How the Australian ban on short selling during the GFC affected market quality and volatility

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ABSTRACT

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Keywords: Short-selling, short selling ban, market quality

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1. INTRODUCTION

Financial economists commonly consider short selling to be a desirable feature of financial markets. The Technical Committee of the International Organisation of Securities Commissions IOSCO (2008) asserts that short selling "assists in providing more efficient price discovery, diminishing market bubbles, improving market liquidity, facilitating hedging and other risk management activities and limiting upward market manipulations" . Academic literature largely concurs with this view and portrays short-sellers in a positive light; they are perceived as sophisticated users of accounting information who aid in the alignment of stock prices with fundamental value Dechow, Hutton, Meulbroek and Sloan (2001).

However, a loss in market confidence prompts most market regulators to blame short selling. On 18 September 2008, the Financial Services Authority (FSA) in the United Kingdom, the Securities and Exchange Commission (SEC) in the United States, and the Ontario Securities Commission (OSC) in Canada surprised markets by implementing a temporary ban on short selling of selected financial stocks to counter the prevalent turmoil in the financial markets. Several other countries including Australia, Germany, Netherlands, France, Switzerland, and Taiwan quickly followed suit, announcing similar policy changes before the opening of the markets on 22 September 2008 see Scannell (2008).

Regulators have made a number of arguments to justify their surprise move. They allege that short selling of bank stocks was the source of enormous selloffs occurring in financial sectors around the globe. The IOCSO (2008) suggest that in the context of a credit crisis, where numerous entities face liquidity challenges but are otherwise solvent, a decrease in their share price induced by short selling may lead to further credit tightening, and potentially bankruptcy, for these. Additionally, the IOCSO argues that short selling can be used as a tool to mislead the market. In line with this view, Christopher Cox, Chairman of the SEC, announced that "the Commission is committed to using every weapon in its arsenal to combat market manipulation that threatens investors and capital markets" see SEC-Press (2008).

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In spite of the justifications of regulators to legitimise the short sale ban, considerable debate has ensued between politicians, private investors, corporate institutions, and the general public regarding the utility and efficacy of the short sale ban and its implementation in various markets around the globe. Questions include: How effective was the ban on short selling? Did the ban have an impact on stock prices? Did the ban impede market efficiency?

Several studies analysing the effects of the 2008 shorting ban have since been conducted in response to this debate, though the majority provide examination into the US or UK markets. Very limited research has been conducted into the effect of the ban on the Australian equity market, despite the fact that Australia provides an interesting ground for research. As the Australian Securities and Investments Commission (ASIC) banned short selling of financial stocks from 22 September 2008 to 25 May 2009, the ban in the Australian equity market operated for a significantly longer period than those implemented in other markets. In addition, it encompassed both the turbulent period experienced in the financial markets at the end of 2008 and the milder period in 2009.

In this study, we explore whether the ban adversely impacted the Australian listed equity market by lowering market efficiency as measured by bid-ask spreads, intraday volatility, and trading activity. We also study the price impact of the shorting ban on ASX-listed financial stocks. Some recent discussions on the 2008 shorting ban have focussed on overall market values, which do appear to have declined.

To isolate the effect of the shorting ban, we compare trading attributes of Australian financial stocks to trading attributes of a control group of Canadian financial stocks. We examine the changes in bid-ask spreads, intraday volatility, and trading activity before, during and after the shorting ban, and compare banned financial stocks to non-banned financial stocks. Fixed-effect panel models demonstrate these effects.

In the next section we explain the process of short selling, followed by background information and a review of the existing literature relevant to this study. Section 3 presents a timeline of events. Section 4 provides details of the data used, including the sample selection criteria,

variable calculations, and summary statistics. Section 5 develops the hypotheses of this paper and describes the methodologies that are employed in order to test these hypotheses, particularly the fixed-effect panel models. Section 6 presents the results and the last section concludes.

2. HISTORY AND LITERATURE REVIEW

"Short selling", by definition, refers to the sale of a financial instrument that the seller does not actually own at the time of the sale. It is usually performed to profit from an expected decline in the price of a financial instrument. Typically, the short-seller will borrow the securities to be sold, and later repurchase identical securities for return to the lender. This is known as "covered short sales". "Naked short selling" is the practice of selling a stock short without first borrowing the shares or ensuring that the shares can be borrowed. Naked short selling is as problematic and generally prohibited. Several countries, including Australia and Canada, had restrictions on naked short selling even before the onset of the financial crisis. Although other financial instruments can be short sold, we concentrate on the shorting of financial stocks.

The process of covered short selling is straightforward. Initially, the short seller enters into an agreement with the lender of the particular stock to borrow shares and return shares of identical type whenever the lender demands. These borrowed shares are sold to another investor and delivered to the clearing agency to satisfy its delivery requirements. As with other transactions, the seller is obligated to deliver the shares on the settlement date. If the short seller were to sell the shares before arranging to borrow them and subsequently fail to acquire the securities from a lender within the required time, s/he "fails to deliver". Consequently, most regulators require covered short selling, that is, that short sellers first find a lender of the securities they intend to sell. Parties are willing to lend securities as they receive an amount of the stock's market value as cash collateral from the short seller on which they can earn a return. However, competition in the stock lending market is substantial and the lender often has to share some of the proceeds with a broker. The money that the lender pays to the broker is known as the rebate and it constitutes a significant part of broker revenue.

The inclusion of brokers in the short selling process may create conflicts of interest given that brokers often hold shares on their clients' behalf. Brokers holding securities on behalf of their clients legally own them, while their clients only hold corresponding interests in their accounts see Grünewald, Wagner and Weber (2009). The effect of this structure is that the broker may be able to lend the shares without explicit consent of the client. The broker lending the shares does not take direct interest in the direction of the security price change. In fact, the broker may even hope for a drop in the share price, since that would increase the likelihood that the short seller can repurchase the stocks. On the other hand, a drop in the price of the security is against the interest of the owner of the shares. This conflict of interest increases as the market falls if more short sellers require the lending services of the broker.

Another potential problem of the short selling process is that the security owners may not realise that they bear credit risk. These security owners, whose brokers act as the security lender, may not know whether – or to whom – their stocks have been lent, yet the owner bears the risk that s/he will not be able to recover securities in the event that the borrower collapses. For example, the investment firm Olivant held a 2.8% equity stake in UBS shares. These shares were held by Lehman Brothers as Olivant's prime broker and share depository. However, when Lehman Brothers filed for bankruptcy in 2008, Olivant was unable to locate its UBS shares and consequently lost its entire equity stake in UBS Grünewald, Wagner and Weber (2009).

2.1 History

The first case of short selling occurred in 1609. Dutch trader Isaac Le Maire, a large shareholder of the Vereenigde Oostindische Compagnie (VOC), decided to sell not only his shares in the company, but more shares than he owned. Stakeholders of the company called Le Maire's action "outrageous," and it eventually led to the first real stock exchange regulation: a ban on short selling. The ban was withdrawn a few years later.

At various times over the last 400 years, short sellers have been blamed for stock market declines, leading market participants to demand restrictions on short selling. Academic research generally argues that short selling is a desirable feature of the market and that short-sellers are the deliverers of bad news rather than the cause. Franklin and Gale (1992) is one of the few

academic studies that argues in favor of short selling bans. Their primary proposition is that short selling may act as a destabilising influence in the economy. Other opponents of short selling, who typically include corporate executives and regulators, also argue that short-sellers can contribute to unwarranted volatility, panics, and excessive stock price declines by acting on false information. A survey conducted by the Opinion Research Corporation on behalf of NYSE Euronext in October 2008 demonstrates this view. A total of 438 chief executive officers (CEOs), chief financial officers (CFOs), and investor relations officials of public companies listed on the major U.S. exchanges, NYSE and Nasdaq, responded to the survey. Almost 60% of all respondents consider short selling to be harmful to their company's stock and to their shareholders, and 75% of the respondents demand that short selling be prohibited in volatile markets. If consideration is limited to the opinions of CEOs, the numbers increase. Among CEOs, 73% consider short selling of stocks to be harmful, and 84% suggest that it should be banned during periods of high volatility NYSE-Press (2008).

The emergency regulations on short selling implemented in 2008 by several regulators around the world led to a renewed interest in the academic world to better understand the effects of short selling constraints, as well as calls for further academic research to be conducted in this field.

2.2 Literature Review

Early theoretical studies on short selling constraints focus on the effect on stock prices. Theoretical models such as Miller (1977) and Harrison and Kreps (1978) suggest that the implication of shorting restrictions is twofold: pessimists are shut out of the market, and optimists do not take into account the absence of pessimists in setting prices. The result is that, in theory, stock prices are overvalued when short selling constraints are in place.

Empirical studies generally support the theoretical view that short selling constraints lead to an obstructed price discovery process. Figlewski (1981) was one of the first test the effect of short sale restrictions on overvaluation by considering the connection between the level of short interest and subsequent stock returns. Chen, Hong, and Stein (2002) find that stocks that experience a decrease in breadth of ownership – indicating limitations on short seller access to

stocks to borrow– tend to have high valuations and consequently underperform those stocks for which breadth increased. Asquith, Pathak, and Ritter (2005) also find that stocks subject to restrictions on short selling underperform significantly. Jones and Lamont (2002) provide a good explanation of the direct costs of short selling, including fees for borrowing stocks, risks that the lender will demand return of the stock at an inopportune time, and legal and institutional constraints. Jones and Lamont's findings suggest that stocks that are expensive to short have high price-earnings ratios and low subsequent returns. Ofek and Richardson (2003) show that employee stock option lock-ups, another barrier to short selling, have a significant adverse effect on subsequent stock returns. Their findings also support the view that stock prices do not incorporate information fully under short selling constraints.[1]

Diamond and Verrecchia (1987) contend that restrictions on short selling affect the incorporation of positive and negative information into the stock price differently. They assert that short sellers, who are unlikely to engage in short selling for liquidity reasons, are likely to be informed. Restrictions on short selling then reduce the speed at which prices adjust to private information. Their study was followed by a range of empirical work that tested and ultimately found support for their predictions [e.g., Asquith and Meulbroek (1995) and Danielsen and Sorescu (2001)]. Biais, Bisiere, and Decamps (1999) find that the Paris Bourse spot market, for which short sale constraints exist, reflects good news significantly faster than bad news. Aitken, Frino, McCorry, and Swan (1998) focus on the Australian Stock Exchange (ASX) where a short sales are revealed as such to the public immediately upon execution. They find that short sales have a greater impact on the share price than ordinary sales and they suggest that short sellers are usually well-informed.

While empirical work usually agrees on the notion that restrictions on short selling influences pricing efficiency, there is mixed evidence on whether short selling stabilises or de-stabilises the market. Building on the model developed by Diamond and Verrecchia (1987), more recent theoretical works see Abreu and Brunnermeier (2003; and Scheinkman and Xiong (2003) propose that short selling restrictions can be a direct cause of, or at least a necessary condition

[1] Other work by Luttmer (1996), Chen and Zhiwu (1995; Chen (2001), Hansen and Jagannathan (1997), Jouini and Kallal (2001), and Duffie, Garleanu, and Pedersen (2002) also examines the effects of market frictions and the resulting mispricing.

for, bubbles and unwarranted volatility. In line with this suggestion, Lamont and Thaler (2003) and Lamont and Stein (2004) show that restrictions on short selling hinder arbitrage, a significant contributor to the year-2000 stock market bubble, contrary to the commonly held view of regulators that short selling constraints can stabilise the market. On the other hand, Franklin and Gale (1992) support the regulators by suggesting that short selling may act as a destabilising influence in the economy. Bernardo and Welch (2002) provide indirect support for this proposition. Their model implies that constraints on short selling deter some market participants from front-running other investors, which should prevent financial crises. In other words, short sales can potentially destabilise an economy. Bris, Goetzmann, and Zhu (2007) suggest that stock prices incorporate negative information faster in countries where short sales are allowed and practiced. Their evidence supports the belief that short sale restrictions are associated with less negative skewness in market returns. However, their evidence also indicates that short selling does not cause a market crash, though it may affect its magnitude.

Most empirical work on market quality portrays short sellers in a positive light. For example, Dechow et al. (2001), Desai, Krishnamurthy, and Venkataraman (2006), and Cohen, Diether, and Malloy (2007) show that short sellers can contribute to improved price discovery, price efficiency, and better risk sharing. They provide evidence that, on average, short sellers appear to be well-informed and to trade based on fundamentals. Boehmer, Jones, and Zhang (2008a) propose that institutional non-program short sellers are most informed. In addition, they find that short sellers provide significant amounts of liquidity to the market. Boulton and Braga-Alves (2009) and Bris (2009) examine the effects of SEC's decision on 15 July 2008 to restrict naked short sales of 19 financial NYSE-listed stocks. Consistent with previous empirical work, their findings suggest that restrictions on short selling negatively affect various measures of liquidity, including bid-ask spreads and trading volume. Daouk and Charoenrook (2005) also find evidence that short sellers add to market quality in non-US markets. They find that index returns are less volatile and markets are more liquid when short selling is allowed. Moreover, they find no evidence that short selling constraints influence the probability of a market crash. They therefore conclude that the ability to sell short is desirable and significantly improves market efficiency.

In contrast, Diether, Werner, and Lee (2009) do not find strong evidence that the ability to sell short adds to market quality. They study the effects of the temporary suspension of short sale price-tests in the US in 2005. Their findings suggest that relaxing short sale restrictions causes intraday volatility to increase while daily volatility is unaffected, and that the impact on market liquidity is insignificant. In one of the few studies to use Australian data, Lecce, Lepone, & Segara (2008) examine various market quality measures in the Australian Stock Exchange (ASX) between 2000 and 2007. Their findings indicate that naked short sales lower market efficiency as measured by volatility, bid-ask spreads, order-depth, and trading volume. Furthermore, they suggest that naked short sales do not lead to more efficient prices.

There are exceptions, but the bulk of the empirical work shows that the ability to sell a stock short improves market quality and pricing efficiency during normal times. However, there are relatively few studies that analyse the effects of short selling constraints on the efficiency of the market during turbulent periods in the economy. Ho (1996) provides evidence from the Singapore stock market that restrictions on short selling have an adverse effect on market quality even during times of a financial crisis. These findings are interesting because many emerging financial markets have relatively harsh constraints on short selling to control speculation and volatility. Ho's findings argue that short selling constraints actually increase volatility. If some investors are not allowed to sell short, their undisclosed negative information will not be incorporated into the price and the short sellers' pessimism will not be manifest. When the market then eventually starts to decline the fall is exacerbated, potentially leading to a crash see Hong and Stein, (2003).

Boehmer, Jones, and Zhang (2009) study the effects of the emergency short sale ban imposed by the SEC on financial stocks in September 2008. Over the 14 trading days when the shorting ban was in place on the NYSE, several market quality measures such as bid-ask spreads, intraday volatility, price impacts, and trade volume were negatively affected by the ban. Gagnon and Witmer (2009) also focus on the 2008 short sale ban in the US. They examine the impact of the shorting ban on pricing efficiency. By analysing stocks that are cross-listed in the US and Canada they find that the difference between the US share price and the Canadian share price increased significantly during the ban period. This is thought to be due to short-sellers being

more preponderant in the US than in Canada at the time. Their study provides evidence that restrictions on short selling cause share prices to be above their equilibrium value as Miller's (1977) price optimism theory suggests. Furthermore, they indicate how crucial the ability to undertake short sales is to arbitrageurs in order to enforce the law of one price across markets. Another study that investigates the price impact of SEC's 2008 emergency shorting ban is Harris, Namvar, and Phillips (2009). Using a factor-analytic model, they indicate that the ban artificially inflates share prices. This resulted in a US$2.3 to US$4.9 billion wealth transfer from buyers to sellers on the US equity markets.

3. TIMELINE OF EVENTS

The recent financial crisis started in the US, but quickly spread to markets across the globe. The turbulence in equity markets led to the implementation of short selling constraints in numerous countries. Though some countries already had restrictions on short selling in place before September 2008, emergency short selling restrictions ranging from impositions of up-tick rules, prohibition of naked short selling, short selling of financial firms, short selling of specially regulated firms, or short selling of all listed firms of varying lengths were imposed by many countries after the crisis began.

Prior to the onset of the financial crisis, naked short selling had already been restricted for some transactions on the ASX as outlined in section 1020B of the Corporations Act. In essence, naked short selling was permitted for a number of securities subject to conditions imposed by the ASX. There were, however, far fewer restrictions on covered short selling Senate Economics Committee, (2008). On Friday, 19 September 2009 the Australian Security and Investments Commission (ASIC) responded to the concerns that the recent global market conditions was coupled with extensive short selling of stocks, particularly financial stocks, by implementing a ban on short selling on all traded stocks. ASIC pronounced that the widespread short selling of stocks may have been causing unnecessary price fluctuations. "These fluctuations if unchecked, threaten the operation of fair and orderly stock markets" [ASIC (2008)]. ASIC announced that the following short selling legislation would be effective from the opening of the market on Monday, 22 September 2008 [ASIC (2008)]. It provided:

a) To ban or not permit naked short selling;

b) To clarify and, in doing so, narrow the permitted class of covered short sales; and
c) To introduce a reporting regime for permitted covered short sales.

Due to almost simultaneous moves by other international regulators including Canada, France, Germany, Switzerland, the UK and the USA, ASIC reassessed its policy over the weekend and made the following changes to its previous rules effective from the opening of the market on Monday, 22 September 2008:

a) Contrary to ASIC's announcement on Friday, covered short sales for all listed stocks will now not be permitted (subject to a limited authorised market-maker exception); and
b) ASIC will reassess and advise the market in 30 days, whether or not it will at that time, or at a later date, reopen covered short sales for non-financial stocks.

On Tuesday, 21 October 2008 ASIC Chairman, Tony D'Aloisio, said "market conditions since the bans were imposed remained difficult" [ASIC (2008)]. Consequently, ASIC decided to keep its shorting ban in place, though other countries such as the US and Canada had already lifted their shorting bans. The ban on short selling of Australian non-financial securities was extended for a further 28 days until 18 November 2008; the ban on Australian financial stocks was extended thrice on 18 November 2008, 21 January 2009 and 5 March 2009.

The 52 financial securities that were prohibited from short selling in Australia include:

a) Those comprising the S&P/ASX 200 Financials (including property funds); and
b) Five other Australian Prudential Regulation Authority (APRA) regulated businesses:
    i) Wesfarmers Ltd;
    ii) The Rock Building Society Ltd;
    iii) Wide Bay Australia Ltd;
    iv) Futuris Corporation Ltd; and
    v) Calliden Group Ltd.

The short selling ban was finally lifted on 25 May 2009, one week before the official end date. Overall, the shorting ban on Australian financial stocks was in place for almost eight months, considerably longer than the ban periods in most other countries.

The Ontario Securities Commission (OSC) announced the introduction of a temporary ban on short selling of a number of financial stocks on Thursday, 18 September 2008. The OSC ban prohibited short selling of securities of 13 financial sector issuers that are listed on the Toronto Stock Exchange (TSX) and are also cross-listed in the US equity market [OSC (2008)]. OSC Chair David Wilson said this move was necessary to "ensure that [the Canadian markets] are not used for purposes of regulatory arbitrage" [OSC, (2008)]. The ban became effective on 19 September 2008.

Unlike the ASX, only a few financial stocks were affected by the Canadian shorting ban. The issuers affected were: Aberdeen Asia-Pacific Income Investment Company Ltd., Bank of Montreal, The Bank of Nova Scotia, Canadian Imperial Bank of Commerce, Fairfax Financial Holdings Limited, Kingsway Financial Services Inc., Manulife Financial Corporation, Royal Bank of Canada, Sun Life Financial Inc., Thomas Weisel Partners Group Inc., Merrill Lynch & Co., Canada Ltd, and The Toronto-Dominion Bank. To be consistent with the Securities Exchange Commission (SEC), the OSC extended the ban on 3 October 2008 until 8 October 2008 [OSC (2008)]. Overall, the ban was in place for 14 trading days. This much shorter duration of the short selling ban provides an ideal control group for our study. The control group consists of selected financial stocks traded on the Toronto Stock Exchange (TSX).

4. SAMPLE SELECTION AND DESCRIPTIVE STATISTICS

4.1 Sample selection

The treatment group of our study consists of Australian financial stocks that were subject to the shorting ban from 22 September 2008 to 25 May 2009. To analyse the changes in market quality and other intraday measures, the sample period extends from 22 January 2008 through 24 July 2009 covering a pre-ban, ban, and post-ban period. The control group consists of Canadian financial stocks listed on the Toronto Stock Exchange (TSX).

The transaction data is from Reuters DataScope Tick History (RDTH). RDTH contains all executed trades which are time-stamped to the nearest hundredth of a second. Since the transaction data does not contain the prevalent bid and ask prices at the time the trades occur, the information is supplemented with Reuters' market depth data which contains bid and ask prices, time-stamped to the nearest hundredth of a second. Each trade is matched with the best bid and ask prices that are prevalent in the market immediately prior the transaction.

Furthermore, daily data on the S&P/TSX Composite Index and S&P/ASX All Ordinaries Index as well as the exchange rate series between the Australian dollar and the Canadian dollar for the entire sample period has been obtained from Reuters RDTH database.

The stocks in the treatment group must fit the following criteria:

a) Be listed on the ASX for the whole sample period;
b) Be affected by the ban on short selling for the entire duration of the ban from 22 September 2008 to 25 May 2009;
c) Have at least one trade and one quote for all trading days over the sample period; and
d) Not have experienced any stock splits during the sample period.

Applying these criteria to the universe of Australian stocks leads to a sample of 45 Australian stocks. We apply a similar set of rules in identifying the TSX listed control group.

To extract the effects of the shorting ban, we employ a matching procedure in conjunction with a fixed-effect panel methodology. It is common belief that financial stocks are affected differently by the financial crisis than non-financial stocks. Unfortunately, all Australian financial firms were subject to the shorting ban in Australia so we were forced to choose non-Australian stocks for the control group.

We chose TSX listed financial stocks as our control stocks for several reasons. Both the ASX and the TSX are fully automated order-driven continuous auction markets based on price-time

priority.[2] Measures of market quality, including transaction costs (the trade weighted relative effective spread), exchange charges and taxes, have been similar for the two exchanges in recent years [Swan and Westerholm (2008)]. The two countries also have similar levels of short interest.[3] And the Standard & Poor's and Moody's the rankings of Canadian financial institutions are similar to the rankings of Australian financial firms. Both countries have a strong financial system with domestic banks solidly within Moody's Aa debt rating band despite the onset of the financial crisis. Most importantly for our purposes, the shorting ban in Canada did not cover all financial stocks listed on the TSX. The ban only prohibited short selling of financial stocks that are cross-listed in the US equity market, in an effort to avoid creating regulatory arbitrage opportunities. Furthermore, the shorting ban was only for a period of 14 trading days, compared to a ban period of over eight months for ASX financials.

We identified a matched sample of 45 Canadian financial stocks following the matching process of Barber and Lyon (1997) and Lyon, Barber and Tsai (1999). Firms are first matched as closely as possible by the Global Industry Classification System (GICS) code. Pairs are then chosen by minimising the difference in market capitalisation between the two firms on 21 January 2008. The tolerance level employed is that used by Aitken, Cook, Harris and McInish (2007). For each company pair the following matching characteristic needs to be satisfied:

$$\left| \frac{\text{Mkt Cap}_{\text{base}} - \text{Mkt Cap}_{\text{control}}}{\frac{\text{Mkt Cap}_{\text{base}} + \text{Mkt Cap}_{\text{control}}}{2}} \right| < 0.75 \qquad (1)$$

where $Mkt\ Cap_{base}$ and $Mkt\ Cap_{control}$ are the market capitalisation (measured in Australian dollars) for the base stock and the control stock, respectively.

The Australian sample and Canadian control pairs, detailed in Table 1, are well matched. The GICS sector, "Financials" for all but one of the pairs, is an exact match for all of the 45 pairs.

[2] Note that the TSX combines the fully automated order driven trading system with market makers, which are assigned to specific stocks.

[3] Justin Wood of the IFSA says that "typically, the amount of short interest is of the order of four or five percent [in Australia]" Wood (2008). Short interest on the TSX has been between four and six percent on average between 1995 and 2000 Ackert and Athanassakos (2005).

The GICS industry is a perfect match for 32 pairs; for the remaining 13 pairs we use a firm from a related GICS industry. All company pairs, with the exception of the one that includes Wesfarmers, meet the size matching condition specified in Equation 1. The closest match for Wesfarmers is TSX-listed SNC - Lavalin Group Inc., with a much smaller market capitalization (A$10 billion vs. A27 billion on 21 January 2008). We retain this pair in the sample on the belief that the benefits of keeping it outweigh the disadvantages of an imperfect match, as defended by Davies and Kim (2009).

Insert Table 1 about here

Seven of the Canadian financial institutions in the sample are subject to the 14-day short sale ban. These stocks enable an analysis of whether there are analogous changes in trading attributes between the affected control stocks and base stocks during this period with this subset of stocks.

4.2 Descriptive Statistics

Table 2 provides summary statistics for the Australian treatment stocks and the Canadian control stocks. For each group, we estimate a time-series average over the entire sample period in order to then calculate a cross-sectional mean. Because we are comparing stocks from different countries, we focus on relative (unit-free) measures such as relative bid-ask spreads and share of market.

Insert Table 2 about here

We matched stocks based on market capitalisation, so those characteristics very similar, but mean share prices are very different, at A$8.37 for Australian stocks compared to A$30.65 for Canadian stocks. This differential explains the large difference in the number of trades between the two groups. Other measures of trading activity, such as dollar turnover and share of market turnover, tend to be similar between the two samples. Average dollar turnover for the Australian stocks in the sample is A$37.588million, 0.77% of total market turnover on the ASX, compared to an average dollar turnover of A$29.285million, representing 0.55% of total TSX market turnover, for Canadian stocks. The Australian stocks in the sample exhibit inferior performance

relative to their Canadian counterparts in market quality as measured by bid-ask spreads and intraday volatility. On average, the Australian stocks exhibit larger spreads and higher intraday volatility than the control Canadian stocks. We hypothesize that this poor performance is at least partially due to the shorting ban. Most measures of trading activity and market quality are positively skewed. Accordingly, we calculate medians as well as means, and we use the logarithm of the mean measures in later parts of this study.

5. HYPOTHESES AND METHODOLOGY

Previous studies have found evidence that restrictions on short selling, measured with various proxies, lead to an overvaluation of stocks. Research also suggests that short selling constraints can have a significant adverse impact on the speed of the price discovery process. However, few studies analyse the effects of an actual ban on short selling on bid-ask spreads and intraday volatility. With our data, we are able to do so. We document the differences in these market quality measures before, during, and after a protracted ban on short selling and compare the outcome to that of a control group of stocks over the same period. We provide rigorous empirical evidence of the impact of the short selling ban by employing a fixed-effect panel model that isolates the effect of the ban.

5.1 Hypotheses

The Reserve Bank of Australia (RBA) indicated that the value of stock loans outstanding was around $60 billion at the end of 2007 RBA, (2008). This value acts as an upper boundary for the amount of short selling, as borrowed stock can be used for purposes other than short selling, but short selling accounts for the predominant part of the equity loans outstanding Senate Economics Committee, (2008). The Investment and Financial Services Association (IFSA) in Australia estimates that short selling averaged approximately 15 percent of trading volume in the years prior the introduction of the shorting ban. The ban did not eliminate all short selling; a limited number of authorised market-makers were allowed to short stocks [ASIC (2008)]. However, the restrictions were significant enough to warrant our first hypothesis:

Hypothesis 1: *The ban on short selling decreases trading activity of short-sale constrained stocks.*

Boehmer, Jones and Zhang (2008a) demonstrate that short sellers focus on high frequency trading and usually maintain their positions only for a relatively short time. Their findings indicate that quantitative hedge funds (including statistical arbitrage hedge funds) are largely responsible for this high frequency shorting activity. These funds often use computerised short-term long-short trading strategies in significant volumes and have been supplying large amounts of liquidity to the market in recent years see Khandani and Lo (2007). As these funds are not exempt from the shorting ban, we expect a sizeable decline in market liquidity. This proposition is also supported by Diamond and Verrecchia's (1987) model which predicts a rise in bid-ask spreads when restrictions on short selling are present in the market – leading to the next hypothesis:

Hypothesis 2: *The shorting ban decreases market liquidity, resulting in an increase in bid-ask spreads.*

Advocates of short selling constraints frequently refer to lower volatility as justification for such constraints. Yet the theoretical models of Abreu and Brunnermeier (2002) and Scheinkman and Xiong (2003) predict that making it more difficult for investors to sell securities short leads to a rise in volatility. Recent empirical work [Boehmer et al (2009)] is consistent with the view that short selling constraints increase intraday volatility. Therefore, our third hypothesis is as follows:

Hypothesis 3: *Implementation of the short selling ban leads to a rise in intraday volatility.*

The findings of most empirical research, including non-US studies, is consistent with the overvaluation effect as hypothesized by Miller (1977). Still, if the market expected the shorting ban to be in place for only a short period, then there may not be a significant change in the stock price. However, we base our last hypothesis on the expectation that, because the shorting ban does prevent pessimistic short sellers from taking a bearish position, share prices will be too high during the ban period:

Hypothesis 4: *The ban on short selling causes stocks to be overvalued.*

5.2 Univariate Analysis

As part of the univariate analysis, we consider a graphical illustration of the changes in trading attributes over the sample period, comparing the base group, 45 Australian stocks, to the 45 matched control stocks which do not face an eight-month shorting ban. We split our sample into four periods:

a) the period before 22 September 2008 called the *pre-ban period*;
b) the period from 22 September 2008 to 8 October 2008 called the *common ban period*;
c) the period from 9 October 2008 to 24 May 2009 called the *ban period*; and
d) the period from 25 May 2008 to 24 July 2009 called the *post-ban period.*

During the *pre-ban period*, none of the stocks in the sample were prohibited from being sold short. For the 13 trading day[4] *common ban period*, the shorting ban was in place in Australia and for seven of the Canadian stocks. The main period of interest is the *ban period* during which only the Australian stocks are subject to a ban on short selling. This period extends over several months and it is here where we will test whether the shorting ban had an adverse impact on the quality of the market. The *post-ban period* refers to the time immediately after the shorting ban in Australia. In addition to exploring the patterns of the variables under investigation, we analyse the differences in the market quality measures between the base group and the control group change over the sample period.

5.3. Multivariate Analysis: Fixed effect panel regression

To formally test the effect on market quality we use a multivariate regression incorporating all of the stocks in the sample. We estimate the following fixed effect panel regression for a variety of dependent variables Y_{it} , including *Trading Activity*, *Bid-Ask Spreads*, and *Intraday Volatility*.

$$Y_{it} = \alpha_i + \sum_{Controls} \beta_{Control} \times Control_{it} \qquad (2)$$
$$+ \beta_1 D_{commonban,\, t} \times D_{bothbanned,\, i} + \beta_2 D_{commonban,\, t} \times (1\text{-}D_{bothbanned,\, i})$$

[4] Friday, 19 September 2008 was excluded from the sample for this methodology due to inconsistency in the starting dates of the shorting ban. In Canada, the ban on short selling became effective on Friday, 19 September 2008 whereas the shorting ban in Australia became effective on Monday, 22 September 2008.

$$+ \beta_3 D_{ban,\,t} + \beta_5 D_{post\text{-}ban,\,t} + \varepsilon_{it}$$

where Y_{it} is measured for stock *i* on day *t*. Y_{it} is the measured quantity *Y* for the Australian base stock less the measured quantity for its matched Canadian counterpart. One can think of it as the market quality differential between the two stocks. The variable α_i in the equation above represents matched pair fixed effects. $Control_{it}$ stands for other control variables. The next section provides a more detailed discussion of these variables. $D_{commonban,t}$ is an indicator variable set to one during the common ban period and to zero otherwise. $D_{bothbanned,i}$ is an indicator variable set to one if the stock pair corresponds to a Canadian control firm subject to the shorting ban in Canada and to zero otherwise. Therefore, $(1\text{-}D_{bothbanned,i})$ refers to pairs where the Canadian firm was never prohibited from short selling even during the common ban period. These pairs are referred to as "not-both-banned" pairs. $D_{commonban,t}$ is interacted with the indicator variables $D_{bothbanned,i}$ and $(1\text{-}D_{bothbanned,i})$ because "both-banned" pairs are expected to behave differently during the common ban period than "not-both-banned" pairs. We might suppose that the dependent variable does not change during the common ban period for "both-banned" pairs for which both stocks are affected by the shorting ban. That is, we expect β_1 in equation (2) to be statistically insignificant and β_2 to be statistically different from zero. The coefficient of $D_{ban,t}$ is the primary variable of interest. It captures whether the market quality differential diverges during the ban period compared to the pre-ban period. $D_{post\text{-}ban,t}$ is an indicator variable set to one during the period after the short sale ban in Australia and to zero otherwise; ε_{it} is the error term of the regression.

In summary, the effect of the shorting ban on a particular quantity *Y* is identified by comparing base stocks to matching control stocks during the pre-ban period versus the common ban period, the ban period, and the post-ban period. This panel regression, a differences-in-differences methodology, examines the change in the market quality differential between the matching stocks over the various time intervals in the sample after controlling for other factors.

We also estimate models with slightly different specifications. For example, in alternate model specifications, we interact all time interval indicator variables. We do so because the difference in behaviour between "both-banned" pairs and "not-both-banned" pairs during the common ban

period may not dissipate immediately due to "sticky" trading. This alternate fixed effect panel regression is specified as follows:[5]

$$
\begin{aligned}
Y_{it} = \alpha_i + \textstyle\sum_{Controls} \beta_{Control} \times Control_{it} \\
(3) \\
+ \beta_1 D_{commonban,\,t} \times D_{bothbanned,\,i} + \beta_2 D_{commonban,\,t} \times (1\text{-}D_{bothbanned,\,i}) \\
+ \beta_3 D_{ban,\,t} \times D_{bothbanned,\,i} + \beta_4 D_{ban,\,t} \times (1\text{-}D_{bothbanned,\,i}) \\
+ \beta_5 D_{post\text{-}ban,\,t} \times D_{bothbanned,\,i} + \beta_6 D_{post\text{-}ban,\,t} \times (1\text{-}D_{bothbanned,\,i}) + \varepsilon_{it}
\end{aligned}
$$

Matched pair fixed effects are part of the control variables. Including these allows for 45 different intercepts, one for each matched pair. These intercepts can be thought of as a set of binary variables that absorb the influences of omitted variables that are different between the matched pairs but are constant over time. In other words, the matched pair fixed effects removes any discrepancy between the paired stocks even during the pre-ban period, or alternatively, the matched pair fixed effects removes the idiosyncratic differences between the two stocks over the sampling period. This approach is closely related to Boehmer, Jones and Zhang (BJZ) (2009).

In addition to pair fixed effects, other control variables are incorporated in some of our panel regression models. These control variables differ slightly depending on the dependent variable. Generally, the additional variables control for differences in:

a) number of transactions;
b) dollar turnover;
c) intraday volatility;
d) bid-ask spread; and
e) stock price.

All control variables are measured in difference terms; i.e., quantity for the Australian firm less the quantity for its matched Canadian counterpart. Consistent with the specifications of

[5] We do not include the indicator variable $D_{bothbanned,i}$ or (1- $D_{bothbanned,i}$)) without interacting it with any other variable in the regressions because it would be overshadowed by the pair fixed effects included in the regressions.

Gajewski and Gresse (2007), who also use fixed effect panel regressions in conjunction with matched pairs in order to examine impacts on market quality, we define the control variables as follows:

- $\Delta\ln(\text{Volume}) = \ln(\text{Volume}_{\text{base stock}}) - \ln(\text{Volume}_{\text{control stock}})$, where *Volume* is the number of trades per day measured in millions
- $\Delta\ln(\text{Dollar Turnover}) = \ln(\text{Dollar Turnover}_{\text{base stock}}) - \ln(\text{Dollar Turnover}_{\text{control stock}})$, where *Dollar Turnover* is measured in millions of Australian dollars;
- $\Delta\text{Volatility} = \text{Volatility}_{\text{base stock}} - \text{Volatility}_{\text{control stock}}$, where *Volatility* is proxied by the range-based high-low volatility;
- $\Delta\text{Bid-Ask Spread} = \text{Bid-Ask Spread}_{\text{base stock}} - \text{Bid-Ask Spread}_{\text{control stock}}$, where *Bid-Ask Spread* is proxied by the volume-weighted relative effective spread;
- $\Delta\ln(\text{Price}) = \ln(\text{Price}_{\text{base stock}}) - \ln(\text{Price}_{\text{control stock}})$, where *Price* denotes the closing price measured in Australian dollars.

We use the natural logarithm of *Volume*, *Dollar Turnover* and *Price* since these variables are always greater than zero and their distributions are considerably skewed to the right. These control variables control for other factors, for example, unexpected company announcements, that affect the dependent variable in addition to the short sale ban. The control variables capture these influences and ensure that these events do not have a potentially misleading effect on the results. We estimate the correlation matrix of the control variables and determine that multicollinearity is not a problem in this methodology.[6]

Ordinary least squares (OLS) estimation assumes that the residual terms from the regression model display constant variance (i.e. homoskedasticity). Tests lead to the conclusion that heteroskedasticity is present in the models, perhaps due to the presence of cross-sectional dependence of regression residuals across firms see Gagnon and Witmer (2009). We therefore use robust standard errors.

[6] Table available from the authors on request

Several studies employ a matched sample setting in order to analyse divergences in market quality measures[7]. Others, including BJZ (2009), Clifton and Snape (2009), and Gagnon and Witmer (2009), specifically analyse the effects of the 2008 shorting ban. However, there are several features that make our study unique. We match stocks from two different countries by GICS sector, GICS industry and market capitalisation. BJZ (2009) and Clifton and Snape (2009) use stocks from different industries as their control stocks while matching on the same exchange. Gagnon and Witmer (2009) consider US and Canadian stocks which are listed on both exchanges, including non-financials in their control group. The inclusion of non-financial stocks, Gagnon and Witmer (2009) state, "may make it more difficult to compare behaviour between the two groups" (p.21). One would expect the originators of the global financial meltdown, i.e. financial firms, to behave differently during this era than non-financial firms. Our study examines the effects of the September 2008 shorting ban on market quality by comparing banned financial firms to non-banned financial firms. Although the stocks come from two different countries, they portray similar characteristics and trading attributes during normal economies. Moreover, the fixed effects regression setting and the analysis of the changes in differences between these groups mitigates the problems of matching stocks across markets.

Our study incorporates a significantly longer sample period (and ban period) than other studies which have focused on the 2008 shorting ban and incorporates a relatively calm period in financial markets as well as the period of the crisis. Others generally investigate stocks in the US or in the UK, where the shorting ban was in effect for 14 trading days or for three and a half months, respectively. The sample period for those studies generally extends over less than six months, covering the period from mid-2008 to the end of 2008. This period encompasses the height of the financial crisis including the collapse of Lehman Brothers in September 2008, Merrill Lynch's hasty sale to the Bank of America and the US Federal Reserve seizure of the global insurance giant American International Group (AIG). The peculiarity of this period may potentially act as caveat to these studies. Assessing causality during these extra-ordinary times can be difficult because it is ambiguous what would have happened if the shorting ban did not occur [see Flatley (2009)]. In contrast, the shorting ban in Australia was in effect for over eight

[7] See, for example, Boulton and Braga-Alves (2009), Gajewski and Gresse (2007), Affeck-Graves et al (1994), Bacidore and Sofianos (2002), Bessembinder (1999; 2003), Jain and Kim (2006), and Venkataraman (2001).

months, including both the turbulent period at the end of 2008 and the calmer, more normal period in 2009. Our results provide evidence on how a shorting ban impacts market efficiency and volatility in the absence of a crisis.

Another unique feature of this study is the calculation of potentially more informative variables. For example, we calculate accurate spread measures using intraday, trade-by-trade data, rather than relying on average daily bid and ask price to calculate bid-ask spreads [e.g. Gagnon and Witmer (2009)]. To analyse the effect of the short sale ban on trading activity, we calculate dollar turnover and share of market turnover. Share of market turnover is a relative measure that has not been used previously for this purpose. Variations in overall market values such as turnover and trade volume are likely to occur during times of global financial turbulence – with or without a ban on short selling. Relative measures tend to be more stable. Thus, using share of total market turnover as a key proxy for trading activity should provide more reliable results.

6. RESULTS

6.1 Univariate Analysis

Table 3 provides descriptive statistics for the different groups of firms for various periods. For each group, a time-series average is estimated over the stated period before computing a cross-sectional mean (Panel A) or median (Panel B). In addition to Table 4, Figures 1 and 2 provide details on trading activity for Australian base stocks and Canadian control stocks before, during, and after the ban.

In Figure 1 it can be seen that, prior to the ban, dollar turnover is on average larger for the Australian stocks than for the Canadian control stocks, A$47million and A$34million, respectively. The correlation coefficient of 0.52 supports our matching procedure.

Turnover of the two groups spikes during the week prior the implementation of the shorting ban but the spike is more pronounced in Canada than in Australia. The high turnover for the sample is consistent with a the Canadian market; total turnover on the TSX market is about twice as high during this time as during the rest of the sample period. The ASX follows a similar pattern. One explanation for this drastic increase in turnover in Canada and in Australia in mid-September

2008 is that there was a lot of market sensitive news and uncertainty amongst investors. Another possible explanation for the rise in turnover of financial stocks is that investors predicted the ban and flooded the market to enter into "last-minute" short positions.

During the ban period, average turnover of Australian financial stocks is A$28million, a decrease of over 40% relative to the pre-ban period. A difference-in-means test between the two periods reveals a t-statistic of 14.16. Average turnover of Canadian control stocks remains relatively constant at A$33million, confirmed by the difference-in-means test. These divergent trends suggest that the shorting ban significantly lowered trading activity of Australian financial stocks.

This conclusion is supported by developments in the post-ban period. When the shorting ban ends on 25 May 2009, turnover of the Australian financial stocks rises sharply and remains significantly higher over the following two months. Average turnover of Australian financial stocks is A$37million during the post-ban period. Average turnover of the Canadian control group, on the other hand, drops slightly to A$28million during this period.

The resultant pattern of the difference in turnover between base stocks and control stocks (i.e. the turnover differential) emphasises the adverse impact of the shorting ban on trading activity. The turnover differential between the two groups is A$13million before the ban, -A$5million during the ban period (when only Australian stocks are prohibited from short selling), and A$9million after the ban. Figure 1 illustrates the changes in turnover differential over the sampling period. Note that in the post-ban period the gap in dollar turnover does not completely revert to its initial level. One possible explanation for this is that trading strategies, especially by hedge funds, are not adjusted instantaneously.

Insert Figure 1 about here

To see if these results are robust, we also analyse the patterns in the share of market turnover. The share of market turnover is a relative measure and is thought to be more stable, especially during times when overall market trading values seem to behave erratically. The patterns in share of market turnover are presented in Figures 2 and 3. During the pre-ban period, turnover of

Australian base stocks represents, on average, 0.82% of total market turnover. Share of market turnover for control stocks is 0.51%, a differential of 0.31% between the two groups.[8] This differential decreases substantially during the ban period to 0.15%. After the ban period, the gap widens again to 0.19%. The control group's share of market turnover remains constant over ban and post-ban periods, the share of market turnover for the base group increases after the ban is lifted. The pattern in share of market turnover, like that of turnover, suggests that the ban on short selling substantially lowered the trading activity in the affected stocks.

Insert Figures 2 and 3 about here

Figure 4 illustrates the behaviour of volume-weighted relative effective bid-ask spreads for the base group and the control group for the time interval around the shorting ban. The time-weighted relative effective bid-ask spread series and the average relative bid-ask spread series exhibit very similar patterns, so we focus mainly on the volume-weighted relative effective bid-ask. Details on the time-weighted relative effective bid-ask spread and average relative bid-ask spread are in Table 3, and Figure 4.

Insert Figure 4 about here

Before the ban, the differential in volume-weighted relative effective spread between the base group and the control group is relatively small in magnitude at about 22 basis points. The spread series of the Australian base stocks and the Canadian control stocks appear to follow a similar pattern during this time, an observation corroborated by the pair-wise correlation coefficient of 0.50.[9]

Figure 6 shows that for both groups, bid-ask spreads begin to increase during early September 2008. There appears to be a break in the pattern of the two series just after the common ban period; i.e. early October 2008. Bid-ask spreads for the Canadian control stocks reach a high on 10 October 2008, the day after the shorting ban in Canada is lifted, and subsequently return to

[8] The pair-wise correlation coefficient of the two series is approximately 0.10 during this period.

[9] Prior to the ban, the pair-wise correlation coefficient between the base group and the control group is 0.60 and 0.49 for the time-weighted relative effective bid-ask spread and average relative bid-ask spread, respectively.

prior, pre-ban levels. Bid-ask spreads for base stocks remain relatively high throughout the ban period. The average volume-weighted relative effective spread for the base stocks is 0.99% during the ban period, more than twice as high as the average spread during the pre-ban period (0.42%). For comparison, the average volume-weighted relative effective spread for the control stocks is 0.32% during the ban period compared to 0.20% over the pre-ban period. The bid-ask spread differential between the two groups fluctuates around a much wider band during the ban period than during the pre-ban period. The difference in volume weighted relative effective spreads is presented in Figure 5. The average spread differential increases from 22 basis points during the pre-ban period to 67 basis points during the ban period, indicating a much larger drop in liquidity for base stocks relative to control stocks. The difference in means test results in a highly significant t-statistic of 15.31.

Insert Figures 5 and 6 about here

In the post-ban period, the spread differential is lower at 61 basis points but remains high. The lack of complete reversal in the spread differential after the ban period could be explained by trading strategies not being immediately adjusted upon termination of the ban. Note also that the pair-wise correlation in the volume-weighted relative effective spread series between the base group and the control group drops substantially from 0.50 before the ban to 0.03 during the ban period, and then rises to 0.08 during the post-ban period.

Insert Figure 6 about here

Figure 7 provides details on intraday volatility for the Australian base stocks and the Canadian control stocks. We concentrate on the range-based high-low intraday volatility measure, but the results for the realised volatility measure are analogous. A key advantage of the range-based volatility measure is that it is robust to the effects of bid-ask bounce [see Bandi and Russell (2006)].

During the pre-ban period, average high-low volatility for base stocks is 4.4%, exceeding the average high-low volatility of 3.1% for control stocks. Although the magnitude of the average volatility is different between the two groups, the two series appear to move in tandem and the

pair-wise correlation coefficient between the two series is a strikingly high 0.89 during the pre-ban.[10]

Insert Figure 7 about here

Volatility for both groups begins to rise in early September 2008, and it continues to increase during the common ban period (i.e. from 22 September 2008 to 8 October 2008). On average, volatility for both groups is almost twice as high during the common ban period as during the pre-ban period. As in the bid-ask spread series, the pattern of the volatility series for the two groups exhibits a break just after the common ban period. Volatility for the Canadian control stocks falls from early October 2008 to early November 2008, almost reaching pre-ban levels. Volatility for the banned Australian financial stocks, on the other hand, stays relatively high throughout the ban period. The volatility differential has increased 1.3% during the pre-ban period to 2.8% during the ban period. This evidence supports the proposition that in the absence of short sellers and under the resulting low levels of liquidity, intraday volatility increases. The developments in the post-ban period strengthen this view. Average volatility for the base group and the control group is 4.6% and 3.1%, respectively, very similar to the numbers in the pre-ban period. A test for the difference in average volatility differentials between the pre-ban and the ban period reveals a statistically significant t-statistic of 2.80. On the other hand, a test for the difference in average volatility differentials between the pre-ban and the post-ban period reveals an insignificant t-statistic of 0.34. Hence, only during the ban period did the volatility differentials diverge significantly.

6.3 Multivariate Analysis

In this section, we discuss the results of the fixed effect panel regressions described in Section 5.3 . These regressions test the impact of the short sale ban on a range of variables such as dollar turnover, share of market turnover, bid-ask spreads, and intraday volatility. Throughout the section we refer to Tables 5, 6, and 7 in which the multivariate regression results are reported.

[10] Pair-wise correlation is lower during the common ban period, the ban period, and the post ban period relative to the pre-ban period but it remains positive and significant. The correlation coefficients are 0.75, 0.82, and 0.56, respectively.

6.3.1 Trading Activity

Table 5 illustrates the effect of the short sale ban on trading activity. Panel A of Table 5 reports the results of the panel regressions when the dependent variable is daily dollar turnover differential. Panel B reports the regression results when the differential in share of market turnover is used as the dependent variable.

In Model (1), we include the three indicator variables *Common Ban*, *Ban*, and *Post-Ban*, which are equal to one if the observation falls into the respective time interval, and to zero on all other days (see Section 5.3.2). The indicator variable *Common Ban* is interacted with the indicator variables *Bothbanned* and *(1-Bothbanned)* to allow for different behaviour between "both-banned" pairs and "not-both-banned" pairs in the common ban period. Recall that for seven pairs in the sample the Australian firm as well as the Canadian counterpart are prohibited from short selling during the reasonably short common ban period. These pairs are referred to as "both-banned" pairs. They are expected to behave differently during the common ban period than the other 38 ("not-both-banned") pairs in the sample. The interaction terms capture this difference.

The variable *Ban*, however, is the variable of interest in the experiment. *Ban* is equal to one if an observation falls into the relatively long Australian ban period from 9 October 2008 to 22 May 2009 and to zero otherwise. Hence, the coefficient of *Ban* measures by how much the dollar turnover differential between the two groups changes from the pre-ban period to the ban period. Under the null hypothesis that the shorting ban has no impact on trading activity, the coefficient would be statistically indistinguishable from zero. In Model (1) of Table 5, the coefficient associated with *Ban* is equal to -15.89, a large value that is statistically significant at the 1% level. The coefficient implies that during the Australian ban period the differential in dollar turnover between base stocks and control stocks decreases by A$15.89million.

Note that the coefficient on *Post-Ban* is -4.81 and is also statistically significant. Even in the post-ban period, the dollar turnover differential is significantly lower than during the pre-ban period, though much less pronounced than during the ban period. It appears that the impact on turnover differentials dissipates in the post-ban period, supporting the idea that the change in the turnover differentials is mainly attributable to the shorting ban rather than to some other factor.

Coefficients β_1 and β_2 are also quite interesting. The coefficient on the interaction term *Common Ban * (1-Bothbanned)*, β_2, is negative and statistically significant at the 1% level, suggesting that, as expected, during the common ban period the turnover differential for "not-both-banned" pairs is lower than during the pre-ban period. The coefficient on *Common Ban * Bothbanned*, β_1, is also statistically significant at the 1% level, indicating that the turnover differential for "both-banned" pairs also decreased during the common ban period. The negative and significant sign of β_1 suggests that stocks subject to the shorting ban in Australia suffered a larger decrease in turnover than stocks subject to the ban in Canada, perhaps because there were more short sellers in the Australian market than in the Canadian one during the pre-ban period.

Model (2) of Table 5 includes interaction terms for all three time indicator variables (i.e. *Common Ban*, *Ban*, and *Post-Ban*) with *Bothbanned* and *(1-Bothbanned)*. The difference in behaviour between "both-banned" and "not-both-banned" pairs during the common ban period may not disperse immediately. Furthermore, the "both-banned" pairs correspond to the largest stocks in the sample. In Model (2), the interaction variables *Ban*Bothbanned* and *Ban*(1-Bothbanned)* are the variables of interest. The coefficients associated with these variables are -56.17 and -8.30, respectively, and both are highly statistically significant, showing that the dollar turnover differential decreases by A$56.17million for "both-banned" pairs and by A$8.30million for "not-both-banned" pairs. The difference in magnitude between the two coefficients can be attributed to the fact that "both-banned" pairs are the largest stocks in the sample and therefore exhibit greater trading activity that the others. After the ban period the dollar turnover differentials, coefficients β_5 and β_6, for are lower than before the ban, but the decrease in turnover differentials in the post-ban period is much smaller than during the ban period. We conclude that the change in the turnover differentials is mainly attributable to the shorting ban rather than to some other factor.

Insert Table 5 about here

In Models (3) and (4) of Table 5, we incorporate two additional control variables, Δ*Volatility* and Δ*Bid-Ask Spread*. The first control variable controls for differences in volatility between the

matching stocks; the second one controls for the potential influence of liquidity shifts. The inclusion of these two control variables is advocated by Lo & Wang (2000), who argue that liquidity shifts and changes in price volatility can have an effect on turnover. They indicate that realised returns frequently generate portfolio rebalancing needs and hence price volatility should be positively related to turnover.[11] The inclusion of these two control variables only marginally changes the magnitudes of the other coefficients in the model. The statistical significance of all variables remains unaffected. In fact, the coefficients on the variables of interest and their respective t-statistics all increase when including the additional control variables in the regression. These results support the hypothesis that the drop in turnover differentials is driven by the shorting ban and that it is independent of changes in other firm-specific factors.

As a robustness test, we use the differential in share of market turnover as the dependent variable in the multivariate regressions (see Panel B of Table 5). The results bolster the conclusions reached earlier.

6.3.2 Bid-Ask Spread

We analyse the impact of the short sale ban on bid-ask spreads in Table 6. Panel A of Table 6 reports the results of the fixed effect panel regressions when the differential in volume-weighted relative effective spread is used as the dependent variable. Panel B provides a robustness test and reports the regression results when the differential in time-weighted relative spread is used as the dependent variable.

In Model (1), a positive and statistically significant coefficient of *Ban*, indicating an increase in bid-ask spreads for banned stocks, signifies a significant decline in market liquidity. The coefficient on *Ban* is 0.0044 with a highly significant t-statistic of 42.72. The coefficient on *Post-Ban* is 0.0040 with a t-statistic of 30.11, suggesting that the increase in the spread differential dissipates in the post-ban period. A natural question is whether some economic variables not included in the matching procedure explain the observed changes in spread differentials. Referring to Gajewski and Gresse (2007), Stoll (2000), and Huang et al (1996),

[11] Our results are consistent with Lo & Wang (2000). The coefficient on Δ*Volatility* is positive and statistically significant in all models suggesting that price volatility is positively related to trading activity.

relevant components of the spread series comprise volatility, trading frequency, turnover, and price. These variables may not fully be controlled for by the matching control stocks.

Therefore, we include ΔVolatility, Δln(Volume), Δln(Dollar Turnover), and Δln(Price) as control variables in Models (3) and (4) of Table 6. Consistent with the theory, volatility coefficients are significantly positive, suggesting that larger volatility differentials are associated with larger spread differentials. The differences in volume and dollar turnover do not significantly impact the spread differentials. Price coefficients are significantly negative, which indicates that the differences in stock price partially explain the differential spreads. Also note that the adjusted R-squared increases considerably when the control variables are incorporated.[12] After controlling for these four factors, the coefficient on *Ban* is 0.0014. It is still economically large and highly statistically significant with a t-statistics of 13.78 [see Model (3)]. Spreads of Australian banned stocks increase more substantially during the ban period than their matched counterparts even after controlling for changes in intraday volatility, trade volume, dollar turnover, and price.

In Model (4), we include the four control variables and also interact all three time indicator variables (i.e. *Common Ban*, *Ban*, and *Post-Ban*) with *Bothbanned* and *(1-Bothbanned)*. This time, the interaction variables *Ban*Bothbanned* and *Ban*(1-Bothbanned)* are the variables of interest in the experiment. The coefficients associated with these variables are equal to 0.0001 and 0.0017, respectively. Both coefficients have the expected sign but only the coefficient on *Ban*(1-Bothbanned)* is statistically significant.

This indicates that during the ban period where only Australian base stocks are subject to the short sale ban, the spread differential for "not-both-banned" pairs increases by 17 basis points relative to the pre-ban period. On the other hand, the spread differential for "both-banned" pairs does not change significantly over this period. From this, one may suggest that the short sale ban did not have a significant impact on the spread differential of these pairs which include the largest Canadian and the largest Australian stocks in the sample. However, the developments in the post-ban period lead to a different conclusion.

[12] Adjusted R-squared increases from 0.45 to 0.58 after including the control variables to Model (1). Adjusted R-squared increases from 0.46 to 0.58 when adding the control variables to the variables in Model (2).

The coefficient on *Post-Ban*Bothbanned* in Model (4) is -0.0010 with a t-statistic of -9.49. This shows that when the short sale ban was lifted in Australia the spread differential of these pairs dropped significantly – indicating that liquidity of the Australian stocks increased much more compared to their Canadian counterparts. Yet again, this provides evidence that the short sale ban had an adverse effect on liquidity of affected stocks which is consistent with the results from Models (1) to (3).

Finally, while the two interaction terms *Common Ban*Bothbanned* and *Common Ban*(1-Bothbanned)* are not the primary variables of interest, it is worth noting that the coefficients on these variables are predominantly insignificant in Models (1) to (4). This suggests that there was no significant change in the spread differential for "both-banned" and "not-both-banned" pairs during the relatively short common ban period compared to the pre-ban period.

To see if the results are robust to the way the bid-ask spreads are calculated, an identical regression analysis is performed using the differential in time-weighted relative effective spread as the dependent variable. The regression results are reported in Panel B of Table 6 and confirm our prior findings.

The magnitude and statistical significance of the coefficients in the models do not change notably. The variables referring to the ban period are still positive and statistically significant. In other words, the spread differentials generally increase in the ban period and drop during the post-ban period in which shorting is allowed again for all stocks in the sample. According to these patterns, the short sale ban seems to have significantly lowered liquidity in affected stocks. The results are robust to the inclusion of the four additional control variables Δ*Volatility*, Δ*ln(Volume)*, Δ*ln(Dollar Turnover)*, and Δ*ln(Price)*.

6.3.3 Volatility

Table 7 illustrates how the short sale ban affected intraday volatility. Panel A of Table 7 reports the results of the panel regressions when the high-low volatility differential is used as the dependent variable. As a robustness test, we run similar panel regressions using the differential in realised volatility as the dependent variable. The results are reported in Panel B of Table 7.

In Model (1), the coefficient on *Ban* is 0.0145 with a highly significant t-statistic of 20.88. This means that the volatility differential between base stocks and matching control stocks is 1.45% higher during the ban period than during the pre-ban period. This jump in the volatility differential is due to base stocks experiencing a much greater increase in volatility during the ban period relative to the control stocks.

The coefficient on *Post-Ban* is notably smaller at 0.0021 with a t-statistic of 2.85. This means that, after the ban period, the volatility differentials almost return to levels which were present before the ban. This provides strong evidence for the notion that the divergence in the volatility differentials can mainly be attributed to the shorting ban.

The developments in the reasonably short common ban period also seem interesting to note here. The coefficient on *Common Ban*(1-Bothbanned)* is -0.0128 which is practically large and statistically significant at the 1% level. This means that the volatility differential for "not-both-banned" pairs is lower in the common ban period relative to the pre-ban period. This implies that volatility increases more for Canadian firms which are not on the Canadian ban list relative to their matched Australian counterparts.

One possible explanation for the spike in volatility of Canadian financial stocks which are not subject to the shorting ban in Canada is that investors wanting to sell Canadian financial stocks short are now forced to move to these non-banned stocks. Investors that used to practice short selling in large Canadian financial stocks (which are cross-listed in the US markets) are not permitted to do so between 22 September 2008 and 8 October 2008, i.e. during the common ban period. These investors are likely to substitute the large banned financial stocks with smaller non-banned financial stocks for their short selling practices. This shift in trading patterns could potentially be the cause for the jump in volatility of non-banned Canadian financial stocks in the common ban period. Another explanation could be the uncertainty of whether these smaller financial stocks are going to be added to the ban list in Canada at a later stage.

Other studies that examine intraday volatility under a fixed-effect panel regression setting often control for trading activity and price [see Eom, Ok and Park (2007)]. We will follow a similar procedure in Models (3) and (4) of Table 7. The control variables included in these fixed-effect panel regressions are Δln(Volume), Δln(Dollar Turnover), and Δln(Price).

The coefficients on the control variables are statistically significant at the 5% level and have the expected signs. An increase in the number of trades in the Australian base stocks relative to their matched control stocks (i.e. an increase in the volume differential) is associated with an increase in the volatility differential. The coefficients on Δ*ln(Dollar Turnover)* have a similar interpretation. Price coefficients are negative and highly significant suggesting that price differentials partially explain the volatility differentials. Again, note that the adjusted R-squared increases noticeably when the control variables are incorporated into the models.

After adding these three control variables to Model (1), the coefficient on *Ban* is 0.0124 with a highly significant t-statistics of 17.49 [see Model (3)]. It shows that, during the ban period, volatility of Australian stocks subject to the ban increase by 1.24% more than their non-banned counterparts even after controlling for differences in trading activity and price.

The coefficient on *Post-Ban* is -0.0057 with a t-statistic of -7.12. This indicates that the volatility differential drops considerably after the short sale ban in Australia is lifted. The volatility differential is even lower in the post-ban period relative to the pre-ban period. Yet again, this provides strong evidence that the short sale ban led to an increase in volatility of affected stocks.

Model (4) differs to Model (3) in that it allows for different behaviour between "both-banned" pairs and "not-both-banned" pairs. The coefficients on *Ban*Bothbanned* and *Ban*(1-Bothbanned)* are 0.0045 and 0.0141, respectively. Both coefficients are positive and highly significant indicating that the volatility differential for both groups of pairs is higher during the ban period compared to the pre-ban period. The coefficients on *Post-Ban*Bothbanned* and *Post-Ban*(1-Bothbanned)*, on the other hand, are significantly lower at -0.0040 and -0.0057, respectively. This implies that the volatility differential for both groups of pairs decreases considerably after the termination of the short sale ban in Australia. This is consistent with the

results from Model (3). Thus, the conclusion that the shorting ban had an adverse affect on volatility remains unchanged – even when distinguishing between larger and smaller firms.

As a robustness check, the 10-minute realised volatility is used as the proxy for price volatility instead of the range-based high-low volatility measure used in the previous section. In other words, an identical regression analysis as in Section 6.3.3(a) is performed, this time using the differential in 10-minute realised volatility as the dependent variable. The regression results are reported in Panel B of Table 7.

The findings are the same as in Section 6.3.3(a). It is understandable that the magnitude of the coefficients changes when the differential in 10-minute realised volatility is used as the dependent variable. Yet, the sign and the statistical significance of the variables of interest do not change noticeably. The coefficients on the variables of interest (i.e. the indicator variables referring to the ban period) are still positive and statistical significant. The indicator variables associated with the post ban period are considerably lower – often even negative and statistically significant. This suggests that the volatility differentials generally increase in the ban period and decrease during the post-ban period in which shorting-selling is permitted again for all stocks in the sample. The finding that the shorting ban had an adverse affect on volatility is robust to model specification and the inclusion of trading activity and price control variables.

Insert Table 6 about here

7. CONCLUSION

We conduct a comprehensive analysis of ASIC's emergency ban on short selling of stocks on the ASX. Unlike in other countries, the ban on financial stocks lasted for over eight months. The focus of this study is on how this relatively long shorting ban on financial stocks affected the quality of the ASX market. We use a matching procedure to compare stocks affected by the ban to otherwise similar stocks that are unaffected.

We explore the patterns of different market quality measures including trading activity, bid-ask spreads, and intraday volatility with a univariate analysis. Differences in these measures between

base stocks and control stocks are examined and compared over the pre-ban, ban, and post-ban period.

We then formally test the impact of the shorting ban with fixed-effect panel regressions. This setting enables us to the control for other firm specific variables that are not directly included in the matching procedure but may explain the observed changes in market quality differentials. We find strong evidence that stocks subject to the short sale ban in Australia suffered a severe degradation in market quality, as measured by trading activity, bid-ask spreads, and intraday volatility. Our findings are robust to a variety of variable and model specifications and tests. Our conclusions are based on a sample which extends over 18 months including an eight-month ban-period. This period covers the turbulent era in the financial markets at the end of 2008 as well as the more ordinary time in 2009. Hence, this study overcomes the criticism that other studies on the 2008 shorting ban often encounter regarding the peculiarity of their ban period.

Even if ASIC achieved its implicit goal of raising stock prices – artificially or not – it is questionable whether the ban was desirable. It appears that the shorting ban in Australia generated much higher costs than benefits. Our findings clearly illustrate that the shorting ban had substantially negative effects on the ASX market, resulting in lower liquidity and larger price volatility.

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Figure 1

Difference in turnover between base stocks and control stocks where the Canadian control stocks have never been banned

This figure shows the average difference in daily turnover measured in Australian dollars between the base group and the control group for each day from 22 January 2008 through 24 July 2009 – using only pairs that correspond to Canadian stocks which have never been banned from short selling. It is measured as turnover for base stocks minus turnover for matching control stocks averaged cross-sectionally for each trading day.

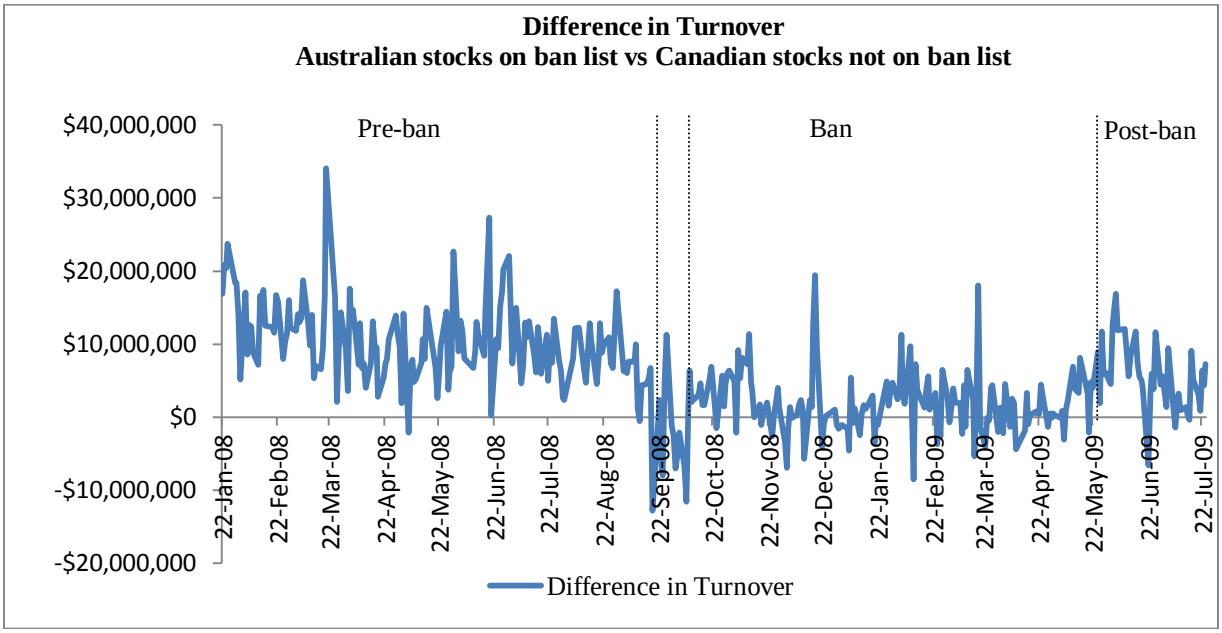

Figure 2

Average Turnover of Australian Base Stocks and Canadian Control Stocks

This figure shows the average daily turnover measured in Australian dollars for the base group and the control group for each day from 22 January 2008 through 24 July 2009.

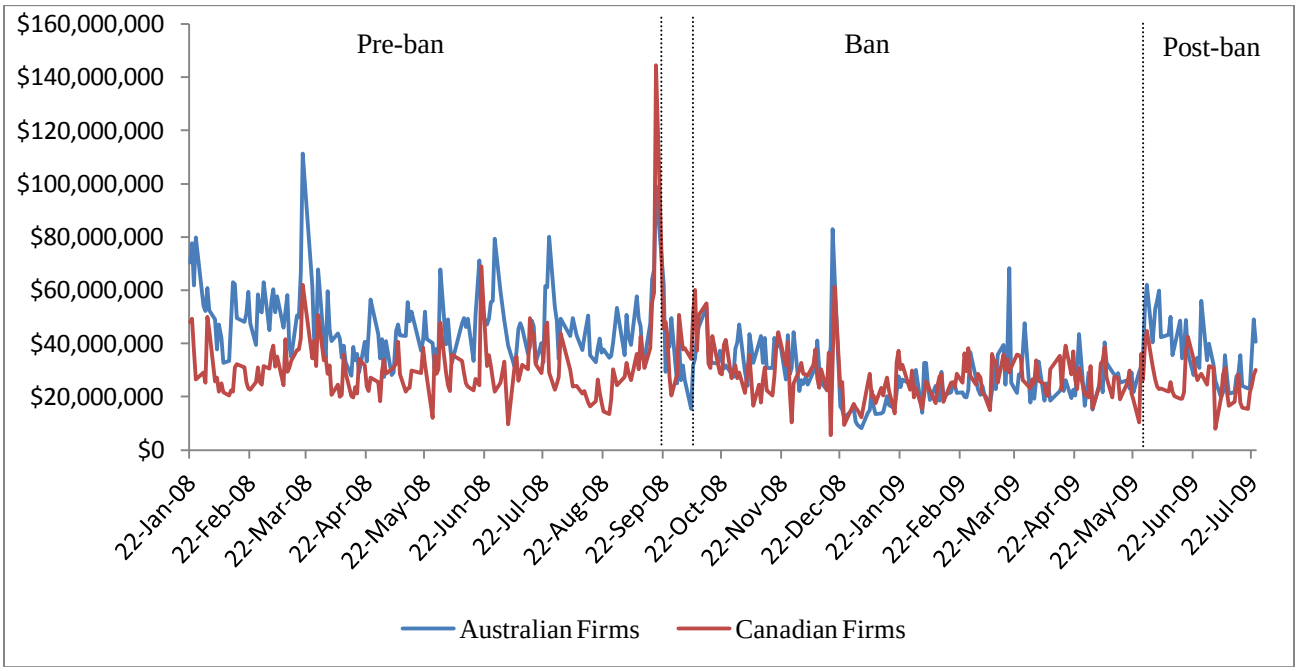

Figure 3

Share of Market Turnover of Australian Base Stocks and Canadian Control Stocks

This figure shows the average daily share of market turnover for each group of stocks from 22 January 2008 to 24 July 2009. It is measured as average turnover for either the base group or the control group on a given trading day divided by total turnover of the respective market on that day.

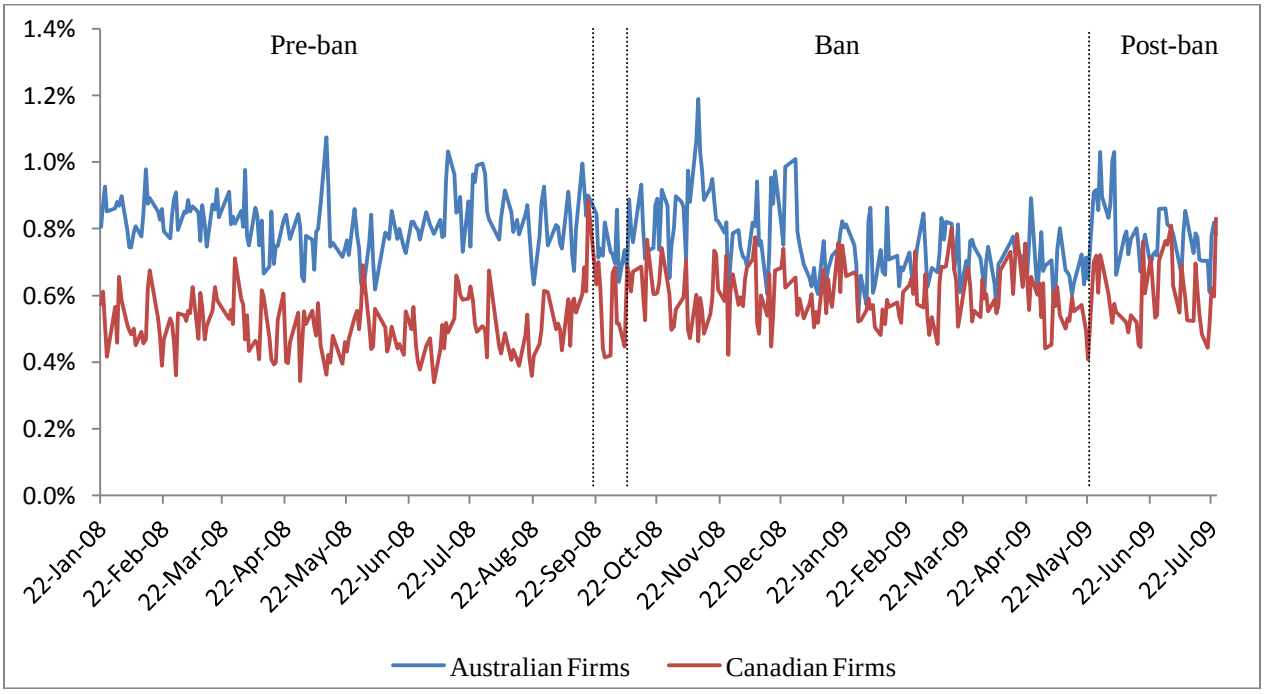

Figure 4

Time-Weighted Relative Effective Spread of Australian Base Stocks and Canadian Control Stocks

This figure shows the time-weighted relative effective bid-ask spread for each trading day from 22 January 2008 through 24 July 2009. For each day the equally-weighted average for the 45 ASX-listed stocks versus the 45 Canadian control stocks is reported.

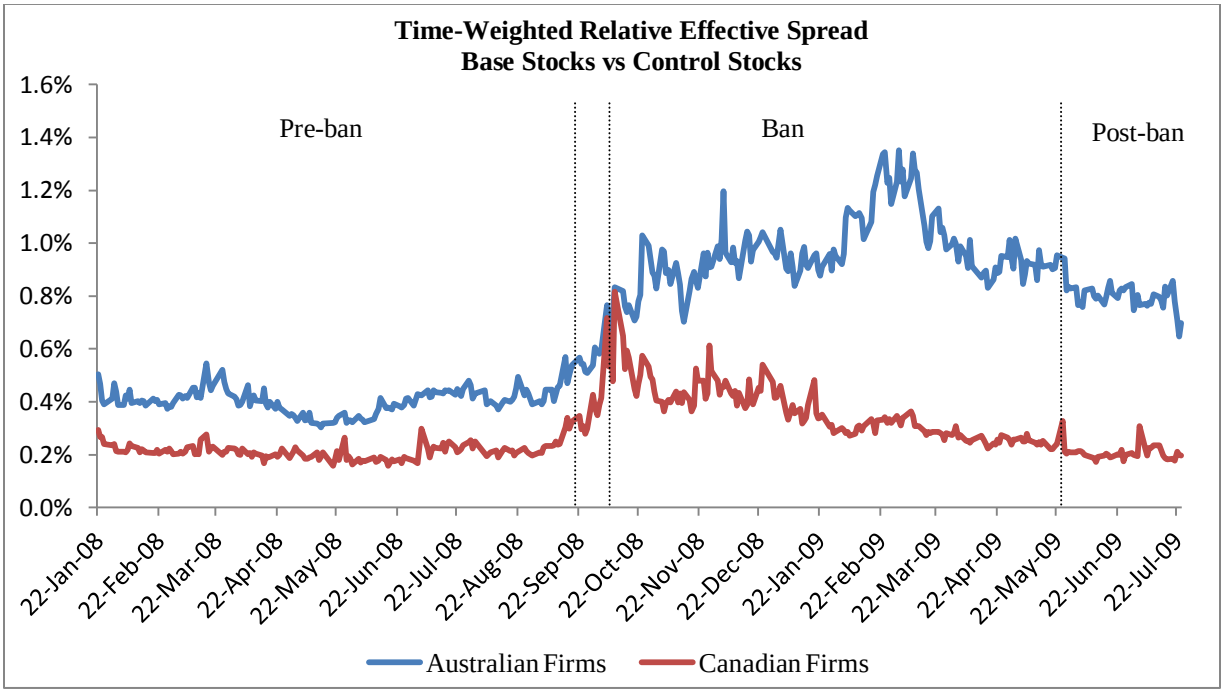

Figure 5

Difference in the volume-weighted relative effective bid-ask spread between base stocks and control stocks where the Canadian control stocks have never been banned

This figure shows the average difference in bid-ask spreads between the base group and the control group for each day from 22 January 2008 through 24 July 2009 – using only pairs that correspond to Canadian stocks which have never been banned from short selling. The volume-weighted relative effective bid-ask spread is used as the spread measure. The difference is calculated by deducting the time-weighted relative effective bid-ask spread of control stocks from the time-weighted relative effective bid-ask spread of base stocks and then averaging cross-sectionally.

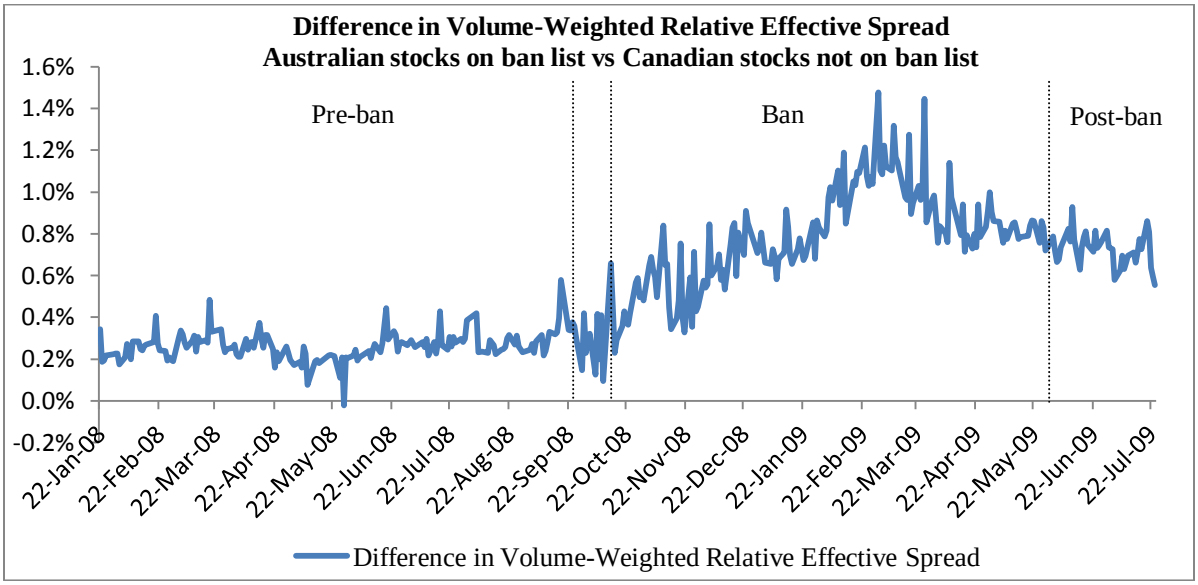

Figure 6

Volume-Weighted Relative Effective Spread of Australian Base Stocks and Canadian Control Stocks

This figure shows the volume-weighted relative effective bid-ask spread for each trading day from 22 January 2008 through 24 July 2009. For each day the equally-weighted average for the 45 ASX-listed stocks versus the 45 Canadian control stocks is reported.

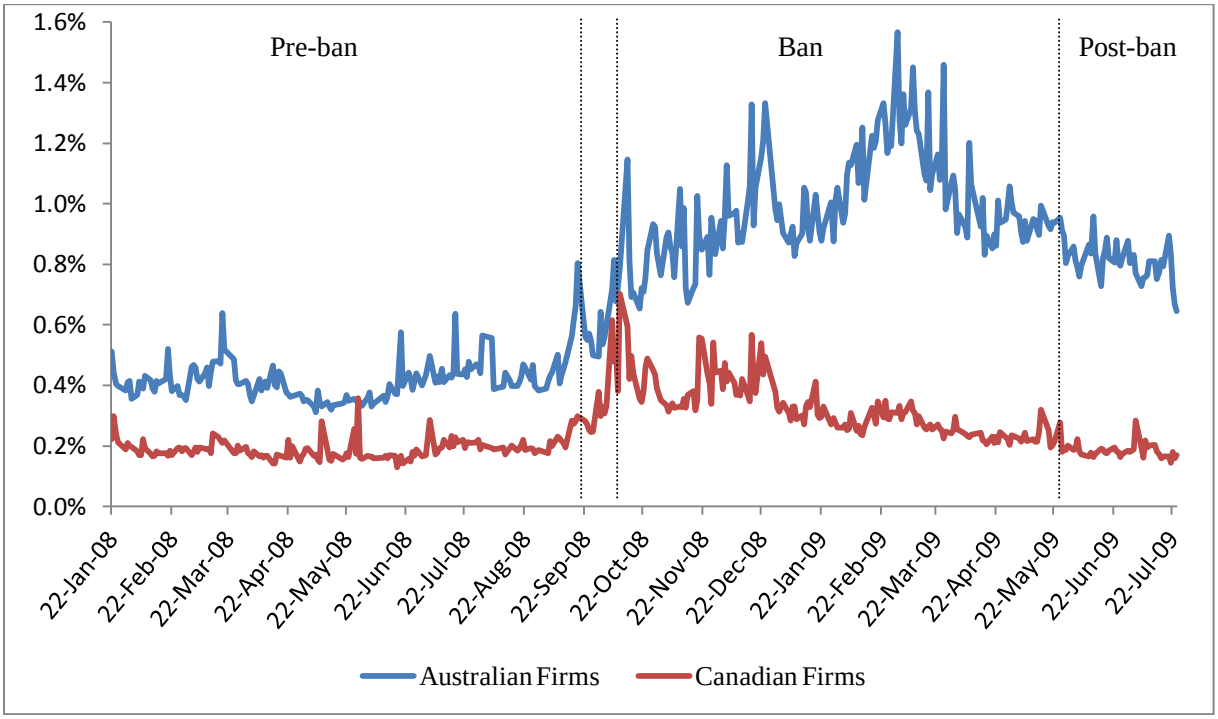

Figure 7

Intraday Volatility of Australian Base Stocks and Canadian Control Stocks

The volatility measure is the range-based high-low intraday volatility defined as the natural logarithm of the daily high price over the daily low price recorded for a given stock on a given trading day. For each day from 22 January 2008 through 24 July 2009 the equally-weighted average for the 45 ASX-listed stocks versus the 45 Canadian control stocks is reported.

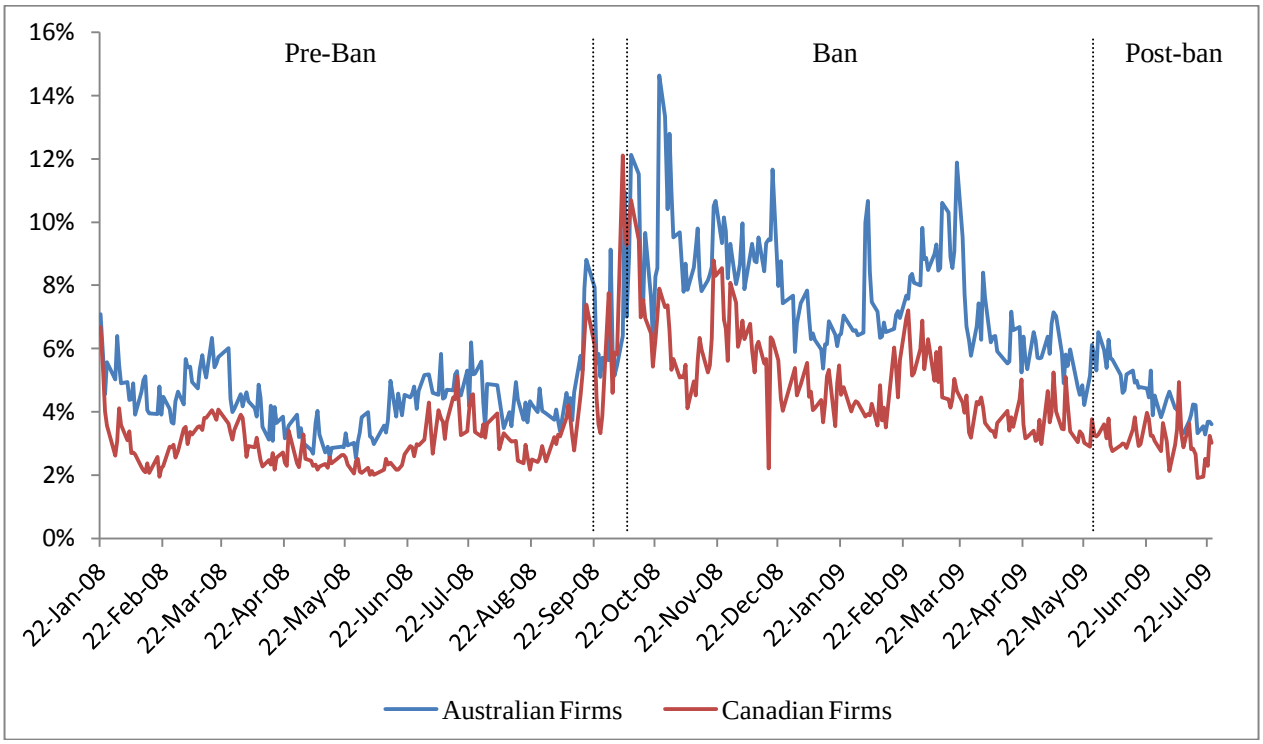

Table 1: GICS industry classification of the treatment and control group

Panel A: Australian firms

GICS Sector	GICS Industry	Number of firms
Financials	Banks	6
Financials	Consumer Finance	1
Financials	Diversified Financial Services	3
Financials	Insurance - Life & Health	2
Financials	Insurance - Property & Casualty	2
Financials	Investment Services	5
Financials	Investment Trusts	4
Financials	REIT - Residential & Commercial	10
Financials	Real Estate Operations	9
Financials	Real Estate Management & Development	2
Industrials	Trading Companies & Distributors	1
	Total	45

Panel B: Canadian firms

GICS Sector	GICS Industry	Number of firms
Financials	Banks	8
Financials	Consumer Finance	2
Financials	Diversified Financial Services	1
Financials	Insurance - Life & Health	4
Financials	Insurance - Property & Casualty	1
Financials	Investment Services	5
Financials	Investment Trusts	8
Financials	REIT - Residential & Commercial	11
Financials	Real Estate Operations	4
Industrials	Engineering & Construction	1
	Total	45

Table 2: Summary Statistics

This table reports summary statistics for the base group and the control group for the entire sample from 22 January 2008 to 24 July 2009. The statistics are calculated using all observations. Market capitalisation is determined as the number of shares outstanding as at 22 January 2008 multiplied by the closing share price on this date for each stock. Market capitalisation of the Canadian control stocks is converted to Australian dollars using the exchange rate prevalent on 21 January 2008. Price refers to closing prices where Canadian stock prices are converted to Australian dollars using the exchange rate prevalent on the given day. Trade volume, dollar turnover, and share of market turnover refer to trading activity where trade volume is the number of trades per day and dollar turnover is the daily turnover measured in Australian dollars. VWRSP stands for volume-weighted relative effective spread; TWRSP stands for time-weighted relative spread; RASP stands for relative average spreads; HLVOL is the high-low intraday volatility measure; RVOL10 is the ten-minute realised volatility.

	Australian Base Stocks							**Canadian Control Stocks**						
Variable	**Obs**	**Mean**	**Std. Dev.**	**Skewness**	**Kurtosis**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Skewness**	**Kurtosis**	**Min**	**Max**
Market Cap. (AUD million)	45	12,139.54	18,792.88	2.281	7.566	218.68	77,124.72	45	12,669.67	19,799.29	1.946	5.747	470.80	73,401.47
Return	16,335	-0.0024	0.0568	-1.782	59.875	-1.1830	0.8930	16,335	-0.0006	0.0337	0.073	8.915	-0.3514	0.3768
Price (AUD)	16,380	8.37	12.01	1.940	6.344	0.032	69.02	16,380	30.65	44.41	5.710	38.110	2.45	401.71
Trade Volume (million)	16,380	6.669	11.608	8.359	139.143	0.020	340.904	16,380	0.835	1.639	4.535	33.445	0.001	22.29
Dollar Turnover (AUD million)	16,380	37.588	71.164	3.403	19.615	0.015	1,038.027	16,380	29.285	61.857	4.035	29.989	0.012	1,034.272
Share of market turnover	16,380	0.0077	0.0138	2.666	11.363	0.00001	0.1284	16,380	0.0055	0.0111	3.104	15.610	0.000004	0.1409
VWRSP	16,380	0.0071	0.0091	3.948	33.401	0.0004	0.1645	16,380	0.0031	0.0024	4.296	43.622	0.0003	0.0499
TWRSP	16,380	0.0068	0.0081	2.451	9.973	0.0003	0.0658	16,380	0.0030	0.0024	3.313	32.492	0.0002	0.0499
RASP	16,380	0.0222	0.0236	2.844	16.732	0.0002	0.2677	16,380	0.0072	0.0078	3.803	31.080	0.0000	0.1412
HLVOL	16,380	0.0593	0.0468	3.055	18.602	0.0045	0.5965	16,380	0.0427	0.0308	2.560	14.813	0.0001	0.4197
RVOL10	16,380	0.0022	0.0067	11.265	186.145	0.0000	0.1684	16,380	0.0006	0.0010	8.200	120.608	0.0000	0.0252

Table 3: Descriptive Statistics for the Pre-ban, Common ban, Ban, and Post-ban Period

This table provides descriptive statistics for the base group and the control group in various periods where the control group is split into two further sub-groups; i.e. Canadian control stocks that have never been banned from short selling and Canadian control stocks that are on the Canadian ban list. For each group, we estimate a time-series average over the stated period before calculating a cross-sectional mean (Panel A) or median (Panel B). The pre-ban period is from 22 January 2008 to 19 September 2008, the common ban period is from 22 September 2008 to 8 October 2008, the ban period is from 9 October 2008 to 24 May 2009, and the post-ban period is from 25 May 2009 to 24 July 2009. Dollar turnover and share of market turnover refer to trading activity where dollar turnover is measured in Australian dollars. VWRSP stands for volume weighted relative effective spread; TWRSP stands for time weighted relative spread; RASP stands for relative average spreads; HLVOL is the high-low intraday volatility measure; and RVOL10 is the ten-minute realised volatility.

	Stocks on Australian ban list				**Matched sample of never banned Canadian stocks**				**Matched sample of stocks on Canadian ban list**			
Panel A. Means	pre-ban	**common ban**	**ban**	**post-ban**	**pre-ban**	**common ban**	**ban**	**post-ban**	**pre-ban**	**common ban**	**ban**	**post-ban**
Number of stocks	45	45	45	45	38	38	38	38	7	7	7	7
Number of days	154	13	154	43	154	13	154	43	154	13	154	43
Dollar Turnover (AUD)	47,376,186	34,858,071	28,075,060	36,970,375	12,909,744	21,094,978	12,793,342	11,875,137	145,016,001	201,357,600	143,404,088	116,924,548
Share of market turnover	0.0082	0.0075	0.0075	0.0079	0.0020	0.0025	0.0023	0.0025	0.0220	0.0232	0.0258	0.0251
VWRSP	0.0042	0.0060	0.0099	0.0081	0.0022	0.0039	0.0036	0.0021	0.0008	0.0015	0.0009	0.0006
TWRSP	0.0041	0.0059	0.0097	0.0080	0.0024	0.0046	0.0040	0.0023	0.0009	0.0018	0.0010	0.0008
RASP	0.0134	0.0216	0.0251	0.0141	0.0065	0.0125	0.0115	0.0075	0.0039	0.0082	0.0049	0.0032
HLVOL	0.0436	0.0661	0.0781	0.0460	0.0309	0.0646	0.0521	0.0320	0.0303	0.0589	0.0442	0.0271
RVOL10	0.0010	0.0022	0.0041	0.0011	0.0003	0.0013	0.0009	0.0003	0.0002	0.0011	0.0006	0.0002
Panel B. Medians												
Number of stocks	45	45	45	45	38	38	38	38	7	7	7	7
Number of days	154	13	154	43	154	13	154	43	154	13	154	43
Dollar Turnover (AUD)	11,121,999	7,910,736	4,875,341	7,375,121	4,419,109	5,723,215	3,564,165	3,857,365	144,381,527	174,297,121	137,268,514	115,645,503
Share of market turnover	0.0019	0.0017	0.0013	0.0016	0.0007	0.0007	0.0006	0.0008	0.0228	0.0203	0.0248	0.0246
VWRSP	0.0037	0.0042	0.0057	0.0044	0.0018	0.0033	0.0031	0.0018	0.0006	0.0012	0.0007	0.0004
TWRSP	0.0038	0.0044	0.0059	0.0041	0.0022	0.0041	0.0037	0.0021	0.0006	0.0014	0.0007	0.0004
RASP	0.0097	0.0163	0.0171	0.0096	0.0058	0.0100	0.0097	0.0065	0.0032	0.0066	0.0039	0.0021
HLVOL	0.0388	0.0587	0.0644	0.0367	0.0278	0.0570	0.0483	0.0296	0.0282	0.0537	0.0427	0.0258
RVOL10	0.0005	0.0011	0.0016	0.0004	0.0002	0.0009	0.0007	0.0002	0.0002	0.0008	0.0006	0.0002

Table 4: Panel regressions of trading activity

This table reports the results of two-way fixed effects panel regressions for the 90 stocks (45 pairs) in our sample. In Panel A, the independent variable is the difference in dollar turnover (measured in millions of Australian dollars) between the base stock and its match. In Panel B, the independent variable is the difference in share of market turnover between the base stock and the control stock.

	Panel A: Δ Dollar Turnover				**Panel B: Δ Share of Market Turnover**			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Common Ban * Bothbanned	-55.61	-73.47	-56.33	-73.05	-0.0004	-0.0024	-0.0005	-0.0024
	(-4.19)***	(-5.45)***	(-4.28)***	(-5.45)***	(-0.28)	(-1.62)	(-0.34)	(-1.60)
Common Ban * (1-Bothbanned)	-15.92	-12.73	-14.62	-11.58	-0.0014	-0.0011	-0.0012	-0.0009
	(-11.97)***	(-9.79)***	(-10.87)***	(-8.93)***	(-7.22)***	(-5.53)***	(-6.17)***	(-4.64)***
Ban	**-15.89**		**-18.26**		**-0.0016**		**-0.0019**	
	(-21.74)* **		**(-22.07)*** **		**(-13.33)*** **		**(-14.16)*** **	
Post-Ban	-4.81		-5.94		-0.0012		-0.0013	
	(-4.55)***		(-5.34)***		(-6.14)***		(-6.54)***	
Ban * Bothbanned		**-56.17**		**-56.19**		**-0.0058**		**-0.0058**
		(-14.01)* **		**(-14.07)*** **		**(-8.90)*** **		**(-8.93)*** **
Ban * (1-Bothbanned)		**-8.30**		**-10.26**		**-0.0008**		**-0.0011**
		(-20.82)* **		**(-21.77)*** **		**(-11.40)*** **		**(-12.90)*** **
Post-Ban * Bothbanned		-6.41		-6.40		-0.0028		-0.0028
		(-1.08)		(-1.08)		(-2.52)**		(-2.53)**
Post-Ban * (1-Bothbanned)		-4.52		-5.15		-0.0009		-0.0010
		(-7.99)***		(-8.41)***		(-8.75)***		(-8.79)***
ΔVolatility			96.21	90.11			0.0148	0.0139
			(16.18)***	(14.83)***			(14.71)***	(13.89)***
ΔBid-Ask Spread			130.51	86.70			0.0254	0.0090
			(5.31)***	(2.21)**			(3.20)***	(1.18)
Observations	16380	16380	16380	16380	16380	16380	16380	16380
Adjusted R-squared	0.36	0.38	0.36	0.38	0.47	0.47	0.47	0.48

Robust t statistics are presented in parentheses. *, **, and *** denotes significance at 10%, 5%, and 1% level respectively. Note that coefficients associated with the ban period (i.e. coefficients of interest) are reported in bold.

Table 5: Panel regressions of bid-ask spread

This table reports the results of two-way fixed effects panel regressions for the 90 stocks (45 pairs) in our sample. In Panel A, the independent variable is the difference in trade volume-weighted relative effective spreads between the base stock and its match (ΔVWRSP). In Panel B, the independent variable is the difference in time-weighted relative spreads (ΔTWRSP).

	Panel A: ΔVWRSP				**Panel B: ΔTWRSP**			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Common Ban * Bothbanned	0.0008	-0.0002	0.0001	-0.0001	0.0008	-0.0002	-0.0001	-0.0003
	(5.25)***	(-1.51)	(0.44)	(-1.61)	(4.57)***	(-1.61)	(-0.39)	(-1.81)*
Common Ban * (1-Bothbanned)	-0.00006	0.0004	0.00002	0.0002	-0.0002	-0.0001	-0.0002	-0.0002
	(-0.20)	(1.29)	(0.08)	(0.74)	(-1.79)*	(-0.42)	(-1.52)	(-1.12)
Ban	**0.0044**		**0.0014**		**0.0042**		**0.0011**	
	(42.72)* **		**(13.78)*** **		**(50.62)*** **		**(17.51)*** **	
Post-Ban	0.0040		0.0010		0.0040		0.0009	
	(30.11)***		(7.39)***		(33.33)***		(8.73)***	
Ban * Bothbanned		**0.0002**		**0.0001**		**0.0001**		**0.0000**
		(2.38) **		**(1.49)**		**(6.54)*** **		**(0.74)**
Ban * (1-Bothbanned)		**0.0052**		**0.0017**		**0.0050**		**0.0015**
		(43.25)* **		**(14.64)*** **		**(51.28)*** **		**(18.01)*** **
Post-Ban * Bothbanned		0.00003		-0.0010		0.00004		-0.0008
		(0.41)		(-9.49)***		(1.84)*		(-10.36)***
Post-Ban * (1-Bothbanned)		0.0047		0.0013		0.0047		0.0014
		(30.57)***		(9.12)***		(33.77)***		(10.18)***
ΔVolatility			0.0221	0.0219			0.0208	0.0203
			(13.24)***	(13.11)***			(15.27)***	(15.18)***
Δln(Volume)			0.0003	0.0003			-0.0004	-0.0004
			(0.67)	(0.70)			(-2.35)**	(-2.26)**
Δln(Dollar Turnover)			-0.0004	-0.0004			0.0000	0.0000
			(-0.95)	(-0.96)			(0.04)	(0.01)
Δln(Price)			-0.0062	-0.0061			-0.0067	-0.0066
			(15.41)***	(-14.87)***			(-25.07)***	(-24.02)***
Observations	16380	16380	16380	16380	16380	16380	16380	16380
Adjusted R-squared	0.45	0.46	0.58	0.58	0.55	0.56	0.70	0.70

Robust t statistics are presented in parentheses. *, **, and *** denotes significance at 10%, 5%, and 1% level respectively. Note that coefficients associated with the ban period (i.e. coefficients of interest) are reported in bold.

Table 6: Panel regressions of volatility

This table reports the results of two-way fixed effects panel regressions for the 90 stocks (45 pairs) in our sample. In Panel A, the independent variable is the difference in the range based high-low volatility measure between the base stock and its match. In Panel B, the independent variable is the difference in realised volatility between the base stock and the control stock.

	Panel A: ΔHLVOL				**Panel B: ΔRVOL10**			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Common Ban * Bothbanned	0.0030	-0.0037	0.0056	0.0024	0.0001	-0.0001	0.0001	-0.0002
	(0.80)	(-1.00)	(1.74)*	(0.74)	(0.25)	(-1.14)	(0.45)	(-1.20)
Common Ban * (1-Bothbanned)	-0.0128	-0.0116	-0.0065	-0.0059	0.0001	0.0003	0.0002	0.0004
	(-5.66)***	(-5.10)***	(-3.03)***	(-2.74)***	(0.30)	(0.93)	(0.75)	(1.57)
Ban	**0.0145**		**0.0124**		**0.0025**		**0.0017**	
	(20.88)* **		**(17.49)*** **		**(16.42)*** **		**(12.91)*** **	
Post-Ban	0.0021		-0.0057		0.0001		-0.0011	
	(2.85)***		(-7.12)***		(1.40)		(-7.62)***	
Ban * Bothbanned		**0.0003**		**0.0045**		**0.0001**		**0.0003**
		(0.32)		**(4.66)*** **		**(0.81)**		**(3.16)*** **
Ban * (1-Bothbanned)		**0.0173**		**0.0141**		**0.0030**		**0.0020**
		(21.54)* **		**(17.20)*** **		**(16.43)*** **		**(13.09)*** **
Post-Ban * Bothbanned		-0.0001		-0.0040		-0.0002		-0.0007
		(-0.06)		(-4.19)***		(-4.71)***		(-9.34)***
Post-Ban * (1-Bothbanned)		0.0025		-0.0057		0.0002		-0.0011
		(2.94)***		(-6.12)***		(1.82)*		(-6.73)***
Δln(Volume)			0.0045	0.0046			0.0003	0.0003
			(2.56)**	(2.62)***			(1.16)	(1.23)
Δln(Dollar Turnover)			0.0071	0.0070			0.0004	0.0004
			(4.12)***	(4.05)***			(1.34)	(1.276)
Δln(Price)			-0.0199	-0.0191			-0.0029	-0.0028
			(-10.18)***	(-9.72)***			(-6.89)***	(-6.56)***
Observations	16380	16380	16380	16380	16380	16380	16380	16380
Adjusted R-squared	0.23	0.24	0.31	0.31	0.08	0.08	0.10	0.10

Robust t statistics are presented in parentheses. *, **, and *** denotes significance at 10%, 5%, and 1% level respectively. Note that coefficients associated with the ban period (i.e. coefficients of interest) are reported in bold.