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Abstract

The announcement of a convertible bond call is associated with an average contemporaneous abnormal stock price decline of 1.75% and an ensuing price recovery in the conversion period. A price fall and the subsequent recovery suggest price pressure as the explanation for the announcement effect.

In a perfect capital market the option to convert will not be exercised early. The increase in the number of shares outstanding will then occur at the end of the conversion period and not at the earlier announcement date. This study's focus is on the increase in supply that occurs at the announcement day due to short selling of the calling company's stock. Two groups actively engage in short selling in anticipation of, and response to, a convertible bond call. Arbitrageurs buy the convertible and short stock against the equity component of their bond position. Underwriters hedge their exposure by shorting stock.

This study examines the relation between short selling around a call announcement, the number of new shares to be issued upon conversion, the predictability of the call, the price reaction to the call announcement, and the subsequent price recovery. We conclude that short selling induced price pressure explains at least part of the stock price response to calls. The study's results suggest that an understanding of the stock price response to convertible bond calls actually requires an understanding of optimal compensation schemes, risk aversion, and agency problems within the firms that short sell in response to calls. When short selling by arbitrageurs and underwriters temporarily depresses prices by 1.75%, what are the Shleifer and Vishny (1997) "limits of arbitrage" that give rise to the benefit of hedging by selling such underpriced stock?

1 Introduction

The announcement of an in-the-money convertible bond call is associated with an average contemporaneous abnormal stock price decline of 1.75% and an ensuing price recovery in the conversion period. This paper will argue and provide evidence that the decline in stock prices is due to investors short selling the underlying stock at or around the call announcement. Two types of investors may have strong incentives to hedge their equity exposure by short selling at the time of the call. First, the convertible hedge desks of investment banks will try to lock in arbitrage profits by buying the called convertible bond and short selling the underlying stock. Second, a possible underwriter of the call will short sell in order to hedge the equity risk associated with the call. The short selling of stock by these two types of investors is at least in part causing the short-run price pressure. However, the willingness to bear the transaction costs and the price impact costs of selling such underpriced stock is the consequence of risk aversion and agency problems within investment banks and is taken as evidence on the limits of arbitrage.

In their paper '*The Limits of Arbitrage*' Shleifer and Vishny (1997) consider professional arbitrageurs and describe important implications of the difference between *textbook* arbitrage and what they denote *real* arbitrage. Textbook arbitrage is generally argued to ensure that prices are close to fundamentals and hence to ensure that markets are efficient. The standard argument for this is that many small investors are seeking arbitrage opportunities in the market and as every investor has only a small amount of capital at stake, they are effectively risk neutral. However, in many cases the evaluation of existing arbitrage opportunities requires highly specialized knowledge. In addition, real arbitrage will always entail some risk and require capital.[1] Therefore, in reality the arbitrageurs will only make money on average, and may under certain circumstances need additional capital to either execute additional trades or cover possible losses. This means that many real arbitrage activities will only be performed by a few professional arbitrageurs having the required knowledge and access to the necessary capital. Such professional arbitrageurs will be large and highly specialized investment banks. Furthermore, the capital requirements can create an agency relationship between 'the knowledge' and 'the capital'. The agency relationship can exist at several levels within the professional arbitrageur, or between the professional arbitrageur and the investors providing the capital at stake.[2] Because capital is fundamental in real arbitrage, the professional

[1] For example, Tuckman and Vila (1992) show that holding costs is enough to make perfectly hedged arbitrage strategies risky. Similarly, Pontiff (1996) documents the importance of other arbitrage costs.

[2] Lakonishok, Shleifer, and Vishny (1992) provide a more detailed description of such agency problems.

arbitrageur will fear the situation where the providers of capital start withdrawing capital. The risk aversion and the agency relationship described cause limits of arbitrage. This is because both phenomena will make the arbitrageurs less effective in exploiting real arbitrage opportunities and thereby less effective in keeping markets efficient.[3]

Anticipated or realized calls of convertible bonds provide a case where such *real* arbitrage opportunities can exist. As explained in section 3.3 the original holders of convertible bonds (such as convertible bond funds) wish to sell the convertible bonds at anticipated or realized calls. The buyers will typically be arbitrageurs such as the convertible hedge desks of investment banks. In order to induce these new investors to buy the convertible bonds from the original holders, the price of the convertible bond must fall. Hence, this scenario will make it possible for the convertible hedge desk to buy the bonds relatively cheaply.[4] By buying the bonds, the desks will now be exposed to equity risk because the value of a convertible bond is positively correlated with the stock price. This risk can be hedged by short selling the underlying stock.[5] Consistent with such an arbitrage strategy, Howe, Lin, and Singh (1998) show that the price of convertible preferred stocks decrease at the announcement of a call and that the trade in the convertible preferred stocks increases. In addition, these authors provide some evidence that at the time of a call it is a profitable strategy to buy the called convertible preferred stock and hedge the associated risk by short selling the underlying stock.

In addition to the convertible hedge desks, a possible underwriter of the call may also have an incentive to sell short in the case of convertible bond calls. An underwriter guarantees that the bonds called are converted into new stock in the firm and hence, the underwriter prevents the case where the firm suddenly has so come up with cash in order to pay for the redemption of the bonds. Normally, the underwriter will do this by paying in cash the call payment promised to those bondholders who do not convert and by buying the corresponding stock from the firm. This means that the underwriter will buy the new shares and pay the call payment in situations where a conversion

[3]There is a growing amount of literature related to these limits of arbitrage. Two recent examples are Wurgler and Zhuravskaya (2000) and Xiong (2001). Wurgler and Zhuravskaya (2000) argue that arbitrage will be risky because stocks do not, in practice, have perfect substitutes. This will make risk averse arbitrageurs trade less aggressively and hence, this 'arbitrage risk' will prevent arbitrage from flattening demand curves for stocks. Xiong (2001) uses an equilibrium model to study speculators taking risky positions (or in our terminology seeking real arbitrage opportunities). In this model Xiong shows that a capital loss from an unfavorable shock can make speculators liquidate their positions resulting in amplification of the original shock. Surveys and further discussions of related literature can be found in Shleifer (2000), Campbell (2000), and Hirshleifer (2001).

[4]In a more general analysis of convertible bonds, Athanassakos and Carayannopoulos (2000) provide evidence that convertible bonds are often underpriced in the sense that negative conversion option values are implied.

[5]The investment strategy of buying convertible bonds and selling short the underlying stock is known as convertible bond arbitrage.

is not optimal for the bondholders. This is the reason why underwriters too have incentives to hedge by short selling the stock. The incentive of the hedge desks and the underwriter to hedge by short selling stock is further described in section 3.

In order to provide evidence for such hedging this paper makes the first study of short selling around calls of convertible securities. More precisely, the study examines the relation between short selling, the trade volume associated with a call, the predictability of the call, the stock price reaction to the call announcement, and variables related to hedging.

The study shows that short selling of stock increases in anticipation of the call and that during the conversion period, the number of shares sold short is more than three times higher than the level after the call. On average, the total short selling involves at least 19% of the new shares to be issued upon conversion. This corresponds to nearly 14 days of trading based on the average trade volume before the call. Furthermore, the study provides evidence of a large increase in trade volume at the announcement of the call, and this trade volume is related to the number of new shares to be issued upon conversion of the bonds. Such an increase in trade volume is likely to depress stock prices, thus causing the short-run price pressure around the convertible bond call. In addition, the study documents in several ways that short selling is not only caused by a possible underwriter. Finally, the study shows that the relation between the announcement effect and several variables describing the call is consistent with a hedging induced price pressure.

The rest of this paper is organized as follows: The next section discusses related literature. Section 3 describes calls of convertible bonds in four subsections. Firstly, the characteristics of a called convertible bond; secondly, the use of underwriters; thirdly, the risk faced by the different parties involved in the call; and finally, the short selling and hedging associated with convertible bond calls. Section 4 briefly describes the methodology and data-set used in this paper. Section 5 presents and discusses the empirical results in four parts. Firstly, an event study and a price-rebound test document the negative announcement effect and the subsequent recovery of stock prices. Secondly, a study of the price pressure explanation is performed. Thirdly, short selling is examined in detail, including a study of how short selling relates to the called convertible bond. Finally, the announcement effect is linked to hedging and the use of underwriters. Section 6 gives implications of the results and suggests further research. A short summary and concluding remarks are given in section 7. Appendix A examines how the hedging of equity risk associated with convertible bonds will be affected by a call. Appendix B describes the event study method.

2 Related literature

A negative announcement effect was first documented by Mikkelson (1981). Mikkelson found an announcement effect only for convertible bonds and not for convertible preferred stocks and used a tax argument to explain his findings.[6] Later, several studies showed that the announcement effect also exists for convertible preferred stocks, eliminating the validity of the tax argument. Harris and Raviv (1985) provided a theoretical model that explained why the call might be taken as a signal revealing bad news about the firm's prospects. The basic idea is that if the management of a firm expect dividends to increase in the future, there is no reason to call the bond because bondholders will convert voluntarily. This way a call will reveal to the stock market that the management do not expect dividends to increase in the future. Ofer and Natarajan (1987) claimed to find empirical evidence for this bad-news explanation. For the calling firms, they found a negative cumulative abnormal return for the period following the announcement. However, several papers (Cowan, Nayar, and Singh (1990) and Campbell, Ederington, and Vankudre (1991)) subsequently showed that the empirical evidence does not seem to support the signaling model as argued in Ofer and Natarajan (1987). Furthermore, Byrd (1992), Byrd and Moore (1996), and Ederington and Goh (2001) showed that no evidence for the bad-news explanation can be found by investigating how financial analysts react to the call announcement. In addition, Ederington and Goh (2001) documented that insiders purchase more stock than normal in the firm around the time of the call which also contradicts the bad-news explanation.

In contrast to Ofer and Natarajan (1987), Mazzeo and Moore (1992) documented a recovery of stock prices during the conversion period. Based on this and other tests, Mazzeo and Moore argued that the announcement effect is due to a price pressure caused by investors wanting to sell the new stock received upon conversion of the bonds. However, a problem with the arguments in Mazzeo and Moore (1992) is that – as it follows from section 3 in this paper – bondholders will not convert at the time of the call announcement, and hence the new shares will not be issued until later. In addition, the bondholders will not in general hold any of the underlying stock at the time of the call. Therefore, Mazzeo and Moore (1992) do not provide an explanation as to how the later increase in the supply of shares actually translate into price pressure at the time of the announcement.

Several studies have documented that changes in the supply of stock may lead to price effects.

[6]Interest payments on convertible bonds are tax deductible while this is not the case for dividends paid on convertible preferred stocks.

These price effects can be either short term effects due to a lack of liquidity in the stock market or long-term effects due to downward-sloping demand curves. Some of these studies include Kraus and Stoll (1972), Mikkelson and Partch (1985), Harris and Gurel (1986), and Shleifer (1986).

Singh, Cowan, and Nayar (1991) showed that whether the call is underwritten or not seems to be relevant for the size of the announcement effect. They found that the announcement effect is significant for underwritten calls only and argued that this is due to the fact that underwriters are primarily used by firms with the most unfavorable information or because of an agency conflict in the calling firm. The use of underwriters would for example indicate an agency conflict if managers and underwriters collude at the expense of the shareholders (Smith (1977)) or if risk averse managers employ underwriters for a personal risk reduction (Amihud and Lev (1981)).

Underwritten calls of convertible bonds have some similarities with underwritten rights offers. Both types of underwriting deals can be seen as a commitment by an investment bank to buy new shares from a firm in the case where a stock price decline makes the right/conversion right out-of-the-money. Singh (1997) examined underwritten rights offers and found that in the rights offering period, underwriters purchase rights hedged with the short sale of the common stock. On average the underwriters acquire 15.80% of the shares offered through purchase and exercise of rights and short sell a corresponding number of shares. Consistent with many of the arguments presented in this paper Singh explained the behavior of the underwriters by an incentive to reduce their exposure to the standby underwriting. In addition, Singh documented that rights offers are associated with negative abnormal returns around the announcement followed by positive abnormal returns after the expiration of the right. Finally, there is a negative correlation between the size of the announcement effect and the number of shares sold short by underwriters.

A final important paper, which should be mentioned, is Jaffee and Shleifer (1990). They considered the delay of convertible bond calls and the use of underwriters.[7] As it will follow from section 3.3, their arguments for the delay and the use of underwriters are related to the explanation of the announcement effect given in the present paper. According to Jaffee and Shleifer (1990), firms will have a high risk exposure when calling a convertible bond issue. This risk is argued to explain the calling firms' behavior. Krishnan and Rao (1996) provided empirical evidence for the arguments in Jaffee and Shleifer (1990). Jaffee and Shleifer (1990) will be described in further detail in section 3.3.

[7]By the delay of convertible bond calls is referred to the findings that firms seem to call later than dictated by the optimal call policy. Footnote 18 describes this in further detail.

3 Convertible bonds

The basic characteristics of convertible bonds are described in nearly all standard finance textbooks, but it is difficult to find a satisfactory description of convertible bonds in the case of a call. Therefore, this section will focus on called convertible bonds. Firstly, the necessary terminology is introduced and the valuation of the different parts of a called convertible is considered. Secondly, underwriters of convertible bond calls and the risk associated with the calls are described. Finally, this leads to a description of how holders of convertible bonds are expected to react to a call announcement.[8]

3.1 Calls of convertible bonds

Convertible bonds are used by firms to raise capital and can be viewed as a hybrid security having characteristics of both ordinary bonds and common stock. The reason is that convertible bonds on one hand are interest paying and have a promised payment at maturity, just like ordinary bonds. On the other hand, convertible bonds have a stock component because the holder of convertible bonds has an option to exchange the bonds for new common stock in the firm.[9] The option to convert is an American style option that matures at the same time as the bond. The terms under which the bond can be exchanged for stock are normally stated in the form of either a conversion ratio or a conversion price. The conversion ratio denotes the number of shares that will be received per face value of the bond, while the conversion price denotes the price in $ face value that will be paid per share received upon a conversion. Both terms are given in the bond indenture and are of course adjusted for stock splits and stock dividends. The relation between the two terms for a bond with face value $1000 is given as

$$\text{Conversion ratio} = \frac{\$1000}{\text{Conversion price}}.$$

In addition to the conversion option, the majority of convertible bonds also gives the issuing firm a call option, making it possible to redeem the bonds prematurely.[10] The firm redeems the bonds by mailing a notice of redemption (the call announcement) to each bondholder in which

[8]The information in sections 3.3 and 3.4 is based on information from several conversations and interviews with different convertible hedge desks and convertible bond managers. In this connection, the author owes special thanks to convertible bond investors at Salomon Brothers, Smith Barney, County NatWest, and Credit Suisse First Boston.

[9]In some cases, a convertible bond is convertible into another firm's stock. In this case, the convertible bond is more precisely called an exchangeable bond.

[10]However, many convertible bonds are non-callable for a period, typically the first three years after they are issued or until stock prices have reached a certain level.

the firm offers to buy each bond for the so-called call payment. The call payment, also known as the effective call price, is the sum of the interest accrued since the last interest payment and a term calculated on the basis of a pre-specified value denoted the call price. The call price states the percentage of the face value that has to be offered to bondholders in addition to the accrued interest and is normally a number higher than 100% decreasing over time towards 100%. Even if the bond is called, it will still be possible for bondholders to convert into stock. The announcement of the call starts the conversion period (or notice period) in which each bondholder has to decide whether to convert into stock or accept the call payment. The length of the conversion period varies but on average it is around 30 calender days. The notice of redemption will state the last date where conversion is possible and the call date (redemption date), where the unconverted bonds will be redeemed and the corresponding call payments made. The call date is often the same date as the last conversion date but it can also be a later date. Figure 1 shows the different dates for a convertible bond call and gives the range in trading days between the different dates.

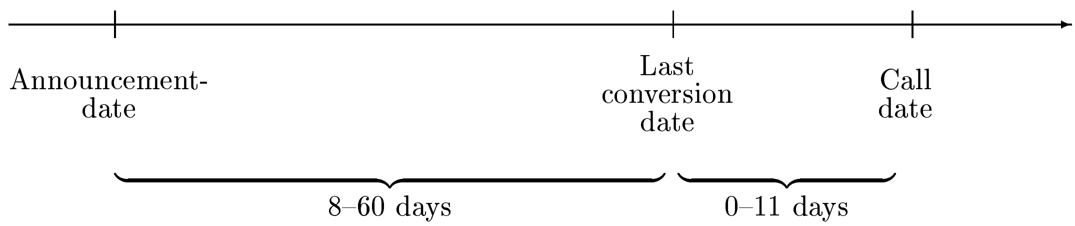

Figure 1: Time-line for calls of convertible bonds. The call date is also known as the redemption date. The number of days between the different days have been taken from the sample of calls of convertible bonds described in section 4.2 and are stated in trading days.

All calls considered in this paper are what is known as conversion forcing (or in-the-money) calls. This means that the conversion value, i.e. the value of the shares that would be received upon a conversion, is higher than the call payment at the time of the call.[11] Therefore, if a bondholder had to choose whether to convert or not at the day of the announcement, it would be optimal to convert into stock. A conversion forcing call is said to fail if the bondholders in the end choose not to convert into stock. Forced conversion is different from voluntary conversion, where the later is a conversion that occurs before the bond is called. The following will consider the value of a convertible bond in the case of a conversion forcing call.

[11] More precisely, the conversion value at a certain point in time is the current stock price times the conversion ratio, i.e. the value in $ of the stock that will be received from an immediate conversion.

If we assume that there are no dividend or interest payments in the conversion period, we can, at the time of a call, consider a convertible bond in two different ways. First, to own the convertible bond is the same as owning the stock into which the bond is convertible plus a put option allowing the bondholder to put the stock to the firm at the end of the conversion period for the call payment. Second, to own the convertible bond also corresponds to have the present value of the call payment plus a call option with a exercise price equal to the call payment, making it possible for the bondholder to receive the stock into which the bond is convertible.

We will now examine these options and their values. Let us assume that we have one convertible bond with conversion ratio n, meaning that it is convertible into n new shares. CP denotes the call payment and τ denotes the length of the conversion period. Finally, we will let S_t be the price of one share at time t and assume that the announcement of the call happens at time $t = 0$.[12] From the above it follows that at the time of the call announcement, the value of the convertible bond D_0^C is given as

$$D_0^C(S_0) = nS_0 + p(nS_0, \tau, CP) \quad (1)$$

$$= PV_0(CP) + C(nS_0, \tau, CP). \quad (2)$$

$PV_0(CP)$ is the present value at time 0 of the call payment, $p(nS, \tau, CP)$ is the value of a European put option on n shares, each worth S, where the put option has time τ to maturity and the exercise price CP. $C(nS, \tau, CP)$ is the value of the corresponding American call option. Contrary to the put option, the call option will be an American style option because the holder of the convertible bond can choose to convert at any time during the conversion period. In the case of an early exercise of the call option, it is worth noting that the exercise price at time $t < \tau$ is $PV_t(CP)$ because the call payment, CP, will only be received at time τ. In the absence of dividends, it is straightforward to show that this American call option will not be exercised before maturity.[13] Therefore, we can see that the two different ways to look at a called convertible bond correspond to the well-known put-call parity.

In the following, we will focus on the value of the put option. In order to present some numbers on the value of the put option, we will now assume a standard Black and Scholes (1973) set-up.

[12] Actually, S_t should be the "diluted" share price, i.e. the value of a share taking into account the number of new shares that will be issued upon conversion of the bonds. However, if the bond is called, it is reasonable to assume that the difference between the diluted and undiluted share price is small. Therefore, in order to simplify notation, we will just let S_t denote the share price.

[13] From a standard arbitrage argument it follows that for the value c_t of the corresponding European call option at time t, we must have $c_t \geq \max[0, S_t - PV_t(CP)]$. But the right hand side is the value obtained from a conversion of the American call option at time t, which gives that the value of the American call option is equal to the corresponding European call option, and thus there will be no early exercise.

As usual, this is a convenient but questionable assumption and the next section will describe why especially in the case of convertible bond calls, this assumption might be inappropriate. According to the Black-Scholes set-up, we assume that the stock price follows a geometric Brownian motion with a constant volatility σ. The value of the put option in (1) is then given by the well-known Black-Scholes formula for a put option. In obtaining numerical values, we assume the following parameters, which according to the data-set seem realistic:

$$\tau = 1/12 \qquad\qquad r = 4\%.$$

By using the Black-Scholes formula, we can calculate the value of the put option relative to the value nS_0, which would be received by an immediate conversion. This relative value of the put option is presented in Table I for different values of the volatility, σ, and the moneyness of the conversion right.[14] The moneyness of the conversion right is denoted in % and is defined as $\frac{nS_0}{CP} - 1$, meaning that if the value received by an immediate conversion is equal to the call payment, the moneyness would be 0%.

	Relative value of the put option		
Moneyness	$\sigma = 0.15$	$\sigma = 0.40$	$\sigma = 0.90$
0%	1.664%	4.432%	10.871%
10%	0.026%	1.198%	6.496%
20%	0.000%	0.240%	3.808%
30%	0.000%	0.037%	2.199%
40%	0.000%	0.005%	1.255%

Table I: The value of the put option, p, in (1) relative to the conversion value, nS_0, as a function of the moneyness of the conversion right and the volatility of stock prices, σ. The three values of σ are selected close to the minimum, the mean, and the maximum of σ for the stocks in the data-set, where σ is estimated within the conversion period. The moneyness is defined as $\frac{nS_0}{CP} - 1$, where CP is the call payment.

From Table I, we observe that if the convertible bond is called when the conversion right is at-the-money, the put option will be worth more than 4.4% of the conversion value for the stock with an average volatility. As expected, the value of the put option is decreasing in the moneyness of the conversion right. However, for a bond convertible into one of the more volatile stocks, the

[14] The value of the put option relative to the conversion value will only be a function of the moneyness, τ, σ, and r, and therefore, the exact values of CP, n, and S_0 are not specified.

put option will have a high value even if the conversion right is deep in-the-money. In general, the put option can indeed be a value attached to a called convertible bond, which it would be suboptimal for the bondholders to throw away by converting immediately after the announcement of the call. Section 3.3 will discuss the value of the put option in further details and explain why to the calling firm and to certain investors the put option may have a value higher than the calculated Black-Scholes value.

If we have a dividend or interest payment within the conversion period, the valuation of the convertible bond becomes more complicated than described above. If for example there is a dividend payment in the conversion period, the formulation in (1) will no longer be valid. This is because the holder of the convertible bond will only be entitled to the dividend payment if the bondholder gives up the put option and converts the bond before the dividend payment.[15] However, from the formulation in (2) and the theory on American call options, it follows that the bondholder will only find it optimal to convert either just prior to a dividend payment or at the end of the conversion period. This result will not change if we also have an interest payment in the conversion period because this might only increase the incentive to delay conversion.

The results above allow us to make the important conclusion that an eventual conversion is expected to happen either just prior to a dividend payment or at the end of the conversion period. However, if there is a risk or costs associated with being long in the convertible bond during the conversion period, for example because of a costly hedge against the risk, it may be optimal to convert earlier. Because the put option has the highest value when the conversion right is just in-the-money, we should expect that the delay in conversion is most pronounced for the calls that are just in-the-money. These results will be important later in section 5.3 when the short selling around a convertible bond call is examined. We will return to the risk and the related hedging after we have described the use of underwriters.

3.2 The underwriter

In some cases, the calling firm chooses to use an underwriter.[16] The underwriter guarantees that all bonds are converted into new stock in the firm. Normally, the underwriter will do this by paying

[15] In the case of a dividend payment within the conversion period, the stock price, S_0, in (1) should be cum dividends, S_0^{cum}, and the put option should be replaced by a call option on a put option. This call option would have an exercise value equal to the dividends of the shares that would be received upon conversion, and the stock price in the put option should be ex dividends, i.e. S_t^{ex}. Hence, with a dividend payment of div per share at time $\hat{t} < \tau$, (1) should instead read $D_0^C(S_0) = nS_0^{cum} + PV_0(\max[0, p(nS_{\hat{t}}^{ex}, \tau - \hat{t}, CP) - n \cdot div])$.

[16] In the sample of calls in this paper, slightly more than 30% are underwritten.

an amount greater than or equal to the call payment to the bondholders who do not convert and by taking the corresponding stock from the firm.[17] Thereby, the underwriter ensures that the firm will get all bonds converted into new stock instead of suddenly having to come up with cash in order to pay the call payment. The underwriter is paid an underwriting fee for providing this insurance to the firm. The underwriting fee will normally be a payment up front (the standby fee) and an additional payment (a take-up fee) for each bond converted into stock by the underwriter.

The underwriting fees are quite substantial. Singh, Cowan, and Nayar (1991) found that the standby fee alone on average corresponds to 1.05% of the face amount of the issue outstanding. If the take-up fee is included, the total underwriting fee is on average 4.19% of the face amount of issue outstanding.

The fact that the underwriter guarantees the conversion of all the bonds means that the underwriter will receive the new shares and pay the call payment in situations where the conversion right ends out-of-the-money. Therefore, the underwriter has actually sold the firm a put option for each outstanding convertible bond. This put option corresponds exactly to the put option in (1). In this way, the calling firm will no longer be exposed to the risk associated with being short these put options. The calling firm pays the underwriter in order to avoid this risk. Consequently, the cost to the calling firm of a failed conversion must be substantial since the firm is willing to pay these high underwriting fees. The next subsection will try to describe the risk and costs associated with a convertible bond call, both for the calling firm and the underwriter.

The underwriting fee should be a payment for the put options the underwriter sells to the firm. According to Table I, among other things this implies that one should expect a negative relation between the moneyness of the conversion right and the underwriting fee. Nayar, Cowan, and Singh (1991) documented such a significant negative relation for a sample of 38 underwritten calls. The next section will provide evidence that the standby fees are much higher than expected according to the Black-Scholes value of the put option and describe why this is the case.

3.3 Risk associated with convertible bond calls

The value of a called convertible bond and the attached put option in a Black-Scholes set-up was considered above. However, the following will explain why the Black-Scholes set-up probably is inappropriate in this case.

[17] First Financial Management Corporation (FFMC) is one example of a firm that applied an underwriter in a convertible bond call. On September 9, 1991, FFMC announced that it was calling for redemption all of its outstanding 7% convertible bonds. The call was underwritten by The First Boston Corp., who offered to redeem bonds at a purchase price of $1066.33. This purchase price was higher than the call payment of $1065.33.

One immediate explanation might be the magnitude of the calls. Table III in section 4.2 gives summary statistics for the data-set and shows that the calls on average involve more than 12% of the firm's stock, making it difficult to perform the standard Black-Scholes replication of the put options. However, there are more interesting and informative explanations as to why parties involved in a convertible bond call may value the put option higher than the Black-Scholes value.

Here, two important factors are risk and risk aversion. The calling firm faces the risk of a failed conversion. The forced conversion fails if a stock price decline in the conversion period makes the option to convert out-of-the-money at the end of the conversion period. In this case, the bondholders will choose not to convert and the firm is forced to raise cash on short notice in order to pay off bondholders. Given the magnitude of the calls, this sudden need for funds can create costs of financial distress for the firm. These costs will especially be substantial after the stock price decline that caused the conversion to fail. Jaffee and Shleifer (1990) argued that the costs of a failed conversion can be substantial and that these costs explain why firms choose to use an underwriter or delay the calls.[18] However, the same arguments also explain why the value of the put option is higher to the calling firm than the Black-Scholes value: If the conversion fails, it is exactly the put options that will be exercised against the firm and require that it raises capital on short notice.

If the firm uses an underwriter to guarantee the conversion, the risk of a failed conversion will be taken by the underwriter as described earlier. The underwriter will be short put options corresponding to those held by the bondholders and for this the underwriter is paid an underwriting fee. According to Singh, Cowan, and Nayar (1991), the standby fee alone is on average 0.79% of the conversion value. In addition, Singh, Cowan, and Nayar (1991) found that on average the conversion value for underwritten calls is 34% above the call payment. If these numbers are compared with the numbers in Table I, it seems that just in standby fee the underwriter for an average firm charges a price for the put option at least twenty times higher than expected according to the Black-Scholes value. Unless there is a collusion between the potential underwriters, this indicates that the underwriters also have risk preferences that make them value the put option higher than

[18] Ingersoll (1977a) and Brennan and Schwartz (1977) both showed that the optimal call policy for the firm is to force conversion immediately when the conversion right comes in-the-money. Inconsistent with this, Ingersoll (1977b) found that the median firm delays the call until the conversion value is 43.9% higher than the call payment. Similarly, Constantinides and Grundy (1987) also found evidence for call delays. However, Asquith (1995) documented that the moneyness of the conversion right of called convertible bonds is not an appropriate measure of call delays because of factors such as call protection or a cash flow advantage of the convertible bonds. Still, after adjusting for these factors, Asquith found that the conversion value on average is 25.8% above the call payments. The 25.8% is in accordance with what Jaffee and Shleifer (1990) argued to be the 'safety premium' required by the calling firms in order to avoid a failed conversion.

the Black-Scholes value. This is surprising because investment banks are expected to behave as if they have a *'portfolio'* of underwriting deals and just hedge against the market risk. If this was the case, the Black-Scholes value would be the correct value of the put option to underwriters. However, this is clearly not the case. On the contrary, the investment banks behave as if they evaluate each underwriting deal individually. With such an evaluation structure, it is clear why the individual employee fears the case where the put options are in-the-money at the end of the conversion period and therefore exercised against the underwriter. In these cases, the underwriter will lose money and the employee may be held responsible. This explains why the put option also will be valued higher than the Black-Scholes value by the underwriter.

That the risk of a failed conversion is non-trivial and taken seriously can be seen from the following two examples from the data-set.[19] First, in 1973 Echlin called a convertible bond where the conversion value at the announcement day was around 40% higher than the call payment. However, because of the OPEC oil price incline, the conversion value dropped below the call price during the conversion period. The call was underwritten by Kidder Peabody, who according to Jaffee and Shleifer (1990) lost more than $5 million on the deal. Second, on November 21, 1980, Digital Equipment announced that they were planning to call a $400 million convertible debt issue. Later (on December 4, 1980), Digital Equipment announced that they had been forced to withdraw the plans because of a decline in stock prices in the period after the announcement of the plans. This convertible bond issue was finally called on January 6, 1981, when according to the firm, the conversion right was again sufficiently deep in-the-money. This call ended up being underwritten by Lehman Brothers.

Finally, the risk also seems to be relevant for investors who hold the convertible bonds at the time of the call or buys them shortly after. These investors will typically not be the same as the investors (like convertible bond funds) who originally bought the convertible bonds. This is because the original holders react to anticipated and realized calls by selling their convertibles to arbitrageurs such as the convertible hedge desks of investment banks. At least three factors may cause this selling behavior. Firstly, there are strict limits to the amount of equity risk these convertible bond funds are allowed to take. Secondly, it may simply be that a call removes the characteristics of the convertible bond, such as a conversion right with long time to maturity, that

[19] There is also an interesting example from the calls of exchangeable bonds. In 1987 IBM made a conversion forcing call of a Eurobond exchangeable into Intel stock owned by IBM. However, because of the 1987 crash, the conversion failed. According to Barron's (December 14, 1987), IBM lost more than $12 million because the firm suddenly had to pay cash to the bondholders instead of Intel stock.

made the funds buy the bonds in the first place. Hence, an anticipated or realized call will often make the bonds unattractive to these funds. Finally, the original holders may not want or are not allowed to hold the stock after the call and therefore see no reason to deal with the practical matters related to the conversion itself. Furthermore, it is important to note that the conversion right will generally make it optimal to sell the bonds in the market rather than converting the bond and selling the shares received upon conversion. It is not the purpose of this paper to explain the behavior of the original bondholders, but the managers of convertible bond funds and convertible hedge desks that we talked to assured us that the original holders are selling the bonds in anticipation of or at realized calls.[20]

By buying the bonds, the convertible hedge desks of investment banks will now be exposed to equity risk because the value of a convertible bond will be sensitive to changes in the stock price. Based on our conversations and interviews (see footnote 8), we find that just like underwriters, the arbitrageurs (convertible hedge desks) evaluate the convertible bond investments on a deal-by-deal basis. Such an evaluation scheme and risk aversion in the convertible hedge desks of course have the consequence that the dealer in each convertible bond trade will have an incentive to hedge out not only the market risk but also the firm specific risk of the convertible bond.

3.4 Short selling and hedging

The section above leads to a description of how we should expect different types of investors to react to anticipated and realized calls of convertibles.

As mentioned, the original holders of convertibles will react to anticipated and realized calls by selling their convertibles to the convertible hedge desks of investment banks. In turn, these desks hedge against their equity exposure by shorting stock. Therefore, the number of shares sold short is expected to increase in the period before the call announcement as the convertible hedge desks buy additional bonds. The same effect is expected to lead to an increase in the short selling around the time of the call as the hedge desks buy additional bonds from the original holders. However, at the time of the call there will be an additional effect; the hedge ratio for the convertible bonds already held by the desks will increase. This is illustrated in appendix A. The appendix shows that unless the call is completely expected by the market, there will be an increase in the convertible's sensitivity to changes in the firm value. When the convertible hedge desk hedges against this risk,

[20]According to several convertible bond managers that we have talked to the fraction of newly issued shares owned by the original bondholders after the conversion is less than 20%.

there will be a similar increase in the number of shares sold short for hedging purposes.

As described in section 3.1, the bonds will not be converted immediately after the call announcement. Therefore, we should expect that the number of shares sold short stays at a high level during the conversion period. Only later in the conversion period when the hedge desks find it optimal, do they convert the bonds and use the shares received to close out their short positions. However, factors such as dividend payments during the conversion period and costs associated with the maintaining of a hedging position can make it optimal to convert early as described in section 3.1. Consequently, these factors can lead to a high conversion rate early in the conversion period, which will influence the short selling pattern.

As seen in section 3.3, underwriters will also have an incentive to hedge the risk they are exposed to. As for convertible hedge desks, this can be done by shorting stock.[21] This means that we should also expect to see underwriters of convertible bond calls shorting stock. The underwriters who are short the put option can, in contrast to the convertible hedge desks, have an incentive to eliminate the put options as soon as possible by buying up bonds and converting them. Such an incentive will exist if the underwriter wants to eliminate the risk exposure as soon as possible, and a positive take-up fee will make this incentive even stronger. This incentive gives an explanation for the observation that in order to get the bonds as early as possible, the underwriters are sometimes willing to redeem the bonds for a payment above the call payment.[22] In addition, this also explains the general perception in the convertible bond market that underwriters are active in the convertible bond market buying up bonds at prices above what other market participants (arbitrageurs) are willing to pay. By converting the bonds, the underwriters then can eliminate their short position in the put options and close out their short positions in the stock at the same time as they receive the take-up fee. Singh (1997) showed that underwriters are buying rights in the market and are short selling stock in the case of underwritten rights offers and explains this by arguments similar to those above.

Such a behavior by the underwriter of convertible bond calls is recognized by the stock market as it can be seen from an article in the Investment Dealers' Digest. On April 29, 1996, the magazine described a call by AMR Corp. of a $1 billion convertible bond issue. The call was underwritten by five investment banks.[23] As underwriters, these investment banks had agreed to buy up to 12.9

[21] When the underwriter short sells to hedge the risk associated with his short position in the put options, this is an example of what is known as 'to lay off'.

[22] This is for example the case for the call described in footnote 17, where the underwriter offers a purchase price higher than the call payment.

[23] CS First Boston, Merrill Lynch, J.P. Morgan, Salomon Brothers and Goldman, Sachs & Co.

million shares if the investors did not convert eliminating any need for AMR Corp. to come up with cash should conversion fail. This call is argued to have a high risk profile not only because of the magnitude of the call but also because the conversion value is just 12.7% above the call payment. As mentioned in the article: "It's one of those deals where the firm's relationship guys are happy, but the risk management side is not happy." The announcement of the call led to a stock price decline of 6.0% increasing the risk of a failed conversion. However, as noted in the article: "... the underwriters themselves were causing some of the pressure on the stock, as they aggressively reduced their risk by buying bonds and shorting the stock in the open market. According to one source, only $400 million of the risk remained two days after the call announcement." The open market operations both reduced the underwriters' risks and allowed them to get the take-up fee, which in this call was 1.25% for the first $200 million, 1.5 % for the next $200 million, and so on.

Based on these arguments, we should expect that the number of shares sold short and hence also the number of shares traded (the trade volume) are related to the call. The number of shares sold short is expected to increase in the period prior to the call with a peak at the announcement of the call. In addition, the number of shares sold short is expected to decline at the end of the conversion period, when the new shares received upon conversion of the bonds are used to close out the short positions. However, the decline in the number of shares sold short may occur before the end of the conversion period if for example an underwriter is converting the bonds as soon as possible. An increase in the short selling of stock is also expected to be seen as an increase in the number of shares traded around the call announcement. The trade volume and the short selling of stock will be examined in sections 5.2 and 5.3.

Such an increase in the short selling of stock will help to explain how new shares issued upon a later conversion can lead to a price pressure at the announcement of the call. Part of the announcement effect may therefore be caused by investors who – for hedging purposes – short stock as described above. The subsequent price recovery will then follow as the hedging positions are closed out. The short selling leads to price pressure because the price has to fall in order to induce investors to absorb the increased supply of shares. Short selling is often argued to indicate a future excess demand for the stock because the short sellers later have to buy shares in the stock market in order to close out their short positions. However, this will not be the case when shares are sold short to hedge a convertible bond call. In this case the short selling represents a future increase in the supply. Section 5.4 examines the relation between the announcement effect and the short selling of stock.

The sections above have argued that short selling is important in connection with convertible bond calls. Therefore, the following will briefly describe how the regulations of short selling take this into account. The Securities and Exchange Commission (SEC) Rule §240.3b-3 defines a 'short sale' as: *The term short sale means any sale of a security which the seller does not own* ... . A holder of a convertible bond will be deemed to own the corresponding shares only when the convertible bond *has* been handed in for conversion. This means that if a convertible bondholder without owning the corresponding shares sells some of these before the bond is handed in for conversion, this will be defined as a short sale.

Short sales are regulated in the SEC Rule §§240.10a-1 and 240.10a-2. From §240.10a-1(a) it follows that short sales are prohibited when stock prices are declining according to the so-called up-tick rule. More precisely, the up-tick rule states that short sales are only permitted at a price higher than the preceding transaction in the same stock (an up-tick) or at the same price as the previous transaction but at a higher price than the last difference price (a zero-plus-tick). However, there are important exemptions from this rule. §240.10a-1(e) states that the up-tick rule does not apply (i.e. you can short stock exempt from the up-tick rule) if you either are the owner of a convertible bond or if you are making a lay-off sale in connection with a standby underwriting commitment. This means that even if stock prices are declining, it will be possible for both arbitrageurs who own convertible bonds and for the underwriter to short sell the corresponding stock. The exemption from the up-tick rule is clearly important in the case of convertible bond calls because the call announcement is associated with declining stock prices.

4 Methodology and data-set

4.1 The methodology

A standard event study is used to derive the pattern of abnormal stock returns in a period around the call announcement. The event study and the related tests are briefly described in appendix B. An estimation period from 150 to 300 days after the announcement is used in order to avoid the selection bias caused by using a pre-event estimation period.[24] This period is used to estimate the normal return parameters according to the market model with the equally weighted index from

[24]Because convertible bonds are typically issued with a conversion right deep out-of-the-money, the stock prices should incline before it will be possible for the firm to force conversion by calling the bond. Hence, the use of a pre-event estimation period will bias the so-called normal returns used in the event study (Cowan, Nayar, and Singh (1990), and Campbell, Ederington, and Vankudre (1991)) and therefore, a post-event estimation window should be used.

CRSP as market index. The event study has also been performed using other methods to calculate the excess returns, with other estimation periods, with the constant return model and with the value weighted index as market index. All these changes give results similar to those in the next section as long as the estimation period is after the event.

This paper also uses some other tests which will be defined and described when used.

4.2 The data-set of convertible bond calls

The data-set consists of calls of convertible bonds in the period 1963-1995. Standard and Poor's Bond Guide and Moody's Bond Guide have been used to identify the calls.[25] From this set of calls, we select those fulfilling the following selection criteria:

- An announcement date can be identified in either the Wall Street Journal or through Lexis-Nexis/Dow Jones News Wires.
- The firm's stock is registered on the New York Stock Exchange (NYSE) or the American Stock Exchange (AMEX) implying that stock information is available on the CRSP-file.
- The conversion value at the time of the announcement is higher than the call payment.[26]

This leads to a sample of 380 calls distributed over time as illustrated in Table II. The table shows that even though there are fewer observations in the beginning of the time period, there is no severe clustering of observations. In addition, because we are interested in how the call affects the stock prices, we have to ensure that a possible effect is not due to other news announced around the call. Finally, in order to apply the event study, stock returns have to exist for a period around the call announcement and in the estimation period. Therefore, when in the rest of this paper we use an event study or results from the event study, we will furthermore require that:

- No other news about the same firm appears in the Wall Street Journal in a two-day period around the announcement date.
- Daily stock returns are available on the CRSP file from 50 days before the call to 300 days after the call.

This reduces the sample to 309 calls, but it is still the largest sample of calls of convertible bonds examined in the literature. The large data-set has been obtained because in contrast to most other

[25] An initial set of calls was kindly provided by W. T. Moore.

[26] The conversion value is calculated as the stock price two days prior to the announcement times the conversion ratio.

studies, the calls were not restricted to have been announced in the Wall Street Journal. In addition to the advantage of a larger data-set, the search in the news wires makes it possible to obtain more accurate announcement dates. It happens that the news about the call is available on the news wires a few days before it is printed in the Wall Street Journal. Because we are examining the announcement effect, it is clearly important that we use the first date where the stock market receives information about the call as announcement date.

Period	63-65	66-68	69-71	72-74	75-77	78-80	81-83	84-86	87-89	90-92	93-95
Calls	5	24	23	24	23	46	32	48	60	41	54

Table II: Distribution through time of the sample of 380 convertible bond calls.

In addition to the announcement date, more detailed information about each individual convertible bond issue is needed. Several sources have been used to collect this information. Some of these are Standard & Poor's Bond Guide, Moody's Bond Guide, Moody's Industrials, the Wall Street Journal, and the Corporate Financing Directory. All information on stock splits, number of shares outstanding, stock prices, stock returns etc. was collected from the CRSP-file.

Summary statistics

Table III provides sample characteristics. From the table, we observe that convertible bond calls in general lead to a quite significant increase in the number of shares outstanding with an average increase of 12.3% and a median of 9.6%. However, the increase in the number of shares outstanding varies from 0.03% to 49.60%. The table also shows that the conversion value varies from 1% to 406% above the call payment with an average of 47%. These numbers indicate the existence of so-called clean-up calls in the sample. Clean-up calls are calls with the purpose of redeeming an issue with only a small amount of face value outstanding. These calls will typically only lead to a small increase in the number of shares outstanding and can have a conversion right deep in-the-money. This is further illustrated by the fact that the minimum face value of a called issue is only $147,000. For clean-up calls, it is often the case that bondholders optimally should have converted voluntarily but for different reasons there may exist so-called *sleeping investors*. In order to avoid having to service such a little amount of debt outstanding, the firm can redeem the debt by calling it. Constantinides and Grundy (1987) and Dunn and Eades (1989) both examined these 'sleeping investors' in further detail.

The length of the conversion period is on average slightly longer than one calendar month, corresponding to 23.5 trading days. The bonds are observed to be called many years before maturity, on average more than 16 years. Finally, it should be noted that 115 of the 380 calls are underwritten corresponding to slightly more than 30%. All in all the characteristics for the present data-set are similar to characteristics reported for data-sets used in other studies of convertible bond calls.

	Mean	Median	Minimum	Maximum
Increase in number of shares (millions)	2.23	1.27	0.01	20.80
Increase in number of shares (%)	12.32	9.61	0.03	49.60
Size of called issue ($ millions)	53.53	30.00	0.15	805.00
Conversion value/call payment	1.47	1.32	1.01	5.06
Length of conversion period (trading days)	23.52	22.00	8.00	60.00
Years left to maturity	16.66	18.00	1.00	27.00

Table III: Descriptive statistics for the 380 convertible bond calls in the period 1963-1995. The increase in the number of shares (millions) is defined as the number of new shares that will be issued upon a full conversion of the bonds outstanding. The increase in number of shares (%) is obtained by dividing the increase in number of shares (millions) with the number of shares outstanding before the call. The size of a called issue is the face value of debt outstanding before the call. The conversion value/call payment gives the moneyness of the conversion right (i.e. the extent to which the conversion right is in-the-money). The conversion value is calculated based on the stock price two days prior to the announcement of the call. The length of the conversion period is the number of trading days from the announcement of the call until the end of the conversion period. The years left to maturity is the number of years from the time of the call until maturity of the bond, had it not been called.

4.3 The short interest data

In order to examine the short selling associated with convertible bond calls, information about the number of shares sold short, also called the short interest, is required.[27] Unfortunately, the short interest numbers are available only on a monthly basis. Because short interest numbers are only available electronically regarding the last few years, the numbers for this study were collected from Standard & Poor's Daily Stock Price Record for NYSE and AMEX. The Daily Stock Price Records report the short interest numbers for each individual stock on the respective stock exchange. The numbers are similar to those published monthly in the Wall Street Journal and represent the total number of shares sold short on the last day of trade on or before the 15th of the month. For this

[27] More precisely, the short interest at a given point in time is the number of shares in an individual firm that has been borrowed for short sales but not repaid at that time.

study it is important to know the exact date for which the short interest is computed. This is required in order to know whether additional short selling caused by the call announcement would be reflected in a certain short interest number or not. Because of the settlement period, the exact calculation date for the short interest will depend on the length of this period. For most of the time period considered, the settlement period was five trading days, but in June 1995 it changed to three trading days. Therefore, the record day for a short sale will be either three or five trading days before the report day. For example if the report date (the 15th) in a standard month before June 1995 is a trading day, the short interest will report the number of shares sold short and still not closed out when the stock exchange closes on the 8th.

The exact calculation day is calculated for all the individual short interest numbers and the time series of short interest numbers for the individual stock are defined such that SI_{-1} is the last short interest number before the announcement, whereas SI_0 is the short interest number, if any, reported between the announcement day and the last day in the conversion period.[28] SI_{+1} is the first short interest number after the last day in the conversion period.[29]

In addition to the complications related to the calculation date, the Daily Stock Price Records are troublesome to work with when collecting the short interest numbers. When there are stock splits or stock dividends, it is often the case that one manually has to recalculate several of the numbers accordingly. In addition, it happens that simple errors have been made in either the order of the months or the order of the short interest numbers. In all cases, the numbers have to be compared across several books with overlapping time periods in order to ensure accuracy. All the short interest numbers have been checked this way and some have furthermore been checked through a comparison to the numbers reported in the Wall Street Journal.

Summary statistics for the short interest numbers are provided in section 5.3, where the short interest numbers are examined.

[28] For six calls, there were actually more than one short interest number in the conversion period. For these calls, the first of these is used as SI_0. One hundred calls did not have a short interest number reported in the conversion period.

[29] An example from the data-set can illustrate the tedious work performed in order to get accurate time series of short interest data. On February 10, 1986, Piedmont Aviation Inc. announced a call of a $50 million convertible bond issue. February 15, 1986, is a Saturday, meaning that the settlement date for the February short interest number is February 14. With a settlement period of five days, the short interest number for February reports the number of shares sold short at the close of the stock exchange on February 7 and will therefore not include the shares sold short because of the call announcement. Hence, the short interest number from February will be SI_{-1}. Similarly, it can be shown that the short interest number for March will report the number of shares sold short on March 7. Because this call has March 3 as last conversion date, this is an example where there is no short interest number reported within the conversion period and the March number will be SI_{+1}. If the last conversion date had been after March 7 but before April 8, the short interest from March would have been SI_0 and the April number would have been SI_{+1}. However, if this had been the case it should be noted that SI_0 would be from a date many days after the call announcement date and thus SI_0 can be problematic in measuring the additional short selling at the announcement.

5 Evidence for a short selling induced price pressure

This section examines the data-set of convertible bond calls and the data-set of short interest numbers described in the previous section. Section 5.1 provides evidence for the announcement effect and the subsequent recovery of stock prices using both an event study, a price-rebound test, and a regression of the price recovery on the announcement effect. Section 5.2 considers price pressure in further detail by examining the trade volume around the call announcement and the relation between the announcement effect and the number of new shares to be issued upon conversion. Section 5.3 examines the short interest numbers including the time pattern. Section 5.4 ends the empirical results by examining whether the announcement effect can be explained by variables expected to be relevant according to the hedge arguments given in section 3.4.

5.1 The announcement effect and price recovery

In addition to documenting the announcement effect, the following provides evidence that stock prices recover after the call announcement. However, it is not obvious during which time period prices should be expected to recover if the stock price pattern is caused by price pressure. Here the conversion period has been chosen because no additional short selling is expected after this period and the short positions are expected to be closed out with new stock issued upon conversion of the bonds. When examining if prices have recovered, there may still be problems associated with the use of the last conversion date. Some stock prices may have recovered earlier whereas the recovery may take even longer for other stocks. These differences can be due to different lengths of the conversion periods or because the depth of the market differs from stock to stock. Furthermore, for calls where there has been no or only little short selling there might be additional price pressure around the end of the conversion period from the new shares issued upon conversion. For these bonds, the shares issued will not be used to close out short positions but will represent an increase in the supply.

5.1.1 The event study

The results from the event study described in appendix B are shown in Table IV. For different event time periods, the table shows the cumulative average abnormal return, ($\overline{CAR}$), and two different tests for $\overline{CAR} = 0$ and their corresponding p-values. The test-statistic Z is the parametric test defined in (B.10) in appendix B whereas J is the non-parametric sign-test defined in (B.12). The announcement period is from day -1 to day 0 to take into account that many of the announcements occured one day before the news was published in the Wall Street Journal.[30]

Period (event days)	$\overline{CAR}$(%)	Z	p-value(%)	J	p-value(%)
-50:-2	8.64	8.54	< 0.01	7.90	< 0.01
-1:0	-1.75	-10.86	< 0.01	-8.93	< 0.01
+1:lcvd	2.24	2.99	0.28	3.13	0.18
lcvd+1:lcvd+50	2.03	1.76	7.77	1.31	19.07
-2:lcvd	0.49	-0.29	77.24	0.40	69.05

Table IV: Results from the event study described in appendix B. Date 0 is the announcement date. lcvd denotes the last day in the conversion period. $\overline{CAR}$ is the cumulative average abnormal return for the different time periods and is defined in (B.9). Z is the corresponding test statistic for the significance of $\overline{CAR}$ defined in (B.10) and J is the sign-test for the significance of $\overline{CAR}$ defined in (B.12). The p-values are calculated based on the fact that both Z and J are asymptotic normally distributed.

These results from the event study can be illustrated graphically as in Figure 2, where the time-pattern for the cumulative average abnormal return is shown. Table IV and Figure 2 both show that as expected according to footnote 24, the stocks have high abnormal returns in the period before the call. The call announcement leads to a highly significant -1.75% abnormal return, but the stock prices recover during the conversion period with an abnormal return of 2.24%, significant at the 1% level. All in all, this gives an insignificant abnormal return of 0.49% in the period from 2 days before the announcement to the end of the conversion period. Figure 2 and Table IV therefore provide evidence for a significant announcement effect and a price recovery of stock prices during the conversion period. The following will examine this further.

5.1.2 The price-rebound test

Instead of examining stock returns, we can consider stock prices in order to examine if stock prices recover during the conversion period. One way to test for a recovery is to compare the stock price two days before the announcement with the stock price at the end of the conversion period as done in Byrd and Moore (1996). Here we extend their test by comparing these stock prices with the

[30] For calls announced only in the News Wires, the announcement day is the day after the call appears in the News-wires in order to be consistent with the announcement dates from the Wall Street Journal. This also solves the problem that these calls may be announced after the stock market has closed and an eventual effect will then only appear the following day.

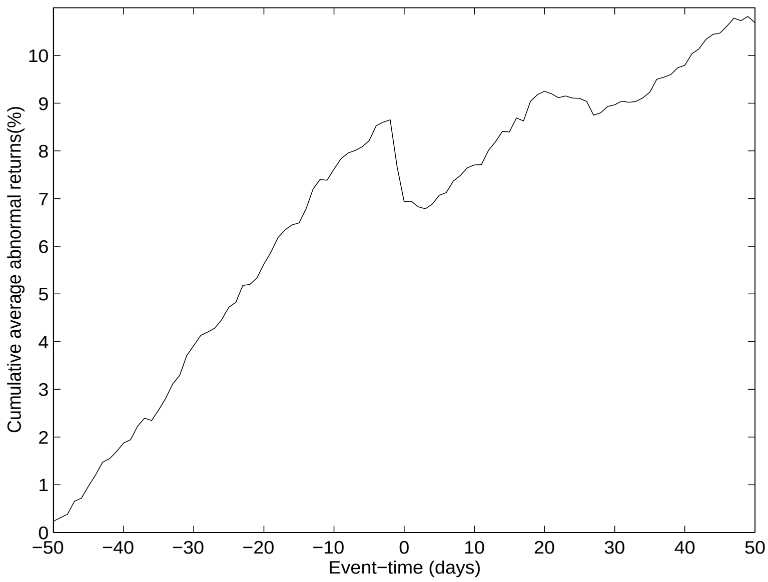

Figure 2: The time pattern in the cumulative average abnormal return ($\overline{CAR}$) from the event study described in appendix B. To estimate the normal returns, a standard market-model is used in a post-event estimation window. Day 0 is the announcement day.

stock price one day after the call announcement, i.e. for each convertible bond in the sample we calculate the following stock price ratios:[31]

$$\frac{P_{-2}}{P_{+1}} \qquad \frac{P_{lcvd}}{P_{+1}} \qquad \frac{P_{lcvd}}{P_{-2}},$$

where $lcvd$ again denotes the last day in the conversion period, and -2 is two days before the call announcement and $+1$ is the day after. As stock prices we use the PRC-variable from the CRSP-file adjusted for stock splits in the conversion period. The results from comparing these ratios to one are given in Table V.

Table V provides further evidence for a recovery of stock prices. As expected, both the median and the mean are larger than one for all ratios and more than half of the sample recovers completely. The first two price ratios document a highly significant price decline at the call announcement and a highly significant price incline during the conversion period. This price pattern is significant both in the mean and in a binomial test looking at the number of price ratios greater than one. All in all, the total effect is a small price incline over the period from two days prior to the call to the end of the conversion period. The t-statistics reveal that the mean of all three ratios is significantly higher than one at the 5% level.

[31] We calculate $\frac{P_{-2}}{P_{+1}}$ instead of $\frac{P_{+1}}{P_{-2}}$ such that all ratios are expected to be larger than one according to the existence of an announcement effect and a subsequent price recovery.

Ratio	#greater than 1/#less than 1	Bin-prob	Median	Mean	t-test for Mean$\leq$ 1
$\frac{P_{-2}}{P_{+1}}$	217/92	$< 0.1\%$	1.0172	1.0171	7.62 ($p < 0.1\%$)
$\frac{P_{lcvd}}{P_{+1}}$	184/125	$< 0.1\%$	1.0168	1.0274	4.81 ($p < 0.1\%$)
$\frac{P_{lcvd}}{P_{-2}}$	167/142	8.6%	1.0052	1.0113	1.89 ($p = 3.0\%$)

Table V: Results from the price-rebound test. #greater than 1/#less than 1 refers to the number of the different price ratios greater respectively less than one. Bin-prob is the probability of drawing at least the observed number of price ratios greater than one under the binomial distribution with probability 0.5 and 309 trials. Median and Mean gives the median and the mean of the price ratios. The t-test is the one-sided t-test for Mean$\leq$ 1 with p as the corresponding p-value.

5.1.3 Price recovery regression

Another way to look at the price recovery is to examine whether the stocks that have the largest price decline also have the largest price recovery during the conversion period. To examine this, we run the same regression as in Mazzeo and Moore (1992):

$$CAR_{i,+1:lcvd} = \alpha + \beta CAR_{i,-1:0} + \epsilon_i.$$

According to a price recovery after the announcement effect, it should be expected that β in the regression is negative. Using Weighted Least Squares,[32] this regression gives:

$\hat{\alpha} = 0.0075$	$\hat{\beta} = -0.29$
$(t = 1.27)$	$(t = -1.61)$
$(p = 20.6\%)$	$(p = 10.7\%)$.

These results are not as strong as in Mazzeo and Moore (1992) but can still be taken as further evidence for a price recovery.[33] There may be several reasons why these results differ from the results in Mazzeo and Moore (1992) and for why they are not stronger. For example, we use a longer time period and an extended data-set including observations where the call announcement is not published in the Wall Street Journal. In general, the emergence of new information about the firm during the conversion period may also cause problems in the regression above. In the event study, we have been strict in only using calls where no new information about the firm was published around the call announcement. It is not possible to use the same selection criteria for

[32]Because the conversion periods are of different lengths, we use 1 divided by $\sigma_i \sqrt{L_{cv,i}}$ as weights, where σ_i is the standard deviation of the daily stock returns for bond i in the estimation period, and $L_{cv,i}$ is the length of the conversion period for bond i.

[33]Similar results are obtained by a regression of $\frac{P_{lcvd}}{P_{+1}}$ on a constant and $\frac{P_{+1}}{P_{-2}}$.

observations with news in the conversion period because this would reduce the data-set to only a few observations. Finally, there are two reasons why the β-coefficient should not necessarily be expected to be significantly negative. First, as described earlier, it is not clear that the last conversion date is the appropriate date to use when examining whether stock prices have recovered. Second, there might be an additional price pressure during the conversion period as more bonds are sold to the convertible hedge desks or as stock received upon conversion are sold in the stock market.

To conclude we can say that the results from the event study and the tests above have shown that stock prices recover during the conversion period, which indicate that the pattern in stock prices is caused by price pressure. The next section examines this in further detail.

5.2 The trade volume and price pressure

Price pressure can be argued to have either a permanent or a temporary effect.[34] The effect is permanent if an increase in supply according to a downward-sloped demand curve leads to a stock price decline at the announcement and no recovery. On the other hand, the effect can be temporary if there is insufficient liquidity in the stock market; the stock prices decline in order to induce the stock market to absorb the new shares. In the case of convertibles, the new shares will not be issued at the announcement of the call. As described in section 3.1, this is because a valuable put option in general will make it optimal to delay conversion. Even if the new shares are not issued at the announcement of the call, they can still affect the prices in the stock market at that time. This will for example be the case if the holders of convertible bonds hedge against the increased equity risk by short selling, as the increase in supply will then happen at the time of the call.

Because a short sale of shares will be registered as a trade, we should expect to see an increase in the daily trade volume of the stock around the call announcement. This is examined in Figure 3. The figure plots the average scaled daily trade volumes against the event-time. By scaled we mean that before the average of the trade volumes is calculated, the trade volumes for the individual stocks are divided by their average for the same period.[35] This is done in order to avoid that stocks with a high daily trade volume become too influential. If an identical number of shares was traded each day, this would give the solid horizontal line at one shown in the figure. The dashed lines give the one-standard deviation band around the mean. From Figure 3 it follows that there is a large

[34] This is considered in for example Kraus and Stoll (1972), Shleifer (1986), and Harris and Gurel (1986).
[35] Scaling by for example the number of shares outstanding gives a similar figure.

increase in the number of shares traded around the day with the call announcement. There are also indications of a higher trade volume in a short period after the announcement. This is consistent with the argument that in a short period after the call announcement, there are investors who sell the convertible bonds to the hedge desks, leading to additional short selling and an associated price pressure. From Figure 2 it also follows that there is indications of additional price pressure the first few days after the call announcement.[36]

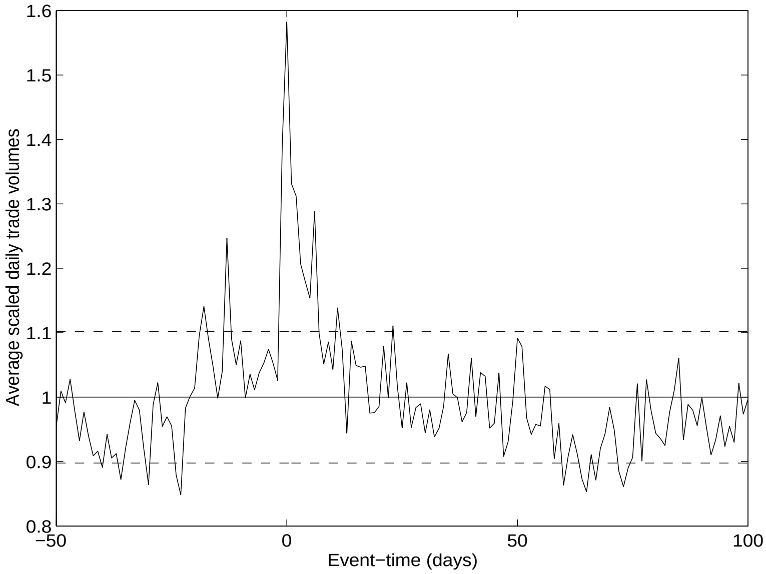

Figure 3: The pattern in average scaled daily trade volumes with day 0 as the announcement day. The trade volumes for the individual stocks are divided by their mean for the same period. The horizontal line at 1 shows the mean of the average scaled daily trade volumes and illustrates how the pattern would have been if the same number of shares was traded every day. The dashed lines give the one-standard deviation band around the mean.

In section 3.4 it was argued that the increase in the trade volume around the announcement of the call is due to hedging performed by convertible hedge desks and a possible underwriter. Therefore, we would expect a relation between the trade volume at the time of the call and the number of new shares that would be issued upon a full conversion of the bonds. In order to have the two measures at the same scale both measures are divided by the number of shares outstanding before the call announcement. If hedging associated with the convertible bond calls is causing the trade volume, a positive relation is expected between the trade volume and the number of shares to be issued. The more new shares that will be issued upon conversion the more shares should be

[36] The cumulative average abnormal return for day +1 to +3 is -0.16% and it is not until day +5 that stock prices reaches a level higher than the level at day 0.

sold in order to hedge the equity risk of the convertible bonds. The relation is examined by running a regression of the total trade volume for day -1 and 0 (denoted $TRVOL_i$) on a constant and the number of new shares to be issued (denoted New_i) where both numbers of shares are relative to the total number of shares outstanding (denoted SO_i). The number of new shares, New_i, to be issued upon a full conversion for call i, is calculated as the face value of the debt outstanding before the call divided by the face value of one bond times the conversion ratio. With this notation, the regression can be written as

$$\frac{TRVOL_i}{SO_i} = \beta_0 + \beta_1 \frac{New_i}{SO_i} + \epsilon_i.$$

The results of the regression are:

$$\begin{array}{ll} \hat{\beta}_0 = 0.0068 & \hat{\beta}_1 = 0.0511 \\ (t = 5.9) & (t = 6.61) \\ (p < 0.01\%) & (p < 0.01\%) \\ Adj.R^2 = 0.12. & \end{array}$$

The regression results provide evidence for the expected positive relation. This means that a higher fraction of new shares relative to the shares outstanding leads to additional trade volume. This is consistent with the argument that the trade is caused by the hedging of the equity risk associated with the convertible bond call.

So far this section has provided evidence for both a price recovery and the fact that the pattern in stock prices may be due to price pressure caused by the call. However, we still need to examine whether the increase in trade volume can be partly explained by investors hedging the risk associated with a called convertible bond. As mentioned earlier, one way to hedge this risk is by short selling the stock. Therefore, the next section examines whether there is a time pattern in the number of shares sold short, and whether the short selling is related to the call.

5.3 The short interest

Earlier, it was described how short selling is expected to be related to convertible bond calls. Firstly, we should expect a relation between the short selling of stock, the call announcement, and the importance of hedging. Secondly, we should not only expect short selling to happen in connection with underwritten calls. Thirdly, it is expected that the amount of short selling is correlated with the size of the call. Finally, we should expect to find a relation between the announcement effect and the amount of short selling. This section will examine the first three of these relations by looking at the monthly short interest numbers. The next subsection will relate the announcement effect to the short selling.

Table VI presents summary statistics on the relative sizes of the short interest numbers. The table lists the short interest three months before the call (SI_{-3}), the short interest associated with the call ($SI_{at\ call}$), and the first short interest number from *after* the last conversion day (SI_{+1}). In the first three rows, the short interest numbers are scaled by the number of shares outstanding before the call, and in the last three rows by the number of new shares to be issued upon conversion.

	Mean (%)	Median (%)	Min (%)	Max (%)	t-test	p-value (%)
$\frac{SI_{-3}}{SO}$	2.13	1.06	0.00	30.30	1.61	5.41
$\frac{SI_{at\ call}}{SO}$	2.80	1.34	0.00	33.01		
$\frac{SI_{+1}}{SO}$	1.05	0.43	0.00	10.86	-10.31	< 0.01
$\frac{SI_{-3}}{New}$	15.94	9.29	0.00	77.45	2.71	0.35
$\frac{SI_{at\ call}}{New}$	21.80	12.97	0.00	89.81		
$\frac{SI_{+1}}{New}$	7.88	3.90	0.00	63.34	-18.60	< 0.01

Table VI: Descriptive statistics for the short interest data for the 380 convertible bond calls in the period 1963-1995 and the corresponding tests for changes in the short interest around the calls. The first three rows in the table measure the short interest relative to the total number of shares outstanding, SO, while the last three rows measure the short interest relative to the number of new shares, New, to be issued upon a full conversion of the bonds. The t-tests test if there is a difference between the short selling at the time of the call ($SI_{at\ call}$) and the short selling in month -3 (SI_{-3}) and in month $+1$ (SI_{+1}) respectively. The t-test is the standard one-sided test of the difference between means using matched pairs. In order to avoid problems when scaling with the number of new shares caused by small calls with a low number of new shares to be issued, it is required in the second part of the table that the call will lead to an increase of at least 2.5% in the number of shares outstanding. This reduces the number of calls to 327.

In earlier sections, the short interest associated with the call was argued to be SI_0. However, due to the data available there are some possible problems with SI_0 as a measure of the short selling caused by the call. First of all, with monthly numbers and many conversion periods shorter than a month, there are many calls for which no short interest number is available from the conversion period. Therefore, we have chosen to define the short interest $SI_{at\ call}$ associated with the call announcement as SI_0 when SI_0 is available and SI_{-1} when it is not. Another problem, described in footnote 29, is that the calculation date for SI_0 may be close to the end of the conversion period for some of the bonds that will have a short interest number from the conversion period. Finally, as described in section 3.4 there may be reasons for an early close-out of the short positions, which also will make it difficult to measure the short selling at the call. This means that even though a SI_0 number is available, it may be a poor measure of the short selling associated with the call.[37]

From Table VI it follows that the short interest around the call is on average 2.8% of the total number of shares outstanding and 21.8% of the new shares to be issued.[38] The amount of short selling varies both relative to the number of shares outstanding and relative to the number of new shares to be issued upon conversion. In both cases, the minimum corresponds to the case where there is no short selling at all. Relative to the number of shares outstanding, the maximum short selling is around 30%, while it is around 80% relative to the number of new shares. The maximum column illustrates that for some calls, it is possible that the number of shares sold short will stay at a high level even after the end of the conversion period. This indicates that there probably are calls where the short selling of stock is not due to the call alone. Another explanation for short selling around convertible bond calls may be that sometimes a call is triggered by a possible merger or acquisition and that some short sellers are betting on the outcome of such corporate events.

To examine short selling even further, Figure 4 plots the time pattern for the three quartiles and the mean of the short interest numbers divided by the number of shares outstanding before the call. Table VI and the figure clearly demonstrate a pattern in the short interest numbers. There is an increase in the short selling before the call and a highly significant decline after the call. Because the decline in the short interest is so pronounced at the end of the conversion period, the short selling must primarily be associated with the call itself and not with other corporate events as mentioned above. However, as described in section 3.4, in theory we should have expected an increase in the short selling from month -1 to month 0. It follows from section 3.1, that this is because the holder of a called convertible bond is expected to delay the conversion decision until the end of the conversion period. Such a delay in conversion implies that the hedging positions should be maintained until the end of the conversion period, and the increase in short selling associated

[37]Some of the problems with $SI_{at\ call}$ may suggest that $\max[SI_{-1}, SI_0]$ is used instead as the short interest associated with the call. All the following analyzes of the short selling have been made using this measure. However, this change of measure did not alter any of the main conclusions but improved the level of significance of some of the results.

[38]When dividing by the number of new shares, we restrict the analysis to the calls that lead to an increase of at least 2.5% in the number of shares outstanding, i.e. we exclude clean-up calls. This helps avoid the problem that might exist when the short interest is divided by a small number of new shares to be issued. One example is a call that leads to only 19.000 new shares being issued. For this call, the short interest is around 2 million shares corresponding to more than one hundred times the new shares to be issued. In addition, the pattern in the short interest seems to be unaffected by the call.

with the announcement of the call should be seen as an increase in SI_{-1} to SI_0. Figure 4 shows no such increase from month -1 to month 0. There are several explanations for the observed pattern. As mentioned above one problem is that SI_0 can be a poor measure of the increase in short selling caused by the call. Another problem is that the calculation of the quartiles and the mean of the short interest numbers for month 0 is based on fewer observations than the other months. This is because SI_0 is not available for one third of the calls.

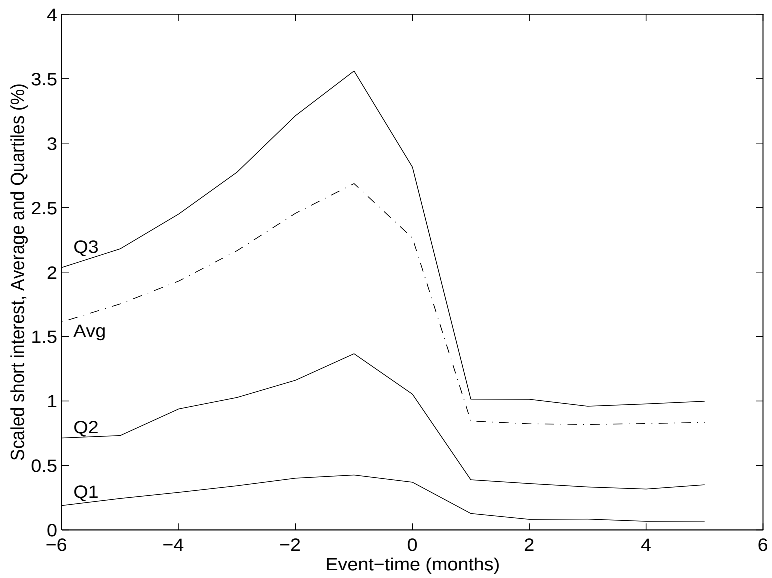

Figure 4: The average and the quartiles of the scaled short interests in % of the number of shares outstanding. The numbers for month 0 denote the first short interest number in the conversion period. If the short interest number for month 0 is not available, the stock is not used in the calculation of the average and quartiles for month 0.

It follows from section 3.1 that several characteristics of the call are expected to influence the conversion behavior of the bondholders and hence also the short selling of stock. One such characteristic is related to the conversion right. The importance of hedging is expected to be negatively related to the extent to which the conversion right is in-the-money measured by the conversion value divided by the call payment (the moneyness). To examine this relation, the data-set is divided into four groups, where group 1 is the 25% of the data-set with the lowest value of the conversion value divided by the call payment, group 2 is the next 25%, and so forth. For each of these groups, Figure 5 plots the time pattern of the short interest.

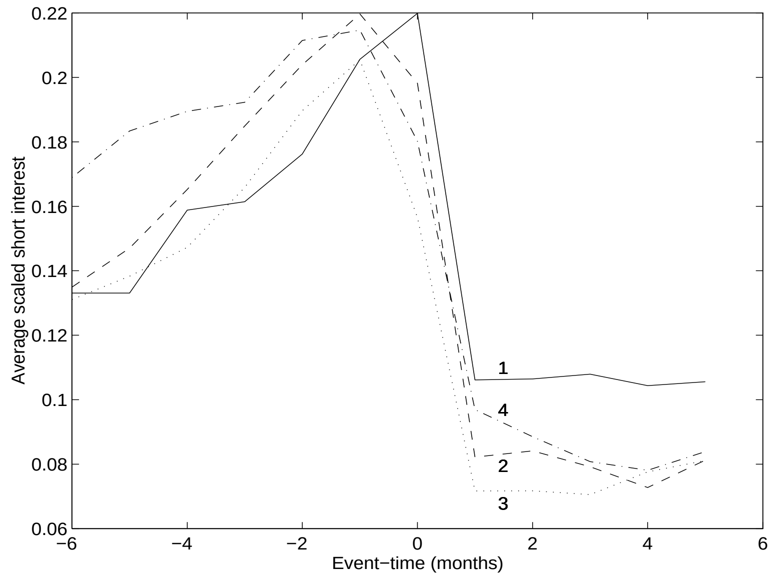

Figure 5: The average scaled short interest for the data-set divided into four groups dependent on the moneyness of the conversion right. Group 1 is the group with the lowest moneyness, group 4 is the one with the highest moneyness. The short interest numbers are scaled by the number of new shares to be issued from conversion and therefore, again it is required that $\frac{New}{SO} > 2.5\%$.

Figure 5 reveals some differences in the time pattern of short interest between the groups. The four groups are seen especially to differ with respect to the change in the short interest from month -1 to 0. Group 1 now shows a clear increase and for the other groups the decline from month -1 to month 0 increases through the groups. This is as expected. A conversion right that is just in-the-money should make short selling more pronounced and persistent and therefore it is more likely that SI_0 will capture an increase in the short selling at the announcement of the call.

Table VII presents a more detailed examination of the changes in the short interest from Figure 5. For the calls with a short interest number for month 0, the table presents the number of calls with $SI_0 > SI_{-1}$ and the number of calls with $SI_0 > SI_{+1}$ for the four groups and the total sample. The pattern in the table corresponds to the pattern in Figure 5. Only group 1 has an significant increase in the short interest number from month -1 to month 0. For the other groups, around half of the short interest numbers actually increase even though Figure 5 shows a large decline in the short interest numbers from month -1 to month 0. The decline in the short selling from month 0 to month $+1$ is clear and highly significant for all groups. If, because of measurement problems, the large decline seen between SI_0 and SI_{+1} for some calls happens between SI_{-1} and SI_0, this can explain the overall decline for three of the four groups in Figure 5 even though around half of the call actually shows an increase in the short selling associated with the announcement.

Group ($\#Obs$)	$\#SI_0 > SI_{-1}$	Bin-prob	$\#SI_0 > SI_{+1}$	Bin-prob
1 (70)	47	0.3%	65	$< 0.1\%$
2 (70)	37	36.0%	64	$< 0.1\%$
3 (70)	28	96.4%	63	$< 0.1\%$
4 (70)	29	94.0%	49	$< 0.1\%$
All (280)	141	47.6%	241	$< 0.1\%$

Table VII: Comparison of the short interest around the calls for the total data-set and for the data-set divided into four groups dependent on the extent to which the conversion right is in-the-money measured by the conversion value divided by the call payment. Group 1 is the group with the lowest value while group 4 is the one with the highest value of the conversion value divided by the call payment. Calls without any short interest for month 0 are excluded. $\#Obs$ refers to the number of observations in the different groups. Bin-prob is the probability of drawing at least the observed number of increases under the binomial distribution with probability 0.5 and $\#Obs$ trials.

All in all, the above provides strong evidence that the time pattern in the short selling of stock is related to the call and that the call leads to a large decrease in the number of shares sold short. This evidence not only supports a hedging induced price pressure but provides in addition strong evidence against the bad-news explanation adding to the evidence presented in for example Ederington and Goh (2001). If a convertible bond call was viewed as bad news about the firm, we should have expected a more permanent increase in the short selling after the call rather than the observed decrease.

In general, a possible underwriter will not be appointed until closely before the call, and hence, the underwriter is only expected to be short selling in a short period around the call. Therefore, the time pattern indicates that short selling is not due to an underwriter alone. We can examine this even further by testing if there is a relation between short selling at the time of the call and an underwriting dummy U_i, which is 1 if the call is underwritten and 0 if it is not.[39] We test this by running the following regression

$$\frac{(SI_{at\ call})_i}{New_i} = \beta_0 + \beta_1 U_i + \epsilon_i,$$

where $(SI_{at\ call})_i$ and New_i are as defined above. Because we are dividing by the number of new

[39] Several other regressions have been performed in order to examine the relation between short selling and whether the call is underwritten or not. None of these provided any evidence for a significant relation between short selling and the underwriting dummy.

shares to be issued, we again require that $\frac{New}{SO} > 2.5\%$. The results of the regression are:

$\hat{\beta}_0 = 0.2196$	$\hat{\beta}_1 = -0.0246$
$(t = 13.48)$	$(t = -0.91)$
$(p < 0.1\%)$	$(p = 36.3\%)$

These results provide no evidence that short selling should only be relevant for the underwritten calls. Instead, it shows an insignificant negative relation between short selling and the underwriting dummy. This is consistent with the argument that the convertible hedge desks also are short selling stock in connection with convertible bond calls. However, the negative coefficient on short selling may also indicate that the short interest numbers especially for the underwritten calls are poor measures of the short selling associated with the call. As mentioned earlier, the underwriter in particular may have incentives to convert as soon as possible and thereby close out a short position early in the conversion period.

Having demonstrated a pattern in the short selling around a convertible bond call, we will now examine whether the number of shares sold short is related to the bond called. First of all, one should expect a positive relation between a measure of the size of the call and the short interest. The number chosen as a measure of the size of the call is the number of new shares that would be issued if all bonds outstanding were converted. $SI_{at\ call}$ is again used as the short interest number of the call. Furthermore, because we are only interested in the increase in the short interest caused by the call, we subtract the short interest in month +1 from this short interest number. This is done under the assumption that the short interest number in month +1 represents the normal level due to other reasons for short selling.

To avoid a possible effect from both the short interest and the number of new shares to be issued being positively related to the number of shares outstanding, we divide by the number of shares outstanding before the call.[40] Figure 6 plots the relation between the short interest and the number of new shares to be issued.

To examine if there is a positive relation, we run the regression

$$\frac{(SI_{at\ call} - SI_{+1})_i}{SO_i} = \beta_0 + \beta_1 \frac{New_i}{SO_i} + \epsilon_i, \tag{3}$$

[40] We obtain similar results if we do not subtract SI_{+1}, or if we do not divide by the number of shares outstanding.

where SO_i and New_i are as defined earlier. The results of the regression are:

$$\hat{\beta}_0 = -0.0019 \qquad \hat{\beta}_1 = 0.1918$$
$$(t = -0.78) \qquad (t = 9.23)$$
$$(p = 43.8\%) \qquad (p < 0.1\%)$$
$$Adj.R^2 = 0.26.$$

These results show a highly significant positive relation between the short interest at the time of the call and the new shares to be issued. From the regression, we obtain the interesting result that the total number of shares sold short on average corresponds to at least 19% of the new shares. However, from Figure 6 we also observe a large cross sectional variation in the amount of short selling. This may be caused by several factors. Firstly, the monthly data on the short interest do not perfectly measure the short interest associated with the call. Secondly, for calls with a high fraction of new shares relative to the shares outstanding, it may be difficult to borrow the shares required in order to short sell. Hence, for the large calls, there may not be as much short selling as expected. Finally, it may simply be that not all convertible bondholders react to a call as explained in this paper. There may for example be convertible bond issues where the original bondholders do not sell the convertible bonds when the call is announced but instead keep the new shares received from the conversion. There may also be convertible bond issues like private placements where the bonds are not traded and hence, no short selling should be expected for these calls.

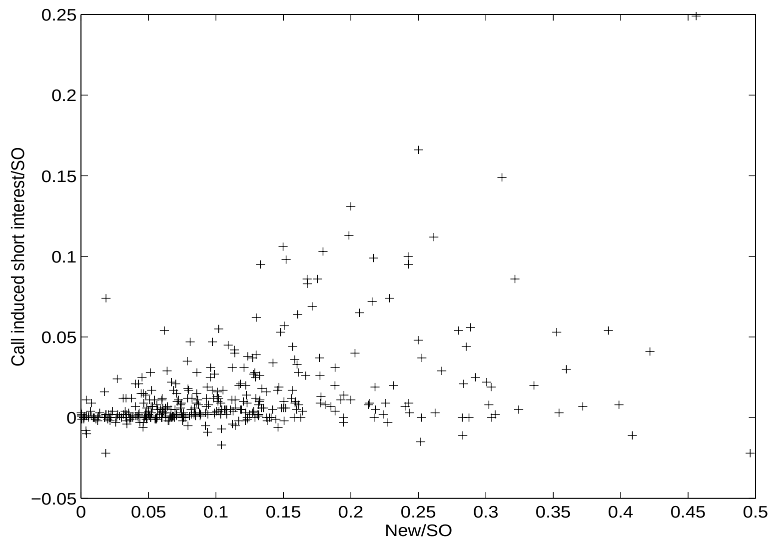

Figure 6: Cross sectional plot of the short interest induced by the call against the number of new shares to be issued upon conversion, both scaled by the number of shares outstanding before the call announcement. As a measure of the short interest induced by the call is used $\frac{SI_{at\ call} - SI_{+1}}{SO}$.

5.4 Hedging induced announcement effect

So far we have provided evidence for an announcement effect, a subsequent price recovery, and showed that the short selling is related to the call. A final step is now to examine if we can explain the announcement effect by hedging. One point to examine is if there is a relation between the announcement effect and the increase in short selling. As a proxy for an increase in the short interest at the call announcement, one can use $SI_0 - SI_{-1}$ for the calls where SI_0 exists. A cross plot of the announcement effect, $CAR_{-1:0}$, against the increase in short interest calculated as $\frac{SI_0 - SI_{-1}}{SO}$ provides only weak evidence for a relation between the short interest pattern and the announcement effect. Only for calls with an increase in the short interest number from month -1 to month 0, are there some evidence for the expected negative relation between the announcement effect and the increase in the short interest.

In an attempt to avoid the problem with the short interest number from month 0, we can instead use SI_{-1} as a measure of the short selling that has occurred already before the announcement. In this case, we should expect a positive relation between the announcement effect and SI_{-1}. This is because a high amount of short selling before the call will imply a small amount of additional short selling at the announcement and hence a less negative announcement effect.[41] One case where SI_{-1} especially is expected to be high is when the call is expected by the market. The reason is that the increased equity risk of the convertible bond would then have led to additional short selling before the call. If, as argued in the previous sections, the announcement effect is due to a hedging-induced price pressure, we should expect that several other variables would help explain the cross sectional variation in the announcement effect. Firstly, a large fraction of new shares to be issued upon conversion relative to the number of shares outstanding is expected to be associated with more price pressure and hence with a more negative announcement effect. This predicts a negative relation between the announcement effect and the size of the call. Secondly, if the conversion right is deep in-the-money, the incentive to hedge may be weak. Therefore, a positive relation is expected between the announcement effect and a measure of the conversion value relative to the call payment. Thirdly, in the case of underwritten calls, hedging performed by the underwriter as

[41] If, as above, we instead used $SI_{-1} - SI_{+1}$ as a measure of the short selling, the sign on the effect from short selling in Table VIII remains the same but the variable becomes slightly less significant. Primarily two factors may explain this difference. Firstly, by subtracting SI_{+1} we may increase the potential error in the short interest number and this way finding a significant relation is less likely. Secondly, by subtracting SI_{+1} and thereafter dividing by the number of new shares to be issued, a few observations become quite negative, which does not make sense in this setting. Furthermore, it can be argued that SI_{-1} is the appropriate measure of short selling in connection with the call. This is because a high level of short selling before the call can make the short selling of additional shares more difficult.

described in section 3.4 may lead to additional price pressure which may not be captured by the short selling measure. This predicts a negative relation between the announcement effect and a dummy variable, which is one for underwritten calls and zero otherwise. Finally, the expectation at the time of the call of the volatility of stock prices in the conversion period may be relevant for the incentive to hedge and should therefore be relevant in explaining the announcement effect. A higher volatility will increase the incentive to hedge and therefore the announcement effect is expected to be negatively related to the volatility.[42]

In order to examine the relation between the announcement effect and the variables described, we run the cross sectional regression

$$CAR_{i,-1:0} = \beta_0 + \beta_1 \frac{(SI_{-1})_i}{New_i} + \beta_2 \frac{New_i}{SO_i} + \beta_3 \frac{CV_i - CP_i}{CP_i} + \beta_4 U_i + \beta_5 \hat{\sigma}_i + \epsilon_i, \tag{4}$$

where CV_i is the conversion value, CP_i is the call payment for bond i, and U_i is an underwriting dummy. The underwriting dummy is 1 if the call is underwritten and 0 if it is not. $\hat{\sigma}_i$ is the volatility of stock prices for bond i estimated in the conversion period. As before, we only use observations with $\frac{New}{SO} > 2.5\%$ in the regression, i.e. we exclude the clean-up calls. Results from the individual regressions and the joint regression in (4) are given in Table VIII, where the joint regression only includes variables that are significant in the individual regressions.

From rows 1–5 in Table VIII it follows that the signs on all the estimated coefficients are as predicted by the hypothesis that the announcement effect is caused by a hedging-induced price pressure. The short selling variable calculated from the monthly data is significantly positive with a p-value of 1.9% meaning that more short selling before the call leads to a less negative announcement effect. The size of the call, the degree in-the-money and the underwriting dummy are all significant with p-values less than 2%. Surprisingly, the volatility turns out to be insignificant. Row 6 documents that the short selling and the underwriting dummy are both significant at the 5% level in a joint regression. Row 8 includes all variables that are significant in the individual regressions. The size and the degree in-the-money of the conversion right are both highly significant whereas the p-values for short selling and the underwriting dummy now have increased to 4.3% and 19.0% respectively. If the volatility is included in the joint regression, it is insignificant with a p-value of 24% without changing the conclusions from row 8.

[42]There are of course no data on the expected volatility. Therefore, we have used the volatility of stock prices estimated in the conversion period as a proxy for the expected volatility. However, the results are qualitatively the same if instead we use the stock price volatility estimated from day −150 to day −50. Alternatively, we could have used other measures such as the arbitrage risk measure used in Wurgler and Zhuravskaya (2000) to measure the incentive to hedge. We have here chosen to use the volatility because it is the volatility which measures the total risk and which is the relevant risk measure when pricing the conversion option.

Row $(Adj.R^2)$	Intercept $\hat{\beta}_0$	Short selling $\hat{\beta}_1$	Size of call $\hat{\beta}_2$	Moneyness $\hat{\beta}_3$	Underwritten $\hat{\beta}_4$	Volatility $\hat{\beta}_5$
1 (1.7%)	-0.0220 $(-9.0, < 1\%)$	0.0210 $(2.4, 1.9\%)$	—	—	—	—
2 (4.8%)	-0.0114 $(-4.7, < 1\%)$	—	-0.0478 $(-3.8, < 1\%)$	—	—	—
3 (2.6%)	-0.0224 $(-9.5, < 1\%)$	—	—	0.0106 $(2.8, 0.5\%)$	—	—
4 (2.0%)	-0.0149 $(-6.9, < 1\%)$	—	—	—	-0.0086 $(-2.4, 1.9\%)$	—
5 (1.4%)	-0.0113 $(-2.6, 1\%)$	—	—	—	—	-0.0155 $(-1.4, 18\%)$
6 (3.1%)	-0.0189 $(-6.7, < 1\%)$	0.0197 $(2.2, 2.8\%)$	—	—	-0.0081 $(-2.2, 2.6\%)$	—
7 (3.8%)	-0.0244 $(-4.11, < 1\%)$	—	—	0.0125 $(3.3, 0.1\%)$	—	-0.0306 $(-2.2, 2.7\%)$
8 (8.4%)	-0.0177 $(-4.2, < 1\%)$	0.0177 $(2.04, 4.3\%)$	-0.0421 $(-3.4, < 1\%)$	0.0088 $(2.4, 1.8\%)$	-0.0047 $(-1.3, 19\%)$	—

Table VIII: Results from the regression given in equation (4). Short selling refers to $\frac{SI_{-1}}{New}$, Size of call is $\frac{New}{SO}$, Moneyness denotes $\frac{CV-CP}{CP}$, Underwritten is a dummy which is one for underwritten calls and zero otherwise, Volatility is $\hat{\sigma}$. SI_{-1} is the short interest number from the month before the announcement, New is the number of new shares to be issued upon conversion, SO is the number of shares outstanding before the announcement, CV is the conversion value, and CP is the call payment. $\hat{\sigma}_i$ is the volatility of stock prices in the conversion period. The brackets list (t-statistics,p-value) for the standard test for significance of the estimated coefficients. Only observations with $\frac{New}{SO} > 2.5\%$ are used.

The changes in the level of significance for some of the variables between the individual regressions and the joint regression may be explained by multicollinearity in the regression. From Figure 6, we already know that there is a positive relation between short selling and the size of the call. Similarly, it turns out that there are several interesting correlations between other of the variables. Short selling is negatively correlated with degree in-the-money, and the degree in-the-money and stock volatility have a strong positive correlation significant at the 1% level, which provides an explanation for the results about the stock volatility in the regression. A higher stock volatility is associated with a deeper in-the-money conversion right.[43] Therefore, the effect of higher volatility

[43] This is also consistent with the argument that the calling firms are averse to the risk of a failed conversion. Therefore, a higher stock volatility will lead the firm to delay the call even further until the conversion value according to the firm is sufficiently above the call payment or as concluded in Asquith (1995): "the required safety premium appears to be a function of stock price volatility."

on hedging is partly offset by the effect of the conversion right being deeper in-the-money, which leads the stock volatility only to be significant in a joint regression including the degree in-the-money as seen from row 7.

Similarly, we can briefly examine the use of underwriters in further detail. A regression of the underwriting dummy on a constant and the moneyness gives a negative relation significant at the 1% level, whereas a regression of the underwriting dummy on a constant and the magnitude of the call gives a positive coefficient on the magnitude, significant at the 5% level. In addition to documenting potential problems of multicollinearity as mentioned above, these regression results provide an interesting insight regarding the use of underwriters. The moneyness of underwritten calls is lower than that of non-underwritten calls whereas the magnitude is larger. For underwritten calls, the conversion value is on average 30.1% above the call payment whereas the same number for non-underwritten calls is 53.6%. This indicates that the use of an underwriter gives the calling firm the ability to call earlier, but the calls are still delayed until the conversion right is quite deep in-the-money. Because of risk aversion, the underwriters are simply not willing to underwrite the call unless there is a safety premium of a certain size.

6 Implications and Further Research

This paper has several important implications for the way one understands optimal behavior within investment banks. The paper has provided evidence that both convertible hedge desks and underwriters are willing to accept relatively high costs of hedging. By short selling underpriced stock, these investment banks in addition to the trading costs incur an average monthly costs corresponding to 1.75% in abnormal returns, and 2.74% in normal returns on the short positions.

This is surprising because investment banks are expected to behave as if they have a 'portfolio' of investments and only hedge systematic risk. Therefore, the results in this paper raise a main question: Why are convertible hedge desks and underwriters willing to accept such high costs of hedging?

Based on the information we have obtained from several conversations with investment banks, the answer is related to the evaluation structure, risk aversion, and the possible agency conflicts at several levels within these banks. Since performance evaluation is done on a deal-by-deal basis, the employees (dealers) are prevented from considering convertible bond calls as a 'diversified portfolio' of deals where only the systematic risk should be considered. Instead, the employees are induced to care also about the total risk and accept the costs of hedging total risk rather than just the costs of hedging the systematic risk. The costs of being unhedged can simply be too high for the individual employee.

This study also provides some information about the optimal behavior of underwriters. The underwriters are also willing to accept the costs associated with hedging. The reason is again that the underwriters also seem to evaluate each underwriting deal on an individual basis. Hence, risk aversion and the evaluation structure are also important factors in explaining the behavior of underwriters. In addition, these 'limits of arbitrage' provide an explanation for why underwriting fees are found to be so high.[44] The fees need to cover the costly hedging performed by the underwriters.

According to the efficient market assumption, abnormal returns should be eliminated by the action of a large number of effectively risk neutral arbitrageurs. However, the 'arbitrageurs' that are involved in convertible bond calls and understand the stock price pattern around the calls are risk averse and highly specialized. Hence, this paper has shown that there are *limits of arbitrage* as arbitrage fails to bring stock prices close to fundamentals around the call announcement. Actually, in the case of convertible bond calls these limits of arbitrage can be argued to force prices even further below fundamental values. This is because the limits of arbitrage are the cause of the short selling of stock that leads to the short term distortion of stock prices.

The study's results suggest that a deeper understanding of the optimal behavior of investment banks requires an understanding of optimal compensation schemes, risk aversion, and agency problems within the firms that short sell in response to calls. Therefore, further research should be directed towards learning more about the evaluations within investment banks and hence provide understanding of each employee's opportunity set and the determinants of the preferences over this set. This would help to provide an improved understanding of the *limits of arbitrage*.

7 Summary and Conclusions

This paper has considered the behavior of investment banks around convertible bond calls. Evidence was provided that convertible hedge desks and a possible underwriter short sell stock at the time of the call as a means of hedging the increased equity risk.

One major insight of the paper is that the pattern in the number of shares sold short is related

[44]Singh, Cowan, and Nayar (1991) find that the standby fee alone on average corresponds to 1.05% of the face amount of the issue outstanding. If the take-up fee is included, the total underwriting fee is on average 4.19% of the face amount of issue outstanding.

to the call. Furthermore, it was shown that the short selling of stock at least in part can explain the pattern in stock prices around the call consistent with a hedging-induced price pressure. For example, the announcement effect was linked to the short selling of stock, to whether the call is underwritten or not, to the size of the call, and to the extent to which the conversion right is in-the-money.

The finding of short selling of stocks with positive abnormal returns in the conversion period raises a main question: Why do arbitrageurs (convertible hedge desks) and underwriters short stocks that are underpriced on average? The proposed answer is that this is due to 'the limits of arbitrage' as considered in Shleifer and Vishny (1997). Risk aversion and the related evaluation structure within these investment banks prevent the employees from considering calls at the diversified level where only systematic risk matters. Instead, the employees have to care about total risk. With such an evaluation structure, it is clear why the risk associated with an unhedged position can be too high. As one employee in an investment bank put it, when asked if he would not prefer to be unhedged rather than to short sell underpriced stock:

> ... it is required that you hedge, and therefore you short sell,

while another answered:

> ... your advice sounds like a career-destroying move!

A Hedging at the time of the call

In section 3.4, it was argued that the announcement effect may be due to a price pressure caused by an increase in the hedge ratio associated with the convertible bonds.[45] In order to examine this further, this appendix will consider how the hedge ratio changes when the bond is called.

In order to examine this, we will use the contingent claim pricing set-up as proposed in Black and Scholes (1973) and Merton (1974) to derive the value of the convertible debt before and after the call is announced. In this set-up, the total value, V_t, of the firm is assumed to follow a geometric Brownian motion given by

$$dV_t = \mu dt + \sigma V_t d\mathcal{B}_t,$$

where $\mathcal{B}_t$ is a standard Brownian motion. Under standard assumptions, it is then possible to use contingent claim pricing to obtain prices for different elements in the capital structure. We now assume that the firm consists only of equity and a non-interest bearing callable convertible bond convertible into γV_t of the firm with a maturity payment of B. Furthermore, if we assume that the market does not expect the bond to be called, the value of the uncalled convertible bond is given by[46]

$$\begin{aligned} D_{uc}^C(V_t,t) = {} & V_t\Phi(h_1) + B\exp(-r\tau)\Phi(-h_1-\sigma\sqrt{\tau}) + \gamma V_t\Phi(-h_1+\tfrac{\ln\gamma}{\sigma\sqrt{\tau}}) \\ & - B\exp(-r\tau)\Phi(-h_1-\sigma\sqrt{\tau}+\tfrac{\ln\gamma}{\sigma\sqrt{\tau}}), \end{aligned} \tag{A.1}$$

where

$$h_1 = \frac{\ln(B\exp(-r\tau)/V) - \frac{1}{2}\sigma^2\tau}{\sigma\sqrt{\tau}}.$$

Here τ denotes the time to maturity for the bond, i.e. the time until B is due. Φ is the cumulative normal distribution function.

If the conversion right is in-the-money and the bond is suddenly called, the value of the bond will be given by the conversion value plus a put option as described in section 3.1. The put option is the right to put the bond to the firm for the call payment, here assumed to be B, so the put option has an exercise value of B and on average a month to maturity; i.e. the value of the called convertible bond is given by

$$D_c^C(V_t,t) = \gamma V_t + \mathrm{BS}^{put}(\gamma V_t, t, \tau^{put}, B). \tag{A.2}$$

[45]By hedge ratio, we here mean the delta ratio, i.e. the number of shares that should be sold short in order to hedge against changes in the stock prices.

[46]Ingersoll (1977a).

We can now use (A.1) and (A.2) to establish how sensitive the value of the convertible is to changes in the firm value before and after the call. By differentiating (A.1) and (A.2) with respect to V_t, we get

$$\frac{\partial D^C_{uc}}{\partial V_t} = 1 - \Phi(d_1) + \gamma\Phi(-h_1 + \frac{\ln\gamma}{\sigma\sqrt{\tau}}) \tag{A.3a}$$

$$\frac{\partial D^C_{c}}{\partial V_t} = \gamma\Phi(-h_1^{put}). \tag{A.3b}$$

To illustrate the difference between these two, we consider a numerical example with the following parameters:[47]

$B = 30$	$\gamma = 0.2$	$\sigma = 0.22$
$\tau = 5$	$\tau^{put} = 0.01$	$r = 0.07.$

Figure 7 shows the two derivatives in (A.3a) and (A.3b) as a function of the firm value V. Since $\gamma = 0.20$ and $B = 30$, the convertible bond will be in-the-money when $V \geq B/\gamma = 150$.

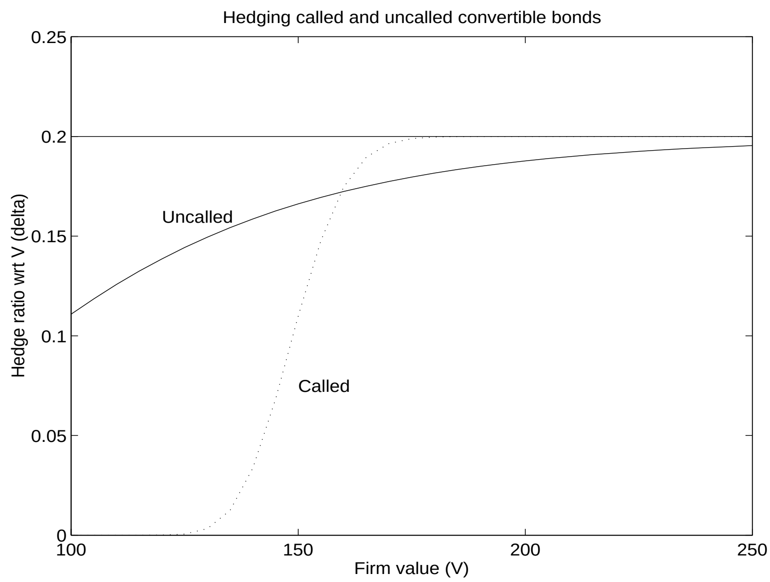

Figure 7: The hedge ratio with respect to the firm value for called and uncalled convertible bonds. The conversion right will be in-the-money when $V \geq 150$.

From the figure follows that when the bond is more than 6% in-the-money, a call will make the convertible bond more sensitive to changes in the firm value. The investors in the convertible hedge desks that we talked to argued that they only hedge the risk associated with the conversion value and leave the put option open. In this case, the hedge ratio will increase from the solid uncalled line to the horizontal line at 0.2.

[47]The conclusions in this appendix are not sensitive to the choice of these parameters.

B The event study

Part of this paper uses an event study to examine the stock price effect of call announcements. Therefore, this appendix includes a brief description of the event study and the related tests. A description of event studies can also be found in Campbell, Lo, and MacKinlay (1997), but some of the tests used in this paper will be slightly different from the tests described there. This is because we want to test for significance of abnormal returns over conversion periods with different lengths. A test taking this into account is described in for example Mikkelson and Partch (1988).

The event study is used to examine the stock price reaction to the call announcements. This is done by calculating the abnormal return for the period with the announcement. Assuming that normal stock returns are generated according to the market model, the abnormal return for firm i on day t is obtained as

$$AR_{it} = R_{it} - (\alpha_i + \beta_i R_{mt}), \tag{B.4}$$

where

$$R_{it} = \text{Stock return for firm } i \text{ on day } t \tag{B.5}$$

$$R_{mt} = \text{Return on day } t \text{ for a market index.} \tag{B.6}$$

The parameters in the market model are estimated for firm i by running the ordinary least squares regression

$$R_{it} = \alpha_i + \beta_i R_{mt} + \epsilon_{it}, \tag{B.7}$$

using stock returns from the so-called estimation period. The estimation period should be separated from the event period. In addition, for convertible bond calls, the estimation period should be after the call announcement as explained in footnote 24.

The cumulative abnormal return, $CAR_{i,\tau_1^i:\tau_2^i}$, for stock i from time τ_1^i to τ_2^i is now given as

$$CAR_{i,\tau_1^i:\tau_2^i} = \sum_{t=\tau_1^i}^{\tau_2^i} AR_{it}. \tag{B.8}$$

Assume now that we have N observations of abnormal stock returns over the considered time period. The cumulative average abnormal return, $\overline{CAR}$, over the time period τ_1 to τ_2 for the N

stocks is then given as[48]

$$\overline{CAR}_{\tau_1:\tau_2} = \frac{1}{N}\sum_{i=1}^{N} CAR_{i,\tau_1^i:\tau_2^i}. \tag{B.9}$$

Tests for significance of the abnormal returns over period τ_1 to τ_2 are based on the following asymptotic normal distributed test statistic:

$$Z = \frac{1}{N}\sum_{i=1}^{N}\left[\frac{CAR_{i,\tau_1^i:\tau_2^i}}{\sqrt{Var\left(CAR_{i,\tau_1^i,\tau_2^i}\right)}}\right], \tag{B.10}$$

where

$$Var\left(CAR_{i,\tau_1^i:\tau_2^i}\right) = \hat{\sigma}_i^2\left[L_i + \frac{L_i^2}{T_2 - T_1 + 1} + \frac{L_i^2(\bar{R}_{mL_i} - \bar{R}_m)^2}{\sum_{t=T_1}^{T_2}(R_{mt} - \bar{R}_m)^2}\right]. \tag{B.11}$$

In (B.11), the variables are given by

$$L_i = \tau_2^i - \tau_1^i + 1, \text{ i.e. the length of the time period under consideration}$$

$$T_1 = \text{The first day in the estimation period}$$

$$T_2 = \text{The last day in the estimation period}$$

$$\bar{R}_m = \frac{1}{T_2 - T_1 + 1}\sum_{t=T_1}^{T_2} R_{mt}$$

$$\bar{R}_{mL_i} = \frac{1}{L_i}\sum_{t=\tau_1^i}^{\tau_2^i} R_{mt}.$$

In addition to the parametric tests described above, it can be worthwhile applying nonparametric tests. Nonparametric tests will be free of specific assumptions about the distribution of abnormal returns and will make it possible to check the robustness of the conclusions from the parametric tests. The sign test is such a nonparametric test. The basis of the sign test is that if the abnormal returns for a period are insignificant, it is equally probable that the abnormal returns are positive or negative. If we let N^+ be the number of positive $CAR_{i,\tau_1^i:\tau_2^i}$ and let N be the number of observations, then the statistic[49]

$$J = \left[\frac{N^+}{N} - 0.5\right]\frac{\sqrt{N}}{0.5} \tag{B.12}$$

will be asymptotically normal distributed.

[48] We will here allow for the case where the considered time periods for the individual stocks have different lengths. Therefore, by τ_1 to τ_2 we mean that the time period for stock i is τ_1^i to τ_2^i.

[49] Campbell, Lo, and MacKinlay (1997, p. 172).

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