LIQUIDITY EXTERNALITIES OF CONVERTIBLE BOND ISSUANCE IN CANADA

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ABSTRACT

The paper examines the impact of convertible bond issuance and arbitrage activity on Canadian equity market liquidity. We use convertible bond issuance event dates for the period of November 2001 to April 2010 to analyze the change in short interest, a proxy for convertible arbitrage activity, and stock liquidity during a one-year event window. Liquidity measures include Amihud, turnover, dollar volume and spread to price ratio. We find that there are significant increases in short interest, but minimal improvements in liquidity following the convertible bond issuances. However, statistical tests support that the change in liquidity is positively related to the change in short interest.

Keywords: Convertible Bond Arbitrage; Short Interest; Stock Liquidity

EXECUTIVE SUMMARY

Research has been done using United States data that finds liquidity externalities that arise from convertible bond issuances. One proposed explanation for this improved liquidity is the effect of the presence of agents, mainly hedge funds that perform convertible bond arbitrage. The strategy involves purchasing convertible bonds and shorting the stock of the bond issuer. This is expected to improve liquidity (measured as Amihud, turnover, dollar volume and spread to price ratio) because arbitrageurs who use this strategy trade independently to market movements of the stock. For example, when the stock price is increases the delta of the long convertible bond will also increase and the arbitrageur will need to short additional stock to maintain delta neutral and vice versa. This dynamic hedging activity trades independently of the market view and therefore lead to liquidity improvements because of the cases where they trade contrary to the market. In this paper, we examine whether liquidity improvements exist after convertible bond issuances and whether the convertible bond arbitrage is a possible cause of it, all within the context of Canada.

The data spans the period from November 2001 to April 2010 and includes all convertible bond issuances in Canada for which sufficient data exist. Market wide effects are accounted for by subtracting changes in liquidity of control firms. Each sample firm is matched with a control firm who is in the same industry and

has a similar market capitalization. We find statistically significant improvements in liquidity relative to the market in only one (Amihud) out of the four previously mentioned liquidity measures, leading us to conclude that liquidity improvements are minimal and not as prominent as in the United States.

In testing the presence of convertible bond arbitrage activity, we measure the change in short interest after the bond issuance. Given the trading strategy, this is a reasonable proxy for measuring this activity. As expected, we find a significant increase in short interest. In addition, we show that there is a clear relationship between our proxy for convertible bond arbitrage activity and improvements in liquidity.

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1. Introduction

In recent years, convertible bond issuance in Canada has increased steadily, from approximately $1 billion in 2001 to $6 billion in 2009. One belief for this increasing trend is that hedge funds, a major group of convertible bond purchasers who use convertible bond arbitrage strategy, have grown significantly (Mitchell et al. 2007). Meanwhile, assets under management of Canadian-based hedge funds have tripled in the past 10 years, from $2 billion in 2001 to $6 billion in 2008. (Canadian Hedge Watch, December 2008) Similar trends are also present in the US market. A previous study (Choi et al. 2009) provides strong evidence that in the US, there are stock liquidity improvements following convertible bond issuances, and the improvements are systematically related to the "arbitrage-induced short selling". A question arises whether there is a similar impact of convertible bond issuances on stock liquidity in Canada.

Before we address this question, it is helpful to introduce the convertible bond arbitrage strategy. A convertible bond can be converted, at the option of the bondholder, into stock of the bond issuer at a contracted price within a given time period. The party engaging in a convertible bond arbitrage strategy buys convertible bond and simultaneously shorts equity of the issuing firm. The goal is to exploit arbitrage profits from underpriced convertible bonds. (Loncarski et al. 2009) A typical arbitrageur employs delta-neutral hedging. The short position is dynamically managed in order to maintain a neutral hedge ratio and thus, avoid

exposure to credit risk and market risk. When the stock price goes up, delta increases, and a greater short position is required in order to maintain delta neutral. Once the arbitrageur sees that the price has increased, he will short more and at that point, the stock could either tick up or tick down. If the stock ticks up again it means that demand is greater than supply. This means that at the point when the arbitrageur shorted additional stock, he was trading contrary to the market. We believe that in this case, there would be liquidity improvements. If the subsequent tick were a down tick, then the arbitrageur would be adding to the high amount of sellers and would not improve liquidity. This is also true vice versa. When the stock price goes down, the arbitrageur buys stock to lessen the size of the short position, as delta would have decreased. Once the arbitrageur sees that the price has decreased, he will decrease his short position and at that point, the stock could either tick up or tick down. If the stock ticks down again it means that supply is greater than demand. This means that at the point when the arbitrageur covered some of this short position, he was trading contrary to the market. We believe that in this case, there would be liquidity improvements. If the subsequent tick were an uptick, then the arbitrageur would be adding to the high amount of buyers and would not improve liquidity. Two out of four possible independent scenarios intuitively lead to improved equity liquidity due to their dynamic hedging activities. In aggregate, we expect liquidity improvements upon the entrance of this type of arbitrageur due to its trades being independent of market view.

The purpose of our study is to examine the presence of convertible bond arbitrage activity and what impact it has on stock liquidity, if any, in the Canadian market. First, we confirm that such arbitrage activities are present by observing the change in short interest before and after bond issuances. We find that there is significant increase in short interest in the month following the issuance. Secondly, we compare stock liquidity measures before and after issuances to see if there are improvements in stock liquidity. A control sample is brought in to account for market-wide effects to increase the robustness of our tests. Then we test how the improvements in liquidity are associated to changes in short interest. The regression results provide some support to the explanation of liquidity improvement by convertible bond arbitrage activity.

The paper proceeds as follows. Section 2 summarizes an overview of related literature. Section 3 outlines our methodology, provides the predictions in theory, and constructs the hypotheses. Section 4 describes the sample and data. Section 5 summarizes empirical results and analysis. Section 6 concludes the paper.

2. Related literature

The main inspiration of this paper comes from the study done by Choi, Getmansky, and Tookes, 2009, which examines the impact of convertible arbitrage on equity markets in the US. It concludes that such arbitrage activity exists, and has impact on market quality, evaluated by liquidity and price

efficiency. One critical aspect of the study is that the authors use changes in short interest at bond issuance as the proxy for the presence and measurement of convertible bond arbitrage activity. The main reason given is that the arbitrage activity is not easy to observe or measure directly. Hedge-fund databases do not provide information for activities of all funds, and each fund may engage in multiple strategies. We inherit this methodology in our study, and continue to use observed increases in short interest to represent convertible bond arbitrage activity. Our paper looks at bonds denominated in Canadian dollar and focuses on liquidity externalities, rather than efficiency, as it provides information that draws more interests. To measure liquidity, Choi et al. used nine different measures, four of which are selected for our study, including turnover, daily dollar volume, Amihud, and spread-to-price ratio. In order to rule out the possibility of market-wide effects, Choi et al. compare results for the bond-issuing firms to that of a set of control firms. They use a scoring system to rank and pick control firms based on industry, exchange, turnover, market capitalization, and book-to-market. In our study, we hand pick control firms based on industry/sector and market capitalization from the TSX index portfolio.

Loncarski et al. 2009 sheds light on the pricing of convertible bonds and delta-neutral hedging dynamics, as the aim of arbitrageurs is to exploit profit from underpriced bonds. The study confirms our expectation that short interest increases by a large amount around the bond issuance date. It also offers some explanations to the diminishing returns from convertible arbitrage. Another piece of literature that provides some insight on this is Khan 2002.

Liquidity is not directly observable or evaluated by any single measure. Commonly used liquidity measures include quoted spread, market depth, order imbalance, price impact, liquidity cost, etc. One of the measures we choose is log-Amihud illiquidity measure, defined as the ratio of daily absolute stock return to dollar volume. This measure is employed in Amihud 2002. The data required to calculate Amihud are daily stock price and volume, which are readily available for our sample.

3. Method and prediction

This section outlines our prediction, methodology, and hypotheses.

In order to examine the stock liquidity externalities in the context of convertible bond arbitrage, we need to observe and measure the arbitrage activity and stock liquidity before and after the issuance, and test the relation between the two. Control sample is used to rule out the market-wide effects on short interest and equity liquidity. Firms in the control sample are selected such that they have similar characteristics to the bond-issuing firms.

The presence of convertible bond arbitrage activity is not directly observed, but represented by the increase in short interest around the issuance date. **Figure 1** shows the changes in short interest in the months prior to and after the bond issuance. Given the obvious spike around the issuance date, one can reasonably say that convertible bond arbitrage activities are present. We test whether or not the increase in short interest is significant. The hypothesis is:

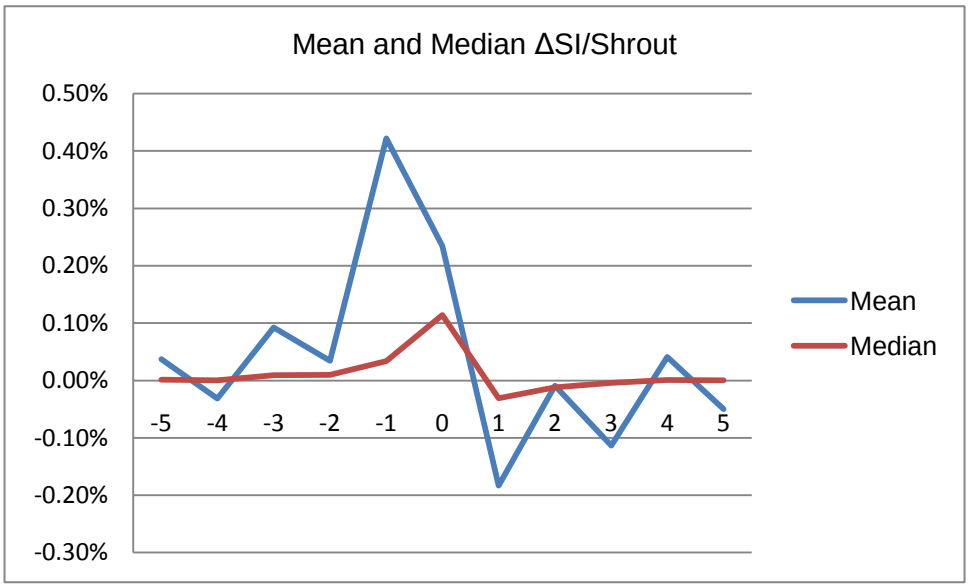
H_0: The short interest after convertible bond issuance is not significantly higher than that before issuance.

Figure 1

Mean and median change in short interest during the event window.

The charts show the mean and median change in short interest -5 to +5 months around the bond issuance. Change in short interest is calculated as the difference between month t and month t-1 as percentage of total shares outstanding.

Sample period is from November 2001 to April 2010, with 229 observations.



Convertible bond arbitrageurs typically dynamically adjust their position to maintain a delta-neutral portfolio. This is done through shorting more stock when the stock price increases or buying stock to cover part of the short position in the case where the stock price decreases. Loncarski et al. 2009 offers a discussion on the delta neutral hedging ratio and the dynamic hedging process in detail. There will be times when this dynamic hedging strategy does lead the arbitrageur to trade contrary to the market. It is reasonable to think that in certain cases their

hedging activities help absorb the orders and support the market. This is the intuition for our hypothesis.

In order to quantify and compare liquidity before and after bond issuance, we examine four proxies for stock liquidity: turnover, daily dollar volume, Amihud illiquidity measure, and spread-to-price ratio. Higher values of dollar volume and turnover indicate higher liquidity. Lower values of spread-to-price ratio and Amihud illiquidity measure indicate higher liquidity. We calculate the change in liquidity as the difference between 3-month average after issuance date and 3-month average before announcement date. We expect to see that there are significant improvements in liquidity. The hypothesis for the test is:

> $\boldsymbol{H_0}$: The stock liquidity after bond issuance is not significantly improved than that before issuance.

There is the possibility that market-wide trends, besides the convertible bond issuance, can also drive the change in short interest and change in stock liquidity. To examine this possibility, we use a control sample to represent the market impact. We compare the short interest and liquidity measures of the control firms with that of the bond-issuing firms by calculating the difference of the change in short interest and change in liquidity measures between the issuing firm sample and the control firm sample. The hypothesis to test the short interest and liquidity change relative to the general market condition is:

> $\boldsymbol{H_0}$: The change in short interest and change in liquidity measures for control firms are not significantly different from that for bond-issuing firms.

Finally, we examine how the change in liquidity is related to the change in short interest. In the regression analysis, we regress change in liquidity, the dependent variable, against change in short interest, the independent variable. The changes are relative to control firms, which is the difference between the change for bond-issuing sample and the change for control sample. Other independent variables include log market capitalization, log conversation ratio, and stock price. The regression equation used is:

$$\Delta Liquidity = \alpha + \beta_1 \Delta Short\ Interest + \beta_2 log\ Market\ Capitalization$$

$$+\beta_3 log\ Conversion\ Ratio + \beta_4 Stock\ Price$$

ΔLiquidity is each of the change in liquidity measures; ΔShort Interest is change in short interest as percentage of shares outstanding; log market capitalization is the natural log of firm size at issuance; log conversion ratio is the natural log of the number of stock each unit of bond is convertible into; and stock price is issuing firm's stock price at issuance.

We expect to see that the relative/controlled improvement in stock liquidity is associated with and can be explained by the relative/controlled increase in short interest. We test the hypothesis:

> ***H0***: The relative change in short interest, the proxy of convertible bond arbitrage activity, is uncorrelated with the relative change in stock liquidity.

4. Sample selection and data

Initially, we search all Canadian convertible bond issues from Bloomberg, and find 581 of them, including currently active ones and historically existed ones. We then obtain short interest and stock price data for a one-year event window, -6 to +6 months from the issuance. Some of the issuing firms only become public during this period. Some issues are too recent to obtain enough data and such samples are taken out of the pool. Short interest is reported monthly. We collect data 6-month prior to announcement and 6-month after issuance. Stock prices are collected daily and then processed (for example, to calculate daily return) accordingly to serve the needs of the analysis.

Bond and issuing firm descriptive information include announcement date, issuance date, term to maturity, face value, issue size, conversion ratio, market capitalization, share outstanding, and average volume. Additional data required calculating liquidity measures are volume in shares, dollar volume, bid price, and ask price. For liquidity related data, e.g. average volume, we use a three-month daily average.

After all data are in place, there are 229 convertible bond issues in the final sample, ranging from November 2001 to April 2010. **Table 1a** summarizes some descriptive statistics. The issuing firms have a mean market capitalization of $1593 million, a median of $391 million. The three-month average daily dollar volume before issuance has a mean of $5.8 million and a median of $1.3 million. Convertible bond issue makes up a significant portion of the equity value, with a

mean of 24%, and a median of 16%. Short interest prior to issuance is typically small. The mean of short interest as percentage of shares outstanding is 1.4%, and the median is 0.6%. Issuing firms in the sample cover 10 sectors, and show heavy concentration. 56% of all convertible bond issues in the sample are from financial or energy sector. **Table 1b** summaries the sector weights of the sample.

Table 1a

Summary statistics for convertible bond issuing firms.

Data includes convertible bond issuances in Canada from November 2001 to April 2010. *Market Cap* is the market capitalization of the issuing firms at the time of issuance. *Debt/Equity* is the net debt to equity ratio of the issuing firms at the time of issuance. *Daily Dollar Volume* is the three-month average daily dollar volume prior to issuance. *Issue Size* is the size, in terms of face value, of the convertible bond issuance. *Issue Size/Market Cap* is the size of the convertible bond issue divided by the market capitalization at the time of issuance. *Short Interest* is the short interest, in terms of number of shares, prior to the issuance. *Short Interest/Shares Outstanding* is the short interest mentioned above divided by the shares outstanding of the issuing firm.

Number of observations = 229

	Mean	Median	Standard Deviation
Market Cap ($ millions)	1593.249	391.210	6985.094
Debt/Equity	0.984	0.703	1.011
Daily Dollar Volume ($ millions)	5.824	1.255	23.095
Issue Size ($ millions)	76.058	60	60.999
Issue Size/Market Cap (%)	24.283	15.769	35.863
Short Interest (000 Shares)	1195.678	308.000	2160.620
Short Interest/Shares Outstanding (%)	1.404	0.625	2.517

To select control firms, we use the historical TSX index as the potential pool. Each convertible bond issue is paired up with one control firm from this pool. The control firm is selected such that it is in the same industry/sector as its pair and has a comparable market capitalization. As well, the control firm should not issue convertible bond in the -6 to +6 month event window around the convertible bond issuance date of its pair. Firms that have issued convertible

bonds in that window do not qualify as a comparable firm due to the possible liquidity effects created by the control firm's convertible bond.

Table 1b

Sector weights of convertible bond issues in sample.

Sector	Number of Issues	Percentage
Financial	65	28.384%
Energy	63	27.511%
Basic Materials	29	12.664%
Industrial	20	8.734%
Consumer, Cyclical	19	8.297%
Consumer, Non-cyclical	13	5.677%
Utilities	11	4.803%
Communications	5	2.183%
Diversified	3	1.310%
Technology	1	0.437%
Total	229	100%

5. Results

In this section, we present the results of our tests and analysis.

5.1. Summary of firm statistics and liquidity measures

Table 2 is a summary for convertible bond and issuing firm statistics and the three-month daily average stock liquidity measures before bond issuance. The statistics describe the entire sample, as well as four subsamples. We follow the method used in Choi et al. 2009, and divide the original sample into four subsamples based on the size of change in short interest around bond issuance. Column P1 (P4) represents the portfolio with smallest (largest) change in short interest as a percentage of shares outstanding.

Table 2

Summary statistics and liquidity measures for issuing firms.
Data is sorted by ΔSI/Shrout and gives us a view of the issuing firms prior to issuance date. (Shrout stands for shares outstanding.)

In Firm and Convertible Bond Characteristics panel, *log Market Cap* is the natural log of the market capitalization of the firms. *Short Int/Shrout* is the short interest prior to the bond issuance divided by the shares outstanding at the time of issuance. *Conversion Ratio* is the number of shares one would get when they choose to convert the bond into shares.

In Liquidity Measures panel, *log Turnover* is the natural log of the ratio between three-month average daily volume and the total shares outstanding. Average daily volume is calculated as the three-month average daily volume and the total shares outstanding is measured on the issuance date. *Log Daily Dollar Volume* is the natural log of the three-month average daily volume. *Log Amihud* is the natural log of the three-month average ratio of daily absolute return to dollar volume (Amihud, 2002). *Spread/Price Ratio* is the difference between the bid and ask price divided by the bid-ask mid-point of the issuing firm. It is also a three-month average.

The last two columns are P4 measures minus P1 measures and the corresponding t-statistics. *, **, and *** indicate 10%, 5%, and 1% significance, respectively.

Number of observation = 229. The sample period is from November 2001 to April 2010.

	Portfolio based on ΔSI/Shrout						
	All	P1	P2	P3	P4	P4 - P1	t-stat
		(Smallest)			(Largest)		
Firm and Convertible Bond Characteristics							
log Mark Cap	19.816	20.043	19.247	20.092	19.879	-0.164	-0.653
Short Int/Shrout (%)	1.404	3.033	0.370	1.007	1.180	-1.853***	-3.139
Conversion Ratio	255.390	179.285	466.505	251.478	125.626	-53.659	-0.974
Liquidity Measures							
log Turnover	-5.833	-5.585	-6.236	-5.804	-5.713	-0.127	-0.933
log Dollar Volume	13.916	14.371	13.178	14.203	13.903	-0.468	-1.461
log Amihud	-17.548	-17.986	-16.800	-17.994	-17.402	0.585	1.405
Spread/Price Ratio (%)	1.220	1.050	1.645	1.074	1.113	0.063	0.148

It is observable that firm size is unrelated to *ΔSI/Shrout*, as log market capitalizations are very close across the four subsamples. The firms that already have a large short interest prior to bond issuance make up the portfolio (P1) with the smallest *ΔSI/Shrout* contrary to what is found in Choi et al. 2009. However, the rest of the subsamples (P2, P3, and P4) show such a pattern that firms tend to have larger *ΔSI/Shrout* if they already have a higher level of short interest prior

to bond issuance. This is consistent with Choi et al. 2009 results and makes intuitive sense because we would expect that hedge funds would like to see an existing and active short interest market in the stock that they choose to execute their trading strategy. We do not see any relation between the conversion ratio and *ΔSI/Shrout* or firm size.

The Liquidity Measures panel summarizes the liquidity measures prior to bond issuance. The turnover, dollar volume, Amihud illiquidity measure, and spread to price ratio present consistent results for each subsample. We notice that the portfolio (P1) with the smallest *ΔSI/Shrout*, is the most liquid portfolio based on all four liquidity measures. The portfolios with higher *ΔSI/Shrout* tend to be less liquid prior to issuance. However, there is no monotonic relation between *ΔSI/Shrout* and liquidity measures.

5.2. Change in liquidity

Table 3 presents the changes in liquidity measures for issuing firms after issuance. Each number in brackets is the t-statistic for the result above it. The change in short interest is measured using data from the first month after issuance. The change in liquidity is the three-month daily average liquidity measures after bond issuance minus that before issuance. Again, it is sorted into four portfolios by the size of *ΔSI/Shrout*.

The short interest for the full sample increases, on average, by 0.23%. Two of the subsamples have decreased short interest, while the other two have

increased short interest of 0.51% and 2.32%, respectively. Positive numbers of Δlog turnover and Δlog dollar volume indicate improvements in stock liquidity; while negative numbers of Δlog Amihud and Δspread/price indicate improvements in liquidity. All four liquidity measures show that there are stock liquidity improvements after issuance. The log turnover and log dollar volume increase by 0.050 and 0.045, respectively; and log Amihud and spread/price decrease by 0.103 and 0.085%.

Table 3

Changes in short interest and liquidity measures for issuing firms after issuance.

Each change is calculated as the measure after issuance minus the measure prior to issuance. *ΔShort Int/Shrout* is the change in short interest divided by shares outstanding. *Δlog Turnover* is the change in the natural log of the ratio between average daily volume and the total shares outstanding. *Δlog Amihud* is the change in the natural log of the average ratio of daily absolute return to dollar volume (Amihud, 2002). *Δlog Daily Dollar Volume* is the change in the natural log of the three-month average daily dollar volume. *ΔSpread/Price Ratio* is the change in the difference between the bid and ask price divided by the bid-ask mid-point of the issuing firm.

Numbers in parentheses are t-statistics. *, **, and *** indicate 10%, 5%, and 1% significance, respectively.

Number of observations = 229. The sample period is from November 2001 to April 2010.

	Portfolio sorted based on ΔSI/Shrout					
	All	P1	P2	P3	P4	P4 - P1
		(Smallest)			(Largest)	
Change in Short Interest and Liquidity Measures						
Δshort Int/Shrout (%)	0.234*	-1.842***	-0.009	0.509***	2.315***	4.158***
	(1.389)	(-3.606)	(-0.874)	(13.755)	(12.395)	(7.576)
Δlog Turnover	0.050*	-0.108*	0.095*	0.068	0.146**	0.253**
	(1.396)	(-1.539)	(1.442)	(1.105)	(1.768)	(2.323)
Δlog Dollar Volume	0.045	-0.123*	0.104*	0.051	0.151**	0.274***
	(1.135)	(-1.549)	(1.309)	(0.700)	(1.828)	(2.371)
ΔLog Amihud	-0.103*	-0.117	0.035	0.048	-0.378***	-0.261*
	(-1.440)	(-1.128)	(0.221)	(0.288)	(-2.942)	(-1.569)
ΔSpread/Price Ratio (%)	-0.085	0.148	-0.115	-0.136**	-0.242**	-0.390*
	(-1.164)	(0.754)	(-0.781)	(-1.690)	(-1.794)	(-1.623)

The turnover, dollar volume, and spread-to-price ratio demonstrate that the portfolio with higher *ΔSI/Shrout* becomes more liquid after issuance by a larger degree. There is also a higher confidence level for improvement in liquidity to be true for the portfolio with the largest *ΔSI/Shrout* (P4). This may be an indication that the improvement in liquidity is associated with convertible arbitrage. However, such relation is not present in the Amihud illiquidity measure.

5.3. Control sample

In addition to convertible bond arbitrage activity, there may be other factors that also contribute to the change in stock liquidity. The most possible and prominent one can be market-wide events or changes. To exclude the market effect and isolate impact of the arbitrage activity, we use a set of sample control firms to compare the results.

Table 4 summarizes the changes in short interest and stock liquidity relative to control firms. The results presented are controlled changes, which are the changes of sample firms' short interest and liquidity measures minus the changes of control firms'. The results are also sorted by the size of controlled *ΔSI/Shrout*.

For the entire sample, controlled change in short interest is higher than the uncontrolled, presented previously in **Table 3**, by 0.024%. It means that the general market trading offsets the convertible bond arbitrageurs' trading by a small amount. However, the liquidity measures, except for log Amihud, do not

support the expectation of liquidity improvement after bond issuance. The controlled Δlog turnover, Δlog dollar volume and Δspread/price are -0.05, -0.11, and 0.17, respectively. The Δlog dollar volume is significantly less than zero. Controlled log Amihud doubles the uncontrolled measure, which is the one liquidity factor that indicates a significant improvement in liquidity.

Table 4

Change in short interest and liquidity measures relative to control firms.

Each change is calculated as the difference between the measure after issuance and prior to issuance for sample firm minus the difference for control firm. *ΔShort Int/Shrout* is the change in short interest divided by shares outstanding. *Δlog Turnover* is the change in the natural log of the ratio between average daily volume and the total shares outstanding. *Δlog Amihud* is the change in the natural log of the average ratio of daily absolute return to dollar volume (Amihud, 2002). *Δlog Daily Dollar Volume* is the change in the natural log of the three-month average daily dollar volume. *ΔSpread/Price Ratio* is the change in the difference between the bid and ask price divided by the bid-ask mid-point.

Numbers in parentheses are t-statistics. *, **, and *** indicate 10%, 5%, and 1% significance, respectively.

Number of observations = 229. The sample period is from November 2001 to April 2010.

	Portfolio sorted based on ΔSI/Shrout					
	All	P1	P2	P3	P4	P4 - P1
		(Smallest)			(Largest)	
Controlled Change in Short Interest and Liquidity Measures						
Δshort Int/ Shrout (%)	0.258*	-2.159***	-0.042***	0.605***	2.672***	0.048***
	(1.430)	(-4.163)	(-2.482)	(14.053)	(13.385)	(8.619)
Δlog Turnover	-0.049	-0.147*	0.019	-0.179**	0.112	0.259**
	(-1.076)	(-1.597)	(0.236)	(-2.197)	(1.076)	(1.847)
Δlog Dollar Volume	-0.108**	-0.223**	-0.035	-0.250***	0.076	0.299**
	(-2.281)	(-2.092)	(-0.428)	(-2.888)	(0.779)	(2.049)
ΔLog Amihud	-0.209***	-0.299**	-0.182	-0.011	-0.341**	-0.042
	(-2.526)	(-1.789)	(-1.227)	(-0.066)	(-1.981)	(-0.172)
ΔSpread/Price Ratio (%)	0.170	0.174	0.017	0.076	0.413	0.002
	(0.909)	(0.643)	(0.185)	(0.622)	(0.602)	(0.321)

Looking at the results by size of *ΔSI/Shrout*, the portfolios with decreased short interest become more illiquid. The portfolio with the largest *ΔSI/Shrout* (P4)

shows improvement in three out of four of the liquidity measures. However, there is no clear pattern or monotonic relation between the size of *ΔSI/Shrout* and liquidity measures. The liquidity results are not conclusive in showing improvements relative to control firms.

5.4. Regression analysis

To estimate the relation among the change in liquidity, convertible arbitrage activity, and other firm and bond characteristics, we regress each Δliquidity measure against Δshort interest as percentage of shares outstanding, log market capitalization, log conversion ratio of convertible bond, and issuing firm stock price. **Table 5** summarizes the coefficients (t-statistics) of the regressions. We expect positive correlation between turnover / dollar volume and change in short interest, but negative correlation between Amihud measure / spread-to-price ratio and change in short.

The coefficients of Δshort interest for Δlog turnover and Δlog dollar volume are 3.02 and 3.67. Given the t-statistics of 1.83 and 2.13, we say that movement in liquidity, based on these two measures, is positively correlated to the convertible arbitrage activity. The coefficient of Δshort interest for Δlog Amihud is -1.03. However, the t-statistic is so low that one cannot conclude there is significant correlation with sufficient confidence. There is no significant relationship between Δspread/price and *ΔSI/Shrout*, either. Firm size seems to negatively affect liquidity. It appears that the larger the log market capitalization, the less improvement we see in the firm's stock after convertible bond issuance.

We do not observe variation or correlation of change in liquidity with conversion ratio from the regression results. Stock prices do not explain changes in the liquidity measures, neither, except for Δlog turnover by a small amount.

Table 5

Regressions on liquidity measures.

Δlog Turnover is the controlled Δlog turnover computed by subtracting the control firm's Δlog Turnover from the sample firm's Δlog turnover. The other liquidity measures are calculated the same way for their respective measures. *Controlled Δshort int/Shrout* is the Δshort int/shrout of the sample firm minus the Δshort int/shrout of the control firm. *Log Market Cap* is the natural log of market capitalization of the sample firms. *Log Conversion Ratio* is the natural log of conversion ratio of the convertible bonds issued by the sample firms. *Price* is the price of the sample firms at issuance date.

Numbers in parentheses are t-statistics. *, **, and *** indicate 10%, 5%, and 1% significance, respectively.

Number of observations = 229. The sample period is from November 2001 to April 2010.

Liquidity Measures	Δ log Turnover	Δ log Daily Dollar Volume	Δ log Amihud	Δ log Spread/Price
Intercept	0.624*	0.531	-1.214*	-0.019
	(1.762)	(1.433)	(-1.866)	(-1.303)
Controlled Δshort Int/Shrout	3.015**	3.671**	-1.027	0.022
	(1.832)	(2.134)	(-0.340)	(0.319)
log Market Cap	-0.093**	-0.080*	0.167**	0.003
	(-2.277)	(-1.865)	(2.230)	(1.572)
log Conversion Ratio	-0.059	-0.062	0.025	0.001
	(-1.193)	(-1.192)	(0.274)	(0.502)
Price	0.012*	0.009	-0.009	0.000
	(1.737)	(1.252)	(-0.716)	(0.034)
Number of Observations	229	229	229	229
Adjusted R2 (%)	3.161%	2.579%	0.641%	-0.119%

6. Conclusion

The objective of this paper is to determine whether there are liquidity externalities, specifically liquidity improvements when a firm issues convertible debt and whether this change in liquidity is linked to convertible bond arbitrage.

Convertible bond arbitrage is a trading strategy that reaps returns from the under pricing of convertible debt. (Loncarski et al. 2009). The strategy involves buying the convertible debt while shorting the stock of the bond issuer. The goal is generally to become delta neutral, effectively eliminating the market risk exposure that is inherent in the bond, and to collect the interest payments. An increase in the stock price would bring the current price closer to the conversion price leading to an increase in the sensitivity of the bond price to the stock price. Arbitrageurs who maintain delta neutral positions will need to short additional stock. The opposite is true when the stock price decreases. This dynamic hedging activity trades independently of the market view and therefore lead to liquidity improvements because of the cases where they trade contrary to the market.

In order to increase the robustness of our result, we compared the change in the proxy for convertible bond arbitrage activity and the change in the liquidity measures after taking into account the changes of those measures that we see in the control firms. By doing this, we eliminate the market wide effects that existed at the time of issuance. Several liquidity measures are computed and minimal liquidity improvements are found in Canada following a convertible bond issuance. The change in short interest divided by shares outstanding is used as a proxy to measure the activity of such arbitrageurs. We expect to see that this proxy will increase immediately after a convertible bond issuance reflecting the entrance of arbitrageurs in the stock. There is an increase in the proxy following a bond issuance and there is a clear positive relationship between the proxy and

liquidity changes. We believe that the minimal improvements in liquidity relative to the United States may be a result of the lesser presence of hedge funds in Canada. Further studies could test this if hedge fund data availability grows. One additional anomaly is found in **Figure 1** that a large statistically significant increase in short interest appears before the announcement date and would be an interesting area to explore.

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