.2.1 Liquidity-Univariate Results

Table 5 reports univariate Pre- and Post-event trading activity and liquidity measures for both the treatment and control sample. The impact of *naked* short-sales on trading activity differs across measures which capture varying components of trading activity. Volume is negative and significant when *naked* short-sales are allowed (Diff-Diff, -37.12), Number of trades is positive and significant when *naked* short-sales are allowed (Diff-Diff, 19.33) while Turnover Value is negative but not significant. These results imply trading volume is reduced while trading frequency increases and the overall dollar value of trades does not change.

<Insert table 5>

In Table 5, Diff-Diff for both Relative bid-ask spreads and Price Impact are positive and significant at the 5% level. Order-depth measures are negative but insignificant at the 5% level suggesting order depth is not significantly affected by changes to *naked* short-sales constraints. Together, the univariate results suggest a mixed impact on trading activity while transaction costs (Relative bid-ask spreads and Price

[25] Price Impact is a measure of liquidity that was first developed by Kraus and Stoll (1972).

Impact) appear to be increased when *naked* short-sales are allowed. In order to verify whether these results are robust we must control for factors which may affect trading activity and liquidity.

4.2.2.2 Liquidity-Multivariate Results

Table 6 reports the result of the pooled cross-sectional regressions of various trading activity and liquidity measures. Trading activity measures are regressed against three dummy variables ($Period_i$, $Group_i$ and $Shortable_i$) and a control variable, $Volatility_i$.[26] Consistent with the univariate analysis, after controlling for changes in volatility, the impact of *naked* short-sales on trading activity is mixed. Number of Trades is the only measure to experience a significant change as represented the $Shortable_i$ (31.84) coefficient which is significant at the 1% level. These results suggest allowing *naked* short-sales do not significantly affect trading volume and value, while increasing the frequency of trading. Therefore *naked* short-sales do not appear to hinder liquidity via a reduction of trading. However, while trading activity remains unaffected, do *naked* short-sales impair the liquidity of the market via reduced order-depths and transaction costs?

<Insert table 6>

Liquidity measures are regressed against three dummy variables ($Period_i$, $Group_i$ and $Shortable_i$), and control variables, $Volume_i$ and $Volatility_i$. Consistent with the univariate analysis, *naked* short-sales result in increased transaction costs as measured by the positive coefficient $Shortable_i$ for both Relative bid-ask spreads (0.0004) and Price Impact (0.0193). Importantly, after controlling for market wide changes in liquidity and factors known to affect liquidity (volume and volatility), transaction costs increase both

[26] Volatility in the regressions presented is proxied by the Classic measure. Results are also conducted using alternative volatility measures. The results are qualitatively similar and available from the authors at request.

statistically and economically. For example, the results imply allowing *naked* short-sales leads to a 4-basis point increase in Relative bid-ask spreads. Consistent with this increase in transaction costs, Order-depth, at both the best and best-five price levels, appears to be significantly reduced when *naked* short-sales are allowed. The $Shortable_i$ coefficient is negative and significant the 5% level. Together the results in Table 6, suggest while trading activity remains unaffected, *naked* short-sales impair the liquidity of the market via reduced order-depths and transaction costs.

There are various reasons why *naked* short-sales could impair liquidity. Firstly, if we take the view that *naked* short-sellers like all short-sellers are on average informed traders as suggested by Diamond and Verrecchia (1987) and Boehmer, Jones and Zhang (2008). By allowing *naked* short-sales this will result in an increase in information asymmetry and subsequently lead to an increase in the adverse selection of the spread. Alternatively, if we assume that *naked* short-sellers are not on average informed, but rather they are short-term traders who profit by manipulating stock prices. By allowing *naked* short-sales, this could have a de-stabilising effect on stock prices, as shown by an increase in volatility, which could in turn impair liquidity.

5. Conclusion

In this study, we examine the impact of *naked* short-sales on returns, volatility and liquidity in a unique market setting where *naked* short-sales are restricted to certain securities on an approved list, which is revised over time. Our results firstly indicate that allowing *naked* short-sales is not consistent with Miller's (1977) overvaluation theory. Abnormal returns, as measured by the market-adjusted and market-model, are found to be to be insignificant using a simulation method as used by Chang et al. (2007). *Naked* short-sales do not appear to conform with the idea adding to the pricing efficiency of stock prices. This may suggest covered short-sales are sufficient to keep prices in line with fundamental value and allowing *naked*-short-sales does not add to the efficiency of prices.

We also analyse the impact of *naked* short-sales on return volatility and reveal a systematic increase in the daily and intraday volatility of individual stock returns. These results are consistent the conjectures that *naked* short-sales have a de-stabilising effect on the market. Finally we provide evidence that *naked* short-sales deteriorate liquidity via wider bid-ask spreads, decreased order depth and reduced trading volumes. The reduction in liquidity when *naked* short-sales are allowed is consistent with the notion that short-sellers are likely to be informed traders (Diamond and Verrecchia, 1987) or traders who have a short-term strategy designed to manipulate prices. This trading behaviour leads to a reduced amount of order near the best quotes and subsequently increases bid-ask spreads.

Overall, the results of this study are of interest to policy makers who have recently moved toward curbing *naked* short-sales. It appears these moves are warranted and the evidence suggests *naked* short-sales not only impair liquidity but also do not add to the efficiency of stock prices. Moving from allowing covered short-sales to allowing *naked* short-sales does not provide any marginal benefit at the individual stock level.

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Table 2
Summary Statistics: List Changes and Addition Events

The table reports the occurrence of events in which individual stocks on the Australian stock exchange experienced *naked* short-sales restriction changes. Column 1 reports the dates on which a new version of the list of designated securities for short selling took effect. Column 2 reports the number of addition events that take place each time the list is revised. An addition event is defined as one in which an individual stock is added to the list and therefore can be sold short from the effective date. The last row of the table reports the cumulative number of addition events.

Event (Effective) date	Number of stocks Added
24-Jan-02	1
15-Apr-02	1
16-Sep-02	9
12-Dec-02	3
17-Dec-02	1
06-Oct-03	7
23-Apr-04	2
29-Apr-04	2
19-Aug-04	1
29-Sep-04	1
21-Mar-05	2
22-Jun-05	5
01-Jul-05	1
03-Oct-05	1
23-Nov-05	1
29-Nov-05	1
12-Jan-06	1
12-May-06	1
25-Jul-06	1
23-Aug-06	23
18-May-07	12
21-May-07	40
22-May-07	90
14-Jun-07	1
15-Jun-07	25
13-Jul-07	25
02-Aug-07	18
04-Sep-07	17
02-Oct-07	9
03-Oct-07	2
01-Nov-07	5
04-Dec-07	8
Cumulated:	317

Table 2
Cumulative Abnormal Returns around additions

The table reports cumulative abnormal returns based on the market model and market-adjusted model around additions. An addition event is defined as one in which an individual stock is added to the list and therefore can be sold short from the event day, denoted as day 0. The estimation window of (−280, −31) is used for the market-model. The one-tailed p-value is obtained by calculating the percentage of the mean abnormal returns observed in the bootstrapped empirical distribution based on 1,000 runs that is less than the average CAR values observed for the actual sample. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Market Model			Market-adjusted Model		
Event window	Mean (%)	Median (%)	One- Tailed p-Value	Mean (%)	Median (%)	One- Tailed p-Value
(-60,-1)	-0.3229	-2.1913	0.66	6.5899	3.5019	0.50
(-30,-1)	-0.8349	-0.6217	0.59	2.4002	0.6801	0.47
(-10,-1)	-0.2436	-0.9521	0.58	0.8747	-0.1335	0.49
(0,10)	-0.5481	-0.4211	0.57	0.7974	0.5716	0.47
(0,30)	-2.4566	-1.837	0.56	1.0797	0.9215	0.42
(0,60)	-7.6185	-5.0705	0.47	-0.5919	-0.829	0.34

Table 3
Univariate Statistics-Volatility

The numbers in the Pre and Post columns are the cross-sectional average of each variable for the pre-period (90-trading days prior to event) and for the post-period (90-trading days subsequent to event), respectively. The Diff column reports the difference between the Pre and Post averages for each variable in both the treatment (stocks added to 'the list') and control sample. We then take the difference of the difference between the treatment and control sample (labelled Diff-Diff). Statistical significance of the differences (Diff and Diff-Diff) is conducted using the Wilcoxon rank sum test. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

		Treatment			Control			
Interval	Measure	Pre	Post	Diff	Pre	Post	Diff	Diff-Diff
Daily	Classic	0.0846	0.0967	0.0122	0.1096	0.0977	-0.0120	0.0242***
	G-K	0.0531	0.0690	0.0159	0.0707	0.0570	-0.0138**	0.0297***
	High-low	2.8677	2.9562	0.0885	3.1004	2.9364	-0.1640	0.2525**
15-minute	Sum Return^2	0.0563	0.0577	0.0014	0.0804	0.0680	-0.0124**	0.0137**
	High-low	0.1479	0.1553	0.0074*	0.1705	0.1618	-0.0087*	0.0161**
Trade	Std. Dev. Returns	0.4411	0.4588	0.0178	0.5113	0.4940	-0.0172	0.0350

Table 4
Multivariate Statistics-Volatility

Volatility$_i$ is the cross-sectional average measure of interest in each interval for both the Pre and Post period and for the treatment and control sample. *Shortable$_i$* is a dummy variable equal to one if the stock is eligible for *naked* short-sales, and zero otherwise. *Period$_i$* is a control dummy variable equal to one if the observation lies in the post-event period, and zero in the pre-event period. *Group$_i$* is a control dummy variable equal to one if the observation belongs to the treatment sample, and zero if the control sample.

	Classic	G-K	High-low	Sum Return^2	High-low	Std Dev Return
Intercept	0.1147	0.0687	3.2752	0.0814	0.1642	0.5178
t-stat	*25.15*	*21.36*	*89.92*	*43.37*	*79.22*	*91.08*
Volume	2.142E-09	6.283E-10	-7.802E-09	1.807E-09	5.681E-09	-4.581E-09
t-stat	*4.38*	*1.82*	*-2.00*	*8.98*	*25.58*	*-7.52*
Period	-0.0290	-0.0155	-0.3080	-0.0216	-0.0175	-0.0572
t-stat	*-4.49*	*-3.41*	*-5.98*	*-8.14*	*-5.96*	*-7.11*
Group	-0.0316	-0.0145	-0.3083	-0.0266	-0.0243	-0.0832
t-stat	*-5.08*	*-3.31*	*-6.21*	*-10.39*	*-8.59*	*-10.73*
Shortable	0.0251	0.0175	0.2548	0.0160	0.0178	0.0266
t-stat	*2.79*	*2.77*	*3.55*	*4.32*	*4.35*	*2.37*
Adjusted R2	0.007	0.002	0.007	0.028	0.077	0.028

Table 5
Univariate Statistics-Volume and Liquidity

The numbers in the Pre and Post columns are the cross-sectional average of each variable for the pre-period (90-trading days prior to event) and for the post-period (90-trading days subsequent to event), respectively. The Diff column reports the difference between the Pre and Post averages for each variable in both the treatment (stocks added to 'the list') and control sample. We then take the difference of the difference between the treatment and control sample (labelled Diff-Diff). Statistical significance of the differences (Diff and Diff-Diff) is conducted using the Wilcoxon rank sum test. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

		Treatment			Control			
Measure	Unit	Pre	Post	Diff	Pre	Post	Diff	Diff-Diff
Volume	1,000 Shares	1430.81	1378.49	-52.32	1974.21	1959.01	-15.19***	-37.12**
Number of trades	Shares	190.77	224.18	33.42***	180.08	194.17	14.09	19.33**
Turnover Value	$1,000	3705.84	3988.50	282.67	4052.97	5234.00	1181.03	-898.37
Price Impact	%	0.4124	0.3926	-0.0198	0.4522	0.4040	-0.0483***	0.0285**
Relative Bid-ask spreads	%	0.8178	0.8207	0.0029	0.8839	0.7923	-0.0916***	0.0945**
Order Depth (best)	1,000 Shares	288.54	292.53	3.99	1146.38	1800.23	653.85	-649.86
Order Depth (best five)	1,000 Shares	1484.79	1370.34	-114.45	3354.24	4001.51	647.28	-761.72

Table 6
Multivariate Statistics-Volume and Liquidity

*L*iquidity$_i$ is the cross-sectional average measure of interest in each interval for both the Pre and Post period and for the treatment and control sample. *Shortable$_i$* is a dummy variable equal to one if the stock is eligible for *naked* short-sales, and zero otherwise. *Period$_i$* is a control dummy variable equal to one if the observation lies in the post-event period, and zero in the pre-event period. *Group$_i$* is a control dummy variable equal to one if the observation belongs to the treatment sample, and zero if the control sample.

	Volume	Number of trades	Turnover Value	Price Impact	Relative Bid-ask spreads	Order Depth (best)	Order Depth (best five)
Intercept	1,975.04	189.91	4,369.67	0.42	0.0082	781.89	2,141.56
t-stat	*20.24*	*38.66*	*16.06*	*86.99*	*86.16*	*8.14*	*14.48*
Volume				-4.57E-09	-8.62E-11	0.21	0.67
t-stat				*-9.13*	*-8.73*	*21.54*	*43.81*
Volatility	95,776.77	8,326.85	22,510.51	31.34	0.61	-8,241.29	-44,578.00
t-stat	*4.38*	*7.56*	*0.37*	*29.63*	*-29.36*	*-0.39*	*-1.37*
Period	61.11	14.07	1207.57	-0.04	-0.0007	685.68	538.93
t-stat	*0.45*	*2.04*	*3.17*	*-5.88*	*-5.67*	*5.21*	*2.66*
Group	-579.66	7.22	-478.47	-0.07	-0.0013	-859.85	-1915.08
t-stat	*-4.40*	*1.09*	*-1.30*	*-10.63*	*-10.32*	*-6.78*	*-9.80*
Shortable	-92.07	31.84	-655.10	0.02	0.0004	-689.39	-640.47
t-stat	*-0.48*	*3.32*	*-1.23*	*2.09*	*1.95*	*-3.76*	*-2.27*
Adjusted R2	0.007	0.013	0.002	0.113	0.11	0.07	0.196