Hedge Funds as International Liquidity Providers: Evidence from Convertible Bond Arbitrage in Canada

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Abstract

We examine the impact of Canadian convertible bond issuance on equity market liquidity. Using issuance event dates between April 2002 and March 2011, we analyse the change in short interest and stock liquidity during a one-year event window. We consider mainstream liquidity measures including turnover, dollar volume, dollar spread, percentage spread and the ratio of daily absolute stock return to dollar volume. We find that after convertible bond issuances, there are significant increases in short interest, but minimal overall improvements in liquidity. The change in liquidity is not significantly related to the change in short interest, except for the firms with largest change in short interest. Interpreting increased short interest after issuance as a proxy for convertible bond arbitrage activity, the results suggest that there is limited positive liquidity externality of hedge fund activity in Canada.

Keywords: Stock Liquidity,Short Interest, Convertible Bond Arbitrage

1. Introduction

Recent studies have shown that convertible bond issuances in the US have stock liquidity externalities. The liquidity enhancement is attributed to convertible bond arbitrage by hedge funds, buying convertible bonds and shorting the stock of the bond issuer. The strategy is expected to improve liquidity because arbitrageurs tend to accommodate excess demand and supply shocks[1]. It is not known whether hedge funds affect the liquidity of equity markets outside the US in a similar way. This paper examines Canadian convertible bond issuances to determine if they lead to enhanced liquidity and to establish whether such improvements can be attributed to convertible bond arbitrage. We find that there is an increase in short interest after issuance, and it is positively associated with a moderate liquidity enhancement. The evidence suggests that the impact of hedge funds on liquidity in Canada is smaller than in the US.

While there are significant differences between the capital markets of the US and Canada, notably size, regulation, access and costs, these differences potentially could lead to different liquidity externalities from hedge fund activity. In recent years, convertible bond issuance in Canada has increased substantially, from approximately $1 billion in 2001 to $6 billion in 2009. This trend has been attributed by Mitchell et al. (2007) to growing demand by hedge funds specializing in convertible bond arbitrage. 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[2]. These increasing trends are similar to the ones in the US markets. A recent study by 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 "arbitrage-

[1] For example, when the stock price rises due to an excess demand shock, the delta of the convertible bond increases and the arbitrageurs short additional stock to maintain a delta-neutral position.The short-selling eases the price-pressure from the buy-order imbalance, improving the liquidity of the stock.

[2] Canadian Hedge Watch, December 2008.

induced short selling". In light of this study and the above similarities, we ask if there is a similar impact of convertible bond issuances on stock liquidity in Canada.

In this paper we test for the presence of convertible bond arbitrage activity in the Canadian market and we examine what impact, if any, it has on stock liquidity. First, we test for significant changes in short interest in the months prior to and after the bond issuance. Next, in order to quantify and compare liquidity before and after bond issuance, we examine five proxies for stock liquidity: turnover, daily dollar volume, dollar spread, percentage spread and the log of the Amihud (2002) illiquidity measure, defined as the ratio of daily absolute stock return to dollar volume. The methodology follows the approach in Choi et al. (2009). Finally, a control sample is used to account for market wide effects to increase the robustness of our tests.

Our first contribution is to report evidence that such arbitrage activities are present in the Canadian capital markets. We find that there is a significant increase in short interest in the month following the issuance. Our second contribution is to document and compare different stock liquidity measures before and after issuances in order to detect improvements in stock liquidity. We find weak evidence (2 out of 5 mainstream measures) of liquidity enhancement. Finally, we test how the improvements in liquidity are correlated with changes in short interest. The regression results provide some support to the explanation of liquidity improvement resulting from convertible bond arbitrage activity. Overall, our results indicate that unlike its substantial impact in the US, convertible bond arbitrage has small liquidity externalities in Canada.

The paper proceeds as follows. Section 2 provides background on the convertible bond arbitrage strategy. Section 3 outlines our methodology and the testable hypotheses. Section 4 describes the data. Section 5 contains the empirical results. Section 6 concludes the paper.

2. Background

First, we introduce the convertible bond arbitrage strategy in more detail. A convertible bond can be converted, at the option of the bondholder, into stock of the bond issuer at the contracted price within a given time period. The convertible bond arbitrage strategy entails buying convertible bond and shorting equity of the issuing firm at the same time. The goal is to obtain an "arbitrage" profit from under-priced convertible bonds relative to the stock (see Loncarski et al. 2009). The second important element of the strategy is delta-neutral hedging. The short position is dynamically managed in order to maintain a delta-neutral position, avoiding exposure to small credit risk and market risk shocks. When the stock price increases, the delta (or hedge ratio) of the convertible bond also increases, and hence a greater short position is required in order to maintain delta neutral position. Once the price has increased, the arbitrageur will short more, mitigating the price-impact when demand is greater than supply. In other words, at the point when the arbitrageurs short additional stock, they provide liquidity to the market. This is also true vice versa: when the stock price decreases, the arbitrageur buys stock to lessen the size of the short position as the delta would have decreased. In aggregate, we expect liquidity improvements because these arbitrageur trades are independent of information, including private one, about the issuer or the market.

Our paper is in the spirit of the study done by Choi et al. (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 that 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 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 externality. In order to rule out the possibility of market-wide effects, Choi et al. compared results for the bond-issuing firms to a set of control firms. In our study, we use a similar robustness check and select control firms based on industry sector, stock exchange and firm characteristics including price to book ratio, market capitalization and turnover.

Loncarski et al. (2009) sheds light on the pricing of convertible bonds and arbitrageur hedging dynamics, arguing that the aim of arbitrageurs is to exploit profit from under-priced bonds. The study helps motivate 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. Similar insights are provided by Khan (2002).

Our measures of liquidity are based on mainstream proxies used in the literature. Liquidity is not directly observable or evaluated by any single measure. Commonly used liquidity measures include quoted spread, market depth, order imbalance, price impact, trading cost, etc. We also use the "log Amihud" illiquidity measure, defined as the ratio of daily absolute stock return to dollar volume, from Amihud (2002). The data required to calculate log Amihud are daily stock price and volume, which are readily available for our sample.

3. Research Design

In order to examine the stock liquidity externality of hedge fund activity in the context of convertible bond arbitrage, we need to measure the arbitrage activity and stock liquidity before

and after the issuance, and test the relationship between the two. Control samples are 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 as the bond-issuing firms.

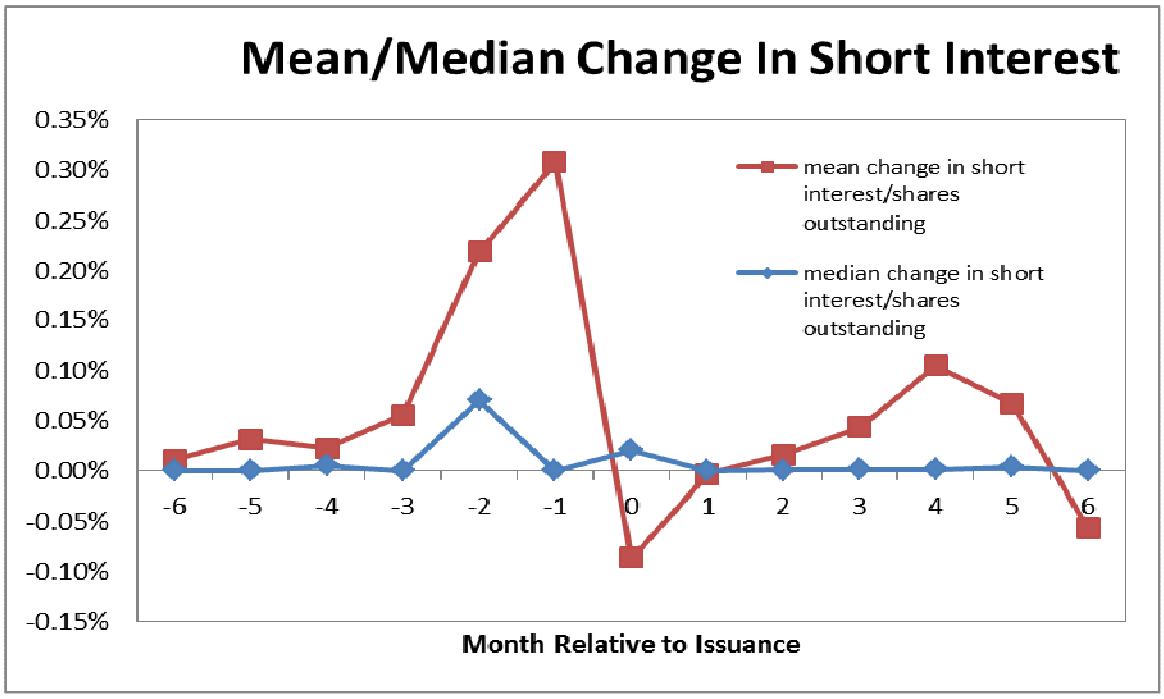
3.1. Change in Short Interest

The presence of convertible bond arbitrage activity is not directly observed, but it is represented by the increases in short interest around the issuance date. An arbitrageur would enter a short position in the issuing firm at the same time as he purchases the convertible bond when it is issued. If this arbitrage activity indeed exists, we expect to see an increase in short interest at the time of bond issuance. Figure 1 shows the changes in short interest in the months prior to and after the bond issuance.

Figure 1

Change in Short Interest during the Event Window

Mean and median non-annualized change in short interest -6 to +6 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 April 2002 to March 2010, with 317 observations.



The spike around the issuance date suggests that convertible bond arbitrage activities are present. We test whether the increase in short interest is significant with the hypothesis,

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

3.2. Liquidity Improvements

After the initial establishment of the long bond-short stock portfolio, Convertible bond arbitrageurs actively adjust their position to maintain it delta-neutral. This involves shorting more stock when the stock price increases and buying stock to cover part of the short position when the stock price decreases.[3] These hedging activities help absorb the order imbalances and support the market. Thus we expect to see improvement in equity liquidity in the post-issue period from the pre-issue period. We define the pre-issue period as the 6-month period ending 1 month before bond announcement date; and we define the post-issue period as the 6-month period commencing 1 month after bond issuance date. We skip the month immediately around announcement and issuance to eliminate possible variations in anticipation or in reaction to the bond issuance. We test the hypothesis,

> ***H_0***: The stock liquidity after bond issuance is not significantly different from that before issuance.

In order to quantify and compare liquidity before and after bond issuance, we examine five proxies for stock liquidity: log turnover measured by daily volume divided by shares outstanding, log daily dollar volume, log Amihud illiquidity measured as daily absolute return over dollar volume, dollar bid-ask spread and percentage spread. We calculate liquidity as the daily average for the pre-issue period and the post-issue period, respectively. Higher values of

[3] Loncarski et al. 2009 discuss delta-neutral hedging ratio and the dynamic hedging process in detail.

turnover and dollar volume, and lower values of Amihud, dollar spread and percentage spread can be interpreted as higher liquidity.

3.3. Controlled Change in Short Interest and Liquidity

We would like to account for the possibility that market-wide trends besides the convertible bond issuance may drive the change in short interest and change in stock liquidity. To examine whether our results are affect by this possibility, we use a control firm sample to represent the market impact. The control firm should come from the same industry sector and stock exchange as the issuing firm. The control firm should not issue convertible bond in the one-year event window. After filtering for these criteria, we select the firm using a scoring method similar to Choi et al. (2009).[4] The ideal control firm is close to the issuer in terms of market capitalization, turnover, and book-to-market ratio.

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 tested for the difference in the short interest and the 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.

3.4. Relationship between Liquidity and Change in Short Interest

Finally, we examine how the change in liquidity is related to the change in short interest. Besides change in short interest, we also control for firm specific factors. Firm size, price and volatility may have impact on stock liquidity. For firms that are already highly liquid, convertible

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$issuer\ \ book-to-market-1)]$. Turnover, market cap, and book-to-market are average values for the pre-issue period. The firm with the lowest score is then selected as the control firm.

bond issuance may not have much impact on liquidity level; while for firms that are less liquid, bond issuance may have greater impact. Stock exchange and bond offering public status may affect trading behaviour and liquidity level, thus are included as dummy variables. To investigate the relationship, we specify the following regression,

$$\Delta liquidity_i = a + b_1 \Delta Short_i + b_2 \Delta log\ Market\ Cap_i + b_3 \Delta Return\ Vol_i + b_4 log\ Price_i + b_5 TSX_i + b_6 Public_i + b_7 PrePost_i + e_i \quad (1)$$

where $\Delta liquidity_i$ is the difference in one of the five liquidity measures between the post-issue period and the pre-issue period;$\Delta Short_i$ is the change in short interest as percentage of shares outstanding in the month of bond issuance;

$\Delta log\ Market\ Cap_i$ is the difference in daily average log market capitalization between the post-issue period and the pre-issue period;

$\Delta Return\ Vol_i$ is the difference in daily return standard deviation between the post-issue period and the pre-issue period;

All the differences and changes are calculated relative to the control firm.

$log\ Price_i$ is daily average log stock price in the pre-issue period;

TSX_i equals to one if the firm is listed on Toronto Stock Exchange, and equals to zero if the firm is listed on TSX Venture Exchange;

$Public_i$ equals to one if the bond is public, and equals to zero otherwise;

$PrePost_i$ is the number of days between the pre-issue period and the post-issue period.

We expect to see that the relative-to-control-firm improvement in stock liquidity is associated with, and can be explained by the relative increase in short interest. We test the hypothesis,

H_0: The relative change in short interest, which is a proxy for convertible bond arbitrage activity, is uncorrelated with the relative change in stock liquidity.

We now describe the data used in our study.

4. Data

We used all convertible bond issued in Canada reported by Bloomberg. For each issue, we collect bond issuing firm, announcement date, issuance date, amount issued and bond public or private status. We eliminate the issues missing announcement date and/or issuance date. We then collect data on issuer industry, stock exchange, daily price, daily volume in shares and in dollars, daily bid-ask spread, shares outstanding, debt-to-equity ratio, market-to-book ratio, and monthly short interest. The data need to cover the pre-issue period through post-issue period. The final sample consists of 317 convertible bond issues, ranging from April 2002 to March 2011. All issuers are public companies listed on Toronto Stock Exchange or TSX Venture Exchange. Table 1 summarizes firm characteristics of our sample.

Table 1

Summary Statistics for Convertible Bond Issuing Firms

The data include convertible bond issuances in Canada from April 2002 to March 2011. *Market Capitalization* is the average market capitalization of the issuing firms in the pre-issue period. Toronto Stock Exchange and TSX Venture Exchange are dummy variables, representing where the issuing firm is listed. *Debt/Equity* is the average debt to equity ratio of the issuing firms in the pre-issue period. *Daily Dollar Volume* is the average daily dollar volume in the pre-issue period. *Issue Amount* is the size, in terms of face value, of the convertible bond issuance. *Short Interest* is the average short interest, in terms of number of shares, in the pre-issue period. *Short Interest/Shares Outstanding* is the short interest divided by the shares outstanding of the issuing firm.

	N	Mean	Median	Standard Deviation
Market Capitalization ($ millions)	317	1449.97	382.88	5799.56
Toronto Stock Exchange	317	0.93	1.00	0.26
TSX Venture Exchange	317	0.07	0.00	0.26
Debt/Equity	317	0.71	0.36	0.98
Daily Dollar Volume ($ millions)	317	6.21	1.28	23.07
Issue Amount ($ millions)	316	92.60	60.00	106.19
Issue Amount/Market Cap (%)	316	21.19	16.35	19.28
Short Interest (000 shares)	317	1100.57	215.27	2845.57
Short Interest/Shares Outstanding (%)	317	0.92	0.48	1.33

Most of the issuers in the sample are from Toronto Stock Exchange. The issuing firms have a mean market capitalization of $1,450 million, and a median of $383 million. The convertible bond is a significant amount of debt issuance, and on average accounts for 21.19% of equity market value. The average daily dollar volume before issuance has a mean of $6.21 million and a median of $1.28 million. Short interest prior to issuance is typically small. The mean of short interest as percentage of shares outstanding is 0.92%, and the median is 0.48%.

5. Results

First we discuss the liquidity before the convertible bond issuance. Next we examine the changes in short interest after issuance and its robustness to market-wide effects. Finally, we test the relationship between the liquidity measures and the changes in short interest.

5.1. Liquidity Measures and Firm Characteristics

Table 2 presents summary statistics for issuing firms and stock liquidity prior to 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 full sample into four subsamples based on the size of change in short interest around bond issuance. Column P1 (P4) represents the portfolio with the smallest (largest) change in short interest as a percentage of shares outstanding.

Table 2

Summary Statistics and Liquidity Measures for Issuing Firms

The table summarizes firm characteristics and liquidity prior to bond issuance. In Panel A, the data are the same as described in Table 1. Panel B reports the liquidity measures, which are calculated as daily average for the pre-issue period. *Log Turnover* is the natural log of daily volume over shares outstanding. *Log Dollar Volume* is the natural log of daily dollar volume. *Log Amihud* is the natural log of daily absolute return over dollar volume (Amihud, 2002). *Dollar Spread* is the ask price minus bid price. *Percentage Spread* is the dollar spread over bid-ask midpoint. Sample is sorted into four portfolios by *ΔShort Interest/Shares Outstanding* in the month of bond issuance. P1 is the portfolio with smallest change in short interest as percentage of shares outstanding in the month of bond issuance; and P4 is the portfolio with largest change. Column P4-P1 is difference in mean measures between P4 and P1. The corresponding t-statistics are issuer-clustered, and reported in parentheses. "*", "**", and "***" denote 10%, 5%, and 1% significance.

	Portfolios Ranked By Change In Short Interest						
	All	P1	P2	P3	P4	P4-P1	t-stat
		Smallest			Largest		
Panel A: Firm and Convertible Bond Characteristics							
Toronto Stock Exchange	0.927	0.962	0.848	0.913	0.987	0.025	(0.99)
TSX Venture Exchange	0.073	0.038	0.152	0.088	0.013	-0.025	(-0.99)
Public	0.770	0.797	0.722	0.750	0.810	0.013	(0.19)
log Market Capitalization	19.729	20.253	18.876	19.783	20.002	-0.250	(-0.95)
Short Interest/Shares Outstanding	0.009	0.015	0.003	0.007	0.011	-0.005	(-1.45)
Panel B: Liquidity Measures							
log Turnover	-6.402	-6.004	-7.113	-6.256	-6.236	-0.232	(-1.54)
log Dollar Volume	13.348	14.229	11.795	13.591	13.775	-0.454	(-1.27)
log Amihud	-15.810	-16.492	-14.682	-15.918	-16.148	0.344	(1.12)
Dollar Spread	0.101	0.086	0.119	0.098	0.100	0.014	(0.76)
Percentage Spread (%)	1.703	0.965	3.498	1.267	1.088	0.123	(0.56)

The first panel shows that firm size is not related to *ΔShort Interest/Shares Outstanding*, 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 *ΔShort Interest/Shares Outstanding*. The rest of the subsamples (P2, P3, and P4) show such a pattern that firms tend to have larger *ΔShort Interest/Shares Outstanding*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 benefit from an existing active short interest market in the stock that they choose for their trading strategy. The second panel summarizes the liquidity measures prior to bond issuance. The turnover, dollar volume, Amihud illiquidity measure, and spread to price ratio are similar across the subsamples. We notice that the portfolio (P1) with the smallest *ΔShort Interest/Shares Outstanding*, is the most liquid portfolio based on all five liquidity measures. However, the rest of the subsamples show that the portfolios with higher *ΔShort Interest/Shares Outstanding* tend to be more liquid prior to issuance. Although arbitrageurs would prefer more liquid firms in executing convertible arbitrage strategy, they can exploit profit from such strategy only when the convertible bonds issued by these firms are underpriced. The observations presented in Panel B may indicate that the convertible bonds issued by the most liquid firms are less likely to be perceived as underpriced, thus arbitrageurs are not selecting these firms for this trading strategy, which in turn leads to minimal changes in short interest of the most liquid portfolio (P1) in reaction to bond issuance.

5.2. Change in Short Interest and Liquidity

Table 3 presents the changes in short interest and stock liquidity after bond issuance. The change in short interest is for the month of bond issuance. The change in liquidity is the difference between post-issue period and pre-issue period. As before, we sort the sample into four portfolios by *ΔShort Interest/Shares Outstanding*.

Table 3

Changes in Short interest and Liquidity after Bond Issuance

The table reports changes in short interest and liquidity. *ΔShort Interest/Shares Outstanding* is the change in short interest divided by shares outstanding in the month of bond issuance. Changes in liquidity are daily average liquidity measure for the post-issue period minus daily average for the pre-issue period. *Δlog Turnover* is the change in natural log of daily volume over shares outstanding. *Δlog Dollar Volume* is the change in natural log of daily dollar volume. *Δlog Amihud* is the change in natural log of daily absolute return over dollar volume. *ΔDollar Spread* is the change in bid-ask spread. *ΔPercentage Spread* is the change in dollar spread over bid-ask midpoint.

Sample is sorted into four portfolios by *ΔShort Interest/Shares Outstanding* in the month of bond issuance. P1 is the portfolio with smallest change; and P4 is the portfolio with largest change. Column P4-P1 is difference in mean measures between P4 and P1. The corresponding t-statistics are issuer-clustered, and reported in parentheses. "*", "**", and "***" denote 10%, 5%, and 1% significance.

	Portfolios Ranked By Change In Short Interest					
	All	P1	P2	P3	P4	P4-P1
		Smallest			Largest	
ΔShort Interest/Shares Outstanding (%)	-0.086	-1.597	-0.009	0.111	1.150	2.748
	(-0.30)	(-1.40)	(-3.34)***	(15.85)***	(10.59)***	(2.40)**
Δlog Turnover	0.058	0.061	0.021	-0.098	0.253	0.192
	(1.64)*	(0.96)	(0.28)	(-1.70)*	(3.15)***	(1.88)*
Δlog Dollar Volume	0.231	0.262	0.071	0.073	0.521	0.259
	(4.61)***	(2.75)***	(0.79)	(0.89)	(5.12)***	(1.86)*
Δlog Aminud	-0.269	-0.320	-0.122	-0.128	-0.507	-0.186
	(-5.64)***	(-3.60)***	(-1.39)	(-1.51)	(-5.43)***	(-1.44)
ΔDollar Spread	-0.009	-0.008	-0.004	0.005	-0.027	-0.019
	(-2.00)**	(-1.49)	(-0.64)	(0.59)	(-2.61)***	(-1.61)
ΔPercentage Spread (%)	-0.077	-0.160	0.094	0.093	-0.336	-0.176
	(-0.91)	(-1.50)	(0.35)	(0.78)	(-2.83)***	(-1.10)

The short interest for the full sample does not change significantly on average, (0.086% of all shares outstanding). The two subsamples with smallest *ΔShort Interest/Shares Outstanding* (P1 and P2) have decreased short interest over the month after issuance, while the other two have increased short interest of 0.11% and 1.15%, respectively. Positive numbers of *Δlog turnover* and *Δlog dollar volume* indicate improvements in stock liquidity; while negative numbers of *Δlog Amihud*, *Δdollar spread* and *Δpercentage spread* indicate improvements in liquidity. Four out of

five liquidity measures show that the full sample stock liquidity improves significantly after issuance. For the portfolio (P1) with smallest *ΔShort Interest/Shares Outstanding*, two liquidity measures (log dollar volume and log Amihud) show significant improvements. For the portfolio (P4) with largest *ΔShort Interest/Shares Outstanding*, all five liquidity measures support liquidity enhancement. For portfolio P2 and P3, liquidity level does not change significantly on average. In addition, the last column of the table shows that liquidity improvement of P4 is only weakly better than that of P1. Overall, the evidence can be interpreted as significant improvement in liquidity associated with convertible arbitrage for the portfolio with the largest change in short interest. There is some weaker evidence of liquidity improvements for all portfolios.

5.3. Controlled Change in Short Interest and Liquidity

Besides convertible bond arbitrage activity, there may be other factors that also contribute to the change in stock liquidity. The most prominent one is market-wide events or changes in liquidity. To exclude the market effects and isolate impact of the arbitrage activity, we use a control sample firms to compare the changes in liquidity and short interest.

Table 4 summarizes the changes in short interest and stock liquidity relative to control firms. The table reports the changes of sample firms' short interest and liquidity measures minus the changes of control firms'. The full sample is resorted into four portfolios by controlled change in short interest divided by shares outstanding during the month of bond issuance.

Table 4

Change in Short Interest and Liquidity relative to Control Firms

The table reports controlled changes in short interest and liquidity. Changes are calculated as changes of issuing firm minus changes of control firm. *ΔShort Interest/Shares Outstanding* is the change in short interest divided by shares outstanding in the month of bond issuance. Changes in liquidity are daily average liquidity measure for the post-issue period minus daily average for the pre-issue period. *Δlog Turnover* is the change in natural log of daily volume over shares outstanding. *Δlog Dollar Volume* is the change in natural log of daily dollar volume. *Δlog Amihud* is the change in natural log of daily absolute return over dollar volume. *ΔDollar Spread* is the change in bid-ask spread. *ΔPercentage Spread* is the change in dollar spread over bid-ask midpoint.

Sample is sorted into four portfolios by controlled *ΔShort Interest/Shares Outstanding* in the month of bond issuance. P1 is the portfolio with smallest change; and P4 is the portfolio with largest change. Column P4-P1 is difference in mean measures between P4 and P1. The corresponding t-statistics are issuer-clustered, and reported in parentheses. "*", "**", and "***" denote 10%, 5%, and 1% significance.

	Portfolios Ranked By Change In Short Interest					
	All	P1	P2	P3	P4	P4-P1
		Smallest			Largest	
ΔShort Interest/Shares Outstanding (%)	-0.197	-2.186	-0.032	0.150	1.302	3.488
	(-0.66)	(-1.89)*	(-4.50)***	(11.78)***	(10.53)***	(3.00)***
Δlog Turnover	0.079	-0.052	0.194	-0.017	0.195	0.247
	(1.54)	(-0.49)	(1.93)*	(-0.22)	(2.03)**	(1.73)*
Δlog Dollar Volume	0.133	0.029	0.075	0.034	0.395	0.367
	(2.04)**	(0.22)	(0.63)	(0.31)	(3.29)***	(2.07)**
Δlog Aminud	-0.182	-0.131	-0.164	-0.080	-0.356	-0.225
	(-3.42)***	(-1.30)	(-1.55)	(-0.86)	(-3.37)***	(-1.54)
ΔDollar Spread	-0.020	-0.047	-0.012	0.018	-0.038	0.009
	(-1.12)	(-1.15)	(-0.22)	(0.85)	(-3.06)***	(0.20)
ΔPercentage Spread (%)	-0.122	-0.093	0.208	-0.428	-0.172	-0.078
	(-1.07)	(-0.58)	(0.70)	(-1.72)	(-0.63)	(-0.25)

For the entire sample, controlled change in short interest is not significant, consistent with the uncontrolled result, presented previously in Table 3.Two of the five liquidity measures support the hypothesis of liquidity improvement after bond issuance. Log dollar Volume increases by 0.133, and is significant at 5-percent level. Log Amihud reduces by 0.182, and is significant at 1-percent level. The other three liquidity measures indicate liquidity enhancement only at lower confidence level.

Looking at the results for the portfolios sorted by size of controlled *ΔShort Interest/Shares Outstanding*, the portfolios with the smallest change in short interest (P1 and P2) have negative change in short interest over the month after issuance, while the ones with the largest one (P3 and P4) have a positive change. Moreover, there is a monotonic relation (except for P1) between the size of change in *Short Interest/Shares Outstanding* around issuance and the change in short interest in the month after issuance. This is consistent with portfolios P3 and P4 picking up the bulk of convertible arbitrage activity. Although there is no clear pattern or monotonic relation between the size of ΔSI/Shrout and liquidity measures, the portfolio with the largest *ΔShort Interest/Shares Outstanding* (P4) shows significant improvement in four of the liquidity measures. In addition, the portfolio with the largest *ΔShort Interest/Shares Outstanding* (P4) has better liquidity enhancement than the portfolio with the smallest *ΔShort Interest/Shares Outstanding* (P1). *Δlog turnover* and *Δlog dollar volume* for P4-P1 are positive and significant. *Δlog Amihud* and *Δpercentage spread* are negative, albeit not significant at 10-percent level. In light of our results above, the controlled liquidity measures show that there are significant improvements in liquidity relative to control firms for issues where there is high convertible arbitrage activity.

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 Δ*Liquidity* measure against *ΔShort Interest/Shares Outstanding* , and control variables, including change in market capitalization, stock price, return volatility and stock exchange dummy. Table 5 reports the results from the regressions in specification (1) for the full sample. Based on prior findings for the US, we expect

a positive relationship with the change in short interest for turnover and dollar volume, and a negative one for the Amihud measure, dollar spread and percentage spread. Based on our findings above, we expect this relationship to exist only for the P3-P4 firms, and not necessarily for the whole sample.

Table 5

Liquidity Regressions

The table reports regression results for the change in liquidity on change in short interest in the month of bond issuance. All changes in the regression are relative to control firm, calculated as changes of issuing firm minus changes of control firm. *ΔShort Interest* is the change in short interest divided by shares outstanding in the month of bond issuance. *Δlog Market Cap*, *ΔReturn Volativlity* and *Δliquidity measures* are the daily average in post-issue period minus the daily average in pre-issue period. *Log Pre-Issue Price* is the daily average of natural log of issuing firm stock price in the pre-issue period. *Toronto Stock Exchange* and *Public* are dummy variables, indicating issuing firm stock exchange and whether the bond is a public offering. *PrePost* is the number of days between the pre-issue period and the post-issue period.

The corresponding t-statistics for estimated coefficients are issuer-clustered, and reported in parentheses. "*", "**", and "***" denote 10%, 5%, and 1% significance.

	Change In Liquidity Measures				
	Δlog Turnover	Δlog Dollar Volume	Δlog Aminud	ΔDollar Spread	ΔPercentage Spread
Intercept	0.178	0.263	-0.313	-0.161	-0.015
	(0.46)	(0.66)	(-0.75)	(-1.17)	(-1.23)
ΔShort Interest	0.140	-0.757	0.623	-0.083	0.002
	(0.07)	(-1.92)*	(2.28)**	(-1.77)*	(0.32)
Δlog Market Cap	0.314	0.953	-0.461	0.036	-0.004
	(3.37)***	(4.48)***	(-3.88)***	(1.34)	(-1.59)
ΔReturn Volatility	4.964	2.589	3.284	0.716	0.608
	(1.94)*	(0.72)	(0.55)	(0.61)	(3.91)***
log Pre-Issue Price	-0.025	0.013	0.008	0.000	0.000
	(-0.65)	(0.26)	(0.19)	(0.01)	(0.51)
Toronto Stock Exchange	-0.522	-0.591	0.429	-0.155	0.024
	(-2.44)**	(-2.67)***	(2.17)**	(-1.00)	(2.65)***
Public	0.068	-0.018	-0.003	-0.008	0.000
	(0.58)	(-0.13)	(-0.02)	(-0.21)	(0.02)
PrePost	0.005	0.005	-0.004	0.004	-0.000
	(1.16)	(1.08)	(-0.73)	(1.57)	(-1.05)
Number of Observations	313	313	313	312	312
R^2	0.106	0.358	0.140	0.032	0.406

For the full sample, the change in liquidity is significantly positively (at the 10% level) related to convertible arbitrage activity for one of the measures (dollar spread). On the other hand, the coefficients of the two other liquidity measures show that change in liquidity is significantly negatively (at the 10% level) related to change in short interest. This is consistent with the result in Table 4 that on average the full sample has reduced short interest level in the month of bond issuance (a sign of lack of convertible arbitrage activity overall) while liquidity improves somewhat. This may be caused by a short interest hike motivated by valuation reasons in reaction to announcement in the month prior to issuance. This type of short interest variation cancels out the average short interest changes in our proxy for convertible arbitrage activity, but does not affect liquidity in the post-issue period. Also, as previously noted portfolio P3 and P4 pick up most of the convertible arbitrage activity. Trading in portfolio P1 and P2 does not appear to represent convertible arbitrage; it reduces overall short interest around issuance but has little effect on liquidity after bond issuance. In consideration of these possibilities, we investigate further the impact of convertible arbitrage activity on stock liquidity.

5.5. Subsample Liquidity Regressions

We divide the full sample into two subsamples and do regression analysis on each subsample separately. The first subsample consists of portfolios P1 and P2, where convertible arbitrage activity does not seem to be significant; the second subsample is portfolio P3 and P4 where convertible arbitrage activity appears to be present. Table 6 presents the results.

Table 6

Liquidity Regressions in Two Subsamples

The table reports regression results of change in liquidity on change in short interest in the month of bond issuance in two subsamples. Subsample One is portfolio P1 and P2 as defined in Table 4; Subsample Two is portfolio P3 and P4. Variables are the same as described in Table 5. Coefficients for *Public* and *PrePost* are not of interest and are reported in the table. The corresponding t-statistics for estimated coefficients are issuer-clustered, and reported in parentheses. "*", "**", and "***" denote 10%, 5%, and 1% significance.

Subsample One	Δlog Turnover	Δlog Dollar Volume	Δlog Aminud	ΔDollar Spread	ΔPercentage Spread
Intercept	0.224	0.265	-0.303	-0.437	-0.009
	(0.39)	(0.40)	(-0.48)	(-1.62)	(-0.43)
ΔShort Interest	0.079	-0.786	0.528	-0.152	-0.000
	(0.04)	(-2.65)***	(1.86)*	(-1.81)*	(-0.05)
Δlog Market Cap	0.248	0.797	-0.393	0.039	-0.007
	(1.97)**	(3.00)***	(-2.39)**	(0.90)	(-2.28)**
ΔReturn Volatility	4.701	2.335	0.067	-0.213	0.460
	(1.41)	(0.55)	(0.01)	(-0.12)	(4.81)***
log Pre-Issue Price	-0.031	0.033	0.006	-0.005	-0.000
	(-0.62)	(0.47)	(0.10)	(-0.31)	(-0.45)
Toronto Stock Exchange	-0.677	-0.768	0.463	-0.314	0.016
	(-1.96)**	(-1.99)**	(1.36)	(-1.06)	(0.91)
Number of Observations	156	156	156	156	156
R^2	0.125	0.313	0.140	0.073	0.413

Subsample Two	Δlog Turnover	Δlog Dollar Volume	Δlog Aminud	ΔDollar Spread	ΔPercentage Spread
Intercept	-0.095	-0.035	-0.001	0.073	-0.019
	(-0.20)	(-0.07)	(-0.00)	(1.13)	(-1.07)
ΔShort Interest	11.291	10.787	-9.642	-2.841	-0.116
	(1.67)*	(1.66)*	(-1.15)	(-1.82)*	(-0.87)
Δlog Market Cap	0.436	1.283	-0.588	0.025	-0.001
	(4.13)***	(12.32)***	(-4.51)***	(1.59)	(-0.22)
ΔReturn Volatility	3.466	0.273	13.191	1.754	0.919
	(0.92)	(0.06)	(2.61)***	(1.78)*	(3.01)***
log Pre-Issue Price	-0.040	-0.046	0.048	0.007	0.001
	(-0.68)	(-0.70)	(0.72)	(0.67)	(0.95)
Toronto Stock Exchange	-0.382	-0.381	0.268	0.004	0.028
	(-1.40)	(-1.33)	(1.31)	(0.20)	(1.61)
Number of Observations	157	157	157	156	156
R^2	0.128	0.470	0.225	0.067	0.469

For subsample one, the coefficients do not support a clear relationship between changes in short interest and liquidity. This is consistent with our expectation as portfolio P1 and P2 do not support the prevalence of convertible arbitrage activity. For subsample two, all five liquidity measures support the prediction that liquidity improvements are positively related to convertible arbitrage activity. Among them, three measures (*log turnover*, *log dollar volume* and *dollar spread*) are significant at 10-percent level. These are consistent with our previous finding that there is significant liquidity enhancement only where there is high convertible arbitrage activity. It appears that arbitrageurs avoid certain convertible bond issues, possibly because these issues are not perceived to be underpriced or the equity is not liquid enough.[5]

We also note that change in firm size measured by log market capitalization is positively related to change in liquidity for the full sample as well as both subsamples. Meanwhile, listing on Toronto Stock Exchange somehow has a negative relationship with liquidity changes.

5.6. Robustness

As a robustness check, we filter the full sample to only include those issues where there is a monthly short interest reported in between the announcement date and issuance date. This way we hope to isolate arbitrage induced shorting activity from valuation induced shorting activity. For the refined sample, we still use change in short interest in the month of issuance as proxy for convertible arbitrage activity. In addition, we use change in short interest in the month of announcement as proxy for announcement effect and shorting activity motivated by valuation reasons.

Table 7 presents the regression results including both proxies as independent variables.

[5] A convertible bond needs to be underpriced in order for the arbitrageurs to profit from such strategy. As seen in Table 2 portfolio P1 is very liquid, so it may be the case these issues are less likely to be underpriced. On the other hand, portfolio P2 issuing firm equity is the least liquid group. There may be additional difficulty/costs in shorting/trading these stocks to establish the initial position and carry out the dynamic hedging process afterwards. For these reasons, arbitrageurs may avoid these issues in executing the convertible arbitrage strategy.

Table 7

Liquidity Regressions: Arbitrage Short and Valuation Short

The table reports regression results of change in liquidity on change in short interest in the month of bond issuance as well as change in short interest in the month of bond announcement. The sample is filtered to only include those issues whose announcement date and issuance date are in different months when monthly short interest is reported. All changes in the regression are relative to control firm, calculated as changes of issuing firm minus changes of control firm. *Arbitrage Short Proxy* is the change in short interest divided by shares outstanding in the month of bond issuance. *Valuation Short Proxy* is the change in short interest divided by shares outstanding in the month of bond announcement. *Δlog Market Cap*, *ΔReturn Volativlity* and *Δliquidity measures* are the daily average in post-issue period minus the daily average in pre-issue period. *Log Pre-Issue Price* is the daily average of natural log of issuing firm stock price in the pre-issue period. *Toronto Stock Exchange* and *Public* are dummy variables, indicating issuing firm stock exchange and whether the bond is a public offering. *PrePost* is the number of days between the pre-issue period and the post-issue period.

The corresponding t-statistics for estimated coefficients are issuer-clustered, and reported in parentheses. "*", "**", and "***" denote 10%, 5%, and 1% significance.

	Change In Liquidity Measures				
	Δlog Turnover	Δlog Dollar Volume	Δlog Aminud	ΔDollar Spread	ΔPercentage Spread
Intercept	2.086	1.744	-0.984	0.047	-0.052
	(2.20)**	(1.75)*	(-0.96)	(0.42)	(-1.07)
Arbitrage Short Proxy	21.879	3.364	0.084	-0.284	0.010
	(6.62)***	(0.99)	(0.02)	(-0.87)	(0.36)
Valuation Short Proxy	4.762	1.726	-5.355	-0.251	-0.082
	(0.68)	(0.19)	(-0.71)	(-0.39)	(-1.18)
Δlog Market Cap	0.284	0.967	-0.635	-0.005	-0.003
	(1.60)	(2.34)**	(-2.23)**	(-0.31)	(-1.58)
ΔReturn Volatility	4.004	0.990	14.428	3.954	0.426
	(0.44)	(0.10)	(1.38)	(1.97)**	(2.86)***
log Pre-Issue Price	-0.105	0.023	0.045	0.013	-0.000
	(-1.08)	(0.17)	(0.39)	(0.81)	(-0.06)
Toronto Stock Exchange	-0.590	-0.766	0.165	-0.039	0.046
	(-1.07)	(-1.30)	(0.56)	(-1.40)	(1.07)
Public	0.273	0.186	-0.062	-0.025	-0.002
	(1.53)	(0.88)	(-0.24)	(-1.36)	(-1.07)
PrePost	-0.018	-0.013	0.007	-0.000	0.000
	(-1.85)*	(-1.28)	(0.54)	(-0.27)	(0.52)
Number of Observations	113	113	113	113	113
R^2	0.471	0.389	0.248	0.238	0.340

The coefficients of *valuation short proxy* are not significant for all five liquidity measures. This makes sense since shorting activity motivated by valuation reasons does not require ongoing adjustment as dynamic hedging does. After controlling for this, only one of them, ΔlogTurnover, is significant at 1-percent level. Three liquidity measures suggest that arbitrage shorting activity might be positively related to liquidity improvements and two liquidity measures indicate negative relationship, but all coefficients are insignificant. Overall, the regression results suggest that there is weak evidence of positive relationship between convertible arbitrage activity and stock liquidity improvements.

6. Conclusion

We examine convertible bond arbitrage in Canada, a trading strategy that involves dynamic hedging trades independent of information about the market or the issuing firm. This strategy has been shown to lead to liquidity improvements in the US, when arbitrageurs trade contrary to the market. This paper investigates whether there are liquidity externalities and liquidity improvements when Canadian firms issue convertible debt, and whether such changes in liquidity can be linked to convertible bond arbitrage.

Following the literature, we use the change in short interest divided by shares outstanding as a measure for the activity of convertible bond arbitrageurs. We expect that this proxy will increase immediately after a convertible bond issuance reflecting the entrance of arbitrageurs in the stock. In our sample of Canadian convertible bond issues, we find an increase in hedge fund activity following a bond issuance. We compute several liquidity measures and find no significant overall liquidity improvements following a convertible bond issue. To examine the robustness of this result, we control for market wide effects that exist at the time of issue. We

compare the change in the measure of convertible bond arbitrage activity and the change in the liquidity measurestothe changes of those measuresin control firms and find similar results. There is no significant overall relationship between hedge fund activity and liquidity changes. However, there is liquidity improvement for firms with the largest change in short interest.

We conjecture that the insignificant overall improvements in liquidity that contrast with prior studies of hedge funds in the United States may be the result of market specialization of hedge funds, if the absolute size of hedge fund profits available in Canada is smaller than the US. Hedge funds with international operations seem to specialize in a segment of the smaller Canadian market, where they perceive significant profit opportunities. It is not clear if the overall Canadian market is not targeted because it is more efficient, or because it is too small for potential profits to cover fixed costs. It is possible that overall higher fixed costs of operating in Canada along with relatively high trading costs compared to the US limit the arbitrage profits of hedge funds. We hope that future studies will address these issues when appropriate data become available.

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