Convertible debt issues and convertible arbitrage – issue characteristics, underpricing and short sales

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Abstract

We study convertible bond arbitrage for the Canadian market. Convertible bond arbitrage is the combination of a long position in underpriced convertible bonds and a short position in the underlying stock. First, we find a downward pressure on cumulative average abnormal returns of the underlying stocks between the announcement and the issuance dates of the convertible bonds. This effect is strongest for equity-like convertible bonds. Second, we find that the convertible bonds are underpriced at the issuance dates, with the equity-like convertibles being more underpriced than debt-like convertible bond issues. Third, we find increased short sales for equity-like convertibles before and after the issuance dates. These short positions remain quite persistent over longer period of time, which suggests that arbitrageurs (hedgers) are more likely to be taking those positions than speculative investors. Finally, we find that in a simple convertible arbitrage setting more equity-like convertibles earned 15 percentage points higher return over a one year period than debt-like convertibles, in particular due to gains on the short position in stock.

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1. Introduction

It is well documented that convertible bonds are undervalued relative to their theoretical value (see, e.g., King, 1986, Kang and Lee, 1996, Ammann et al., 2003 and Chan and Chen, 2005). According to Lhabitant (2002), the underpricing can be explained by three reasons. First of all, the majority of the issuers are below investment grade, and this reduces their liquidity on the market. Second, convertible issues are small in size, and are hardly followed by analysts. Finally, it appears that convertibles are very difficult to price due to the complex structure of convertibles.

Convertibles combine characteristics of both straight debt and equity through a call option written on the issuing firm's equity. In a simulation experiment, Arshanapalli, Fabozzi, Switzer and Gosselin (2004) show that a convertible arbitrage strategy can be highly profitable, especially in down equity markets. A convertible arbitrage strategy usually involves a long position in a convertible security and hedged equity risk by short-selling the underlying stock. The number of stocks sold short depends on the conversion ratio, the delta of the embedded call option, and the sensitivity of delta to changes in the stock price.

Convertible arbitrage trades currently represent more than half of the secondary market trading in convertible securities (see, Lhabitant, 2002), with hedge funds as the most important player in this market. Convertible arbitrage has been one of the most successful hedge fund strategies of the end of the nineties and the beginning of 2000's. Using a survivorship free hedge fund dataset of Tass-Tremont, we find that the number of convertible arbitrage hedge funds grew from about 26 in 1994 to about 145 in May 2003. As of that moment the number of convertible arbitrage hedge funds dropped to about 126 in November 2004. In the same period the assets under management grew from about 0.7 billion in January 1994 (i.e. about 2.2% of the total assets under management in the hedge fund industry) to about 11.5 billion in May 2003 (i.e. about 2.8% of the total assets under management) and to 13.9 billion in November 2004 (i.e. about 1.9% of the total assets under management).

The average annual return over the period 1994 – 2004 was 9.40% with an annual standard deviation of 4.66%. For comparison, during the same period the average annual return of the S&P 500 was 11.68% with a corresponding standard deviation of 15.24%. This indicates that the risk-reward trade-off for the convertible arbitrage strategy was much better than that of a pure equity strategy.

Although successful in the past, convertible arbitrage strategies have shown a much weaker performance more recently. In the popular press it is often argued that the decrease in returns is related to the increased competition among hedge funds, and the lower volatility in the capital market. In this paper we argue that next to the aforementioned reasons, another more important reason for the decreasing returns is that the structure of the convertible issues has changed over time. Using a sample of convertible bond issues in the Canadian market between 1998 and 2004, we show that convertible issues are more debt-like nowadays. Using the binomial tree approach to pricing convertible bonds, as introduced by Tsiveriotis and Fernandes (1998), we show that more debt-like convertible issues induce less underpricing and therefore provide less opportunities for convertible arbitrage.

This paper contributes to the literature in the following three ways. First of all, we examine the pattern of the wealth effects between the announcement and the actual issuance date of the convertible bonds. We observe persistent downward pressure on cumulative average abnormal returns between the announcement and issuance dates. As far as we know Arshanapalli et al. (2004) is the only paper that also examines the issue day effect of convertible bonds. However, they do not distinguish between debt-like or equity-like issues nor do they examine patterns in the short positions of the underlying stock. We find that the downward effect in cumulative average abnormal returns is more pronounced for the issues that are more equity-like. Second, by using information on aggregated bi-monthly short positions on the Toronto Stock Exchange (TSX), we argue that the downward pressure on cumulative average abnormal returns is due to the activities of hedge funds or other investors that engage in convertible arbitrage strategies. Ackert and Athanassakos (2005) find a negative relationship between abnormal returns and short sales in the Canadian market in general, although this effect is diminished for the companies that have convertible bonds outstanding. We observe significant increases in the short positions of the underlying stocks after the announcement of a convertible bond issue, and the increased aggregated short position remains stable after the issue of the convertible. This indicates that hedge funds or other participants that are involved in convertible arbitrage strategies are building their position immediately after the announcement of a convertible issue. Finally, we show that convertible bond issues are more debt-like nowadays, and this could explain why the performance of convertible arbitrage hedge funds is deteriorating more recently.

The remainder of the paper is structured as follows. In Section 2 we describe in more detail the valuation model for convertible debt and present a general set-up of convertible arbitrage, as well as the role of hedge funds. In Section 3 we describe our data sample. Section 4 is devoted to the analysis of wealth effects associated with announcement and issued dates of convertible debt offerings. This is followed with the main analysis regarding the relationship between the mispricing, short sales and abnormal returns of issuers' stocks in Section 5. In Section 6 we provide some insights into the discussion regarding the reasons for the decline in convertible arbitrage returns. Section 7 concludes.

2. Valuation of convertible debt and convertible arbitrage

2.1. Convertible Arbitrage Hedge Funds

According to Lhabitant (2002), convertible arbitrage trades currently represent more than half of the secondary market trading in convertible securities. This indicates that hedge funds are a very important liquidity provider in the convertible market, since they are highly involved in convertible arbitrage strategies. The hedge fund industry has grown enormously. Hedge funds differ from mutual funds and other investment vehicles by their lack of regulation, with limited transparency and disclosure, and by their internal structure (see, e.g., Fung and Hsieh, 1997). For example, most hedge funds try to achieve an absolute return target, irrespective of global market movements, while hedge fund managers typically have incentivebased contracts. Accordingly, hedge funds have a broad flexibility in the type of securities they hold and the type of positions they take. On the other hand, investors in hedge funds are often confronted with lockup periods and redemption notice periods. Such restrictions on withdrawals imply smaller cash fluctuations, and give fund managers more freedom in setting up long-term or illiquid positions.

The non-standard features make hedge funds an interesting investment vehicle for investors with potential diversification benefits. From an investor point of view, it appears that a convertible arbitrage strategy offers a huge diversification benefit due to a low correlation between a convertible arbitrage strategy and a pure equity index like the S&P500. During the period 1994 – 2004 this correlation was about 0.126. Using a sample of Japanese convertible bonds, Agarwal, Fung, Loon and Naik (2004) show that most of the return variation in convertible arbitrage hedge fund indices can be explained by three risk factors. The implied interest rate, the implied credit spread, and the implied option price, are the three main factors that capture the return characteristics of convertible arbitrage strategies. It has to be noticed that these three components also make the pricing of convertibles complex, and that might explain the observed underpricing of convertibles.

2.2. Valuation of convertible debt

In general, a convertible bond can be considered as a bundle of a straight bond and a call written on the underlying equity. There are two theoretical approaches to valuing convertible debt. The so-called *structural models* use the value of the firm as the underlying state variable[4], while in the so called *reduced form models* the value of the firm's equity or rather the default probability is modeled as underlying state variable[5]. The reduced form models have been adopted in most of the recent literature on the pricing of convertible debt.

Grimwood and Hodges (2002) argue that the most widely adopted model among practitioners for valuing convertible debt is the one first considered by Goldman

[4] See for example Ingersoll (1977), Brennan and Schwartz (1977 and 1980), Nyborg (1996)
[5] See for example Jarrow and Turnbull (1995), Tsiveriotis and Fernandes (1998)

Sachs (1994) and then formalized by Tsiveriotis and Fernandes (1998). They use a binomial tree approach to model the stock price process and decompose the total value of a convertible bond (CB) in the equity part and the straight debt part (so-called Cash Only part of a Convertible Bond – COCB). The holder of the hypothetical COCB receives all the cash flows, but no equity flows. The value of the COCB is determined by the convertible bond price, the underlying stock price and the time to maturity, since these so-called early exercise parameters define the boundary conditions. In other words, since early call, put or conversion are possible, the stock prices (which change in time) that trigger these events represent the so-called free boundaries that affect the COCB and CB values. Since the COCB is risky, the pricing equation (Black-Scholes) must include the issuer's risk or the credit spread to account for the relevant risk. The difference between the value of the convertible bond and COCB is the payment in equity. Since the firm can always deliver its own equity, this part can be discounted using the risk-free rate. In this paper we use the methodology of Tsiveriotis and Fernandes to calculate the model prices of convertible debt issues in our sample, since this approach can take into account any call, put and conversion features of convertible debt.

2.3. Evidence of convertible debt underpricing

Convertible debt underpricing has been studied in two contexts – at the issue and following the issue of convertible bonds (Kang and Lee, 1996 and Chan and Chen, 2005) and in the cross section of convertible bonds in the market at a given point in time (King, 1986, Ammann et al., 2003, etc.).

King (1986) studies a sample of 103 U.S. convertible bond issues in 1977 and finds an average underpricing of between 3 and 4.5 percent. He finds deeply out-of-the-money convertible bonds to be underpriced and in-the-money convertible bonds slightly overpriced. Similarly, the bonds associated with lower variance in stock returns are overpriced and those with higher variance in stock returns underpriced.

Carayannopoulos and Kalimipalli (2003) report similar results as King (1986) for a sample of 434 monthly price observations between January 2001 and September 2002 for 25 non-financial issuing firms in the U.S. market. They argue that the overpricing bias for in-the-money convertibles is the result of non-optimal call policies for convertibles, where they tend to be called late. On the other hand the out-of-the money underpricing bias is supposed to indicate systematic underpricing of convertible bonds.

Ammann, Kind and Wilde (2003) investigate the pricing of convertible bonds in the French market in the period between February 1999 and September 2000. On a daily data for a sample of 21 convertible bonds they incorporate the credit risk using the approach of Tsiveriotis and Fernandes (1998). They document an average 3 percent underpricing of convertible bonds in their sample. For other models, which they do not report in detail, they document underpricing in the range of 5.6 to 8.7 percent. Similarly to previous studies they find underpricing to decrease in moneyness and to increase in maturity. Amman et al. conclude that the mispricing can to a certain degree be attributed to the illiquidity in the convertibles market.

Chan and Chen (2005) investigate pricing on a sample of 107 U.S. convertible bond issues in the period from May 1999 to August 2003. Contrary to previous studies they investigate pricing at and subsequent to the issue of convertible bonds. They find underpricing at the issue of around 8 percent, being higher for the issues that have a higher probability of renegotiation or default on some of the covenants. They argue that actual prices converge to their theoretical prices within the first 500 weekdays for convertible bond issues of firms that do not experience rating downgrades. This means that underpricing is mostly limited to the seasoning process and imminent financial distress of the issuer.

Kang and Lee (1996) analyze the excess returns on a sample of 91 new convertible bond issues in the U.S. market in the period between 1988 and 1992. They compute initial raw returns of convertible bonds at the first day of public trading by comparing the closing market price to the offer price of the convertible bond. They find 1.31 percent mean initial raw return and 1.11 percent mean excess return over the benchmark index (Merrill Lynch Convertible Bond Index). The ex ante uncertainty about the market clearing price of a new issue, proxied by the age of the firm, and volatility of the stock returns prior to the issue announcement, are found to affect the degree of underpricing, as younger companies experience more underpricing. In addition to this determinant of underpricing, typically put forward in the IPO literature, Kang and Lee also investigate the effect of risk associated with the debt and equity component on the underpricing. They only find support for the equity component risk, which, measured by the company's beta, positively affects the degree of underpricing. They interpret their results in line with differential information models, which state that the degree of underpricing depends on the information available to the market. According to those models, equity IPO underpricing should be the highest, as the market has the least amount of pricing-related information available for those. SEOs and straight debt offerings should exhibit the least underpricing, as previous security prices are known or not required for the pricing. In the case of convertibles, positive excess returns, as argued by Kang and Lee, can be considered as a premium for the estimation risk regarding the value of the equity component. Similarly to the evidence of Chan and Chen (2005), Kang and Lee show that initial underpricing dissipates (relative to the benchmark portfolio) after 250 trading days. They argue that this is due to the improved information and decrease in estimation risk.

2.4. Convertible arbitrage

The classical convertible arbitrage involves a long position (purchase) in a convertible bond and a short position (sale) in the underlying stock. Similar results can be achieved by warrant hedging (long position in warrant, short position in underlying stock), reverse hedging (short position in warrant, long position in underlying stock), capital structure arbitrage (a technique aimed at exploiting pricing inefficiencies in the capital structure of the firm), and other techniques (Calamos, 2005). In this paper we focus on the classical convertible arbitrage, since we explore the relationship between pricing of convertible bonds, short sales and wealth effects associated with the issue of convertible debt.

The beginnings of convertible arbitrage, albeit not as refined and computationally sound as today, go as far back as to the second half of the nineteenth century, when convertible securities were already being issued (Calamos, 2005). The “arbitrage” setup at that time was based on the same principle as today, taking the long position in bonds and short position in underlying stock.

As already mentioned, in order to establish an arbitrage position, a certain amount of stock has to be sold short. The amount is a function of the conversion ratio (number of stocks into which the convertible bond converts), the sensitivity of the convertible bond price to changes in the price of underlying equity (the so-called delta measure), and the sensitivity of the delta measure to changes in the price of underlying equity (the so-called gamma measure).

The delta is defined as the change in the value of the convertible bond due to the change in the value of the underlying equity. This delta is derived from the option pricing model of Black and Scholes (1973), adjusted for continuous dividend payments in the way suggested by Merton (1973):

$$\text{delta}=\frac{\partial \text{CB}}{\partial \text{S}} \qquad (1)$$

$$\Delta = e^{-\delta(T-t)} \cdot N\left[\frac{\left(ln\left(\frac{S}{X}\right)+\left(r-\delta+\frac{\sigma^2}{2}\right)\cdot T\right)}{\sigma\cdot\sqrt{T}}\right] \qquad (2)$$

S is the current price of the underlying stock, X is the conversion price, δ is the continuously compounded dividend yield, r is the continuously compounded yield on a selected “risk-free” bond, σ is the annualized stock return volatility, T is the initial maturity of the bond and N(.) is the cumulative standard normal probability distribution. The delta measure always takes value between 0 and 1. Values closer to 1 indicate a high sensitivity of the convertible bond value to the underlying equity (stock) value, implying a high probability of conversion.

Convertible arbitrage provides cash inflows from coupon payments, which are enhanced with the short interest credit from the short stock account; while dividend payments on shorted stock represent cash outflows (this is also the reason why non-dividend paying stock is more desirable). In addition, if, at the time of the arbitrage setup, the convertible bonds are underpriced, there is a potential for arbitrage profits.

The hedge ratio and the convertible arbitrage setup are time varying, since they depend on the stock price. When the stock price approaches the conversion price, the delta of a convertible bond increases, since the bond becomes more equity-like (e.g. the price of the bond becomes more sensitive to the changes in the value of the underlying equity). This means that more stock needs to be shorted in order to maintain the neutral hedge ratio, which is defined as a product of the conversion ratio and delta. The opposite holds if the stock price goes down.

As stated in Calamos (2005), convertible arbitrageurs in general look for convertible bonds that are more equity-like (have high volatility, which translates into a higher value of the equity option, a low conversion premium and a high gamma), stocks that pay low or no stock dividend, stocks that are undervalued, liquid and stock that can be easily sold short. Additionally, zero coupon convertible bonds or so-called LYONs (Liquid Yield Option Notes[7]) are said to be less desirable for convertible arbitrage per se, as they do not pay coupons and therefore lack coupon component of cash inflows. For the purpose of this paper we only look into a simple (stylized) setup for convertible arbitrage, where a neutral hedge ratio is determined with the delta measure. We ignore any higher "greeks" or moments in sensitivity of the convertible bond value with respect to changes in the value of the underlying equity. This provides us with the simple and intuitive framework for analyzing the relationship between underpricing, convertible arbitrage and wealth effects associated with the issue of convertible debt.

[7] LYONs are zero coupon convertible bonds that are also callable and putable.

3. Data

We investigate the convertible debt issues in the Canadian market between 1998 and 2004. Data regarding the issues and their characteristics is obtained from the SDC New Issues database and prospectuses of the issuers (available on the SEDAR web site[8]). Data on stock and bond prices, market indices, government bond yields, dividends, number of shares outstanding and convertible bond prices is obtained from Datastream. Data on short interest (short sales) was obtained from TSX. TSX provides the information on consolidated short positions for stocks traded on TSX and TSX Venture exchanges twice a month (every 15th and the last day of the month), as reported by brokers. The data on consolidated short positions provides us a unique opportunity to examine patterns in the number of stocks sold short of the underlying equity of a convertible issue immediately after announcing or issuing the convertible. Furthermore, short sales are not allowed in many markets. Moreover, short sales in the Canadian market are supposed to be easier (less limitation) and less costly to execute than in the U.S. market for example, especially for the stocks of the companies with options or convertible bonds outstanding. This makes Canadian market particularly suitable setting for the investigation of short sales.

3.1. Sample selection

As mentioned, we have obtained the data on convertible bond issues in the Canadian market between 1998 and 2004 from the raw SDC New Issues dataset as the basis for our sample formation. In total, there were 88 new public convertible bond issues denominated in Canadian Dollars and issued registered in SDC during that period. Next, we excluded all exchangeable bonds[9] and zero coupon bonds and also imposed the requirement that announcement and issuance dates (completion of the offer) were verifiable in company announcements and prospectuses on the SEDAR web-site or in Lexis Nexis. These requirements reduced our sample to 72 convertibles. Finally, all our bonds in the sample should have stock price and bond price data

[8] The SEDAR stands for "System for Electronic Document Analysis and Retrieval" and is a service of CSA (Canadian Securities Administration) providing public securities filings. (http://www.sedar.com/)
[9] Exchangeable bonds are bonds that are convertible into some other asset than the (equity) stock of the issuing company.

available on Datastream, as well as all the details of the issue provided in the prospectus. This has left us with a final sample of 61 convertible bond issues.

In Table 1 we present descriptive statistics for the sample, broken down by year of the convertible bond issue. In the table we can observe that changes in volatility and delta over time closely correspond. In particular, the average values of delta have decreased over time, from 0.58 in 1998 to 0.14 in 2004. This implies that, according to the delta measure, at the beginning of our sample period the average issue was much more equity-like than at the end of our sample period. At the same time the average volatility of the issuer's stock price also decreased from 0.48 in 1998 to 0.2 in 2004. Another interesting observation is the average dividend yield, which was between 3 and 4 percent in the years 1998 and 2001, corresponding to the years that also observe more equity-like convertible issues (average delta of 0.58 and 0.61 respectively). In contrast, the average dividend yield increases to more than 9 percent in 2003 and 2004, corresponding to the average delta of 0.21 and 0.14 respectively. The average maturity of the issues is rather constant at around 6 years. The size of the issues on the other hand exhibits some variation, ranging from around 30 million Canadian Dollars in 1999 to about 100 million Canadian Dollars in 2003. Towards the end of the sample period there are no extremely small issues as for example in 1998 (3 million Canadian Dollars) or 2001 (7 million Canadian Dollars).

<Insert Table 1 here>

Given these differences in time we argue that issue characteristics or rather universe of issuers has changed in time. One might of course claim the opposite, namely that the decrease in market volatility caused the decrease in the delta by construction of the delta measure. In other words, it is not because of the changed characteristics of the issue that we observe lower delta values, but rather because of the overall market-wide decrease in volatility. Although we conceive that overall volatility in the market has declined after 2000, we believe that changes in dividend yield, issue size and conversion premium provide enough evidence to substantiate our premise. As already shown, the average dividend yield increased over time.

Typically, companies in more mature industries pay higher dividends or even pay any dividends at all. These are also less risky companies (lower volatility) with more stable cash flows and fewer growth opportunities. It has been shown previously that such companies are more likely to issue debt-like convertibles (see for example Lewis et al., 1999) similarly as they would be more likely to issue straight debt than equity. Additionally we have investigated conversion premiums, defined as a difference between conversion price and stock price at the issue relative to the stock price. Conversion premiums are inversely related to the conversion ratio. Higher conversion ratios (lower conversion premiums) indicate more equity-like convertibles (Kim, 1990) and vice-versa, since a convertible bond with a lower conversion premium is more likely to become in-the-money (all else equal) and be converted into equity. The conversion ratio (or conversion price) on which conversion premium depends is the only parameter in Equation 2 which companies can arbitrary choose. The average conversion premium in our sample of convertible bonds has declined from 0.21 in 1998 to between 0.12 and 0.11 in 2003 and 2004 respectively. This indicates that issuers tried to offset the effect of lower volatility by lowering the conversion premium as convertibles would be even more debt-like otherwise. We see this as an additional evidence that the universe of issuers (other characteristics of issues) that changed over time had an important impact on the delta measure.

4. Wealth effects between the announcement and issue of convertible bonds

We first investigate shareholder wealth effects related to the periods between announcement and more importantly the issuance dates of convertible debt issues. Previous literature[10] on the wealth effects typically focuses on a short event window around the announcement and / or issue dates. In contrast to that, we investigate the wealth effects between the announcement and issue dates of convertible debt issues, as we are interested in the evolution of abnormal returns during this period, and the pattern in the short positions of the underlying stocks.

[10] For the summary of previous empirical research on announcement effects see Loncarski, ter Horst and Veld (2006).

In Figure 1 we present the cumulative average abnormal returns related to the announcement (first plot) and issuance date (second plot) of convertible debt issues. The wealth effects are presented for split subsamples according to the delta measure, where a delta higher than 0.5 denotes more equity-like issues and a delta lower than 0.5 denotes more debt-like issues. On average, the time between the announcement and issuance date is around 19 trading days (or approximately one calendar month).

<Insert Figure 1 here>

The first thing that can be observed in both plots in Figure 1 is the downward pressure on the cumulative average abnormal returns (CAAR) between the announcement date (this is between days -20 and -15 relative to the issuance date) and the issue date. The second and even more important observation is the fact, that this effect is more pronounced for more equity-like convertibles. Next, the inspection of the first plot shows that the large negative wealth effect of around 6 percent associated with the announcement of the equity-like convertible bond issues is absorbed by the market quite instantaneously, within one to two days following the announcement. However, there is an additional downward pressure in CAAR of around 4 percent following the absorption of the announcement effect. Finally, the investigation of the second plot, where time equal to zero denotes the issue date, reveals that CAAR rebound after the issue, offsetting the prior negative effect within the following month.

<Insert Table 2 here>

In Table 2 we present results of standard tests for statistical significance of CAAR, where under the null CAAR equals zero. The wealth effects are significantly negative in the period between the announcement and the issuance date of issues. Equity-like convertible issuers experience around 5 percent negative CAAR in the 15 day period leading to the issue date versus less than about 1 percent negative CAAR for debt-like convertible issuers. The difference is significant for the window (-20,0), where some announcement date effects can still be included. For the later dates, in particular windows (-18,0) and (-15,0), the difference is marginally significant. It seems that most of the wealth effect or the downward pressure on the CAAR is concentrated in the time up to 10 calendar days before the issue (this is five to eight days after the issue announcement). Finally, the downward pressure trend on the CAAR reverses in ten to fifteen days after the issue. The more equity-like convertibles issuers experience on average a significant 1.5 percent positive CAAR in the period of 15 to 20 days after the issue, while this effect is smaller for the more debt-like convertible bond issuer (0.6 percent).

These results are in line with the findings of Arshanapalli et al. (2004), who investigate announcement and issue date wealth effects for a sample of 229 convertible issues in the U.S. market in the period between 1993 and 2001. Arshanapalli et al. document a significant negative CAAR of 3.8 percent in the period of five days before the convertible bond issue. This negative effect is only limited to a period of a few days around the issue date. Similarly to our findings, they also document the rebound in returns following the issue date. Note that they do not investigate the whole period between the announcement and the issue date and do not differentiate between more equity-like and more debt-like convertibles.

5. (Under)Pricing of convertible bonds and short sales

5.1. Pricing of convertible bonds

As mentioned in Section 2.2, we have used the valuation approach suggested by Tsiveriotis and Fernandes (1998). In order to calculate the theoretical (model) price of a convertible bond we have used the following inputs. For the risk-free rate we have used the yield on government bonds (Canadian) of comparable maturity as the convertible bond. Static spread corresponding to the credit risk of the issue is used to accommodate for the credit risk of the issue. Where the data on credit risk was not available, we have assumed that the company was of the BBB risk[11]. In Datastream, only Scotia Capital provides Canadian corporate bond benchmarks for different maturities and different credit ratings. They cover BBB, A and AA rankings of short, medium and long term. Based on the maturities we have extrapolated the following maturities: 1 year (equivalent to short term), 3 years (between short and medium term), 5 years (medium term), 7 years (between medium and long term), 10 years and more (long term). Based on the rankings, we also extrapolated the rankings lower than BBB (BB and B) by adding a spread to BBB. This spread is relative to the spread between BBB and A, but is relatively increasing in lower credit quality and maturity. The price of the underlying stock at the valuation date was taken from Datastream, where we took the average stock price between days -12 and -2 relative to the announcement date of the issue. With respect to the number of steps in the tree, we took a number of months to maturity. Coupon rate, number of coupons per year, conversion ratio and call schedules were obtained from prospectuses. With respect to dividend information, we have assumed a constant dividend yield.

In Table 3 we present the summary statistics for mispricing, based on both the trading and offer prices, and a ratio between equity and debt components. Misp is the mispricing based on the trading price, mispo is the mispricing based on the offer price and mispto is the mispricing computed as the relative difference between the trading price and the offer price. The mispricing is computed as:

$$\text{misp}_t = \frac{\left(\text{model price}_t - \text{trading price}_t\right)}{\text{trading price}_t} \tag{3}$$

or

$$\text{mispo}_t = \frac{\left(\text{model price}_t - \text{offer price}\right)}{\text{offer price}} \tag{4}$$

or

[11] We have also computed model prices by taking the lowest possible credit quality for the issues with no credit risk information available. The mispricing was on average somewhat lower, but it did not affect the results significantly. The calculations are available upon the request.

$$\text{mispto}_t = \frac{(\text{trading price}_t - \text{offer price})}{\text{offer price}} \quad (5)$$

The model price at time t represents the price computed using the binomial tree approach to convertible bond valuation as previously described. Trading price denotes the market price of a convertible bond at time t and offer price represents the price, at which the issue was initially offered to investors at time of subscription.

Based on the model and observed prices at the issuance date and offer prices obtained from the SDC New Issues database, we have computed the two mispricing measures at one point in time, at the issuance date. In addition, we have also computed the ratio between estimated equity and debt components. Similarly as the delta measure, this ratio indicates, whether the issue is more equity or more debt like, as one can expect the ratio to be significantly higher for the convertible debt issues that are more equity-like compared to more debt-like convertible bond issues.

<Insert Table 3 here>

In Table 3 we present the descriptive statistics for the mispricing measures, delta and equity-to-debt component ratio. In the whole sample the convertible bonds exhibit significant underpricing (the model price is on average higher than the observed trading price) by around 10 percent (see Panel A). As expected, the underpricing is significantly higher for more equity-like convertibles (delta>0.5) than in the case of more debt-like convertibles (delta<0.5) by about 20 percentage points (see Panel D). The same conclusion can be reached with respect to the other measure of mispricing where, instead of the trading price, the offer price is used to calculate the mispricing. The offer price is the price at which the convertible bond issue was offered to the public in the subscription process (as reported in the SDC database). As expected, the equity-to-debt component ratio is significantly higher in the case of more equity-like convertibles. This implies that the delta measure appropriately captures the equity vs. debt-likeness characteristic of a convertible bond issue. Finally, the mispricing measure mispto, which is defined as a difference between the first trading price and the offer price relative to the offer price, shows that the underpricing is not significantly different from zero in total and both sub-samples.

Next we investigate the distributions of mispricing measures. Figure 2 shows kernel density estimations (distributions) for different mispricing measures based on the observed prices (the first trading prices) and offer prices for the split samples according to the delta measure. The first plot in Figure 2 is a distribution estimate for mispricing as defined in Equation 3, that is the relative difference between model price and the first trading price. As can be observed, the mispricing is higher for the more equity-like convertibles (as we already established based on the summary statistics in Table 3) and more importantly it is also more widely dispersed and more equally distributed around its mean of 0.239. Contrary to that, the more debt-like convertibles exhibit a lower degree of underpricing, which is mostly concentrated around its mean.

<Insert Figure 2 here>

The second plot in Figure 2 shows a distribution estimate for mispricing as defined in Equation 4, that is the relative difference between the model price and the offer price. Conclusions based on this plot are almost identical to the ones based on the first plot. The mispricing (underpricing) for more equity-like convertible bond issues is on average higher than for debt-like convertibles, with more variation to it.

Finally, the third plot in Figure 2 shows distribution estimate for mispricing as defined in Equation 5. The distributions of this measure for subsamples of more equity and debt-like convertibles are quite similar, which suggests very little difference on average between the first trading and offer price.

So far we have established that convertible bonds in our sample seem to be underpriced. This result is in line with the previous literature on underpricing (see for example Chan and Chen, 2005 and others) at the issue. Moreover, we have shown that the underpricing is higher for the more equity-like convertibles.

Next, we look into the correlations for the whole sample between different measures of mispricing, the equity-to-debt component ratio and the delta measure. These are shown in Table 4.

<Insert Table 4 here>

In Table 4 we observe that the delta measure and the equity-to-debt component ratio are significantly positively correlated with a correlation coefficient of 0.37. More importantly, we observe that the delta measure and the equity-to-debt component ratio, which relate to the characteristics of convertible debt issues, are significantly positively correlated with both mispricing measures, with a correlation coefficient of around 0.76 for the measure based on the comparison between the model and the trading price and a coefficient of 0.66 for the measure based on the comparison between the model and the offer price. This provides further evidence that more equity-like issues, which have both a higher delta and equity-to-debt component ratio than more debt-like issues, are more mispriced (underpriced). This supports the idea that the higher the delta, the larger the equity component of the convertible issue compared to the debt component, which makes the issue more difficult to value. In addition, the mispricing measure based on the comparison between the first day trading price and the offer price is not significantly correlated with the delta measure. This suggests that mispricing at the first trading date, compared to the offer price, does not depend on the structure of the issue. However, it is significantly negatively correlated with the other mispricing measure, which compares model price to the trading price. It seems that different factors affect these two mispricing measures.

Given the CAAR plot of the announcement effects between the announcement date and issuance date in Figure 1, we have speculated that the CAARs could be related to the activity of investors (hedge funds) that engage in convertible arbitrage. First, we present some indirect evidence for that. A significant negative relationship between mispricing and CAARs, in particular for those between the announcement date and up to the issuance date (+10 to 20 trading days on average after the announcement), would give some support to the hypothesis. To investigate that, we run regressions between cumulative average abnormal returns for different event windows and mispricing measures.

<Insert Table 5 here>

In Panel B of Table 5, the regression results for different CAAR dates and mispricing estimates based on trading prices at the issuance date are presented. The table shows that mispricing is significantly negatively associated with cumulative average abnormal returns for all different windows after announcements of convertible debt issues. We see this as indirect evidence to support our premise that convertible arbitrage activities of investors (in particular hedge funds) might cause the downward pressure on the CAAR. The economic impact of mispricing here is also quite significant. For example, an increase in mispricing by 10 percentage points (one standard deviation of the whole sample) leads to an increase in the negative CAAR of around 2.2 percentage points in the event window (0,18).

In Panel A of Table 5 the model statistics are presented. Based on the results, we conclude that mispricing has some explanatory power with respect to the CAAR, as it explains around 12 percent of the variance of CAARs in the period between the announcement and issuance dates of convertible bond issues.

Finally, we investigate mispricing of the convertible bond issues during the first year of trading. Volatility estimates are based on a rolling window sample of the past 250 trading days, delta is estimated for every individual trading day, as well as risk free rate and spread. Stock prices are matched to every individual trading day as well. We used constant dividend yields, computed as the average dividend yield of the past 250 trading days.

<Insert Figure 3 here>

In Figure 3 we present the degree of mispricing for the sub-samples of equity-like and debt-like convertible bonds. Firstly, as before we observe that mispricing is much higher for the equity-like convertibles than for debt-like convertibles over the longer period following the issue of the bond. Secondly, we see that mispricing on average declines in the first 15 trading days following the issue, with a decline of about 7 to 8 percentage points in the case of equity-like convertibles and about 3 percentage points in the case of debt-like convertibles. Interestingly, it increases afterwards for debt-like convertibles and remains at 5 percent, while in the case of equity-like convertibles shows slight downward trend. In the first 15 trading days the decreases in mispricing also coincides with the largest trading volume (demand) of convertible bonds (not reported here).

In Figure 4 we present the degree of mispricing based on the comparison between trading prices and reported offer prices for the convertible bonds.

<Insert Figure 4 here>

From Figure 4 we firstly observe that on average both equity- and debt-like convertibles are underpriced compared to the offer price at the issue. Following the issue, the degree of (offer) mispricing increases for both types of convertibles bonds. Secondly, this increase occurs during the first 15 trading days, similary as mispricing diminishes during the same period if the model and trading prices are compared, since market prices of convertible bonds increase. In the first 15 trading days for example, prices of the equity-like convertibles increase by about 5 percent compared to the offer price, while the increase is between 2 and 3 percent for the more debt-like convertibles. The "offer price" mispricing peaks to about 7 percent for equity-like convertibles in 25 days after the issue and after 100 days starts declining and becomes negative in half a year after the issue due to sharp decline in convertible bond prices. Contrary to that, prices of debt-like convertibles steadily increase.

We find mispricing developments during the initial trading period particularly important for our analysis, as it shows that convertible bond prices are mispriced at the issue. The mispricing does decrease immediately following the issue, but remains present over longer period of time afterwards. This suggests that major activities related to convertible arbitrage take place closely around the issue date.

So far, we have shown that more equity-like convertible bond issues are more underpriced and exhibit more negative cumulative average abnormal returns. Since more underpriced issues are potentially more profitable candidates for convertible arbitrage, we believe that this provides evidence that convertible arbitrage activities further negatively affect cumulative average abnormal returns between announcement and issuance dates of convertible debt issues. Next we turn to evidence based on short sales.

5.2. Short sales and underpricing

One of the basic principles of convertible arbitrage is to short sell the underlying assets (stock) of the convertible bond, while purchasing the convertible bonds at the same time. If short selling activities of the underlying stock increase at and after the announcement of convertible bond issues compared to levels before the announcement, this can be interpreted as additional (and more direct) evidence that convertible arbitrage strategies are affecting the cumulative average abnormal returns between the announcement and issuance dates of convertible bond issues.

For the purpose of investigating the relationship between short sales, characteristics of the issue, mispricing and cumulative average abnormal returns, we define a relative measure of short sales as a ratio between the short interest in a given period and potential number of shares that are to be issued if the convertible bond issue is converted into shares[12]. In Table 6 we present the summary statistics for both the level of relative short sales and changes between consecutive periods.

<Insert Table 6 here>

[12] We have also investigated the second relative measure of short sales defined as a ratio between the short interest in a given time period and the corresponding total number of shares outstanding. The results, which are available upon the request, are very similar and downscaled only.

With respect to the summary statistics for the measure of a level of short interest (Panels A and B in Table 6), we observe that in the case of more equity-like issues the average short interest increases from around 4.5 percent just before the announcement of the issue to 25 percent of the new potential shares issued in 4 weeks following the announcement date. In the case of more debt-like convertibles the mean relative short interest increases slightly from around 9 percent prior to the announcement to 11 percent following the announcement. It declines back to around 9 percent of the new potential shares issued in 4 weeks following the announcement. The difference at AD+1 (approximately two weeks after the announcement of the issue) is statistically significant at the 5 percent level. The difference continues to increase up to the three months following the announcement to about 29 percentage points and then declines to about 18 percentage points after 8 months following the issue announcement (as shown in Panel C). Even after 12 months following the issue, the mean relative short interest for equity-like convertible issuers is higher by around 15 percentage points compared to the short interest of debt-like issuers.

In Panels D and E results for the changes in short interest between consecutive periods are presented. These are again based on the short interest relative to the potentially newly issued shares in case of full convertible issue conversion into equity. From these results we conclude that the highest increase in the short interest for the equity-like convertibles is in at the announcement of the issue and the immediate subsequent period (average increase of 6.3 and 9.7 percentage points respectively). This is followed by a more moderate increase in a period between two weeks and one month after the announcement (just prior to the issue) of around 5 percentage points. Afterwards, the short interest keeps increasing, but at the lower pace of between 2 to 3 percentage points relative to the issue size per two weeks. Contrary to that, companies that issue debt-like convertibles experience an average 1.7 percentage point increase in short positions just after the announcement of the issue and 2 percentage points (complete off-set) decline just after the issue of the bond (AD+3).

In Figure 5 we present mean (first plot) and median (second plot) values of relative short interest in time, based on the potential number of newly issued shares as the denominator. We observe that after the announcement short interest gradually increases for more equity-like convertibles and remains almost unchanged for more debt-like convertibles. This corresponds to previous evidence on mispricing and characteristics of convertible bond issues. Moreover, the persistence in the level of open short positions indicates that investors who take the short position do so over the longer period of time, which is consistent with investors that engage in convertible arbitrage rather than investors that short the stock since they perceive it to be overvalued. If indeed this latter group of investors was shorting the stock, we would observe a decline in short positions after the stock price or rather abnormal returns rebound after the initial downward pressure between the announcement and the issue dates. However, this is not the case, as can be observed from both plots in Figure 5.

<Insert Figure 5 here>

We interpret this as a more direct evidence of convertible arbitrage activities subsequent to the announcements of convertible bond issues. Furthermore, we look into the correlations between mispricing and relative short interest. The results are presented in Table 7.

<Insert Table 7 here>

The results in Table 7 suggest that two different mispricing measure are differently related to the short interest. Mispto measure, which measures mispricing between the first day trading price and offer price is significantly positively related to short interest in a period between the announcement of the offering and the issue date. The second mispricing measure, comparing the model price to the first day trading price (misp), is significantly positively related to the level of short interest only after the issue of the bond. Here, we observe significance of the correlation coefficient immediately after the issue. First, the positive correlation is in line with our expectations, as a higher degree of underpricing (and a higher delta) induces higher relative short interest. Secondly, it seems that the mispricing has two dimensions. They seem to be negatively correlated, as we already pointed out before. The mispricing between the first day trading price and the offer price might be related to inefficiencies and risk of the subscription process, where this can be seen as a risk premia that goes to the underwriter of the issue. The second mispricing measure (comparison between the model price and the first day trading price) in our view relates to the valuation uncertainty of convertible bond and the seasoning process up to the first coupon payment of the bond (which is six months after the issue for typical semi-annual coupon bonds). While the difference between the first day trading price and the offer price seems to affect the level of short interest prior to the issue, the difference between the model price and the first day trading price affects the level of short interest after the issue. This is to say that the hedging activities, related either to the underwriting process or convertible arbitrage, seem to affect the level of short interest.

The relationship between short sales, structure of convertible bond issues and underpricing yields evidence that supports our hypothesis from the introduction. More equity-like convertible bond issues are more underpriced and thus more interesting for arbitrageurs. Since in such cases more stock has to be sold short, there is more downward pressure on cumulative average abnormal returns between the announcement date and the issuance date (and beyond). Ackert and Athanassakos (2005) demonstrate a significant negative relationship between short sales and abnormal returns in the Canadian market. They however also show that this negative relationship is mitigated when companies have options or convertible bonds outstanding. This suggests that information about short sales is evaluated on the basis of other accompanying information, especially when short sales might arise due to hedging activities.

6. Convertible arbitrage returns

The performance of hedge funds that are involved in convertible arbitrage strategies has been decreasing. Based on the figures presented in Table 8 we can observe that, apart from two setbacks in 1994 and 1998, returns on HEDG Convertible Arbitrage index have for the most part been above 15 percent. This performance has however deteriorated in later years. The popular press provides different explanations for this, ranging from stable equity markets, rising interest rates, withdrawals from funds, to increased competition in the hedge fund industry and lower volatilities in the main capital markets. Given the set-up of convertible arbitrage strategy, these factors may indeed contribute to a decreased performance. However, we believe that explanation, which is probably overlooked, may play an important role as well.

<Insert Table 8 here>

An important part of the return in the convertible arbitrage strategy represents the profit from mispricing of convertible bond issues. Here, we argue that convertible arbitrage performance may critically depend on the degree of mispricing of convertible bond issues, which has shown to be to a large extent determined by characteristics of any particular issue. In other words, equity-like convertible bonds are likely to be more underpriced than debt-like convertible bonds, as we have shown in previous sections. If the structure of the convertible bond issues changes over time from more equity-like to more debt-like, we may expect to see less underpricing and less true arbitrage opportunities for convertible arbitrage strategies.

In Table 9 we provide mean and median statistics for delta and mispricing values, broken down by the year of convertible debt issue. We do not have any issues that fulfill our inclusion criteria for the year 2000, but the numbers for the other years do provide some evidence to support our premise.

<Insert Table 9 here>

The first thing that can be observed in Table 9 is that the mispricing of convertible bond issues declined over time. We formally test this and present the results in Panel B in Table 9. Note that the difference in the average mispricing is significant if we compare 2004 with 2002 and 2001, 2003 with 2001 and 2001 with 1998. This is mostly due to the fact that average structure of convertible bond issues changed from predominantly equity-like issues in late 1990s to more debt-like issues in 2003 and 2004 (as measured by delta). We have shown in previous sections that delta and mispricing are significantly positively correlated. Secondly, this change towards more debt-like issues corresponds in time to the decline in convertible arbitrage returns in Table 8. Although we cannot provide direct evidence, since we do not have data on particular hedge fund holdings, we see this as an additional explanation for the deteriorating performance of convertible arbitrage.

Next, we look into convertible arbitrage returns in the case of our convertible bond sample. We employ the simple convertible arbitrage strategy, where we go long in one convertible bond at the issue date and short the appropriate number of underlying stock (corresponding to conversion ratio) to achieve delta neutral hedge at the issue date. We check two specifications of such portfolio. The first specification is with the short position rebate included:

$$CAP_t = \underbrace{CBp_t + AInt_t}_{\text{Convertible bond part}} + \underbrace{\Delta_0 \cdot CR \cdot S_{t-1} \cdot sitc \cdot sirr}_{\text{Short position rebate}} - \underbrace{\Delta_0 \cdot CR \cdot (S_t + Div_t)}_{\text{Stock part}} \tag{6}$$

CAP_t denotes convertible arbitrage portfolio at time t, CBp_t denotes convertible bond price at time t, $AInt_t$ denotes accrued interest at time t, Δ_0 denotes delta value of the convertible bond issue at time 0 (issue date), CR denotes conversion ratio, sitc denotes short interest coverage ratio (maintenance coverage in the short account), sirr denotes short interest rebate rate (we assume it is 75 percent of the yield on comparable government bond) per period t, S_t denotes stock price at time t and Div_t denotes dividend at time t. In this strategy we do not rebalance the short position as the delta changes over time and we also do not consider the so-called short interest rebate. Short interest rebate refers to interest paid on the share of proceeds of sale of shorted stock that needs to be kept with the broker as coverage for future delivery of shorted stock. The second specification is without the short position rebate:

$$CAP_t = \underbrace{CBp_t + AInt_t}_{\text{Convertible bond part}} - \underbrace{\Delta_0 \cdot CR \cdot (S_t + Div_t)}_{\text{Stock part}} \quad (7)$$

We compute returns on convertible arbitrage portfolios as:

$$rCAP_t = \ln(CAP_t) - \ln(CAP_{t-1}) \quad (8)$$

In Figure 6 we present the cumulative average return (buy at the issue and hold strategy) for two sub-sample of more equity-like (delta>0.5) and more debt-like(delta<0.5) convertibles for different portfolio strategies.

<Insert Figure 6 here>

From Figure 6 we observe that returns on convertible arbitrage are positive over different time periods in cases of both equity- and debt-like convertibles. In the case of equity-like convertibles convertible arbitrage earns a return of around 30 percent in one year, while in the case of debt-like convertibles this is around 18 percent. This result is driven by the very negative return on stock of around 35 percent in the case of equity-like convertibles. This, coupled with higher delta, generates the positive return difference for convertible arbitrage for equity-like convertibles. The returns on the long position in convertible bonds, although positive for the first six months (120 trading days) after the issue, turn negative after to –4 percent at the end of the first year after the issue compared to the issue date price. In the case of debt-like convertibles, which have very low delta, convertible arbitrage returns are higher than returns on convertible bond by about 2 percentage points at the end of the first year of trading. Contrary to the equity-like convertibles, the returns on convertible bonds are positive for more debt-like convertibles. These results are consistent with the returns on convertible arbitrage index presented in Table 8, where the highest returns were recorded in downward pressured or stagnating stock markets and years in which most of the issues were more equity-like (end of the nineties). Note that returns on portfolio with included short interest rebate is as expected higher with the difference of about 3 percentage points at the end of the first year of convertible bond trading in the case of equity-like convertibles. In the case of debt-like convertibles the difference between the two portfolio specifications is negligible and not visible in Figure 6.

We have also inspected the returns on convertible arbitrage portfolio with time varying delta and the results remain very much the same, as delta on average does not vary much in time.

7. Conclusion

In this paper we investigate three issues. With respect to the wealth effects associated with announcements and issues of convertible bonds we find sustained downward pressure on cumulative average abnormal returns between the announcement and the issuance date of the bond for more equity-like convertible bonds (higher delta).

Secondly, we investigate whether the activities of investors engaged in convertible arbitrage depress cumulative average abnormal returns between the announcement and issuance dates. Since hedge funds do not report their holdings, we rely on series of other evidence. Firstly, we investigate whether the convertible bonds in our sample are underpriced as previously found in other studies. Next, we investigate a link between the structure of the issue and underpricing. Finally, we investigate the effect of underpricing on short sales of the underlying stock.

The reasoning we provide is the following. The arbitrage opportunity in the convertible arbitrage strategy arises due to mispricing (underpricing) of the convertible bond. The arbitrageur has to short sell delta stock to establish the so-called neutral hedge. For more equity-like convertible bonds, which have higher delta, this means relatively higher short interest than for more debt-like convertibles. We first find that delta and underpricing are significantly positively correlated. Additionally, we show that underpricing and cumulative average abnormal returns between the announcement and issuance dates of a convertible bond issue significantly negatively correlated. Finally, we show that underpricing and relative short interest, measured as the ratio between short interest and number of potentially newly issued shares in conversion, are significantly positively correlated. In our opinion this constitutes several pieces of evidence to support our premise that convertible arbitrage activities negatively affect cumulative average abnormal returns between announcement and issuance dates. Convertible bond issues with higher delta (more equity-like) exhibit higher degree of underpricing. Higher delta of the issue and higher underpricing are significantly negatively related to the cumulative average abnormal returns and significantly positively related to short interest.

Finally, we argue that decreasing convertible arbitrage performance can also be explained by changes in the structure of convertible debt issues in time, as convertible bond issues have become increasingly more debt-like in the past several years.

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Table 1

Descriptive statistics for maturity (in years), principal size (in millions Canadian Dollars), coupon rate, delta, dividend yield, risk-free rate and volatility. Sd represents standard deviation, p25, p50 and p75 denote 25th, 50th and 75th percentile respectively.

year	variable	N	mean	min	max	sd	p25	p50	p75
1998	maturity	9	8.605	5.017	10.156	2.270	6.969	10.147	10.147
	principal	9	71.222	3.000	100.000	38.842	75.000	80.000	100.000
	coupon	9	0.071	0.053	0.100	0.016	0.059	0.070	0.080
	delta	7	0.579	0.151	0.990	0.292	0.407	0.491	0.826
	dividend yield	7	0.032	0.000	0.142	0.052	0.000	0.000	0.044
	risk free rate	9	0.058	0.052	0.073	0.006	0.057	0.057	0.060
	volatility	9	0.485	0.244	1.309	0.417	0.257	0.279	0.349
1999	maturity	3	4.438	3.003	5.211	1.244	3.003	5.100	5.211
	principal	3	31.667	25.000	40.000	7.638	25.000	30.000	40.000
	coupon	3	0.107	0.100	0.120	0.012	0.100	0.100	0.120
	delta	3	0.269	0.247	0.307	0.033	0.247	0.253	0.307
	dividend yield	3	0.133	0.101	0.185	0.046	0.101	0.112	0.185
	risk free rate	3	0.056	0.051	0.067	0.009	0.051	0.052	0.067
	volatility	3	0.350	0.235	0.533	0.160	0.235	0.282	0.533
2001	maturity	7	5.755	5.078	7.117	0.947	5.097	5.142	7.103
	principal	7	47.429	7.000	150.000	51.300	12.500	20.000	75.000
	coupon	7	0.076	0.060	0.090	0.010	0.068	0.075	0.083
	delta	7	0.614	0.152	0.899	0.331	0.156	0.757	0.882
	dividend yield	7	0.035	0.000	0.115	0.052	0.000	0.000	0.103
	risk free rate	7	0.055	0.054	0.058	0.002	0.054	0.055	0.057
	volatility	7	0.548	0.155	1.064	0.367	0.165	0.412	0.850
2002	maturity	12	5.210	5.081	5.586	0.168	5.101	5.126	5.263
	principal	12	65.667	23.000	150.000	33.722	50.000	55.000	80.000
	coupon	12	0.089	0.078	0.100	0.006	0.085	0.088	0.094
	delta	12	0.368	0.000	0.859	0.286	0.150	0.289	0.598
	dividend yield	12	0.085	0.000	0.222	0.072	0.011	0.099	0.138
	risk free rate	12	0.052	0.044	0.056	0.005	0.045	0.055	0.055
	volatility	12	0.389	0.114	0.907	0.225	0.239	0.339	0.465
2003	maturity	11	6.344	3.800	10.181	1.801	5.097	5.531	7.597
	principal	11	100.028	25.000	220.000	67.638	40.000	77.813	150.000
	coupon	11	0.078	0.050	0.098	0.014	0.068	0.083	0.090
	delta	11	0.213	0.018	0.675	0.229	0.056	0.142	0.248
	dividend yield	11	0.090	0.013	0.178	0.055	0.024	0.094	0.120
	risk free rate	11	0.048	0.041	0.054	0.005	0.042	0.051	0.052
	volatility	11	0.228	0.093	0.503	0.142	0.139	0.178	0.308
2004	maturity	19	6.729	5.072	10.275	1.954	5.214	5.575	7.175
	principal	19	71.079	30.000	135.000	28.376	50.000	57.500	100.000
	coupon	19	0.073	0.060	0.090	0.009	0.065	0.070	0.080
	delta	18	0.142	0.003	0.683	0.162	0.040	0.118	0.186
	dividend yield	18	0.111	0.000	0.182	0.049	0.084	0.101	0.159
	risk free rate	19	0.047	0.041	0.056	0.006	0.042	0.043	0.053
	volatility	19	0.200	0.130	0.426	0.066	0.143	0.197	0.224
Total	maturity	61	6.413	3.003	10.275	1.951	5.103	5.331	7.136
	principal	61	70.603	3.000	220.000	44.508	40.000	60.000	100.000
	coupon	61	0.079	0.050	0.120	0.014	0.068	0.080	0.090
	delta	57	0.321	0.000	0.929	0.297	0.072	0.188	0.598
	dividend yield	58	0.084	0.000	0.222	0.062	0.023	0.093	0.127
	risk free rate	61	0.051	0.041	0.073	0.007	0.044	0.052	0.055
	volatility	61	0.331	0.093	1.309	0.262	0.175	0.235	0.350

Table 2

Wealth effect associated with issuance dates of convertible debt issues for split subsamples according to the delta measure. The CAAR window is relative to the issuance date (issuance date = 0), bold values represent values, which are significantly different from zero, where zero denotes no effect. Difference in means is computed as one-sided test, where under null CAAR for the more debt-like convertibles (delta<0.5) are less or equal to CAAR for the mode equity-like convertibles (delta>0.5).

CAAR window		Delta < 0.5		Delta > 0.5		Difference in means	
		p-value	CAAR	p-value	CAAR	p-value	CAAR
-20	0	**0.003**	**-0.58%**	**0.000**	**-6.11%**	**0.030**	**-5.52%**
-18	0	**0.010**	**-0.49%**	**0.000**	**-4.82%**	0.066	-4.33%
-15	0	**0.000**	**-0.89%**	**0.000**	**-4.62%**	0.081	-3.74%
-10	0	**0.000**	**-0.97%**	**0.045**	**-1.49%**	0.382	-0.52%
-5	0	**0.010**	**-0.37%**	0.080	-1.25%	0.270	-0.88%
-2	0	0.286	-0.08%	0.189	-0.70%	0.293	-0.62%
0	1	**0.000**	**-0.60%**	0.301	-0.42%	0.615	0.18%
0	3	0.278	-0.11%	0.446	0.09%	0.580	0.20%
0	5	0.277	0.10%	0.129	-0.93%	0.237	-1.03%
0	10	0.101	0.27%	0.498	0.00%	0.439	-0.26%
0	15	**0.003**	**0.59%**	**0.048**	**1.24%**	0.387	0.65%
0	20	0.217	0.17%	**0.031**	**1.57%**	0.360	1.40%

Table 3

Descriptive statistics for delta, different measures of mispricing (denoted misp, mispo and mispto) and equity-to-debt component ratio (denoted ed). Sd represents standard deviation, cv represents coefficient of variation, p25, p50 and p75 denote 25th, 50th and 75th percentile respectively. *** - denotes significance at level below 1 percent; ** - denotes significance at the level below 5 percent. Under the null means are equal to zero.

Panel A: Total sample of issues

variable	N	mean	min	max	sd	cv	p25	p50	p75
delta	57	0.321 ***	0.000	0.929	0.297	0.925	0.072	0.188	0.598
misp	51	0.097 ***	-0.067	0.500	0.124	1.281	0.017	0.065	0.119
mispo	55	0.101 ***	-0.049	0.476	0.124	1.223	0.019	0.086	0.134
mispto	50	0.003	-0.050	0.056	0.024	8.209	-0.005	0.000	0.018
ed	61	1.065 ***	0.045	23.163	2.968	2.788	0.316	0.513	0.916

Panel B: subsample of issues with delta > 0.5

variable	N	mean	min	max	sd	cv	p25	p50	p75
delta	17	0.739 ***	0.575	0.929	0.122	0.165	0.619	0.757	0.856
misp	13	0.239 ***	0.021	0.500	0.149	0.625	0.139	0.184	0.370
mispo	15	0.218 ***	-0.030	0.476	0.159	0.730	0.095	0.167	0.378
mispto	12	0.003	-0.050	0.056	0.034	11.693	-0.015	0.000	0.028
ed	17	2.296 **	0.074	23.163	5.397	2.350	0.835	0.974	1.297

Panel C: subsample of issues with delta < 0.5

variable	N	mean	min	max	sd	cv	p25	p50	p75
delta	40	0.144 ***	0.000	0.422	0.112	0.778	0.044	0.149	0.201
misp	36	0.040 ***	-0.067	0.188	0.052	1.298	0.003	0.041	0.080
mispo	38	0.052 ***	-0.049	0.209	0.063	1.224	0.006	0.047	0.096
mispto	36	0.004	-0.050	0.040	0.020	4.598	-0.005	0.001	0.019
ed	40	0.411 ***	0.045	1.279	0.240	0.584	0.252	0.403	0.549

Panel D: difference in means between the subsamples (Panel C – Panel B)

variable	difference in means	95% confidence interval		t	p-value
delta	**-0.595**	**-0.665**	**-0.524**	**-17.213**	**0.000**
misp	**-0.198**	**-0.290**	**-0.107**	**-4.696**	**0.000**
mispo	**-0.167**	**-0.257**	**-0.077**	**-3.933**	**0.000**
mispto	0.001	-0.021	0.023	0.134	0.552
ed	-1.885	-4.661	0.890	-1.440	0.085

Table 4

Correlations between different measures of mispricing, equity-to-debt component ratio and delta measure. The first number in each field is coefficient of correlation, the second number is p-value and the third number is number of observations respectively.

	delta	ed	misp	mispo	mispto
delta					
ed	**0.3705* 0.005 57**				
misp	**0.7581* 0.000 49**	**0.5152* 0.000 51**			
mispo	**0.6614* 0.000 53**	**0.4984* 0.000 55**	**0.9756* 0.000 50**		
mispto	-0.137 0.354 48	-0.177 0.220 50	-0.099 0.496 50	0.121 0.404 50	

Table 5

OLS regressions of cumulative average abnormal returns (CAAR) of windows between 0 up to 30 days after the issue announcement on mispricing.

Panel A: model statistics

Event window	Obs	R2	F-test	p-value
0,7	51	0.142	8.131	0.0064
0,11	51	0.142	8.083	0.0065
0,14	51	0.161	9.396	0.0035
0,18	51	0.119	6.613	0.0132
0,22	51	0.098	5.314	0.0254
0,30	51	0.009	0.444	0.5081

Panel B: model results

Event window		coef.	SE	t	p-value	[95% Conf. interval]	
0,7	**misp**	**-0.1890**	**0.0663**	**-2.85**	**0.01**	**-0.3221**	**-0.0558**
	_cons	-0.0095	0.0103	-0.92	0.36	-0.0303	0.0112
0,11	**misp**	**-0.1908**	**0.0671**	**-2.84**	**0.01**	**-0.3256**	**-0.0559**
	_cons	-0.0145	0.0105	-1.38	0.17	-0.0355	0.0066
0,14	**misp**	**-0.2319**	**0.0757**	**-3.07**	**0.00**	**-0.3839**	**-0.0799**
	_cons	-0.0181	0.0118	-1.53	0.13	-0.0418	0.0056
0,18	**misp**	**-0.2213**	**0.0860**	**-2.57**	**0.01**	**-0.3942**	**-0.0484**
	_cons	-0.0174	0.0134	-1.30	0.20	-0.0443	0.0096
0,22	**misp**	**-0.2093**	**0.0908**	**-2.31**	**0.03**	**-0.3917**	**-0.0268**
	_cons	-0.0095	0.0142	-0.67	0.50	-0.0380	0.0189
0,30	**misp**	-0.0685	0.1028	-0.67	0.51	-0.2751	0.1381
	_cons	-0.0163	0.0160	-1.02	0.31	-0.0485	0.0159

Table 6

Descriptive statistics for relative measure of short interest. Sd represents standard deviation, cv represents coefficient of variation, p25, p50 and p75 denote 25th, 50th and 75th percentile respectively. AD+/-t denotes number of fortnights relative to the fortnight of the announcement date of a convertible bond issue.

Panel A: short interest relative to potentially newly issued shares for the subsample of issues with delta > 0.5

Period	N	mean	min	max	sd	cv	p25	p50	p75
AD-2	17	0.037	0.000	0.270	0.066	1.797	0.004	0.013	0.031
AD-1	17	0.045	0.000	0.269	0.074	1.658	0.004	0.013	0.026
AD	17	0.107	0.000	0.368	0.117	1.085	0.015	0.061	0.163
AD+1	17	0.205	0.000	0.664	0.211	1.033	0.042	0.135	0.281
AD+2	17	0.250	0.001	0.780	0.252	1.008	0.056	0.158	0.367
AD+3	17	0.272	0.000	0.800	0.258	0.951	0.071	0.218	0.382
AD+4	17	0.306	0.000	0.952	0.309	1.010	0.072	0.194	0.490
AD+5	17	0.333	0.000	1.128	0.335	1.003	0.079	0.249	0.480
AD+6	17	0.345	0.000	1.119	0.342	0.989	0.065	0.236	0.536
AD+7	17	0.375	0.000	1.320	0.394	1.050	0.061	0.240	0.538
AD+8	17	0.354	0.000	0.971	0.343	0.969	0.061	0.246	0.517
AD+16	17	0.316	0.007	0.788	0.269	0.851	0.053	0.254	0.500
AD+24	17	0.285	0.010	0.813	0.250	0.876	0.072	0.210	0.396

Panel B: short interest relative to potentially newly issued shares for the subsample of issues with delta < 0.5

Period	N	mean	min	max	sd	cv	p25	p50	p75
AD-2	40	0.086	0.000	0.770	0.172	1.997	0.003	0.011	0.079
AD-1	40	0.093	0.000	0.598	0.160	1.717	0.005	0.016	0.083
AD	40	0.110	0.000	0.587	0.165	1.504	0.006	0.023	0.160
AD+1	40	0.100	0.000	0.633	0.163	1.623	0.008	0.021	0.129
AD+2	40	0.097	0.000	0.602	0.160	1.650	0.007	0.026	0.128
AD+3	40	0.076	0.000	0.578	0.132	1.739	0.009	0.031	0.066
AD+4	40	0.091	0.000	0.640	0.154	1.689	0.010	0.039	0.084
AD+5	40	0.092	0.000	0.545	0.137	1.488	0.011	0.042	0.098
AD+6	40	0.094	0.000	0.551	0.142	1.511	0.010	0.043	0.106
AD+7	40	0.087	0.000	0.557	0.124	1.415	0.012	0.051	0.113
AD+8	40	0.087	0.000	0.546	0.123	1.413	0.017	0.055	0.099
AD+16	40	0.140	0.001	0.999	0.192	1.369	0.028	0.077	0.154
AD+24	40	0.131	0.000	0.478	0.147	1.122	0.018	0.057	0.213

Panel C: difference in means between the subsamples (Panel B – Panel A),

under the alternative hypothesis, mean of Panel A > mean of Panel B

Period	Difference in means	95% confidence interval		t	p-value
AD-2	0.049	-0.014	0.113	1.563	0.938
AD-1	0.049	-0.014	0.111	1.565	0.938
AD	0.002	-0.075	0.080	0.060	0.524
AD+1	**-0.104**	**-0.222**	**0.014**	**-1.818**	**0.040**
AD+2	**-0.153**	**-0.290**	**-0.016**	**-2.307**	**0.015**
AD+3	**-0.196**	**-0.334**	**-0.058**	**-2.966**	**0.004**
AD+4	**-0.215**	**-0.379**	**-0.050**	**-2.725**	**0.007**
AD+5	**-0.241**	**-0.417**	**-0.065**	**-2.874**	**0.005**
AD+6	**-0.251**	**-0.431**	**-0.072**	**-2.929**	**0.004**
AD+7	**-0.288**	**-0.493**	**-0.082**	**-2.950**	**0.004**
AD+8	**-0.267**	**-0.446**	**-0.087**	**-3.123**	**0.003**
AD+16	**-0.176**	**-0.324**	**-0.028**	**-2.446**	**0.011**
AD+24	**-0.154**	**-0.289**	**-0.020**	**-2.380**	**0.013**

Panel D: changes in short interest compared to the previous period for the subsample of issues with delta > 0.5 (short interest relative to potentially newly issued shares)

Period	N	mean	min	max	sd	cv	p25	p50	p75
AD-1	17	0.008	-0.015	0.109	0.029	3.731	-0.001	0.000	0.002
AD	17	0.063	-0.002	0.228	0.069	1.106	0.007	0.054	0.096
AD+1	17	0.097	0.000	0.328	0.103	1.061	0.018	0.070	0.157
AD+2	17	0.045	-0.008	0.153	0.053	1.167	0.001	0.020	0.085
AD+3	17	0.022	-0.027	0.105	0.036	1.658	0.000	0.007	0.026
AD+4	17	0.034	-0.105	0.457	0.122	3.544	0.000	0.001	0.021
AD+5	17	0.027	-0.016	0.175	0.049	1.777	0.000	0.005	0.037
AD+6	17	0.012	-0.064	0.066	0.031	2.633	-0.001	0.008	0.023
AD+7	17	0.030	-0.166	0.647	0.166	5.580	-0.010	0.000	0.009
AD+8	17	-0.021	-0.393	0.038	0.097	-4.594	-0.006	0.000	0.003

Panel D: changes in short interest compared to the previous period for the subsample of issues with delta < 0.5 (short interest relative to potentially newly issued shares)

Period	N	mean	min	max	sd	cv	p25	p50	p75
AD-1	40	0.007	-0.358	0.306	0.079	11.419	-0.002	0.001	0.011
AD	40	0.017	-0.186	0.251	0.071	4.265	-0.005	0.001	0.017
AD+1	40	-0.009	-0.379	0.320	0.091	-9.685	-0.018	0.000	0.007
AD+2	40	-0.003	-0.560	0.330	0.117	-37.750	-0.003	0.000	0.007
AD+3	40	-0.021	-0.486	0.040	0.087	-4.080	-0.010	0.000	0.008
AD+4	40	0.015	-0.041	0.348	0.059	3.835	-0.005	0.000	0.017
AD+5	40	0.001	-0.537	0.342	0.105	134.931	-0.006	0.000	0.011
AD+6	40	0.002	-0.074	0.114	0.032	17.266	-0.008	0.000	0.009
AD+7	40	-0.007	-0.418	0.127	0.077	-11.637	-0.004	0.000	0.017
AD+8	40	0.000	-0.123	0.053	0.030	-249.111	-0.005	0.000	0.011

Table 7

Correlations between different measures of mispricing and relative short interest (measured as a ratio between short interest and potential number of newly issued shares). AD+/-t denotes fortnights relative to the fortnight of the announcement date. The first number in each field is coefficient of correlation and the second number is a p-value respectively.

	misp	mispto	AD+1	AD+2	AD+3	AD+4	AD+5	AD+6	AD+7	AD+8	AD+9	AD+10	AD+11	AD+12
misp														
mispto	-0.0172													
	0.9055													
AD+1	0.1678	**0.2674***												
	0.2392	**0.0529**												
AD+2	0.2133	**0.3049***	0.8499*											
	0.1329	**0.0264**	0											
AD+3	**0.3030***	0.222	0.8423*	0.9247*										
	0.0307	0.1101	0	0										
AD+4	**0.3288***	0.194	0.7853*	0.8818*	0.9315*									
	0.0185	0.1639	0	0	0									
AD+5	**0.3831***	0.1822	0.8143*	0.8511*	0.9095*	0.9267*								
	0.0055	0.1917	0	0	0	0								
AD+6	**0.3808***	0.1691	0.8067*	0.8293*	0.9012*	0.9186*	0.9914*							
	0.0058	0.2261	0	0	0	0	0							
AD+7	**0.3255***	0.1751	0.7495*	0.7930*	0.8928*	0.8854*	0.9064*	0.9063*						
	0.0198	0.2098	0	0	0	0	0	0						
AD+8	**0.3729***	0.1908	0.7920*	0.8285*	0.9291*	0.9212*	0.9438*	0.9391*	0.9794*					
	0.007	0.1711	0	0	0	0	0	0	0					
AD+9	**0.4219***	0.1759	0.7777*	0.8036*	0.9151*	0.9072*	0.9393*	0.9345*	0.8771*	0.9462*				
	0.002	0.2077	0	0	0	0	0	0	0	0				
AD+10	**0.4174***	0.1905	0.7541*	0.7899*	0.8957*	0.9055*	0.9208*	0.9152*	0.8652*	0.9225*	0.9798*			
	0.0023	0.1719	0	0	0	0	0	0	0	0	0			
AD+11	**0.4002***	0.1978	0.7518*	0.7681*	0.8751*	0.8781*	0.9063*	0.9094*	0.8589*	0.9156*	0.9716*	0.9687*		
	0.0036	0.1556	0	0	0	0	0	0	0	0	0	0		
AD+12	**0.4161***	0.1891	0.7591*	0.7702*	0.8731*	0.8685*	0.9104*	0.9161*	0.8519*	0.9076*	0.9680*	0.9611*	0.9867*	
	0.0024	0.1749	0	0	0	0	0	0	0	0	0	0	0	

Table 8

Convertible arbitrage performance index and equity indices. Data provided by CFSB/Tremont HedgeIndex (http://www.hedgeindex.com)

Year	HEDG CA	MSCI World Index	S&P 500
2005	-3.48%	7.61%	4.88%
2004	1.98%	15.25%	10.88%
2003	12.90%	33.76%	28.68%
2002	4.05%	-19.54%	-22.10%
2001	14.58%	-16.52%	-11.89%
2000	25.64%	-12.92%	-9.10%
1999	16.04%	25.34%	21.04%
1998	-4.41%	24.80%	28.58%
1997	14.48%	16.23%	33.36%
1996	17.87%	14.00%	22.96%
1995	16.57%	21.32%	37.58%
1994	-8.07%	5.58%	1.32%

Table 9

Mean and median values of delta and mispricing across years.

Panel A: Mean and median values of delta and mispricing across years.

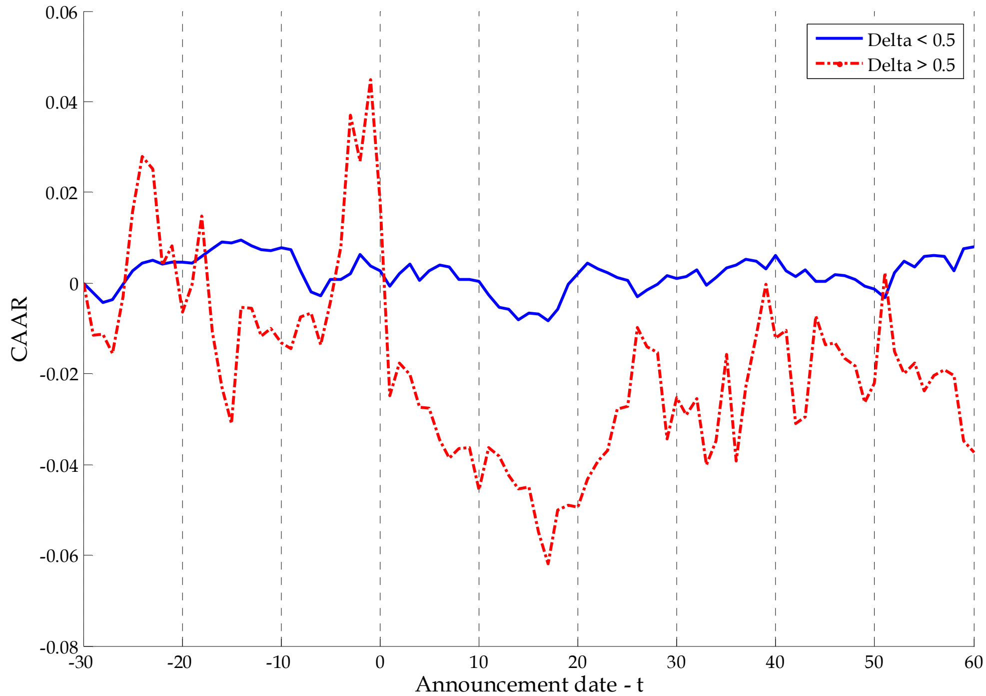
year	variable	N	mean	median
1998	delta	7	0.613	0.760
	misp	5	0.072	0.089
1999	delta	3	0.270	0.255
	misp	1	0.093	0.093
2001	delta	7	0.613	0.757
	misp	6	0.276	0.318
2002	delta	12	0.368	0.288
	misp	10	0.129	0.092
2003	delta	11	0.239	0.141
	misp	11	0.061	0.059
2004	delta	17	0.111	0.117
	misp	18	0.047	0.021
Total	delta	57	0.321	0.188
	misp	51	0.097	0.065

Panel B: difference in means between different years (year 1 – year 2)

		difference in means				
year 1	year 2	difference	95% confidence interval		t	p-value
1998	**2001**	**-0.204**	**-0.408**	**0.001**	**-2.467**	**0.025**
1998	2002	-0.056	-0.153	0.041	-1.250	0.117
1998	2003	0.011	-0.047	0.070	0.420	0.340
1998	2004	0.025	-0.030	0.080	0.957	0.176
2001	2002	0.148	-0.058	0.353	1.636	0.069
2001	**2003**	**0.215**	**0.011**	**0.419**	**2.594**	**0.021**
2001	**2004**	**0.229**	**0.024**	**0.433**	**2.771**	**0.017**
2002	2003	0.068	-0.030	0.165	1.482	0.080
2002	**2004**	**0.081**	**-0.015**	**0.178**	**1.809**	**0.046**
2003	2004	0.013	-0.043	0.070	0.494	0.313

Figure 1

Wealth effects associated with announcement and issuance dates of convertible debt issues for split subsamples according to the delta measure



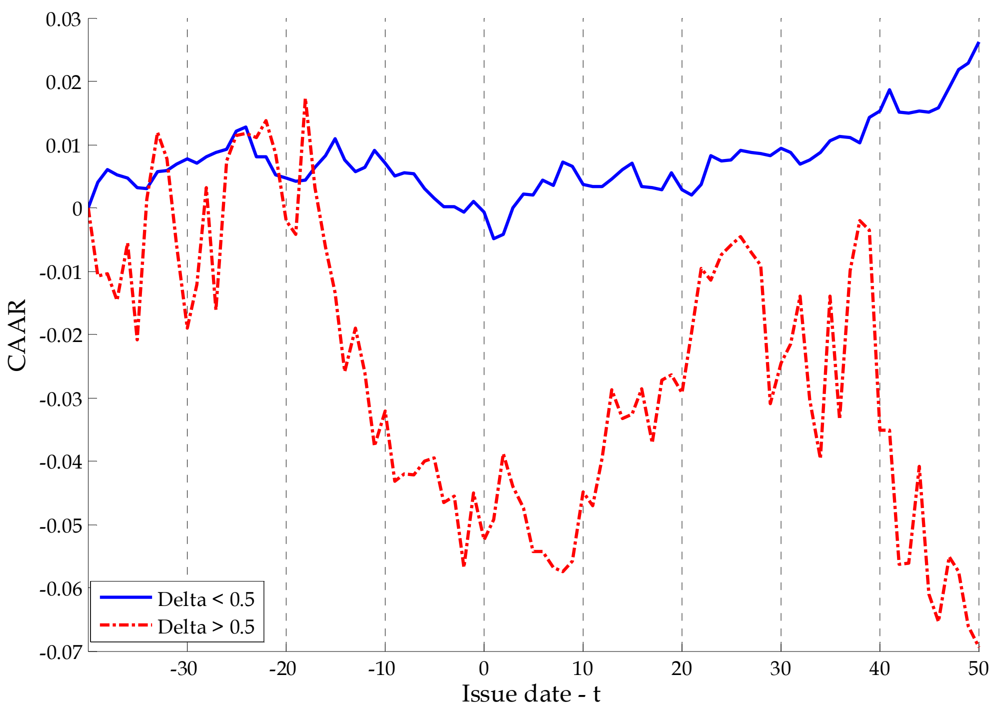


Figure 2

Kernel density plots for the split sample according to the delta measure

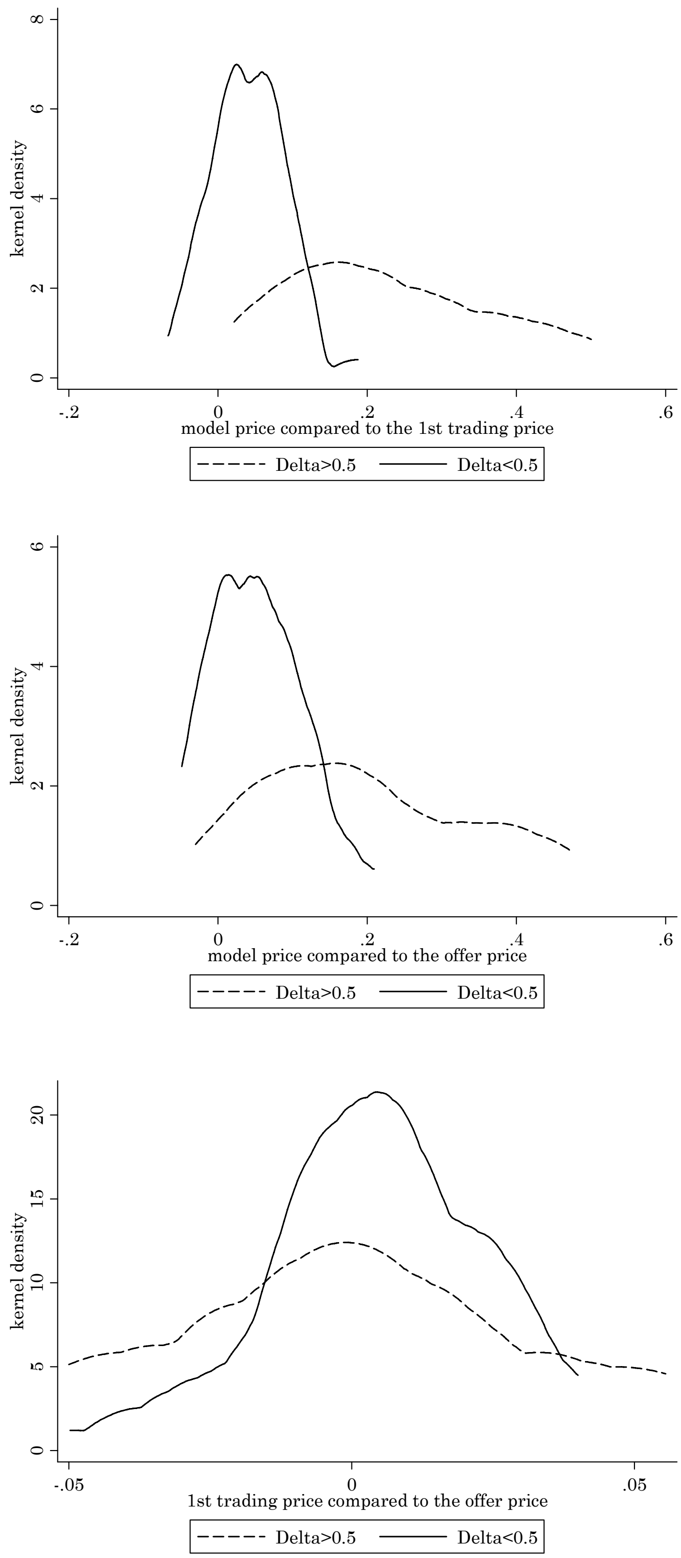


Figure 3

Mean values of mispricing in time for split sample according to delta measure. Mispricing is based on the comparison of theoretical convertible bond price and closing bond convertible price in the market at time t (t=0 is issue date).

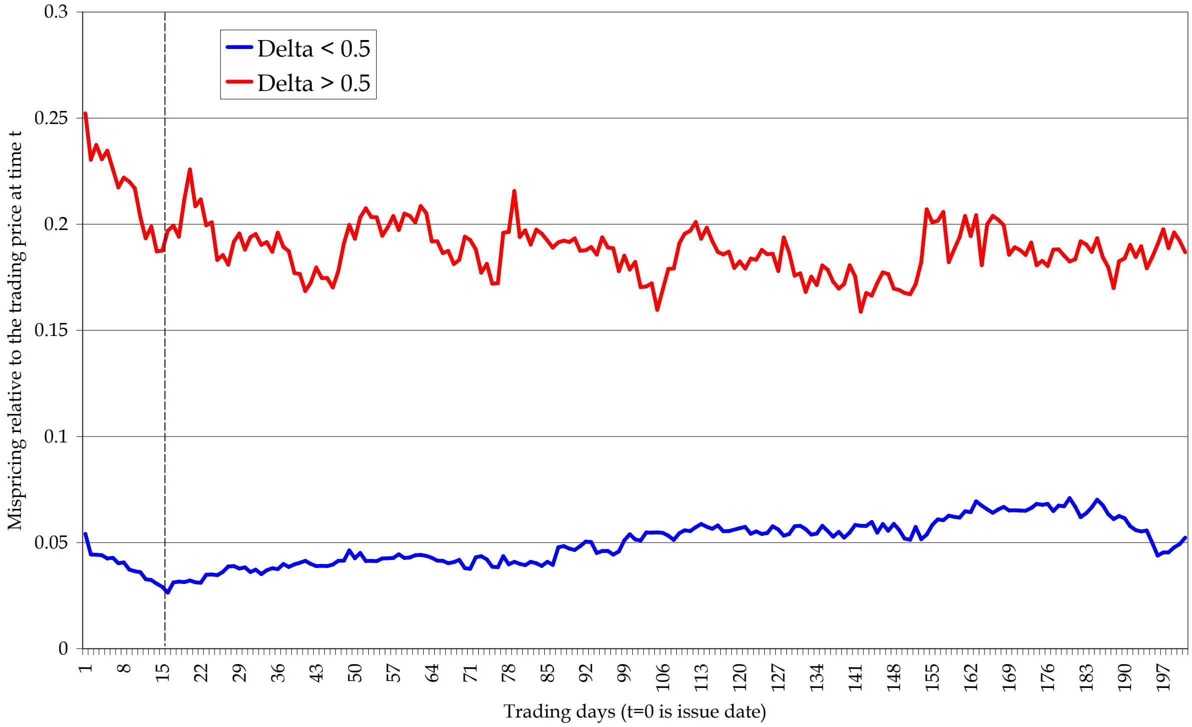


Figure 4

Mean values of mispricing in time for split sample according to delta measure. Mispricing is based on the comparison of closing convertible bond trading price in the market and offer price at time t (t=0 is issue date).

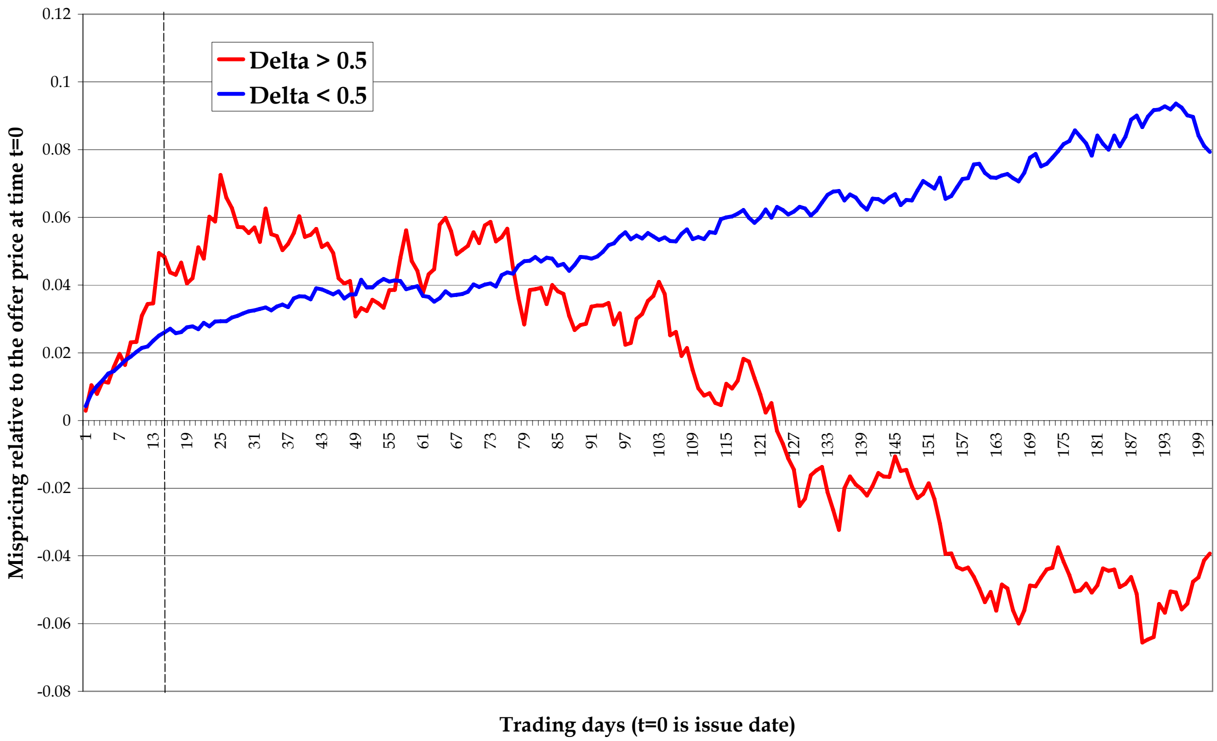
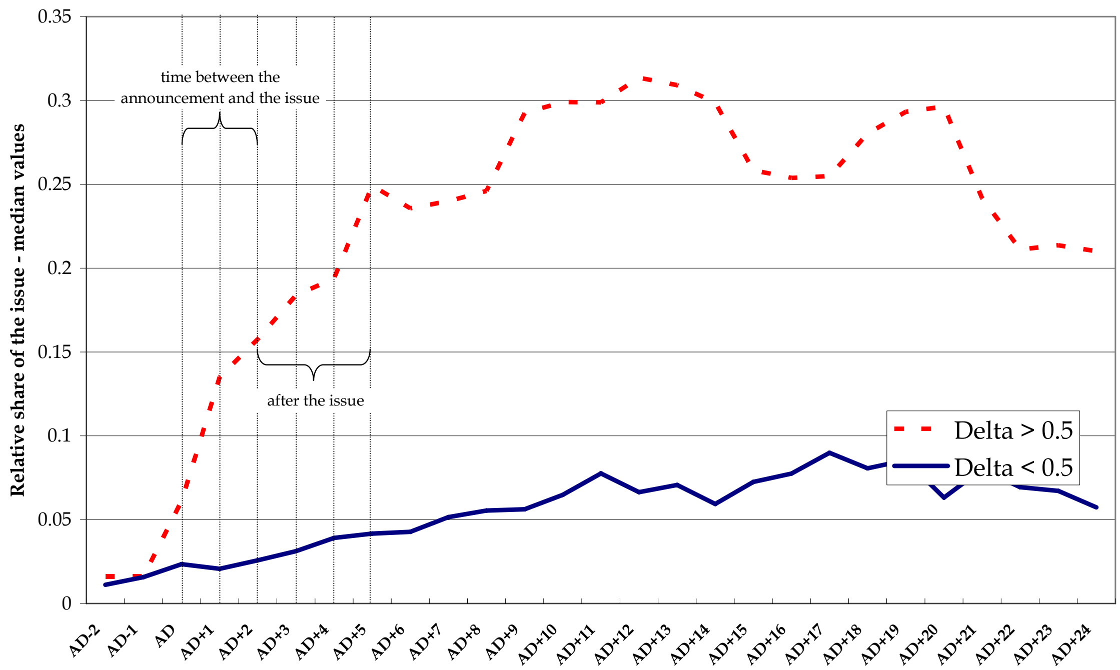


Figure 5

Median and mean values of short interest (measured as a ratio between short interest and potential number of newly issued shares) in time for split sample according to delta measure. AD+/-t denotes fortnights relative to the fortnight of the announcement date.



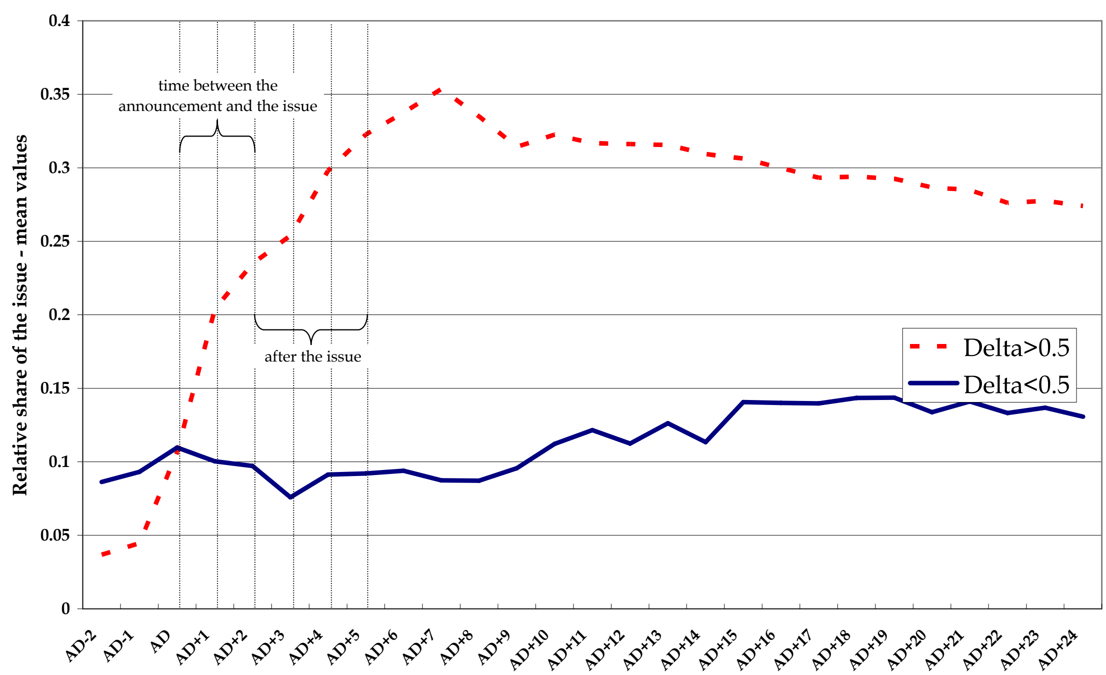


Figure 6

Cumulative average convertible bond returns, raw stock price returns and convertible arbitrage returns for convertible arbitrage portfolio as defined in equations (6) and (7) for the sub-samples based on the constant delta value.