Convertible Bond Arbitrage, Liquidity Externalities, and Stock Prices *

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Abstract

In the context of convertible bond issuance, we examine the impact of arbitrage activity on underlying equity markets. In particular, we use changes in equity short interest following convertible bond issuance to identify convertible bond arbitrage activity and analyze its impact on stock market liquidity and prices for the period 1993 to 2006. There is considerable evidence of arbitrage-induced short selling resulting from issuance. Moreover, we find strong evidence that this activity is systematically related to liquidity improvements in the stock. These results are robust to controlling for the potential endogeneity of arbitrage activity.

Keywords: Convertible Bond Arbitrage, Liquidity, Market Efficiency, Hedge Funds.

JEL Classification: G12, G14

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1 Introduction

Does arbitrage activity impact market quality? Although this question is not new, the proliferation of hedge funds in recent years has brought increasing attention to important questions regarding their impact on both liquidity and market efficiency (see, e.g., Securities and Exchange Commission (SEC) (2003)). In this paper, we focus on one particular strategy: convertible bond arbitrage. The growth in the issuance of the equity-linked debt securities can be attributed, at least in part, to the growing supply of capital provided by hedging strategies. Convertible bond issuance has increased more than sixfold in the past fifteen years, from $7.8 billion in 1992 to $50.2 billion in 2006 (SDC Global New Issues database). In fact, the widespread belief among Wall Street practitioners is that convertible bond arbitrage hedge funds purchase 70% to 80% of the convertible debt offered in primary markets.[1]

In order to clarify the intuition as to why convertible bond arbitrage might impact liquidity in underlying equity markets, it is useful to outline the basics of the strategy. The aim of convertible bond arbitrage is to exploit mispricing in convertible bonds, usually by buying an undervalued convertible bond (Henderson, 2005) and taking a short position in the equity.[2] A typical convertible bond arbitrage strategy employs delta-neutral hedging, in which a manager buys the convertible bond and sells short the underlying equity at the current delta. The position is set up so that no profit or loss is generated from very small movements in the underlying stock price, and where cash flows are captured from both the convertible bond's yield and the short position's interest rebate. If the price of the stock increases, the

[1] While they do not constitute the entire universe of convertible bond arbitrageurs, hedge funds are an important subset. Mitchell, Pedersen, and Pulvino (Forthcoming), report that convertible arbitrage funds account for 75% of the market. Similar estimates can be found in the popular press. See, e.g., a Wall Street Journal article (Pulliam, 2004) reporting on convertible bond issuance in 2004 that "As much as 80% of those issues were bought by hedge funds, according to brokers who work on convertible-bond trading desks." The Financial Times (Skorecki, 2004) reports that hedge funds bought 70% of new issues in 2003 and that 95% of trades in converts are made by hedge funds. The evidence presented in this study of large increases in short selling near issuance is consistent with that view.

[2] A convertible bond is a hybrid debt instrument: it is a bond that may, at the option of the holder, be converted into stock at a specified price for a given time period. Due to the conversion option, convertible bonds purchasers may profit from equity price gains but they also have downside protection since they are guaranteed bond payments (and, in the event of bankruptcy, are senior to equity holders).

arbitrageur adds to the short position (because the delta has increased). Similarly, when a stock price declines, the arbitrageur buys stock to cover part of the short position (due to the decrease in delta). Aggregate equity market trading demand, in contrast, is expected to move in the opposite direction. For example, Chordia, Roll, and Subrahmanyam (2002) document a positive correlation between stock returns and order imbalances. This means that the activities of convertible bond arbitrageurs, a class of investors trading against net market demand, should improve liquidity. This potentially positive role for hedge funds and other convertible bond arbitrageurs is contrary to the view of a destabilizing role for arbitrageurs in markets (see Mayhew (2000) for a survey of this literature).

Although we do not have direct data on convertible bond arbitrage activity in individual stocks, we are able to identify firms and dates on which we know that this strategy is likely to be used (convertible bond issuance dates). For the period 1993 to 2006, we estimate convertible bond arbitrage activity by calculating changes in short selling at and around issuance. The methodology allows us to use aggregate data to identify the presence and estimate the impact of a particular type of trader in stock markets. Our approach is simple, yet it captures the strategy of interest, as we observe large increases in short interest near convertible debt offerings.

Our proxy for arbitrage activity (change in short interest of issuing firms) has several advantages over using hedge fund databases to estimate convertible bond arbitrage activity. First, this provides a measure of *positions* taken by arbitrageurs (in individual securities). Fund flows data in hedge fund databases are self-reported and therefore provide an incomplete measure of convertible bond arbitrage activity. Second, there may be style misclassification and funds reporting multiple strategies to hedge fund databases. Third, even if we measured the assets of the funds perfectly, the positions would still be unobservable due to the use of leverage.

We find considerable evidence of arbitrage activity (i.e., short selling in the stock) at the date of bond issuance. We also find increased equity market liquidity following bond

issuance. Moreover, these liquidity improvements are positively and significantly related to convertible bond arbitrage activity. We also observe changes in stock price volatility. Following convertible debt issuance there is an average decrease in total volatility and a decrease in the idiosyncratic component of volatility. We do not find evidence of a systematic relationship between convertible bond arbitrage activity and these volatility changes. We measure price efficiency using return autocorrelation and variance ratios (measure presented in Lo and MacKinlay (1988), which captures the extent to which stock prices follow a random walk). We do not observe significant changes in either of these measures following issuance. Taken together, we interpret the findings as evidence that convertible bond arbitrage activity tends to affect equity markets positively; however, this is primarily through liquidity improvements, not through stock prices.

A critical aspect of the analysis is that we do not observe arbitrage activity directly; instead, we infer it based on changes in short interest at bond issuance. We conduct several tests to examine the validity of this important assumption.[3] First, we rule out the possibility that changes that we observe are due to changes in market-wide variables or to factors impacting firms with similar characteristics. We do this by conducting all analyses based on changes relative to a set of control firms (matched on size, book-to-market, turnover, industry, and exchange). Second, it could be that short selling that we observe is due to valuation shorting resulting from news of the convertible bond issue, not due to classic convertible bond arbitrage. In order to address this issue, we hand-collect announcement dates for our sample of convertible bond issues. This allows us to separate the impact of announcement period shorting versus issue period shorting (which we interpret as valuation shorting versus convertible bond arbitrage, respectively). Finally, we construct a theoretical measure of convertible bond arbitrage that does not depend on short-selling data (under the assumption that arbitrageurs are primary buyers of the bonds). If the short selling that we observe is due to arbitrage, then we would expect measured changes in short interest to be

[3]We thank an anonymous referee for encouraging this line of inquiry.

correlated with this theoretical measure. We also examine whether the theoretical measure is systematically related to liquidity and price efficiency changes in the stock. In all of these tests, we find evidence consistent with the view that the short selling that we observe near convertible bond issues is due to convertible bond arbitrage.

The main contribution of this paper is that we identify arbitrage *activity* and are able to estimate its impact on market quality (we use changes in equity market liquidity and price efficiency as measures of quality). By identifying a particular trader type, our methodology allows us to shed additional light on the mechanisms through which quality changes following issuance occur. We find that changes in liquidity vary systematically with the positions taken by arbitrageurs. The findings in this paper may be of interest to managers of issuing firms concerned about liquidity and efficiency spillovers in their stock as a result of their capital structure decisions.

This paper is organized as follows. Section 2 contains a brief review of related literature. Section 3 constructs the main hypotheses. Section 4 describes the data and sample. Section 5 presents the analysis of arbitrage activity, liquidity, and prices. Finally, Section 6 concludes.

2 Related Literature

The notions of liquidity and efficiency "externalities" underlie much of the analysis in this paper. The idea in Ross (1976) and subsequent theoretical works (e.g., Grossman (1988); Biais and Hillion (1994); Easley, O'Hara, and Srinivas (1998)) that the introduction of options markets can enhance efficiency by making markets less incomplete and/or positively impacting informativeness of stock prices has been followed by empirical investigations of the impact of derivatives markets on the market for the underlying asset (e.g., Kumar, Sarin, and Shatsri (1998); DeTemple and Jorion (1990)).[4] Mayhew (2000) provides an excellent

[4]More recently, Basak and Croitoru (2006) show how the presence of arbitrageurs improves market quality and risk sharing in the context of rational markets with heterogeneous risk-averse investors and short-sales

survey of this literature. The main findings indicate a positive impact on liquidity and no negative impact on price efficiency. Most authors report a decrease in total volatility and an increase in trading volume following the introduction of options. We consider our study of the liquidity and efficiency externalities of convertible bond markets to be an extension of this line of research. Because of the embedded option in the convertible bond, the issuance of convertible bonds is analogous to the introduction of options.[5] Our identification (based on short selling) allows us to provide a more direct test of the impact of arbitrageurs. While prior work has provided evidence that the introduction of new securities markets can impact equity market quality on average, we identify the mechanisms through which quality changes occur.

Our basic empirical strategy uses increases in short interest near debt issuance to identify arbitrage activity. In that way, it is closely related to the growing empirical literature on short-selling activity. There has been considerable focus on the relationship between future stock returns and both observed short sales and short-sales constraints (see, e.g., Asquith, Pathak, and Ritter (2005); Boehme, Danielsen, and Sorescu (2006); Diether, Lee, and Werner (2005); Jones and Lamont (2002); Dechow, Hutton, Meulbroek, and Sloan (2001); Asquith and Meulbroek (1996)). The information content of short sales in event settings has also received attention in the recent empirical literature (e.g., Christophe, Ferri, and Angel (2004)). All of these papers provide evidence that short selling and short-sales constraints impact stock prices, suggesting that short sellers help to incorporate negative information into prices.

Although short sellers can help facilitate the incorporation of negative information into prices, many are uninformed. They use short sales to hedge other positions. Little has been done to distinguish this type of short seller.[6] This is an important distinction because the

constraints.

[5]In fact (unreported analysis), we find that the absence of put or call options on a particular stock is associated with greater convertible bond arbitrage activity. This result confirms the idea that the existence of substitute markets is critical in any trading decision.

[6]Boehmer, Jones, and Zhang (2006) use proprietary order-level data from the NYSE to quantify the

impact of short selling on market quality will obviously depend largely on who is engaging in the short sale. Uninformed short sellers are likely to add liquidity to markets (rather than reduce it as a result of potential adverse selection). Asquith et al. (2005, p. 270) note that, "Of course, a firm might have a high short-interest ratio because there is both valuation shorting and arbitrage shorting taking place simultaneously. Unfortunately, we cannot identify these situations precisely." Our event-based approach takes us further toward identification of this specialized investment strategy from the aggregate data in that the change in short interest near the issue date can be attributed, in large part, to convertible bond arbitrage activity.[7]

There are three recent papers that use changes in short interest near events to infer the impact of a particular type of trader. Arnold et al. (2005) use the Tax Payer Relief Act of 1997 (which made selling short against the box more costly) as a laboratory for testing hypotheses regarding changes in the information content of short interest when tax-motivated short sellers (i.e., uninformed sellers) no longer have incentives to short.[8] This event-driven approach to trader identification is similar in spirit to ours; however, we examine not only average changes, but also cross-sectional implications of the introduction of a particular trader type.[9] Mitchell, Pulvino, and Stafford (2004) use short interest in acquirers near merger announcements to identify activities by risk arbitrageurs and estimate the impact of this trading activity on prices. Bechmann (2004) also examines changes in short selling near a corporate event. He provides evidence that short selling induced by hedging activities explains part of the stock price decline following convertible bond calls. In both Bechmann (2004) and Mitchell et al. (2004), the focus is mainly on price pressure induced by short-

information content of the flow of shorting activity by the type of account initiating the sale. In this way, they are able to make distinctions between the information content of sales and trader type. Their focus is on characterizing the information content of short sales, by size and trader (account type).

[7]We provide results of several tests of whether the changes in short selling are due to arbitrage or other factors.

[8]Selling short against the box allows investors with a long position in the stock to eliminate the exposure to the stock while deferring capital gains until a later tax period.

[9]That is, we examine the sensitivity of changes in liquidity and volatility to the magnitude of the increase in short selling due to arbitrage.

selling activity while our focus is on impact of arbitrage on stock market liquidity and prices.

Although they do not constitute the entire universe of convertible bond arbitrageurs, convertible bond arbitrage hedge funds do play a role in primary issues of convertible debt and have an impact on stock market quality. Risks and rewards of providing liquidity by hedge funds in the convertible bond market are thoroughly studied by Agarwal, Fung, Loon, and Naik (2006). Underpricing of convertible bonds at issue, risk, and returns of the convertible bond arbitrage strategy are studied by Henderson (2005). He finds evidence that new issues of convertible bonds are underpriced at issue but that excess returns occur soon after issuance (mainly in the first six months), which may decrease the presence of convertible bond arbitrageurs over longer horizons. Mitchell, Pedersen, and Pulvino (Forthcoming) analyze the impact of capital outflows in hedge funds on convertible bond prices. Choi, Getmansky, and Tookes (2007) examine supply and demand in the convertible bond market, mapping the measure of arbitrage activity used in this paper to fund flows and returns in convertible bond arbitrage hedge funds.

3 Arbitrage, Liquidity, and Stock Prices: Predictions

This section outlines our main predictions. We measure changes in short selling near convertible bond issuance and relate this proxy for convertible bond arbitrage activity to changes in liquidity and stock price efficiency. As mentioned in the introduction, the typical convertible bond arbitrage strategy (delta hedging) implies that arbitrageurs engaged in dynamic hedging are likely to trade in the opposite direction of the rest of the market: they increase their short positions as stock prices increase, and decrease them when stock prices decrease. This should result in improved market liquidity (our alternative hypothesis). In this section, we test the following two null hypotheses:

H_0 (Liquidity): Convertible bond arbitrage activity (i.e., increased short selling near issuance) is uncorrelated with changes in liquidity.

H_0 (Efficiency): The increase in short selling near issuance is uncorrelated with changes in efficiency.

If convertible bond arbitrageurs have no special knowledge about the value of the underlying shares, we can interpret their participation in the equity market as an influx of traders whose presence improves liquidity since their presence would initially increase the supply of shares to buyers. If they are privately informed, however, adverse selection costs can increase, and liquidity can decrease. We do not expect to observe evidence of the latter possibility because convertible bond arbitrageurs typically act to exploit perceived underpricing in the bond, not equity.

Convertible bond arbitrageurs can also impact the efficiency of equity prices. In theory, if these traders are privately informed and the short selling that we identify in the data is due to an informational advantage about equity market valuation, price efficiency would increase following issuance.[10] Even if these short sellers are not privately informed but are trading to exploit a known inefficiency such as autocorrelation, efficiency will also increase following issuance.[11] If instead short sellers are taking equity market positions primarily to hedge their positions in the bonds, then their presence would not directly impact efficiency of stock prices. We conjecture that although convertible bond arbitrageurs are sophisticated traders, they are relatively uninformed (i.e., they have no private information about the value of the equity that they short) and that they are trading to manage equity risk exposure, not to exploit mispricing. If this is the case:

P1: Convertible bond arbitrage activity (i.e., the increase in short selling near issuance) will be associated with improved market liquidity (via dynamic hedging strategies, in which arbitrageurs' trading activity tends to be in the opposite direction of the market).

P2: Convertible bond arbitrage activity will not impact the efficiency of prices.

[10] For example, see Diamond and Verrecchia (1987).

[11] We thank an anonymous referee for suggesting this possibility.

For more precise interpretation of ***P2***, it is useful to make a distinction between convertible bond arbitrage and other arbitrage activity (e.g., valuation shorts or exploitation of known autocorrelation). It may be reasonable to expect short selling due to general arbitrage activity to improve price efficiency; however, convertible bond arbitrageurs typically take their positions to hedge risk associated with the bond issue.

In our empirical analysis, we use a variety of proxies for both liquidity and price efficiency. For liquidity, we examine several measures: turnover; number of trades; the Amihud (2002) illiquidity measure; order imbalance, quoted spread, and quoted depth. High values for turnover, number of trades, and depth are interpreted as high liquidity. Low values of the Amihud (2002) measure, order imbalance, and spreads are interpreted as high liquidity. For stock price efficiency, we use: (1) the variance ratio, which compares stock price variances over different frequencies, where smaller deviations from 1 imply greater efficiency;[12] and (2) autocorrelation, where smaller return autocorrelation is interpreted as greater efficiency.[13] We also examine long-run stock returns following bond issue. The latter is a test of efficiency in that it asks whether the short-sales positions that we observe in the data would make money over various horizons.

[12]See Lo and MacKinlay (1988).

[13]In unreported tests, we examined two additional efficiency measures: idiosyncratic volatility and R-squared. Results using these two measures are similar to the other efficiency measures. The distinction between idiosyncratic and systematic volatility is motivated by Bris et al.(2004). They interpret an observed low R-squared as evidence of efficiency. Similarly, we interpret an increase in idiosyncratic volatility as evidence of improved price efficiency because it suggests that more firm-specific information is incorporated into prices.

4 Data and Sample Selection

4.1 Short Interest and Convertible Debt Issues

The initial sample for this study consists of all convertible debt issues (public, private, and Rule 144a) by U.S. publicly traded firms for the period July 1993 through May 2006.[14] Issue dates and other characteristics of the issues are from the SDC Global New Issues database and the Mergent Fixed Income Securities Database (FISD). We obtain monthly short-interest data directly from the NYSE and the Nasdaq and match the short-interest data with the SDC data using ticker and date identifiers. Because the monthly short-interest files reflect short interest as of three trading days (five for the first years of our sample) prior to the fifteenth of each month, we calculate a trade date for each file and use that date to match to the SDC data.[15] We then match these data to the CRSP/COMPUSTAT tapes and NYSE TAQ Database. We also obtain data on institutional holdings from the Thompson Financial Institutional (13f) Holdings and analyst opinion from I/B/E/S. For inclusion in the final sample, we require non-missing data on short interest, all liquidity and efficiency measures, and all control variables such as institutional holdings, analyst opinion, and historical volatility (see variables included in the regressions in Table 4, below).

Table 1 contains summary statistics on our sample of 846 convertible bond issues. The issuing firms have a mean (median) market capitalization of $4.7 ($1.2) billion. The convertible bond issue sizes constitute significant proportion of equity value, with the mean (median) dollar value of proceeds equal to 18.0% (14.9%) of equity market capitalization.

[14] We begin the analysis in 1993 because NYSE TAQ data are used to construct some of the liquidity and price-efficiency measures.

[15] It is critical to correctly match the short-interest dates to the issue dates. The monthly short-interest files are based on short interest as of trade dates that occur during the middle of the month at non-constant days across months (due to settlement). Following the documentation from the short-interest files that we received from Nasdaq and the NYSE, we define the trade date as: 5 trading days before the 15th (or the preceding trading day if the 15th is not a trading day) through June 1995, and 3 trading days after June 1995. If a convertible bond is issued before the cutoff trade date of that month, that month is matched to the issue month. Otherwise, the next month is matched to the issue month. This algorithm is consistent with Bechmann (2004).

The firms for which we observe credit rating are rated "junk," with median S&P rating of BB-. In addition, our sample consists of about the same number of NYSE and Nasdaq issuers. We will investigate whether exchange listing is related to the prevalence of this strategy. Note that we do observe short selling in these stocks prior to issuance (or announcement, whichever is earlier), with mean (median) short interest during the prior six months equal to 4.5% (3.1%) of shares outstanding.

4.2 Proxy for the Presence of the Convertible Bond Arbitrage Strategy

Our proxy for the presence of the convertible bond arbitrage strategy is change in short interest intensity ("SI") during the month of the convertible bond issue. We initially define two measures of change in short interest as follows:

- $SI\_\%Shrout$ is change in short interest (number of shares) divided by total shares outstanding. The change in short interest is the difference between short interest in the current month and short interest in the previous month.
- $SI\_\%Issue$ is the dollar value change in short interest divided by issue proceeds. It is defined as difference between short interest in the current month and short interest in the previous month, times closing stock price on the issue date, divided by issue size (face value of the convertible bond times its offer price).

The first measure, $SI\_\%Shrout$, is the focus of our study because it provides a measure of the relative importance of the new arbitrageurs in the market for the stock. The second measure, $SI\_\%Issue$, is related to issue characteristics — namely, the amount of short-selling activity as a fraction of the issue size (which may be directly linked to hedging activity). Figure 1 reports means and medians of our SI measures during months -6 to $+6$ relative to the issue date (month 0). Consistent with our ex ante expectation, the figures show that we

are capturing an increase in short selling related to the issue. The median increase in short interest relative to shares outstanding, $SI\_\%Shrout$, at issue, is 1.7%. The median dollar value increase in short interest relative to issue size, $SI\_\%Issue$, at issue, is 13.1%.[16] As shown in Figure 1, both measures capture similar variation in short-selling activity. We focus on $SI\_\%Shrout$ in the main analysis due to our interest in the implications of convertible bond arbitrage for the market for the underlying stock.[17] We use this increase as a proxy for convertible bond arbitrage activity.[18]

Given the large increases during month 0, our analysis focuses on changes in short interest during this month. In the main analysis of changes in liquidity and stock price volatility we examine a relatively short time horizon (six months prior to and following issue and announcement) in order to isolate the impact of this strategy.[19] Not surprisingly, there is significant time-series variation in the short-interest measures. Given these observations and findings in the literature of distinct time-series patterns in short interest in the aggregate data (see, e.g., Lamont and Stein (2004)), we include year and month fixed effects in all cross-sectional regression specifications to control for month-to-month variation.

Figure 2a provides a description of the time series of convertible bond issuance in the sample. Issuance has steadily increased over time. We have also seen a growth in the total assets managed by convertible bond arbitrage hedge funds.

[16]We examined the time-series of changes in short-interest and, not surprisingly, observe significant time-series variation in the data. Therefore, we include time (year and month) fixed effects in all regressions.

[17]However (in unreported tests) we have replicated the analysis using $SI\_\%Issue$. All liquidity results are qualitatively similar (but weaker). The efficiency results are almost identical.

[18]Though it is true that short sellers can also short due to private information (see, e.g., Christophe et al.(2004) for the case of earnings announcements) and/or other types of arbitrage activity, the fact that we capture the increase in shorting over a relatively short horizon relative to the bond issue date makes us confident that our SI measures are, in large part, capturing convertible bond arbitrage. We explicitly test this in an analysis of short selling near announcement of the issue versus the actual issue date (see the discussion of Table 6).

[19]Convertible bonds often have call provisions; however, beginning with Ingersoll (1977) the empirical evidence has suggested that firms call too late. Further, callability should minimally impact our study over the six-month horizon because callable bonds often have call protection periods, generally greater than six months. See, e.g., Asquith (1995).

5 Convertible Bond Arbitrage, Liquidity, and Stock Prices

In this section, we examine links between changes in short interest near issuance and equity market characteristics.

5.1 Summary of Firm Characteristics, By SI Portfolio

Table 2 provides summary statistics of all of the firms prior to issuance in the sample (column "All").[20] We also divide the sample into four portfolios based on the change in short interest at issue, using the $SI\_\%Shrout$ measure, in order to provide some insight into the types of issuers for which the convertible bond arbitrage strategy is most evident. Portfolio 1 (4) corresponds to the smallest (largest) short-interest change. Panel A of the table reveals the following: First, Nasdaq stocks see the largest SI change following issuance, as there is a smaller fraction of Nasdaq stocks in the smallest SI portfolio compared to the largest SI portfolio. Second, small issuers and private issues experience higher SI change in their underlying stocks. Third, convertible bond arbitrage activity is higher in stocks that have a high pre-issue short interest, indicating that arbitrageurs choose issues where they believe they will have the ability to short the stock. Finally, as would be expected if convertible bond arbitrageurs are shorting shares to manage equity risk, the amount of short selling following issuance is positively and significantly related to the conversion ratio (number of shares into which the bond can be converted).[21]

Panel B of Table 2 reports stock liquidity measures. Number of trades, dollar volume, Amihud's (2002) illiquidity measure, order imbalance, and spread indicate that stocks in the smallest SI portfolio are more liquid. Share turnover and depth indicate otherwise.

[20] All measures are calculated using daily or monthly data from the 6 months (2 months for *Intraday AR(1)*) ending 1 month prior to issuance or announcement, whichever is earlier.

[21] In robustness analysis, we use conversion ratio directly in order to construct a theoretical measure of arbitrage based only on bond characteristics, not observed changes in short interest.

However, as noted above, firms in the high SI portfolio tend to be smaller, making the direct comparison of the level of liquidity measures inappropriate. We therefore focus on *changes* in liquidity in our main analysis, and control for pre-issue liquidity level and change in firm size in our regressions.

In Panel C of Table 2 we present descriptive statistics on a variety of return and price efficiency measures. We observe higher convertible bond arbitrage activity in stocks with higher average returns and standard deviation of returns, as well as higher betas, higher idiosyncratic volatility, and lower R-squared parameters (estimated from a market model regression). We also calculate autocorrelation of returns and variance ratios (see Lo and MacKinlay (1988)), which we use as measures of the degree of efficiency. Daily and intraday AR(1) parameters are calculated using daily returns and 30-minute interval returns, respectively. From the table we do not observe a significant relationship between changes in short interest in these efficiency measures. This suggests that stock price efficiency is not an important factor in convertible bond arbitrage (as would be expected, if equity positions are taken primarily to hedge equity risk).

5.2 Impact of Convertible Bond Arbitrage on Liquidity and Prices

5.2.1 Average Changes, by SI Portfolio

In Table 3a, we present results from the examination of the impact of convertible bond arbitrage on stock market liquidity and prices. All changes are defined as the "post-issue" period mean (6 months (120 trading days) beginning 1 month (20 trading days) following the bond issue or announcement, whichever is earlier) minus the "pre-issue" period mean (6 months (120 trading days) ending 1 month (20 trading days) prior to the bond issue or announcement, whichever is later).[22] Along with changes in short interest, we measure

[22]We exclude the +/− 1 month (20 trading days) around the bond issue and announcement to avoid mechanical changes in liquidity and efficiency measures that directly result from the bond issue (e.g., the "uptick" rule can generate temporary pressures due to traders taking initial positions related to the issue).

changes in the following liquidity proxies: share turnover, number of trades, dollar volume, the illiquidity measure developed by Amihud (2002), order imbalance (absolute difference between buyer- and seller-initiated trades), and time-weighted average quotes.[23] The Amihud (2002) measure is a proxy for Kyle's (1985) λ and is defined as absolute return divided by dollar volume.

We find strong evidence of an increase in liquidity based on all measures following issuance (with the exception of quoted depth, which indicates a decrease in liquidity).[24] Consistent with the prediction *(P1)*, these improvements increase systematically with arbitrage activity, $SI\_\%Shrout$. For example, change in (log) turnover for the largest SI portfolio is .31 higher than that for the smallest SI portfolio. These findings suggest that convertible bond arbitrageurs supply (uninformed) liquidity to equity markets. Most important, because we link liquidity changes to SI, we provide direct evidence of the impact of arbitrageurs on liquidity. Prior literature on the impact of derivatives markets on stock markets document only average changes in these variables (see, e.g., Mayhew (2000) for a survey).

For stock prices and efficiency, the following measures are presented: average daily returns, standard deviation of daily returns, idiosyncratic volatility, R-squared, beta, AR(1) parameters, and variance ratios. In regression analysis, we rely on the latter two variables to capture changes in efficiency. The standard deviation of returns is included in Table 3a so that we can compare the results with the empirical regularity of decreases in volatility following the introduction of options markets. If arbitrageurs impact stock price efficiency, then we would expect decreases in return predictability, as captured by the AR(1) parameters. Further, the variance ratio (Lo and MacKinlay (1988)) captures the extent to which stock prices follow a random walk.

Panel B of Table 3a provides evidence that the impact of convertible bond arbitrage on stock price efficiency is very weak. Consistent with prior work, we do find an average decrease

[23]We also examine opening quotes. Results are qualitatively similar.

[24]However, regression analysis (Table 4) shows that quoted depth increases with arbitrage activity, after we control for other variables.

in both total return variance as well as the idiosyncratic component of returns following convertible bond issuance. However, we do not find evidence that these average declines vary systematically with short-selling activity (i.e., there is no evidence that arbitrage is what is driving the declines). Average returns decrease near issuance and these decreases are higher for the highest SI portfolios (consistent with the observation that returns decrease following announcement of convertible bond issues). Beta and R-squared both increase but only the former is systematically increasing across convertible bond arbitrage portfolios. We do not observe significant changes in the AR(1) parameters or variance ratios. Across SI portfolios, the only systematic variation that we observe is in returns and beta. Taken together, the results in Panel B of Table 3a do not indicate an impact of convertible bond arbitrage on stock price efficiency. Regression analysis (below) will further investigate these findings.

It is possible that the results in Table 3a are being driven by market-wide changes in liquidity and volatility, rather than convertible bond arbitrage activity. To examine this potentially important issue, we analyze the measures in Table 3a for a set of control firms. In Table 3b, we examine the possibility that our results are driven by the impact of short-selling activity in general, rather than convertible bond arbitrage. To do this, we match firms in the sample based on size, market-to-book, turnover before issuance; exchange, and industry (using Fama and French (1997) industry definitions). The following procedure is used for identifying matching firms from the CRSP/COMPUSTAT database: Firms that have issued any convertible debt during years -1 to $+1$ relative to issue are eliminated from the universe of potential control firms; same exchange is required (e.g., NYSE issuers match only on NYSE firms); firms are further matched on Fama French (1997) industry code, if no such firm exists (very rarely), switch to two-digit SIC; finally, for the remaining sample of firms, a score is assigned for each potential control firm where $score$ =[abs($\frac{turnover}{issuer\ turnover} - 1$)+abs($\frac{market\ cap}{issuer\ market\ cap} - 1$))+(abs($\frac{book-to-market}{issuer\ book-to-market} - 1$)]. The firm with the lowest score is chosen.

Results from the control sample are reported in Table 3b.[25] All results in Table 3b are presented as *differences* between the issuer and control firms. From the table, it is clear that the liquidity results are robust to matched firm controls. For stock price efficiency measures we do not observe significant differences between the issuing firms and control firms, suggesting a little or no role in stock price efficiency for convertible bond arbitrageurs. If convertible bond arbitrageurs take positions mainly to exploit mispricing in the bond (and not the stock), then this would be expected. Because it is important to control for market-wide effects, the change variables in the analysis henceforth are presented as deviations from control firms.

5.2.2 Regression Analysis

We use an event study methodology to further characterize the relationships among convertible bond arbitrage, liquidity, and stock prices. These tests are more restrictive than the tests based on portfolio sorts in Table 3a; however, we would like to explicitly control for factors other than SI, short-interest intensity. We use regression analysis to estimate the impact of short selling as well as other stock characteristics on changes in liquidity and price-efficiency measures during the six months prior to and following the convertible bond issue and announcement.

[25] In addition, we conduct two "issue matches": We match convertible bond issuers to a sample of straight-debt issuers (by size, book to market, industry, exchange, and issue size). This distinguishes the effect of convertible bond issuance from a general increase in leverage. Results are similar to those in Table 4, with the exception of spread and depth variables: we find that SI is positively and significantly related to increases in turnover and number of trades. SI is negatively and significantly related to spreads and Amihud's (2002) illiquidity measure. In our second "issue match," we match convertible bond issuers to firms issuing seasoned equity because purchasers of the equity issue would not need to manage a short inventory, as is the case for convertible bond arbitrage. Results are similar to those in the straight-debt analysis. In general, we find that the impact of SI is somewhat stronger in these robustness checks than in the main analysis. Detailed results are available upon request. We thank William Fung for encouraging the equity issuer robustness check.

$$\Delta Liquidity_i \text{ or } \Delta Efficiency_i = \tag{1}$$
$$\alpha + \beta_1 SI\_\%Shrout_i + \beta_2 \Delta Market\ Cap_i + \beta_3 \Delta Volatility_i +$$
$$\beta_4 \Delta Institutional\ Holdings_i + \beta_5 Pre\text{-}Issue\ Price_{\mathrm{i}} + \beta_6 NYSE_i +$$
$$\beta_7 Public_i + \beta_8 \Delta PrePost_i + \sum_{t=1993Jul}^{2006Apr} \beta_{9t} YearMonthDum_{i,t} + \epsilon_i$$

Explanatory Variables

- *SI_%Shrout* is the short-interest intensity measure, which is change in short interest (number of shares) divided by total shares outstanding. The change in short interest is the difference between short interest in the current month and short interest in the previous month. This measure is interpreted as the amount of convertible bond arbitrage activity.
- Δ*Market Cap* is the change in (log) market capitalization, measured by average daily shares outstanding times closing stock price.
- Δ *Volatility* is the change in the standard deviation of daily returns.
- Δ*Institutional Holdings* is the change in institutional holdings (shares held by 13f institutions) divided by total shares outstanding.
- *Pre-Issue Price* is the average (log) price during the pre-issue period.
- *NYSE* is a dummy variable, equal to 1 if the firm is listed on NYSE and 0 otherwise.

- *Public* is a dummy variable, equal to 1 if the convertible bond is a public offering, and 0 otherwise.

- $\Delta PrePost$ is the number of days between the pre- and the post-issue period.[26]

- $YearMonthDum_t$ are year and month fixed effects, indicating timing of the convertible bond issue.

The estimated coefficient on $SI\_\%Shrout$ is of primary interest. We expect to observe a positive role for $SI\_\%Shrout$ in liquidity changes (*P1*) and no impact of $SI\_\%Shrout$ on changes in price efficiency (*P2*). Control variables include changes in size, volatility, and institutional holdings. We control for volatility in liquidity regressions due to their documented relationship. For example, Pastor and Stambaugh (2003) find correlation of .57 between market illiquidity and volatility. Spiegel and Wang (2005) report high correlation between idiosyncratic volatility and liquidity (i.e., liquidity produces perfect volatility sorts for a cross-section of stocks). We also include pre-issue price as proxy for liquidity level (price and liquidity are negatively correlated; higher-priced stocks have lower spreads due to the fixed component in spreads) because we anticipate more room for marginal liquidity improvements for less-liquid stocks. We also allow for variation based on exchange and whether an issue is public or private (e.g., liquidity of the bond issue might be higher for public issues) and time effects.

The results of analysis are presented in Table 4. All standard errors are heteroskedasticity-consistent and include industry clustering using Fama and French (1997) industry definitions. The proxy for convertible bond arbitrage activity (SI) is significantly and positively related to liquidity improvements based on four of the six liquidity measures (number of trades, turnover, Amihud, and depth). We do not observe systematic variation of SI with either

[26]In order to separate out the potential impact of the announcement on liquidity and efficiency variables, the pre- and post-issue periods are defined as follows: The pre-issue period is defined as the 6 months ending 20 trading days prior to the issue or the announcement of the issue, whichever is first. The post-issue period is the 6 months beginning 20 trading days following issue or announcement, whichever is later. When the announcement month is the same as the issue month, this measure equals 40 trading days.

order imbalance or spread. (The spread result is somewhat puzzling because this measure showed significant changes based on portfolio sorts; however, change in market capitalization already captures a price change, and therefore the coefficient on percentage spread (change in spread/price) in the regression equation may pick up changes in dollar spread, rather than percentage spread.) Neither of the price efficiency measures are related to SI. We interpret this as evidence that these traders do not enhance efficiency and simply provide supply to equity markets, as in the prediction *(P2)*.

Although it is not the main focus of the analysis, it is also interesting to note that liquidity increases with increases in institutional holdings, market capitalization, and volatility.

An assumption underlying much of the analysis in this paper is that the change in short interest near issuance is due to convertible bond arbitrage, which we do not directly observe. We attempt to separate other possible explanations of the observed short selling by providing several tests of whether the data are consistent with convertible bond arbitrage, including analysis of long-run stock returns following issuance (i.e., if the increase in short interest is due to valuation shorting, we would expect short sellers to make money from their positions). We then conduct a second test using hand-collected announcement dates for the sample of issuers to isolate the impact of convertible bond announcement- versus issue-period shorting (which we interpret as valuation shorting and convertible bond arbitrage, respectively). Finally, we introduce a theoretical measure of convertible bond arbitrage that does not depend on short-selling data. The basic idea is that if we are, in fact, capturing convertible bond arbitrage activity in the data then the theoretical measure should be related to the actual measure. The results of these tests are consistent with short selling due to arbitrage and are presented below.

5.3 Long-Run Returns

As a final efficiency check, we test whether short sellers make money from their equity market positions. Results are presented in Table 5 and are consistent with the findings for the other

efficiency measures: there is no evidence that short sellers at issuance make money from their positions; however, we do observe a significantly negative return of -1.30% between announcement and issue date (when they are at least two trading days apart). Therefore, it may be that valuation shorts make money based on positions taken at the announcement of the issue, while short sellers engaged in convertible bond arbitrage strategies take positions near issuance and do not earn abnormal returns from equity positions.

Table 5 also suggests that there may be important differences between short selling that is observed on announcement versus issue dates and that these differences in short selling might provide powerful identification for the type of short selling (i.e., convertible bond arbitrage versus other types of arbitrage) that we are observing in the data. We delve deeper into this question by using the hand-collected data on announcement dates for all issues to separate the impact of short selling due to the market's knowledge that the bond is being issued from actual convertible bond arbitrage (which would be more likely to coincide with the issue itself). The results of this analysis are presented in the next section.

5.4 Convertible Bond Arbitrage Versus Valuation Shorts

5.4.1 Robustness Analysis Using Announcement Versus Issue Dates

Because we do not observe convertible bond arbitrage activity directly, we face the challenge that we may be picking up the impact of short selling due to some other factor. A particular concern is valuation short selling due to information that the firm is raising convertible debt. In order to address this issue, we hand-collect data on announcement dates of all convertible bond issues in our sample and identify 132 issues for which the announcement date and the issue date are such that the observed change in short interest for announcement and issuance occur during different short-interest reporting months.[27] The results of analysis are presented in Table 6 and are consistent with the main regressions in Table 4. With the exception

[27]We use *Lexis-Nexis* and *Factiva* news searches to identify the earliest date on which the bond issue is mentioned in the news.

of depth, all liquidity changes that are significantly related to our proxy for convertible bond arbitrage in the main analysis are also significant in this analysis. More important, changes in short interest during the announcement month ($SI\_\%Shrout\_Announcement$) are not significantly related to any observed liquidity and efficiency changes.

In the next section, we further aim to isolate the impact of convertible bond arbitrage by repeating the analysis using a measure of arbitrage that relies solely on bond characteristics, and does not use short-selling data.

5.4.2 Robustness Analysis Using Theoretical Arbitrage

In this section we present another way to address the concern that the measured change in short interest at the time of the convertible bond issue is due to impact of valuation short sellers rather than convertible bond arbitrage. In order to address this issue, we take a second approach that requires no reliance on short-selling data near issuance. We construct a theoretical measure of convertible bond arbitrage based on a delta-neutral hedge (at the time of issue), using bond characteristics and an option-pricing model. We use a delta-neutral hedge because this is one of the most popular convertible bond arbitrage strategies. This allows us to isolate arbitrage in a way that does not depend on the data and therefore eliminates any potential for observed short selling due to factors unrelated to convertible bond arbitrage. Although we do not expect the entire issue to be bought by hedge funds engaged in this strategy, this identification technique assumes that a fraction of convertible bonds are bought by funds engaged in this activity. The calculation of $Theoretical\_SI\_\%Shrout$ follows.

Convertible bonds can be valued as the sum of an equity warrant and a straight bond, by using the binomial option pricing model for constant interest rates or a trinomial model with stochastic interest rates. We use the first approach,[28] where a convertible bond value equals

[28]This technique is often used to value convertible bonds (Connolly (2005)). The author emphasizes that in order for this approach to provide correct results, conversion price should be used as the exercise price for the equity warrant.

a straight bond value plus an equity warrant value calculated by the Black-Scholes option pricing model.[29] The price of the straight bond is calculated by using time to maturity, coupon and par value of the convertible bond, risk-free rate, and yield to maturity of a straight bond.[30,31] Convertible bond prices at issue are obtained from FISD. This allows us to calculate the equity warrant value, implied volatility of the warrant, and delta of the convertible bond. The theoretical number of shares to be shorted is obtained from the following equation:[32,33]

$$Theoretical\_SI\_\%Shrout = Delta * Conversion\ Ratio * Number\ of\ Bonds * 0.75 \quad (2)$$

It is important to note that $Theoretical\_SI\_\%Shrout$ is a noisy proxy for the actual convertible arbitrage activity. In reality, arbitrageurs can deviate from this theoretical value and do not fully hedge equity market risk due to a managerial decision to take a directional bet on the equity movement, short-sales constraints, or availability of alternatives to shorting

[29]This theoretical framework is appropriate here for several reasons. First, even though the Black-Scholes model provides prices for European options, convertible bonds are issued out-of-the money reducing the importance of American option features. Moreover, 74.6% of convertible bond issuers do not pay dividends. Therefore, the European approximation is appropriate. The Black-Scholes model does not allow for the callability option of convertible bonds. However, we calculated delta for each convertible bond and tested delta's sensitivity to maturity. We found that sensitivity is minimal; therefore, the assumptions of the theoretical model are justified in the data.

[30]Risk-free rate is obtained from Ken French's website (http: //mba.tuck.dartmouth.edu/pages/faculty/ken.french) for each year.

[31]Yield to maturity is obtained from the actual yield to maturity of a straight bond issued within 90 days of the issue of the convertible bond. The straight bond is matched on credit rating, maturity, and coupon. Credit ratings are obtained from the S&P. If they are not available from the S&P, we obtain credit ratings from Moody's and Fitch. For non-rated bonds (bonds not rated by S&P, Moody's and Fitch), all non-rated straight bonds that are issued within 90 days of the convertible bond issue are considered and further matched on coupon and maturity.

[32]Delta measures the change in the convertible bond's price with respect to the change in the underlying stock price.

[33]Conversion ratio and number of bonds are obtained from FISD. We multiply the resulting theoretical SI by 75% because 75% of convertible bonds are bought by hedge funds (Mitchell, Pedersen, and Pulvino (2007)).

such as put options.[34,35] "The most theoretically accurate convertible model will not ensure your success as a convertible arbitrageur any more than having the most expensive golf clubs will ensure your golf handicap. Because theoretical valuation is as much art as science, a good convertible valuation model is a necessary tool for the arbitrageur's trade — but it is only a tool" (Calamos (2003)).

The results of this analysis are presented in Table 7. Instead of observed short selling, as captured in Table 4, we analyze the impact of $Theoretical\_SI\_\%Shrout$ arbitrage on liquidity and prices. Though much weaker than the main results (because we are using a theoretical, rather than observed measure), the results of the analysis using theoretical SI are somewhat consistent with those presented in Table 4. $Theoretical\_SI\_\%Shrout$ is statistically significant for turnover and though insignificant, signs are consistent with measured SI for changes in: Amihud, number of trades, and depth. Similar to the measured SI, the evidence suggests no role for improvements in efficiency measures.

5.5 Robustness Analysis: Potential Endogeneity of Arbitrage

It is possible that convertible bond arbitrageurs are attracted to stocks for which they expect increases in liquidity. While our prior is that the direction of the causality runs from the arbitrageurs, we explicitly account for potential simultaneity by estimating a simultaneous equations model of both changes in market quality and short-interest changes. We therefore estimate the system using simultaneous equations.

[34]Correlation between $Theoretical\_SI\_\%Shrout$ and $SI\_\%Shrout$ is 24.8%.

[35]In several cases, we calculated that $Theoretical\_SI\_\%Shrout$ comprises about 20% of shares outstanding.

$$\Delta Liquidity_i = \tag{3}$$
$$\alpha + \beta_1 SI\_\%Shrout_i^{IV} + \beta_2 \Delta Market\ Cap_i + \beta_3 \Delta Volatility_i +$$
$$\beta_4 \Delta Institutional\ Holdings_i + \beta_5 Pre\text{-}Issue\ Price_{\rm i} + \beta_6 NYSE_i +$$
$$\beta_7 Public_i + \beta_8 \Delta PrePost_i + \sum_{t=1993Jul}^{2006Apr} \beta_{9t} YearMonthDum_{i,t} + \epsilon_i$$

and

$$SI\_\%Shrout_i = \tag{4}$$
$$\alpha + \beta_1 \Delta Liquidity_i^{IV} + \beta_2 \Delta Dollar\ Volume_i + \beta_3 \Delta Volatility_i +$$
$$\beta_4 \Delta Institutional\ Holdings_i + \beta_5 Dividends_{\rm i} + \beta_6 Conversion\ Premium_{\rm i} +$$
$$\beta_7 NYSE_i + \beta_8 Public_i + \beta_9 \Delta PrePost_i + \sum_{t=1993Jul}^{2006Apr} \beta_{10t} YearMonthDum_{i,t} + \epsilon_i$$

The explanatory variables in the liquidity change regressions are identical to those in Table 4, except $SI\_\%Shrout_i^{IV}$ instrumented. Similarly, liquidity change variables are instrumented in the $SI\_\%Shrout_i$ regressions. The other explanatory variables in the $SI\_\%Shrout_i$ regression are chosen to proxy for characteristics of firms that tend to be attractive to convertible bond arbitrageurs:[36]

- *Dollar Volume* is the mean daily dollar volume during the pre-issue period. This variable is included to capture the impact of stock liquidity *levels* on convertible bond arbitrage activity. It is easier to dynamically hedge more liquid stocks.

[36] See Calamos (2003,p 25).

- *Volatility* is the mean standard deviation of daily returns during the pre-issue period. Convertible bond arbitrageurs are expected to prefer higher volatility issuers (higher potential trading profits due to the embedded option in the bond).

- *Institutional Holdings* is the level of institutional holdings (shares held by 13f institutions) divided by shares outstanding at calendar year end prior to issuance. This variable is a proxy for the availability of shares to borrow.

- *Dividends* are stock dividends and are included because convertible bond arbitrageurs are expected to prefer low/no dividend-paying stocks since short sellers have to pay dividends.

- *Conversion Premium* is the conversion premium. Calamos (2003, p. 25) states that arbitrageurs tend to prefer stocks with conversion premia that are less than 25% because low conversion ratios imply lower interest rate and credit risk.

- *NYSE* is a dummy variable, equal to 1 if the firm is listed on NYSE and 0 otherwise.

- *Public* is a dummy variable, equal to 1 if the convertible bond is a public offering, and 0 otherwise.

- $\Delta PrePost$ is the number of months between the pre- and the post-issue period.

- $YearMonthDum_t$ are year and month fixed effects, indicating timing of the convertible bond issue.

In the first-stage regressions for arbitrage activity, we use percentage of shares affected by the issue (conversion ratio * number of bonds / shares outstanding) and analyst opinion prior to issuance (percentage of buy recommendations) as instruments, in addition to the explanatory variables specified in the simultaneous equations. These are chosen because convertible bond arbitrageurs short stocks with high percentage of shares affected by the issue (see the calculation of theoretical convertible bond arbitrage in the previous section) and

because there may be more shorting in stocks with negative analyst recommendations. In the first-stage regressions for $\Delta Liquidity_i$, we include change in analyst coverage and change in absolute price deviation from \$30 as instruments (in addition to the other exogenous variables). We expect that there is a high correlation between analyst coverage and liquidity levels, and that stock price close to \$30 indicates higher liquidity.[37]

The results from simultaneous equations for each liquidity measure are presented in Table 8. The main findings are qualitatively similar to the main regression (with the exception of depth, for which we do not observe a statistically significant increase after controlling for potential endogeneity). Moreover, the liquidity changes do not impact arbitrage activity (short-interest changes, in Panel B of the table).

5.6 Further Evidence of Convertible Bond Arbitrage: 2005—2006 Reg-SHO Data

Ideally, the preceding analysis would measure the change in short interest during the few days surrounding issuance; however, the short-interest data are available only on a monthly basis and do not perfectly capture short sales transactions. We take advantage of newly available data on short-selling activity (beginning in 2005, as a result of Regulation SHO) in order to investigate whether our monthly data capture short-sales transactions close to the issue date.[38] If arbitrageurs dynamically hedge, then transactions will provide additional information. The SHO transactions data allow us to supplement the main analysis in two ways: (1) we are able to observe trading at the issue date and (2) we can examine changes in

[37]Percentage of shares affected is highly significant (t-statistic of 6.21) in the first-stage regression of arbitrage activity. We thank an anonymous referee for suggesting the importance of conversion ratio. Analyst opinion is also significant (t-statistic of 1.92) in the first-stage. For first-stage liquidity regressions, the analyst coverage variable is significant for four of six measures: turnover, number of trades, order imbalance, and depth. Price deviation from \$30 is significant in spread and depth. We use all exogenous variables and instruments in the first-stage regressions. We also confirm that the right-hand side variables in the liquidity regressions are not significant in the SI regressions and vice versa. First-stage results are not reported (for brevity) and are available upon request.

[38]The U.S. Securities and Exchange Commission adopted Regulation SHO in June 2004.

short-selling activity following issuance. If arbitrageurs hedge dynamically, then we expect to observe an increase in short selling following issuance.

Figure 3 illustrates short-selling activity near the convertible bond issue date for the sample of 64 issues for which Reg-SHO data are available (those in 2005 and 2006). The increase in short selling on Day 0 provides further evidence that we are identifying convertible bond arbitrage activity and not short selling due to other factors. The figure also suggests that the level of short-selling activity following issuance is higher during the post-period, which is consistent with dynamic hedging by arbitrageurs. We explicitly test whether short selling increased in the results presented in Table 9.

Table 9 summarizes changes in short-selling activity in stocks of convertible bond issuers between March 2005 and May 2006. The "Pre-period" is defined as the 20 trading days ending 1 month prior to issuance or announcement, whichever is first. "Post-period" is defined as the 20 trading days beginning 1 month following issuance or announcement, whichever is later. The change is defined as the mean (or median) measure in post-period minus the mean (median) measure in pre-period.[39] For comparison, we also present results for control firms.[40] Control firms are identified based on size, market-to-book, turnover, industry, and exchange (as described in Section 4). The key finding in the table is that short-selling activity increases following issuance. Moreover, we do not find similar results for the control firms. The cross-sectional results presented in the previous sections indicate that the convertible bond arbitrage strategy has a significant impact on liquidity of the

[39]Note that this "pre-" and "post-"period definition differs from that used in the main analysis (six-month period ending and beginning 20 trading days prior to and following issuance and announcement). We tighten the window over which we measure transactions in order to maximize the number of issues for analysis, given that the SHO data do not begin until 2005.

[40]Diether, Lee, and Werner (2005) find that volatility increases, spreads widen, and more symmetric trading patterns result from the suspension of the "uptick" rule for SHO pilot stocks. This implies that analysis of control firms is critical in this study because SHO relaxes the short-sales constraints for a subsample of stocks. The results in Table 9 indicate that the documented changes in short-selling activity for issuing firms are not driven by Regulation SHO. In our sample of 64 issuers, 14 are pilot stocks (in which the "uptick" rule was suspended). As a further check, we deleted these 14 stocks from the analysis, and results are similar. In addition, of the matched firms, 12 are pilot stocks. Therefore, regulation SHO affects both groups, but the strong results of increased short-selling activity in Table 9 are evident only for issuing firms.

market for the underlying stock.

6 Conclusion

In this paper, we investigate the link between convertible bond arbitrage, liquidity, and stock prices with the goal of improving our understanding of the impact of arbitrageurs on market quality, measured by stock liquidity and efficiency. A typical convertible bond arbitrage strategy employs delta-neutral hedging in which a manager buys the convertible bond and sells the underlying equity at a specific delta. If the price of the stock increases, to keep the same delta hedge, the manager sells the stock. When the price of the stock decreases, the manager buys back the stock. Aggregate trading demand is expected to move in the opposite direction of this convertible bond arbitrage activity. Therefore, convertible bond arbitrageurs are expected to improve liquidity in the stock.

We examine changes in short interest near an event in which the convertible bond arbitrage strategy is widely used (bond issuance date), and are able to use aggregate data to estimate the equity positions taken by convertible bond arbitrageurs. This simple methodology allows us to identify the presence and impact of a particular trader type. We add to findings in previous studies documenting average changes in equity market quality when new securities are introduced in that we are able to examine cross-sectional implications of the introduction of a particular trader type. Specifically, we examine the sensitivity of changes in liquidity and volatility to the magnitude of the increase in short selling due to the arbitrage activity. This helps to shed additional empirical light on the issue of how the introduction of new securities that are used by arbitrageurs can impact overall market quality.

We document improvements in liquidity following issuance of convertible debt. More important, we find that the increase in liquidity is systematically related to the intensity of convertible bond arbitrage activity. This suggests positive liquidity spillovers due to the

arbitrage activity in equity markets. We do not find evidence of a systematic relationship between arbitrage activity and stock price volatility and efficiency; however, we do find evidence of average changes in volatility measures near bond issuance. We perform a variety of robustness checks, including controlling for the potential endogeneity of convertible bond arbitrage activity and find similar results.

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Table 1
Issuing Firms and Characteristics

This table presents summary statistics for the sample of convertible bond issues between July 1993 and May 2006. *Market Cap* is the issuing firm's equity market capitalization. *NYSE* and *Nasdaq* are dummy variables, indicating where the issuing firm is listed. *Debt/Equity* is the ratio of long-term debt to equity market capitalization in the fiscal year prior to issuance. *Daily Dollar Volume* is the average daily dollar volume of the stock. *Beta* is the coefficient estimate of the regression of daily stock excess returns on CRSP value-weighted market excess return. *Issue Size* is the face value of the convertible bond times its offer price. *Short Interest* is the average monthly short interest. *Institutional Holdings/Shares Outstanding* is the institutional holdings (by 13f institutions) divided by shares outstanding in the calendar year end prior to issuance. *Credit Rating* is the bond rating issued by S&P. If the bond is not rated by S&P, Moody's or Fitch rating is used, in that order, as available. 444 of 846 bonds are rated by at least one of the three agencies.

All daily and monthly measures are calculated using data from the 6 months ending 1 month prior to issuance or announcement, whichever is earlier.

N = 846

	Mean	Median	Standard Deviation
Market Cap ($ million)	4,687	1,179	13,457
NYSE	0.49	0	0.50
Nasdaq	0.51	1	0.50
Debt/Equity	0.60	0.18	1.58
Daily Dollar Volume ($ million)	42.58	12.67	103.10
Beta	1.34	1.27	0.75
Issue Size ($ million)	291.20	175.50	368.92
Issue Size/Market Cap (%)	17.97	14.90	13.38
Short Interest (000 Shares)	5,497	2,152	14,753
Short Interest/Shares Outstanding (%)	4.47	3.05	4.75
Institutional Holdings/Shares Outstanding (%)	65.00	68.37	22.45
Credit Rating [1]	BB	BB-	

[1] For calculating the mean and median credit rating, a number is assigned to each rating: best (AAA or Aaa) = 1, second best = 2, etc. Using this system, mean rating = 12.29, which lies between BB and BB- for S&P and Fitch (or Ba2 and Ba3 for Moody's), median = 13 (BB- or Ba3), standard deviation = 3.85. Only rated issues are included in the calculation.

Figure 1
Mean and Median Short-Interest Intensities

The charts show the mean and median short-interest intensities during the event window (months -6 to +6). *SI_%Issue* is the dollar value of the monthly change in short interest/issue size. That is: difference between short interest in the current month and short interest in the previous month, times the closing stock price on the issue date, divided by issue size (face value of the convertible bond times offer price). *SI_%Shrout* is the monthly change in short interest divided by the number of shares outstanding in the prior month.

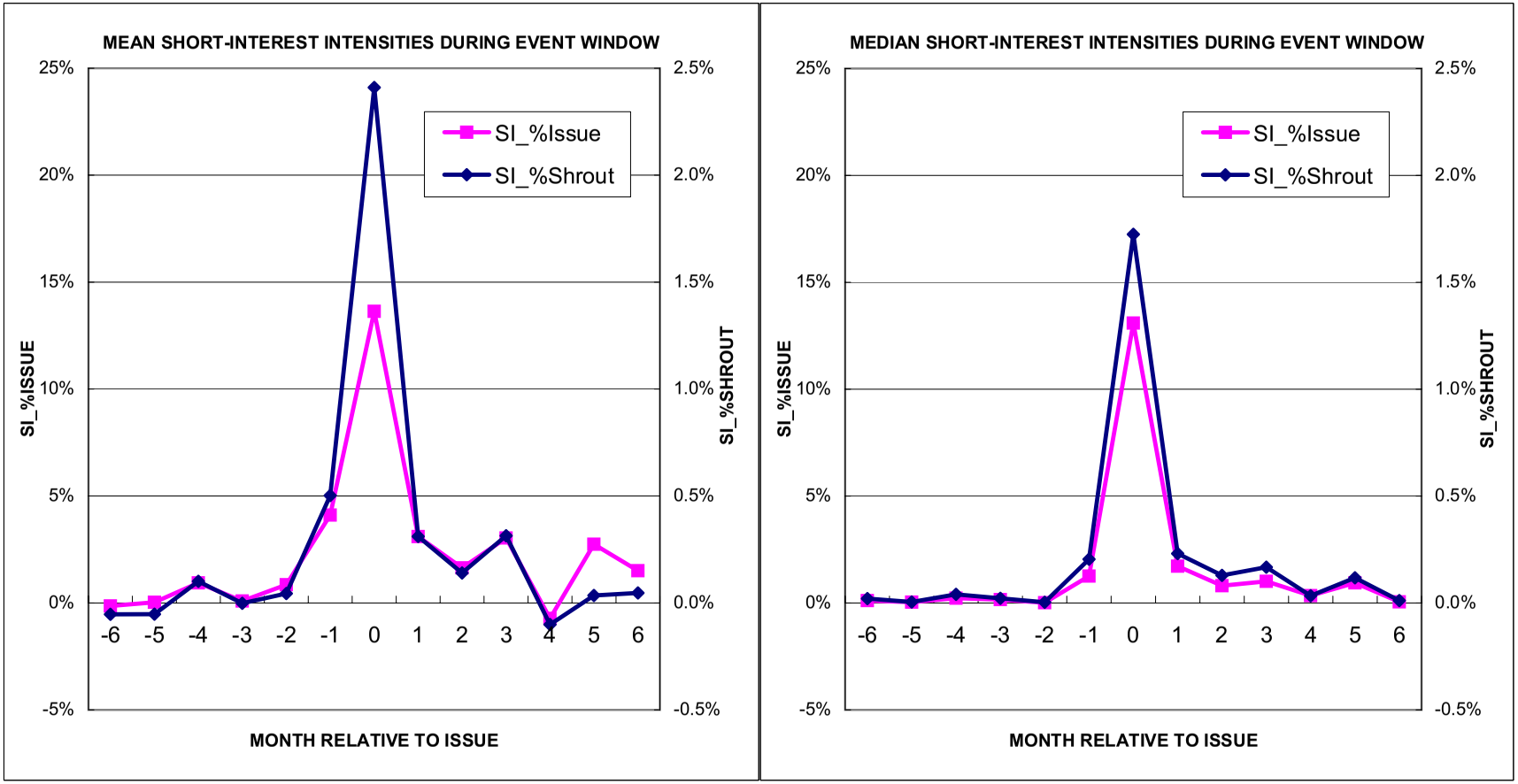
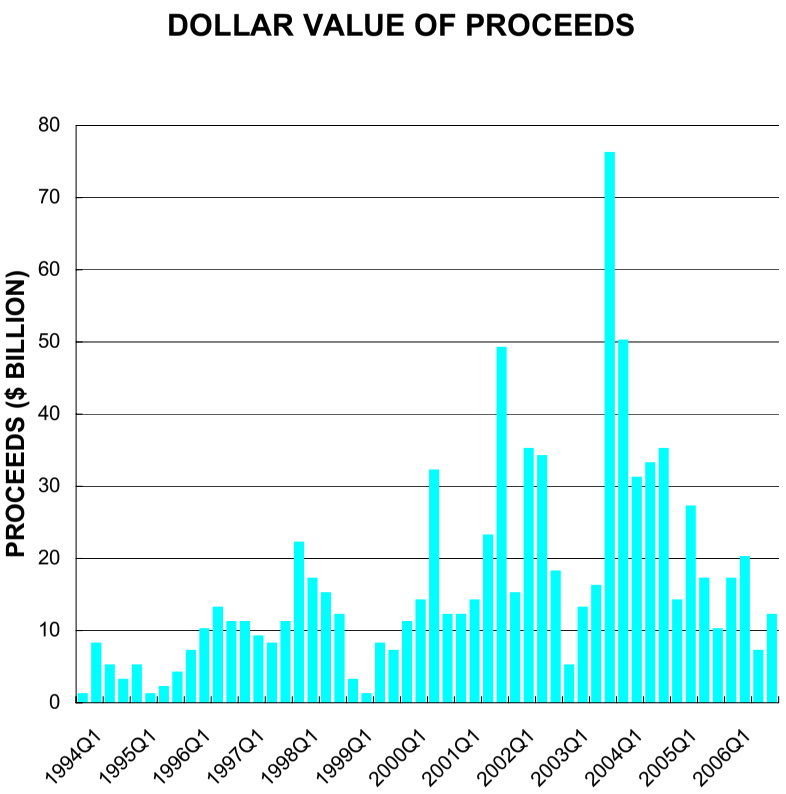


Figure 2a
Dollar Value of Proceeds and Number of Issues



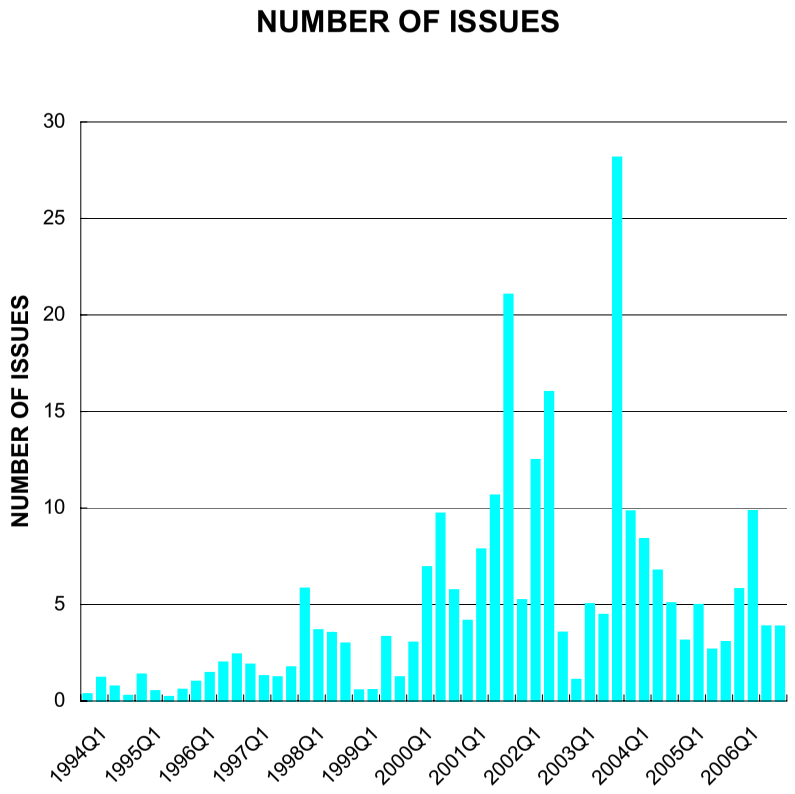


Figure 2b
Total Assets of Convertible Bond Arbitrage Hedge Funds

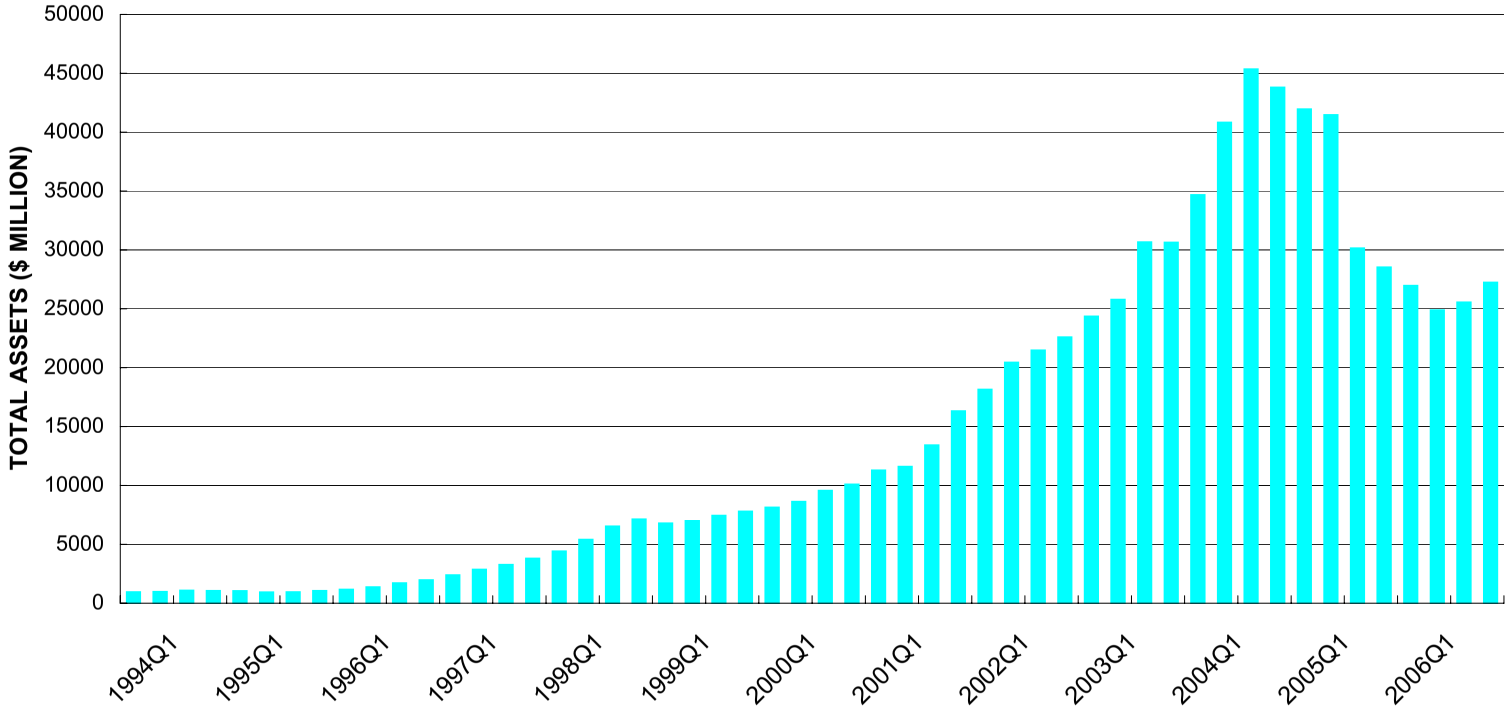


Table 2
Issuing Firm Characteristics, SI Portfolio Sorts

This table presents firm characteristics prior to issuance. Portfolios are based on arbitrage activity (*SI_%Shrout*) at issuance. *SI_%Shrout* is the monthly change in short interest divided by the number of shares outstanding in the prior month.

In Panel A, *NYSE* and *Nasdaq* are dummy variables, indicating where the issuing firm is listed. *Public* is 1 if the convertible bond is a public offering, 0 if private. *Market Cap* is the equity market capitalization. *Short Interest/Shares Outstanding* is the average monthly short interest divided by shares outstanding prior to issuance. *Institutional Holdings/Shares Outstanding* is the institutional holdings (by 13f institutions) divided by shares outstanding at calendar year end prior to issuance. *Conversion Ratio* is the number of shares of common stock that could be obtained by converting one bond. *Conversion Premium* is the percentage amount by which the conversion price exceeds the market value of the common stock at issuance.

In Panel B, *Turnover* is the average daily volume divided by shares outstanding. *Number of Trades* is the average daily number of stock transactions on the firm's primary exchange. *Dollar Volume* is the average daily dollar stock volume. *Amihud* is the average ratio of daily absolute return to dollar volume. *OIBNUM* is the average daily absolute difference between the numbers of buyer- and seller-initiated trades divided by their sum. *Dollar Spread* and *Percentage Spread* are the difference between bid and ask quotes (time-weighted), expressed as dollars and percentage of bid-ask midpoint, respectively. *Total Depth/Shares Outstanding* is the sum of bid and ask quoted depths divided by shares outstanding.

In Panel C, *Return* and *Standard Deviation of Return* are the mean and standard deviation of daily stock return, respectively. *Idiosyncratic Volatility* and *R-Squared* are, respectively, the standard deviation of residuals and R-Squared from the regression of daily stock excess return on CRSP value-weighted market excess return. *Beta* is the coefficient estimate of the same regression. *Daily AR(1)* and *Intraday AR(1)* are the first-order autocorrelation of returns, calculated using daily returns and 30-minute interval returns, respectively. *Variance Ratio (5)* is the 5-day variance ratio in Lo and MacKinlay (1988).

All measures in Panels B and C are calculated using daily or monthly data from the 6 months (2 months for *Intraday AR(1)*) ending 1 month prior to issuance or announcement, whichever is earlier. The last two columns show the mean measures of Portfolio 4 minus Portfolio 1 and the industry- and time-clustered t-statistics of the difference between the means. *, **, and *** denote 10%, 5%, and 1% significance, respectively.

N = 846

Panel A Firm and Convertible Bond Characteristics

		Portfolios based on SI_%Shrout					
	All	P1 (Smallest)	P2	P3	P4 (Largest)	P4-P1	t-stat
NYSE	0.505	0.626	0.552	0.474	0.349	-0.277***	(-5.59)
Nasdaq	0.495	0.360	0.448	0.526	0.646	0.286***	(5.79)
Public	0.252	0.280	0.278	0.265	0.184	-0.096**	(-2.29)
log Market Cap	21.076	21.720	21.402	20.779	20.404	-1.316***	(-9.54)
Short Interest/Shares Outstanding (%)	4.466	4.476	3.851	4.311	5.185	0.709***	(13.95)
Institutional Holdings/Shares Outstanding (%)	65.002	65.171	65.768	63.860	65.205	0.034	(1.52)
Conversion Ratio	43.918	37.216	33.681	50.348	54.426	17.211***	(2.80)
Conversion Premium (%)	35.062	34.624	36.190	37.043	32.400	-2.223	(-0.61)

Table 2 (cont'd)

Panel B: Liquidity Measures								
		Portfolios based on SI_%Shrout						
		All	P1 (Smallest)	P2	P3	P4 (Largest)	P4-P1	t-stat
log Turnover		-4.949	-5.103	-4.955	-4.941	-4.799	0.304***	(3.47)
log Number of Trades		5.987	6.220	6.135	5.849	5.744	-0.476***	(-3.28)
log Dollar Volume		16.125	16.615	16.446	15.836	15.603	-1.013***	(-5.95)
log Amihud		-20.585	-21.240	-20.903	-20.267	-19.929	1.311***	(9.27)
OIBNUM (%)		16.789	15.909	16.302	17.201	17.741	1.832**	(2.37)
Dollar Spread		0.125	0.114	0.122	0.124	0.139	0.026*	(1.88)
Percentage Spread (%)		0.538	0.440	0.433	0.618	0.662	0.222***	(3.44)
Total Depth/Shares Outstanding (%)	**x 1000**	8.366	7.185	6.859	8.904	10.512	3.327**	(2.19)

Panel C: Return and Price-Efficiency Measures								
		Portfolios based on SI_%Shrout						
		All	P1 (Smallest)	P2	P3	P4 (Largest)	P4-P1	t-stat
Return (%)		0.238	0.166	0.269	0.256	0.261	0.094***	(2.61)
Standard Deviation of Return (%)		3.572	3.053	3.333	3.726	4.175	1.122***	(6.27)
Idiosyncratic Volatility (%)		3.210	2.699	2.997	3.344	3.799	1.100***	(6.81)
R-Squared (%)		18.482	21.655	17.603	18.535	16.149	-5.505***	(-3.84)
Beta		1.334	1.257	1.317	1.366	1.396	0.139*	(1.88)
Daily AR(1) (%)		-0.965	-2.324	-1.145	0.174	-0.567	1.757	(1.56)
Intraday AR(1) (%)		0.048	-0.528	-0.153	0.336	0.536	1.063	(1.26)
Variance Ratio (5)		1.035	1.022	1.014	1.060	1.045	0.023	(0.99)

Table 3a
Changes in Firm Characteristics

This table presents the changes in firm characteristics, by portfolios based on change in short interest (*SI_%Shrout*) at issuance. *SI_%Shrout* is the monthly change in short interest divided by the number of shares outstanding in the prior month. Changes in firm characteristics are defined as the average measure in post-issue period minus the pre-issue period measure. "Pre-issue period" is defined as the 6 months (2 months for *Intraday AR(1)*) ending 1 month prior to issuance or announcement, whichever is earlier. "Post-issue period" is the 6 months (2 months for *Intraday AR(1)*) starting 1 month after issuance or announcement, whichever is later.

In Panel A, *Short Interest/Shares Outstanding* is the average monthly short interest divided by shares outstanding. *Turnover* is the average daily volume divided by shares outstanding. *Number of Trades* is the average daily number of stock transactions on the firm's primary exchange. *Dollar Volume* is the average daily dollar stock volume. *Amihud* is the average ratio of daily absolute return to dollar volume. *OIBNUM* is the average daily absolute difference between the numbers of buyer- and seller-initiated trades divided by their sum. *Dollar Spread* and *Percentage Spread* are the difference between bid and ask quotes (time-weighted), expressed as dollars and percentage of bid-ask midpoint, respectively. *Total Depth/Shares Outstanding* is the sum of bid and ask quoted depths divided by shares outstanding.

In Panel B, *Return* and *Standard Deviation of Return* are the mean and standard deviation of daily stock return, respectively. *Idiosyncratic Volatility* and *R-Squared* are, respectively, the standard deviation of residuals and R-Squared from the regression of daily stock excess return on CRSP value-weighted market excess return. *Beta* is the coefficient estimate of the same regression. |*Daily AR(1)*| and |*Intraday AR(1)*| are the absolute value of first-order autocorrelation of returns, calculated using daily returns and 30-minute interval returns, respectively. |*Variance Ratio (5) - 1*| is the absolute deviation of the 5-day variance ratio in Lo and MacKinlay (1988) from 1.

The last column shows the mean measures of Portfolio 4 minus Portfolio 1. Industry- and time-clustered t-statistics of the changes and differences are in parentheses. *, **, and *** denote 10%, 5%, and 1% significance, respectively.

N = 846

Panel A: Changes in Liquidity Measures

		Portfolios based on SI_%Shrout				
	All	P1 (Smallest)	P2	P3	P4 (Largest)	P4-P1
Short Interest/Shares Outstanding (%)	2.371***	0.181	1.233***	2.598***	5.465***	5.284***
	(17.90)	(1.02)	(8.44)	(11.55)	(19.27)	(15.81)
log Turnover	0.239***	0.079***	0.217***	0.272***	0.387***	0.308***
	(15.06)	(3.25)	(7.27)	(9.41)	(11.29)	(7.35)
log Number of Trades	0.325***	0.195***	0.343***	0.336***	0.426***	0.231***
	(15.74)	(6.52)	(9.07)	(9.67)	(10.57)	(4.60)
log Dollar Volume	0.441***	0.241***	0.436***	0.510***	0.574***	0.333***
	(15.88)	(6.75)	(9.37)	(10.77)	(9.13)	(4.60)
log Amihud	-0.458***	-0.330***	-0.475***	-0.510***	-0.519***	-0.188**
	(-17.02)	(-8.55)	(-11.52)	(-11.20)	(-8.05)	(-2.51)

Table 3a (cont'd)

Panel A (cont'd)

		Portfolios based on SI_%Shrout					
		All	P1 (Smallest)	P2	P3	P4 (Largest)	P4-P1
OIBNUM (%)		-1.041***	-0.893***	-0.924***	-0.961***	-1.385***	-0.492
		(-7.07)	(-3.72)	(-3.26)	(-3.57)	(-4.58)	(-1.27)
Dollar Spread		-0.021***	-0.022***	-0.017***	-0.019***	-0.027***	-0.006
		(-7.40)	(-4.30)	(-3.21)	(-4.42)	(-4.70)	(-0.77)
Percentage Spread (%)		-0.134***	-0.081***	-0.105***	-0.188***	-0.160***	-0.079***
		(-11.48)	(-5.36)	(-9.36)	(-5.52)	(-6.57)	(-2.77)
Total Depth/Shares Outstanding (%)	**x 1000**	-0.712**	-0.287	-0.192	-1.903	-0.467	-0.180
		(-1.97)	(-0.95)	(-0.35)	(-1.58)	(-0.96)	(-0.31)

Panel B: Changes in Return and Price-Efficiency Measures

	Portfolios based on SI_%Shrout					
	All	P1 (Smallest)	P2	P3	P4 (Largest)	P4-P1
Return (%)	-0.201***	-0.128**	-0.230***	-0.214***	-0.232***	-0.105**
	(-11.70)	(-4.26)	(-7.76)	(-6.83)	(-5.91)	(-2.12)
Standard Deviation of Return (%)	-0.250***	-0.341***	-0.183*	-0.356***	-0.123	0.219
	(-4.20)	(-3.98)	(-1.94)	(-3.49)	(-0.96)	(1.42)
Idiosyncratic Volatility (%)	-0.275***	-0.339***	-0.209**	-0.358***	-0.193*	0.146
	(-5.37)	(-4.26)	(-2.55)	(-3.88)	(-1.66)	(1.04)
R-Squared (%)	2.309***	1.678*	1.790**	2.152**	3.612***	1.934
	(4.48)	(1.88)	(2.10)	(2.24)	(3.66)	(1.45)
Beta	0.083***	0.046	0.025	0.080*	0.180***	0.135**
	(3.06)	(1.21)	(0.47)	(1.67)	(3.41)	(2.07)
|Daily AR(1)| (%)	-0.295	0.077	-0.419	-0.431	-0.406	-0.483
	(-0.87)	(0.11)	(-0.58)	(-0.66)	(-0.61)	(-0.50)
|Intraday AR(1)| (%)	2.521	9.973	0.856	-0.276	-0.447	-10.420
	(1.34)	(1.34)	(1.23)	(-0.67)	(-0.77)	(-1.40)
|Variance Ratio (5) - 1| (%)	-1.102	-0.584	-0.911	-2.490	-0.428	0.156
	(-1.43)	(-0.41)	(-0.60)	(-1.47)	(-0.28)	(0.07)

Table 3b
Control Firm Results: Changes in Firm Characteristics

The changes (from pre- to post-issue) in issuing firm characteristics *minus* the changes in control firm characteristics are shown. Portfolios are based on change in short interest (*SI_%Shrout*) at issuance. *SI_%Shrout* is the monthly change in short interest divided by the number of shares outstanding in the prior month. Control firms are matched based on size, book-to-market, and turnover before issuance; exchange, and industry. Changes in firm characteristics are defined as the average measure in post-issue period minus the pre-issue period measure. "Pre-issue period" is defined as the 6 months (2 months for Intraday AR(1)) ending 1 month prior to issuance or announcement, whichever is earlier. "Post-issue period" is the 6 months (2 months for Intraday AR(1)) starting 1 month after issuance or announcement, whichever is later.

In Panel A, *Short Interest/Shares Outstanding* is the average monthly short interest of the stock divided by shares outstanding. *Turnover* is the average daily volume divided by shares outstanding. *Number of Trades* is the average daily number of stock transactions on the firm's primary exchange. *Dollar Volume* is the average daily dollar stock volume. *Amihud* is the average ratio of daily absolute return to dollar volume. *OIBNUM* is the average daily absolute difference between the numbers of buyer- and seller-initiated trades divided by their sum. *Dollar Spread* and *Percentage Spread* are the difference between bid and ask quotes (time-weighted), expressed as dollars and percentage of bid-ask midpoint, respectively. *Total Depth/Shares Outstanding* is the sum of bid and ask quoted depths divided by shares outstanding.

In Panel B, *Return* and *Standard Deviation of Return* are the mean and standard deviation of daily stock return, respectively. *Idiosyncratic Volatility* and *R-Squared* are, respectively, the standard deviation of residuals and R-Squared from the regression of daily stock excess return on CRSP value-weighted market excess return. *Beta* is the coefficient estimate of the same regression. |*Daily AR(1)*| and |*Intraday AR(1)*| are the absolute value of first-order autocorrelation of returns, calculated using daily returns and 30-minute interval returns, respectively. |*Variance Ratio (5) - 1*| is the absolute deviation of the 5-day variance ratio in Lo and MacKinlay (1988) from 1.

The last column shows the mean measures of Portfolio 4 minus Portfolio 1. Industry- and time-clustered t-statistics of the differences are in parentheses. *, **, and *** denote 10%, 5%, and 1% significance, respectively.

N = 846

Panel A: Liquidity Measures (Changes in Issuing Firm Minus Changes in Control Firm)						
		Portfolios based on SI_%Shrout				
	All	P1 (Smallest)	P2	P3	P4 (Largest)	P4-P1
Short Interest/Shares Outstanding (%)	2.462***	0.252	0.875***	3.003***	5.726***	5.473***
	(12.29)	(1.22)	(3.17)	(5.80)	(16.21)	(13.38)
log Turnover	0.209***	0.048	0.184***	0.223***	0.379***	0.331***
	(10.09)	(1.40)	(4.44)	(5.39)	(8.84)	(6.04)
log Number of Trades	0.162***	0.041	0.185***	0.134***	0.289***	0.248***
	(7.66)	(1.13)	(4.36)	(3.13)	(6.41)	(4.30)
log Dollar Volume	0.321***	0.076	0.319***	0.356***	0.531***	0.455***
	(10.34)	(1.53)	(5.61)	(5.46)	(7.57)	(5.29)
log Amihud	-0.334***	-0.123**	-0.317***	-0.351***	-0.545***	-0.422***
	(-11.45)	(-2.46)	(-6.13)	(-5.74)	(-8.12)	(-5.04)

Table 3b (cont'd)

Panel A (cont'd)

	Portfolios based on SI_%Shrout					
	All	P1 (Smallest)	P2	P3	P4 (Largest)	P4-P1
OIBNUM (%)	-0.370*	0.233	-0.643	-0.370	-0.696*	-0.929
	(-1.71)	(0.58)	(-1.48)	(-0.85)	(-1.65)	(-1.60)
Dollar Spread	0.001	0.001	0.001	0.005	-0.003	-0.004
	(0.26)	(0.18)	(0.17)	(0.72)	(-0.47)	(-0.47)
Percentage Spread (%)	-0.045**	0.031	-0.063*	-0.069	-0.077*	-0.107**
	(-2.42)	(1.32)	(-1.81)	(-1.62)	(-1.82)	(-2.23)
Total Depth/Shares Outstanding (%) x 1000	0.569	1.482	-0.942	-0.145	1.880	0.398
	(0.48)	(0.78)	(-0.26)	(-0.09)	(1.05)	(0.15)

Panel B: Return and Price-Efficiency Measures (Changes in Issuing Firm Minus Changes in Control Firm)

	Portfolios based on SI_%Shrout					
	All	P1 (Smallest)	P2	P3	P4 (Largest)	P4-P1
Return (%)	-0.102***	-0.032	-0.067	-0.152***	-0.155***	-0.124**
	(-4.65)	(-0.93)	(-1.30)	(-4.17)	(-3.41)	(-2.17)
Standard Deviation of Return (%)	-0.130*	-0.079	0.032	-0.358***	-0.118	-0.039
	(-1.77)	(-0.90)	(0.19)	(-3.48)	(-0.64)	(-0.19)
Idiosyncratic Volatility (%)	-0.142**	-0.085	0.012	-0.354***	-0.142	-0.057
	(-1.94)	(-0.94)	(0.07)	(-3.23)	(-0.76)	(-0.28)
R-Squared (%)	0.757	0.165	0.588	1.014	1.259	1.094
	(1.42)	(0.16)	(0.61)	(1.00)	(1.09)	(0.71)
Beta	0.002	-0.043	0.006	-0.058	0.104	0.147*
	(0.07)	(-1.03)	(0.09)	(-1.10)	(1.60)	(1.90)
|Daily AR(1)| (%)	-0.020	1.108	-0.671	-0.418	-0.097	-1.206
	(-0.04)	(1.16)	(-0.66)	(-0.46)	(-0.09)	(-0.86)
|Intraday AR(1)| (%)	4.152	2.691	6.651	8.521	-1.240	-3.930
	(1.40)	(0.32)	(1.22)	(1.35)	(-1.52)	(-0.46)
|Variance Ratio (5) - 1|	0.026	1.652	-0.302	-1.506	0.259	-1.392
	(0.02)	(0.89)	(-0.15)	(-0.63)	(0.11)	(-0.45)

Table 4
Regression of Liquidity and Efficiency Changes on Short-Interest Intensities and Firm Characteristics

The liquidity and efficiency changes are regressed on arbitrage activity (*SI_%Shrout*) and firm characteristics. "Pre-issue period" is the 6 months ending 1 month prior to the issuance or announcement, whichever is earlier. "Post-issue period" is the 6 months beginning 1 month after issuance or announcement, whichever is later.

Δ Turnover , Δ*Trades* , and *Δ Amihud* are changes in the post-issue log *Turnover* , log *Number of Trades* , and log *Amihud* , respectively, from the pre-issue measures. *Turnover* is the average daily stock volume divided by shares outstanding. *Number of Trades* is the average daily number of stock transactions. *Amihud* is the average daily ratio of absolute return to dollar volume. Δ*OIBNUM* , Δ*Spread* , and Δ*Depth* are the percentage changes in the post-issue *OIBNUM* , *Percentage Spread* , and *Total Depth/Shares Outstanding* , respectively, from the pre-issue measures. *OIBNUM* is the average daily absolute difference between the numbers of buyer- and seller-initiated trades divided by their sum. *Percentage Spread* is the difference between bid and ask quotes (time-weighted), expressed as percentage of bid-ask midpoint. *Total Depth/Shares Outstanding* is the sum of bid and ask quoted depths divided by shares outstanding.

Δ |AR(1)| and *Δ |VR(5) from 1|* are the percentage changes in the post-issue *|Daily AR(1)|* and *|Variance Ratio (5) - 1|* , respectively, from the pre-issue measures. *|Daily AR(1)|* is the absolute value of first-order autocorrelation of daily returns. *|Variance Ratio (5) - 1|* is the absolute deviation of 5-day variance ratio from 1.

SI_%Shrout is the monthly change in short interest (from the month prior to issuance) divided by the number of shares outstanding in the month prior to issuance. *Δ Market Cap* and *Δ Volatility* are the post-issue equity market capitalization and standard deviation of daily return minus the corresponding pre-issue period measures. Δ*Institutional Holdings* is the change in institutional holdings (by 13f institutions) divided by shares outstanding at issuing calendar year end from prior calendar year end. *Pre-issue Price* is the average (log) price in pre-issue period. *NYSE* and *Public* are dummy variables. *Δ Pre Post* is the number of days between the last day in pre-issue period and the first day in post-issue period. Estimates on the year-month dummies are not reported.

All variables (except *Pre-issue Price*) are expressed as deviation from control firms (issuer minus control). Heteroskedasticity-consistent industry-clustered t-statistics are in parentheses. *, **, and *** denote 10%, 5%, and 1% significance, respectively.

	Liquidity												Efficiency			
	Δ Turnover	t-stat	Δ Trades	t-stat	Δ Amihud	t-stat	Δ OIBNUM	t-stat	Δ Spread	t-stat	Δ Depth	t-stat	Δ |AR(1)|	t-stat	Δ |VR(5)-1|	t-stat
Intercept	0.091	(0.58)	-0.116	(-1.23)	-0.192	(-0.65)	0.064	(0.59)	0.030	(0.36)	0.648***	(3.31)	1.947	(0.25)	4.948	(1.04)
SI_%Shrout	2.993***	(3.16)	2.474***	(4.23)	-3.042***	(-3.75)	-0.460	(-1.01)	0.375	(0.85)	1.950***	(2.69)	-46.239	(-0.71)	-3.528	(-0.17)
ΔMarket Cap	0.170***	(4.97)	0.617***	(19.39)	-0.982***	(-21.84)	-0.192***	(-9.92)	-0.512***	(-12.73)	-0.733***	(-6.53)	-5.828	(-0.62)	-1.639**	(-2.00)
ΔVolatility	10.063***	(6.47)	9.552***	(6.63)	-0.369	(-0.36)	-2.294***	(-2.75)	2.944***	(2.70)	5.976***	(2.69)				
ΔInstitutional Holdings	0.438***	(8.62)	0.158***	(3.00)	-0.468***	(-4.15)	-0.038	(-1.07)	-0.213***	(-3.69)	-0.116	(-0.95)	0.811	(0.10)	-0.812	(-0.56)
Pre-issue Price x 100	-0.260	(-0.09)	3.976**	(2.07)	1.125	(0.34)	-1.931*	(-1.90)	0.325	(0.17)	-9.983***	(-2.81)	117.303	(0.70)	-32.742	(-0.36)
NYSE	-0.080**	(-2.27)	-0.119***	(-4.22)	-0.020	(-0.40)	0.048**	(2.02)	-0.016	(-0.84)	0.084	(0.94)	4.034	(1.08)	-0.647	(-0.51)
Public	-0.027	(-0.52)	0.058	(1.19)	0.099*	(1.71)	-0.037	(-1.55)	0.059*	(1.81)	-0.094	(-0.99)	-16.484	(-1.11)	3.549	(1.44)
ΔPre Post x 1000	1.466*	(1.85)	0.330	(0.60)	-0.685	(-0.50)	-0.581	(-1.06)	-0.608	(-1.09)	-0.581	(-0.35)	-14.450	(-0.11)	-24.060	(-1.08)
N	846		846		846		846		846		846		846		846	
RSq. (%)	36.81		56.36		57.81		33.42		58.03		35.95		10.47		59.58	

Table 5
Long-Run Returns

In Panels A and B, *Cumulative Return* is the holding period return from long stock positions starting after market close on issue date and announcement date, respectively. Panel C shows the average daily return of issuers and control firms between market close on announcement date and the trading day prior to issue date, for issues that are announced at least 2 trading days prior to issuance. Control firms are matched based on size, book-to-market, and turnover before issuance; exchange, and industry.

Industry- and time-clustered t-statistics of the differences in returns are in parentheses. *** denotes 1% significance.

N = 846

Panel A: Long-Run Returns After Issuance

Cumulative Return (Not Annualized)	Issue date	+6 months	+12 months	+18 months	+24 months
Issuing Firm		6.57%	9.22%	12.24%	16.53%
Control Firm		5.47%	8.85%	13.68%	17.66%
Difference		1.10%	0.37%	-1.44%	-1.13%
t-stat		(0.58)	(0.13)	(-0.41)	(-0.31)

N = 846

Panel B: Long-Run Returns After Announcement

Cumulative Return (Not Annualized)	Announcement date	+6 months	+12 months	+18 months	+24 months
Issuing Firm		3.94%	6.64%	9.73%	13.82%
Control Firm		6.26%	10.16%	14.00%	18.31%
Difference		-2.32%	-3.52%	-4.27%	-4.49%
t-stat		(-1.14)	(-1.14)	(-1.21)	(-1.21)

N = 348

Panel C: Returns Between Announcement and Issuance

Average Daily Return Between Announcement and Issue Dates	
Issuing Firm	-1.30%
Control Firm	0.13%
Difference	-1.43%***
t-stat	(-6.80)
Average Number of Trading Days	10.21

Table 6
Identification of Arbitrageurs Versus Valuation Shorts:
Analysis of the Impact of Shorting at Announcement Compared to Issue Date

The liquidity and efficiency changes are regressed on arbitrage activity (*SI_%Shrout* and *SI_%Shrout_Announcement*, calculated based on issuance and announcement, respectively) and firm characteristics. Only issues where issuing and announcement months fall into different monthly short-interest files are included. "Pre-issue period" is the 6 months ending 1 month prior to the issuance or announcement, whichever is earlier. "Post-issue period" is the 6 months beginning 1 month after issuance or announcement, whichever is later.

Δ Turnover, Δ*Trades*, and *Δ Amihud* are changes in the post-issue log *Turnover*, log *Number of Trades*, and log *Amihud,* respectively, from the pre-issue measures. *Turnover* is the average daily stock volume divided by shares outstanding. *Number of Trades* is the average daily number of stock transactions. *Amihud* is the average daily ratio of absolute return to dollar volume. Δ*OIBNUM*, Δ*Spread*, and Δ*Depth* are the percentage changes in the post-issue *OIBNUM*, *Percentage Spread*, and *Total Depth/Shares Outstanding*, respectively, from the pre-issue measures. *OIBNUM* is the average daily absolute difference between the numbers of buyer- and seller-initiated trades divided by their sum. *Percentage Spread* is the difference between bid and ask quotes (time-weighted), expressed as percentage of bid-ask midpoint. *Total Depth/Shares Outstanding* is the sum of bid and ask quoted depths divided by shares outstanding.

Δ|AR(1)| and *Δ|VR(5) from 1|* are the percentage changes in the post-issue |*Daily AR(1)*| and |*Variance Ratio (5) - 1*|, respectively, from the pre-issue measures. |*Daily AR(1)*| is the absolute value of first-order autocorrelation of daily returns. |*Variance Ratio (5) - 1*| is the absolute deviation of 5-day variance ratio from 1.

SI_%Shrout and *SI_%Shrout_Announcement* are the monthly change in short interest (from the month prior to issuance and announcement, respectively) divided by the number of shares outstanding in the month prior to issuance and announcement, respectively. *Δ Market Cap* and *Δ Volatility* are the post-issue equity market capitalization and standard deviation of daily return minus the corresponding pre-issue period measures. Δ*Institutional Holdings* is the change in institutional holdings (by 13f institutions) divided by shares outstanding at issuing calendar year end from prior calendar year end. *Pre-issue Price* is the average (log) price in pre-issue period. *NYSE* and *Public* are dummy variables. *Δ Pre Post* is the number of days between the last day in pre-issue period and the first day in post-issue period. Estimates on the year-month dummies are not reported.

All variables (except *Pre-issue Price*) are expressed as deviation from control firms (issuer minus control). Heteroskedasticity-consistent industry-clustered t-statistics are in parentheses. *, **, and *** denote 10%, 5%, and 1% significance, respectively.

	Liquidity												Efficiency			
	Δ Turnover	t-stat	Δ Trades	t-stat	Δ Amihud	t-stat	Δ OIBNUM	t-stat	Δ Spread	t-stat	Δ Depth	t-stat	Δ |AR(1)|	t-stat	Δ |VR(5)-1|	t-stat
Intercept	-0.429	(-0.77)	-0.785	(-1.54)	0.803	(1.07)	0.207	(0.81)	0.012	(0.05)	0.463	(1.08)	-0.324	(-0.03)	-0.531	(-0.04)
SI_%Shrout	9.917**	(2.42)	8.812***	(2.73)	-10.752**	(-2.33)	-1.766	(-0.93)	-0.668	(-0.44)	6.460	(1.41)	-82.517	(-0.90)	-49.302	(-0.42)
SI_%Shrout_Announcement	0.638	(0.07)	8.914	(1.04)	-0.938	(-0.11)	0.039	(0.01)	1.822	(0.65)	8.205	(0.82)	398.006	(1.40)	36.531	(0.27)
ΔMarket Cap	0.065	(0.33)	0.432**	(2.18)	-0.747***	(-2.87)	-0.179*	(-1.74)	-0.495***	(-5.37)	-0.597***	(-2.85)	-0.857	(-0.15)	-3.883	(-0.59)
ΔVolatility	8.211***	(3.27)	5.204**	(2.01)	-3.528	(-0.99)	-0.826	(-0.39)	-1.499	(-1.43)	5.275*	(1.81)				
ΔInstitutional Holdings	0.483**	(2.38)	0.139	(0.49)	-0.213	(-0.64)	-0.130	(-0.77)	-0.390***	(-3.59)	-0.324	(-1.12)	7.427	(0.71)	1.189	(0.21)
Pre-issue Price x 100	15.156	(0.96)	24.156*	(1.84)	-28.479	(-1.38)	-1.615	(-0.24)	-1.038	(-0.18)	-0.254	(-0.02)	116.379	(0.41)	126.260	(0.48)
NYSE	-0.103	(-0.61)	-0.103	(-0.77)	0.200	(0.68)	-0.134	(-1.19)	-0.009	(-0.10)	-0.243	(-1.21)	-4.477	(-1.02)	5.033	(0.84)
Public	-0.080	(-0.36)	0.040	(0.19)	0.069	(0.23)	-0.076	(-0.92)	0.113	(1.58)	0.015	(0.07)	-9.113	(-1.16)	8.748	(0.98)
ΔPre Post x 1000	-1.599	(-0.97)	-2.204	(-1.30)	0.441	(0.13)	-0.140	(-0.06)	-0.359	(-0.40)	-4.177	(-1.21)	26.510	(0.44)	-29.153	(-0.37)
N	132		132		132		132		132		132		132		132	
RSq. (%)	75.67		82.09		67.82		72.49		88.60		71.24		70.92		78.37	

Table 7
Arbitrageurs Versus Valuation Shorts: Robustness Analysis Using Theoretical Convertible Bond Arbitrage (SI)

The liquidity and efficiency changes are regressed on theoretical arbitrage activity (*SI_%Shrout_Theoretical*) and firm characteristics. *SI_%Shrout_Theoretical* is calculated based on the delta of convertible bond, conversion ratio, and the number of convertible bonds in the issue. It represents the theoretical number of shares required to sell short (divided by total shares outstanding) in order to delta hedge the convertible bond position. "Pre-issue period" is the 6 months ending 1 month prior to the issuance or announcement, whichever is earlier. "Post-issue period" is the 6 months beginning 1 month after issuance or announcement, whichever is later.

Δ Turnover, Δ*Trades*, and *Δ Amihud* are changes in post-issue log *Turnover*, log *Number of Trades*, and log *Amihud*, respectively, from the pre-issue measures. *Turnover* is the average daily stock volume divided by shares outstanding. *Number of Trades* is the average daily number of stock transactions. *Amihud* is the average daily ratio of absolute return to dollar volume. Δ*OIBNUM*, Δ*Spread*, and Δ*Depth* are the percentage changes in the post-issue *OIBNUM*, *Percentage Spread*, and *Total Depth/Shares Outstanding*, respectively, from the pre-issue measures. *OIBNUM* is the average daily absolute difference between the numbers of buyer- and seller-initiated trades divided by their sum. *Percentage Spread* is the difference between bid and ask quotes (time-weighted), expressed as percentage of bid-ask midpoint. *Total Depth/Shares Outstanding* is the sum of bid and ask quoted depths divided by shares outstanding.

Δ |AR(1)| and *Δ |VR(5) from 1|* are the percentage changes in the post-issue |*Daily AR(1)*| and |*Variance Ratio (5) - 1*|, respectively, from the pre-issue measures. |*Daily AR(1)*| is the absolute value of first-order autocorrelation of daily returns. |*Variance Ratio (5) - 1*| is the absolute deviation of 5-day variance ratio from 1.

Δ Market Cap and *Δ Volatility* are the post-issue equity market capitalization and standard deviation of daily return minus the corresponding pre-issue period measures. Δ*Institutional Holdings* is the change in institutional holdings (by 13f institutions) divided by shares outstanding at issuing calendar year end from prior calendar year end. *Pre-issue Price* is the average (log) price in pre-issue period. *NYSE* and *Public* are dummy variables. *Δ Pre Post* is the number of days between the last day in pre-issue period and the first day in post-issue period. Estimates on the year-month dummies are not reported.

All variables (except *Pre-issue Price*) are expressed as deviation from control firms (issuer minus control). Heteroskedasticity-consistent industry-clustered t-statistics are in parentheses. *, **, and *** denote 10%, 5%, and 1% significance, respectively.

	Liquidity												Efficiency			
	Δ Turnover	t-stat	Δ Trades	t-stat	Δ Amihud	t-stat	Δ OIBNUM	t-stat	Δ Spread	t-stat	Δ Depth	t-stat	Δ |AR(1)|	t-stat	Δ |VR(5)-1|	t-stat
Intercept	0.032	(0.22)	-0.180	(-1.51)	-0.367	(-1.17)	-0.020	(-0.17)	-0.025	(-0.21)	0.784***	(4.05)	6.398	(0.61)	-1.989	(-0.38)
SI_%Shrout_Theoretical	1.318***	(2.63)	0.406	(0.85)	-0.875	(-1.28)	0.272	(1.58)	0.333	(1.36)	0.660	(0.69)	-17.808	(-0.60)	23.501*	(1.80)
ΔMarket Cap	0.172***	(6.01)	0.629***	(19.34)	-0.977***	(-23.00)	-0.202***	(-8.77)	-0.506***	(-11.60)	-0.758***	(-6.04)	-6.495	(-0.67)	-1.369	(-1.31)
ΔVolatility	9.825***	(5.79)	9.667***	(6.20)	-0.803	(-1.00)	-2.366***	(-2.68)	2.796**	(2.56)	5.705***	(2.61)				
ΔInstitutional Holdings	0.432***	(8.93)	0.172***	(4.11)	-0.477***	(-4.18)	-0.041	(-1.19)	-0.217***	(-3.76)	-0.164	(-1.28)	0.317	(0.04)	-0.783	(-0.60)
Pre-issue Price x 100	0.866	(0.31)	3.990	(1.62)	1.675	(0.52)	-0.784	(-0.65)	2.213	(1.04)	-10.278***	(-3.42)	115.310	(0.49)	73.417	(0.68)
NYSE	-0.079*	(-1.85)	-0.129***	(-3.33)	-0.023	(-0.42)	0.070***	(2.95)	-0.017	(-0.82)	0.065	(0.78)	5.841	(1.23)	-0.586	(-0.39)
Public	-0.078	(-1.45)	0.019	(0.38)	0.151**	(2.06)	-0.039	(-1.62)	0.060*	(1.76)	-0.096	(-1.08)	-19.989	(-1.10)	3.406	(1.30)
ΔPre Post x 1000	2.114*	(1.95)	1.258*	(1.76)	-0.849	(-0.44)	-0.882	(-1.29)	-1.106	(-1.55)	-1.897	(-1.11)	-41.610	(-0.24)	-0.150	(-0.01)
N	733		733		733		733		733		733		733		733	
RSq. (%)	39.50		58.49		58.80		35.83		60.03		37.11		10.57		62.78	

Table 8

Simultaneous Equations Estimation: Changes in Liquidity, Prices, and Short Interest

This table presents a simultaneous equation system of liquidity changes and arbitrage activity (*SI_%Shrout*). Panel A shows the regressions of liquidity changes on *Instrumented SI_%Shrout* and other variables, while Panel B shows the regressions of *SI_%Shrout* on *Instrumented ΔLiquidity* and other variables. First-stage results are not reported. "Pre-issue period" is the 6 months ending 1 month prior to the issuance or announcement, whichever is earlier. "Post-issue period" is the 6 months beginning 1 month after issuance or announcement, whichever is later.

ΔTurnover, *ΔTrades*, and *ΔAmihud* are, respectively, log *Turnover*, log *Number of Trades*, and log *Amihud* in post-issue period minus the corresponding measures in pre-issue period. *Turnover* is the average daily stock volume divided by shares outstanding. *Number of Trades* is the average daily number of stock transactions. *Amihud* is the average daily ratio of absolute return to dollar volume. *ΔOIBNUM*, *ΔSpread*, and *ΔDepth* are the percentage changes in the post-issue *OIBNUM*, *Percentage Spread*, and *Total Depth/Shares Outstanding*, respectively, from the pre-issue measures. *OIBNUM* is the average daily absolute difference between the numbers of buyer- and seller-initiated trades divided by their sum. *Percentage Spread* is the difference between bid and ask quotes (time-weighted), expressed as percentage of bid-ask midpoint. *Total Depth/Shares Outstanding* is the sum of bid and ask quoted depths divided by shares outstanding.

In Panel A, *Instrumented SI_%Shrout* is estimated from a first-stage regression (see main text for specification). *ΔMarket Cap* and *ΔVolatility* are the post-issue equity market capitalization and standard deviation of daily return minus the corresponding pre-issue period measures. *ΔInstitutional Holdings* is the change in institutional holdings (by 13f institutions) divided by shares outstanding at issuing calendar year end from prior calendar year end. *Pre-issue Price* is the average (log) price in pre-issue period. *NYSE* and *Public* are dummy variables. *ΔPre Post* is the number of days between the last day in pre-issue period and the first day in post-issue period. Estimates on the year-month dummies are not reported.

In Panel B, *Instrumented ΔLiquidity* are the different liquidity changes (*ΔTurnover*, *ΔTrades*, *ΔAmihud*, *ΔOIBNUM*, *ΔSpread*, *ΔDepth*) estimated from first-stage regressions (see main text for specification). *Pre-issue Dollar Volume* and *Pre-issue Volatility* are, respectively, the average (log) dollar volume and standard deviation of daily return in pre-issue period. *Pre-issue Institutional Holdings* is the institutional holdings divided by shares outstanding at calendar year end prior to issuance. *Pre-issue Dividend* is the dividend rate one year prior to issuance. *Conversion Premium* is the percentage amount by which the conversion price exceeds the market value of the common stock at issuance. Estimates on the year-month dummies are not reported.

All variables (except *Pre-issue Price*) are expressed as deviation from control firms (issuer minus control). Heteroskedasticity-consistent industry-clustered t-statistics are in parentheses. *, **, and *** denote 10%, 5%, and 1% significance, respectively.

Panel A: Liquidity Changes

	Δ Turnover	t-stat	Δ Trades	t-stat	Δ Amihud	t-stat	Δ OIBNUM	t-stat	Δ Spread	t-stat	Δ Depth	t-stat
Intercept	-0.124	(-0.72)	-0.237**	(-2.18)	-0.055	(-0.21)	0.076	(0.67)	0.004	(0.05)	0.569***	(2.61)
Instrumented SI_%Shrout	10.963***	(4.43)	6.931***	(3.81)	-8.073***	(-3.19)	-0.888	(-1.06)	1.318	(1.63)	4.857	(1.38)
ΔMarket Cap	0.142***	(2.72)	0.601***	(16.98)	-0.964***	(-18.44)	-0.190***	(-10.07)	-0.516***	(-12.49)	-0.743***	(-5.94)
ΔVolatility	10.487***	(7.64)	9.789***	(7.42)	-0.637	(-0.54)	-2.317***	(-2.85)	2.994***	(2.89)	6.131***	(2.74)
ΔInstitutional Holdings	0.408***	(7.11)	0.141**	(2.48)	-0.449***	(-3.84)	-0.037	(-1.00)	-0.217***	(-3.77)	-0.127	(-0.99)
Pre-issue Price x 100	4.646	(1.32)	6.719***	(2.79)	-1.971	(-0.66)	-2.194**	(-2.01)	0.905	(0.48)	-8.193**	(-2.32)
NYSE	-0.027	(-0.45)	-0.089**	(-2.23)	-0.054	(-0.84)	0.045*	(1.92)	-0.010	(-0.53)	0.104	(0.96)
Public	0.028	(0.55)	0.089*	(1.79)	0.064	(1.04)	-0.040	(-1.55)	0.065**	(2.08)	-0.074	(-0.85)
ΔPre Post x 1000	0.233	(0.28)	-0.360	(-0.50)	0.093	(0.00)	-0.510	(-0.99)	-0.750	(-1.34)	-1.030	(-0.60)
N	846		846		846		846		846		846	
RSq. (%)	18.94		44.25		46.81		18.80		48.68		21.63	

Table 8 (cont'd)

All coefficients are x 1000

Panel B: Short-Interest Changes

When Instrumented ΔLiquidity =	Δ Turnover	t-stat	Δ Trades	t-stat	Δ Amihud	t-stat	Δ OIBNUM	t-stat	Δ Spread	t-stat	Δ Depth	t-stat
Intercept	11.448*	(1.78)	12.987*	(1.85)	11.477*	(1.83)	13.528*	(1.90)	13.423*	(1.67)	15.181*	(1.69)
Instrumented ΔLiquidity	9.686	(0.89)	5.302	(0.71)	-5.270	(-1.47)	-17.790	(-0.77)	-9.180	(-1.55)	-3.730	(-0.99)
Pre-issue Dollar Volume	-0.710	(-0.60)	-1.120	(-1.01)	-1.250	(-1.07)	-1.210	(-1.08)	-1.520	(-1.15)	-1.410	(-1.07)
Pre-issue Volatility	199.239*	(1.95)	175.534**	(1.96)	142.304***	(2.70)	188.692*	(1.73)	146.362**	(2.50)	162.161**	(2.37)
Pre-issue Institutional Holdings	6.785**	(2.15)	5.471*	(1.71)	5.937*	(1.92)	5.227	(1.52)	5.440*	(1.72)	5.493	(1.60)
Pre-issue Dividend	-7.350	(-1.34)	-7.040	(-1.20)	-7.640	(-1.35)	-7.760	(-1.11)	-7.010	(-1.22)	-5.870	(-1.09)
Conversion Premium (%)	-0.050**	(-2.42)	-0.050***	(-2.57)	-0.040*	(-1.88)	-0.060***	(-2.91)	-0.050**	(-2.29)	-0.060***	(-3.24)
NYSE	-7.120*	(-1.82)	-7.400**	(-2.04)	-7.860**	(-2.48)	-7.300**	(-1.96)	-8.180**	(-2.56)	-8.040***	(-2.69)
Public	-6.510**	(-1.96)	-7.460**	(-2.36)	-6.580**	(-2.07)	-7.950**	(-2.21)	-6.790**	(-2.20)	-7.690**	(-2.38)
ΔPre Post x 1000	0.158***	(2.95)	0.176***	(2.97)	0.176***	(2.98)	0.169***	(3.23)	0.175***	(2.92)	0.179***	(3.06)
N	846		846		846		846		846		846	
RSq. (%)	5.13		4.98		5.51		4.89		4.72		4.06	

Figure 3
Reg-SHO – Short-Selling Activity for Issuers and Control Firms

This chart depicts a short-selling activity during the event window (trading days -20 to +20) for convertible bond issuers and control firms between March 2005 and May 2006. Control firms are matched based on size, book-to-market, and turnover before issuance; exchange, and industry. The short-selling activity measure is the change from expected daily short-sales volume divided by total shares outstanding. Expected short-sales volume is the average short-sales volume from days -40 to -21 relative to issuance.

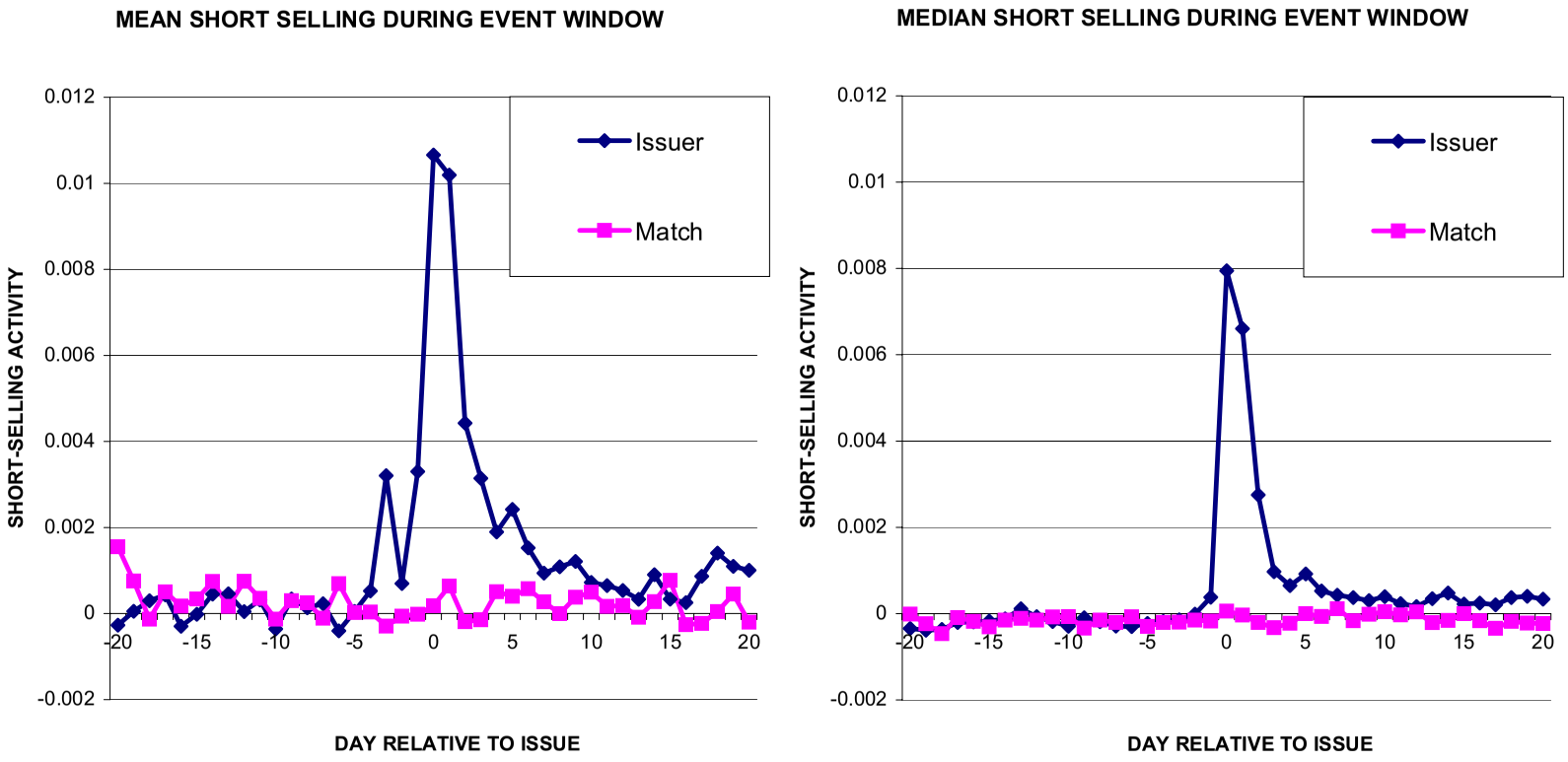


Table 9
Reg-SHO – Changes in Short-Selling Activity Analysis

This table shows the short-selling activity in stocks of convertible bond issuers and control firms between March 2005 and May 2006. Short-selling activity is measured using Reg-SHO Data, which contains short-sale transactions data beginning January 2005. "Pre-period" is defined as the 20 trading days ending 1 month prior to issuance or announcement, whichever is earlier. "Post-period" is defined as the 20 trading days beginning 1 month following issuance or announcement, whichever is later. The change is defined as the mean measure in post-period minus the mean measure in pre-period. Control firms are matched based on size, book-to-market, and turnover before issuance; exchange, and industry.

Number of Short Sales is the daily number of stock transactions that involve short sales. *Short Sales/ Shares Outstanding* is the daily short-sales volume divided by the total shares outstanding.

Industry- and time-clustered t-statistics of the changes are in parentheses. *, **, and *** denote changes that are 10%, 5%, and 1% significant, respectively.

	Issuing Firm	Control Firm
Pre-period Number of Short Sales (log)	6.036	5.474
Post-period Number of Short Sales (log)	6.295	5.623
Change in (log) Number of Short Sales	0.258***	0.149**
t-stat	(4.68)	(2.57)
Pre-period Short Sales/Shares Outstanding (%)	0.298	0.227
Post-period Short Sales/Shares Outstanding (%)	0.345	0.230
Change in Short Sales/Shares Outstanding (%)	0.046*	0.003
t-stat	(1.79)	(0.10)
N	64	64