Convertible Bond Arbitrageurs as Suppliers of Capital *

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Abstract

This paper examines the potential impact of capital supply on security issuance. We focus on the role of convertible bond arbitrageurs as suppliers of capital to issuers of convertible bonds. We estimate a simultaneous equations model of demand and supply of convertible bond capital, linking the time series of aggregate convertible bond issuance to measures of capital supply: convertible bond arbitrage hedge fund flows, returns, and a proxy for arbitrageurs' use of leverage. We find that issuance is positively and significantly related to increases in all three supply measures. To provide further interpretation, we conduct two additional sets of tests. First, we use the ban on short selling in September and October 2008 as a natural experiment to examine the impact of an exogenous shock to the supply of capital from convertible bond arbitrageurs. We find a significant decline in issuance during the ban. Second, using fund flows as a supply proxy, we employ an identification strategy that uses price-quantity pairs to distinguish changes in supply from arbitrageurs that are due to shifts in market supply conditions versus demand conditions. We find significant sensitivity of issuance to both supply- and demand-driven flows. Results from all three empirical approaches provide evidence that the supply of capital from convertible bond arbitrageurs impacts issuance.

Keywords: corporate capital structure, supply of capital, convertible bond arbitrage, hedge funds.

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1 Introduction

Consistent with the Modigliani and Miller (1958) assumption of perfect supply of capital, most literature on firms' capital structure and issuance decisions has focused on demand-side determinants. Recent evidence (Faulkender and Petersen (2006); Sufi (2007); Lemmon and Roberts (2008); Leary (2008)) has called into question this widespread assumption that the supply of capital is frictionless, and highlights the need for an improved understanding of the precise role of supply. This paper uses the convertible bond market to shed light on this question. In particular, we investigate the role of convertible bond arbitrageurs as suppliers of capital.[1]

Convertible bonds have been an important source of financing for a wide variety of firms, and have been particularly popular among distressed firms with depressed equity prices. While much smaller than the market for straight debt, the convertible bond market has, at times, been comparable in size to the market for new equity issues.[2] The convertible bond market provides a useful laboratory for studying the role of capital supply on issuance. One reason is that suppliers as a group are fairly well defined. Convertible bond arbitrage hedge funds are widely believed to purchase more than 75% of primary issues of convertible debt.[3] By focusing on a market in which convertible bond arbitrage hedge funds account for such a large fraction of primary market activity, we are able to isolate important measures of capital supply (such as hedge fund flows). For example, in 2007, total convertible bond issuance was $56 billion, an increase of more than 70 percent from the prior year. Over the same period, net flows into convertible bond arbitrage hedge funds increased 17 percent from the

[1] A convertible bond is a bond that may, at the option of the holder, be converted into stock at a specified price for a given time period. Convertible bond arbitrageurs aim to exploit mispricing in convertible bonds, typically by buying an undervalued convertible bond and hedging equity price risk by taking simultaneously a short position in the equity. Due to the conversion option, convertible bond purchasers may profit from equity price gains, but they also have downside protection since they are guaranteed bond payments.

[2] Convertible bond issuance (public, private and Rule 144a) by our sample of U.S. publicly traded firms was $10.7 billion in 1996, $43.1B in 2001 and $55.9B in 2007. By comparison, US initial equity offerings were $42.2B in 1996, $34.3B in 2001, $35.3B in 2007 (Ritter, 2008).

[3] For example, Mitchell, Pedersen, and Pulvino (2007), report that convertible arbitrage hedge funds account for 75% of the market. Even larger estimates can be found in the popular press.

prior year. That variation in supply of capital to hedge funds is observable (fund flows are reported and available in widely studied databases) greatly improves the analysis; however, a second useful aspect of focusing on convertible bonds is that we can verify the underlying assumption that arbitrageurs are important by using aggregate market data on short selling at the time of convertible bond issuance. Short selling activity at the time of issuance is consistent with arbitrage activities in the market for issuers' stock.[4]

The primary aim of this paper is to examine the relationship between convertible bond issuance and capital supply. We estimate a simultaneous equations model of demand and supply of convertible bond capital, linking the time series of aggregate convertible bond issuance to measures of capital demand as well as supply. In order to correctly estimate a system of supply and demand equations, we would ideally measure the time series of bond underpricing. Because these data are unobservable, we take an alternative approach. We first estimate theoretical bond values at-issue and then we use offering prices to calculate the offering discount relative to the bonds' estimated fair value. We then calculate the monthly time series of average bond underpricing.

We include three supply measures to help shed light on a potential role for arbitrageurs as suppliers of capital: convertible bond arbitrage hedge fund flows; fund returns (which, like flows, alter the size of assets under management); and the degree of leverage used by convertible bond arbitrageurs, captured by the change in short interest in issuers' stock near convertible bond issues. Given that arbitrageurs are primary market purchasers and that

[4]While it is possible for convertible bond arbitrageurs to hedge a short position in the bond with a long position in the stock at the time of issuance, this would be inconsistent with the empirical evidence in Agarwal, Fung, Loon and Naik (2008) that the return dynamics of convertible bond arbitrage hedge funds are explained by portfolios involving "delta hedged" positions, with long positions in convertible bonds and short positions in underlying equity. Choi, Getmansky and Tookes (2009) find large increases in short interest in convertible bond issuers at the date of issuance. Moreover, convertible bonds are underpriced at issue (See e.g., Chan and Chen (2007)). Despite the the widespread belief that hedge funds hold positions for only short time horizons, the evidence from both of these papers is that convertible bond arbitrageurs maintain positions for a significant period of time. Choi, Getmansky and Tookes (2009) find that the increase in short interest observed at issuance persists; Chan and Chen (2007) find that convergence of underpriced bonds to fundamental value takes several months, making it worthwhile for funds to hold the bonds.

convertible bonds tend to be underpriced relative to fundamental value at issue (Kang and Lee (1996), Henderson (2006), and Chan and Chen (2007)), positive shocks to the capital positions of these arbitrageurs might result in upward bond price pressure, making issuance more attractive to firms. An observed positive relationship between issuance and any of these three variables would be in contrast to the classical assumption of perfect external capital markets (in the literature stemming from Modigliani and Miller (1958)), in which demand is the only determinant of firms' financing decisions). We use two-stage least squares to account for potential endogeneity of flows and leverage and we find that issuance is positively and significantly related to increases in all three capital supply measures. Not only is issuance sensitive to the amount of capital available to hedge fund managers, but it is also sensitive to managers' use of the funds that they raise (i.e., leverage) and returns to the strategy. Our main results are not only statistically significant, they are also economically significant. Our main results suggest that, all else equal, a one standard deviation increase in hedge fund flows leads to a 72.9% increase in the supply of funds to issuers of convertible bonds.

To provide further interpretation of the main finding that supply of capital from arbitrageurs impacts issuance, we conduct two sets of (reduced-form) robustness analysis. First, we use the ban on short selling in September and October 2008 as an exogenous shock to the supply of capital from convertible bond arbitrageurs. Because short selling plays an important role in convertible bond arbitrage strategies, the inability to short sell is expected to reduce arbitrageurs' willingness to supply convertible bond capital to firms. Our examination of convertible bond issuance patterns near the short sales ban reveals a significant decline in issuance, even after controlling for issuance of other types of securities.

Second, using one-period lagged fund flows into convertible bond arbitrage hedge funds as a supply proxy, we employ an identification strategy that uses price-quantity pairs to distinguish changes in supply from arbitrageurs that are due to shifts in convertible bond market supply conditions versus demand conditions. This identification strategy is similar in

spirit to that used in Cohen, Diether and Malloy (2007). Based on the signs of the monthly changes in underpricing and proceeds over the sample period, we place each month into one of four categories: (1) increased demand; (2) decreased demand; (3) increased capital supply; (4) decreased capital supply. We place the monthly flows into these four capital supply and demand "bins" (i.e., we interact monthly flows with dummy variables for each of the four capital supply/demand conditions). To our knowledge, this is a novel application of bond underpricing estimation. Rather than simply forecasting future issuance using lagged flows, our approach explicitly accounts for the possibility that funds may raise capital in anticipation of high deal flow, causing lagged flows and issuance to be positively correlated at short horizons. An important contribution of this empirical approach is that we attempt to separate fund flows due to firms' demand for funds versus flows due to changes in capital supply conditions.[5] We find that, while variation in demand conditions appear to be most important, there is significant sensitivity of issuance to both supply- and demand-driven flows. Taken together, results from all three empirical approaches provide strong evidence that the supply of capital from convertible bond arbitrageurs impacts issuance, and are inconsistent with the traditional view that only demand matters for issuance.

A growing literature examining financing patterns by firms suggests that capital supply plays an important role in issuance decisions. For example, Faulkender and Petersen (2006) find that firms with effective access to public debt markets have substantially more debt in their capital structures. Sufi (2007) shows that firms with a loan rating use more debt after the introduction of syndicated bank loan ratings, which increases the supply of debt financing for these firms. Lemmon and Roberts (2008) and Leary (2008) use events to show how shocks to the supply of credit impact financing and investment.

Our paper makes three main contributions. First, we estimate a simultaneous equations

[5]Frazzini and Lamont (2008) find that corporate issuance is responsive to mutual fund flows. They interpret this as evidence that firms increase the supply of shares in response to demand by investors. The authors use mutual fund flows as a measure of demand due to retail sentiment. Our basic analysis, in which we find a positive relationship between supply variables and future issuance is along the lines of their paper.

model of supply and demand, in which we are able to link convertible bond issuance to convertible bond arbitrage hedge fund flows and other variables reflecting potential sources of capital supply. We include levered positions of convertible bond arbitrageurs (to our knowledge, a unique application) in order to account for leverage as a potential source of capital. We find that this significantly impacts issuance, even after controlling for direct measures of capital supply (i.e., fund flows). Second, our event-based analysis of the impact of the short selling ban of 2008 on issuance provides an opportunity to formally examine one potential implication of short sales regulation. Finally, beyond documenting a role for capital supply in convertible bond issuance, this paper suggests a possible role for hedge funds and arbitrageurs in markets that extends beyond trading activity and their impact on price efficiency.

The remainder of the paper is organized as follows. Section 2 describes the data and presents the main hypothesis to be tested. Section 3 presents the main analysis of issuance in a simultaneous demand and supply framework. Section 4 contains the analysis of the impact of the short selling ban on convertible bond issuance. Section 5 presents the third empirical approach, in which we decompose hedge fund flows based on shifts in market capital supply and demand conditions. Section 6 concludes.

2 Data and Hypotheses

2.1 Hypothesis Tests

The main goal of this paper is to examine the impact of capital supply on issuance. We study this question by measuring the impact of capital supply from convertible bond arbitrageurs on observed convertible bond issuance.[6] Faulkender and Petersen (2006) find that market frictions can make the source of capital important in capital structure decisions. In partic-

[6] Agarwal, Fung, Loon and Naik (2008) study the risk and rewards of liquidity provision by convertible arbitrage hedge funds. Our analysis is different in that we link issuance activity with the capital supply from arbitrageurs.

ular, they report that firms with access to public debt markets have higher leverage. Our analysis addresses a similar issue in that we test whether variation in the size and activity of a particular source of capital supply (convertible bond arbitrageurs) impacts equilibrium issuance patterns. This would occur in the presence of market frictions. In the absence of frictions, the observed level of convertible debt issuance is a function of demand for debt, which depends on the price of debt and demand factors, and the supply of debt, which depends on the price of debt and capital supply factors unrelated to the supply of capital from convertible bond arbitrageurs. In the absence of constraints on the supply of capital from arbitrageurs, the observed quantity of proceeds supplied will be unrelated to changes in the size and activity level of convertible bond arbitrageurs, who are main suppliers of capital to convertible bond issuers. However, in the presence of market frictions (namely capital supply constraints), convertible bond arbitrageurs play an important role in the determination of the equilibrium amount of convertible debt financing firms obtain.

We test the null hypothesis that the supply of capital from convertible bond arbitrageurs has no impact on convertible bond issuance.

H0: Capital supply from arbitrageurs and convertible bond issuance are unrelated.

We first test this basic hypothesis using a simultaneous equations methodology, in which we explicitly model the relationships among quantities of convertible bond capital supplied, capital demanded, and prices. If issuers face a binding constraint on the amount of available capital, then we expect to observe a positive relationship between issuance and the variables related to the capital supply from arbitrageurs. To shed further light on this hypothesis, we conduct two additional sets of analysis. The first is an event study, in which we use the short selling ban of 2008 as a natural experiment to test the impact of a shock to arbitrageurs' ability to supply capital to issuers. The second is a reduced-form analysis that uses price-quantity pairs to divide the sample period into four categories of market conditions: increased demand, decreased demand, increased capital supply, and decreased

capital supply. We then test the null hypothesis that "supply-driven" flows do not impact future issuance.

2.2 Data and Variable Construction

The supply and demand estimation requires data on quantities and prices (in our case, underpricing) of convertible bonds, as well as supply and demand proxies.

2.2.1 Quantities and Prices

Proceeds *Proceeds* are defined as the sum of the dollar values of all convertible bonds issued during month t by U.S. issuers listed on NYSE and Nasdaq, as reported in SDC. Utilities (SIC codes 4900-4999) are excluded to avoid the potential concern that issuance policies are the result of regulation. The log of proceeds is used in the main regression analysis.

Underpricing Estimating supply and demand relationships requires a measure of convertible bond underpricing at the time of issuance. Because this is not directly observable, we estimate empirically the theoretical value of each sample bond i, P_i^{Model} , relative to the bond's offering price on the issue date. The estimation procedure follows Henderson (2006) and details are provided in the Appendix. To quantify pricing in the new issues market, we compute the premium of the estimated bond value over the offering price as:

$$\frac{P_i^{Model}}{P_i^{Issue}} - 1,$$

where P_i^{Issue} denotes the issue price of the ith bond in the sample.

Using the above estimate of underpricing for each bond, we construct the time series of monthly average convertible bond underpricing. For each sample month t, during which N bonds are issued, the underpricing measure is:

$$Average\ Underpricing_t = \frac{\sum_{j=1}^{N} Underpricing_{j,t} * Proceeds_{j,t}}{\sum_{j=1}^{N} Proceeds_{j,t}},$$

where $Proceeds_{j,t}$ are the proceeds from the jth convertible bond offering in month t.

$Average\ Underpricing_t$ measures the value-weighted-average underpricing during month t. That is, the price at which issuers sell their bonds relative to the estimated value of these bonds, averaged across all issuers during each month. In periods where issuers sell convertible bonds at large discounts, the ratio of the model's estimated value to the offering price is higher. Thus, in periods with severe underpricing, the variable *Average Underpricing* is higher, indicating a higher ratio of estimated value to offering price. During periods in which issuers sell their bonds for amounts near estimated fair values, *Average Underpricing* will have lower values. If the issue price equals the fair value estimate the variable takes the value 0.[7]

Henderson (2006) and Chan and Chen (2007) report that at issue, convertible bonds are significantly underpriced relative to their fundamental value. In a perfect capital market, one would expect convertible bonds to be correctly priced; however, these issuers are often low-rated firms which may face market frictions and financing constraints due to, for example, information asymmetry. We expect suppliers to be more willing to supply capital when *Average Underpricing* is high, and issuers more willing to issue capital when underpricing is low.

2.2.2 Supply Measures

Convertible Bond Arbitrage Hedge Fund Flows Hedge fund flows are interpreted as a potential source of financing for issuers and is a main variable of interest. *Flow* is defined as the percentage flow into convertible bond arbitrage hedge funds during month t. Consistent with the extant empirical literature, we calculate Flow using the change in assets

[7]Note that this paper uses theoretical price for each issue, thus, we do not have to use ex-post data on realized returns.

adjusted for returns:

$$Flow_t = \frac{Assets_t - Assets_{t-1}(1 + r_t)}{Assets_{t-1}},$$

where r_t is the asset return from time $t-1$ to t, and $Assets_t$ represent the sum of all assets of convertible bond arbitrage funds at time t.[8]

Inputs to the *Flow* variable are from the TASS and CISDM/MAR databases. Both Live and Graveyard sub-databases were used to eliminate survivorship bias. These databases cover several hedge fund strategies, including convertible bond arbitrage. We focus only on funds that are dedicated to the convertible bond arbitrage in order to isolate variation in flows and returns to convertible bond arbitrage. The TASS database contains 247 convertible bond arbitrage hedge funds and CISDM database contains 218 convertible bond arbitrage hedge funds. We deleted hedge funds for which more than 25% of assets under management were missing. If assets were missing, flows were linearly extrapolated up to 3 missing asset observations. All asset values were converted to U.S. dollars. Several funds that report to the TASS database also report to the CISDM database. The TASS and CISDM databases were merged after accounting for hedge funds that report to both databases, resulting in a final sample of 247 unique convertible bond arbitrage hedge funds reporting to either or both databases over the sample period.

Convertible Bond Arbitrage Excess Returns Since fund size can also grow without new flows (through returns), we also control for convertible bond arbitrage fund returns as a potential source of capital. *Excess Return* is calculated as the monthly asset-weighted excess return (above the riskfree rate) to convertible bond arbitrage hedge funds, as reported in the TASS and CISDM databases. We use this as a supply variable in the proceeds supply regressions.

[8] Returns are net of fees. We assume that fees are withdrawn from the fund. However, sometimes, there is a provision for fees to be reinvested into the fund.

Arbitrage Activity and Leverage: ΔSI In addition to resources from flows and returns, convertible bond arbitrage fund managers may use leverage to finance their purchases of primary bond issues. Convertible bond arbitrageurs often take simultaneous short positions in the stock of the issuer. While we do not have direct data on convertible 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) and we estimate convertible bond arbitrage activity by calculating changes in short selling at issuance.[9]

We obtain data on all convertible debt issues (public, private and Rule 144a) by U.S. publicly traded firms for the sample period from SDC. Monthly short interest data are from the NYSE and the Nasdaq and are matched with the SDC data using ticker, CUSIP and date identifiers. ΔSI is defined as the sum of the dollar change in short interest (short interest in issue month t minus short interest in the preceding month), divided by the market capitalization of all NYSE and Nasdaq securities during that month. We interpret this variable as aggregate convertible bond arbitrage activity. It captures both funds buying bonds as well as their use of leverage.

ΔSI is a potentially important control variable in this analysis because it provides a measure of positions taken by arbitrageurs. Fund flows data in hedge fund databases are self-reported and therefore may provide an incomplete measure of convertible bond arbitrage activity. There may be mis-classification and funds reporting multiple strategies. Finally, this variable captures leverage which, even if we measured the assets of the funds perfectly, would be unobservable. Note that while it may be somewhat surprising that firms would be willing to issue convertible bonds if they expect that arbitrageurs will take short positions in their equity; however, Choi, Getmansky and Tookes (2009) find that the short selling due to convertible bond arbitrage activity actually improves equity market liquidity and has no

[9] While it is possible that valuation arbitrageurs also short the stock near convertible bond issuance, we would expect most of the short selling by these traders to occur at the announcement of the bond issue and not at the issuance date. Choi, Getmansky and Tookes (2009) find that most of the short selling by convertible bond arbitrageurs occurs near the issuance date.

negative impact on prices. In addition, Stein (1992) and Gomes and Phillips (2008) report less negative stock price reactions for convertible issues than for equity issues.

Other supply variables We include two additional supply variables, which are proxies for expected transactions costs associated with a dynamic convertible bond arbitrage strategy. A typical convertible bond arbitrage strategy employs delta-neutral hedging, in which an arbitrageur buys the convertible bond and sells short the underlying equity at the current delta. After establishing the initial position, which is set up so that no profit or loss is generated from very small movements in the underlying stock price, convertible bond arbitrageurs engage in dynamic hedging. If the price of the stock increases, the arbitrageur adds to the short position because the delta has increased. Similarly, when the stock price declines, the arbitrageur buys stock to cover part of the short position due to the decrease in delta. To capture expected transactions costs from dynamic hedging, we include VIX_t, the Chicago Board Options Exchange Volatility Index, a measure of the implied volatility of S&P 500. After controlling for underpricing, VIX_t captures the extent to which arbitrageurs expect to adjust their short positions as market prices evolve over time. The second measure is $SumDollarVol_t$, the monthly dollar volume ($Trillion) on the NYSE and Nasdaq. This is a proxy for equity market liquidity. Liquid equity markets will increase arbitrageurs' ability to adjust short positions and therefore increase their willingness to supply convertible bond capital.

2.2.3 Demand Measures

The demand variables are of two types: financial constraints and investment demand. These are chosen to be consistent with findings in the literature, beginning with Fazzarri, Hubbard and Petersen (1988) that financial constraints impact both financing and investment. Because convertible debt has been a popular source of financing for firms approaching distress and those with declining equity performance, variation in financial constraints should explain

variation in demand from firms for convertible debt financing. The amount of existing leverage is one such variable that is expected to impact the demand for convertible debt. This is because debt becomes riskier as firms become more levered, creating potential incentives problems. Green (1984) shows that convertible debt can be a solution to the risk-shifting problem when firms take on risky debt.[10]

We should note that our analysis is based on time series variation in aggregate issuance and aggregate demand. Our data limit our ability to provide cross-sectional evidence; however, the time series tests are still informative about the impact of financial constraints on firms' external financing decisions.

Financing Constraints There are four proxies for financial constraints:

1. $Cash\ Flow_t$, defined as the sum of earnings before extraordinary items and depreciation, divided by beginning-of-quarter capital. Lower cash flow is associated with more binding financial constraints.

2. $Leverage_t$, the lagged debt to total capital of all NYSE and Nasdaq firms (lagged leverage is used in order to exclude the impact of contemporaneous convertible debt issuance). As leverage increases, firms approach their debt capacities and the risk of debt rises. Convertible bonds may be particularly appealing in this setting (see e.g., Green (1984) in which convertible bonds can solve incentive problems for firms with risky debt).

3. $Dividends_t$, the 12 month rolling average dividends of all NYSE and Nasdaq firms, as reported in CRSP, divided by end-of-quarter capital. When dividend payouts are high, firms are less financially constrained.

4. $Cash\ Holdings_t$, defined as cash and short term investments divided by end-of-quarter capital. When there is more internal cash in the economy, firms are less financially

[10] While Green (1984) focuses on post-issue risk shifting, Mayers (1998) introduces a sequential financing model and shows that callable convertible debt can solve over-investment problems.

constrained and are expected to rely less on external financing (due to the transactions costs associated of raising external capital).

These four variables are used in Almeida, Campello and Weisbach (2004) and are based on the Kaplan-Zingales (1997) Index.[11]

Investment Opportunities Q_t, the main proxy for investment opportunities, is defined as the book value of assets, plus end-of-quarter CRSP market value of equity, minus the book value of common equity, divided by total assets. In extended models, we include a second investment demand control, *Other Proceeds*, which are defined as the (log) sum of the dollar values of straight debt and equity issued during month t by U.S. issuers listed on NYSE and Nasdaq, as reported in SDC. This controls for time variation in overall financing demand not captured by Q.[12]

2.2.4 Sample: Summary Statistics

We begin the sample in September 1995 since we are unable to estimate reliably the underpricing measure at the monthly frequency prior to that month. Moreover, to adjust for survivorship bias in the hedge fund databases, the sample should be started after 1994.[13] The sample period ends in September 2008, the date of the last available CRSP quarterly update. As can be seen from Figure 1, convertible bond issuance varies with both fund flows into convertible bond arbitrage hedge funds and with the amount of convertible bond arbitrage activity in the underlying stock. The plots in Figure 1 suggest that convertible bond arbitrageurs are an important source of capital. The correlations between quarterly

[11] Many of these measures of quarterly data are at the firm level; however, they are updated monthly and aggregated to the market level. For example, in the data, a firm with cash flow equal to X during a fiscal quarter ending in March will have cash flow value of X/3 for January, February and March. While a firm with a fiscal quarter ending in February and quarterly cash flow equal to Z will have cash flow of Z/3 for December, January and February, with a new cash flow value for the month of March.

[12] While our Tobin's Q definition is widely used in the literature, it may suffer from measurement error problems. See, for example, Whited (2001).

[13] The Graveyard database became available in 1994, thus, funds that were dropped from the Live database before 1994 are not included in TASS and CISDM/MAR databases.

proceeds and both percentage flows and the arbitrage activity proxy are positive (.141 and .635, respectively) and statistically significant. Figure 1 reveals what appear to be trends in the data. In order to remove the trend effects, all variables for which we observe a significant coefficient a in the regression $y_t = \gamma + at$ are pre-whitened in all regressions.[14]

Summary statistics are presented in Table 1. There is significant issuance over the sample period, with median monthly issuance of nearly \$1.9 billion and 2.7% of all dollar issuance (i.e., total of equity, straight, and convertible debt). Convertible bond arbitrage hedge funds' assets average \$12.3 billion and average net inflows are 1.2%. When comparing flows to total issuance, it is important to note that, although arbitrageurs are a primary source of convertible bond capital, we would not expect the magnitudes of inflows to map one-to-one with issuance. There are several reasons for this. First, we only focus on dedicated convertible bond arbitrage funds. This excludes multi-strategy funds with substantial convertible bond arbitrage operations. Second, we do not capture the entire universe of convertible bond arbitrage hedge funds and are only able to observe those that self-report into TASS and CISDM. This means that some large funds are excluded. Our underlying assumption is that flow dynamics are representative of the industry. Third, hedge funds often use leverage, so flows are not a precise representation of the convertible bond purchasing power of these funds. The net capital outlay for a convertible arbitrage position is the cost of purchasing the bond less the proceeds from short-selling the issuer's shares to immunize the bond position from equity risk. Finally, convertible bond mutual funds may also purchase convertible bonds.[15]

The convertible bond arbitrage strategy was profitable over the sample period, with average monthly excess returns of 36 basis points. ΔSI, our proxy for convertible bond arbitrage activity (funds' use of leverage when purchasing convertible bonds) is .003% of

[14] All variables except $CashFlow$ and ΔSI are pre-whitened.

[15] In extended analysis (Table 4), we explicitly account for flows and returns from mutual funds with the Lipper Objective code CV (convertibles). There are 103 unique convertible mutual funds during our sample period.

total NYSE and Nasdaq market capitalization. This measure captures issue month shorting activity in issuing firms' stock. We also observe substantial underpricing. During the sample period, the *Average Underpricing* variable has mean and median values of 7.14% and 5.79%, respectively. While the bond underpricing variable is calculated as an estimated when-issued premium, as opposed to the initial first-day excess return measure employed in the IPO literature, the magnitude of underpricing that we observe in our sample of convertible bonds is economically significant – nearly 40% of the underpricing observed in IPO issues over the same period.[16] These levels are consistent with the average degree of convertible bond underpricing for the U.S. market reported by other researchers (see e.g., Chan and Chen (2007) and Henderson (2006)). Financial constraint measures are also in the table. Of them, cash flow is the most volatile (as one might expect). Of the supply proxies, dollar volume, the equity market liquidity proxy, is also rather volatile.

3 The Impact of Capital from Convertible Bond Arbitrageurs on Issuance

3.1 Empirical Model

Because quantities of convertible bonds issued and underpricing of these bonds are jointly determined, we use a simultaneous equations methodology. In particular, we use two-stage least squares to estimate the following system of supply and demand equations:

$$\begin{aligned} Proceeds_t^D &= \alpha^D + \beta_1 Underpricing_t + \beta_2 X_t + \varepsilon_t, \qquad (1) \\ Proceeds_t^S &= \alpha^S + \gamma_1 Underpricing_t + \gamma_2 Z_t + \nu_t, \\ Proceeds_t^D &= Proceeds_t^S. \end{aligned}$$

[16] Initial public offering underpricing averaged 19.14 percent during the same period. (See Ritter, Jay, March 2008, "Some Factoids About the 2007 IPO Market.")

The first equation in the system describes the demand (from firms) for convertible debt. $Underpricing_t$ is the value-weighted underpricing measure described in Section 2 and in the Appendix (in short, it is the ratio of theoretical bond value to issue price, minus one). Consistent with traditional models of supply and demand, $Underpricing_t$ is assumed to be endogenous. X_t is a vector of variables that proxy for current financial constraints: $Cash\ Flow_t$, $Leverage_{t-1}$, $Dividends_t$, $Cash\ Holdings_t$, and Q_t. These variables are based on the Kaplan-Zingales (1997) Index and are assumed to be exogenous.[17] We expect that the quantity of convertible bond proceeds demanded by firms is decreasing in the extent to which they must discount them, $Underpricing_t$.[18] We expect that financial constraints will increase equilibrium demand for convertible bonds. Financial constraints become more binding when internally generated funds are scarce and when firms face external financing frictions, which may be exacerbated by deteriorating performance. Poor economic performance may make straight bond financing expensive due to potential risk-shifting incentives (e.g., in Green (1984), convertible debt is a solution to the risk-shifting problem). Poor performance can also cause equity values to decline. If equity is currently undervalued, convertible debt may be a "backdoor" to equity financing (as in Stein, 1992). That is, we expect $Proceeds_t^D$ to be negatively related to $CashFlow$, $Dividends$ and $Cash\ Holdings$ and positively related to $Leverage$ and investment opportunities, Q.

The second equation in the system describes the supply (from arbitrageurs) of convertible debt capital. $Underpricing_t$ is the underpricing measure described above (it is treated as an endogenous variable). Z_t is a vector of variables that proxy for capital supply from convertible bond arbitrageurs: $Flow_t$, $Excess\ Return_{t-1}$, VIX_t, $SumDollarVol_t$, and ΔSI_t. The ΔSI variable captures the tendency of firms to engage in convertible bond arbitrage

[17] In unreported analysis, we have repeated the estimation using lagged Kaplan-Zingales (1997) measures. Results are unchanged.

[18] In our case, "demand" is the quantity of convertible bond financing demanded by issuers. In price-quantity space, this has an upward slope (i.e., the shape of a traditional supply curve). Because we are focusing on underpricing, rather than price levels, the expected slope is negative.

activity and use leverage.[19]

All variables in Z are assumed to be exogenous, with the exception of $Flow$ and ΔSI, which may be determined jointly with equilibrium proceeds. These two endogenous variables are instrumented using estimates from a first stage regression. In the first stage regressions, we include contemporaneous flows into merger arbitrage hedge funds as an instrument for $Flow$. Merger arbitrage flows capture supply of capital to hedge funds that use short selling strategies, but is unrelated to convertible bond issuance. We use lagged ΔSI as an instrument for ΔSI. These instruments, all of the exogenous explanatory variables specified in the simultaneous equations system, and lags of all endogenous variables are included in the first stage regressions.

The $Proceeds_t^S$ equation is the main focus of the analysis. We expect that flows into convertible bond arbitrage hedge funds, past returns to these funds and their ability to use leverage via short positions in the stock (ΔSI) will all increase convertible bond arbitrage hedge fund managers' willingness to supply capital to convertible bond issuers. The estimated coefficients on the latter supply measures (particularly $Flow_t$) are a main focus of this analysis since they allow us to measure the extent to which a particular type of capital supply impacts equilibrium issuance. We also expect that, after controlling for convertible bond underpricing, the expected transactions costs from convertible bond arbitrageurs' dynamic hedging strategies are increasing in market volatility, VIX_t, and decreasing in market liquidity proxy $SumDollarVol_t$. This implies negative and positive signs on the estimated coefficients on VIX_t and $SumDollarVol_t$, respectively. Finally, we expect that the quantity of convertible bond proceeds supplied by arbitrageurs is increasing in the extent to which they are discounted, $Underpricing_t$.

The last equation in (1) defines the equilibrium condition that demand for convertible

[19] The ΔSI variable captures both arbitrageurs' supplying capital to issuers and their use of leverage (i.e., short positions in the underlying stock, which is a function of the issuer-determined bond conversion ratio). The component of ΔSI that reflects bond purchases is expected to be positively related to flows; however, the leverage component may provide incremental explanatory power.

debt issuance equals supply.

3.2 Main Results

Results from estimating Equations 1 are given in Table 2.[20] There are three versions of the model, which differ only in the convertible bond arbitrage supply proxies included in the analysis. Model 1 uses $Flow_t$ as the only measure of supply from arbitrageurs. This is our preferred proxy for convertible bond arbitrageurs' willingness to provide greater quantities of capital since flows represent new, uncommitted capital.[21] Model 2 includes both $Flow_t$ and $Excess\ Return_{t-1}$ since convertible bond arbitrage hedge fund managers might also be willing to supply a greater quantity of capital following periods of high returns to the strategy (their assets have just grown and they have more capital available to them). Model 3 includes $Flow_t$, $Excess\ Return_{t-1}$, and ΔSI_t in order to account for the possibility that convertible bond arbitrageurs' ability to use leverage via simultaneously short selling the underlying stock of the issuer increases capital available to them.

The results from estimating Model 1 are provided in Table 2 and show an estimated coefficient of -7.582 on the β_1 coefficient in the $Proceeds_t^D$ equation. Consistent with our hypothesis, this implies that the quantity of convertible bond proceeds is decreasing in the amount by which firms must underprice them. This negative slope confirms a reasonable specification for the demand equation. The financial constraints measures all have the predicted signs, with the exception of $Cash\ Holdings_t$,which has a positive (but insignificant) estimated coefficient. This is not very surprising since the regression controls for contemporaneous cash flow (which is negatively and significantly related to proceeds demanded).

[20] First stage results are not reported, for brevity.

[21] Note that a firm issuing convertibles is not likely to know whether funds are flowing into or out of hedge funds. The main concern of firms is the amount and price of capital they raise at any given time period (firms' bankers may be thought of as information intermediaries, keeping them informed as to how much and at what price they are able to issue in current markets). The equilibrium supply and demand framework allows us to capture quantity and price-setting mechanism. We thank an anonymous referee for encouraging the structural simultaneous equations approach.

In the $Proceeds_t^S$ equation, we observe a positive, but not quite significant, estimated coefficient on the underpricing measure. The other estimated supply coefficients are precisely as predicted. The positive coefficient of 26.105 on $Flow_t$ is not only statistically, but also economically significant. It implies that, all else equal, a one standard deviation increase in hedge fund flows leads to a 72.9% increase in the supply of funds to issuers of convertible bonds.[22]

When we include $Excess\ Return_{t-1}$ (Model 2) and ΔSI_t (Model 3), we find additional evidence that supply of capital from convertible bond arbitrageurs is important to equilibrium issuance. Both of these variables have positive and significant effects on the equilibrium quantity of proceeds supplied. From Model 2, all else equal, a one standard deviation increase in flows results in a 67.2% increase in proceeds supplied and a one standard deviation increase in the prior month's returns results in a 30.5% increase in proceeds supplied. The results in Model 3 suggest that, all else equal: a one standard deviation increase in Flows results in a 50.5% increase in proceeds supplied; a one standard deviation increase in the prior month's returns results in a 17.1% increase in proceeds supplied; and a one standard deviation increase in ΔSI_t results in a 54.9% increase in proceeds supplied. The latter (ΔSI) result not only provides evidence of arbitrageurs as sources of capital, but also suggests the potential importance of using data-driven strategies to infer arbitrage activities.

In Table 3, we repeat the analysis presented in Table 2, but we add an additional control variable, $Other\ Proceeds_t$. This variable is defined as the (log) sum of all straight debt and equity issues reported in the Securities Data Corporation's New Issues Database. It is included to control for firms' contemporaneous demand for new financing (in addition to what is captured by Q). The addition of the new variable, $Other\ Proceeds_t$ is important, as it has a positive and significant estimated coefficient. The signs, significance and estimated

[22] Note that in all three specifications, we observe negative and significant coefficients on lagged flows in the first stage underpricing regression. This suggests a mechanism by which flows lead to greater convertible bond issuance: they improve the terms (i.e., price) at which firms can issue convertibles. We thank an anonymous referee for highlighting this relationship.

magnitudes of the other variables in the system remain consistent. Interestingly, the only exception to this is positive coefficient on $Underpricing_t$ in the supply equation (γ_1), which becomes significant.

It is widely believed that convertible bond arbitrage hedge funds are the primary purchasers of convertible debt issues. However, other investors, such as mutual funds, also hold convertible debt. We use the Thomson 13F database to identify the mutual funds with the Lipper Objective Code CV ("Convertible Securities Funds"). There are 103 unique Convertible Securities Funds during our sample period, with asset size that is comparable to our sample of hedge funds ($5.5 billion at the end of 1995; $15.6 Billion as of March 2008).[23] In the robustness analysis presented in Table 4, we repeat the main regressions (Table 2), but include returns and flows from convertible mutual funds as a second potential source of capital. The main finding in Table 2 of the importance of the supply of capital from convertible bond arbitrage hedge funds (measured by both $Flow_t$ and ΔSI_t) is robust to including mutual funds. The coefficient on convertible bond arbitrage hedge fund excess return becomes insignificant; however this is not surprising given that the correlation of .72 between that variable and mutual fund excess return (i.e., potential multicollinearlty). Interestingly, we do not find evidence that mutual fund flows are important. In all three specifications, the estimated coefficient on mutual fund flows is insignificant. One interpretation of this result is that hedge funds are most active in primary issue markets (consistent with Mitchell, Pedersen, and Pulvino (2007) who report that convertible arbitrage hedge funds account for 75% of the market). Mutual funds may purchase more of their convertible bonds in secondary markets and/or they may focus more on purchasing preferred convertible stock.[24]

Taken together, the results in Tables 2-4 from the simultaneous equations analysis reveal an important role for supply of capital from convertible bond arbitrageurs. In the next two

[23] The sample period only runs through March 2008 due to availability of the mutual fund data.

[24] Convertible preferred stock issues were approximately 1/3 (in both number and dollar value) the issues of convertible debt during our sample period.

sections, we take two alternative approaches to the analysis, which allow us to shed more light on this finding.

4 The Short Selling Ban of 2008: A Natural Experiment

In this section, we take an alternative empirical approach to examining the impact of capital supply from convertible bond arbitrageurs on issuance. We use the short selling ban of September 2008 to examine the impact of a shock to convertible bond arbitrageurs' ability to supply capital in the convertible bond market.[25] The ability to sell short the equity of convertible bond issuers is critical to the convertible bond arbitrage strategy (both because of hedging equity risk and because the initial short position increases available capital). If supply of capital matters to issuance, we should see a drop in convertible bond issuance during the time of the short selling ban.[26]

In the second half of 2008, following steep equity price declines of financial issuers, the United States Securities and Exchange Commission (S.E.C.) took steps to restrict short selling in these firms in an effort to stabilize these downward price movements. On July 15, 2008, the S.E.C. issued an emergency order prohibiting naked short selling in 19 financial stocks. On September 19, 2008, the S.E.C. imposed much stronger restrictions and completely banned short selling in 799 stocks (mainly financial firms). This ban remained in effect through October 17, 2008.

Table 5 provides summary statistics on issuance during the year 2008. As can be seen from the table, there was a steep decline in convertible bond issuance during the Septem-

[25] We are grateful to the editor for encouraging this line of inquiry.

[26] In fact, anecdotal evidence is consistent with this conjecture. See e.g., *WSJ*, "Short-Sale Ban Wallops Convertible-Bond Market," 9/26/2008. One interesting example is Vineyard National Bank (VNBC), which announced a $250 million convertible debt offering on 9/19/08. On that same day, VNBC was placed on the list of stocks subject to the short sales ban. In its subsequent 10K filing, the firm reportes that, after discussions with investors, the 9/19/08 convertible debt offering was terminated and management was pursuing a potential sale of the bank.

ber/October short selling ban. Average weekly proceeds decreased from $944 million during the first half of the year to approximately $15 million during the short selling ban. The number of issues also dropped, from nearly three per week during January through July 2008, to just one issue during the entire 4 week period of the short selling ban. Given that convertible bonds tend to be an important source of financing for firms in distress, this ban may have come at a particularly critical time for firms most vulnerable to a decline in the overall health of the economy. We observe increases in the fraction of convertible bond issuance relative to total issuance during the weeks prior to the ban, when overall economic conditions were deteriorating. Panel B of Table 5 shows issuance patterns for financial firms, which accounted for 40 percent of the dollar value of all issuance from January through mid-July. Firms in this troubled sector saw even steeper declines in issuance during the second half of 2008.[27] Financial firms essentially vanished from the issuance market from September through December 2008, with the exception of one $60 million issue. Panel C of the table shows Troubled Assets Relief Program (TARP) allocations, which became available to financial firms during the last months of 2008. Because of the size and potential importance of these allocations (nearly $230 billion), we include them as a control variable in robustness analysis.

To test for statistical significance of the decline suggested by the summary statistics, we propose a simple test. For the calendar year 2008, we run a regression of weekly convertible bond issuance on dummy variables set equal to one if a short selling restriction is in effect during week t:

$$Proceeds_t = \alpha + \beta_1 Other\ Proceeds_t + \beta_2 FIN19_t + \beta_3 SHORTBAN_t + \varepsilon_t, \quad (2)$$

[27] Bris (2008) studies the July ban on naked shorting in 19 financial firms and finds heavy convertible issuance among these firms, with 6 issues during his sample period (Bank of America, Citigroup twice, Fannie Mae, Lehman Brothers, and Merrill Lynch). He finds that shorting activity before the SEC emergency order was highest for firms that were issuing convertible bonds, which suggests that significant shorting was done by convertible bond arbitrage funds rather than the valuation short sellers, who regulators feared might drive down prices. Choi, Getmansky and Tookes (2009) find that former type of short selling does not negatively impact equity prices.

Where: $Proceeds_t$ is the (log) sum of the dollar value of all convertible bonds issued during week t. $Other\_Proceeds_t$ is the (log) sum of straight debt and equity issued during week t. This variable is included to control for time variation in firms' overall financing needs. $Fin19$ equals 1 if the naked short selling ban on 19 stocks was in effect during week t (i.e., July 20, 2008 through August 9, 2008). $ShortBan$ =1 if the full ban on short selling 799 stocks was imposed during week t. Because weeks are measured from Sunday to Saturday, the dummy variables are set equal to one if the restriction is in place during at least half of the week.[28] If these regulatory supply shocks to convertible bond arbitrageurs impact issuance, we will observe negative and significant coefficients on the dummy variables *Fin19* and $ShortBan$. Results are in Table 6.

Panel A of Table 6 shows results of estimating Equation 2 for all firms in the sample. The negative and significant coefficient of -3.482 on $ShortBan$ in Model 1 (Equation 2) is consistent with our hypothesis that the supply shock imposed via the S.E.C.'s short sale ban negatively impacted issuance. We do not observe substantial changes in overall convertible bond issuance during the earlier July restrictions on naked short selling ($Fin19$). This is not very surprising given the fact only naked short selling was banned and the universe of stocks was somewhat small (19 versus 799 in the September through October ban). As expected, the results from estimating Model 1 show that convertible bond issuance is positively and significantly related to contemporaneous issuance in straight debt and equity. This provides validation for including a control for market-wide swings in issuance, especially during the second half of 2008, when aggregate issuance saw steep declines.

In interpreting the Model 1 results for the full sample of firms, one might be concerned that the short selling ban focused mainly on financial firms. However, it is important to note that this ban took away an important hedging tool from convertible bond arbitrageurs and also introduced potential uncertainty regarding future short selling rules in all stocks.

[28] For $Fin19$, these dates are July 20, 2008 through August 9, 2008. For $ShortBan$, these dates are September 21, 2008 through October 18, 2008. Results are not sensitive to redefining the dummies based on whether a restriction is in place on any day during week t.

It also eliminated any financing provided by the short equity position. Moreover, even firms not typically classified as financials, such as General Motors and General Electric, were on the list of banned firms. Finally, the inability to short financials impacted the dynamic strategy (and presumably returns) of hedge funds, and may have decreased supply of capital available for other new issues.

Panel B of Table 6 shows results of estimating Equation 2 for financial firms only. We find that the signs on the estimated coefficients on both $ShortBan$ and $Fin19$ are negative, but, somewhat surprisingly, they are not significant. This may be due to noise given the smaller sub-sector (SIC codes 6000-6999 only) or to impending government financing programs (i.e., the Troubled Assets Relief Program).

As an additional check, we re-estimate Equation 2, but control for lagged convertible bond issuance. Results from this regression are given in Panel A, Model 2 and are consistent with the Model 1 findings. The main conclusions from the analysis of financial firms (Panel B) also remain unchanged in this second specification.

Finally, we should note that the steep decline in convertible issuance by financial firms at the tail end of 2008 may have been due in part to TARP funds, as the need for additional financing may have been temporarily relieved by the TARP. In a final check, we replace the $Other\_Proceeds_t$ variable with $Other\_Proceeds\_TARP_t$, the sum of $Other\_Proceeds_t$ and all TARP allocations during week t. We re-estimate Models 1 and 2 using this new variable. Results are given by Model 3 and Model 4 in the table, respectively. Our main observation that issuance significantly declined during the supply shock to convertible bond arbitrageurs during the $ShortBan$ period remains.

To summarize, we find preliminary evidence that the short selling ban of 2008 cut off an important supply of capital to issuers of convertible debt and negatively impacted issuance for all firms. This evidence of reduced issuance following an exogenous shock to capital supply is consistent with earlier findings from the structural estimation of supply and demand of convertible debt (Table 2).

5 Reduced Form Approach: Identification of Capital Supply and Demand Conditions

The primary aim in Section 3 is to measure the sensitivity of convertible bond issuance to the supply of capital. In the main analysis, we present results from a simultaneous equations model of financing supply and demand. In this section, we take an alternative, reduced-form approach and measure the impact of short run shifts in supply from convertible bond arbitrage hedge funds on future issuance. This approach allows us to shed further light on the results presented in Table 2.

The empirical approach presented in this section consists of two parts. In the first stage of the analysis, we conduct initial tests, estimating the relationship between flows to convertible bond arbitrage hedge funds and future issuance. In the second stage, we place flows into categories, based on whether they are "supply-" versus "demand-" driven. These categories are based on short-run shifts in market supply and demand conditions, which we identify by dividing the sample period into $Demand\_Out$, $Demand\_In$, $Supply\_Out$, and $Supply\_In$ months. The intuition and methodology is in the spirit of Cohen, Diether and Malloy (2007) in that we employ an identification strategy that uses price-quantity pairs.[29] We begin with the changes (defined over periods t-2 and t-1) in issuance and underpricing. Using these measures, we categorize each period as one of the following:

1. $Demand\_Out$: Increase in underpricing relative to the preceding month, increase in the quantity of proceeds relative to the preceding month

2. $Demand\_In$: Decrease in underpricing relative to the preceding month, decrease in the quantity of proceeds relative to the preceding month

3. $Supply\_Out$: Decrease in underpricing relative to the preceding month, increase in the quantity of proceeds relative to the preceding month

[29] This intuition can also be found in recent working papers (e.g., Wang (2008); Dastidar (2008); Sheen (2009)). However, to our knowledge, ours is a novel application within the fund flow literature.

4. *Supply_In*: Increase in underpricing relative to the preceding month, decrease in the quantity of proceeds relative to the preceding month.

   For each period t, we use last period's shift in capital supply/demand conditions to predict current period issuance (as well as flows).

Figure 2 shows the quarterly time series of convertible bond issuance and underpricing, our measures of price and quantity. Note that there is substantial variation in the relationship between shifts in issuance and shifts in underpricing. For example, in Q1 2000, there was a \$4.14 billion increase in issuance from the prior quarter and a 3.6% increase in underpricing. Quarter 2 2006 shows a similar increase in issuance, but a 4.6% decrease in underpricing. These periods would be classified as "*Demand_Out*" and "*Supply_Out*" issuance markets, respectively. We interpret issuance following demand (supply) shifts as shifts in demand (supply), along the supply (demand) curve. A positive coefficient for supply measures during supply shift periods is interpreted as evidence of a role for capital supply in issuance decisions.

An observed positive relationship between lagged "demand-driven flows" and issuance and no relationship between flows and issuance when supply has shifted would provide empirical support for the classical assumption of perfect external capital markets (in the literature stemming from Modigliani and Miller (1958)), in which demand is the only determinant of firms' financing decisions. A positive relationship between issuance and flows when capital supply has decreased is consistent with a binding capital supply constraint, whereas this positive relationship following increases in capital supply is interpreted as firms adjusting the timing of issuance in order to take advantage of favorable shifts in capital supply (especially if capital supply constraints are anticipated).

5.0.1 Estimation and Results

Basic Proceeds and Flow Regressions Our initial test under the reduced-form approach examines the importance of lagged supply of capital measures on next period proceeds. We regress convertible bond issuance on three proxies for the supply of capital, fund flows, returns, and use of leverage, as well as lagged issuance and underpricing:

$$\begin{aligned} LogProceeds_t &= \alpha + \beta_1 LogProceeds_{t\text{-}1} + \beta_2 Flow_{t\text{-}1} + \beta_3 ExcessReturn_{t\text{-}1} \\ &\quad + \beta_4 \Delta SI_{t\text{-}1} + \beta_5 Underpricing_{t\text{-}1} + \varepsilon_t \end{aligned} \tag{3}$$

Lagged returns and flows capture changes in capital available to convertible bond arbitrage hedge funds. We also include ΔSI as a control since it acts as an additional source of capital (the arbitrageur receives cash for the shorted shares, offsetting part of the cost of the bond purchase). We also include lagged proceeds to control for potential autocorrelation, and include lagged underpricing, which could be driven by either capital demand or capital supply conditions (or both).

Table 7, Panel A contains the results of the proceeds regressions from Equation (3). All standard errors are robust to heteroskedasticity and autocorrelation (as in Newey and West (1987)). Consistent with our main findings in Table 2, we find strong evidence that issuance is sensitive to the supply of capital, with positive, significant coefficients on all lagged capital supply measures; convertible bond arbitrage hedge fund flows, returns, and ΔSI. All else constant, at the mean level of proceeds, a one-standard deviation increase in fund flows results in a 20.4% increase in proceeds; a one standard deviation increase in convertible bond arbitrage hedge fund returns results in a 15.7% increase in proceeds; and a one standard deviation increase in convertible bond arbitrage activity (leverage) results in a 31.1% increase in next period proceeds.

Consistent with the main results shown in Table 2, the above results suggest that increases in capital supply results in higher proceeds, but it is also possible that proceeds influence

capital supply. Panel B of Table 7 contains results of the regression in which supply of capital is the dependent variable.

$$\begin{aligned} Flow_t &= \alpha + \beta_1^{Flow} LogProceeds_{t\text{-}1} + \beta_2^{Flow} Flow_{t\text{-}1} + \beta_3^{Flow} ExcessReturn_{t\text{-}1} \\ &\quad + \beta_4^{Flow} \Delta SI_{t\text{-}1} + \beta_5^{Flow} Underpricing_{t\text{-}1} + \varepsilon_t \end{aligned} \tag{4}$$

This specification allows us to examine whether issuance causes fund flows (in a Granger sense). The results of estimating Equation (4) are presented in Table 7, Panel B. We do not observe evidence that lagged proceeds impact new flows. This finding, along with the evidence that lagged flows impact future proceeds, suggests uni-directional causality between proceeds and flows. We also find that flows are positively autocorrelated. This is consistent with prior evidence that flows are persistent (Ding, Getmansky, Liang, and Wermers (2008)). Somewhat puzzling is the negative (albeit insignificant) coefficient on underpricing. One possible explanation is the long subscription and redemption periods in hedge funds (in our sample, medians are 30 and 60 days, respectively), making flows less sensitive to recent underpricing. In fact, in unreported analysis, when we extend the horizon over which we measure flows from monthly to quarterly observations, the observed negative relationship between lagged underpricing and flows is no longer statistically significant.

Identification of Capital Supply and Demand Conditions

The results in Table 7 suggest a strong relationship between issuance and short run shifts in the supply of capital available to arbitrageurs. In order to distinguish whether issuance is sensitive to capital demand- versus supply- driven flows, we employ a simple empirical strategy exploiting price and quantity data on monthly issues. We interact fund flows with indicator variables based on recent (one period lagged) capital supply and demand shifts. We focus on the sensitivity of issuance to flows given that they represent new, uncommitted capital available to convertible bond arbitrageurs.

Proceeds Regressions, with Decomposed Capital Supply (Fund Flows)

Table 8 contains the results that capture the dynamics of convertible bond proceeds and decomposed capital supply. We decompose flows based on capital supply and demand conditions, and find that proceeds are positively and significantly related to flows following increases in demand ($Demand\_Out$) as well as increases in capital supply of capital ($Supply\_Out$). We interpret the $Demand\_Out * Flow$ results as evidence that the average sensitivity to flows that we observe in Table 2 is, at least in part, driven by "demand-driven" flows. For the $Demand\_in * Flow$ analysis, as one might expect, when demand shrinks, there is little or no sensitivity of issuance to supply of funds. A possible interpretation of the positive, significant coefficient on flows during $Supply\_Out$ periods is that managers take advantage of their timing flexibility by issuing in anticipation of constrained capital supply. That is, firms may raise money when convertible bond capital from hedge funds is plentiful and "cheap," regardless of whether they need it for current investment. The statistically insignificant coefficient on flows during periods of decreased capital supply ($Supply\_In$) is inconsistent with the traditional view that capital supply impacts issuance decisions when capital supply constraints are currently binding.

A second observation from Table 8 is that the change in elasticity of issuance to flows between outward- and inward- demand shift regimes (i.e., the coefficient on the lagged $Demand\_Out * Flow$ interaction minus lagged $Demand\_In * Flow$ interaction) is 21.831 and is statistically significant at the 1% level. The difference between the estimated coefficients on the outward- and inward- capital supply shift regimes, while positive (7.154), is not statistically different from zero. This finding suggests that demand conditions are most important in interpreting the observed correlation between lagged flows and proceeds in Table 2. While this does provide some empirical support for the focus on demand variables in much of the literature, the $Supply\_Out$ result suggests that analyses could be improved if supply variables are also included in analyses.

Note that we also include all four of the main effects (and suppress the intercept) so that the estimated coefficient on each of the main effects is interpreted as the unconditional mean

of log proceeds for the corresponding capital supply/demand shift period.[30]

Ratio of Convertible Proceeds to Total Issuance As an extension, we replace the dependent variable in the proceeds regression (log dollar proceeds) with the ratio of convertible bond proceeds to total issuance. Total issuance is defined as the sum of convertible bond proceeds and other proceeds (i.e., straight debt and equity), obtained from SDC Platinum. The new variable, $\frac{Convertible\_Bond\_Proceeds_t}{\text{Total\_Issuance}_t}$ is attractive because it captures the relative weight of convertible bonds in firms' capital structures. This variable closely links with the capital structure literature in which firms, faced with the need to raise a fixed amount of capital at a particular time, choose the optimal debt-to-equity mix. Considerations that are considered in the literature include: agency problems; asymmetric information/pecking order theories; tax deductibility of coupon payments; and clientele (for example, non-dividend payers may have limited equity clientele due to constraints on institutional investors).

In a survey or CFOs of large firms, Graham and Harvey (2001) report that 58% see convertible debt as a way to issue delayed common stock[31] and that 42% of CFOs see convertible debt as less expensive than straight debt. On the other hand, firms may have some flexibility in the timing of security issuance. If firms face capital supply constraints, then they may choose to raise more capital than currently needed for investment during favorable conditions and raise less during unfavorable ones. For example, Julio, Kim and Weisbach (2007) find that macroeconomic conditions play an important role in the issuance of low quality debt, with firms issuing less low-quality debt during downturns. Baker and Wurgler (2002) show that firms issue and repurchase equity to take advantage of market mispricing, and as a result, capital structure is the outcome of firms' past decisions to time the equity market. This "market timing" test has been controversial. For example, Alti

[30] There is significant variation in short-run supply and demand conditions. Based on our identification strategy, we observe: 33 Demand_Out months; 29 Demand_In months; 40 Supply_Out months; and 43 Supply_In months.

[31] Stein (1992) claims that convertible bonds are a "backdoor" to equity financing. In this case, firms might substitute convertible bonds for equities when the former is "cheap."

(2006) argues that firms that have a history of high market to book values and issuance might have a common set of unobservable characteristics. He gets around this problem by looking only at IPO issuance during "hot" and "cold" markets. He finds that while "hot" market IPO firms initially have more equity, they increase their leverage ratios so that the impact of market timing on leverage disappears within two years.

The results of the analysis using the ratio of proceeds to total issuance are presented in Table 9 and are consistent with the observation that the supply of capital matters for firms' choice of convertible debt versus other sources of financing.[32] The ratio of convertible bond proceeds to total proceeds is positively and significantly related to convertible bond arbitrage hedge fund flows following both high demand and high supply conditions. As in the previous analysis, variation in demand conditions matter more for the sensitivity of issuance to flows.

To summarize, when we decompose flows based on shifts in demand and capital supply conditions, we find significant sensitivity of issuance to both capital supply- and demand-driven flows (i.e., flow during periods of increased capital supply and increased demand, respectively). This result is invariant to whether we measure convertible bond proceeds alone or the ratio of convertible bond proceeds to total issuance (straight debt, convertible debt and equity). That sensitivity of issuance to flows increases following favorable shifts in supply conditions is inconsistent with the traditional view that only demand conditions matter and suggests that firms take advantage of short-term fluctuations in arbitrageurs' willingness to supply capital at more favorable terms.

Moreover, inconsistent with the view that capital supply sensitivity occurs when issuers are more supply-constrained, we do not observe sensitivity of issuance to fund flows following inward shifts in capital supply. While the supply-shift analysis is most relevant to our main research question, we do find that variation in demand conditions appears to be more important than variation in capital supply conditions. The difference in sensitivity of

[32]Note that if there is positive correlation in supply and demand conditions across security markets, one would expect to find weaker results in the ratio regressions than in the main analysis.

issuance to flows when there is an increase in demand versus a decrease in demand is large, positive and significant. This is not the case for positive versus negative shifts in capital supply conditions.

6 Conclusions

In the context of convertible bonds, we examine the role of capital supply in issuance decisions by firms. In particular, this paper uses a simultaneous equations methodology and links convertible bond issuance to a potentially important source of supply: convertible bond arbitrageurs. We document a strong link between variables that capture supply of capital (through hedge fund returns and fund flows, as well as past arbitrage activity) and bond issuance.

Our main finding is that convertible bond arbitrageurs' ability to supply convertibles bond capital (i.e., fund flows) is an important driver of issuance. We also find that demand-side variables such as financial constraints and investment demand proxies (i.e., Q and total issuance in non-convertible debt and equity) all impact issuance in ways that are predicted by theory. In extended analysis that uses an event study methodology, we find additional evidence of a significant role for the supply of capital from arbitrageurs. The September/October 2008 ban on short selling resulted in an unfavorable shift in supply conditions and a decline in issuance. We also introduce a third methodology, in which we decompose convertible bond arbitrage hedge fund flows based on market supply and demand conditions. We find that shifts in both supply- and demand-driven flows matter for future issuance. In the decomposition analysis, we do not find strong evidence that current supply constraints bind; however, we do observe that issuance responds strongly to supply of capital when there has been a favorable shift in supply conditions. This is consistent with issuers taking advantage of the flexibility in the timing of the issuance by waiting until favorable shifts in supply have occurred.

Beyond providing evidence of an important role for capital supply in firms' capital structure and issuance decisions, our analysis sheds new light on the role of arbitrageurs in markets: beyond their trading to correct mispricing, they are important suppliers of investment capital to firms.

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Appendix: Theoretical Bond Price Calculation

This Appendix contains details of the convertible bond valuation model used to measure underpricing in the new issuance market. The convertible bond pricing model employed in this paper is a modified version of the binomial pricing model, similar to the procedure in Henderson (2006). The sample of new-issue convertible bonds comes from the SDC new issues database. All convertible bonds issued by public U.S. firms in U.S. marketplaces, including public and private issues, are included. We exclude all exchangeable and mandatory issues. Any issues missing important terms, such as the coupon rate or conversion ratio are eliminated from the sample.

For each convertible bond new issue, i, in our sample period, we compute the theoretical value of the bond at the time it is issued, designated as $P_{i,0}^{Model}$. The first step in this process is construction of the stock price tree. The model assumes that the issuer's stock price follows a geometric Brownian motion process with constant drift and volatility while having a constant hazard rate of default, λ, and recovery rate. The binomial tree is constructed using 50 time steps per year, or $dt = 1/50$. Thus, the number of time-steps on the binomial tree equals 50 times the years remaining until final maturity. At each time-step, the stock price S may move up (to uS) or down (to dS), where the size of the stock price changes is a function of the stock's return volatility:

$$u = e^{\sqrt{\sigma^2 - \lambda} dt}. \tag{A1}$$

$$d = \frac{1}{u}. \tag{A2}$$

The historical return volatility, σ^2, for each convertible bond issuer's stock is the standard deviation of daily historical stock returns during the window beginning 160 trading days leading up to the announcement and ending 20 days prior to the issuance. The default

intensity, λ, is inferred from credit spreads at the time of the offering. Specifically, with an implied recovery rate R, the implied default intensity is:

$$\lambda = \frac{r_c - r_f}{1 - R}, \tag{A3}$$

where r_c is the yield on straight bonds with the same credit yield as the issue, r_f is the risk-free yield, and R is the fraction of par expected to be recovered in the event of default. For convertible bonds that are not rated, we assume each issue is BBB rated. Based on Moody's statistics on historical recovery rates, we use 40% as the anticipated recovery rate.

The probability of the up- and down-steps, p_u and p_d, respectively, are computed as:

$$p_u = \frac{e^{(r-q)dt} - de^{-\lambda dt}}{u - d}, \tag{A4}$$

$$p_d = \frac{ue^{-\lambda dt} - e^{(r-q)dt}}{u - d}, \tag{A5}$$

where the parameter q is the continuously compounded dividend rate which is estimated as the trailing 12-month dividend rate on the issuer's stock. Since dividends are not paid continuously, the discrete distributions are converted to a continuous basis.

Using backwardation, construction of the convertible bond tree follows from the stock tree. Starting at the terminal node, corresponding to the final maturity date of the bond, the value of the bond is set equal to the maximum of the conversion value (conversion ratio times the stock tree price) or the par value of the bond plus the final coupon payment. Specifically, the expiration date T value (i.e., terminal node bond price) of the ith convertible bond in the sample is:

$$P_{i,T} = MAX[PAR + C, CR_i \times S_{i,T}], \tag{A6}$$

where CR_i is the conversion ratio, or the number of shares into which the bonds may be converted at the investor's option, and $S_{i,T}$ designates the issuer's stock price which corresponds to the terminal nodes on the stock tree.

The prior nodes on the tree are populated by working backwards. Starting with the time-step immediately prior to expiration, the price of the bond is the maximum of the discounted expected payoff or the conversion value. Specifically,

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$$P_{i,t} = MAX(e^{-r_f dt}(p_u P^u_{t+1} + p_d P^d_{t+1} + (1 - p_u - p_d)R \times PAR), CR_i \times S_{i,t}]. \quad \text{(A7)}$$

Using call and put schedules compiled from SDC, Bloomberg, and Mergent for each bond, on all dates when the bonds are callable we impose the condition that the bond's value must be equal to the minimum of the price in the above equation, which we refer to as the value if the bond continues, or the maximum of the conversion value and the call price. Specifically,

$$P^{Callable}_{i,t} = MIN[P_{it}, MAX[CALL_{it}, CR_i \times S_{i,t}]], \quad \text{(A8)}$$

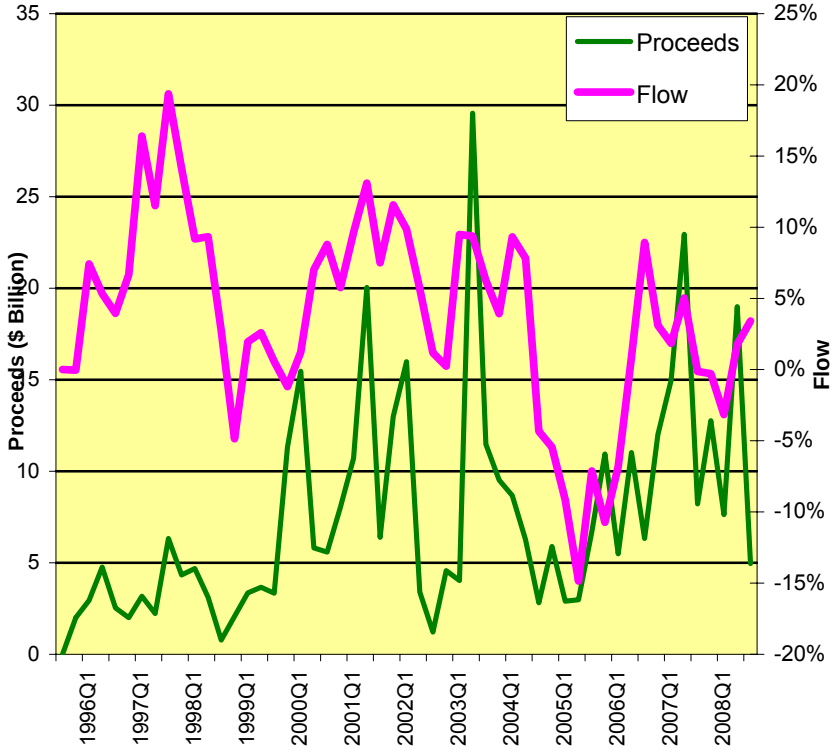
where $CALL_{i,t}$ is the call price of the ith convertible bond at time t. Additionally, for any dates on which the bonds are putable, we assume the bond holder will put the bonds back with the issuer at the put price, $PUT_{i,t}$, if that value is greater than the price in equation A.7 above:

$$P^{Putable}_{i,t} = MAX[PUT_{it}, P_{it}]. \quad \text{(A9)}$$

Figure 1
Convertible Bond Proceeds and Capital Supply Variables

The figures plot the relationship between quarterly convertible bond issuance and two potential sources of capital supply: fund flows into convertible bond arbitrage hedge funds (*Flow*) and short selling in the underlying stock of the issuer (*ΔSI*). Quarterly percentage flow is defined as the sum of monthly dollar flow, divided by asset value at the end of the prior quarter. Quarterly *ΔSI* is defined as the sum of the dollar change in short interest (SI) of all convertible bond issuers in the current issue month (short interest in issue month t minus short interest in the preceding month), divided by the total market capitalization of all NYSE and Nasdaq firms.

Convertible Bond Proceeds and Flow



Convertible Bond Proceeds and ΔSI

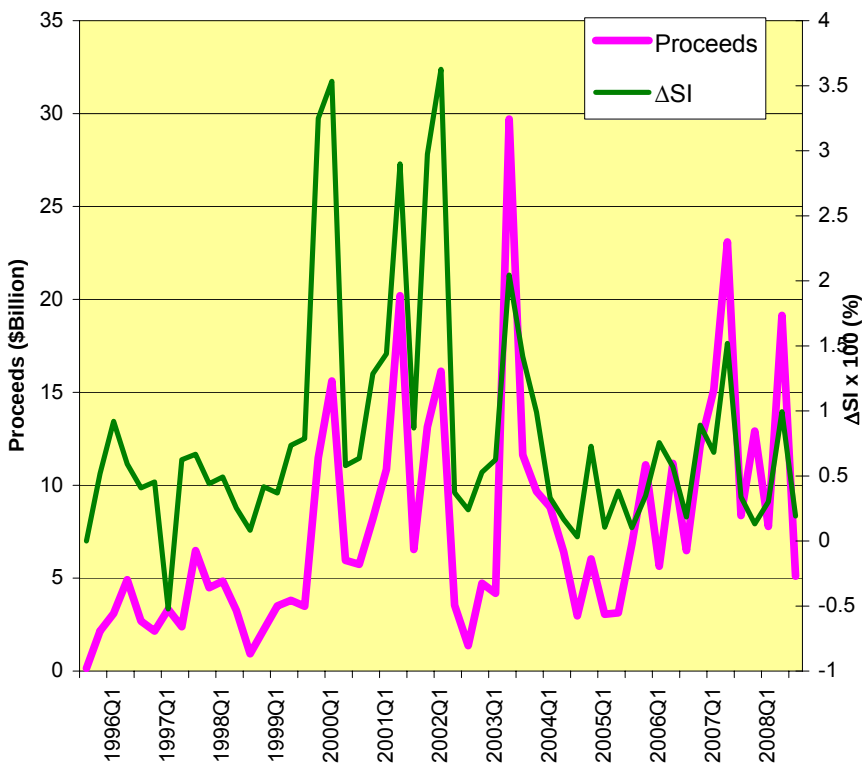


Figure 2
Convertible Bond Quantities and Underpricing

This figure plots the relationship between quarterly convertible bond issuance (the sum of dollar proceeds during quarter t) and average monthly underpricing during quarter t. See the Appendix for estimation details for the underpricing variable.

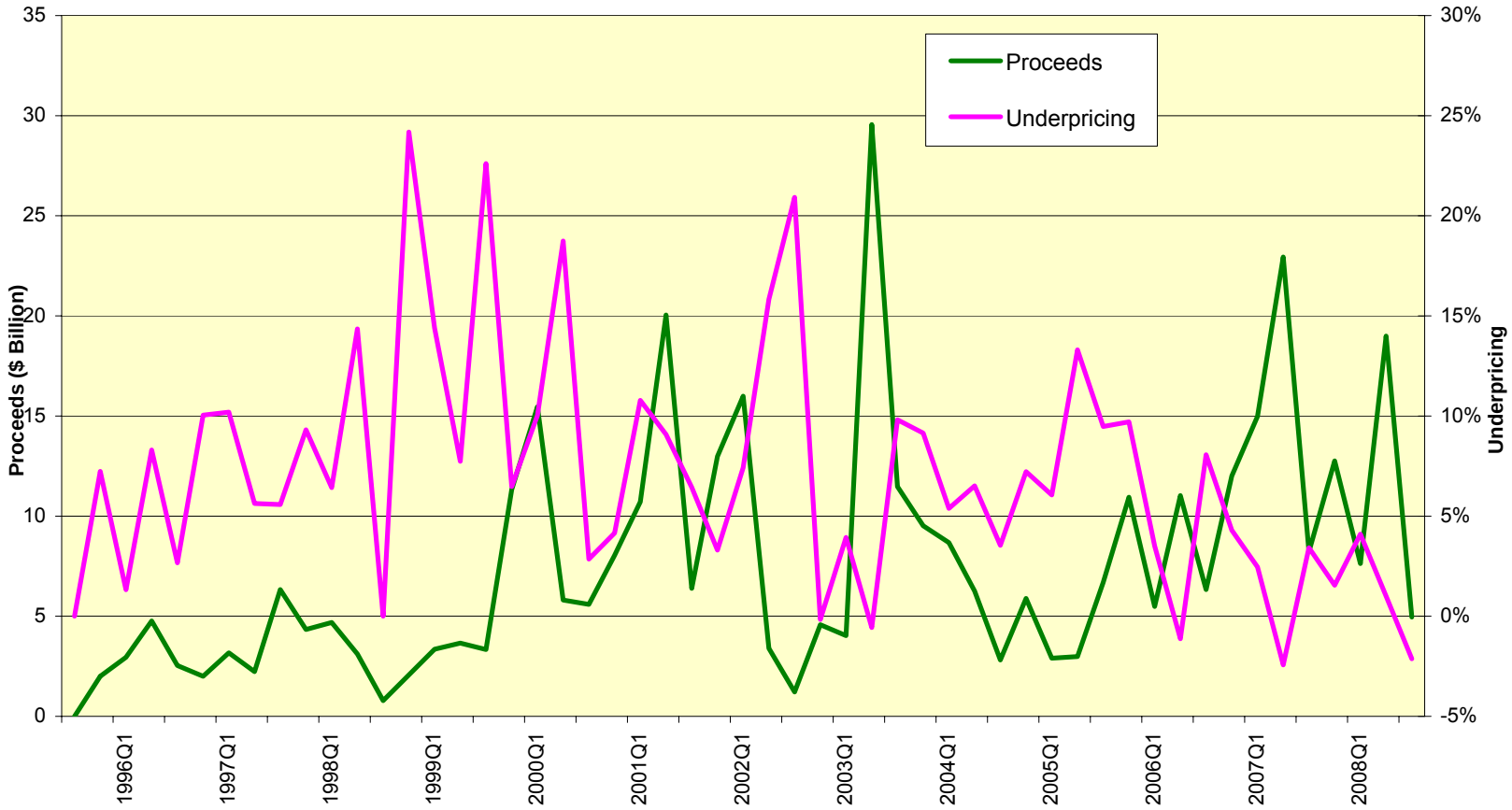


Table 1
Convertible Bond, Hedge Fund and Firm Statistics

This table presents summary statistics on the sample of monthly convertible bond arbitrage hedge funds, proceeds and pricing, as well as firm characteristics. The sample period is from September 1995 through September 2008.

Proceeds are the sum of all proceeds of convertible bonds issued in the current month. *Proceeds/Total* is the total convertible bond proceeds divided by all issuance (proceeds from straight debt, equity, and convertible bonds) in the current month. *Underpricing* is the value-weighted monthly average model estimate for the underpricing of convertible bonds, expressed as percentage of offering price. See the Appendix for the details of estimating the theoretical bond pricing model. *Flow* is defined as the total monthly dollar flow into convertible bond arbitrage hedge funds, divided by total assets in the prior month. *Excess Return* is the asset-weighted monthly return in excess of risk-free rate. *Assets* represent the total assets under management by convertible bond arbitrage hedge funds in the current month. ΔSI is constructed by summing the dollar change in short interest (SI) of all convertible bond issuers in the current issue month (short interest in issue month minus short interest in the preceding month), divided by the total market capitalization of all NYSE and Nasdaq firms.

Firm characteristics are: *Q*, defined as the book value of assets, plus end-of-quarter CRSP market value of equity, minus the book value of common equity, divided by total assets; *Leverage*, the debt to total capital of all NYSE and Nasdaq firms; *Dividends*, the 12 month rolling average dividends of all NYSE and Nasdaq firms as reported in CRSP, divided by end-of-quarter capital; *Cash Holdings*, defined as cash and short term investments divided by end-of-quarter capital; *Cash Flow*, defined as the sum of earnings before extraordinary items and depreciation, divided by beginning-of-quarter capital. All quarterly COMPUSTAT data items are converted into monthly data. *VIX* is the Chicago Board Options Exchange Volatility Index, a measure of the implied volatility of S&P 500; *Dollar Volume* is the monthly dollar volume ($Trillion) on the NYSE and Nasdaq.

N = 151

	Mean	Median	Maximum	Minimum	Standard Deviation	Skewness	AR(1)
Proceeds ($billion)	2.649	1.880	13.943	0.090	2.507	2.132	0.440
Proceeds/Total (%)	3.456	2.666	11.953	0.150	2.421	1.358	0.265
Underpricing (%)	7.143	5.787	42.675	-8.712	8.251	1.030	0.125
Flow (%)	1.204	1.563	8.765	-7.771	2.794	-0.711	0.559
Excess Return (%)	0.361	0.464	4.409	-9.393	1.486	-1.839	0.312
Assets ($billion)	12.278	10.942	31.068	1.211	8.148	0.723	0.996
ΔSI x 100 (%)	0.285	0.172	2.627	-0.754	0.428	2.742	0.400
Q	1.819	1.863	2.088	1.394	0.160	-0.873	0.931
Leverage (%)	33.918	33.646	49.609	31.717	1.979	3.686	0.852
Dividends x 100 (%)	7.727	7.415	13.843	6.089	1.124	2.120	0.811
Cash Holdings (%)	15.451	14.200	27.071	11.288	3.523	1.493	0.942
Cash Flow x 100 (%)	6.406	17.765	70.976	-102.690	28.639	-1.757	0.907
VIX (%)	20.022	19.980	39.390	10.420	5.860	0.434	0.821
Dollar Volume ($trillion)	2.389	1.999	7.587	0.543	1.552	1.456	0.920

Table 2
Simultaneous Equation Model of Convertible Bond Financing

This table presents results of a simultaneous equation model of convertible bond issuance:

$$(1)\ ConvertibleProceeds_t^D = \alpha + \beta_1 Underpricing_t + \beta_2 X_t + \varepsilon_t$$

$$(2)\ ConvertibleProceeds_t^S = \alpha + \gamma_1 Underpricing_t + \gamma_2 Z_t + \nu_t$$

$$(3)\ ConvertibleProceeds_t^D = ConvertibleProceeds_t^S$$

The dependent variables are *ConvertibleProceeds*, the (log) of convertible bond proceeds issued during month t. Superscripts *D* and *S* represent demand and supply, respectively. *Underpricing* is the value-weighted monthly average model estimate for the underpricing of convertible bonds, expressed as percentage of offering price. See the Appendix for the details of estimating the theoretical bond pricing model.

X is a vector of demand variables and *Z* is a vector of supply variables. Explanatory variables in *X* are: *Cash Flow*, defined as the sum of earnings before extraordinary items and depreciation, divided by beginning-of-quarter capital; *Q*, defined as the book value of assets, plus end-of-quarter CRSP market value of equity, minus the book value of common equity, divided by total assets; *Leverage*, the lagged debt to total capital of all NYSE and Nasdaq firms (lagged leverage is used in order to exclude the impact of contemporaneous convertible debt issuance); *Dividends*, the 12 month rolling average dividends of all NYSE and Nasdaq firms as reported in CRSP, divided by end-of-quarter capital; *Cash Holdings*, defined as cash and short term investments divided by end-of-quarter capital. All quarterly COMPUSTAT data items are converted into monthly data. These are based on the variables in the Kaplan-Zingales (1997) Index and are all proxies for firms' financial constraints.
Explanatory variables in Z are: *Flow,* defined as the total monthly dollar flow into convertible bond arbitrage hedge funds, divided by total assets in the prior month; *Excess Return,* defined as the asset-weighted monthly convertible bond arbitrage hedge fund return in excess of the risk-free rate; *VIX* is the Chicago Board Options Exchange Volatility Index, a measure of the implied volatility of S&P 500; *Dollar Volume* is the monthly dollar volume ($Trillion) on the NYSE and Nasdaq; and ΔSI, constructed by summing the dollar change in short interest (SI) of all convertible bond issuers in the current issue month (short interest in issue month minus short interest in the preceding month), divided by the total market capitalization of all NYSE and Nasdaq firms. All variables in X and Z are assumed to be exogenous, with the exception of *Flow* and ΔSI. *Underpricing* is also assumed to be endogenous. These three endogenous variables are instrumented using estimates from a first stage regression (see main te for a full description).

*, ** and *** denote 10%, 5% and 1% significance, respectively.

	Model 1		Model 2		Model 3	
DEMAND FOR CAPITAL	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**
Intercept	0.110	(1.42)	0.112	(1.37)	0.104	(1.52)
$Underpricing_t$	-7.582**	(-2.23)	-8.560***	(-2.70)	-4.155*	(-1.76)
Q_t	1.876	(1.08)	1.636	(0.92)	2.718*	(1.87)
$Leverage_{t-1}$	25.701***	(3.51)	26.745***	(3.57)	22.040***	(3.61)
$Dividends_t$	-1564.730*	(-1.91)	-1699.240***	(-2.04)	-1093.380	(-1.62)
Cash $Holdings_t$	1.048	(0.13)	0.277	(0.03)	3.750	(0.54)
Cash $Flow_t$	-124.778***	(-2.69)	-126.434***	(-2.60)	-118.974***	(-2.93)
Adj-RSq. (%)	13.50		13.54		16.14	
SUPPLY OF CAPITAL	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**
Intercept	-0.028	(-0.29)	-0.042	(-0.49)	-0.380***	(-3.78)
$Underpricing_t$	6.729	(1.55)	5.609	(1.54)	3.209	(1.25)
$Flow_t$	26.105***	(3.02)	24.050***	(3.16)	18.082***	(3.14)
Excess $Return_{t-1}$			20.532***	(2.96)	11.507**	(2.02)
ΔSI_t					12837.700***	(4.21)
VIX_t	-0.0626*	(-1.94)	-0.057**	(-2.03)	-0.046**	(-2.30)
Dollar $Volume_t$	0.211*	(1.72)	0.201*	(1.83)	0.152*	(1.85)
Adj-RSq. (%)	4.46		9.18		26.22	

Table 3
Simultaneous Equation Model of Convertible Bond Financing, with Other Issuance Control

This table presents results of a simultaneous equation model of convertible bond issuance:

$$(1)\ ConvertibleProceeds_t^D = \alpha + \beta_1 Underpricing_t + \beta_2 X_t + \varepsilon_t$$

$$(2)\ ConvertibleProceeds_t^S = \alpha + \gamma_1 Underpricing_t + \gamma_2 Z_t + \nu_t$$

$$(3)\ ConvertibleProceeds_t^D = ConvertibleProceeds_t^S$$

The dependent variables are *ConvertibleProceeds* , the (log) of convertible bond proceeds issued during month t. Superscripts *D* and *S* represent demand and supply, respectively. *Underpricing* is the value-weighted monthly average model estimate for the underpricing of convertible bonds, expressed as percentage of offering price. See the Appendix for the details of estimating the theoretical bond pricing model.
X is a vector of demand variables and *Z* is a vector of supply variables. Explanatory variables in *X* are: *Cash Flow* , defined as the sum of earnings before extraordinary items and depreciation, divided by beginning-of-quarter capital; *Q* , defined as the book value of assets, plus end-of-quarter CRSP market value of equity, minus the book value of common equity, divided by total assets; *Leverage* , the lagged debt to total capital of all NYSE and Nasdaq firms (lagged leverage is used in order to exclude the impact of contemporaneous convertible debt issuance); *Dividends* , the 12 month rolling average dividends of all NYSE and Nasdaq firms as reported in CRSP, divided by end-of-quarter capital; *Cash Holdings* , defined as cash and short term investments divided by end-of-quarter capital. *Other Proceeds* is the (log) monthly issuance of non-convertible debt and equity as reported in the *SDC Database* . All quarterly COMPUSTAT data items are converted into monthly data. These are based on the variables in the Kaplan-Zingales (1997) Index and are all proxies for firms' financial constraints.

Explanatory variables in Z are: *Flow*, defined as the total monthly dollar flow into convertible bond arbitrage hedge funds, divided by total assets in the prior month; *Excess Return*, defined as the asset-weighted monthly convertible bond arbitrage hedge fund return in excess of the risk-free rate; *VIX* is the Chicago Board Options Exchange Volatility Index, a measure of the implied volatility of S&P 500; *Dollar Volume* is the monthly dollar volume ($Tril.) on the NYSE and Nasdaq; and ΔSI, constructed by summing the dollar change in short interest (SI) of all convertible bond issuers in the current issue month (short interest in issue month minus short interest in the preceding month), divided by the total market capitalization of all NYSE and Nasdaq firms. All variables in X and Z are assumed to be exogenous, with the exception of *Flow* and ΔSI. *Underpricing* is also assumed to be endogenous. These three endogenous variables are instrumented using estimates from a first stage regression (see main text for a full description).
*, ** and *** denote 10%, 5% and 1% significance, respectively.

	Model 1		**Model 2**		**Model 3**	
DEMAND FOR CAPITAL	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**
Intercept	0.119	(1.56)	0.120	(1.54)	0.112*	(1.70)
$Underpricing_t$	-8.074**	(-2.50)	-8.407***	(-2.94)	-4.638**	(-2.10)
Q_t	0.301	(0.17)	0.203	(0.11)	1.304	(0.88)
$Leverage_{t-1}$	17.277**	(2.43)	17.537**	(2.46)	14.586**	(2.44)
$Dividends_t$	-941.595	(-1.21)	-980.020	(-1.27)	-544.637	(-0.85)
$Cash\ Holdings_t$	-5.948	(-0.71)	-6.280	(-0.76)	-2.515	(-0.36)
$Cash\ Flow_t$	-109.006**	(-2.40)	-109.394**	(-2.37)	-105.006***	(-2.68)
$Other\ Proceeds_t$	0.994***	(3.56)	1.004***	(3.60)	0.885***	(3.77)
Adj-RSq. (%)	18.14		18.72		22.27	
SUPPLY OF CAPITAL	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**
Intercept	-0.02171	(-0.25)	-0.03474	(-0.43)	-0.380***	(-3.77)
$Underpricing_t$	6.007*	(1.76)	4.790*	(1.69)	3.277	(1.52)
$Flow_t$	24.743***	(3.56)	22.481***	(3.66)	18.226***	(3.68)
$Excess\ Return_{t-1}$			20.149***	(3.07)	11.558**	(2.06)
ΔSI_t					12804.430***	(4.30)
VIX_t	-0.0577**	(-2.18)	-0.051**	(-2.24)	-0.047***	(-2.64)
$Dollar\ Volume_t$	0.200*	(1.79)	0.188*	(1.89)	0.153***	(1.94)
Adj-RSq. (%)	6.47		11.39		27.20	

Table 4
Simultaneous Equation Model of Convertible Bond Financing with Mutual Fund Control

This table presents results of a simultaneous equation model of convertible bond issuance:

$$(1)\ ConvertibleProceeds_t^D = \alpha + \beta_1 Underpricing_t + \beta_2 X_t + \varepsilon_t$$

$$(2)\ ConvertibleProceeds_t^S = \alpha + \gamma_1 Underpricing_t + \gamma_2 Z_t + \nu_t$$

$$(3)\ ConvertibleProceeds_t^D = ConvertibleProceeds_t^S$$

The dependent variables are *ConvertibleProceeds* , the (log) of convertible bond proceeds issued during month t. Superscripts *D* and *S* represent demand and supply, respectively. *Underpricing* is the value-weighted monthly average model estimate for the underpricing of convertible bonds, expressed as percentage of offering price. See the Appendix for the details of estimating the theoretical bond pricing model.

X is a vector of demand variables and *Z* is a vector of supply variables. Explanatory variables in *X* are: *CashFlow* , defined as the sum of earnings before extraordinary items and depreciation, divided by beginning-of-quarter capital; *Q* , defined as the book value of assets, plus end-of-quarter CRSP market value of equity, minus the book value of common equity, divided by total assets; *Leverage* , the lagged debt to total capital of all NYSE and Nasdaq firms (lagged leverage is used in order to exclude the impact of contemporaneous convertible debt issuance); *Dividends* , the 12 month rolling average dividends of all NYSE and Nasdaq firms as reported in CRSP, divided by end-of-quarter capital; *Cash Holdings* , defined as cash and short term investments divided by end-of-quarter capital. All quarterly COMPUSTAT data items are converted into monthly data. These are based on the variables in the Kaplan-Zingales (1997) Index and are all proxies for firms' financial constraints.

Explanatory variables in Z are: *Flow,* defined as the total monthly dollar flow into convertible bond arbitrage hedge funds, divided by total assets in the prior month; *Excess Return,* defined as the asset-weighted monthly convertible bond arbitrage hedge fund return in excess of the risk-free rate; MF Flow, defined as the total monthly dollar flow into convertible bond arbitrage mutual funds, divided by total assets in the prior month; MF Excess Return, defined as the asset-weighted monthly convertible bond arbitrage mutual fund return in excess of the risk-free rate; *VIX* is the Chicago Board Options Exchange Volatility Index, a measure of the implied volatility of S&P 500; *DollarVolume* is the monthly dollar volume ($Trillion) on the NYSE and Nasdaq; and ΔSI, constructed by summing the dollar change in short interest (SI) of all convertible bond issuers in the current issue month (short interest in issue month minus short interest in the preceding month), divided by the total market capitalization of all NYSE and Nasdaq firms . All variables in X and Z are assumed

*, ** and *** denote 10%, 5% and 1% significance, respectively.

	Model 1		Model 2		Model 3	
DEMAND FOR CAPITAL	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**
Intercept	0.117	(1.28)	0.123	(1.27)	0.098	(1.28)
$Underpricing_t$	-8.303**	(-2.14)	-9.584***	(-2.61)	-4.396*	(-1.73)
Q_t	1.757	(0.87)	1.402	(0.67)	2.840*	(1.75)
$Leverage_{t-1}$	29.121***	(3.32)	30.771***	(3.40)	24.088***	(3.47)
$Dividends_t$	-1438.850	(-1.26)	-1561.800	(-1.30)	-1063.920	(-1.12)
$Cash\ Holdings_t$	0.841	(0.09)	-0.369	(-0.04)	4.533	(0.59)
$Cash\ Flow_t$	-113.469**	(-2.16)	-114.642**	(-2.04)	-109.892**	(-2.47)
Adj-RSq. (%)	11.45		11.33		14.67	
SUPPLY OF CAPITAL	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**
Intercept	0.001	(0.01)	-0.005	(-0.06)	-0.294***	(-2.83)
$Underpricing_t$	8.519	(1.45)	5.097	(1.28)	3.412	(1.34)
$Flow_t$	25.404***	(2.95)	21.852***	(3.43)	17.621***	(3.23)
$MF\ Flow_t$	-0.360	(-0.68)	-0.277	(-0.72)	-0.108	(-1.52)
$Excess\ Return_{t-1}$			9.353	(0.76)	11.364	(1.32)
$MF\ Excess\ Return_{t-1}$			6.578	(1.63)	1.055	(0.34)
ΔSI_t					10317.06***	(3.40)
VIX_t	-0.056	(-1.58)	-0.034	(-1.30)	-0.038*	(-1.83)
$Dollar\ Volume_t$	0.279*	(1.92)	0.209*	(1.90)	0.175**	(2.05)
Adj-RSq. (%)	4.71		12.21		27.05	

Table 5
Convertible Bond Issuance Patterns During 2008

This table presents summary statistics of weekly convertible bond issuance during the calendar year 2008. *$CB Proceeds* are the dollar value of all convertible bond issues ($Million). *$CB Proceeds Per Week* are the average dollar value of weekly convertible bond issuance during the period of interest. *#CB issues* are the number of convertible bond issues by firms in the sample. *Convert Proceeds/Total Issuance* is the weekly average of the dollar value of all convertible bond issues divided by the dollar value of all convertible, straight debt, and equity issues in the Securities Data Corporation New Issues database. *Fraction Zero Issuance Weeks* is the number of weeks with zero convertible bond issuance divided by the number of weeks in the sub-period. Panel A provides summary statistics for all firms; Panel B gives summary statistics for financial firms only. Troubled Asset Relief Program (TARP) allocations are given in Panel C. TARP allocations are as reported in: United States Department of the Treasury, January 6, 2009, "Section 105(a) Troubled Assets Relief Program Report to Congress." Weeks are from Sunday through Saturday. Based on this definition, there are 53 weeks in 2008, with Week

Relevant Date Ranges and Short Selling Policies:
(1) July 15: SEC announces that naked shorting is prohibited for 19 financial stocks, beginning July 21. Ban expired Aug 12.
(2) September 19: SEC announces short selling ban for 799 stocks, effective immediately. Ban expired October 17.
(3) October 14: Troubled Assets Relief Program (TARP). Equity infusions in first group of banks began October 28.

	Full Year	Sub- Periods				
	Jan 1 - Dec 31	Jan 1 - July 19	July 20 - Aug 9	Aug 10 - Sept 20	Sept 21 - Oct 18	Oct 19 - Dec 31
Number of Weeks	**53**	**29**	**3**	**6**	**4**	**11**
Panel A: All Firms						
$ CB Proceeds ($M)	$33,302.4	$27,382.2	$2,992.9	$1,810.8	$60.0	$1,056.5
$ CB Proceeds/Week	$628.3	$944.2	$997.6	$301.8	$15.0	$96.0
# CB Issues	107.0	81.0	8.0	9.0	1.0	8.0
# CB Issues/Week	2.0	2.8	2.7	1.5	0.3	0.7
Convert Proceeds/Total Issuance	0.04	0.03	0.05	0.10	0.00	0.02
Fraction Zero Issuance Weeks	0.25	0.10	0.00	0.17	0.75	0.55
Panel B: Financial Firms						
$ CB Proceeds ($M)	$13,225.00	$12,265.00	$900.00	$0.00	$60.00	0.00
$ CB Proceeds/Week	$249.53	$422.93	$300.00	$0.00	$15.00	0.00
# CB Issues	18.00	15.00	2.00	0.00	1.00	0.00
# CB Issues/Week	0.34	0.52	0.67	0.00	0.25	0.00
Fraction Zero Issuance Weeks	0.70	0.52	0.67	1.00	0.75	1.00
Panel C: TARP						
TARP Allocations		0.0	0.0	0.0	0.0	$227,614
TARP Allocations per week		0.0	0.0	0.0	0.0	$20,692

Table 6

Supply Shock Analysis: Impact of Short Sales Restrictions on Convertible Bond Issuance

This table presents results of a regression of weekly convertible bond issuance on contemporaneous issuance of straight debt and equity, as well as dummy variables indicating short sales restrictions. The analysis is based on calendar year 2008. The dependent variable is *Convertible Proceeds* , the (log) sum of all proceeds of convertible bonds issued in the current week.

Explanatory variables are: *Other Proceeds* , the (log) sum of all proceeds of equity and straight debt issued in the current week; *Fin19* , a dummy variable equal to one if the U. S. Securities and Exchange Commission's (S.E.C.'s) ban on naked short selling in 19 financial stocks is in effect during week *t* (July 20-Aug 9); *ShortBan* , a dummy variable equal to one if the S.E.C.'s ban on short selling in 799 stocks is in effect during week *t* (Sept 21-Oct. 18). *Other Proceeds TARP* is the (log) sum of all proceeds of equity and straight debt, as well as TARP allocations during week *t* . Weeks are from Sunday through Saturday. Based on this definition, there are 53 weeks in 2008, with Week 0 beginning Tuesday, January 1 and ending Saturday, January 5. Panel A presents regression results for all firms in the sample. Panel B presents results for financial firms only.

*, ** and *** denote 10%, 5% and 1% significance, respectively.

Panel A: All Firms	**Model 1**		**Model 2**		**Model 3**		**Model 4**	
CONVERTIBLE PROCEEDS	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**
Intercept	-6.277**	(-2.22)	-5.867**	(-2.01)	-0.754	(-0.19)	-0.226	(-0.06)
Other Proceeds$_t$	1.165***	(3.90)	1.012***	(3.14)				
Fin19$_t$	1.753	(1.20)	1.539	(1.05)	2.129	(1.30)	1.645	(1.03)
ShortBan$_t$	-3.482***	(-2.72)	-3.075**	(-2.37)	-3.384**	(-2.33)	-2.806**	(-1.98)
Convertible Proceeds$_{t-1}$			0.189	(1.44)			0.318**	(2.33)
Other Proceeds TARP$_t$					0.558	(1.36)	0.348	(0.82)
Adj-RSq. (%)	30.72		33.08		12.52		20.18	

Panel B: Financial Firms	**Model 1**		**Model 2**		**Model 3**		**Model 4**	
CONVERTIBLE PROCEEDS	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**	**Coeff.**	**t-stat**
Intercept	-1.606	(-1.41)	-8.666***	(-2.71)	-11.212***	(-2.88)	-8.827**	(-2.15)
Other Proceeds$_t$	0.423***	(3.26)	1.082***	(3.10)				
Fin19$_t$	-0.087	(-0.05)	-0.032	(-0.02)	0.411	(0.26)	0.305	(0.20)
ShortBan$_t$	-0.129	(-0.09)	-0.523	(-0.40)	-0.213	(-0.15)	-0.109	(-0.08)
Convertible Proceeds$_{t-1}$			0.202	(1.47)			0.280**	(2.08)
Other Proceeds TARP$_t$					1.345***	(3.38)	0.428**	(2.44)
Adj-RSq. (%)	13.47		24.65		14.63		19.47	

Table 7
Dynamics of Convertible Bond Proceeds and Hedge Fund Flows

This table reports regression results of convertible bond proceeds and hedge fund flows on convertible bond and hedge fund characteristics. The dependent variable in Panel A is *log Proceeds* , the (log) sum of all proceeds of convertible bonds issued in the current month. The dependent variable in Panel B is *Flow*. *Flow* is defined as the total monthly dollar flow into convertible bond arbitrage hedge funds, divided by total assets in the prior month.

Excess Return is defined as the asset-weighted monthly convertible bond arbitrage hedge fund return in excess of the risk-free rate. ΔSI is constructed by summing the dollar change in short interest (SI) of all convertible bond issuers in the current issue month (short interest in issue month t minus short interest in the preceding month), divided by the total market capitalization of all NYSE and Nasdaq firms. *Underpricing* is the value-weighted monthly average model estimate for the underpricing of convertible bonds issued during the month, expressed as percentage of offering price. See the Appendix for the details and estimation of the theoretical bond pricing model. For both regressions, all t-1 measures refer to the measures in the previous month.

All variables are pre-whitened to remove the time trend. Newey-West adjusted t-statistics (with 3 lags) are in parentheses. *, ** and *** denote 10%, 5% and 1% significance, respectively.

Panel A: Convertible Bond Proceeds

	log Proceeds$_t$	**t-stat**
Intercept	-0.028	(-0.44)
Flow$_{t-1}$	7.297***	(2.83)
Excess Return$_{t-1}$	10.584**	(2.16)
ΔSI$_{t-1}$ x 10^{-4}	0.727***	(3.78)
log Proceeds$_{t-1}$	0.068	(0.53)
Underpricing$_{t-1}$	-0.413	(-0.50)
N	150	
Adj-RSq. (%)	24.46	

Table 7 (cont'd)

Panel B: Hedge Fund Flows		
	$Flow_t$	**t-stat**
	(All coefficients are x 100)	
Intercept	0.000	(0.17)
$Flow_{t-1}$	0.444***	(4.65)
Excess $Return_{t-1}$	0.052	(0.31)
ΔSI_{t-1} x 10^{-4}	-0.002	(-0.50)
log $Proceeds_{t-1}$	0.004	(1.09)
$Underpricing_{t-1}$	-0.046**	(-2.17)
N	150	
Adj-RSq. (%)	25.33	

Table 8

Dynamics of Convertible Bond Proceeds (with Supply/Demand Conditions)

This table presents regression results of convertible bond proceeds on convertible bond and hedge fund characteristics, with supply/demand conditions. The sample period is divided into periods of *Demand_Out* , *Demand_In* , *Supply_Out*, and *Supply_In* based on the changes in convertible bond underpricing and proceeds from the preceding month. The dependent variable is *log Proceeds* , the (log) sum of all proceeds of convertible bonds issued in the current month.

Flow is the total monthly dollar flow into convertible bond arbitrage hedge funds, divided by total assets in the prior month and is interacted with the *Supply/Demand_In/Out* dummies. *Excess Return* is the asset-weighted monthly return in excess of the risk-free rate. ΔSI is constructed by summing the dollar change in short interest (SI) of all convertible bond issuers in the current issue month (short interest in issue month t minus short interest in the preceding month), divided by the total market capitalization of all NYSE and Nasdaq firms. All t-1 measures refer to the measures in the previous month.

All variables are pre-whitened to remove the time trend. Newey-West adjusted t-statistics (with 2 lags) are in parentheses. *, ** and *** denote 10%, 5% and 1% significance, respectively.

	log Proceeds$_t$	**t-stat**
Demand_Out$_{t-1}$ * Flow$_{t-1}$	16.268***	(5.20)
Demand_In$_{t-1}$ * Flow$_{t-1}$	-5.563	(-1.24)
Supply_Out$_{t-1}$ * Flow$_{t-1}$	12.394**	(2.36)
Supply_In$_{t-1}$ * Flow$_{t-1}$	5.240	(1.26)
Excess Return$_{t-1}$	9.232*	(1.90)
ΔSI$_{t-1}$ x 10^{-4}	0.681***	(3.19)
log Proceeds$_{t-1}$	0.123	(0.78)
Demand_Out$_{t-1}$	-0.057	(-0.51)
Demand_In$_{t-1}$	-0.269	(-1.65)
Supply_Out$_{t-1}$	-0.065	(-0.50)
Supply_In$_{t-1}$	0.151	(1.46)
N	146	
Adj-RSq. (%)	29.09	

Table 9
Dynamics of the Ratio of Convertible Bond Proceeds to Total Issuance (with Supply/Demand Conditions)

This table presents regression results of convertible bond proceeds on convertible bond and hedge fund characteristics, with supply/demand conditions. The sample period is divided into periods of *Demand_Out* , *Demand_In* , *Supply_Out*, and *Supply_In* based on the changes in convertible bond underpricing and proceeds from the preceding month. The dependent variable is *Proceeds/Total* , the proceeds of convertible bonds divided by the proceeds of all issuance (straight debt, equity, and convertible bonds) in the current month.

Flow is the total monthly dollar flow into convertible bond arbitrage hedge funds, divided by total assets in the prior month. It is interacted with the *Supply/Demand_In/Out* dummies. *Excess Return* is the asset-weighted monthly return in excess of the risk-free rate. ΔSI is constructed by summing the dollar change in short interest (SI) of all convertible bond issuers in the current issue month (short interest in issue month t minus short interest in the preceding month), divided by the total market capitalization of all NYSE and Nasdaq firms. All t-1 measures refer to the measures in the previous month.

All variables are pre-whitened to remove the time trend. Newey-West adjusted t-statistics (with 2 lags) are in parentheses. *, ** and *** denote 10%, 5% and 1% significance, respectively.

	Proceeds/Total$_t$	**t-stat**
Demand_Out$_{t-1}$ * Flow$_{t-1}$	0.248*	(1.70)
Demand_In$_{t-1}$ * Flow$_{t-1}$	-0.184	(-1.40)
Supply_Out$_{t-1}$ * Flow$_{t-1}$	0.364**	(2.08)
Supply_In$_{t-1}$ * Flow$_{t-1}$	0.216	(1.46)
Excess Return$_{t-1}$	0.235*	(1.74)
ΔSI$_{t-1}$ x 10^{-4}	0.013**	(2.08)
Proceeds/Total$_{t-1}$	0.112	(0.84)
Demand_Out$_{t-1}$	0.001	(0.30)
Demand_In$_{t-1}$	-0.003	(-0.94)
Supply_Out$_{t-1}$	-0.004	(-0.94)
Supply_In$_{t-1}$	0.004	(1.17)
N	146	
Adj-RSq. (%)	17.21	