Impact of Anonymity on Liquidity in Limit Order Books: Evidence from Cross-listed Stocks

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Abstract

This paper examines anonymity effects on liquidity migration of cross-listed stocks using a natural experiment created by the staggered move to anonymity regime undertaken by ASX and NZX. The 2SLS instrumental variable estimation shows two interesting trends. When considering liquidity impact on cross-listed stocks after ASX switched to anonymous trading, bid-ask spreads, quoted depth and trading volume improve on ASX, but deteriorate on NZX. On the other hand, when considering NZX's adoption of anonymous trading, liquidity decreases on ASX, but increases on NZX. Consistent with our hypothesis, anonymity attracts the trading of cross-listed stocks from the foreign counterparty. Results also suggest the existence of commonality in liquidity in financial markets, and the inclusion of this commonality in natural experiment studies may be necessary.

Keywords: anonymity, liquidity, cross-listed, commonality in liquidity, natural experiments

1. INTRODUCTION

On 6 July 2007 the New Zealand Stock Exchange (NZX) adopted anonymous trading by removing broker IDs[1], following the Australian Stock Exchange (ASX)'s move to anonymity on 28 November 2005. NZX, which is overshadowed by ASX, aimed to incentivize traders and improve market liquidity. The fear of losing competitiveness to the ASX new anonymous system was seen as an apparent motive behind NZX's adoption of anonymity.

This staggered movement to anonymous markets by ASX and NZX provides an ideal natural experiment to examine the impact of anonymous trading on liquidity for cross-listed stocks on ASX and NZX. Prior natural experiments on how anonymity affects market liquidity are inconclusive because of the employment of different econometric specifications. Foucault et al. (2007)'s ordinary least squares (OLS) regression analysis shows that anonymity results in decreased bid-ask spreads in Paris Bourse after controlling for changes in spread determines (including stock price, trading volume and volatility), however Maher et al. (2008) obtain the opposite conclusion using instrumental variable two-stage least squares regression model (2SLS). Majois (2007) find the decrease in spread in Paris Bourse completely vanishes, with the event dummy variable being non-significant after adding the spread on the NYSE as an additional control variable for a market-wide factor in the regression of Foucault et al. (2007).

By overcoming this methodological issue in prior literature, we contribute to the literature in two ways. The first contribution is our natural experimental methodology. Eom et al. (2007) argue that the existing event studies have been econometrically flawed, because endogenous variables such as volume and volatility are used as controls in the model. Maher et al. (2008) suggest using 2SLS instrumental variables estimation to overcome this endogeneity issue. Majois (2007) argue that a "global liquidity factor" should be also taken into account in natural experiment study to assess the impact of a change in design on market liquidity. By incorporating these

[1] Anonymous trading started on 6 July 2007 when NZX's new electronic trading platform –Trayport was implemented. This date was verified by the NZX.

views, we apply 2SLS instrumental variables technique and control for both stock specific and overall market movements in order to isolate anonymity effects from other compounding factors. We use the same liquidity measure of the same cross-listed stock in the home (foreign) market as a natural control for individual determinants of liquidity in the foreign (home) market. To control for market-wide factors, a sample of control stocks matched 1-2 with each cross-listed stocks in each market is constructed.

Second, this study investigates anonymity effects from a new perspective, by observing liquidity migration of cross-listed stocks between the home and foreign markets. Our natural experiment allows us to study the effects of anonymity simultaneously in both ASX and NZX during periods of staggered regulatory changes. We investigate if the observed anonymity effects are consistent across the two discrete changes. Moreover, similar market structure between the Australian and New Zealand exchange ensures the comparability of results.

The results of 2SLS estimation shows that bid-ask spreads, depth and trading volume improve on ASX, however deteriorate correspondingly in NZX, after ASX introduced anonymous trading. On the other hand, the adoption of anonymous trading on NZX leads to an opposite findings, i.e. liquidity increases on NZX, but decreases on ASX. These results suggest that anonymity regime attracts the trading of cross-listed stocks from the foreign counterparty, and yields significant benefits to both exchanges.

The remainder of the paper is organized as follows. In the next section, we review the literature pertaining to liquidity impact of trader anonymity, and outline several hypothesis tested in this study. Section 3 describes the relevant institutional details for ASX and NZX markets and Section 4 presents the data and Section 5 sets out the research methodology. Section 6 reports the results and Section 7 provides robustness check. Section 8 concludes.

2. THEORY AND HYPOTHESES

Anonymity enables traders to execute transactions on the market without displaying their identifiers, allowing them to conceal trading intentions. Many theoretical models predict that informed traders choose to trade in an anonymous venue, so that their trading activity is less likely to be detected (O'Hara 1995; Madhavan, 1995; Foster and George, 1992). They fear that revealing their presence will drive liquidity traders out of the market place and increase their execution costs (Harris, 2003; Benveniste et al., 1992). Theoretically, this reasoning assumes market participants' ability to discriminate between informed and uninformed traders in transparent markets by observing traders' identities.

The preference for anonymity by informed traders is evident in many empirical studies. For example, Grammig et al. (2001) analyse trader anonymity in the German stock market, where transparent floor trading system co-exists with an anonymous electronic market. They estimate the probability of informed trading for these two parallel markets, and find that a higher level of anonymity is associated with a higher probability of informed trading. Heidle and Huang (2002) document similar findings in their study on information-based trading between anonymous competing dealers (electronic screen-based NASDAQ), and transparent auction markets (specialist system such as NYSE and AMEX). They find that the probability of informed trading declines for the firms that transfer their exchange listing from anonymous to transparent venue, and increases from transparent to anonymous venue. Their comparison of the two trading structures shows that the probability of informed trading is more pronounced in an anonymous system than in a transparent auction market.

The informed trader's preference for anonymous market is clear, whereas the empirical evidence on liquidity impact is mixed. Early research, such as Grammig et al. (2001) and Heidle and Huang (2002) find that spreads in anonymous trading platform are wider than on transparent platform. However Simaan et al. (2003) find that market makers quote narrower spreads on anonymous Electronic Communication Networks (ECNs) than on transparent NASDAQ dealer system, because anonymity

reduces the probability of collusion amongst quote setters. Since these studies conduct comparisons between different market microstructures (i.e. anonymous electronic systems versus transparent floor or dealer systems), Commerton-Forde and Tang (2009) point out that such comparison poses inherent problems in isolating the effects of anonymity from other market structure effects.

Recent research uses natural experiments. Commerton-Forde and Tang (2009) point out that natural experiments control more effectively for the dissimilarities in market microstructures. Foucault et al. (2007) use natural experiment on Euronext Paris, which switched to anonymous broker regime on 23 April 2001. They develop a theoretical model which enables them to conclude that anonymous quotes can lead to overall tighter bid-ask spreads. Their model explains that in a market when broker identification codes are displayed, uninformed traders estimate the proportion of informed trades in the market before submitting orders. The ratio of informed to uninformed traders will result in overall impact on spread. When the participation rate of informed traders is small, uninformed traders actively set the best quotes as they are aware that there is a relatively low chance that informed traders will pick off their limit orders. This leads to narrower spreads. Conversely, when informed traders' participation rate is high, wide spreads from uninformed traders are predicted. However, in anonymous markets market participants generally are unable to discriminate between informed and uninformed traders by observing traders' identities, and to pick off uninformed orders or free-ride informed orders. They will therefore place more aggressive limit orders, not behave differently on informed and uninformed trades. This is consistent with the study by Garfinkel and Nimalendran (2003), who compare the impact of insider trading on market maker behaviour for anonymous NASDAQ and transparent NYSE. They show that NASDAQ dealers do not adjust to the presence of insider by raising effective spreads. The effective spreads of stocks traded in anonymous NASDAQ dealer system are narrower than in transparent NYSE specialist system.

On this basis, Foucault et al. (2007) conclude that anonymous quotes lead to tighter bid-ask spreads. They test this proposition by using data on large stocks from Paris Bourse. Their OLS regression analysis shows the decrease in bid-ask spreads following the switch to anonymous broker IDs, after controlling for changes in spread

determinants.

Following this line of thought, Comerton-Forde et al. (2005) conduct natural experiment and employ the same multivariate methodology to include markets in Paris, Tokyo, and Korea. They find higher liquidity in markets that move to anonymous trading. Comerton-Forde and Tang (2009) replicate the Foucault et al. (2007) spreads model, but with the addition of a trend term, for investigating the market quality of ASX after the removal of broker identifiers. They obtain similar results with lower spreads, and greater depth in anonymous markets. They also examine the direction of order flow in ASX and NZX (transparent market at that time), and find the evidence of the migration of trading activity from the NZX to ASX for large cross-listed stocks after the removal of broker identifiers on ASX.

These studies provide strong empirical evidence for believing that the adoption of anonymous market should lead to an improvement of bid-ask spread (thus liquidity). However, Maher et al. (2008) claim that those results are sensitive to the econometric specification employed. They replicate the above studies for the five exchanges including Paris, Brussels, Tokyo, Australia, and Korea, but using fixed effect instrumental variables estimation. They show the opposite findings, that anonymity leads to an increase in the effective bid-ask spread, intraday volatility and a decrease in overall trading volume. They argue that this is because these studies do not control for endogenous variables such as volume and price. The ignorance of endogentiy issues can seriously affect results.

Eom et al. (2007) adopt a panel-data approach to control for endogeneity. They show that increasing pre-trade transparency in the form of increasing level of quote disclosure in the Korean Exchange (KRX) limit order book improves market quality. Poskitt et al. (2011) study anonymity effects on liquidity of NZX-listed stocks. Their OLS and 2SLS estimations point to the same conclusion that the NZX's market share improves in the trading of cross-listed stocks in relation to ASX (also anonymous market at that time), although they find that effective spreads increases following the switch to anonymity regime on NZX.

Majois (2007) points out that a global liquidity factor should be also taken into

account in natural experiment study to assess the anonymity effects on market liquidity. This is because that market-wide factors can influence liquidity in financial markets as a whole (Chordia et al., 2000). Majois replicate the regression analysis of Foucault et al. (2007) and shows that the decrease in spread also appears on the NYSE, which did not experience any broker regime change. Majois further shows that after adding the spread on the NYSE as an additional control variable in the regression analyzing the spread in Paris, the post-event dummy variable becomes non-significant. Majois attributes this to a global phenomenon that would affect liquidity around the world.

Motivated by previous study, this paper uses the natural experiments in the form of staggered regulatory changes by ASX and NZX, to examine the effects of anonymity on liquidity for both Australian and New Zealand cross-listed stocks. Incorporating the views of Maher et al. (2008) and Majois (2007), the study uses instrumental variables 2SLS estimation with controlling for both stock-specific and market-wide liquidity factors.

Based on the theoretical rational outlined in Foucault et al. (2007) that limit order book traders are more willing to trade aggressively in an anonymous trading venue, as well as the evidence obtained by Comerton-Forde and Tang (2009) and Poskitt et al. (2011) on the increased cross-listed shares trading in the home market, this paper tests whether trader anonymity affects liquidity migration of cross-listed stocks between home and foreign markets.

Specifically, we expect that the change from a transparent market to an anonymous market in ASX will lead to an improvement in liquidity on ASX, but a decline on NZX. This leads to the first pair of hypotheses:

Hypothesis 1A: Liquidity of cross-listed stocks on ASX will increase after ASX introduced anonymous trading.

Hypothesis 1B: Liquidity of cross-listed stocks on NZX will decrease after ASX introduced anonymous trading.

The measure of liquidity encompasses bid-ask spreads, quoted depth and trading volume. Lee and Ready (1993) identify that both spread and depth are needed to draw conclusion in the changes in liquidity. A widening (narrowing) of the spread, combined with a decrease (increase) in depth, infers a decrease (increase) in liquidity unambiguously. It is surprising that much of the anonymity literature focus on the spread and evidence on depth is limited. For example, Foucault et al (2007) find an ambiguous effect on depth in Euronext Paris after the switch to pre-trade anonymity. For this reason, this paper extends the work examining the liquidity impact of the adoption of anonymous trading on bid-ask spread to depth. It is expected that bid-ask spread and depth will improve on ASX, and deteriorate correspondingly on NZX, after ASX introduced anonymous trading.

The third liquidity measure is volume, which examines anonymity effects on trading activity. Comerton-Forde and Tang (2009) find an increased ASX's trading volume of cross-listed stocks relative to NZX after the removal of broker identifiers on ASX. Poskitt et al. (2011) also find that the switch to anonymous trading improves the NZX's share of trading of cross-listed stocks relative to ASX.

It is therefore expected that all these three principal measures of liquidity will be improved on ASX, and deteriorated on NZX after ASX's adoption of anonymous trading. On the other hand, the second pair of hypotheses anticipates the opposite findings after NZX introduced trader anonymity.

Hypothesis 2A: Liquidity of cross-listed stocks on ASX will decrease after NZX introduced anonymous trading.

Hypothesis 2B: Liquidity of cross-listed stocks on NZX will increase after NZX introduced anonymous trading.

3. INSTITUTIONAL DETIALS

Both ASX and NZX operate analogous open electronic limit order books, with ASX being relatively larger than NZX. As of December 2011, 2079 companies were listed

on ASX, including 1983 domestic companies and 96 foreign companies. The top 500 stocks by market capitalization are included in the broad-based All Ordinaries index (All Ords). By that time, 151 companies listed on the NZX's main board, in which 108 are domestic securities. The NZX 50 index comprises the 50 largest and most liquid companies.

Both markets are highly integrated and competitive, and market participants can easily trade in either market. The trading hours of NZX are 10:00 a.m. to 4:45 p.m. New Zealand Standard Time (NZST) and the trading hours of ASX are 10:00 a.m. to 4:00 p.m. Australian Eastern Standard Time (AEST). The difference in time zones between Australia and New Zealand is small, with New Zealand usually 2 hours ahead of AEST. Trading hours on ASX and NZX overlap from 10:00 a.m. to 2:45 p.m. on ASX and 12:00 a.m. to 4:45 pm on NZX (both in local time). For most of the year, this results in 4.75 hours of overlapping operation between the two markets. However, due to differences in the start and end dates of daylight savings, this overlap can range between 3.75 hours to 5.75 hours.

Prior to the change in broker anonymity regime, both markets displayed the full limit order book, including individual broker identification numbers. Brokers were able to identify the parties of other limit orders and the counter parties to trades after transactions occurred. As part of Equity Market Reform[2], ASX removed broker identifiers from the trading screens on 28 November 2005. By then, 40 stocks were traded on both ASX and NZX, including 21 Australian companies and 18 New Zealand companies. One and half year later, NZX started its anonymous trading on 6 July 2007. By the time, 35 stocks listed on both exchanges including 20 Australian-incorporated stocks and 15 New Zealand-incorporated stocks. Table 1 and Table 2 list these stocks and calculates the common trading days in both markets during a 6-month time period around the regulatory changes. The level of trading activity in these stocks varies considerably. Approximately half of them trade on all or

[2] See the ASX (2005) publication: Enhancing the Liquidity of Australian Equity Market. ASX believes that trader anonymity will provide investors with a greater range of trading options and will thus attract market liquidity and improve price discovery to the benefit of all market participants.

most days in both markets, while the remainder trade infrequently or not at all.

Table 1: List of Cross-listed Stocks during a 3-month Period around ASX's Introduction of Anonymity Regime

This table reports summary trading statistics for 40 stocks listed on both ASX and NZX. Common Trading Days reports the number of days the company's stocks were traded on both ASX and NZX during a 3-month overlapping time period before and after the introduction of anonymous market by ASX (excluding one week before and after the change). Final Sample is "Yes" if the company is included in this data sample, otherwise it is "No".

Company Name	Code	Final Sample	Common Trading Days	Reason for Exclusion
Panel A: Australian Companies				
Australian Foundation Investment Co. Ltd	AFI	Yes	91	
AMP Ltd	AMP	Yes	112	
Australia and New Zealand Banking Group Ltd	ANZ	Yes	106	
APN News & Media Ltd	APN	No	43	Acquisition on 20/12/2005
AXA Asia Pacific Holdings Limited	AXA	Yes	111	
Babcock & Brown Infrastructure	BBI	No	0	Thin trading on NZX
Downer EDI Limited	DOW	No	0	Thin trading on NZX
Energy World Corporation Limited	EWC	No	0	Thin trading on NZX
Lend Lease Corporation Limited	LLC	No	0	Thin trading on NZX
Lion Nathan Ltd	LNN	Yes	106	
National Australia Bank Limited	NAB	No	0	Thin trading on NZX
Pacific Brands Limited	PBG	Yes	64	
People Telecom Limited	PEO	No	0	Thin trading on NZX
Pan Pacific Petroleum NL	PPP	Yes	56	
Rio Tinto Limited	RIO	No	0	Thin trading on NZX
RMG Limited	RMG	No	0	Thin trading on NZX
Summit Resources Limited	SMM	Yes	99	
Tag Pacific Limited	TAG	No	12	Thin trading on NZX
Telstra Corporation Ltd	TLS	Yes	108	
Transpacific Industries Group Ltd	TPI	No	0	Thin trading on NZX
Westpac Banking Corporation	WBC	Yes	113	
Panel B: New Zealand Companies				
Auckland International Airport Ltd	AIA	Yes	110	
Air New Zealand Ltd	AIR	Yes	106	
Carter Holt Harvey Limited	CAH	Yes	110	
Fletcher Building Ltd	FBU	Yes	113	
Fisher & Paykel Appliances Holdings Ltd	FPA	Yes	109	
Fisher & Paykel Healthcare Corporation Ltd	FPH	Yes	94	
Gensis Research and Development Corporation Ltd	GEN	No	0	Thin trading on ASX
Heritage Gold NZ Ltd	HGD	No	19	Thin trading on ASX
Nuplex Industries Ltd	NPX	Yes	51	
New Zealand Oil & Gas Ltd	NZO	Yes	68	
Kathmandu Holdings Limited	KMD	No	0	Thin trading on ASX
Sky City Entertainment Group Ltd	SKC	Yes	110	
Sky Network Television Ltd	SKT	No	0	Thin trading on ASX
Telecom Corporation of New Zealand Ltd	TEL	Yes	113	
Tower Ltd	TWR	Yes	113	
Vea Advantage Limited	VEA	Yes	104	
Waste Management NZ Limited	WAM	Yes	42	
The Warehouse Group Limited	WHS	Yes	87	

Table 2: List of Cross-listed Stocks during 3-month Period around NZX's Introduction of Anonymity Regime

This table reports summary trading statistics for 35stocks listed on both ASX and NZX. Common Trading Days reports the number of days the company's stocks were traded on both ASX and NZX during 3-month overlapping periods before and after the introduction of anonymous market by NZX (excluding one week before and after the change). Final Sample is "Yes" if the company is included in this data sample, otherwise it is "No".

Company Name	Code	Final Sample	Common Trading Days	Reason for Exclusion
Panel B: Australian Companies				
Australian Foundation Investment Co. Ltd	AFI	Yes	102	
AMP Ltd	AMP	Yes	113	
Australia and New Zealand Banking Group Ltd	ANZ	Yes	111	
APN News & Media Ltd	APN	No	23	Missing data
Babcock & Brown Infrastructure	BBI	No	0	Thin trading on NZX
Downer EDI Limited	DOW	No	0	Thin trading on NZX
Energy World Corporation Limited	EWC	No	0	Thin trading on NZX
Goodman Fielder Limited	GFF	Yes	109	
Lend Lease Corporation Limited	LLC	No	0	Thin trading on NZX
L & M Petroleum Limited	LMP	Yes	76	
Lion Nathan Ltd	LNN	Yes	100	
National Australia Bank Limited	NAB	No	0	Thin trading on NZX
Pacific Brands Limited	PBG	Yes	37	
People Telecom Limited	PEO	No	0	Thin trading on NZX
Pan Pacific Petroleum NL	PPP	Yes	96	
Rio Tinto Limited	RIO	No	0	Thin trading on NZX
Tag Pacific Limited	TAG	No	6	Thin trading on NZX
Telstra Corporation Ltd	TLS	Yes	107	
Transpacific Industries Group Ltd	TPI	No	0	Thin trading on NZX
Westpac Banking Corporation	WBC	Yes	113	
Panel B: New Zealand Companies				
Auckland International Airport Ltd	AIA	Yes	110	
Air New Zealand Ltd	AIR	Yes	113	
Fletcher Building Ltd	FBU	Yes	112	
Fisher & Paykel Appliances Holdings Ltd	FPA	Yes	106	
Fisher & Paykel Healthcare Corporation Ltd	FPH	Yes	111	
Gensis Research and Development Corporation Ltd	GEN	No	0	Thin trading on ASX
Heritage Gold NZ Ltd	HGD	Yes	74	
Nuplex Industries Ltd	NPX	Yes	36	
New Zealand Oil & Gas Ltd	NZO	Yes	91	
Kathmandu Holdings Limited	KMD	No	0	Thin trading on ASX
Sky City Entertainment Group Ltd	SKC	Yes	110	
Sky Network Television Ltd	SKT	No	0	Thin trading on ASX
Telecom Corporation of New Zealand Ltd	TEL	Yes	104	
Tower Ltd	TWR	Yes	113	
The Warehouse Group Limited	WHS	Yes	64	

4. DATA AND SUMMARY STATISTICS

To be included in the final sample, stock data needs to be available throughout the 6-month study period around the regulatory change in broker regime. To avoid any potential data errors associated with the switch and allow for a period of learning, one week before and after the exact broker identification change date has been excluded for each exchange. This is defined as the "learning period" (Goldstein and Kavajecz, 2000; Maher et al, 2008). Therefore, a period of 3-month before and after the regulatory change are used in the analysis, with the exclusion of learning period.

We conduct separate analysis on anonymity effects for the regulatory change in ASX and NZX. "ASX anonymity" is labeled for studying liquidity impact after ASX introduced broker anonymity regime on 28 November 2005. The 3-month period prior to the change is from 29 August 2005 to 21 November 2005, and the 3-month period after the change is from 5 December 2005 to 27 January 2006. "NZX anonymity" is labeled for studying liquidity impact after NZX's adoption of anonymous trading on 7 July 2007. The pre-change period is from 6 April 2007 to 29 June 2007, and the post-change period is from 13 July 2007 to 4 October 2007.

Since some stocks are rarely traded and would not provide reliable observations, a sample stock is required to be traded at least once every five trading days. Stocks are also excluded if they undergo acquisitions during the sample period to circumvent any possible problems caused by structure changes. After all this filtering, Table 1 shows 24 cross-listed stocks selected for studying ASX anonymity. This includes 10 Australian companies and 14 New Zealand companies. Table 2 shows 22 stocks selected for studying NZX anonymity, including 10 Australian companies and 12 New Zealand companies.

This final sample covers all industry sectors including consumer, energy, financials, health care, information technology, materials, telecommunication services and utilities. Seven cross-listed stocks are components of the S&P/ASX 200, among which six are Australian incorporated (AMP, ANZ, GFF, PBG, TLS, and WBC), and one is New Zealand incorporated (TEL). Five stocks are included in NZX 10 (AIA,

FBU, FPH, SKC and TEL), which are all New Zealand incorporated.

For each stock, trade and quote data is obtained from the Reuters DataScope Tick History Database, provided by the Securities Industry Research Centre of Asia Pacific (SIRCA). The trade data is in a one-minute interval, containing fields with the security code, date, time, price and volume. In each interval, the last trade price and the total volume traded are calculated. The quote data is time-stamped to the nearest $1/100^{th}$ of a second. Each quote consists of the best bid and ask price along with the number of shares willing to be transacted at that respective price. For consistency, one-minute quote data set is generated from this data. We record the prevailing quotes and respective depth levels at the end of each minute. In order to observe liquidity change in both ASX and NZX simultaneously, and to reduce the data set to a more manageable size, a single daily observation is calculated from the one-minute data set. The average price and depth, and the total trading volume are computed during overlapping trading hours each day for each stock on NZX and ASX respectively. All intraday data has thus been summarized to a daily basis during overlapping trading hours. As a result, for each stock and each liquidity measure, the working sample consists of at most 120 daily observations during the 6-month study period.

Table 3 and Table 4 present brief summaries of the trading activity for these stocks during the study periods of ASX and NZX anonymity respectively. In general, the trading of cross-listed stocks is more active in the home market. For example, the trading activity of Australian companies (Panel A) is substantially higher on ASX. The average number of trades per day on ASX ranges from 6 to 1298, compared to a range from 2 to 17 on NZX. Similarly, the daily number of shares traded is typically hundreds of times higher on ASX. On the other hand, the trading in New Zealand companies (Panel B) is generally higher on NZX. The average trade size and the average number of shares traded are several times higher on NZX. The similar trading patterns are also recorded during the period of NZX anonymity. Total trades on ASX is 1,207,130 with 94% are from Australian incorporated stocks, whilst total trades on NZX is 69,992, of which 91% is from New Zealand stocks. The discrepancy in the average price at which the stocks trade across the two markets reflects the New Zealand-Australia exchange rate which was approximately equal to 1.09 on average over ASX anonymity period, and 1.13 over NZX anonymity period.

Table 3: Summary trading statistics for final sample of stock of ASX anonymity

This table presents sample stocks' average price, number of shares traded, trade size and number of trades per day over study period of ASX anonymity on both the New Zealand Australian exchanges. Average NZX and ASX prices are expressed in their respective currencies

	Trading on ASX				Trading on NZX			
Company Name	Price ($)	Shares Traded	Trade Size	Trades/Day	Price ($)	Shares Traded	Trade Size	Trades/Day
Panel A: Australian Companies								
Australian Foundation Investment Co. Ltd	4.2	151,655	2,334	65	4.58	8,975	3,213	3
AMP Ltd	7.6	3,198,212	3,981	805	8.28	14,444	1,283	9
Australia and New Zealand Banking Group Ltd	23.8	2,540,856	1,922	1,298	25.81	7,738	1,598	5
AXA Asia Pacific Holdings Limited	5.0	970,496	3,529	276	5.39	8,843	1,424	6
Lion Nathan Ltd	7.8	484,480	2,219	217	8.45	11,726	2,503	5
Pacific Brands Limited	2.6	1,823,388	7,138	252	2.85	6,853	3,609	2
Pan Pacific Petroleum NL	0.1	257,570	39,435	6	0.13	71,407	22,807	3
Summit Resources Limited	0.7	640,162	8,119	74	0.75	59,957	8,691	6
Telstra Corporation Ltd	4.1	21,422,834	12,935	1,627	4.47	46,789	5,149	9
Westpac Banking Corporation	21.8	2,676,927	2,166	1,195	23.66	27,019	1,526	17
Panel B: New Zealand Companies								
Auckland International Airport Ltd	1.9	43,242	6,525	6	2.02	974,549	16,588	59
Air New Zealand Ltd	1.1	31,194	4,420	6	1.21	254,487	15,494	14
Carter Holt Harvey Limited	2.4	142,020	5,654	24	2.55	1,635,395	120,255	13
Fletcher Building Ltd	7.0	42,681	2,499	16	7.59	390,401	6,950	54
Fisher & Paykel Appliances Holdings Ltd	3.1	20,277	2,842	6	3.41	227,375	7,481	29
Fisher & Paykel Healthcare Corporation Ltd	3.3	27,436	8,945	4	3.63	327,175	8,778	37
Nuplex Industries Ltd	4.1	6,579	2,787	3	4.49	46,590	2,693	16
New Zealand Oil & Gas Ltd	0.9	22,026	6,992	3	0.93	135,309	8,826	15
Sky City Entertainment Group Ltd	4.3	38,742	2,682	13	4.70	570,692	10,234	51
Telecom Corporation of New Zealand Ltd	5.4	1,255,801	7,943	157	5.85	3,475,368	26,414	129
Tower Ltd	1.9	477,621	4,725	96	2.09	337,119	11,018	26
Vea Advantage Limited	3.5	342,944	4,482	82	3.79	53,541	5,944	7
Waste Management NZ Limited	5.6	6,756	2,855	2	6.08	98,961	3,724	27
The Warehouse Group Limited	3.5	10,142	2,554	4	3.82	192,355	6,397	30

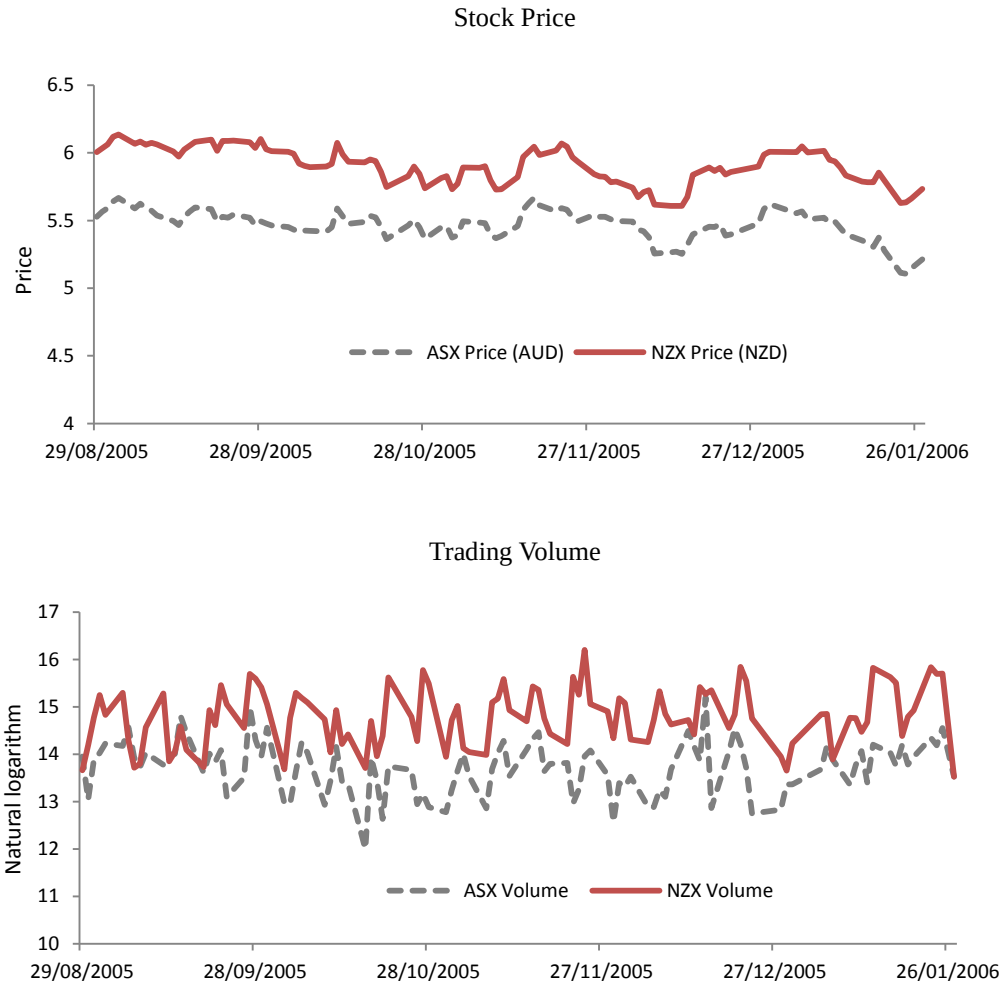
Table 4: Summary trading statistics for final sample of stock of NZX anonymity

This table presents sample stocks' average price, number of shares traded, trade size and number of trades per day over study period of NZX anonymity on both the New Zealand Australian exchanges. Average NZX and ASX prices are expressed in their respective currencies.

	Trading on ASX				Trading on NZX			
Company Name	Price ($)	Shares Traded	Trade Size	Trades/Day	Price ($)	Shares Traded	Trade Size	Trades/Day
Panel B: Australian Companies								
Australian Foundation Investment Co. Ltd	5.7	201,208	1,980	103	6.52	6,619	1,943	3
AMP Ltd	10.4	3,667,692	2,178	1,683	11.76	13,729	1,071	11
Australia and New Zealand Banking Group Ltd	29.3	3,310,134	1,115	2,957	33.27	11,392	1,679	6
Goodman Fielder Limited	2.5	2,432,382	4,932	514	2.80	33,089	6,023	5
L & M Petroleum Limited	0.2	242,013	23,741	10	0.18	82,759	16,152	5
Lion Nathan Ltd	9.0	697,434	1,126	630	10.24	9,679	2,100	4
Pacific Brands Limited	3.4	1,662,999	3,058	602	3.80	4,133	2,395	2
Pan Pacific Petroleum NL	0.2	1,252,546	25,801	47	0.28	236,378	33,618	7
Telstra Corporation Ltd	4.6	19,949,531	13,330	1,514	5.23	17,570	2,998	5
Westpac Banking Corporation	26.6	2,990,328	1,140	2,622	30.22	24,025	1,447	11
Panel B: New Zealand Companies								
Auckland International Airport Ltd	2.6	55,999	4,626	13	2.94	1,708,632	23,548	72
Air New Zealand Ltd	2.3	54,236	4,289	15	2.57	647,372	18,265	39
Fletcher Building Ltd	10.7	110,165	1,413	90	12.17	671,205	8,247	81
Fisher & Paykel Appliances Holdings Ltd	3.2	45,363	13,928	11	3.63	499,994	13,090	37
Fisher & Paykel Healthcare Corporation Ltd	3.1	50,001	4,013	15	3.50	828,225	10,800	76
Heritage Gold NZ Ltd	0.1	371,205	50,804	7	0.08	118,601	27,449	4
Nuplex Industries Ltd	6.2	3,001	1,490	2	7.10	29,007	1,907	15
New Zealand Oil & Gas Ltd	0.9	63,119	7,800	8	1.06	219,459	9,750	22
Sky City Entertainment Group Ltd	4.2	55,290	2,876	19	4.82	958,539	11,148	73
Telecom Corporation of New Zealand Ltd	4.1	1,975,694	6,273	323	4.62	4,061,509	35,028	119
Tower Ltd	2.0	289,998	2,450	129	2.30	282,338	7,569	35
The Warehouse Group Limited	5.6	17,725	2,598	6	6.33	287,291	7,603	36

Figure 1 shows a representative section of the price and volume behavior of TLS in both markets. Clearly, price series track each other closely, and trading volume in the two markets also follow a similar pattern. This implies a very close relationship between home and cross-listed markets.

Figure 1: Plot of Stock Price and Trading Volume for TEL



5. METHODOLOGY

As observed earlier, the sample stocks trade more frequently in their home market. Hasbrouck (1991) points out that illiquid stocks tend to exhibit higher information asymmetry. Easley et al. (1996) indicate that inactive stocks are subject to greater informed trading. Literature on home bias also finds information differences between foreign and domestic investors. Therefore, information effects would be greater for foreign stocks, which is less liquid comparing to domestic stocks.

Given the differences in trading characteristics between domestic and foreign stocks, we conduct separate analysis for Australian and New Zealand incorporated stocks. This also allows us to observe if anonymity effects are consistent across the two groups of stocks.

5.1 Univariate Analysis

For each market, liquidity is examined over a 6-month period around the event date, and measured in three principal ways. First, the bid-ask spreads are calculated as:

$$Spread\ (\$) = Ask - Bid,$$

$$Relatvie\ Spread = \frac{(\text{ask} - \text{bid})}{(\text{ask} + \text{bid})/2}\ ,$$

where *Spread ($)* is denoted as dollar spread, and *Relative Spread* is the spread calculated in percentage. Ask and bid are the best ask and bid prices, respectively.

The second liquidity measure is quoted depth. It is calculated as the average dollar value of shares on offer at the best bid and ask:

$$Depth\ (\$) = \frac{(\text{ask volume} + \text{bid volume}) * \text{price}}{2}$$

The third liquidity measure is dollar trading volume. It is calculated as the number of

shares traded multiplied by the price per share:

$$Volume\ (\$) = \text{number of shares traded} * \text{price}$$

Table 5 and Table 6 report univariate analysis for these liquidity measures during the regulatory change in ASX and NZX, respectively. Cross-sectional means for bid-ask spreads, depth and trading volume for NZX and ASX are provided in Panel A and B, respectively. Separate figures are reported for the pre-event period *Pre*, post-vent period *Post*, and the difference between the *Pre* period and *Post* period. *Difference* is calculated as *Post* less *Pre*. Figures within parentheses are t-statistics of the differences (from unequal variance)[3]. Dollar spread, depth and volume on ASX and NZX are specified in their respective currencies.

Table 5: Univariate Analysis of ASX Anonymity

The table reports cross-sectional average for bid-ask spread, dollar depth and volume for ASX anonymity. *Pre* is the pre-event period, and *Post* is the post-event period. *Difference* is calculated as *Post* less *Pre*. t-statistics of the differences (from unequal variance) are estimated in parentheses. Dollar spread, depth and volume on ASX and NZX are specified in their respective currencies.

	Trading on ASX			Trading on NZX		
	Pre	*Post*	*Difference*	*Pre*	*Post*	*Difference*
Panel A: ASX companies						
Spread ($)	0.013	0.012	-0.001	0.099	0.086	-0.013
			(-3.0)***			(-1.7)*
Relative Spread (%)	1.089	0.783	-0.306	2.760	1.876	-0.884
			(-2.7)***			(-4.5)***
Depth ($000)	463	452	-11	41	43	2
			(-0.1)			(1.1)
Volume ($000)	26,041	25,681	-360	144	118	-26
			(-0.2)			(-1.5)
Panel B: New Zealand Companies						
Spread ($)	0.050	0.043	-0.008	0.020	0.021	0.002
			(-2.5)**			(1.7)*
Relative Spread (%)	1.997	1.344	-0.653	1.036	0.670	-0.366
			(-4.9)***			(-4.3)***
Depth ($000)	68	52	-16	175	103	-72
			(-3.0)***			(-3.9)***
Volume ($000)	772	876	104	2,734	3,194	460
			(0.8)			(1.2)

[3] Two-sample t-test on the mean difference is based on Selvanathan et al (2006).

Table 6: Univariate Analysis of NZX Anonymity

The table reports cross-sectional average for bid-ask spread, dollar depth and volume for NZX anonymity. *Pre* is the pre-event period, and *Post* is the post-event period. *Difference* is calculated as *Post* less *Pre*. t-statistics of the difference in liquidity (from unequal variance) are estimated in parentheses. Spread ($), depth ($) and volume ($) on ASX and NZX are specified in their respective currencies.

	Trading on ASX			Trading on NZX		
	Pre	*Post*	*Difference*	*Pre*	*Post*	*Difference*
Panel A: ASX companies						
Spread ($)	0.011	0.012	0.001	0.210	0.245	0.034
			(3.4)***			(1.8)*
Relative Spread (%)	0.942	1.075	0.134	3.040	3.752	0.712
			(1.1)			(2.8)***
Depth ($000)	506	554	48	22	23	1
			(0.5)			(1.2)
Volume ($000)	32,145	38,143	5,998	93	200	107
			(2.1)**			(3.3)***
Panel B: New Zealand Companies						
Spread ($)	0.054	0.062	0.008	0.018	0.020	0.001
			(1.4)			(1.7)*
Relative Spread (%)	1.680	2.143	0.463	0.859	1.147	0.288
			(3.7)***			(2.6)***
Depth ($000)	40	30	-10	70	60	-10
			(-3.0)***			(-2.8)***
Volume ($000)	1,064	924	-140	3,811	4,535	724
			(-0.8)			(1.5)

Consistent with Table 3 and Table 4, greater trading activity with narrower spread at the home market is evident. Average depth and volume for Australian companies are many times higher on ASX than on NZX, whilst liquidity of New Zealand companies is also higher on NZX. Spreads of Australian stocks are lower on ASX and spreads of New Zealand stocks are lower on NZX, reflecting a better liquidity on the home market.

This univariate analysis is not very indicative of anonymity effects. The simple statistics in the tables may ignore some factors that also affect liquidity in the stocks of interest. For example, comparing *Pre* to *Post* from Table 5, bid-ask spreads of Australian companies decline in both exchanges. Relative spreads of New Zealand companies also decrease significantly on both exchanges.

Similarly, after the introduction of anonymity on NZX, liquidity and spread deteriorate in both exchanges. Clearly, the overall market trends either upturn or

downturn would make it difficult to identify any anonymity effects on the trading of cross-listed stocks. Chordia et al. (2000) refer this to the commonality in liquidity in financial markets. In the study of NYSE stocks, they show that quoted spreads and depth co-move with market and industry wide liquidity. This suggests that market liquidity is affected not only by a structural change, but also by market-wide factors. This confirms the need for multiple regression models that are able to properly isolate the anonymity effects.

5.2 Fixed Effect Instrumental Variable (IV) Estimation

Multivariate analysis is conducted by employing instrumental variable 2SLS technique, so as to overcome possible endogeneity problem (Maher et al., 2008). The structure of the model is as follows:

$$Liquidity_{i,t} = \beta_0 + \beta_1 Stock\ Control_{i,t} + \beta_2 Price\ Difference_{i,t} + \beta_3 Market\ Control_t + \beta_4 Change_{i,t} + \alpha_i + \varepsilon_{i,t} \quad (1)$$

where the subscript *i* denotes individual firms, *t* denotes the day, α_i is a firm-specific parameter, *Change*=1 if day *t* is after the introduction of anonymity, and zero otherwise. This variable is the key variable for assessing the impact of the broker identification policy change. *Liquidity* is the natural logarithm of ASX/NZX liquidity (spread, depth and volume), *Stock Control*, *Price Difference* and *Market Control* are three log-transformed control variables. Gujarati (2003) comments that the log transformation compresses the scales in which the variables are measured, and increases the model accuracy.

Stock Control is natural logarithm of the same liquidity measures of the same stock *i* on NZX (ASX), when dependent variable is liquidity of the cross-listed stock *i* on ASX (NZX). Instead of using volume, price and volatility as individual determinants, this variable is an idea natural control for stock-specific shift in liquidity. However, introducing the NZX (ASX) liquidity as an independent variable in ASX (NZX) liquidity regression may give the impression of two-way or mutual causality. A 2SLS using instrumental variables is implemented, if Hausman specification test of simultaneity indicates that *Stock Control* is indeed endogenous in the regression.

In accordance with Gujarati (2003), the instrumental variable must be theoretically justified, and are required to be correlated with the endogenous variable, but uncorrelated with the error term of the original regression. Three instruments are used in this study including lagged *Stock Control*, natural logarithm of *market capitalization* and natural logarithm of *trade size*. The theoretical basis of using lagged explanatory variable is that past (that is lagged) variable are not systematically correlate with current condition (Harris, 1994). The inclusion of market capitalization is to capture the degree of information asymmetry among stocks. This is because the smaller the stock, the greater the information asymmetry (Hasbrouck, 1991), which will be reflected in bid-ask spread, depth and volume (Maher et al., 2008). The last instrumental variable used in the first-stage regression is *trade size*. Maher et al. (2008) indicates that when predicting the impact of policy change on spread, trade size can serve as strong instruments. All these instrumental variables have been used in related literature (e.g. Harris, 1994; Maher et al., 2008). We perform tests of the relevance and validity of various combinations of instruments before applying them. The 2SLS analysis is conducted individually for each of these three liquidity measures, each study period and each group of stocks (i.e. Australian and New Zealand incorporated stocks). Since not every instrumental variable satisfies the required conditions of relevance and exogeneity in every analysis, the 2SLS estimation implements instruments that satisfy these conditions and uses fitted values from the first-stage regressions as the explanatory variables in the second stage.

The second control variable is *Price Difference*, which is defined as logarithmic price difference between NZX and ASX prices (NZX price minus ASX price), in which ASX price is converted into New Zealand dollar by using prevailing exchange rate. As indicated by Grammig et al. (2005), foreign exchange rate influences the differential between home and foreign markets prices. Liquidity from foreign market is then crucial for performing arbitrage trading, bringing prices to fundamental values and keeping markets efficient (Shleifer and Vishny, 1997). It is likely that a source of liquidity in the trading of cross-listed stocks comes from their foreign counterparts, where traders seek the cheapest trading location or price advantages. Including *Price Difference* is thus to capture price difference effects.

The last control variable is *Market Control* to control for a market-wide factor.

Chordia et al., (2000) find that market-wide factors can influence liquidity in financial markets as a whole. Majois (2007) also points out that natural experiments methodology needs to control for a global liquidity factor. In our study, the market-wide commonality seems to appear in Australian and New Zealand markets as shown in the previous univariate analysis. Without controlling for a market-wide factor, the analysis from ordinary least squares regression shows a decreased depth in both ASX and NZX during the study period of NZX anonymity[4]. In fact, during middle August 2007, global financial crisis struck financial markets, resulting overall market downturn. Within our study period, the Australian All Ordinaries Index (New Zealand NZ50 Index) was 6392.2 (4236.7) on 6 July 2007, and fall to 5670.3 (3894.3) on 17 August 2007, a decline of 11.3% (8.1%), before recovering to 6579.9 (4279.8) points on 4 October 2007.

Therefore, to independence of possible broad market movements, we introduce *Market Control* by constructing a control sample of non-cross-listed stocks matched 1-2 with each cross-listed stock in each market. Following an approach similar to Bacidore and Sofianos (2000), these control stocks are matched based on the priority of trading volume, price, then market capitalization and industry if possible. The order of these selection criteria is due to trading characteristics of the sample stocks and the constraints on selecting NZX-listed matched stocks. The New Zealand stock exchange is a very small market. During our study period, only 63 New Zealand domestic stocks are available to be chosen as control stocks (after excluding the sample stocks and overseas stocks). These stocks are relatively small comparing to the sample stocks. The majority is middle and small cap stocks, and only 3 out of 63 are included in NZX 10 index. Moreover, the trading of some ASX's large cap stocks on NZX may be hundreds of times less than the trading on ASX. For example, TLS (Telstra Corporation Ltd) has a market capitalization of $AUD 55 billion, whilst its daily average trading volume on NZX is only about $AUD110,000. Matching priority is thus in order of trading volume, price, and then market capitalization and industry.

Appendix 1 and 2 list these control stocks that matched with the cross-listed stock for ASX and NZX anonymity respectively. Table 7 provides summary statistics for the sample and matched stocks over the study periods of ASX and NZX anonymity. It

[4] Results are available on request.

shows that the NZX control stocks are relatively smaller compared to the sample stocks, as discussed earlier. For the trading on ASX, the sample stocks have average trading volume and price similar to their matched sample, suggesting that the matching procedure is effective in identifying suitable control stocks.

The average liquidity variable across these matched stocks is calculated as a market liquidity proxy, i.e *Market Control* for controlling the effect of broad market movements. To ensure that the results are not subject to stock matching bias, we also construct a 1-1 matched sample, as well as use all 63 NZX stocks as a proxy of market liquidity. The results are robust to these alternative comparison samples[5].

[5] Those results are available on request.

Table 7: Summary Statistics for Sample (Cross-listed) Stocks and Matched (Non-cross-listed) Stocks

This table contains summary statistics for our sample of cross-listed stocks and matched non-cross-listed stocks during the study periods of ASX and NZX anonymity. The mean dollar volume, price and market capitalization are calculated, and all are specified in their own currencies.

	Trading on ASX				Trading on NZX			
	Mean	Median	Min	Max	Mean	Median	Min	Max
Panel A: ASX Anonymity								
Volume ($000)								
24 Sample firms	10,358,618	385,292	19,024	83,887,016	1,559,467	263,002	9,888	20,099,244
48 Matched firms	10,074,113	1,186,351	13,856	209,750,036	161,424	59,503	6,810	1,381,952
Price ($)								
24 Sample firms	5.24	3.81	0.12	23.78	5.69	4.15	0.13	25.81
48 Matched firms	6.80	3.84	0.06	40.71	3.23	2.39	0.36	20.41
Market capitalization ($)								
24 Sample firms	8,152,041,096	1,758,482,328	52,584,706	51,095,740,487	8,848,185,445	1,908,296,058	57,678,714	55,579,093,522
48 Matched firms	5,301,219,350	1,105,946,835	5,519,509	80,046,243,288	495,397,359	207,209,407	8,442,474	3,975,042,410
Panel B: NZX Anonymity								
Volume ($000)								
22 Sample firms	14,989,281	462,615	14,926	94,172,447	2,113,681	296,032	9,251	18,716,873
44 Matched firms	20,552,633	3,060,492	14,189	391,265,530	228,197	83,623	5,980	2,350,977
Price ($)								
22 Sample firms	6.22	3.72	0.06	29.32	7.06	4.20	0.08	33.27
44 Matched firms	10.17	5.97	0.13	54.55	3.50	2.55	0.65	10.38
Market capitalization ($)								
22 Sample firms	10,168,900,313	2,081,436,766	14,353,305	57,484,652,160	11,536,300,743	2,359,558,159	17,344,206	65,140,855,990
44 Matched firms	8,369,723,866	2,128,814,279	11,374,257	117,832,559,252	643,099,988	251,916,273	34,361,883	5,231,507,813

6. RESULTS

Using instrumental variables 2SLS of equation (1), this session tests the two pairs of hypotheses, *Hypothesis 1A* and *Hypothesis 1B* for the liquidity impact on the trading of cross-listed stocks after ASX's adoption of anonymous trading, and *Hypothesis 2A* and *Hypothesis 2B* for the liquidity impact after NZX's introduction of anonymous trading. The equation is conducted separately for Australian and New Zealand incorporated stocks and uses robust standard errors.

6.1 Liquidity Impact of ASX Anonymity

Table 8 reports the results of 2SLS estimation. The dependent variable is liquidity of cross-listed stock *i* on ASX, the *stock control* variable is the same liquidity measure of same stock *i* on NZX (*NZX Liquidity*), and the control variable for market commonality is the average liquidity of 48 matched stocks on ASX (*Market Control)*. When analyzing this change in ASX liquidity, equation (1) can be expressed as:

$$ASX\ Liquidity_{i,t} =$$

$$\beta_0 + \beta_1 NZX\ Liquidity_{i,t} + \beta_2 Price\ Difference_{i,t} + \beta_3 ASX\ Market\ Control_t +$$

$$\beta_4 Change_{i,t} + \alpha_i + \varepsilon_{i,t} \qquad (2)$$

The first stage diagnostics and various statistics reported in Table 8 shows that a 2SLS model is necessary for all liquidity measures except depth ($) regression in Panel A. The instruments include 3 lags of *NZX liquidity* measures, log-transformed *trade size* and *market capitalization*. Hausman specification test of simultaneity and Durbin-Wu-Hausman chi-sq test of endogeneity are used to determine whether the instrumental variable is the preferred estimator. The null hypothesis is that there are no endogeneous variables or that endogeneity does not affect the OLS estimator. If both tests indicate no endogeneity issue as well as no preferred IV estimates, OLS estimates will be used. Instruments are implemented if they passed the tests of relevance and validity. The condition of relevance is tested by examining the fit of the first stage endogenous regressor (*NZX Liquidity*) on the full set of instruments. The

first stage coefficients, partial R-square and partial F statistics on relevance of instruments are reported. The Sargan test of over identifying restrictions and LM IV test of redundancy are used for the instruments validity. The Anderson canon.corr. LM statistic is to examine whether the equation is adequately identified.

The 2SLS results show that all ASX liquidity measures including bid-ask spreads, depth and volume, are directly related to the liquidity on NZX, and the liquidity of matched stocks on ASX. This indicates the evidence of commonality in liquidity, and significant association between liquidity in domestic and foreign market. The evidence of price difference impacts seems to appear in some liquidity measures. In our daily time-series analysis, this may presents an arbitrage opportunity that traders try to take advantage of a price difference between the markets, by buying an asset where the price is low and resell it where the price is high. The extent and direction of price difference effects depend on various factors, such as trade direction (buy or sell initiated) and transaction costs of buying, holding and reselling. An estimation of price impact on liquidity is beyond the scope of this paper, our study aims to examine anonymity effects using multiple regression models that are able to control for other factors that simultaneously affect the liquidity[6].

After controlling for all these confounding factors, the *change* dummy variable shows that ASX's move to anonymous market leads to an improved liquidity on ASX in the trading of both Australian and New Zealand companies, supporting *Hypothesis 1A*. Panel A shows that the dollar spread of Australian stocks decreases, which is statistically significant 5% level. Panel B indicates that this liquidity effect is more apparent in New Zealand stocks, which have a significant (at 1% level) decrease in both dollar and relative spread, and significant increase (at 10% level) in depth. In the volume regression, the *change* variable is positive but not significant. The independent variables explain approximately 97% (73%) of the variation in dollar spreads, 78% (76%) in relative spread, 92% (76%) in depth, and 90% (64%) volume for Australian (New Zealand) stocks, indicating each regression fits the data quite well.

[6] We also conduct regression analysis without including price difference as control variable, and converting the AUD price series to New Zealand using prevailing exchange rate. We obtain the same conclusion. These results are available on request.

Table 8: Impact of ASX Anonymity on ASX Liquidity - IV 2SLS Estimation

This table reports the 2SLS estimation of equation (2). The instruments include 3 lags of *NZX liquidity* measures, *trade size* and *market capitalization*. Hausman specification test of simultaneity and Durbin-Wu-Hausman chi-sq test of endogeneity are used to determine whether a 2SLS procedure is necessary. Instruments are implemented if they passed the tests of relevance and validity. The condition of relevance is tested by examining the fit of the first stage endogenous regressor (*Stock Control*) on the full set of instruments. The first stage coefficients, partial R-square and partial F statistics on relevance of instruments are reported. The Sargan test of over identifying restrictions and LM IV test of redundancy are used for the instruments validity. The Anderson canon.corr. LM statistic is to examine whether the equation is adequately identified. *. **. *** denote statistical significance at the 10%, 5% and 1% levels.

	Panel A: Australian stocks				*Panel B: New Zealand Stocks*			
	Spread (%)	Spread ($)	Depth ($)	Volume ($)	Spread (%)	Spread ($)	Depth ($)	Volume ($)
Constant	-1.64	-2.70	1.90	0.88	-0.32	-1.45	1.20	-2.36
	(-4.7)***	(-7.6)***	(1.2)	(0.5)	(-0.3)	(-2.2)**	(0.61)	(-0.98)
NZX Liquidity	0.00	-0.02	0.06	0.53	0.75	0.32	0.72	0.83
	(0.2)	(-0.7)	(2.1)**	(4.1)***	(4.8)***	(8.5)***	(8.8)***	(5.64)***
Price Difference	0.82	0.35	-0.83	4.62	-0.87	0.70	-5.29	-6.62
	(1.9)*	(0.9)	(-0.5)	(1.4)	(-0.5)	(0.6)	(-4.8)***	(-2.41)**
Market Control	0.55	0.53	0.66	0.46	0.07	0.27	0.04	0.07
	(8.3)***	(6.6)***	(4.8)***	(3.7)***	(0.5)	(1.8)**	(0.2)	(0.39)
Change	0.01	-0.02	-0.02	0.08	-0.09	-0.08	0.06	0.10
	(0.6)	(-2.1)**	(-0.6)	(1.5)	(-3.6)***	(-3.9)***	(1.7)*	(1.34)
R-squared	0.97	0.78	0.92	0.90	0.73	-1.45	0.71	0.64
Hausman specification t-test	2.01**	0.26	0.88	2.51**	0.81	1.07	1.29	1.20
Durbin-Wu-Hausman chi-sq test	3.36*	7.00***	2.28	20.92***	10.54***	9.71***	28.39***	16.87***
First stage coefficients								
lag 1 of NZX liquidity	0.32***	0.32***		0.11***	0.22***	0.22***		0.21***
lag 2 of NZX liquidity	0.13***	0.14***					0.23***	0.07***
lag 3 of NZX liquidity							0.07***	
Trade size ($)							0.18***	
Market capitalization ($)				2.36**	-0.53*	0.06		
Partial R-sq	0.15	0.15		0.04	0.065	20.53***	0.16	0.06
Partial F statistic	52.05***	54.43***		16.60***	28.50***	72.93***	67.28***	24.86***
Anderson canon. corr. LM statistic	151.41***	155.23***		39.14***	88.91***		217.18***	71.37***
Sargan statistic	0.15	0.01		0.36	0.29		0.09	1.21
LM test of redundancy								
lag 1 of NZX liquidity	91.88***	93.04***		12.58***	72.90***			53.48***
lag 2 of NZX liquidity	17.52***	18.54***					181.97***	7.06***
lag 3 of NZX liquidity							74.29***	
Trade size ($)							163.76***	
Market capitalization ($)				20.08***	10.16***			

Table 9 presents the 2SLS results for the liquidity impacts on NZX after ASX switched to anonymous trading. When analyzing this changing in NZX liquidity, equation (1) can be expressed as:

$$NZX\ Liquidity_{i,t} =$$
$$\beta_0 + \beta_1 ASX\ Liquidity_{i,t} + \beta_2 Price\ Difference_{i,t} + \beta_3 NZX\ Market\ Control_t +$$
$$\beta_4 Change_{i,t} + \alpha_i + \varepsilon_{i,t} \quad (3)$$

The dependent variable is the liquidity of cross-listed stock *i* on NZX, the control variable *Stock Control* is the same liquidity measure of same stock *i* on ASX (*ASX Liquidity*), and *Market Control* is the average liquidity variable across 48 matched samples on NZX.

The 2SLS results provide evidence that ASX's move to anonymous market adversely affects the liquidity on NZX, supporting *Hypothesis 1A*. The trading of Australian stocks on NZX is deteriorated with a declining in volume at 10% significance level. The deterioration in liquidity is more obvious for New Zealand stocks. There is a considerable increase in both percentage and dollar spreads, and decrease in depth, which are all statistically significant at 1% level. The results also show the evidence on the commonality in liquidity. NZX liquidity of cross-listed stocks is positively related to ASX liquidity and liquidity of matched stocks.

There is a weak evidence of increased ASX's market share of Australian domestic stocks (generally large and liquid stocks), as shown by decreased NZX's volume (10% significance level) and marginally increased ASX' volume. There is no apparent change in the volume of New Zealand stocks (generally small and less liquid stocks). These results are somewhat consistent with Comerton-Forde and Tang (2009), who find that ASX market share increases in the large stocks that are cross-listed on NZX after ASX adopted anonymity regime.

Table 9: Impact of ASX Anonymity on NZX Liquidity - IV2SLS Estimation

This table reports the 2SLS estimation of equation (3). The instruments include 3 lags of *ASX liquidity* measures, *trade size* and *market capitalization*. Hausman specification test of simultaneity and Durbin-Wu-Hausman chi-sq test of endogeneity are used to determine whether a 2SLS procedure is necessary. Instruments are implemented if they passed the tests of relevance and validity. The condition of relevance is tested by examining the fit of the first stage endogenous regressor (*Stock Control*) on the full set of instruments. The first stage coefficients, partial R-square and partial F statistics on relevance of instruments are reported. The Sargan test of over identifying restrictions and LM IV test of redundancy are used for the instruments validity. The Anderson canon.corr. LM statistic is to examine whether the equation is adequately identified. *. **. *** denote statistical significance at the 10%, 5% and 1% levels.

	Panel A: Australian stocks				*Panel B: New Zealand Stocks*			
	Spread (%)	Spread ($)	Depth ($)	Volume ($)	Spread (%)	Spread	Depth ($)	Volume ($)
Constant	-1.80	-0.63	9.67	-5.09	-2.82	-3.24	5.08	1.44
	(-2.5)**	(-0.9)	(6.09)***	(-2.1)**	(-6.4)***	(-8.5)***	(3.7)***	(0.9)
ASX Liquidity	0.42	0.36	0.13	1.19	0.26	0.23	0.56	0.65
	(4.7)***	(4.1)***	(2.61)***	(5.0)***	(3.8)***	(3.5)***	(7.5)***	(4.9)***
Price Difference	-1.75	-1.59	-5.86	-6.75	3.80	4.11	4.15	7.25
	(-1.2)	(-1.0)	(-4.16)***	(-1.5)	(2.4)**	(2.6)***	(4.3)***	(3.3)***
Market Control	-0.07	0.36	-0.15	0.01	0.28	0.12	0.08	0.57
	(-0.5)	(2.3)**	(-0.96)	(0.09)	(3.6)***	(1.4)	(0.5)	(4.6)***
Change	-0.01	-0.02	-0.05	-0.15	0.06	0.07	-0.09	-0.05
	(-0.4)	(-0.5)	(-1.29)	(-1.8)*	(3.5)***	(4.1)***	(-2.8)***	(-0.8)
R-squared	0.60	0.74	0.60	0.43	0.751	0.713	0.737	0.617
Hausman specification t-test	0.53	1.42	0.60	0.66	1.98**	1.70*	1.12	1.52
Durbin-Wu-Hausman chi-sq test	0.29	0.38	0.44	27.72***	2.03	1.06	21.62***	13.03***
First stage coefficients								
lag 1 of ASX liquidity				0.21***	0.265***	0.268***	0.29***	0.167***
lag 2 of ASX liquidity				0.14***	0.057*	0.056***	0.165***	0.082***
lag 3 of ASX liquidity								
Trade size ($)					-0.061***	-0.06***		
Market capitalization ($)				1.28***				
Partial R-sq				0.11	0.11	0.11	0.15	0.04
Partial F statistic				15.49***	43.04***	43.61***	87.28**	20.99***
Anderson canon. corr. LM statistic				88.54***	143.22***	145.40***	196.22***	50.72***
Sargan statistic				1.42	0.052	0.68	0.84	0.19
LM test of redundancy								
lag 1 of ASX liquidity				41.34***	86.82***	89.67***	110.62***	35.15***
lag 2 of ASX liquidity				18.71***	4.26**	4.22**	37.40***	8.63***
lag 3 of ASX liquidity								
Trade size ($)					25.09***	25.13***		
Market capitalization ($)				15.52***				

In summary, the results from testing the first pair of hypotheses show that liquidity increases on ASX and decreases on NZX, after ASX switched to anonymous trading. This shift in liquidity is in the form of a significant decline of bid-ask spreads and an improvement of quoted depth on ASX, and a significant deterioration of spreads, quoted depth and trading volume on NZX. These results provide support to Foucault et al. (2007) that anonymity makes limit order book traders more willing to trade. Strong evidence is also found for market-wide commonality in liquidity. Liquidity of cross-listed stocks in domestic and foreign market and the overall market movement are directly related, providing support to Chordia et al. (2000) and Majois (2007).

6.2 Liquidity Impact of NZX Anonymity

This session presents the results of tests for *Hypothesis 2A* and *Hypothesis 2B* and provides evidence of liquidity impact on ASX trading after NZX's adoption of broker anonymity regime. The 2SLS estimation is based on equation (2), where *Market Control* is the average liquidity variable across 44 matched samples on ASX.

Table 10 shows that liquidity of cross-listed stocks on ASX co-moves with NZX liquidity and market liquidity, providing evidence of liquidity commonality in financial markets. After controlling for stock-specific and market-wide factors, the post-anonymity dummy variable shows decreased liquidity of cross-listed stocks on ASX after NZX introduced anonymous trading, supporting *Hypothesis 2A*. Panel A reveals that Australian stocks experience a significant increase in percentage and dollar spreads and a significant decline in dollar depth and volume. These declinations are statistically significant at 1% level. Panel B indicates that the liquidity impact is less significant in the trading of New Zealand stocks. Percentage spread increases, which is statistically significant at 10% level, whilst no significant change in depth and volume.

Table 10: Impact of NZX Anonymity on ASX Liquidity - IV 2SLS Estimation

This table reports the 2SLS estimation of equation (2). The instruments include 3 lags of *NZX liquidity* measures, *trade size* and *market capitalization*. Hausman specification test of simultaneity and Durbin-Wu-Hausman chi-sq test of endogeneity are used to determine whether a 2SLS procedure is necessary. Instruments are implemented if they passed the tests of relevance and validity. The condition of relevance is tested by examining the fit of the first stage endogenous regressor (*Stock Control*) on the full set of instruments. The first stage coefficients, partial R-square and partial F statistics on relevance of instruments are reported. The Sargan test of over identifying restrictions and LM IV test of redundancy are used for the instruments validity. The Anderson canon.corr. LM statistic is to examine whether the equation is adequately identified. *. **. *** denote statistical significance at the 10%, 5% and 1% levels.

	Panel A: Australian stocks				*Panel B: New Zealand Stocks*			
	Spread (%)	Spread	Depth ($)	Volume ($)	Spread (%)	Spread	Depth ($)	Volume ($)
Constant	-0.22	-3.09	1.98	-3.71	2.53	1.50	-0.70	-5.55
	(-0.6)	(-11.2)***	(1.8)*	(-1.9)**	(2.7)***	(1.6)*	(-0.4)	(-1.6)
NZX Liquidity	0.07	0.02	0.04	0.49	0.79	0.67	0.67	1.25
	(2.3)**	(2.6)***	(1.8)*	(3.9)***	(4.1)***	(3.1)***	(6.8)***	(6.0)***
Price Difference	0.26	0.81	0.92	2.44	0.14	-0.51	2.54	5.52
	(0.4)	(1.9)*	(0.8)	(1.3)	(0.1)	(-0.5)	(2.1)**	(1.4)
Market Control	0.50	0.48	0.60	0.62	0.51	0.54	0.28	-0.15
	(7.9)***	(7.3)***	(6.3)***	(5.1)***	(3.2)***	(2.9)***	(2.1)***	(-0.6)
Change	0.10	0.05	-0.18	-0.14	0.06	0.02	-0.03	-0.08
	(7.7)***	(4.6)***	(-5.7)***	(-2.3)**	(1.7)*	(0.5)	(-0.66)	(-0.9)
R-squared	0.98	0.84	0.93	0.92	0.68	0.75	0.66	0.51
Hausman specification t-test	2.71**	1.23	1.22	0.84	1.73*	1.91*	1.96**	2.65***
Durbin-Wu-Hausman chi-sq test	0.19	0.48	1.95	17.75***	9.09***	4.51**	15.60***	31.95***
First stage coefficients								
lag 1 of NZX liquidity	0.30***			0.14***			0.18***	0.11***
lag 2 of NZX liquidity	0.12***			0.13***	0.18***	0.13***	0.14***	0.09***
lag 3 of NZX liquidity					0.14***	0.15***		
Trade size ($)							0.170***	
Market capitalization ($)								1.71***
Partial R-sq	0.13			0.04	0.07	0.05	0.16	0.05
Partial F statistic	55.54***			15.51***	24.39***	17.67***	54.88***	19.80***
Anderson canon. corr. LM statistic	128.55***			38.97***	82.05***	63.35***	183.75***	54.92***
Sargan statistic	0.00			1.51	0.06	0.05	0.91	0.50
LM test of redundancy								
lag 1 of NZX liquidity	85.52***			18.98***			42.07***	12.97***
lag 2 of NZX liquidity	14.44***			14.70***	38.27***	27.60***	25.75***	9.68***
lag 3 of NZX liquidity					20.42***	20.77***		
Trade size ($)							95.09***	
Market capitalization ($)								20.17***

Table 5-11 presents the 2SLS results of the anonymity effects in the trading of cross-listed stocks on NZX. The estimation is based equation (3), where *market control* is the average liquidity variable of 48 matched stocks on NZX.

The table shows again the evidence of liquidity commonality in Australia and New Zealand markets. The coefficient of *Market Control* variable is statistically significant in most regressions. The post-anonymity dummy variable shows that the switch to anonymous market by NZX leads to a significant improvement in NZX market share in the trading of cross-listed stocks, supporting *Hypothesis 2B*. The dollar value of trades increases drastically in NZX, which is statistically significant at 1% level. Correspondingly, trading volume decreases considerably in ASX, which is statistically significant at 5% level. These findings provide support to Poskitt et al. (2011), who show an increasing in the NZX's share of trading in cross-listed stocks after the switch to anonymous trading.

There is no significant change in spreads and depth, which could be due to the fact that at the time when NZX adopted anonymity regime, ASX has already been operating anonymously. These results stand in contrast to Poskitt et al. (2011), whose univariate and multivariate analyses show an increased effective spread associated with the removal of broker identifiers in NZX. This can be explained by the methodology in Poskitt et al. (2011)'s analysis. They use OLS and 2SLS without controlling for liquidity commonality. Given global financial crisis in August 2007, results obtained by Poskitt et al. (2011) are probably not surprising.

After controlling for stock-specific and market-wide factors, the 2SLS results provides evidence supporting the second pair of hypotheses that liquidity increases on NZX and decreases on ASX, after NZX's switch to anonymous trading. This liquidity shift is evidenced by a deterioration of spreads, depth and trading volume on ASX, and an improvement of trading volume on NZX.

Table 11: Impact of NZX Anonymity on NZX Liquidity -IV 2SLS Estimation

This table reports the 2SLS estimation of equation (3). The instruments include 3 lags of *ASX liquidity* measures, *trade size* and *market capitalization*. Hausman specification test of simultaneity and Durbin-Wu-Hausman chi-sq test of endogeneity are used to determine whether a 2SLS procedure is necessary. Instruments are implemented if they passed the tests of relevance and validity. The condition of relevance is tested by examining the fit of the first stage endogenous regressor (*Stock Control*) on the full set of instruments. The first stage coefficients, partial R-square and partial F statistics on relevance of instruments are reported. The Sargan test of over identifying restrictions and LM IV test of redundancy are used for the instruments validity. The Anderson canon.corr. LM statistic is to examine whether the equation is adequately identified. *. **. *** denote statistical significance at the 10%, 5% and 1% levels.

	Panel A: Australian stocks				*Panel B: New Zealand Stocks*			
	Spread (%)	Spread	Depth ($)	Volume ($)	Spread (%)	Spread	Depth ($)	Volume ($)
Constant	2.23	2.78	6.82	-2.06	-2.87	-2.54	2.65	1.65
	(2.8)***	(2.2)**	(3.4)***	(-0.9)	(-1.2)	(-7.25)***	(1.7)*	(0.8)
ASX Liquidity	0.95	0.96	0.29	0.75	0.35	0.30	0.54	0.73
	(5.8)***	(3.0)***	(3.1)***	(4.5)***	(7.0)***	(5.7)***	(6.5)***	(6.1)***
Price Difference	-0.21	0.28	-0.25	-2.13	-0.89	-1.15	-1.80	-3.93
	(-0.2)	(0.2)	(-0.2)	(-0.8)	(-1.0)	(-1.3)	(-2.2)**	(-1.3)
Market Control	0.47	0.40	-0.06	0.37	0.24	0.23	0.34	0.47
	(2.8)***	(2.09)**	(-0.3)	(2.7)***	(2.6)**	(2.3)**	(2.6)***	(4.1)***
Change	-0.04	0.02	-0.01	0.22	-0.02	-0.01	0.00	0.15
	(-0.8)	(0.5)	(-0.2)	(2.6)***	(-0.6)	(-0.4)	(0.1)	(2.1)**
R-squared	0.50	0.84	0.38	0.41	0.81	0.71	0.75	0.73
Hausman specification test	2.48**	2.76**	1.81**	2.11**	2.49**	1.55	1.41	3.58***
Durbin-Wu-Hausman chi-sq test	7.74***	3.15*	10.84***	5.12**	23.36***	15.75***	18.89***	23.61***
First stage coefficients								
lag 1 of ASX liquidity	0.29***	0.288***	0.283***	0.339***	0.31***	0.30***	0.20***	0.16***
lag 2 of ASX liquidity	0.15***	0.146***	0.221***	0.134***	0.19***	0.18***	0.10***	
lag 3 of ASX liquidity								
Trade size ($)			0.327***					
Market capitalization ($)	-0.42***						0.87***	2.0***
Partial R-sq	0.33	0.13	0.34	0.17	0.2	0.18	0.09	0.05
Partial F statistic	66.76***	31.90***	126.13***	30.95**	125.32***	109.75***	34.37**	25.10***
Anderson canon. corr. LM statistic	329.89***	130.32***	338.65***	162.50***	232.06***	205.96***	107.84***	57.55***
Sargan statistic	0.84	0.00	0.77	1.26	0.01	0.08	0.09	0.87
LM test of redundancy								
lag 1 of ASX liquidity	72.65***	73.53***	82.85***	99.25***	109.27***	101.54***	46.11***	28.77***
lag 2 of ASX liquidity	21.54***	21.83***	64.91**	17.14**	46.65***	39.91**	11.87***	
lag 3 of ASX liquidity								
Trade size ($)			135.24***					22.04***
Market capitalization ($)	79.87***						19.89***	

7. ROBUSTNESS CHECK

Maher et al. (2008) find that using different econometric models, such as OLS and instrumental variables estimation come to opposite conclusion for spread measures. In order to obtain unbiased conclusion of anonymity effects, this section provides additional tests to examine the robustness of the reduction in bid-ask spreads and increase in quoted depth and volume after the change to an anonymous market structure. It firstly conducts the OLS analysis, and secondly employs 2SLS using different length of event window.

7.1 OLS Analysis

Table 12 presents the results of OLS with company fixed effects. Panel A identifies the impact of ASX anonymity on ASX liquidity in the trading of cross-listed stocks based on equation (2), whilst Panel B examines NZX liquidity based on equation (3). The OLS regression is performed separately for Australian and New Zealand stocks.

Consistent with Table 8, Panel A shows that after controlling for stock-specific and market-wide factors, Australian stocks have a significant reduction in spread (at 10% significance level), whilst New Zealand stocks have a significant decrease in both relative spreads and spread (at 1% significance level), though the dummy variable of depth regression is no longer significant. Panel B obtains the same conclusion as in Table 9, that is, the introduction of ASX anonymous trading affect adversely on NZX liquidity of cross-listed stocks, in particular for New Zealand companies. This OLS regression analysis further supports the first pair of hypotheses (*Hypothesis 1A* and *Hypothesis 1B*) that market liquidity improves on ASX, and deteriorates on NZX, after ASX switched to anonymous regime. The shift in liquidity from NZX to ASX seems more apparent in the trading of New Zealand companies.

Table 12: Impact of ASX Anonymity - OLS Fixed Effect Estimation

This table presents the results of regression model in an OLS fixed effects specification. Panel A reports the results from equation (2) and Panel B reports the results from equation (3). The model uses robust standard errors and it is conducted separately for each liquidity measure. *. **. *** denote statistical significance at the 10%, 5% and 1% levels.

	Australian stocks				*New Zealand Stocks*			
Panel A: Impact of ASX Anonymity on ASX Liquidity								
	Spread (%)	Spread	Depth ($)	Volume ($)	Spread (%)	Spread	Depth ($)	Volume ($)
Constant	-1.44	-2.58	1.90	2.15	-1.80	-1.45	4.48	1.36
	(-3.9)***	(-7.8)***	(1.2)	(1.7)*	(-2.5)***	(-2.2)**	(2.5)**	(0.6)
NZX Liquidity	0.05	0.04	0.06	0.13	0.32	0.32	0.37	0.31
	(4.5)***	(4.2)***	(2.2)**	(6.5)***	(8.8)***	(8.5)***	(11.4)***	(10.5)***
Price Difference	0.94	0.54	-0.83	2.56	0.88	0.70	-3.96	-3.95
	(2.2)**	(1.4)	(-0.5)	(0.8)	(0.7)	(0.6)	(-3.6)***	(-1.7)*
Market Control	0.54	0.51	0.66	0.66	0.22	0.27	0.10	0.34
	(8.0)***	(6.6)***	(4.8)***	(7.2)***	(1.7)*	(1.8)**	(0.6)	(2.4)**
Change	0.01	-0.02	-0.02	-0.01	-0.06	-0.08	0.03	0.02
	(0.8)	(-1.8)*	(-0.6)	(-0.2)	(-2.7)***	(-3.9)***	(0.9)	(0.3)
R-squared	0.98	0.79	0.92	0.933	0.76	0.79	0.73	0.71
Panel B: Impact of ASX Anonymity on NZX Liquidity								
Constant	-1.80	-0.63	9.67	1.49	-2.88	-3.18	6.98	4.97
	(-2.5)**	(-0.9)	(6.1)***	(1.0)	(-8.1)***	(-10.6)***	(5.5)***	(4.4)***
ASX Liquidity	0.42	0.36	0.13	0.40	0.18	0.18	0.29	0.24
	(4.7)***	(4.1)***	(2.6)***	(5.6)***	(8.7)***	(8.5)***	(10.1)***	(8.9)***
Price Difference	-1.75	-1.59	-5.86	-6.52	3.69	3.89	2.82	6.69
	(-1.2)	(-1.0)	(-4.1)***	(-1.7)*	(2.3)**	(2.6)**	(3.2)***	(3.2)***
Market Control	-0.07	0.36	-0.15	0.33	0.35	0.19	0.15	0.62
	(-0.5)	(2.3)**	(-0.9)	(2.8)	(4.5)***	(2.4)**	(1.2)	(6.2)***
Change	-0.01	-0.02	-0.05	-0.14	0.05	0.06	-0.10	-0.05
	(-0.4)	(-0.5)	(-1.3)	(-1.9)**	(2.8)***	(3.6)***	(-3.1)***	(-0.9)
R-squared	0.60	0.74	0.60	0.53	0.75	0.71	0.76	0.69

Table 13 presents the results of OLS fixed effect estimation for the liquidity impact on ASX trading (Panel A) and NZX trading (Panel B), after NZX switched to anonymity regime. Consistent with Table 10, Panel A shows that the trading of cross-listed stocks on ASX is seriously affected. Australian stocks record the increased spreads and decreased depth and volume. In the trading of New Zealand stocks, there is a significant (at 1% level) increase in relative spread, and the dummy variable *Change* in the depth regress becomes negative and significant at 5% significance level.

On the other hand, Panel B shows that NZX's introduction of anonymous trading leads to an increased trading volume for both Australian and New Zealand stocks. These results further support the second pair of hypotheses (*Hypothesis 2A* and *Hypothesis 2B*), that stock liquidity deteriorates on ASX, and improves on NZX, after the switch to anonymous regime on NZX. The evidence of commonality in liquidity is also shown, as all ASX liquidity measures are directly related to NZX liquidity and the liquidity of matched stocks.

Table 13: Impact of NZX Anonymity - OLS Fixed Effect Estimation

This table presents the results of regression model in an OLS fixed effects specification. Panel A reports the results from equation (2) and Panel B reports the results from equation (3). The model uses robust standard errors and it is conducted separately for each liquidity measure. *. **. *** denote statistical significance at the 10%, 5% and 1% levels.

	Australian stocks				*New Zealand Stocks*			
Panel A: Impact of NZX Anonymity on ASX								
	Spread (%)	Spread	Depth ($)	Volume ($)	Spread (%)	Spread	Depth ($)	Volume ($)
Constant	-0.12	-3.09	1.98	-0.21	1.15	0.46	2.43	0.13
	(-0.3)	(-11.2)***	(1.8)*	(-0.1)	(1.6)	(0.7)	(1.7)*	(0.1)
NZX Liquidity	0.04	0.02	0.04	0.15	0.33	0.29	0.36	0.37
	(4.1)***	(2.6)***	(1.8)*	(6.2)***	(7.2)***	(6.1)***	(10.2)***	(9.7)***
Price Difference	-0.17	0.81	0.92	4.37	-0.33	-1.10	2.25	6.95
	(-0.2)	(1.9)*	(0.8)	(2.3)***	(-0.3)	(-1.4)	(2.2)**	(2.7)***
Market Control	0.51	0.48	0.60	0.58	0.72	0.73	0.33	0.38
	(8.8)***	(7.3)***	(6.3)***	(5.3)***	(5.4)***	(4.5)***	(2.6)***	(2.2)**
Change	0.10	0.05	-0.18	-0.08	0.10	0.04	-0.09	-0.08
	(8.6)***	(4.6)***	(-5.7)***	(-1.7)*	(3.5)***	(1.3)	(-2.2)**	(-1.1)
R-squared	0.98	0.84	0.93	0.94	0.68	0.75	0.66	0.68
Panel B: Impact of NZX Anonymity on NZX								
Constant	1.60	0.90	8.30	0.09	-3.20	-2.84	5.88	8.13
	(2.1)**	(1.2)	(4.5)***	(0.1)	(-7.7)***	(-8.5)***	(4.6)***	(7.1)***
ASX Liquidity	0.52	0.42	0.09	0.47	0.16	0.13	0.24	0.25
	(5.1)***	(3.4)***	(2.0)**	(6.8)***	(7.5)***	(6.2)***	(10.2)***	(8.9)***
Price Difference	0.32	1.43	-0.55	-1.26	-1.06	-1.41	-1.23	-0.26
	(0.3)	(1.6)	(-0.4)	(-0.6)	(-1.2)	(-1.8)*	(-1.7)*	(-0.1)
Market Control	0.62	0.52	-0.02	0.41	0.35	0.32	0.33	0.37
	(3.8)***	(3.0)	(-0.1)	(3.0)***	(3.9)***	(3.4)***	(2.6)***	(3.8)***
Change	-0.02	0.05	-0.07	0.20	-0.02	-0.01	-0.06	0.14
	(-0.4)	(1.1)	(-1.2)	(2.4)**	(-0.6)	(-0.4)	(-1.4)	(2.4)***
R-squared	0.50	0.84	0.388	0.424	0.81	0.72	0.75	0.80

7.2 Length of Event Window

To examine whether the improved liquidity still hold in a longer period after the change to an anonymous market structure, it would be of interest to have a more extended post-anonymity period to further analyze our findings. The instrumental variable 2SLS re-estimate all liquidity measures using data from 3-month pre-event to 4-month post-event.

Table 14 reports the results of equation (2) for the liquidity impact on ASX trading, while Table 15 reports the results of equation (3) for the liquidity impact on NZX trading after ASX's switch to broker anonymity regime. The results show an improvement of bid-ask spreads and depth on ASX, and a deterioration of bid-ask spreads, depth and volume on NZX. All coefficient estimates are consistent with original results, suggesting the robustness of the results to the length of the event window around the ASX's anonymity regime change.

Table 14: Sensitivity to Event Window - Impact of ASX Anonymity on ASX Liquidity

This table presents the results from equation (2), using data from 3 months pre-event and 4 months post-event. The instruments include 3 lags of *NZX liquidity* measures, *trade size* and *market capitalization*. Hausman specification test of simultaneity and Durbin-Wu-Hausman chi-sq test of endogeneity are used to determine whether a 2SLS procedure is necessary. Instruments are implemented if they passed the tests of relevance and validity. The condition of relevance is tested by examining the fit of the first stage endogenous regressor (*NZX Liquidity*) on the full set of instruments. The first stage coefficients, partial R-square and partial F statistics on relevance of instruments are reported. The Sargan test of over identifying restrictions and LM IV test of redundancy are used for the instruments validity. The Anderson canon.corr. LM statistic is to examine whether the equation is adequately identified. *. **. *** denote statistical significance at the 10%, 5% and 1% levels.

	Panel A: Australian stocks				*Panel B: New Zealand Stocks*			
	Spread (%)	Spread	Depth ($)	Volume ($)	Spread (%)	Spread	Depth ($)	Volume ($)
Constant	-1.18	-2.73	1.74	0.61	-1.27	-0.60	0.26	-1.76
	(-3.3)***	(-8.6)***	(1.3)	(0.4)	(-1.7)*	(-0.7)	(0.2)	(-0.9)
NZX Liquidity	0.01	-0.02	0.06	0.59	0.62	0.69	0.70	0.75
	(0.3)	(-0.6)	(2.4)**	(5.7)***	(4.8)***	(4.3)***	(7.9)***	(5.7)***
Price Difference	0.64	0.26	-1.35	3.71	-0.12	-0.55	-4.60	-6.18
	(1.7)*	(0.7)	(-0.9)	(1.3)	(-0.1)	(-0.4)	(-4.4)***	(-2.4)**
Market Control	0.61	0.52	0.68	0.44	0.02	0.07	0.15	0.12
	(9.6)***	(7.2)***	(5.7)***	(3.6)***	(0.1)	(0.5)	(1.0)	(0.8)
Change	-0.01	-0.02	-0.01	0.07	-0.08	-0.10	0.08	0.11
	(-0.1)	(-2.3)**	(-0.2)	(1.4)	(-3.6)***	(-4.6)***	(2.4)**	(1.6)
R-squared	0.98	0.79	0.92	0.88	0.74	0.77	0.70	0.66
Hausman specification t-test	2.45**	0.1	0.12	6.45**	1.05	1.51	0.74	1.18
Durbin-Wu-Hausman chi-sq test	3.09*	7.36***	1.88	38.10***	6.86***	6.92***	36.30***	19.51***
First stage coefficients								
lag 1 of NZX liquidity	0.32***	0.32***		0.12***	0.22***	0.214***		0.21***
lag 2 of NZX liquidity	0.14***	0.14***					0.21***	0.10***
lag 3 of NZX liquidity							0.09***	
Trade size ($)							0.18***	
Market capitalization ($)				2.53**	-0.64*			
Partial R-sq	0.15	0.16		0.05	0.07	0.05	0.16	0.06
Partial F statistic	65.86***	71.75***		25.47***	40.10***	41.54***	67.28***	27.52***
Anderson canon. Corr. LM statistic	180.62**	192.14***		39.14***	114.86***	77.80***	256.25***	98.58***
Sargan statistic	0.19	0.01		1.23	0.01		0.04	0.61
LM test of redundancy								
lag 1 of NZX liquidity	107.88***	112.93***		15.65***	79.22***			63.67***
lag 2 of NZX liquidity	22.63***	24.51***					198.02***	16.31***
lag 3 of NZX liquidity							105.44***	
Trade size ($)							175.99***	
Market capitalization ($)				31.79***	23.72*			

Table 15: Sensitivity to event window - impact of ASX anonymity on NZX liquidity

This table presents the results for impact of ASX anonymity on NZX in a 2SLS IV estimation using data from 3 months pre-event and 4 months post-event. The instruments include 3 lags of ASX liquidity measures, log-transformed trade size and market capitalization. We use Hausman specification test of simultaneity (presented with absolute t-value) and Durbin-Wu-Hausman chi-sq test of endogeneity in OLS to determine whether a 2SLS procedure is necessary. We report first stage coefficients, partial R-square and partial F statistics for the instruments used. The Anderson canon.corr. LM statistic is to examine whether the equation is identified. The Sargan statistic test validity of instruments and LM test of redundancy examines individually whether each instrument is redundant. The model reports robust standard errors. *. **. *** denote statistical significance at the 10%, 5% and 1% levels.

	Panel A: Australian stocks				*Panel B: New Zealand Stocks*			
	Spread (%)	Spread	Depth ($)	Volume ($)	Spread (%)	Spread	Depth ($)	Volume ($)
Constant	-2.27	-1.23	9.65	-3.31	-2.85	-3.44	5.10	0.57
	(-3.4)***	(-1.9)*	(6.6)***	(-1.8)*	(-7.1)***	(-10.2)***	(3.9)***	(0.4)
ASX Liquidity	0.41	0.36	0.13	0.93	0.21	0.17	0.52	0.75
	(5.1)***	(4.4)***	(3.1)***	(5.4)***	(3.4)***	(2.9)***	(7.6)***	(5.1)***
Price Difference	-1.57	-1.62	-5.07	-4.82	3.03	3.35	3.78	7.40
	(-1.2)	(-1.2)	(-3.8)***	(-1.3)	(2.0)**	(2.5)**	(4.2)***	(3.3)***
Market Control	-0.16	0.19	-0.15	0.15	0.32	0.13	0.12	0.53
	(-1.2)	(1.3)	(-1.1)	(1.1)	(4.5)***	(1.7)*	(0.9)	(4.8)***
Change	0.01	0.03	0.00	-0.11	0.04	0.05	-0.08	-0.11
	(0.2)	(0.83)	(-0.1)	(-1.5)	(2.4)**	(3.5)***	(-2.9)***	(-1.7)*
R-squared	0.59	0.76	0.62	0.43	0.75	0.71	0.72	0.57
Hausman specification t-test	0.07	0.87	0.61	0.85	3.38**	1.76*	0.84	0.83
Durbin-Wu-Hausman chi-sq test	0.13	0.38	1.18	14.98***	0.46	0.01	21.32***	18.62***
First stage coefficients								
lag 1 of ASX liquidity				0.29***	0.27***	0.27***	0.29***	0.15***
lag 2 of ASX liquidity				0.16***	0.06**	0.06***	0.17***	0.07***
lag 3 of ASX liquidity								
Trade size ($)					-0.06***	-0.061***		
Market capitalization ($)								
Partial R-sq				0.17	0.11	0.11	0.16	0.03
Partial F statistic				15.49***	53.82***	55.23***	87.28**	21.10***
Anderson canon. corr. LM statistic				31.32***	174.26***	175.74***	143.64***	49.41***
Sargan statistic				0.63	0.37	0.32	1.24	0.69
LM test of redundancy								
lag 1 of ASX liquidity				93.96***	107.02***	107.93***	134.92**	34.61***
lag 2 of ASX liquidity				30.02***	5.92**	6.33**	47.11***	8.51***
lag 3 of ASX liquidity								
Trade size ($)					29.78***	29.80***		
Market capitalization ($)								

Table 16 and Table 17 report the results for the liquidity impacts after the NZX's change in broker regime. There is an increase in NZX liquidity and a corresponding decrease in ASX liquidity. Table 16 shows that the trading on ASX is seriously affected. Bid-ask spreads, depth and trading volume are significantly deteriorated, and this adverse impact is more evident in Australian-incorporated stocks. Table 17 shows that NZX market share in the trading of cross-listed stocks is improved. Consistent with original results in Section 6, there is evidence on liquidity migration of cross-listed stocks from ASX to NZX, in particular for Australian stocks. The fact of quantitatively similar using different length of event window indicates that our results are robust.

Table 16: Sensitivity to Event Window - Impact of NZX Anonymity on ASX Liquidity

This table presents the results from equation (2), using data from 3 months pre-event and 4 months post-event. The instruments include 3 lags of *NZX liquidity* measures, *trade size* and *market capitalization*. Hausman specification test of simultaneity and Durbin-Wu-Hausman chi-sq test of endogeneity are used to determine whether a 2SLS procedure is necessary. Instruments are implemented if they passed the tests of relevance and validity. The condition of relevance is tested by examining the fit of the first stage endogenous regressor (*NZX Liquidity*) on the full set of instruments. The first stage coefficients, partial R-square and partial F statistics on relevance of instruments are reported. The Sargan test of over identifying restrictions and LM IV test of redundancy are used for the instruments validity. The Anderson canon.corr. LM statistic is to examine whether the equation is adequately identified. *. **. *** denote statistical significance at the 10%, 5% and 1% levels.

	Panel A: Australian stocks				*Panel B: New Zealand Stocks*			
	Spread (%)	Spread	Depth ($)	Volume ($)	Spread (%)	Spread	Depth ($)	Volume ($)
Constant	-0.50	-3.37	1.16	-4.75	2.54	2.11	0.31	-2.94
	(-1.6)	(-12.5)***	(1.1)	(-2.4)**	(3.0)***	(2.6)**	(0.2)	(-1.1)
NZX Liquidity	0.06	0.04	0.04	0.54	0.97	0.91	0.64	1.08
	(5.6)***	(4.5)***	(1.8)*	(4.1)	(5.4)***	(4.4)***	(7.5)***	(6.7)***
Price Difference	-0.40	0.68	1.25	3.05	0.36	-0.04	2.60	4.60
	(-0.6)	(1.3)	(1.3)	(1.8)*	(0.4)	(-0.1)	(2.4)**	(1.4)
Market Control	0.43	0.40	0.67	0.65	0.33	0.43	0.22	-0.15
	(7.9)***	(6.1)***	(6.9)***	(5.3)***	(1.9)*	(2.2)**	(1.7)*	(-0.7)
Change	0.11	0.06	-0.14	-0.17	0.05	0.00	-0.07	-0.09
	(10.3)***	(5.6)***	(-4.4)***	(-3.0)***	(1.7)*	(0.1)	(-1.9)*	(-1.2)
R-squared	0.98	0.82	0.92	0.91	0.66	0.73	0.66	0.573
Hausman specification t-test	1.08	0.25	1.12	0.45	1.70*	2.94**	0.89	1.87*
Durbin-Wu-Hausman chi-sq test	2.41	0.11	1.61	22.51***	9.09***	15.71***	19.92***	27.61***
First stage coefficients								
lag 1 of NZX liquidity				0.13***	0.15***	0.17***	0.20***	0.12***
lag 2 of NZX liquidity				0.10***	0.19***	0.13***	0.15***	0.10***
lag 3 of NZX liquidity								
Trade size ($)							0.17***	
Market capitalization ($)								1.69***
Partial R-sq				0.041	0.078	0.06	0.17	0.06
Partial F statistic				15.51***	28.97***	22.05***	71.13***	24.57***
Anderson canon. corr. LM statistic				33.52***	106.41***	79.53***	234.53***	80.10***
Sargan statistic				1.34	1.21	1.18	0.56	0.78
LM test of redundancy								
lag 1 of NZX liquidity				17.47***	56.96***	41.67***	59.01***	12.97***
lag 2 of NZX liquidity				12.03***	32.06***	23.72***	34.30***	9.68***
lag 3 of NZX liquidity								
Trade size ($)							106.88***	
Market capitalization ($)								20.17***

Table 17 Sensitivity to Event Window - Impact of NZX Anonymity on NZX's Liquidity

This table presents the results from equation (3), using data from 3 months pre-event and 4 months post-event. The instruments include 3 lags of *ASX liquidity* measures, *trade size* and *market capitalization*. Hausman specification test of simultaneity and Durbin-Wu-Hausman chi-sq test of endogeneity are used to determine whether a 2SLS procedure is necessary. Instruments are implemented if they passed the tests of relevance and validity. The condition of relevance is tested by examining the fit of the first stage endogenous regressor (*ASX Liquidity*) on the full set of instruments. The first stage coefficients, partial R-square and partial F statistics on relevance of instruments are reported. The Sargan test of over identifying restrictions and LM IV test of redundancy are used for the instruments validity. The Anderson canon.corr. LM statistic is to examine whether the equation is adequately identified. *. **. *** denote statistical significance at the 10%, 5% and 1% levels.

	Panel A: Australian stocks				*Panel B: New Zealand Stocks*			
	Spread (%)	Spread	Depth ($)	Volume ($)	Spread (%)	Spread	Depth ($)	Volume ($)
Constant	2.10	-2.70	7.85	-0.82	-2.70	-2.40	3.41	6.05
	(2.9)***	(-7.2)	(4.6)***	(-0.4)	(-7.2)***	(-8.2)***	(2.3)**	(4.2)***
ASX Liquidity	1.03	1.06	0.17	0.63	0.32	0.26	0.57	0.45
	(6.2)***	(4.2)***	(2.5)**	(4.4)***	(7.0)***	(5.5)***	(7.2)***	(4.8)***
Price Difference	0.19	0.58	-0.24	-1.73	-0.93	-1.03	-1.92	-0.85
	(0.2)	(0.6)	(-0.2)	(-0.7)	(-1.2)	(-1.4)	(-2.4)**	(-0.4)
Market Control	0.39	0.29	-0.06	0.35	0.30	0.30	0.24	0.36
	(2.8)***	(2.0)	(-0.4)	(2.7)***	(3.6)***	(3.5)***	(2.0)**	(4.0)***
Change	-0.02	0.05	-0.06	0.24	-0.03	-0.03	0.01	0.10
	(-0.4)	(1.2)	(-1.3)	(3.0)***	(-1.4)	(-1.3)	(0.2)	(1.8)*
R-squared	0.49	0.84	0.37	0.40	0.82	0.71	0.73	0.79
Hausman specification t-test	1.5	1.78*	0.45	1.61	2.99***	1.93	2.08**	4.58***
Durbin-Wu-Hausman chi-sq test	8.45***	4.76**	4.83**	2.78**	18.78***	15.75***	26.21***	5.55**
First stage coefficients								
lag 1 of ASX liquidity measure	0.34***	0.34***	0.31***	0.35***	0.31***	0.30***	0.21***	0.16***
lag 2 of ASX liquidity measure	0.10**	0.10***	0.23***	0.13***	0.19***	0.17***	0.12***	0.15***
lag 3 of ASX liquidity measure								
Trade size ($)			0.35***					
Market capitalization ($)	-0.37***	0.10**					0.84***	
Partial R-sq	0.29	0.15	0.406	0.179	0.19	0.17	0.10	0.05
Partial F statistic	63.44***	31.41***	161.24**	37.83**	139.14***	120.35***	42.01**	33.01***
Anderson canon. corr. LM statistic	342.55***	176.99***	471.54***	198.01***	263.98***	231.28***	134.64***	57.55***
Sargan statistic	0.34	0.36	1.07	0.82	0.05	0.26	2.13	1.41
LM test of redundancy								
lag 1 of ASX liquidity measure	115.07***	112.87***	123.43***	124.83***	128.99***	118.91***	56.62***	30.32***
lag 2 of ASX liquidity measure	11.40***	11.35***	74.38**	17.75**	49.14***	41.03**	18.99***	29.47***
lag 3 of ASX liquidity measure								
Trade size ($)			170.75***					
Market capitalization ($)	66.58***	6.61**					22.56***	

8. CONCLUSION

This paper examines liquidity impact of changes in limit order anonymity in Australia and New Zealand. After controlling for both stock-specific and market-wide liquidity factors, the 2SLS instrumental variable estimation shows that spreads decline, quoted depth and trading volume increase with the introduction of anonymous market. We find that liquidity of cross-listed stocks migrates from foreign counterparts. The ASX's introduction of anonymous trading leads to a significant improvement of bid-ask spreads and quoted depth in ASX, and a significant deterioration of liquidity in the foreign market, NZX. On the other hand, NZX's adoption of broker anonymity regime attracts liquidity migration from ASX. These results support Foucault et al. (2005) that limit order book traders are more willing to trade aggressively and reduce bid-ask spread in an anonymous venue.

Interestingly, without controlling for commonality in liquidity, our univariate analysis shows that liquidity deteriorates in both Australian and New Zealand markets after NZX adopted anonymity regime. In fact, the global financial crisis crashed the equity markets in early August 2007, resulting world-wide market downturn. Our results also provide support to Chordia et al. (2000) and Majois (2007), that the inclusion of market-wide commonality may be necessary in natural experimental studies.

Moreover, we find that liquidity impact is more apparent in the trading of foreign cross-listed stocks, which is less liquid compared to their home market trading. This difference may be due to higher probability of information-based trading in less liquid foreign stocks (Easley et al., 1996). Stocks with greater information asymmetry seem more likely to be traded in an anonymous market. These results are consistent with Garfinkel and Nimalendran (2003), who show that traders in anonymous trading venue do not actively adjust to the presence of insider trading by raising effective spreads.

An important implication of these findings is for market design. The adoption of anonymity regime has yield significant benefits for both ASX and NZX in the trading of cross-listed stocks. NZX's switch to anonymous trading not only halts the migration of trading from NZX to ASX, but also increases the NZX's liquidity in the trading of cross-listed stocks. Future research on cross-listed stocks could examine whether these results hold on other stock exchanges.

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Appendix 1: 1-2 Matched stocks for ASX Anonymity

Sample Stocks	Matched stocks from NZX	Matched stocks from ASX
Panel A: Australian Companies		
Australian Foundation Investment Co. Ltd	NZX Limited	Sydney Airport
	Team Talk Limited	Bendigo and Adelaide Bank Limited
AMP Ltd	Pyne Gould Corporation Limited	Insurance Australia Group Limited
	Hellaby Holdings Limited	Alumina Limited
Australia and New Zealand Banking Group Ltd	Tourism Holdings Limited	Newcrest Mining Limited
	Rubicon Limited	Commonwealth Bank of Australia
AXA Asia Pacific Holdings Limited	Turners & Growers Limited	GPT Group
	Lyttelton Port Company Limited	Qantas Airways Limited
Lion Nathan Ltd	Property for Industry Limited	Aristocrat Leisure Limited
	Methven Limited	Gunns Limited
Pacific Brands Limited	NZF Group Limited	Boral Limited
	The Colonial Motor Company Limited	Paladin Energy Ltd
Pan Pacific Petroleum NL	Comvita Limited	Cue Energy Resources Limited
	Smiths City Group Limited	Molopo Energy Limited
Summit Resources Limited	Renaissance Corporation Limited	Indophil Resources NL
	Kingfish Limited	Kingsgate Consolidated Limited
Telstra Corporation Ltd	Dorchester Pacific Limited	BHP Billiton Limited
	Horizon Energy Distribution Limited	Tabcorp Holdings Limited
Westpac Banking Corporation	Pumpkin Patch Limited	QBE Insurance Group Limited
	Scott Technology Limited	Suncorp Group Limited
Panel B: New Zealand Companies		
Auckland International Airport Ltd	Goodman Property Trust	Australian Infrastructure Fund
	Infratil Limited	Virgin Australia Holdings Limited
Air New Zealand Ltd	Ryman Healthcare Limited	Coffey International Limited
	Tenon Limited	Data3 Limited
Carter Holt Harvey Limited	Kiwi Income Property Trust	Investa Office Fund
	Northland Port Corporation (NZ) Limited	Primary Health Care Limited
Fletcher Building Ltd	Vector Limited	Flight Centre Limited
	The New Zealand Refining Company Limited	WorleyParsons Limited
Fisher & Paykel Appliances Holdings Ltd	Skellerup Holdings Limited	REA Group Ltd
	Cavalier Corporation Limited	Blackmores Limited
Fisher & Paykel Healthcare Corporation Ltd	Ebos Group Limited	Redflex Holdings Limited
	Briscoe Group Limited	Australand Property Group
Nuplex Industries Ltd	PGG Wrightson Limited	Zimplats Holdings Limited
	Sanford Limited	Discovery Metals Limited
New Zealand Oil & Gas Ltd	Restaurant Brands New Zealand Limited	Amalgamated Holdings Limited
	Abano Healthcare Group Limited	RuralAus Investments Limited
Sky City Entertainment Group Ltd	Port of Tauranga Limited (NS)	GUD Holdings Limited
	Freightways Limited	CPT Global Limited
Telecom Corporation of New Zealand Ltd	Contact Energy Limited	Transurban Group
	TrustPower Limited	Amcor Limited
Tower Ltd	Michael Hill International Limited	InvoCare Limited
	Steel & Tube Holdings Limited	Transfield Services Limited
Vea Advantage Limited	CDL Investments New Zealand Limited	David Jones Limited
	Wellington Drive Technologies Limited	Ten Network Holdings Limited
Waste Management NZ Limited	Allied Farmers Limited	Colorpak Limited
	Veritas Investments Limited	JB Hi-Fi Limited
The Warehouse Group Limited	Hallenstein Glasson Holdings Limited	Northern Star Resources Ltd
	Mainfreight Limited	Allied Gold Mining PLC

Appendix 2: 1-2 Matched stocks for NZX Anonymity

	Matched stocks from NZX	Matched stocks from ASX
Panel A: Australian Companies		
Australian Foundation Investment Co. Ltd	NZX Limited	Sydney Airport
	Team Talk Limited	Bendigo and Adelaide Bank Limited
AMP Ltd	Pyne Gould Corporation Limited	Insurance Australia Group Limited
	Hellaby Holdings Limited	Alumina Limited
Australia and New Zealand Banking Group Ltd	Kiwi Income Property Trust	Newcrest Mining Limited
	Rubicon Limited	Commonwealth Bank of Australia
Goodman Fielder Limited	Turners & Growers Limited	GPT Group
	Lyttelton Port Company Limited	Qantas Airways Limited
L & M Petroleum Limited	Comvita Limited	Aristocrat Leisure Limited
	Smiths City Group Limited	Gunns Limited
Lion Nathan Ltd	Property for Industry Limited	Boral Limited
	Methven Limited	Paladin Energy Ltd
Pacific Brands Limited	Allied Farmers Limited	Cue Energy Resources Limited
	Veritas Investments Limited	Molopo Energy Limited
Pan Pacific Petroleum NL	Renaissance Corporation Limited	Indophil Resources NL
	Kingfish Limited	Kingsgate Consolidated Limited
Telstra Corporation Ltd	Dorchester Pacific Limited	BHP Billiton Limited
	Tourism Holdings Limited	Tabcorp Holdings Limited
Westpac Banking Corporation	Pumpkin Patch Limited	QBE Insurance Group Limited
	Scott Technology Limited	Suncorp Group Limited
Panel B: New Zealand Companies		
Auckland International Airport Ltd	Goodman Property Trust	Australian Infrastructure Fund
	Infratil Limited	Virgin Australia Holdings Limited
Air New Zealand Ltd	Ryman Healthcare Limited	Coffey International Limited
	Tenon Limited	Data3 Limited
Fletcher Building Ltd	Vector Limited	Investa Office Fund
	The New Zealand Refining Company Limited	Primary Health Care Limited
Fisher & Paykel Appliances Holdings Ltd	Skellerup Holdings Limited	Flight Centre Limited
	Cavalier Corporation Limited	WorleyParsons Limited
Fisher & Paykel Healthcare Corporation Ltd	Ebos Group Limited	REA Group Ltd
	Briscoe Group Limited	Blackmores Limited
Heritage Gold NZ Ltd	South Port New Zealand Limited (NS)	Redflex Holdings Limited
	Seeka Kiwifruit Industries Limited	Australand Property Group
Nuplex Industries Ltd	PGG Wrightson Limited	Zimplats Holdings Limited
	Sanford Limited	Discovery Metals Limited
New Zealand Oil & Gas Ltd	Restaurant Brands New Zealand Limited	Amalgamated Holdings Limited
	Abano Healthcare Group Limited	RuralAus Investments Limited
Sky City Entertainment Group Ltd	Port of Tauranga Limited (NS)	GUD Holdings Limited
	Freightways Limited	CPT Global Limited
Telecom Corporation of New Zealand Ltd	Contact Energy Limited	Transurban Group
	TrustPower Limited	Amcor Limited
Tower Ltd	Michael Hill International Limited	Transfield Services Limited
	Steel & Tube Holdings Limited	David Jones Limited
The Warehouse Group Limited	Hallenstein Glasson Holdings Limited	Northern Star Resources Ltd
	Mainfreight Limited	Allied Gold Mining PLC