New Studies in Convertible Bond Investment and Financing

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ABSTRACT

New Studies in Convertible Bond Investment and Financing

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This series of paper studies convertible bond financing from the perspective of both issuers and investors. Based on an empirical study, convertible bond financing seems to be overused: it would appear that convertible bond financing should be dominated by sequential issues of straight bonds followed by new equity issues sometime thereafter. A new model is introduced to demonstrate that managers of all types of firms, irrespective of quality would choose convertible bonds in their financing plans when facing uncertainties about the timing of the project. Convertible bond issuance can be optimal for firms that do not have an established record of strong historical performance but have opportunity sets that include good projects subject to timing uncertainties. The first part of this study focuses on the investor perspective and investigates the returns of holding convertibles/underlying stocks, as well as the returns of convertible hedging strategies. Naked long position of convertible bonds from issuance date and hedging based on the characteristics of convertibles can derive good returns. Consequently, investors can benefit from both the upside expectation of convertible issuing firms and the structured terms of convertibles. Next, convertible bonds are studied from the perspective of issuer. Here, liquidity risk, firm risk, and issue risk premium factors are identified as determinants of abnormal returns around the convertible bond issue dates. The market responds favorably to firm volatility risk, but negatively to the liquidity risk and issue risk premium factors. The cumulative effects of these risks determine the abnormal returns of convertible bonds.

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INTRODUCTION

1.1. PUZZLES OF CONVERTIBLE BOND FINANCING

Convertible bonds ('CBs' hereinafter), which are bonds that can be converted into a firm's stock at a specified price during a given period, have become more popular financing instruments through time. According to SDC data, from 1995 to 2007, the total value of CB issues increased in the US by 699.27%. Over this period, the ratio of CB financing to equity financing expanded from 10.15% to 32.07%, with a peak ratio of 50.13% in 2001[1].

The benefits of using CBs come from a few perspectives. New issues can be consummated rapidly since they tend to be marketed via conference calls rather than road shows. Furthermore, the execution risk, which relates to exposure to random price changes as a consequence of the time required to execute an order, is limited. CBs can also be flexible tools for balance sheet management since coupons and conversion prices can be tailored to the issuer's needs. Additional features can also be included in CB issuances in order to meet issuer's needs as well as investors' needs. Ostensibly, the option features will permit the firm to enjoy lower interest costs relative to straight debt. Furthermore, agent costs could be decreased with the use of CBs.

Given these advantages of CBs, the popularity of CB's still appears to be a puzzle

[1] The peak ratio in 2001 might be attributed to a couple of factors: 1) the collapse of the securities market in 2001 would make equity financing unappealing relative to CB financing, since equity financing could be issued at depressed prices; and 2) with the increase in risk aversion subsequent to the crash, the lower volatility of CBs made them more attractive to investors than new equity issues.

from a number of perspectives. First, establishing a fair price for any particular CB is complex, due to its long-term option-like characteristics. CBs are typically embedded with interacting indenture components that may not respond uniformly to expected or unexpected events. Consequently, it is still a challenge to 'correctly' price CBs for both issuers and investors. CB's would seem to violate the principle of Ockham's Razor, in that they do not provide simple solutions to problems such as financing and investment.

Additionally, CB financing introduces an element of uncertainty to the firm's cash flow and future financing requirements due to the uncertain nature of investor holding periods over longer horizons. Firms with a large overhang of unconverted CB's often face difficulty when they must resort to capital markets for subsequent financing. Empirically[2], the conversion process of CBs is slow. Several empirical studies show that the price of CBs has to stay well above the conversion price for a considerable period of time before issuers use their call rights to force investors to exercise their CBs.

Furthermore, CBs could be more expensive than either equity or bond although it appears to be cheaper at first glance. Empirically we find that firms issuing CBs, especially issuers who are large in size but low in rating, do not issue normal corporate bond first and then issue equity afterwards, although this alternative financing plan ('AP' hereinafter) could significantly ameliorate dilution effects. For example, from 1990 to 2006, a simulated portfolio that comprises underlying stocks of all the issuers whose issue size is at least \$100 million generates a return of 24.18% and 41.97% respectively at the end of second and third year after the issuance date. If the sample includes observations only with a rating of B or lower, the returns are 50.58% and 92.29%, respectively; and that for a rating of Caa or lower become as high as 210.63% and

[2] For example: Ederington, Caton and Campbell (1997), Byrd, Mann, Moore and Ramanlal (1998).

264.48% at the end of second and third year. In contrast, the average conversion premium of CBs in the same period is only 28.20% in the same database. Consequently, the dilution effects of AP seem to be less, especially for low rating issuers with large issue size. From the above, it would appear a puzzle that CB financing should be dominated by AP.

A number of scholars have suggested various constructive roles for CB's, including: 1) to use CBs to inject new equity into the capital structure with lower asymmetric information costs (Stein, 1992), 2) to be an alternative to straight debt as a means of preserving cash flow via lower interest costs (Billingsley and Smith, 1996), and 3) to reduce financing costs as an alternative to sequential financings using equity and/or straight debt when facing serially correlated real investment option opportunities (Mayers, 1998) etc. However, why firms do not use AP cannot be explained in the extant theoretical literature.

Two additional reasons might help to justify the puzzling choices of issuers. 1) CB issuers cannot implement the AP due to debt capacity constraints, which can be measured by the type of assets that can be pledged, how much debt a firm has already used, and the profitability of the firm; and 2) the delayed equity issuance in the AP may occur at significant price discounts. However, we show that neither of these two reasons can justify the puzzle either.

In this thesis, I propose an alternative perspective for the popularity of CBs, and study what CBs can do for both investors and issuers. This approach is rooted in the unique structure of CB's as contingent claims that appeal to both firms and investors facing uncertainties. This chapter provides a general summary of the thesis. Then the detailed research theme is developed in subsequent chapters. Chapter 2 studies various trading strategies for CB investors and arbitrageurs. Chapter 3 provides a normative analysis on why CBs should be used as a method of financing by firms, and why they should be represented in the portfolio of a rational investor. Chapter 4 empirically investigates the implications of the model for issuers

1.2. TRADING STRATEGIES RELATED TO CBS

Chapter 2 studies market efficiency and CB hedging and arbitrage from the perspective of investors. From this standpoint, one cannot go without mentioning hedge funds, which purportedly actively exploit return predictability inefficiencies in CB market. According to Evans (2002), hedge funds purchased nearly 70% of all CB issuance in 2001. Atlas (2005) notes that hedge funds account for more than 75% of the daily trading in CBs. Trading by hedge funds may impact on the profitability of outright short selling strategies, as well as CB arbitrage strategies. Consequently in this chapter, I examine a large set of trading strategies related to CBs to test for abnormal returns for several trading strategies, including various approaches for testing other forms of fixed income arbitrage.

We begin by examining the naked long position of CBs/ underlying stocks, and the sensitivity of CB returns to various risk factors. Then we test for market efficiency based on deviations from the "law of one price" using relative returns of different combinations of long CBs with short positions in underlying stocks, which include equal money positions, delta-neutral positions as well as bearish/bullish gamma positions. In addition, it has been tested for market efficiency from the perspective of the pricing of comparable CBs, as a further test of the "law of one price" for securities that are close substitutes. Furthermore, it tests strategies of buying comparably cheap financial instruments and selling expensive ones using portfolios that comprise CBs versus call options or other corporate bonds of the same issuer. Finally, because a large portion of CBs issued in the US are categorized as junk bonds, we also look at the performance of portfolios of CBs that are combined with credit default swaps (CDS) to ameliorate credit risk.

The returns are calculated based on portfolios simulated under trading strategies that are employed in several different scenarios. We find that investors can benefit from investing in CBs by buying CBs from the issuance or holding certain hedged positions. Hedged positions that are based on the characteristics of the CBs are shown to provide superior absolute and relative returns. The bullish gamma hedging strategy taken at the time of the issuance of the CBs and the delta-neutral strategy with larger delta change tolerance are shown to be particularly advantageous. Meaningful hedging opportunities between CBs and other financial instruments are also observed. Risk components of these trading strategies show different impacts with respect to the trading strategies examined. In summary, what we find in the investment related to CBs does not fully support market efficiency.

1.3. CONVERTIBLE BOND ISSUANCE, RISK AND FIRM FINANCIAL POLICY: A NEW APPROACH

Chapter 3 develops a theoretical model that captures essential risk components of CB's that addresses the role of CB's in the financial policies of firms as well as in the portfolio decisions of CB investors. This chapter uses elements of continuous-time finance and behavioral finance to develop a model that directly addresses the question: "Why do firms issue CBs rather than equity or straight debt, given managers' expectations about the firms' future performance?" This model serves to characterize the behavioral aspects of both managers and investors when facing uncertainties. The model demonstrates that in an environment of *timing uncertainty,* in which firms cannot predict when a new project will become fully operational, CB issuance could be an optimal financial decision for managers, firms, and investors. However, cost/benefit trade-offs for CBs may be present, and as a consequence, their issuance per se need not always be good news for the market. Firms who lack a strong historical performance record as well as those with a limited portfolio of promising new projects will have greater incentives to issue CB's than other types of firms. To further justify this rationale, previous studies in both the efficient markets and behavioral finance literature are appealed to.

It finds that with uncertainty on the timing of payouts for the CB-financed project, there are different expected return/risk dynamics for firms with different levels of risk. On the whole, CB financing of new projects is more appropriate for firms whose risk profiles are not low. This can be empirically tested by looking at the impact of firm risk and issuance risk on the abnormal returns around the issuance date of CBs. Furthermore, variation of the risk profiles over time should also influence the returns of underlying stocks after the CB issuance date. Since the overall risks of the firms (the sum of the risks of firms and issuance) are higher than those before CB issuance, the underlying stock returns should decrease subsequent CB issuance. However, with the passage of time, if the project proves to be good, the risk deduction for firm risks will overweight the risk addition for CB issuance risk, the underlying stock prices should increase. This is another pattern that could be empirically tested.

Volatility related proxies can measure the risks of CBs and equities. The standard deviation of beta can be used to measure the risk of equities since: 1) beta is a better measurement of risk than the standard deviation when we deal with diversified portfolios; 2) we want to evaluate the determinants of abnormal returns, not the returns, so we resort to higher moments of the beta; and 3) the standard deviation of beta can measure the fluctuation of the market's attitude toward the firm issuing CBs. Vega, which measures the sensitivity of CB price to the volatility of underlying stocks, act as one part of the issuance risk. Another aspect of the issuance risk is the liquidation/dilution effect that is dependent on the relative size of the CB issuance.

This new rationale implies that investors could get some benefits in investing in CBs by applying the following two types of trading strategies. The first is to hold a naked long position of CB's from the issuance date because CBs incorporate a premium that represents the seriously considered future upside expectation from the management. The possibility of achieving superior returns under this strategy is larger if the issuer possesses higher reputation cost when poor performance shows up. The second trading strategy predicated by the rationale involves hedging CBs with different financial instruments. This is because when using the different combinations of terms to write the contract of CBs, issuers in effect transform CBs into structured financial notes that balance the requirement of issuers and investors. By investing in CBs, investors simultaneously get a combination of different financial instruments, which might be technically impossible to replicate or prohibitive in terms of financial costs to replicate.

There is a high probability that investment opportunities will appear among different financial instruments when their prices fluctuate. Hedging can be used to mitigate or eliminate investment risk.

1.4. A TEST OF THE MODEL FROM THE PERSPECTIVE OF ISSUERS

Chapter 4 provides new evidence on the effects of the risk profiles of firms on the returns to CB issues. It remains somewhat of a puzzle that a considerable body of empirical evidence demonstrates that the issuance of new CB's is associated with negative abnormal returns of the underlying shares at the existence a couple of factors: 1) the market normally reacts positively to the normal corporate bond issuance, but CBs are no more than special corporate bonds; 2) there are more benefits of using CBs than that of normal bonds or equity; and 3) substantial growth in the CB market is observed, while concurrently, on average, the equity market reacts negatively to CB issuance. We examine the underlying firm characteristics that serve as drivers of the abnormal returns when CB's are issued. The focus is on the relations between short-term wealth effect around the issuance of CBs and the characteristics of issuer firms and the features embodied in the issues themselves. In particular, we examine the three factors proposed by Chapter 3: the impact of liquidity risk (logarithmic issue size), issue risk (Vega), and firm volatility risk (standard deviation of beta) on the abnormal returns to CB issues.

Abnormal returns around the filing date to SEC and the issuance date of CB's are calculated with the traditional single factor market model. Two methodologies are employed to study the relation between abnormal returns and firm's characteristics: 1) to compare the average characteristics across samples. We divide the abnormal returns into two groups: positive abnormal return group and negative abnormal return group. Then we compare the average characteristics values between the two groups to find out whether there are significant characteristics differences across the groups; and 2) to test whether characteristics related to the issuer and CBs could determine the abnormal returns around the issuance date.

Different econometric methods and grouping methods are employed to test the robustness of the findings: 1) abnormal returns calculated by Carhart-Fama-French approach, instead of the single factor model; 2) market returns using value-weighted portfolio containing all issues in the CRSP database and S&P 500 Index, instead of using equity-weighted portfolio; 3) observations are grouped into three groups, instead of two, to compare the mean values; 4) truncated regressions including only with observations with extreme absolute abnormal returns; 5) White Method to address the problem of heteroskedastic errors; and 6) regression of CAR (cumulative abnormal return) by employing both FGLS (Feasible Generalized Least Squares) and Error-Components Model with fixed effects.

We confirm that there are significant negative returns around the event windows. All three risk factors serve as significant drivers for the abnormal returns around the CB issuance date. The market responds favourably to the issuance of CBs by issuers with mild level of firm volatility risk. However, liquidity risk and issue risk are significantly negatively related to performance. The latter two risk components serve to compromise the risk management benefits of CBs for firms. These findings are robust to different grouping criteria and estimation methods.

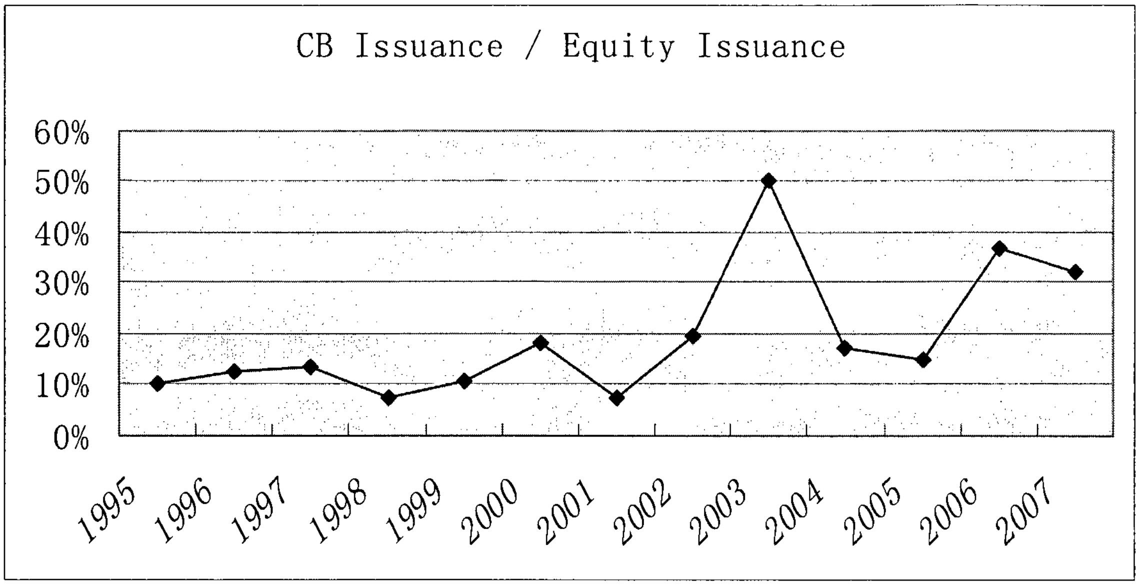
1.5. CONCLUSION

We conduct a series of studies that take into account the terms of CB's, which differentiate them from pure equity/bond issues. To the best of our knowledge, this study is the first in this area to analyze CBs from the perspective of both firms and investors, and reflects the dynamics of a market place wherein the characteristics of both issuers and investors change through time.

Our results suggest further research would focus on the pricing and the risk management of CB's by explicitly valuing the indentures as distinct options, which also further extends Lo and Wang (1995). These studies will be based on the philosophy that derivative securities pricing and corporate financing decisions should be linked more closely since they can be related to the same underlying asset and can be accommodated in a set of consistent price processes that preclude arbitrage opportunities.

FIGURE 1-1. The Ratio of CB Financing to Equity Financing in US

This figure depicts the ratio of CB Financing to Equity Financing in US from 1995 to 2001. The data is from SDC Platinum. The total amount of financing includes public, private, and US 144 financing.



Chapter 2

MARKET EFFICIENCY AND RETURNS FROM CONVERTIBLE BOND HEDGING AND ARBITRAGE STRATEGIES

ABSTRACT

This paper studies the returns of convertibles as well as the returns of a large array of convertible hedging and arbitrage strategies during the period 1990-2006. Market efficiency tests are performed using various portfolios that comprise opposite long bonds and short underlying equity positions; the returns and risks of convertible bond convergence hedging portfolios, as well as combinations of convertible bonds, corporate bonds, and options of the same issuer. Hedged positions based on the characteristics of the bonds are shown to provide superior absolute and relative returns. A bullish gamma hedging strategy put on at the time of the issuance of the convertibles and a delta-neutral strategy with larger delta change tolerance are shown to be particularly advantageous. Meaningful hedging opportunities between convertibles and other financial instruments are also observed.

2.1. LITERATURE REVIEW AND INTRODUCTION

Convertible bonds ('CB' or 'CBs' hereinafter), which are bonds that can be converted into a firm's stock at a specified price during a given period, have become more popular financing instruments through time. New issues can be consummated rapidly since they tend to be marketed via conference calls rather than road shows. Furthermore, the execution risk, which relates to exposure to random price changes as a consequence of the time required to execute an order, is limited. CBs can also be flexible tools for balance sheet management since coupons and conversion prices can be tailored to the issuer's needs. Additional features can also be included in convertible bond issues in order to meet issuer's needs as well as investors' needs. Ostensibly, the option features will permit the firm to enjoy lower interest costs relative to straight debt. However, accountants and rating agencies treat convertible bonds as debt.[3] On the other hand, it is argued that convertible bonds are issued by firms with speculative-grade ratings that could not raise capital by issuing either equity or straight debt. The implication of this is that convertible bonds are likely to be issued by firms that are smaller and riskier.

Arshanapalli, Fabozzi, Switzer, and Gosselin (2005) perform an event study for firms listed on either the NYSE, NASDAQ, or AMEX that issue convertible bonds during the period 1993 to 2001 and find significant negative cumulative abnormal returns

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[3]Knutson (1971) looks at the accounting implications of convertible bond costs and their impact on the financial statements of firms. He suggests that managers should be aware of how costly convertible securities are likely to be. Further, caution should be taken by both managers and investors when analyzing the effect of convertible securities could have on firms' statements. Knutson found that, on average convertibles securities are more costly than indicated in the firm's financial statements. The understatement of the real cost of convertibles is, on average, 55 % for debt convertibles. This explains the undervaluation of costs in financial statements. These misrepresentations caused by convertible securities tend to overstate earnings per share. Further, he found that in many cases the "fully-diluted earnings per share more closely approximates real earnings per share that does primary." This means the real cost of convertibles is clearly higher than the nominal interest on face value of the securities and managers and investors should give a special attention to the real costs of these securities. The strong analogy for some issues with executive stock options suggests that our results may be of interest to the latter literature as well.

of –2.19% over the period from two days before to two days after the issuance of convertible bonds for their sample of firms. The event study on the announcement dates shows significant negative cumulative abnormal returns of around -3% over the interval beginning from the day before the announcement to the end of the announcement day. The results are consistent with Dann and Mikkelson (1984) and Davidson, Glascock and Schwartz (1995), which show negative impacts of convertible issues for earlier time periods. Hence, over the past three decades, the empirical evidence suggests that convertible bond issuance has an adverse impact on the issuers owing to dilution effects and/or adverse information effects that overwhelm agency and tax benefit effects.

This empirical regularity, coupled with the claim that the underlying convertible bond prices change in a disproportional sense relative to the stocks,[4] has given rise to an industry of convertible arbitrage hedge funds, which purportedly exploit returns' predictable inefficiencies.[5] According to Evans (2002), hedge funds purchased nearly 70% of all new CB issues in 2001. Atlas (2005) notes that hedge funds account for more than 75% of the daily trading in CBs.

Trading by hedge funds may impact on the profitability of outright short selling strategies, as well as convertible arbitrage strategies.[6] Whether such short selling coupled with long positions in the convertible bonds is consistently profitable and a violation of market efficiency in a returns predictability sense is an empirical matter that we propose

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[4] For example, in Business Week (November 16th 1998), it is suggested that a company's convertible bond tends to rise at two-thirds the rate of its common stock price.

[5] See Fama (1991).

[6] Stefanini (2007) discusses the mechanics of several strategies of this sort. The proportion of the market that hedge funds occupy has more than doubled since 1994. Hedge funds provide liquidity in the market by frequent trading, and by taking offsetting positions to other institutions by taking over their convertible bond positions when the underlying stock price begins to rise. In such cases, the convertible bond starts to track the stock's performance, making the security less appealing to institutions preferring to own the stock outright rather than the bond.

to test.[7]

In particular, in this paper we examine a large set of trading strategies related to CBs to test for abnormal returns for several trading strategies, including various approaches for testing other forms of fixed income arbitrage. As a first step, we examine the naked long position of CBs/ underlying stocks, and the sensitivity of convertible returns to various risk factors.

Second, we test for efficiency based on deviations from the "law of one price" using relative returns of different combinations of long CBs with short positions in underlying stocks, which include equal money positions, delta-neutral positions as well as bearish/bullish gamma positions. We also study the robustness of the various trading strategies to leverage effects and alternative parameter inputs.

In addition, we test for efficiency from the perspective of the pricing of comparable CBs, as a further test of the "law of one price" for securities that are close substitutes. In particular, we examine trading profits of buying the relatively "cheap" CBs and short selling the expensive ones, using the criteria of the implied volatility difference as well as the abnormal credit spread difference of CBs issued by the same firms.

We also test strategies of buying comparably cheap financial instruments and selling expensive ones using portfolios that comprise CBs versus call options or other corporate bonds of the same issuer. Finally, because a large portion of CBs issued in the United States are categorized as junk bonds (i.e., have high credit risk), we also look at the performance of portfolios of CBs that are combined with credit default swaps (CDS)

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[7] For example, Duarte, Longstaff, and Yu (2006) test the risk and return of a number of fixed income arbitrage strategies over the period and excess returns on the order of one to 6% each year. They find positive arbitrage returns but the returns that are more significant for trading strategies involving more "intellectual capital."

to ameliorate credit risk.

2.2. DATA DESCRIPTION

The sample consists of all CB offerings over the period January 1, 1990 to December 31, 2006 for which the underlying shares are traded on either the New York Stock Exchange (NYSE), the American Exchange (AMEX), or the over-the-counter (NASDAQ) market from the SDC Platinum database. Since we focus on trading/hedging strategies that can actually be implemented, to ameliorate potential liquidity constraints, we require that the proceeds amount plus the over-allotment sold in the hosted market of the convertible bonds is in excess of $100 million. There are no upper limits on the outstanding amount. The sample includes both coupon and zero-coupon bonds.

The basic CB data, including conversion price, coupon rate, expiry date, issuance date, ratings, and issue size are obtained from SDC. Missing observations from SDC are replaced with data from the Convertible bond Database that was provided to us from Morgan Stanley.

The time series of CB prices are obtained from DataStream. We focus on the returns and hedging strategies from the issuance date to four years after the issuance. The CBs prices include both on-the-run and off-the-run observations. Hence, the results should be relatively free of survival bias. The issuance date of a CB refers to the first trading date after the issuance of the CB. The CBs prices are quoted as "clean" prices (i.e., they do not include accrued interest). Accrued interest is added to these prices in order to calculate holding period returns.

Stock returns are obtained from CRSP. Benchmark interest rates such as Treasury bills and bonds of different maturities, CDS spreads are obtained from Datastream. The CDS spreads are the average of 3-year CDS bid and ask spreads. The ratings for the corporate bonds are from Moody's.

Other corporate bond prices and yields of the same issuers during the observation period were retrieved from TRACE (Trade Reporting and Compliance Engine). The yield of different bonds of the same issuer could differ greatly because of different ratings. For each issuer, we designate the corporate bond with the highest (lowest) yield over time as the high (low) yield bond.

The historical option prices of the same issuers during the observation period are obtained from Ivy DB Option Metrics. For each observation, we retrieve the information on date, expiry date, strike prices, and best bid/ask prices. The option prices used in the analyses are calculated as the average of the best bid and best ask prices when the market close. We match the issuer, and strike price and expiry date to identify the most comparable option to the CBs.

The final sample consists of 125 CBs issuances over the period January 1990 to December 2006. A breakdown of the sample by year of issuance is shown in Table 2-1. The study period includes both bullish and bearish equity market periods. The average principal amount is highest in 2000, coincident with the peak of the high-tech market. Since the early 1990's conversion premia[8] have increased, reflecting higher volatility and/or a tilt in preferences towards issues with more pure debt-like structures.

2.3. METHODOLOGY

Our approach is to subject CBs and portfolios that comprise CBs, including

[8] Conversion Premia = (conversion price-current stock price)/current stock price.

various hedged portfolios, to a battery of tests for abnormal returns/deviations from the "law of one price." The returns of CBs include the variation of the market prices to which we add the daily accrued coupon rates. The underlying stock returns include dividends. Interest opportunity costs are considered only in the zero initial self capital investment trading strategies. The yield of the Moody's Aaa corporate bond at the time of the trading is the proxy for the cost of borrowing,[9] while the 10-year Treasury bond rate is the proxy for the lending rate.

There are two types of returns: buy-and-hold returns and rebalanced returns. Reinvestment of the gains/losses is only considered for the latter. We carry out the simulations for up to four years following the first trading date when data are available. The simulated returns are not annualized except in the option hedge strategy. Tests of significance are based on using standard *t-statistics.*

2.3.1. The Return Characteristics of Pure Long CBs/Underlying Stocks

As background to analyzing various CB portfolio trading strategies, in this section, we look at the behaviour of CB returns. The returns are calculated based on the purchase of one CB or its underlying stock position at the issuance date. The simulated portfolio consists of all 125 firms included in the sample.

Table 2-2 shows the average (non-annualized) returns of a pure long CBs portfolio over various holding periods relative to the issuance date.

It is interesting to note that the returns over the early months subsequent to the issuance are insignificantly different from zero. However, they become significantly

[9] We also performed the tests using the yield of the Moody's Baa corporate bond index as a proxy for the borrowing rate. The results are robust to the use of this variable, and are available from the authors on request.

positive from the seventh month after the issuance and onwards; they reach their peak value during the fourth year.

Table 2-3 looks at the extent to which these returns can be explained by equity market risk, interest rate risk, and credit risk, which are the three main risks of CBs'. We use the S&P 500 return as the proxy for equity market risk.[10] Interest rate risk is determined as the term spread, calculated as the difference between the rate of the 3-month Treasury bill and 6-month Treasury bill.[11] The difference between the average of Moody's Aaa utility and Aaa industrial bond rates and the average of Baa utility and Baa industrial bond rates is the proxy for credit risk that we employ.

The impact of the three risk factors on CB holding period return series is assessed using random component panel data regressions. The method run regressions based on Equation 2-2 instead of Equation 2-1.

$$y = X\beta + D\eta + \varepsilon, E(\varepsilon\varepsilon^T) = \sigma_\varepsilon^2 I_n \tag{2-1}$$

$$P_D y = P_D X\beta + residuals \tag{2-2}$$

where

$$P_D = D(D^T D)^{-1} D^T$$

D is an n*m matrix of dummy variables, constructed in such a way that the element in the row corresponding to observation it, for i = 1; : : : ;m and t = 1; : : : ; T, and column j, for j = 1; : : : ;m, is equal to 1 if i = j and equal to 0 otherwise.

Panel A of Table 2-3 provides estimates that are based on the complete sample; Panel B shows the results for CBs with a Moody's rating of B or lower. We note that for

[10] Since S&P return volatility is closely correlated with the interest rate risk and credit risk, to use this measure as a proxy for equity risk would give rise to a collinearity problem in the regression analyses.

[11] This proxy for interest rate risk assumes mean reversion of interest rates and term spreads. The results are robust to other spread proxies, return differentials based on other maturities, as well as on spreads based on interest rate differentials for different maturities.

all firms in the sample, CB returns display significant equity risk and interest rate risk components. Somewhat intuitively, we note that these two risk components as well as credit risk are reflected in the return series for low-rated firms.

Table 2-4 reports the average returns of buying the underlying shares of the CBs from the issuance date of the CBs. For all the firms in the sample, the underlying stock performance is negative over the six month period subsequent to a new issue of CBs. This is consistent with the aforementioned literature demonstrating poor stock market performance in the aftermath of new CB issues.

Figure 2-1 depicts the average volatility from the first trading date after the issuance of CBs. Panel A shows the behavior of the daily rolling normalized volatility of returns. Normalized daily volatility is defined as the daily volatility on day D (calculated as the volatility of the logarithmic returns from D-240 (240 trading days before D) to D-1 (one trading day before D) divided by the volatility in the first trading date after the issuance. It is evident that there is a U-shape to the normalized volatility series with volatility declining until 3.05 years after the issuance date, and then rising thereafter. Panel B shows normalized quarterly volatility, with two alternative normalizations: 1) based on the volatility relative to the first quarter before the issuance as 2) based on the volatility of the first quarter after the issuance as well as after we calculate the volatility in a different way, which is the volatility of the logarithmic returns in that quarter. The quarterly volatility series also show a general declining pattern for the three years subsequent to the issuances, irrespective of the normalization volatility measure.

Table 2-5 provides an assessment of equity market risk, interest rate risk and credit risk on the returns of the underlying shares, using random effects panel data regressions. The results contrast somewhat with those of Table 2-3. In particular, as might be expected, unlike the bond series, interest rate risk is not reflected in the underlying share returns for the sample of firms with Moody's ratings of B or lower; however interest rate risk exists in the complete sample. On the other hand, similar to the results reported in Table 2-3, credit risk is reflected in the equity return series, both for the complete sample as well as for CBs with Moody's ratings of B or lower.

In sum, these results provide some support for initiating various trading strategies using convertibles. The behavior of the CB and underlying stock returns over the first few months subsequent to the CB issues suggests that there may be benefits to arbitrage strategies involving long CB/short stock positions initiated at the time of the issuance of the CBs. Also, since the CBs and their underlying shares demonstrate some differential responses to interest rate and credit risk, explicitly accounting for such risks in the investment strategies may be beneficial. We now turn to addressing these issues in various arbitrage portfolios.

2.3.2. Simple Arbitrage Strategy Returns: Hedge with Equal Money but Opposite Direction of CBs and Underlying Stock

In this section, we begin to implement various trading strategies that exploit the nonlinear relationship of the CBs with respect to their underlying shares. Our first strategy is a "naïve" strategy with equal money long CB/short underlying stock positions. With naïve hedging, when the convertible price is less than the par, the hedge is less precise and the price inefficiencies may be greater. In this case, the naïve hedging may be deemed as a relative-value strategy. In contrast, when the convertible price is at a large premium (e.g. greater than 120% of par), the prices of the CB and underlying stock will converge. For such CBs, the 1:1 hedging can be considered as a form of convergence hedging.

As demonstrated above, the shares underlying the CBs normally perform poorly during the first few months subsequent to the issuance date. Since the delta of the CBs is normally less than 1, equal money positions that are long CBs and short the underlying stocks are bearish and should be expected to generate positive returns during the first few months subsequent to CB issuances.

We simulate a portfolio by buying 1000 USD of CBs and shorting 1000 USD of underlying stocks from the issuance date of the CBs. This is a zero initial outlay by the investor. For convenience, the returns that are reported here are based on the long asset position in the portfolio.

As shown in Table 2-6, the strategy generates returns that are on average positive from the first month to the ninth month subsequent to the CB issuances. The trading profit reaches its maximum ($5554) at the end of the fifth month after CB issuance and declines thereafter.

However, these results are not robust to the time frame examined. As is shown in Panels B and C, the strategy performed consistently well only before 2001. The average returns are normally negative but not significant for the issues after 2001. This may in part be due to the non-linear convergence effects: as noted earlier, conversion premia for CBs are higher after 2001.[12]

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[12] When the CBs are traded above par, CB arbitrage is a convergence strategy, as mentioned above – as underlying stock prices tend to converge – hence declining equity prices are more likely to be matched by similar declines in the CBs (as in well publicized case of GM in 2005, when both its equity and bond prices collapsed in tandem). This does not rule out the effects of increased competition caused by a profusion of

2.3.3. Delta Neutral Hedge

A popular approach used in convertible arbitrage is a delta neutral strategy. In this case, the position is structured to try to keep the combined CB/equity position insensitive to changes in the price of the underlying stock. However, maintaining a market neutral position may require rebalancing transactions. This rebalancing influences to the return of convertible arbitrage strategies.

The delta of CBs is calculated based on the Black and Scholes (1973) formula modified by Merton (1973) to incorporate a continuous dividend yield.

$$Delta = e^{-q(T-t)}\Phi\left(\frac{\ln\left(\frac{S}{X}\right)+\left(r-q+\frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{(T-t)}}\right) \tag{2-3}$$

where, S is the price of the underlying stock, X is the conversion price, q is the continuously compounded dividend yield of the underlying stock, r is the continuously compounded yield of the 10-year Treasury bond, σ is the volatility of the logarithmic returns of underlying stocks calculated during the period from 240 days to 1 day before the issuance date. T-t is the time till maturity. $\Phi(\cdot)$ is the cumulative distribution function of the standard normal distribution.

The delta neutral hedge trading strategy studied in this paper is set up by buying CBs, while short selling shares in accordance with the value of the CB delta. In the

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CB arbitrageurs in the marketplace, which would reduce the potential benefits of such trading strategies. It should be noted that our trading strategy compares favorably with the returns from a convertible hedge fund portfolio based on the HFR Convertible Index. Specifically, for the entire sample period, the average one-month holding period of the HFR Convertible Index is .823% (t-value .833) versus our strategy return of 1.12% (t-value =1.70). For the sample covering through 2001 our strategy's one month average return of 2.63% (t-value 2.47) dominates the HFR Convertible Index return of .96% (t-value=.998). For the post 2001 Sample, neither portfolio provides significant returns (average return for our strategy -.54% (t-value -.79) vs. HFR Convertible Index average return of .49% (t-value: .50)).

absence of convexity effects, the returns of the portfolio do not change with the change of CBs and underlying stock price. A long CB/short underlying stock portfolio represents a long volatility position. Since the gamma of the portfolio is positive, if the implied volatility of CBs of the portfolio increases over the period of the hedge, the extra returns in CBs will contribute to the returns of the portfolio, and vice versa.

The portfolio in this study is made without initial capital investment. Portfolios are set up (and rebalanced if necessary) according to the previous trading day's delta. If there is extra money left after the rebalance, the surplus will be invested in a risk free vehicle; if there is not enough cash for the rebalance, the shortage will be covered by borrowing money from the market. No transaction cost is considered here.

The delta neutral portfolio cash flows emanate from: 1) coupon returns 2) the interest rate gains or costs from the net cash position of the portfolio, and 3) the dividend cash outflows of the underlying stock from the shorted underlying stocks.

The returns of the delta-neutral portfolio are calculated as the returns of the total long position in the portfolio. Table 2-7 reports the daily portfolio returns of delta neutral hedging with daily rebalancing. Each day we rebalance the portfolio by the previous day's delta. On the whole, for most of the first 36 months after the issuance, the delta neutral portfolio returns are positive, as is shown in Panel A of Table 2-7. The number of positive return observations in the portfolio is larger than that of negative ones in the first 15 months, during which period the returns are also significant.

If we divide the sample into two periods: a) issues before the end of 2001 and b) post 2001 issues, similar to the results of the equal money hedge position, we find that the delta neutral portfolios are generally positive only in the earlier period. In addition; as shown in Figure 2-2, the standard deviation of the observations issued before 2001 is also higher (0.039 vs. 0.027), so the higher returns of the sample observations prior to the end of 2001 may in part be due to incremental gamma effects If we compare the returns of the delta-neutral portfolio in Table 2-7 and the relative volatility in Panel B of Figure 2-1, we find that the volatility after issuance first goes down and then goes up until the fifth quarter; peak delta-neutral portfolio returns are observed over this same period. Furthermore, we note that the correlation coefficient of the quarterly volatility and the quarterly average portfolio return is as high as 71.36%.

In Table 2-8, we compare returns under different rebalancing strategies, including daily rebalancing, as well as rebalancing only when delta changes no less than a delta change tolerance of 0.02, 0.04, 0.1, 0.2 and 0.3, respectively.

For observations prior to the end of 2001, as the delta change tolerance increases from 0.02 to 0.3, average portfolio returns increase from 1.29% to 7.05%.

The last two rows of Table 2-8 show the effects of variations in leverage, defined as self capital allocations for buying the CBs in the portfolio. Here the returns of the delta-neutral portfolio are calculated as the returns of the initial self invested capital. With increased leverage, portfolios can earn higher (though riskier) returns under the delta-neutral criteria. The last two rows in Table 2-8 show the leverage effect when the leverage ratio is equal to two and three respectively.[13] We find that the absolute values of the highest and lowest returns are bigger, while the volatilities increase dramatically: from 0.0230 without leverage to 0.5607 with a leverage of 3. [14]

[13] Leverage ratio is calculated as: value of debt in a long position in a hedge / Self capital requirement.
[14] According to the Net Capital Requirements for Brokers and Dealers, the capital requirement for a hedge position of convertible debt securities should be no less than the 15% of the market value of the long position in the hedge. From this rule, it can be said that the upper limit for the leverage ratio is

To identify the risk components of delta neutral hedging strategies, we performed regressions of returns on the risk components used in Exhibits 3 and 6. [15] Equity risk, interest rate risk, and credit risk are all significant determinants of delta neutral returns at the 1% level. Interest rate risk and credit risk have positive effects on the returns. However, unlike the pure CB or pure equity returns, equity risk has a negative impact, suggesting that delta neutral CB portfolios may help investors smooth the equity portion of their wealth function

2.3.4. Gamma Hedge

As discussed above, volatility is the most important factor that captures the returns of a delta-neutral portfolio. Hence, it seems most appropriate to investigate the returns of a gamma hedging strategy. The CB gamma is defined as the rate of change of the delta with respect to the price of the underlying stock. It is the second partial derivative of the CBs price with respect to the underlying stock price.

Our estimate of the gamma of CBs is based on the Black and Scholes (1973) formula modified by Merton (1973) to incorporate continuous dividend yield.

$$Gamma = e^{-q(T-t)} \frac{\phi\left(\dfrac{\ln\left(\dfrac{S}{X}\right)+\left(r-q+\dfrac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{(T-t)}}\right)}{S\sigma\sqrt{(T-t)}} \qquad (2\text{-}4)$$

where ϕ ($\cdot$) is the probability distribution function of the standard normal distribution, and all other parameters have been defined in the delta neutral hedge.

85%/15%=5.67.

[15] These results are omitted to conserve space, and are available on request.

While delta-neutral hedging is a non-directional strategy because theoretically we can benefit from capturing gamma regardless of the direction of the stock price move, gamma hedging is a directional one (as are other hedges that we explore subsequently: in this paper, the convergence hedge, option hedge and capital structure hedge). Since the dimension of delta-gamma neutral is two, we must make use of a second derivative relationship (which has non-linear functions) to form the gamma neutral portfolio. Our focus is to exploit the portfolio's gamma to derive incremental profits. We do not restrict our portfolio to have a gamma equal to zero in a delta-gamma neutral strategy.

Rather, our approach is to study both bearish and bullish gamma hedges, which are based on bets on the direction of the future stock returns. The bearish gamma position is set up by long one CBs and short underlying stocks with numbers larger than what we do in a delta-neutral portfolio. So when the stock price goes down, the bearish gamma portfolio can derive higher returns than the delta-neutral portfolio. The bullish position is the adverse of the bearish one. The returns we study are again the returns on the total long position of the assets in the simulated portfolio. No initial self capital investment is required. Again, positive net capital is invested in a risk free asset; while negative net capital is borrowed from the market.

Table 2-9 reports the average portfolio returns of bullish gamma CBs hedging. The bullish portfolio is set up by going long CBs and short selling the underlying stocks of 0.09 less than the delta in a delta-neutral portfolio. If stock prices actually go up as expected, then the portfolio gains will be enhanced. The portfolio is rebalanced when delta changes by at least 0.3. We find that the average portfolio returns are positive in the first 36 months, with the highest value of 7.78%. The returns are significant at a level of

1% from the third to the 17*th* month after the issuance date. The number of positive return observations is larger than that of negative ones in the previous 20 month.

Table 2-10 reports summary statistics of the gamma portfolio's average month end returns with respect to different delta adjustment parameter inputs for gamma hedging, with a delta-neutral portfolio as a benchmark for comparison. From the table, unsurprisingly the volatility of both the bullish and bearish gamma hedging portfolios is larger than that of the delta-neutral hedging portfolio, due to their greater equity exposures. In contrast, the average returns of bullish gamma hedging portfolios before and after 2001 are much stable compared with that of bearish gamma hedging. Furthermore, the bullish hedging from the issuance of CBs can generate better returns than that of both the delta-neutral portfolio and bearish gamma hedging. This is not surprising because of two reasons: 1) the underlying stock prices normally perform well during the first three years after the issuance of CBs; and 2) because the gamma of the portfolio is positive definite, when the underlying share price rises, the convertible value rises a bit more than what predicted by delta; while when the share price goes down, the convertible loses somewhat less. So a bullish bet is in a better position to take advantage these two factors.

Figure 2-3 shows the portfolio gamma as a function of the stock price change and the returns for the daily gamma hedging portfolio of both bearish hedging and bullish hedging with different parameters.

Average month end gammas after the issuance during the post 2001 sample period are found to be larger than those of the earlier period, over the first 36 months after the CB issuances. As is shown in the Part A of Figure 2-3, gamma is larger when the underlying stock price is near the exercise price. In other words, stock prices of firms issuing CBs after 2001 are generally closer to the exercise price than those before 2001. This is also reflected in the patterns of conversion premia shown in Table 2-1. The price of higher gamma portfolios may reflect a premium for gamma-seeking investors, which may explain the higher observed returns for the strongly bullish gamma portfolio (Delta -.14) in the post 2001 period.

In the construction of the gamma hedged portfolios above, we change the delta by adding or subtracting a fixed number. We also performed the analyses using a flexible approach for adjusting deltas: using the mid point of the current delta and the delta calculated from the expected future price then we change the delta with a flexible number. The results remain unaffected. On the whole, bullish gamma hedging from the issuance of CBs appears to be a robust investment strategy.[16]

2.3.5. Implied Volatility Convergence Hedge

Delta-neutral and gamma hedging involve taking opposite long/short positions between CBs and their underlying stocks. In this section, we explore convergence hedging strategies, which are transactions between different CBs. As we know, CBs consists of two main assets: a warrant and a bond. So we can have an implied volatility convergence hedge and a credit spread convergence, correspondingly.

The valuation of CBs requires the assumption of: 1) the underlying stock volatility to value the option, and 2) the credit spread for the fixed income portion that takes into account the firm's credit profile and the ranking of the convertible within the

[16] We also performed a the risk component analysis for gamma hedge, we find that all three risk components (equity, interest rate, and credit risk) are significantly negative at a level of 1%.

capital structure. Based on the market price of the convertible, we can determine the implied volatility (using the assumed spread) or implied spread (using the assumed volatility). The performance of an implied volatility hedge can test the market efficiency of the option component. A credit spread convergence hedge can test the efficiency of the bond component. The implied volatility is calculated by using the Black-Scholes-Merton formula on the option part of the CBs. And the option part of CBs is the difference between the CBs price and calculated theoretical bond value by discounting the cash flows.

The convergence test does not state that the implied volatility or credit spread of two CBs should be the same. Factors such as rating, dates, and conversion price etc. of CBs could be reflected in spreads and can be taken into account ex ante. What we want to test is whether the abnormal volatility differences between two CBs can be pursued to make profit. Figure 2-4 depicts the implied volatility relationship of two different CBs of the same issuer. We find that the implied volatility difference does exist, and the difference shows jumps from time to time.

In order to eliminate the possible effects of different ratings, the CBs studied here are required to belong to the same issuer, and the ratings of the different CBs are required be the same. To identify the opportunity, the portfolio is set up when the implied volatility difference of CBs is large enough compared with the historical data. We buy the CBs with lower implied volatility and short the CBs with higher implied volatility of the same issuer under the delta neutral criteria. No initial self capital investment is required for the hedging strategy, and the returns are calculated as the returns of total long assets. In order to delete opportunities result from the same jumps, we require that in any consecutive 5 trading days (one week) only one portfolio will be set up the first time when an abnormal implied volatility difference exists.

Table 2-11 reports the average portfolio returns of implied volatility hedging. The portfolio is set up by buying low implied volatility and short selling large implied volatility CBs of the same issuer. It is a zero initial self investment capital hedging strategy. The returns are listed as days from the first set-up day of the portfolio when the implied volatility difference is large enough. The table only reports the results of the first 66 days, because after 66 days, the returns are not economically or statistically significant any more. The returns are positive and mostly significant at a level of 5% during the first 66 days. The highest return is 4.07% at the 54th days from the set up of the portfolio. The number of positive-return observations is generally larger than that of negative-return ones during this whole period. Overall, only a few opportunities for benefiting from convergence hedging are observed – indeed, only 20 are identified over the entire sample period.

We find that the market corrects the implied volatility difference, but it does take some time for the implied volatility to converge. This may be due to thin trading in the underlying CBs. A recommended trading strategy based on these results is to identify the opportunity and then buy and hold the hedging position for about three months from the first time the opportunity shows up.[17]

2.3.6. Credit Spread Convergence Hedge

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[17] We also perform a risk components analysis for the portfolio returns after each reset with a strategy of resetting when implied volatility change floating values. We find that the equity risk and credit risk influence play the key role for this strategy: they are significantly negative at the 1% level. As a contrast, the interest rate risk has positive influence, but it is not significant.

In this section, we study the performance of a credit spread convergence hedging strategy. The credit spread is calculated as the difference between the yield of 10-year Treasury bond and the yield of the CB; the yield of the CB is calculated from the difference between the CB's price and the calculated theoretical option value based on historical volatility.

Figure 2-5 depicts the credit spread relationship of two different CBs of the same issuer. It is evident that the credit spread is volatile, although it does exhibits some mean-reverting behavior.

To identify a credit spread trading opportunity, a portfolio is set up when the credit spread difference of CBs is large relative to their historical means. We buy the CBs with lower credit spread and short the CBs with higher credit spread of the same issuer. Another requirement of this hedge is that the portfolio should generate non-negative cash flows with the two CBs. In every consecutive 5 trading days (one week), one portfolio will only be set up at the first time an abnormal credit spread difference shows up. No initial self capital investment is required for the hedging strategy, and the returns are calculated as the returns of total long assets. The portfolio is set up by buying low credit spread and short large credit spread CBs of the same issuer.

Because the credit spread between CBs of the same issuer could be normal, if all other factors stay the same in each reset, the portfolio returns could grow larger as time goes on as a result of the normal difference. In Table 2-12, we show the first difference of average portfolio returns of credit hedging. The first difference is calculated as the up-to-date returns subtracted by the returns in the first set-up day. In order to get a clear picture, the returns are listed as both months and days from the first set-up day of the portfolio when the credit spread difference is large enough. From Panel A of Table 2-12, we find that the month-end portfolio returns are positive and economically significant as a whole. The returns are mostly significant during the first five months. The number of positive observations is larger than that of negative ones. If we analyze total returns rather than first differences, we find that they are positive and significant at a level of at least 5%.

Panel B of Table 2-12 reports the first difference day-end returns for the first one month from the first set-up day when the credit spread difference is large enough. The return of the first day is the total returns of the portfolio at the end of the first day; the other returns are listed as the first difference of this first day's return. We find that the total return of the first day is positive and significant at a level of 1% at the first set-up date of the portfolio. From the second to the fifth day, the first difference return is negative, and become positive thereafter. The number of positive observations becomes larger than that of negative ones from the sixth day. From this, we may say that the market correct the credit spread difference quite quickly, and the market is efficient here. The bond part of the market efficiency is different from the option counterpart, which might result from the different liquidity of the option market and the corporate bond market. [18]

2.3.7. Call Option Hedge

To explore the effects of volatility on CB hedging strategies, in this section, we

[18] For the risk components for the portfolio returns after each reset with a strategy of resetting when credit spread change floating values, we find all three risk factors have significant negative influences at a level of 1%. Compared with that of the implied volatility convergence strategy, the credit spread convergence can generate returns in longer period because interest rate difference could persist between different CBs of the same issuer.

examine the relation between options and CBs of the same issuer to find possible arbitrage opportunities. Here we tried to locate the CBs whose exercise price of the CBs is much higher than the current stock price. We sell deep out-of-the-money call options of the same issuing firms, and buy CBs to get higher possible hedged returns compared with naked position in CBs. These options are chosen with the most similar exercise prices and much less maturity. The price of these call options are generally a few cents only.

The trading strategy for this hedge is to have buy-and-hold returns over the overlapped life of the CBs and call options. The intention of the strategy is to sell the hedged call option while hoping it will not get exercised until till the maturity date of the option, by taking advantage deep of the out-of-moneyness. If the option does not end in-the-money, the portfolio can generate returns from the price gains or losses of the CBs, the coupon rate of the CBs and the original price to write the call option. On the other hand, if the option ends in-the-money, the portfolio will realize the returns from the coupon rate of the CBs and the original price to write the call option if the number of long and short position matches.

In this study, we identify the opportunity by locating CBs whose exercise price is at least as high as 250% of the current stock price, and checked moneyness at the end to calculate the buy-and-hold returns of the hedged portfolio. The number of call options being shorted is set to be equal to the conversion shares of the long CBs position. This hedging strategy requires an initial self capital investment, and the returns are calculated as the returns of the initial capital. We only calculate the buy-and-hold returns of the portfolio, and annualized the returns to make it comparable among different opportunities. There are only 3 out of the 17 CBs that finally end the in-the-money in the studied period, which is 4 years after the issuance. The annualized median of the returns is 32.39%. However, because the liquidity of the deep out-of-money options and CBs is very low, normally it is difficult to set up big position and make large profits from this trading strategy.

2.3.8. Capital Structure Hedge

Besides using CBs, we can also use other corporate bonds issued by the same firm to set up a hedging portfolio. Some of the bonds have low ratings but can generate potentially high returns. For others, it is the reverse. We can use the combination of CBs and other non-convertible corporate bonds to pursue possible arbitrage opportunities. For each issuer, we refer to the highest yield (lowest yield) bond as the high (low) yield bond. We conjecture that price inefficiency is more likely to exist in low-rated financial debentures, so the capital structure hedge studied here is mainly focused on low-rated CBs issuers.

The hedging portfolio is set up using two types of trading strategies. The first one is to buy CBs with a rating of B or lower and short sell the low yield bond of the same issuer. There is no initial self capital investment, and the returns are calculated as the returns of total long assets. Table 2-13 reports the returns of such hedging strategies from the issuance date of the CBs.

We find that the returns are positive in the first 26 months from the issuance of CBs, most of which become significant after the third month. From the second month, the number of positive return observations becomes larger than that of negative ones. If we focus only on CBs that are rated Caa or below, the returns of the portfolio are bigger; if we use all the issuing firms instead, the returns are smaller.

The second trading strategy of the capital structure hedging is to short sell CBs with a rating of B and under, and buy high yield bond of the same issuer. Table 2-14 reports the returns of such hedging strategies from the issuance date of the CBs. Because the price of pure bond cannot go up very high, while the CBs price does not have an upper price limit, so we add a 25%-up stop-loss strategy when setting up the portfolio in order to close out the position when the CB's price goes up 25%.

From Table 2-14, we find that the returns during the earlier period are positive on the whole, but become negative from the twelfth month. This pattern is consistent with the findings that during the earlier period, to invest in the low rated CBs will generate negative returns over the first few months from the issuance only. If we analyze the daily returns of the first month from the issuance date of CBs, which is shown in Part B of Table 2-14, we find that during earlier days, the returns are volatile and not significant. From the beginning of forth week, the returns are positive and significant at a level of 10%.

2.3.9. Credit Default Swap Hedge

A credit default swap (CDS) is the most popular form of credit derivative, allowing a party to buy or sell credit protection against a given reference entity. To obtain credit protection, the buyer of a CDS makes periodic payments to the credit protection seller. In the event of default (i.e., a credit event) of the reference entity, the credit protection seller will either take delivery of the defaulted bond paying par value (physical settlement) or pays the buyer the difference between the par value and the recovery amount of the bond (cash settlement). Thus, if an investor buys a CB while simultaneously buying a CDS where the reference entity is the issuer of that CB, the investor is in fact transferring the credit risk associated with the CB.[19] This is appealing since a large portion of CBs issued in the United States are non-investment grade, and therefore have significant credit risk.

The trading strategy studied here is based on the previous finding that issuers perform better than average after the issuance of CBs. The portfolio is set up by simultaneously buying CBs and buying CDS to transfer the credit risk. In the event of a default, the holder of the portfolio has the right to sell the protected CB to the CDS seller for par value or received a cash payment for the impaired CB values, depending on the settlement method (physical or cash). This trading strategy provides investors with more comfort when buying low-rated CBs, while pursuing potentially high returns.

Table 2-15 reports the month-end returns for this strategy for the subsample of the firms in our study where CDS prices were available at the time of issuance, 16 firms. The CDS price data used in computing the returns were for CDS contracts with a term of three years, using the average bid and ask price at the issuance date of the CB. The returns reported in Table 2-15 are calculated as the returns of a simulated portfolio with zero initial self capital investment from the issue date.

On the whole, we find that portfolios of long bonds with CDS protection to hedge credit risk do not exhibit stalwart performance over the first year subsequent to their issuance. Average returns are negative and insignificant over the first eight months following the issuance. For the limited sample with data extending beyond one year, average returns do improve, however after 14 months subsequent to the CB issuances.

[19] The investor in such a strategy is still subject to CDS counterparty risk.

The limited sample size for testing this strategy makes it difficult to make any statement about the viability of this trading strategy. No doubt that with the increase in the number of reference entities for which credit protection can be bought, future studies will be provide more insight into this strategy.

2.4. CONCLUSION

This paper examines the returns of several hedged portfolios involving CBs. In particular, we test for deviations from the law of one price by studying the relative returns of different combinations of long CBs with short positions in the underlying stocks, which include equal money positions, delta-neutral positions, as well as bearish/bullish gamma positions.

These trading strategies are found to be robust to alternative specifications of leverage effects and alternative parameter inputs. We also examine trading profits of buying CBs deemed to be relatively "cheap" and short selling those deemed to be expensive, employing as our criteria for cheap and rich the abnormal implied volatility difference as well as the abnormal credit spread difference for CBs issued by identical firms.

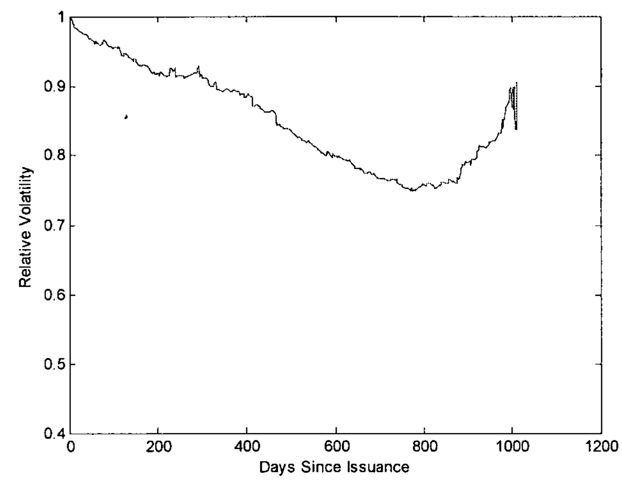
We also test strategies that involve portfolios that comprise returns of CBs versus call options or other corporate bonds of the same issuer. Finally, since a large portion of CBs issued in the United States are rated non-investment grade, we also look at the performance of portfolios of CBs that are combined with credit default swaps in order to remove credit risk.

The returns are calculated based on portfolios simulated under trading strategies that are employed in several distinct scenarios. We find that investors can benefit from acquiring CBs at issuance and holding certain hedged positions. Hedged positions that are based on the characteristics of the bonds are shown to provide superior absolute and relative returns. The bullish gamma hedging strategy taken at the time of the issuance of the convertibles and the delta-neutral strategy with larger delta change tolerance are found to be particularly advantageous. Meaningful hedging opportunities between convertibles and other financial instruments are also observed. In summary, we find support for trading opportunities with CB-related strategies, suggesting that market commentators that predict the demise of such opportunities in the CB market may be wrong.

FIGURE 2-1. Average Volatility of Underlying Stocks from Issuance Date

Panel A. Daily Volatility:

This figure depicts the average normalized volatility from issuance date of CBs. Panel A shows the behaviour of the daily rolling normalized volatility of returns. Normalized daily volatility is defined as the daily volatility on day D (calculated as the volatility of the logarithmic returns from D-240 (240 trading days before D) to D-1 (one trading day before D) divided by the volatility in the first trading date after the issuance.



Panel B. Quarterly Volatility

This figure depicts the average normalized quarterly volatility (relative volatility) from issuance date. The volatility in Quarter D is calculated as the volatility of the logarithmic returns in that quarter. Two alternative normalizations are shown: 1) based on the volatility relative to the first quarter before the issuance, and 2) based on the volatility of the first quarter after the issuance.

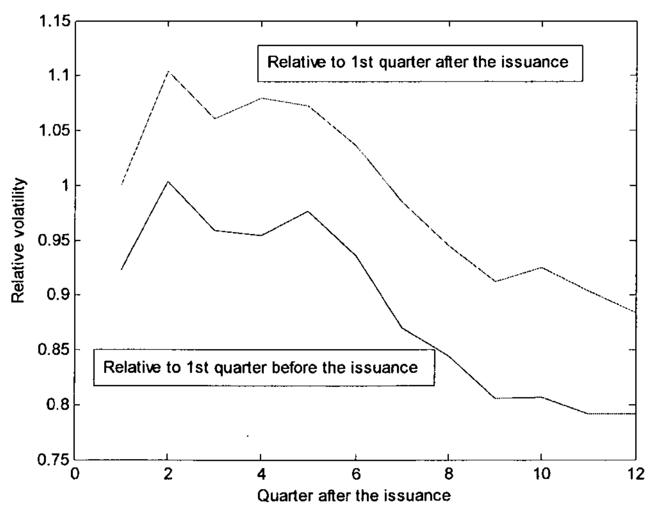
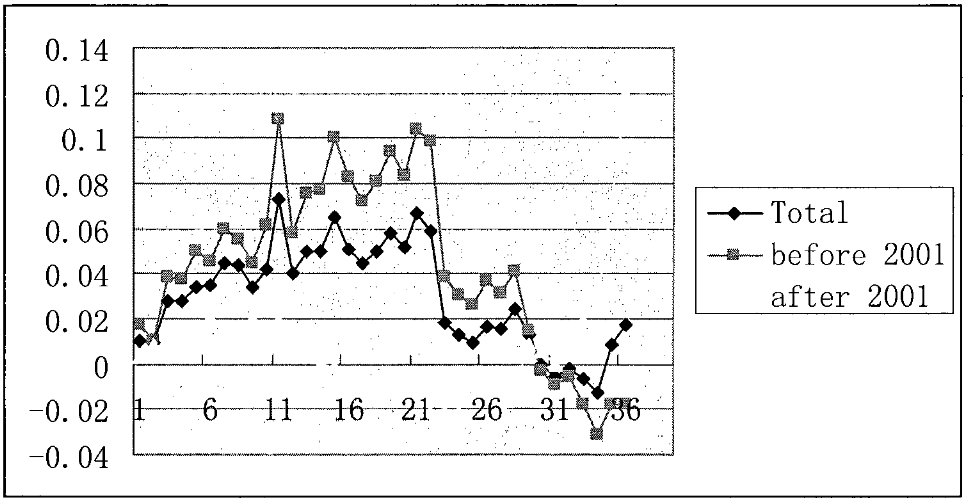


FIGURE 2-2. Average Month end Returns of Delta Neutral Hedge from Issuance Date

Panel A. Daily Rebalancing Returns:
This figure depicts the average daily rebalancing returns of the delta-neutral portfolio for different sample periods: the total sample, issues prior to the end of 2001, and post 2001 issues.



Part B. Returns under Different Rebalancing Policy:
This figure depicts the average monthly returns of the delta-neutral portfolio across different rebalancing policies: daily rebalance, and rebalancing for delta changes of no less than 0.02, 0.04, 0.1, 0.2 and 0.3 respectively.

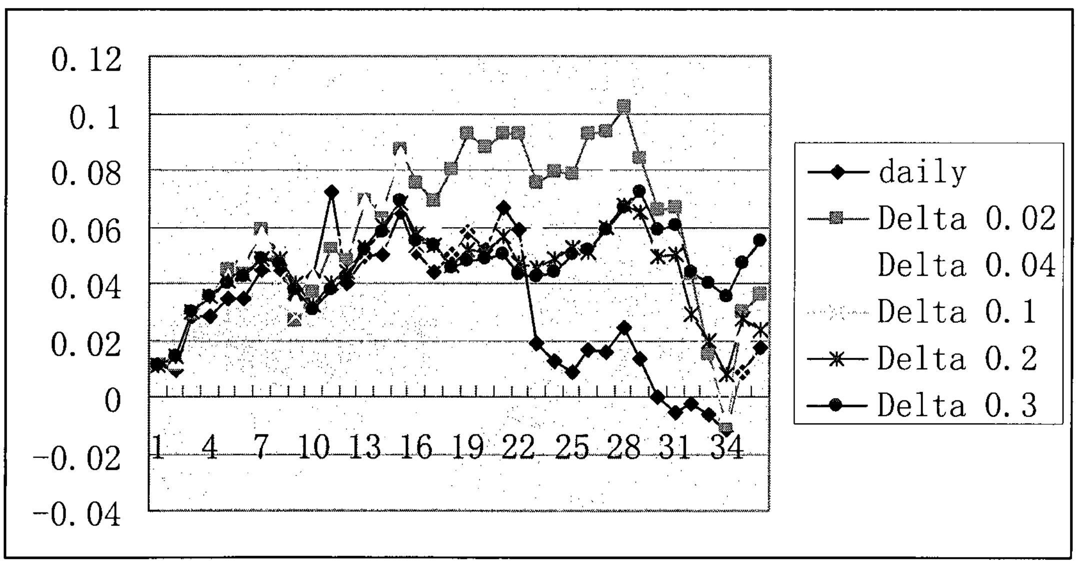
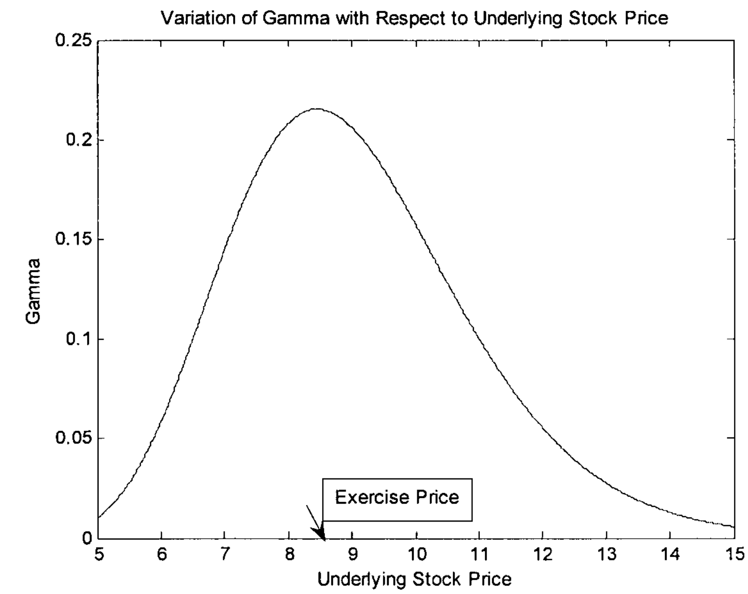


FIGURE 2-3. Gamma and Gamma Hedge from Issuance Date

Part A. Gamma:
This figure depicts the variation of gamma when the underlying stock price changes, holding all other parameters constant.



Part B. Portfolio Returns in Gamma Hedge
This figure depicts the average daily gamma hedging portfolio of both bearish hedging and bullish hedging. Returns are shown for delta-neutral hedging (No Adjustment), bullish hedging with parameters of minus 0.09 and 0.14 from the initial delta values, and bearish hedging with parameters of plus 0.09 and 0.14 from the initial delta values respectively.

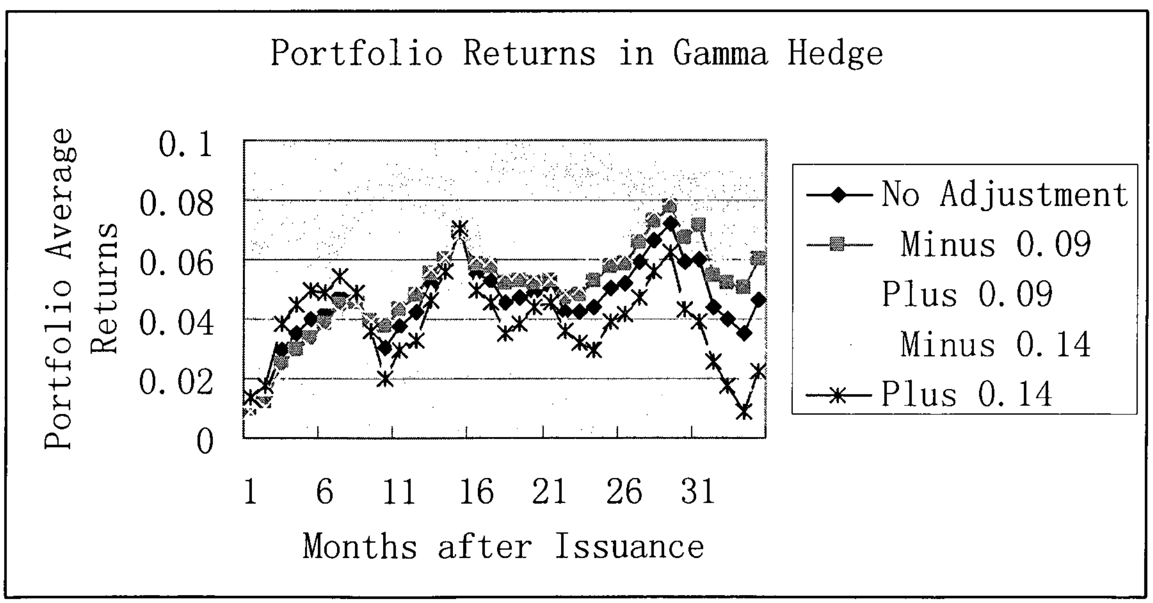


FIGURE 2-4. Implied Volatility Relationship

This figure depicts the implied volatility relationship of two different CBs of the same issuer.

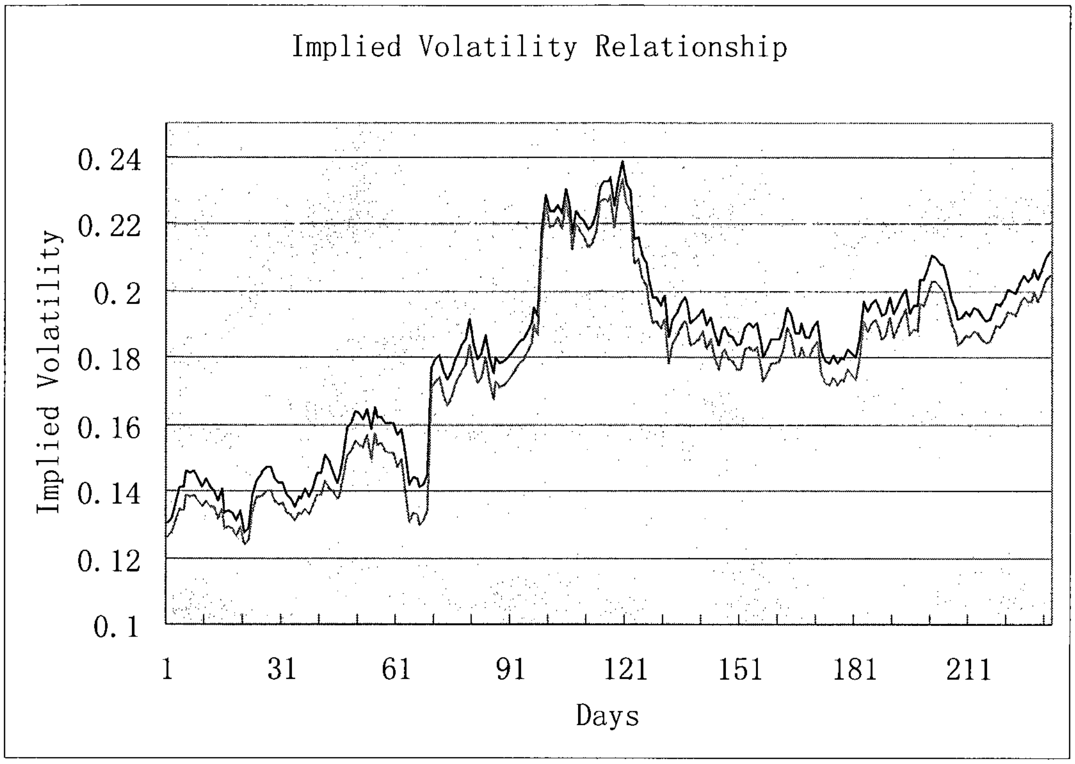


FIGURE 2-5. Credit Spread Relationship

This figure depicts the Credit Spread relationship of two different CBs of the same issuer.

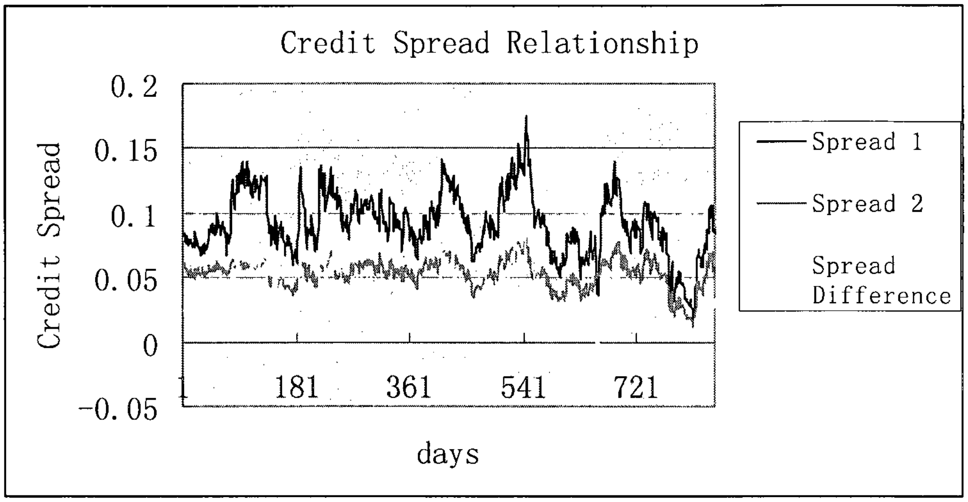


TABLE 2-1. Distribution of Convertible Bond Issuance by Year

This table reports the yearly characteristics of convertible bond issues used in the study. To ensure liquidity, an issue is included only if its proceeds amount plus the over-allotment sold in the hosted market of the convertible bonds exceeds $100 million.

Year	Number of Issues	Coupon (%)		Principal Amount (Million USD)		Conversion Premium (%)	
		Mean	Median	Mean	Median	Mean	Median
1990	6	N/A	N/A	433.67	425.00	15.50	14.50
1991	9	N/A	N/A	449.78	400.00	15.55	14.26
1992	10	4.46	4.75	326.50	112.50	20.79	21.84
1993	10	3.09	4.69	422.00	262.50	22.69	20.01
1994	4	5.25	6.25	356.25	250.00	54.31	23.38
1996	1	5.00	5.00	500.00	500.00	26.44	26.44
1997	1	6.00	6.00	90.00	90.00	25.01	25.01
2000	3	N/A	N/A	2299.20	2712.50	31.26	26.78
2001	22	1.72	0.00	788.08	525.00	55.20	28.74
2002	5	3.90	4.50	1156.00	1000.00	30.02	32.08
2003	14	2.97	2.81	679.02	287.50	37.54	35.25
2004	11	2.69	2.00	342.27	300.00	39.43	40.00
2005	11	4.14	3.88	453.65	275.10	25.58	28.00
2006	18	2.50	2.50	362.50	320.00	26.23	27.49
Total	125						

Note: The coupon rates in 1990, 1991, and 2000 in this sample are floating interest rate.

TABLE 2-2. Returns of Long Convertible Bonds from Issuance Date

This table indicates the average buy-and-hold returns of buying one convertible bond at the issuance date. The first column represents the holding period. The second column reports the returns of the pure long CBs portfolio; t-statistics for the returns are shown in column three. Column four (five) is the number of positive/negative returns; column six is the total number of observations at the end of X months after the issuance date. Column seven is the significance level of the t-statistics: 1, 2, and 3 denote statistical significance at the 10%, 5% and 1% levels in a two-tails test respectively.

Months	Returns	t-value	Positive	Negative	Total	Significance
1	0.36%	0.61	75	49	124	0
2	0.50%	0.58	66	55	121	0
3	-0.14%	-0.14	59	61	120	0
4	0.14%	0.12	60	58	118	0
5	0.76%	0.48	63	54	117	0
6	1.82%	1.21	66	49	115	0
7	3.61%	2.00	67	46	113	2
8	5.91%	2.90	65	45	110	3
9	8.04%	3.66	68	39	107	3
10	9.10%	3.93	69	37	106	3
11	9.61%	3.97	68	37	105	3
12	11.39%	4.52	69	33	102	3
13	10.85%	4.13	67	32	99	3
14	10.60%	4.13	65	31	96	3
15	11.06%	4.27	66	31	97	3
16	13.41%	4.88	70	25	95	3
17	14.84%	4.71	69	26	95	3
18	17.82%	4.17	68	26	94	3
19	18.08%	3.61	67	25	92	3
20	17.39%	4.14	69	21	90	3
21	17.00%	4.58	75	15	90	3
22	17.94%	4.71	72	16	88	3
23	19.44%	5.69	74	14	88	3
24	23.64%	5.33	73	13	86	3
25	24.90%	5.25	71	13	84	3
26	25.19%	5.20	70	13	83	3
27	26.40%	5.31	70	10	80	3
28	26.45%	5.47	69	12	81	3
29	26.65%	5.56	68	12	80	3
30	28.99%	5.32	68	11	79	3
31	31.60%	5.69	70	8	78	3
32	32.57%	6.34	67	9	76	3
33	34.93%	6.92	67	7	74	3
34	38.40%	6.97	67	6	73	3
35	36.93%	6.62	61	8	69	3
36	37.26%	6.37	59	4	63	3
37	37.05%	5.88	55	5	60	3
38	36.80%	5.62	53	5	58	3
39	39.08%	5.78	53	4	57	3
40	40.67%	5.88	53	4	57	3
41	41.69%	5.92	52	5	57	3
42	42.78%	5.96	48	5	53	3
43	41.98%	5.73	44	4	48	3
44	42.00%	5.44	42	4	46	3
45	42.72%	5.22	41	4	45	3
46	37.22%	5.53	40	3	43	3
47	37.96%	5.45	37	4	41	3
48	31.21%	4.36	21	5	26	3

TABLE 2-3. Risk Components of Pure Long Convertible Bonds Returns

Random Effect Panel Data regressions of CB holding returns on equity market risk, interest rate risk, and credit risk. The independent variables are: a) S&P 500 return; b) the term spread, calculated as the difference between the rate of the 3-month Treasury bill and 6-month Treasury bill; c) the difference between the average of Moody's Aaa utility and Aaa industrial bond rates and the average of Baa utility and Baa industrial bond (as the proxy of the credit risk). Panel A includes all the observations in the sample; Panel B includes firms with Moody's ratings of B or lower.

Panel A. All firms

Independent Variable	Coefficient	*t*-value
Constant	-.0001	-.192
Equity Risk	0.298	10.591***
Interest Rate Risk	0.344	4.496***
Credit Risk	0.013	0.321
F statistic	75.3***	

Panel B. Low rating firms (B or lower)

Independent Variable	Coefficient	*t* value
Constant	-0.001	0.801
Equity Risk	1.047	8.256***
Interest Rate Risk	0.700	2.287**
Credit Risk	0.273	1.978**
F statistic	34.5***	

** significant at 5% level
*** significant at 1% level

TABLE 2-4. Returns of Long Underlying Stocks from Issuance Date

This table reports the average buy-and-hold returns of buying one underlying stock at the CB issuance date. The first column represents the holding period. The second column reports the returns of the pure long CBs portfolio; t-statistics for the returns are shown in column three. Column four (five) is the number of positive/negative returns; column six is the total number of observations at the end of X months after the issuance date. Column seven is the significance level of the t-statistics in column three: 1, 2, and 3 denote statistical significance at the 10%, 5% and 1% levels in a two-tails test respectively.

Months	Returns	*t*-value	Positive	Negative	Total	Significance
1	-0.69%	-0.60	66	59	125	0
2	-1.39%	-0.93	63	59	122	0
3	-3.90%	-2.17	56	67	123	2
4	-4.30%	-2.13	55	67	122	2
5	-3.70%	-1.51	57	63	120	0
6	-0.90%	-0.24	54	64	118	0
7	0.18%	0.05	56	59	115	0
8	3.56%	0.84	58	54	112	0
9	6.56%	1.50	55	54	109	0
10	14.03%	1.92	61	47	108	1
11	12.17%	1.80	57	51	108	1
12	14.61%	2.02	54	49	103	2
13	12.40%	1.74	50	50	100	1
14	11.25%	1.53	50	48	98	0
15	10.51%	1.46	52	46	98	0
16	13.73%	1.92	53	44	97	1
17	15.02%	2.09	55	42	97	2
18	19.53%	2.40	58	37	95	2
19	18.72%	2.17	54	40	94	2
20	17.38%	2.27	57	36	93	2
21	16.17%	2.22	59	33	92	2
22	18.13%	2.39	55	35	90	2
23	20.10%	2.79	56	34	90	3
24	24.18%	3.13	62	28	90	3
25	24.35%	3.19	61	28	89	3
26	26.81%	3.37	60	28	88	3
27	25.62%	3.28	58	29	87	3
28	26.27%	3.22	54	33	87	3
29	26.57%	3.22	57	29	86	3
30	29.23%	3.42	58	28	86	3
31	35.21%	4.05	59	27	86	3
32	38.23%	4.50	60	26	86	3
33	39.38%	4.73	60	25	85	3
34	42.27%	5.02	63	21	84	3
35	41.25%	4.73	60	22	82	3
36	41.97%	4.57	58	20	78	3
37	41.79%	4.31	54	23	77	3
38	46.30%	4.32	51	25	76	3
39	50.47%	4.48	52	23	75	3
40	51.29%	4.71	55	20	75	3
41	51.97%	4.67	53	22	75	3
42	54.61%	4.79	49	21	70	3
43	54.00%	4.60	46	21	67	3
44	51.22%	4.24	45	19	64	3
45	49.10%	4.04	43	20	63	3
46	48.40%	3.95	41	20	61	3
47	47.36%	4.00	43	18	61	3
48	64.24%	4.12	31	9	40	3

TABLE 2-5. Risk Components of Underlying Equity Returns

Random Effect Panel Data regressions of the equity returns of the CB issuers on equity market risk, interest rate risk, and credit risk. The independent variables are: a) S&P 500 return; b) the term spread, calculated as the difference between the rate on the 3-month Treasury bill and 6-month Treasury bill; c) the difference between the average of Moody's Aaa utility and Aaa industrial bond rates and the average of Baa utility and Baa industrial bond rates (as the proxy of the credit risk). Panel A includes all the observations in the sample; Panel B includes firms with Moody's ratings of B or lower.

Panel A. All firms

Independent Variable	Coefficient	*t*-value
Constant	-0.003	-3.44***
Equity Risk	1.162	25.687***
Interest Rate Risk	0.239	2.035**
Credit Risk	0.262	4.072***
F statistic	234.0**	

Panel B. Low rated firms (B or lower)

Independent Variable	Coefficient	*t*-value
Constant	-0.002	1.221
Equity Risk	3.086	17.973***
Interest Rate Risk	0.243	0.608
Credit Risk	0.670	3.493***
F statistic	135.3***	

** significant at 5% level
*** significant at 1% level

TABLE 2-6. Returns of Equal Position of CB and Stocks from the Issuance Date

This table reports the holding period returns of portfolios consisting of equal money amounts in long CBs and short underlying stocks from the issuance date.

Panel A. Complete Sample

Month	Returns	t-value	Positive	Negative	Total	Trading Profit
1	1.12%	1.70*	68	56	124	1401.8
2	1.67%	2.02**	69	53	122	2086.1
3	3.79%	3.59***	73	48	121	4740.0
4	4.26%	3.67***	75	45	120	5319.1
5	4.44%	3.39***	75	44	119	5554.0
6	2.36%	0.85	76	40	116	2946.0
7	2.83%	1.00	69	44	113	3533.8
8	2.16%	0.75	70	40	110	2694.7
9	1.26%	0.45	61	47	108	1575.8
10	-5.24%	-0.85	60	46	106	-6544.2
11	-3.61%	-0.64	59	47	106	-4510.2
12	-3.74%	-0.64	53	49	102	-4673.8

* significant at 10% level; ** significant at 5% level; *** significant at 1% level

TABLE 2-6. (Continued)

Panel B. Sample to the end of 2001

Month	Returns	t-value	Positive	Negative	Total	Trading Profit
1	2.63%	2.47**	41	24	65	3284.1
2	3.21%	2.56**	37	28	65	4017.7
3	6.62%	4.07***	46	19	65	8276.5
4	8.12%	5.21***	48	17	65	10151.0
5	9.14%	5.32***	50	15	65	11428.0
6	8.83%	4.80***	51	14	65	11034.0
7	9.24%	4.54***	47	18	65	11551.0
8	9.88%	4.50***	49	15	64	12354.0
9	8.42%	3.68***	45	19	64	10531.0
10	8.72%	3.38***	43	21	64	10899.0
11	9.35%	3.42***	44	20	64	11691.0
12	10.54%	3.73***	41	22	63	13171.0

* significant at 10% level; ** significant at 5% level; *** significant at 1% level

Panel C. Post 2001 Sample

Month	Returns	t-value	Positive	Negative	Total	Trading Profit
1	-0.54%	-0.79	27	32	59	-671.9
2	-0.09%	-0.09	32	25	57	-116.5
3	0.51%	0.45	27	29	56	635.2
4	-0.31%	-0.21	27	28	55	-391.0
5	-1.21%	-0.71	25	29	54	-1516.2
6	-5.89%	-1.05	25	26	51	-7361.9
7	-5.86%	-1.00	22	26	48	-7322.2
8	-8.60%	-1.49	21	25	46	-10745.0
9	-9.16%	-1.62	16	28	44	-11450.0
10	-26.50%	-1.83*	17	25	42	-33124.0
11	-23.36%	-1.80*	15	27	42	-29198.0
12	-26.80%	-1.96*	12	27	39	-33500.0

* significant at 10% level; ** significant at 5% level; *** significant at 1% level

TABLE 2-7. Returns of Delta Neutral Hedge from Issuance Date

This table reports the portfolio returns of delta neutral hedging with daily rebalancing. Each day we rebalance the portfolio based on the previous day's delta. The portfolio consists of long CBs and short share positions. Panel A includes all the observations in the sample; Panel B & C shows issued up to end of 2001 and post 2001 respectively.

The last column provides the significance levels of the returns (notes1, 2 and 3 indicate significance at the 10%, 5% and 1 % levels, respectively).

Panel A. Complete Sample

Months	Returns	*t*-value	Positive	Negative	Total	Significance
1	1.07%	2.18	72	52	124	2
2	0.98%	1.53	64	58	122	0
3	2.83%	2.64	67	54	121	3
4	2.82%	3.16	73	47	120	3
5	3.43%	2.98	65	54	119	3
6	3.48%	3.08	61	55	116	3
7	4.48%	2.87	66	47	113	3
8	4.41%	2.99	68	42	110	3
9	3.43%	1.67	58	50	108	1
10	4.24%	1.61	58	48	106	0
11	7.25%	1.70	54	52	106	1
12	3.99%	2.10	52	50	102	2
13	4.98%	2.15	50	50	100	2
14	5.01%	2.28	47	50	97	2
15	6.49%	2.61	50	47	97	2
16	5.08%	1.88	44	51	95	1
17	4.43%	1.53	44	51	95	0
18	4.99%	1.44	36	58	94	0
19	5.82%	1.39	36	56	92	0
20	5.19%	1.26	32	59	91	0
21	6.69%	1.33	31	59	90	0
22	5.91%	1.05	31	57	88	0
23	1.86%	0.58	27	61	88	0
24	1.27%	0.42	27	59	86	0
25	0.90%	0.29	25	59	84	0
26	1.63%	0.43	25	58	83	0
27	1.57%	0.45	22	59	81	0
28	2.46%	0.65	25	56	81	0
29	1.32%	0.38	26	54	80	0
30	0.00%	0.00	26	53	79	0
31	-0.58%	-0.18	24	54	78	0
32	-0.22%	-0.06	20	56	76	0
33	-0.65%	-0.18	21	53	74	0
34	-1.28%	-0.33	19	54	73	0
35	0.83%	0.19	18	51	69	0
36	1.73%	0.37	19	44	63	0

Panel B. Sample to end of 2001

Months	Returns	t-value	Positive	Negative	Total	Significance
1	1.77%	2.08	39	26	65	2
2	1.05%	0.98	26	39	65	0
3	3.84%	2.07	34	31	65	2
4	3.77%	2.60	39	26	65	2
5	4.99%	2.72	34	31	65	3
6	4.59%	2.66	34	31	65	3
7	6.00%	2.39	38	27	65	2
8	5.56%	2.50	42	22	64	2
9	4.44%	1.37	33	31	64	0
10	6.16%	1.49	35	29	64	0
11	10.79%	1.56	35	29	64	0
12	5.77%	2.19	34	29	63	2
13	7.52%	2.22	32	31	63	2
14	7.73%	2.47	32	31	63	2
15	10.06%	2.84	37	26	63	3
16	8.24%	2.07	30	31	61	2
17	7.23%	1.69	29	32	61	1
18	8.09%	1.59	25	36	61	0
19	9.45%	1.56	26	35	61	0
20	8.38%	1.39	22	38	60	0
21	10.34%	1.40	21	39	60	0
22	9.87%	1.20	23	36	59	0
23	3.82%	0.85	18	41	59	0
24	3.02%	0.72	20	37	57	0
25	2.62%	0.62	19	37	56	0
26	3.72%	0.71	18	38	56	0
27	3.13%	0.65	15	40	55	0
28	4.10%	0.78	18	37	55	0
29	1.50%	0.32	19	36	55	0
30	-0.32%	-0.07	19	35	54	0
31	-0.90%	-0.21	18	35	53	0
32	-0.55%	-0.12	14	37	51	0
33	-1.83%	-0.39	16	35	51	0
34	-3.09%	-0.63	15	36	51	0
35	-1.81%	-0.35	13	36	49	0
36	-1.80%	-0.33	14	33	47	0

Panel C. Post 2001 Sample

Months	Returns	t-value	Positive	Negative	Total	Significance
1	0.29%	0.71	32	27	59	0
2	0.88%	1.43	38	19	57	0
3	1.66%	1.98	33	23	56	1
4	1.69%	1.87	33	22	55	1
5	1.56%	1.29	31	23	54	0
6	2.07%	1.57	27	24	51	0
7	2.42%	1.78	28	20	48	1
8	2.80%	1.70	26	20	46	1
9	1.96%	1.09	25	19	44	0
10	1.32%	0.66	23	19	42	0
11	1.93%	0.87	19	23	42	0
12	1.12%	0.45	18	21	39	0
13	0.66%	0.29	18	19	37	0
14	-0.01%	-0.01	15	19	34	0
15	-0.09%	-0.04	13	21	34	0
16	-0.58%	-0.27	14	20	34	0
17	-0.60%	-0.25	15	19	34	0
18	-0.72%	-0.26	11	22	33	0
19	-1.29%	-0.42	10	21	31	0
20	-0.96%	-0.32	10	21	31	0
21	-0.57%	-0.19	10	20	30	0
22	-2.13%	-0.73	8	21	29	0
23	-2.15%	-0.71	9	20	29	0
24	-2.17%	-0.67	7	22	29	0
25	-2.58%	-0.73	6	22	28	0
26	-2.74%	-0.73	7	20	27	0
27	-1.76%	-0.44	7	19	26	0
28	-1.03%	-0.25	7	19	26	0
29	0.87%	0.20	7	18	25	0
30	0.60%	0.14	7	18	25	0
31	0.00%	0.00	6	19	25	0
32	0.40%	0.08	6	19	25	0
33	1.89%	0.35	5	18	23	0
34	2.80%	0.46	5	17	22	0
35	7.20%	0.98	5	15	20	0
36	11.98%	1.33	5	11	16	0

TABLE 2-8. Returns of Delta Neutral Hedge with Different Inputs from Issuance Date

This table reports summary statistics of the delta-neutral portfolio's average monthly returns with respect to different rebalancing policies. Entire sample results are shown, as well as for two sub-samples: observations prior to the end of 2001 and post 2001 issues. Results are shown for daily rebalancing, for rebalancing when delta change no less than 0.02, 0.04, 0.1, 0.2 and 0.3, and with daily rebalancing for portfolios with leverage is equal to 2 and 3 respectively.

Rebalancing Policy		Total	Before 2001	After 2001
Daily Rebalance	Mean	0.0299	0.0437	0.0074
	Std	0.0230	0.0388	0.0274
	Max	0.0725	0.1079	0.1198
	Min	-0.0128	-0.0309	-0.0274
Rebalance if Delta change≥0.02	Mean	0.0587	0.0129	-0.0061
	Std	0.0285	0.0520	0.0348
	Max	0.1019	0.1698	0.0832
	Min	-0.0103	-0.0010	-0.0688
Rebalance if Delta change≥0.04	Mean	0.0526	0.0129	-0.0205
	Std	0.0237	0.0443	0.0331
	Max	0.0884	0.1496	0.0624
	Min	-0.0066	0.0001	-0.0719
Rebalance if Delta change≥0.1	Mean	0.0409	0.0679	-0.0111
	Std	0.0198	0.0184	0.0130
	Max	0.0710	0.1236	0.0316
	Min	-0.0145	-0.0075	-0.0605
Rebalance if Delta change≥0.2	Mean	0.0436	0.0650	0.0045
	Std	0. 0153	0.0154	0.0131
	Max	0. 0685	0.1081	0.0881
	Min	0. 0080	-0.0001	-0.0381
Rebalance if Delta change≥0.3	Mean	0.0463	0.0705	0.0007
	Std	0.0130	0.0115	0.0126
	Max	0.0723	0.1106	0.0740
	Min	0.0111	0.0164	-0.0421
Daily Rebalance leverage=2	Mean	0.3593	0.5113	0.0552
	Std	0.2670	0.4113	0.1078
	Max	0.8903	1.3077	0.4805
	Min	0.0016	-0.0170	-0.1063
Daily Rebalance leverage=3	Mean	0.5671	0.8501	-0.0093
	Std	0.5607	0.8687	0.1514
	Max	1.7755	2.6719	0.4980
	Min	-0.2689	-0.3883	-0.2754

TABLE 2-9. Returns of Bullish Gamma Hedge from Issuance Date

This table reports the portfolio returns of bullish gamma hedging. The portfolio is rebalanced when delta changes no less than 0.3; and the bullish position is set up by long buying CBs and short selling the underlying stocks of 0.09 less than what should be hedged in delta-neutral portfolio.

Months	Returns	*t*-value	Positive	Negative	Total	Significance
1	0.98%	2.60	80	45	125	2
2	1.19%	2.52	68	55	123	2
3	2.47%	3.66	78	44	122	3
4	2.93%	4.17	79	42	121	3
5	3.40%	4.13	76	44	120	3
6	3.86%	4.43	75	42	117	3
7	4.45%	4.81	73	41	114	3
8	4.59%	4.45	77	34	111	3
9	3.89%	3.40	66	43	109	3
10	3.76%	2.98	64	43	107	3
11	4.33%	3.38	61	46	107	3
12	4.79%	3.43	65	38	103	3
13	5.51%	3.72	58	43	101	3
14	6.00%	3.78	62	36	98	3
15	6.86%	3.91	60	38	98	3
16	5.88%	3.31	56	40	96	3
17	5.75%	3.21	56	40	96	3
18	5.18%	2.59	52	43	95	2
19	5.31%	2.57	50	43	93	2
20	5.22%	2.56	50	42	92	2
21	5.26%	2.47	41	50	91	2
22	4.68%	2.18	41	48	89	2
23	4.77%	2.12	42	47	89	2
24	5.27%	2.16	41	46	87	2
25	5.74%	2.18	37	48	85	2
26	5.85%	1.99	32	52	84	2
27	6.57%	2.17	38	44	82	2
28	7.28%	2.26	36	46	82	2
29	7.78%	2.42	39	42	81	2
30	6.70%	2.04	37	43	80	2
31	7.16%	2.17	37	42	79	2
32	5.41%	1.19	37	40	77	0
33	5.24%	1.06	32	43	75	0
34	5.05%	0.95	32	42	74	0
35	5.99%	0.99	32	38	70	0
36	6.43%	0.94	33	31	64	0

In the last column, 1, 2, and 3 denote statistical significance at the 10%, 5% and 1% levels of a two-tails test respectively.

TABLE 2-10. Returns of Gamma Hedging with Different Inputs from Issuance Date

This table reports the summary statistics of the gamma portfolio's average monthly returns with respect to different delta adjustment parameters. The complete sample results are shown (Column Total and the last two columns) for issues prior to the end of 2001, and post 2001 issues. Results are shown for delta neutral hedging, for bullish hedging with parameters of minus 0.09 and 0.14 from the initial delta values, respectively, and for bearish hedging with parameters of plus 0.09 and 0.14 from the initial delta values respectively.

Rebalancing Policy		Total	Before 2001	After 2001
Delta neutral hedging	Mean	0.0463	0.0705	0.0007
	Std	0.0130	0.0115	0.0126
	Max	0.0723	0.1106	0.0740
	Min	0.0111	0.0164	-0.0421
Bullish Gamma Hedging Delta-0.09	Mean	0.0504	0.0584	0.0366
	Std	0.0154	0.0206	0.0268
	Max	0.0778	0.0935	0.1353
	Min	0.0098	0.0121	0.0051
Bearish Gamma Hedging Delta+0.09	Mean	0.0418	0.0821	-0.0355
	Std	0.0127	0.0285	0.0374
	Max	0.0702	0.1319	0.0225
	Min	0.0125	0.0205	-0.0928
Bullish Gamma Hedging Delta-0.14	Mean	0.0527	0.0517	0.0564
	Std	0.0173	0.0189	0.0324
	Max	0.0807	0.0845	0.1692
	Min	0.0090	0.0097	0.0055
Bearish Gamma Hedging Delta+0.14	Mean	0.0390	0.0883	-0.0558
	Std	0.0138	0.0311	0.0461
	Max	0.0705	0.1437	0.0221
	Min	0.0090	0.0223	-0.1226

TABLE 2-11. Returns of Implied Volatility Convergence Hedge

This table reports the average portfolio returns of implied volatility hedging. The portfolio is set up by buying low implied volatility and short large implied volatility CBs of the same issuer. It is a zero initial self investment capital hedging strategy. The returns are listed as days from the first set-up day of the portfolio when the implied volatility difference is exceeds its threshold.

Days	Returns	t-value	Positive	Negative	Total	Significance
1	0.58%	1.09	12	8	20	0
2	0.03%	0.14	8	12	20	0
3	0.57%	3.49	15	5	20	3
4	0.75%	1.92	13	7	20	1
5	0.69%	1.70	14	6	20	0
6	0.66%	2.11	14	6	20	2
7	0.78%	1.25	12	7	19	0
8	0.73%	1.37	12	6	18	0
9	1.06%	1.42	14	4	18	0
10	0.88%	1.06	11	6	17	0
11	0.88%	1.40	11	6	17	0
12	0.55%	1.28	10	7	17	0
13	0.98%	1.94	12	5	17	1
14	1.32%	1.70	11	6	17	0
15	1.06%	2.13	11	5	16	2
16	1.53%	2.42	12	3	15	2
17	1.24%	1.51	10	4	14	0
18	1.44%	2.04	10	4	14	1
19	1.49%	2.03	9	4	13	1
20	1.71%	2.35	9	4	13	2
21	1.21%	1.61	7	5	12	0
22	1.50%	2.40	8	4	12	2
23	1.81%	2.64	9	3	12	2
24	2.31%	2.80	9	3	12	2
25	2.24%	2.66	10	2	12	2
26	1.79%	2.33	10	2	12	2
27	1.64%	1.90	8	4	12	1
28	1.65%	2.46	10	2	12	2
29	1.96%	2.48	9	3	12	2
30	2.23%	2.99	9	3	12	2
31	1.84%	2.23	9	3	12	2
32	2.44%	2.55	9	3	12	2
33	2.21%	2.26	8	4	12	2
34	2.59%	2.27	9	3	12	2
35	2.88%	2.51	9	3	12	2
36	2.57%	2.25	8	4	12	2
37	2.80%	2.41	9	3	12	2
38	2.72%	2.30	9	3	12	2
39	2.55%	1.73	8	4	12	0
40	2.69%	2.30	8	4	12	2
41	2.22%	1.80	7	5	12	1
42	1.26%	0.86	6	6	12	0
43	1.69%	1.36	7	5	12	0
44	1.52%	1.19	8	4	12	0
45	1.60%	1.34	7	5	12	0
46	1.54%	1.24	6	6	12	0
47	2.02%	1.60	7	5	12	0
48	1.95%	1.51	6	6	12	0
49	2.57%	2.15	8	4	12	1
50	2.51%	1.93	7	5	12	1
51	2.81%	2.05	7	5	12	1
52	3.23%	2.54	8	4	12	2
53	3.56%	2.56	8	4	12	2
54	4.07%	2.67	7	4	11	2
55	3.11%	2.06	7	4	11	1
56	2.73%	1.76	6	5	11	0
57	3.10%	2.35	7	4	11	2
58	2.89%	1.84	6	5	11	1
59	2.77%	1.81	5	6	11	1
60	1.95%	1.07	5	6	11	0
61	2.45%	1.38	5	6	11	0
62	2.09%	1.24	6	5	11	0
63	1.48%	0.89	6	5	11	0
64	2.45%	1.63	7	4	11	0
65	2.57%	1.85	7	4	11	1
66	0.82%	0.48	6	5	11	0

In the last column, 1, 2, and 3 denote significance at the 10%, 5% and 1% levels respectively.

TABLE 2-12. Returns of Credit Spread Convergence Hedge

This table reports the first difference of average portfolio returns of credit spread hedging. The first difference is calculated as the up-to-date returns subtracted by the returns in the first set-up day. We buy the CBs with lower credit spread and short the CBs with higher credit spread of the same issuer.

Panel A. Month end Returns from the first set-up day when credit spread difference exceeds its threshold

Months	Returns	t-value	Positive	Negative	Total	Significance
1	3.13%	1.87	16	6	22	1
2	2.39%	1.62	9	5	14	0
3	4.18%	2.59	8	1	9	2
4	5.97%	3.73	7	0	7	3
5	4.89%	2.27	6	1	7	1
6	3.51%	1.39	3	1	4	0
7	4.90%	1.30	2	1	3	0
8	2.24%	0.46	2	1	3	0
9	0.74%	0.14	2	1	3	0
10	4.25%	2.21	3	0	3	0
11	6.14%	3.29	2	0	2	1
12	9.36%	2.90	2	0	2	0
13	13.54%	11.05	2	0	2	3
14	13.97%	3.89	2	0	2	1
15	17.23%	2.34	2	0	2	0
16	19.07%	1.82	2	0	2	0
17	18.41%	1.71	2	0	2	0
18	25.83%	1.63	2	0	2	0
19	23.90%	1.70	2	0	2	0

Panel B. Day end Returns from the first set-up day when credit spread difference exceeds its threshold

Days	Returns	t-value	Positive	Negative	Total	Significance
1	2.88%	2.75	21	12	33	3
2	-0.12%	-0.14	21	12	33	0
3	-0.12%	-0.18	16	17	33	0
4	-1.36%	-1.46	16	17	33	0
5	-0.23%	-0.40	15	18	33	0
6	0.28%	0.34	20	13	33	0
7	1.31%	0.98	21	12	33	0
8	0.65%	0.53	21	12	33	0
9	0.90%	0.71	21	12	33	0
10	1.88%	1.77	21	9	30	1
11	1.58%	1.51	19	10	29	0
12	1.92%	1.96	21	8	29	1
13	2.05%	2.16	20	9	29	2
14	2.01%	1.75	15	13	28	1
15	1.28%	1.09	12	15	27	0
16	1.92%	1.52	13	13	26	0
17	1.96%	1.55	16	10	26	0
18	2.26%	1.60	18	8	26	0
19	2.48%	1.69	17	9	26	0
20	2.99%	1.73	16	7	23	1
21	3.13%	1.87	16	6	22	1

In the last column, 1, 2, and 3 denote significance at the 10%, 5% and 1% levels respectively.

TABLE 2-13. Capital Structure Hedge: Long CBs & Short Bond

This table reports the average portfolio returns of capital structure hedge, which involve buying CBs and short selling bond of the same issuer, which has a rating of B and under rating when issue CBs. It is a zero initial self investment capital hedging strategy. The returns are listed for various monthly holding periods from the issuance date of the CBs.

Months	Returns	t-value	Positive	Negative	Total	Significance
1	0.87%	0.44	4	5	9	0
2	5.37%	1.20	6	3	9	0
3	4.43%	1.26	7	4	11	0
4	3.41%	2.37	7	2	9	2
5	4.37%	1.23	3	3	6	0
6	5.93%	2.27	5	3	8	1
7	5.52%	2.63	7	2	9	2
8	5.20%	2.19	6	2	8	1
9	7.62%	2.21	3	2	5	1
10	14.82%	3.77	7	0	7	3
11	15.80%	2.97	6	0	6	2
12	16.72%	2.04	6	0	6	1
13	14.70%	1.71	4	2	6	0
14	18.07%	1.62	4	1	5	0
15	29.50%	1.33	1	1	2	0
16	8.37%	3.21	2	0	2	1
17	2.06%	0.51	3	1	4	0
18	9.53%	2.54	3	0	3	1
19	11.07%	1.08	2	1	3	0
20	8.47%	1.44	4	1	5	0
21	6.27%	1.19	3	1	4	0
22	15.37%	4.02	4	0	4	2
23	16.21%	2.87	3	0	3	1
24	16.58%	2.52	3	0	3	1
25	20.43%	4.25	4	0	4	2
26	19.12%	3.44	4	0	4	2

In the last column, 1, 2, and 3 denote statistical significance at the 10%, 5% and 1% levels of a two-tails test respectively.

TABLE 2-14. Capital Structure Hedge: Long Bond & Short CBs

This table reports the average portfolio returns of capital structure hedge, which involve buying bonds and short selling CBs of the same issuer, which has a rating of B and under rating when issue CBs. It is a zero initial self investment capital hedging strategy. The returns are listed for various monthly periods from the issuance date of the CBs.

Panel A. Month-end portfolio performance

Months	Returns	t-value	Positive	Negative	Total	Significance
1	5.29%	2.14	7	2	9	1
2	5.65%	1.38	5	1	6	0
3	8.12%	1.59	6	2	8	0
4	11.46%	2.04	4	1	5	1
5	14.93%	1.22	2	1	3	0
6	3.62%	0.59	2	5	7	0
7	12.52%	1.36	3	1	4	0
8	26.36%	2.13	2	0	2	0
9	28.20%	1.95	2	0	2	0
10	14.21%	1.16	2	1	3	0
11	25.80%	1.59	2	0	2	0
12	-0.34%	-0.08	1	1	2	0

Panel B. Day-end portfolio performance

Days	Returns	t-value	Positive	Negative	Total	Significance
1	1.61%	0.87	5	2	7	0
2	1.26%	0.88	4	4	8	0
3	-0.43%	-0.25	3	5	8	0
4	1.18%	0.73	5	5	10	0
5	0.48%	0.16	3	3	6	0
6	0.29%	0.17	5	4	9	0
7	-0.85%	-0.43	3	5	8	0
8	2.52%	1.35	5	3	8	0
9	2.34%	1.04	6	3	9	0
10	3.72%	1.79	7	1	8	0
11	2.03%	0.85	5	4	9	0
12	3.28%	1.50	7	2	9	0
13	3.55%	1.43	7	2	9	0
14	3.37%	1.45	7	4	11	0
15	5.07%	1.99	6	3	9	1
16	6.02%	2.07	6	2	8	1
17	5.88%	2.01	5	2	7	1
18	6.65%	2.29	6	2	8	1
19	6.26%	2.20	5	4	9	1
20	4.38%	2.00	6	5	11	1
21	5.29%	2.14	7	2	9	1

In the last column, 1, 2, and 3 denote statistical significance at the 10%, 5% and 1% levels of a two-tails test respectively.

TABLE 2-15: Returns CDS Hedge from Issue Date

This table reports the portfolio returns of CDS Hedge from issuance date of CBs. The portfolio is set up by long CBs and buying CDS to transfer the credit risk in the portfolio.

Months	Returns	t-value	Positive	Negative	Total	Significance
1	-0.65%	-0.58	8	8	16	0
2	-1.25%	-0.67	6	10	16	0
3	-2.62%	-0.84	6	9	15	0
4	-2.70%	-0.85	5	10	15	0
5	-6.38%	-1.10	6	9	15	0
6	-4.32%	-1.05	4	9	13	0
7	-2.48%	-0.50	5	8	13	0
8	-0.65%	-0.12	6	6	12	0
9	4.59%	0.81	6	6	12	0
10	3.78%	0.57	5	6	11	0
11	1.34%	0.21	5	6	11	0
12	2.29%	0.30	5	5	10	0
13	-0.61%	-0.07	5	4	9	0
14	9.23%	0.81	4	3	7	0
15	9.57%	0.82	4	3	7	0
16	12.36%	1.18	4	3	7	0
17	14.49%	1.61	5	2	7	0
18	12.01%	1.56	5	2	7	0
19	5.96%	0.87	4	2	6	0
20	3.20%	0.53	4	2	6	0
21	2.99%	0.64	3	2	5	0
22	9.36%	1.99	4	1	5	0
23	10.82%	2.27	4	1	5	1
24	19.17%	2.49	4	1	5	1
25	17.56%	1.92	4	1	5	0
26	19.27%	2.09	3	1	4	0
27	21.76%	1.83	3	1	4	0
28	23.23%	2.12	3	1	4	0
29	20.12%	2.01	3	1	4	0
30	19.20%	2.35	3	1	4	1
31	21.11%	2.34	4	0	4	1
32	22.96%	2.58	3	1	4	1
33	39.57%	2.62	3	0	3	1
34	42.53%	2.61	3	0	3	1
35	29.16%	2.28	2	0	2	0
36	28.64%	2.34	2	0	2	0

In the last column, 1, 2, and 3 denote statistical significance at the 10%, 5% and 1% levels of a two-tails test respectively.

Chapter 3

CONVERTIBLE BOND ISSUANCE, RISK, AND FIRM FINANCIAL POLICY: A NEW APPROACH

ABSTRACT

Empirically, it would appear that convertible bond financing should be dominated by sequential issues of straight bonds followed by new equity issues sometime thereafter. A new model is introduced that addresses the role of convertible bonds in the firm's financial policy. The model demonstrates that managers of all types of firms, irrespective of quality would choose convertible bonds in their financing plans when facing uncertainties about the timing of the project. This result holds even for the case in which management's prognosis about the likelihood of success of the project is correct. Convertible bond issuance can be optimal for firms that do not have an established record of strong historical performance but have opportunity sets that include good projects subject to timing uncertainties. For other firms, there may be cost/benefit tradeoffs on their use. Investors can derive direct benefits from the signaling properties of convertibles: their issuance per se is a credible signal on the expected future prospects of the firm. Furthermore, convertibles provide indirect advantages to investors since they help to complete the markets. Alternative instruments are incapable of replicating the payout structure of convertibles in a cost-effective manner. These direct vs. indirect effects can be empirically tested, based on the return structure of naked vs. hedged positions in convertible bonds.

3.1. INTRODUCTION

Convertible bonds ('CBs' hereinafter) are hybrid securities with both debt and equity features, and have served as a major source of financing for firms over the past two decades. According to SDC data, from 1995 to 2006, the total value of CB issues increased in the US by 581.60%. Over this period, the ratio of CB financing to equity financing expanded from 10.15% to 36.75%.

The popularity of CBs appears puzzling from a number of perspectives. First, establishing a fair price for any particular CB is complex, due to its long-term option-like characteristics. CBs are typically embedded with interacting indenture components that may not respond uniformly to expected or unexpected events. Consequently, it is still a challenge to 'correctly' price CBs for both issuers and investors. CBs, as complex financial instruments for problems related to financing and investment are not consistent with Principle of Ockham's Razor.[20] Why do firms issue CBs and do investors find them attractive? The purpose of this essay is to develop a theoretical model to address these issues.

Researchers have identified several justifications for CB issuance including: providing lower cost financing relative to straight bonds or pure equity financing, dealing with asymmetric information, tax benefits, risk mitigation benefits, as well as agency benefits (e.g. Jensen and Meckling (1976), Green (1984), Brennan and Schwartz (1988), Stein (1992), Jalan and Barone-Adesi (1995), Isagawa (2000, 2002), Loncarski, Horst, and Veld (2006 a)).

[20] The principle says that "the explanation of any phenomenon should make as few assumptions as possible, eliminating those that make no difference in the observable predictions of the explanatory hypothesis or theory."

Counterbalancing these benefits of CBs are various potential costs, however.[21] CBs could be more expensive than either pure equity or straight debt financing, given the firm's ex ante prospects. For example, if a firm projects some likelihood of poor performance *ex ante*, CBs might not be converted. And issuers may be forced to redeem CBs when their cash flow is already under pressure. Firms on the verge of financial distress will encounter further difficulties in their future financing plans as a consequence of CB investor disappointment. Managers put at risk both their personal portfolios invested in the firm and their reputation for their future careers. In this scenario, issuers could be better off if they had chosen equity financing instead. On the other hand, if the management is certain about the favourable prospects of their new projects, it could be cheaper for them to use some other form of financing besides convertibles. Specifically, they could issue regular corporate bonds at the initial financing stage for the new project, then wait until the stock price rises to reflect the benefits of the project, and then finance with equity. We refer to this alternative (straight debt followed by straight equity) serial financing plan as AP henceforth.

Additionally, CB financing introduces an element of uncertainty to the firm's cash flow and future financing requirements due to the uncertain nature of investor holding periods over longer horizons. Firms with a large overhang of unconverted CB's often face difficulties when they must resort to capital markets for subsequent financing. Empirically, the conversion process of CBs is slow (e.g. Ederington, Caton and Campbell (1997), Byrd, Mann, Moore and Ramanlal (1998)). Several empirical studies show that the price of CBs has to stay well above the conversion price for a considerable period of

[21] Knutson (1971) looks at the accounting implications of convertible bond costs and their impact on the financial statements of firms. He suggests that managers should be aware of how costly convertible securities are likely to be.

time before issuers use their call rights to force investors to exercise their CBs. It appears that issuers do not deploy theoretically optimal call strategies, such as that of Brennan and Schwartz (1977a): "call the bond as soon as the value of the bond if called is equal to the value if not called."

Suboptimal call policies can be attributed to a number of factors: 1) management wants CBs to be converted into equity, 2) financial stress could show up if CBs are called too early, and 3) to call is a bad signal for the issuer. Investors also tend to hold CBs longer than would appear optimal for a number of reasons[22], including: 1) their desire to share in the upside potential of the firm – holding a CB is less risky than holding the underlying stocks of the company since investors receive a more stable stream of returns when they buy the CBs; 2) it is optimal to hold an American call option, which is a key term embedded in CBs, until maturity without exercise; and 3) investors can set up hedged portfolios by combining CBs with other CBs, call or put options, bonds and underlying shares to realize good portfolio returns with low-risk, as demonstrated in Chapter 2.

Empirically, what could be the difference in dilution effect between the CB financing plan and the AP plan? As noted in Chapter 2, from 1990 to 2006, a simulated portfolio comprised of the underlying stocks of all the issuers whose issue size is at least $100 million generates a return of 24.18% and 41.97% respectively at the end of the second and third year from the issue date. If the sample includes observations only with a rating of B or lower, the returns are 50.58% and 92.29%; and that for a rating of Caa or lower becomes as high as 210.63% and 264.48% at the end of the second and third year

[22] When holding CBs, not the stocks, investors can benefits from the coupon payment. The dividend is a cost of CB holders if the conversion price is not adjusted when the firm pays dividends. However, some CBs do have the terms about adjustment upon dividends.

from the issue date. In contrast, the average conversion premium of CBs in the same period is only 28.20%.[23] If these CB issuing firms had chosen the AP plan instead - i.e. to first issue regular bonds to meet capital requirements, as there are no dilution effects,[24] it is safe to say that the stock returns of the firm after the bond issuance could be similar to those provided by the CB financing plan. Consequently, if these firms chosen to issue equity two or three years after the regular bond financing, the equity issuance price should be higher than the conversion price in the CB financing plan. Consequently the dilution effects of AP seem to be less, especially for lower-rated issuers with larger issue size. It would appear that CB financing should be dominated by AP. Although there are some interest rate-cost savings by issuing CBs compared with issuing straight corporate bonds, this cost is only charged in the life of the bond, not the life of the firm. The dilution effect is more important for current shareholders.

This puzzle cannot be well explained in the extant theoretical literature. Two papers are relevant to this puzzle. Stein (1992) develops a backdoor equity financing theory of CBs, which asserts that medium quality firms prefer to postpone their equity financing, only if information asymmetries completely disappear at the second period. However, from the empirical findings of Chapter 2, it seems to postpone the equity financing for two or three years is not a bad idea for such firms. Thus, the empirical evidence supports the alternative rationale proposed in this paper: issuers choose to use CBs in order to flexibly deal with uncertainties. Mayers (1998) deems CBs a better financing plan than two-period straight debt since CBs can reduce financing costs.

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[23] The average conversion premium for CBs with a B or lower and CCC or lower issuance rating is 33.82% and 24.86% respectively in the same database.

[24] Although interest cost is higher because of the higher coupon rates of normal corporate bonds.

However, Mayers (1998) does not address the AP.[25]

Two additional reasons might help to justify the puzzling choices of issuers. First, CB issuers cannot implement the AP due to debt capacity constraints, which can be measured by the type of assets can be pledged, how much debt a firm has already used, and the profitability of the firm. Does the debt capacity differ greatly between CB issuers vs. non-issuers? Debt capacity ratios can be inferred from the empirical estimates of Essig (1992).[26] Based on these results, the difference in debt capacity between firms with CBs in their capital structure and firms who do not use CBs is marginal: the ratio[27] of property, plant and equipment plus inventory to total assets is 57.13%, and 57.85%; the ratio of total debt to market value of equity is 83.95% and 83.32%; the ratio of EBDIT to sales is 13.51% and 13.36% respectively for the CB users vs. nonusers. Using COMPUSTAT data, we note that in the period from 1995 to 2006, CB issuing firms with a rating of B or lower have a long-term debt to equity ratio of 14.15%, and a total debt to equity ratio of 69.02%. The CB offering as such does not affect their overall debt ratio.[28] Hence, debt capacity constraints do not appear to influence choices between issuance of CB's vs. AP.

Another potential reason for issuing CB's is that the delayed equity issuance in the AP may occur at significant price discounts. However, if issuers use the proceeds to make good investments, equity issuance may not be bad news at all. Jung, Kim and Stulz (1996) find that firms with the most valuable investment opportunities do not experience adverse stock returns when they issue equity. Furthermore, according to the empirical

[25] In SDC, there are some issuers keep issuing CBs across limited time periods, which cannot be explained by the sequential argument.
[26] Essig (1992) confirms that the estimates in Table 8 are robust on a year-to-year basis in his sample.
[27] These are weighted averages based on market capitalization.
[28] It is apparent, therefore, that firms adjust the maturity structure of their debt after the CB issuance.

findings in the Chapter 2, two to three years subsequent to the CB issuance, pronounced equity price increases are observed for CB issuing firms. Consequently, we cannot say these firms choose CBs because the price discount in equity financing would be larger.

This essay develops a model that directly addresses the question: "Why do firms issue CBs rather than equity or straight debt, given managers' expectations about the firms' future performance?" This model serves to characterize the behavioral aspects of both managers and investors when facing uncertainties. The model demonstrates that in an environment of *timing uncertainty,* in which firms cannot predict when a new project will become fully operational, CB issuance could be an optimal financial decision for managers, firms, and investors. Firms that lack a strong historical performance record as well as those with a limited portfolio of promising new projects will have greater incentives to issue CB's than other types of firms. This hypothesis is supported by the empirical evidence.

The discrete model used in Chapter 3 is most comparable to that of Stein (1992) and Mayers (1998). However, my model is based on different assumptions and has different implications. Stein's (1992) model is based on asymmetric information about assets in place, and tries to use convertibility to solve a financing problem at the time of the CB issuance. Mayers' (1998) model is based on uncertainty about the value of future investment options, and tries to solve a future financing problem using the objective of cost minimization. This paper is based on uncertainty about the timing of the cash flows of a newly invested project, and tries to analyze the time-varying risk profiles of firms, in order to address why firm still want to use CB instead of the AP plan when the financing cost of CBs is not necessarily low.

This paper has relevance for corporate financing and investment decisions and financial engineering practice. The remainder of this paper is organized as follows: Section 2 provides a brief literature review. Section 3 introduces a new model that addresses the role of convertible bonds in the firm's financial policy. Section 4 sets forth the empirical evidence that supports the model. Section 5 provides a summary and conclusion.

3.2. LITERATURE REVIEW

The question of why firms use CBs and how the market reacts to their issuance has been addressed in a considerable body of research over the past half century. Modigliani and Miller (1958, 1961, and 1963) propose that financing decisions, including those related to the issuance of convertibles, are irrelevant to the firm's valuation. Stiglitz (1969 and 1974) shows the irrelevance theory to be valid under more general conditions. However, Jensen and Meckling (1976) and Green (1984) provide seminal arguments that CBs can be used to alleviate existing shareholders' risk-taking incentives that are at the expense of bondholders by allowing debt holders to share in the upside. Myers and Majluf (1984) and Myers (1984) argue that firms issue CBs to avoid asymmetric information in their pecking order theory. They argue that CBs should dominate equity financing since CBs are less risky. Heinkel and Zechner (1990) show that with information asymmetry, CB's have a role in mitigating the over-investment problem faced by all-equity financed firms. Constantinides and Grundy (1989) and Stein (1992) suggest that firms use CBs to inject new equity into the capital structure with lower asymmetric information costs. Lewis, Rogalski, and Seward (2001) explain the use of

CBs based on equity market rationing, which supports Stein (1992). Baker and Wurgler (2002) extend the asymmetric information approach and demonstrate that firms can use different financial instruments to time the market based on managements' expectations.

Brennan and Kraus (1987) and Brennan and Schwartz (1988) argue that the appeal of CB's relates to their insensitivity to company risk. Mayers (1998) argues that firms use CBs to reduce financing costs as an alternative to sequential financings using equity and/or straight debt in the presence of serially correlated real options/investment opportunities. Carlson, Fisher, and Giammarino (2004, 2006) confirm that beta provides a good measure of risk for studying the return dynamics around equity financing.

Several empirical papers have examined the motivation for firms to issue CB's, firm characteristics associated with CB issues, and the market reaction to CB issuance. Billingsley and Smith (1996) conclude that firms use convertibles primarily as an alternative to straight debt as a means to preserve cash flow via lower interest costs. Essig (1992) shows that the ratios of R&D to sales, market value to book value of equity, and long-term debt to equity as well as the volatility of the firm's cash flows, are all positively associated with firms' propensities to employ convertible debt. Lee and Figlewicz (1999) compare different characteristics of firms that issue convertible debt versus convertible preferred stock. The choice of the former is found to be associated with proxies for asymmetric information, financial distress, and taxes.

In sum, the existing theoretical literature cannot fully address the puzzle of CB financing. Several empirical studies have identified and tested factors that help explain CB financing. These studies have largely focused on the issuers' perspective only. Our argument is that from an incentive compatibility perspective, one should focus both on issuers and investors to study the role of CBs in the firm's financial policy.

3.3. A NEW PERSPECTIVE ON CB ISSUANCE

We propose an alternative perspective for the popularity of CBs. This approach is rooted in the unique structure of CB's as contingent claims that appeal to both firms and investors facing uncertainties.

3.3.1. Background Assumptions and Exposition of the Approach

The analysis starts with the basic premise that CBs can be tailored to the expectations of managers concerning uncertainty. The conversion premium can be set to adjust the likelihood of future conversion. The maturity is normally set to be quite long in order to decrease risks resulting from technical delays in the project or from unfavorable market conditions. The actual life of CBs could be shortened by the call rights set by issuers. Coupon rates can be flexibly set to change the holding value of CBs in different time periods. Mandatory conversion can also be used to facilitate the conversion. The conversion price could bear a reset option to facilitate the conversion of CBs. Put rights may be added to make CBs more attractive. By issuing CBs, managers in fact possess a real option to make their financing and investment decisions simultaneously, so that they can comfortably wait for further information before committing additional resources to the project.

A side effect of the incorporation of diverse contingent claims within the CB indenture, transforms CBs into structured financial notes that balance the requirement of issuers and investors.[29] By investing in CBs, investors simultaneously get a combination of different financial instruments, which might be technically impossible to replicate or prohibitive in terms of financial costs to replicate.[30] As illustrated in Chapter 2, profitable trading opportunities exist using:

a) combinations of CB's with underlying stocks, exploiting the non-linear price relationship between CBs and underlying stocks;

b) combinations of CB's with call or put options; and

c) combinations of CB's with other CBs, or corporate bonds.

There is a high probability that investment opportunities will appear among different financial instruments when their prices fluctuate. Hedging can be used to mitigate or eliminate investment risk. In fact, several studies show that CB hedge funds generate meaningful returns with low volatilities compared with the stock mutual funds, and even index funds,[31] and these returns cannot be explained by Fama-French factor models.

Second, issuance can be accomplished without too much difficulty since the value of CBs can be easily agreed upon by parties, who recognize the inherent uncertainties surrounding the payoffs. A CB is a combination of a straight non-callable corporate bond and several options for investors and issuers. When the volatility of underlying stocks increase, the bond price goes down, but the conversion option value goes up. *Ceteris paribus*, the value of CBs remains relatively stable. As the life of CBs is normally long,

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[29] Das (2000) argues that the combinations of derivatives and underlying financial instruments which exhibit structures with special risk/return profiles that may not be otherwise attainable on the capital market without significant transaction costs being incurred – at least for private investors.

[30] According to SDC, from 1986 to 2005, the average life of the CBs is 16.75 years, while the largest is 30.09 years. The long-maturity of the call option in CBs makes it hard to get in ordinary option market.

[31] Woodson and Woodson (2002) find that the returns of convertible, equity index, and bonds are 14.28%, 8.69%, and 6.55%, while the standard deviation are 8.62%, 13.25%, and 4.29% respectively.

an increase in the value of conversion option can more than compensate for the depreciation in the value of the pure bond component of. In addition, the risks of CBs serve to restrain excess risk-seeking activities of management. When the future performance is poor, CB holders can maintain their positions until maturity, while earning the bond interest component. Alternatively, prior to maturity CBs holders can redeem their CBs based on the put rights established in the CB indentures. In the event of bankruptcy, CB holders have pre-emptive rights to the firms' assets relative to equity holders. On the whole, CBs returns will be linked to equity returns, but their overall risk will be lower than that of a pure equity investment.

Third, by using CBs, issuers can credibly signal the upside potential of their new projects to investors when facing uncertainty. Since conversion prices are normally set at a premium over current stock prices, and stock prices tend to stay well above conversion prices for an extended period prior to conversion, managers should believe that their firms has great upside potential when they choose to issue CBs. Otherwise, they would be better off to issue equity to eliminate potential financial distress risk associated with CBs. The implication of this consideration is investors could gain by holding naked long position of CBs at the issuance.

In sum, CBs can have a beneficial role for issuers, in conveying information about the firm's prospects to potential investors, in the presence of uncertainty.

3.3.2. The Model in a Continuous-Time Framework

Technically, the valuation models of CBs can be classified into several categories. The first group, known in the literature as ***structural models***, uses the value of the firm as the underlying state variable, with the lower reorganization boundary and the allocation of residual values of the firm on liquidation are treated exogenously (Sundaresan (2000)). Ingersoll (1977) and Nyborg (1996) use this method to price CBs, and Lewis (1991) extends it to incorporate more complicated capital structures. These models are well entrenched in economic theory, and are straightforward to implement when sufficient restrictions are included for deriving closed form solutions. However, empirically, such models have several limitations, including: 1) different call and put features cannot be easily incorporated, 2) path-dependent features cannot be incorporated, and 3) there is no reliable data source of firm value in continuous time.

An alternative to structural models that is favored by practitioners is the class of ***reduced form*** models that use the value of equity as the underlying state variable, with default outcomes and recovery rates set exogenously. For these models, a CB is a corporate bond plus a call option on firm equity. One common practice when we study the risks and sensitivities of CBs is to treat the call option of CBs as the main source of risk of CBs and calculate the Greeks[32] of CBs based on Black and Scholes (1973).

Models based on binomial trees represent an extension of the reduced form modeling approach. These models incorporate credit risk into CB valuation. Goldman Sachs (1994) is the first to price CBs using the binomial tree method proposed by Cox, Ross, and Rubinstein (1979). Tsiveriotis and Fernandes (1998) formulize this method. Carayannopoulos and Kalimipalli (2003) use a trinomial tree to incorporate credit-risk. Shivers (2003) incorporates more CB features in setting up their binomial trees. Other models are based on simulations. Buchan (1997) extends the Monte Carlo simulation methodology to price CBs. These numerical methods allow for the incorporation of many

[32] Delta, Gamma, and Vega etc.

CB features into the estimation. However their computation time is huge and the availability of data makes it hard to fully meet the requirements of parameter inputs.[33]

Our approach herein is to develop a new structural model for CBs, which extends previous work, to allow us to calculate the value of the CB issuing firm from the issue date. Chapter 4 performs empirical tests of the model based on the reduced form, and then on the structural model as a robustness test.

Assume that a firm has a value V which follows a diffusion process with constant rate of return volatility:[34]

$$\frac{dV}{V} = \mu dt + \sigma dW \tag{3-1}$$

where $\mu(\bullet)$ is the drift, and W is a standard Brownian motion. Similar to Black and Cox (1976), we assume that there exists a riskless asset that pays a constant rate of interest r. We assume further that at the outset there is only equity in the firm's capital structure, and the firm subsequently chooses to issue CBs to raise capital. Let F1 (V, τ) and F2 (V, τ) be the values of CB and equity respectively. The Value of the firm, V can be written as:

$$V = F1\ (V, \tau) + F2\ (V, \tau) \tag{3-2}$$

It is well-known that the CB's value follows the partial differential equation

$$\frac{1}{2}\sigma^2 V^2 F1_{VV}(V,\tau) + rVF1_V(V,\tau) - rF1(V,\tau) + F1_\tau = 0 \tag{3-3}$$

where $F1_V$ and $F1_{VV}$ are the first-order and second-order of partial differential of F1 with respect to V respectively, τ is the time to maturity.

Substituting F2=V-F1 into the formula, we have

[33] The simulation-based method can decrease the number of computation time. However, to price American options (which one of the CB's main features) is still tedious.

[34] We assume the CB is a zero-coupon bond for simplicity.

$$\frac{1}{2}\sigma^2 V^2 F2_{VV}(V,\tau) + rVF2_V(V,\tau) - rF2(V,\tau) + F2_\tau = 0 \tag{3-4}$$

It should be noted that if one were to assume that the value of the financial asset is time-independent, following Leland (1994), we can derive close-form solutions incorporating default risk and recovery rates. Sarkar (2003) extends this approach to study the early and late calls of CBs. Since we assume the financial asset is time-dependent, Leland-type models in which t is not present, cannot be employed here. Imposing the boundary conditions, obtain the solution of Equation 3-3 as:

$$F1(V,T) = e^{-rT} E^Q \begin{bmatrix} V_T, V_T \le B \\ B, \gamma V_T \le B \le V_T \\ \gamma V_T, B \le \gamma V_T \end{bmatrix} \tag{3-5}$$

Consequently, we have:

LEMMA 1

The value of the equity F2(V,T) for a firm with a convertible bond F1(V,T) in its capital structure is given by:

$$F2(V,T) = V - F1(V,T) = e^{-rT} E^Q \begin{bmatrix} 0, V_T \le B \\ V_T - B, \gamma V_T \le B \le V_T \\ (1-\gamma)V_T, B \le \gamma V_T \end{bmatrix}$$

$$= C(V,B,T) - \gamma C(V, \frac{B}{\gamma}, T)$$

where B is the contracted payment to CB holder at maturity of the part without conversion; C(•) is the call option value in Black-Scholes formula; γ is the dilution factor($\gamma = \frac{m}{m+n}$), m is the shares converted from CBs, n is the initial shares before the CB issuance.

PROOF: See Appendix A.

Using Lemma 1 we can study the relationship between firm's equity value and time. Part A and Part B of Figure 3-1 depict this relationship with smaller (γ=10%) and bigger (γ=50%) dilution factor respectively.[35] We find that the relationship is bell-shaped. At the criteria of maximum of shareholder's value, the use of CBs is more suitable for firms with lower level of risk. This is especially true if the CB issue size is relatively big compared to the current shareholder value, which is shown in the Part B of Figure 3-1.

In a similar vein, we can extend Lemma 1 to incorporate regular corporate bonds in the firm's capital structure. The results are provided in Appendix C.

Extending Merton (1974), let $\sigma 2$ be the standard deviation of the return on the equity of the firm.

LEMMA 2

The ratio of the risk of the firm after the CB issuance σ, to the risk of the firm before the CB issuance σ_2 is given by:[36]

$$\frac{\sigma}{\sigma_2} = \frac{1}{\Phi(d_1) - \gamma\Phi(d_1^{'})}$$

$$d_1 = \frac{\ln\left(\frac{V}{B}\right) + \left(r + \frac{\sigma^2}{2}\right)\tau}{\sigma\sqrt{\tau}}$$

$$d_1^{'} = \frac{\ln\left(\frac{V\gamma}{B}\right) + \left(r + \frac{\sigma^2}{2}\right)\tau}{\sigma\sqrt{\tau}}$$

where $\Phi(\bullet)$ is the cumulative distribution function of the standard normal

[35] In our database, the range of γ is [0.002, 13.522].

[36] If we deem CBs will mostly probably be converted into underlying shares, the total risks of a CB issuer have positive relation to the risk of equity of the firm in the future.

distribution.

PROOF: See Appendix B.

Figure 3-2 depicts the relationship of the ratios of total risk to equity risk over time after the CB issuance. Since we assume that there are only two assets in the firm's capital structure, the additional risk of the firm is brought by the issuance of CBs. We find that the CB issuance increases the total risk of the issuing firm. Furthermore, the lower the risk before the issuance, the higher the percentage increases of the total risk because of the CB issuance. Firms with higher risks before the CB issuance experience a more rapid decline in total risk over time relative to their counterparts.

Figure 3-1 and Figure 3-2 serve to illustrate that with uncertainty on the timing of payouts for the CB-financed project, there are different expected return/risk dynamics for firms with different levels of risk. On the whole, CB financing of new projects is more appropriate for firms whose risk profiles are not low. This can be empirically tested by looking at the impact of firm risk and issuance risk on the abnormal returns around the issuance date of CBs for firms with different risk profiles. Variation of the risk profiles over time should also influence the returns of underlying stocks after the CB issuance date. Volatility related proxies can measure the risks of CBs and equities. The standard deviation of beta is selected to measure the risk of equities since: 1) beta is a better measurement of risk than the standard deviation when we deal with diversified portfolios; 2) we want to evaluate the determinants of abnormal returns, not the returns, so we resort to higher moments of the beta; and 3) the standard deviation of beta can measure the fluctuation of the market's attitude toward the firm issuing CBs. Vega, which measures the sensitivity of the CB price to the volatility of underlying stocks, represents one aspect of the issuance risk. Another aspect of the issuance risk is the liquidation/dilution effect that is dependent on the relative size of the CB issuance.

The reduced form of the CB model essentially separates the bond and option components of the instrument. The bond component is evaluated as a corporate bond belonging to the risk class represented by its rating, while the equity part of the CB is an option to exchange the bond for the number of shares represented by the conversion ratio. This option will be in-the-money if the share price exceeds the conversion price, the share equivalent of the market value of the bond component, which plays the role of the option's strike price. This evaluation can only be considered an approximation, since neither the conversion price stays constant over the life of the CB, nor does the call option follow the Black-Scholes option model. The value of the CB's bond component varies with macroeconomic conditions as the risk spread appropriate to its class changes, implying that the conversion price (the option's strike price) is not constant. Similarly, the Black-Scholes model applied to the option component assumes that there is no default risk of the firm, since the lognormal model of the underlying equity does not hold under such risk. Last but not least, the risk of the bond issue affects directly the option value in a complex way, since both the strike price and the probability distribution of the equity value change with it. Nonetheless, the reduced form of the model has been established as a professionally acceptable practice, and for this reason we use it for our main series of empirical tests.

Under the Black-Scholes model the risk of the option component with respect to the equity value is measured by the delta, while the Vega measures the sensitivity of CB price to the volatility of the underlying stock; the latter measure is particularly important here because of the approximate nature of the Black-Scholes model applied to the CB. Both delta and Vega are calculated by using the reduced form models of Black and Scholes (1973), extended by Merton (1973).

$$Delta = e^{-q(T-t)}\Phi\left(\frac{\ln\left(\frac{S}{X}\right)+\left(r-q+\frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{(T-t)}}\right)$$

$$Vega = e^{-q(T-t)}S\sqrt{(T-t)}\phi\left(\frac{\ln\left(\frac{S}{X}\right)+\left(r-q+\frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{(T-t)}}\right) \qquad (3\text{-}6)$$

The structural estimate of Vega better-grounded in theory than the reduced form version, since it explicitly incorporates the dilution factor. However, in practice it is somewhat problematic. The conversion price should be calculated based on face value. However, our available data only provide the actual proceeds of the CB offering. So strictly speaking, empirical work based on the proceeds of CB can only be deemed as a proxy for the real Vega.

$$Delta1 = e^{-q(T-t)}\left[\Phi\left(\frac{\ln\left(\frac{S}{X}\right)+\left(r-q+\frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{(T-t)}}\right)-\gamma\Phi\left(\frac{\ln\left(\frac{S\gamma}{X}\right)+\left(r-q+\frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{(T-t)}}\right)\right]$$

$$Vega1 = e^{-q(T-t)}V\sqrt{(T-t)}\left(\phi\left(\frac{\ln\left(\frac{V}{B}\right)+\left(r-q+\frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{(T-t)}}\right)-\gamma\phi\left(\frac{\ln\left(\frac{V\gamma}{B}\right)+\left(r-q+\frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{(T-t)}}\right)\right) \qquad (3\text{-}7)$$

3.3.3. The Rationale in the Discrete-Time Model

We adapt the traditional Stein (1992) model to study the firm's choice among three major financing instruments: a (regular) corporate bond, equity, and CBs. The purpose of the financing is to support a new investment project that has payouts that occur at uncertain dates in the future. In other words, there is uncertainty in the timing at which the project will become fully operational. Several assumptions are made to facilitate the analysis:

1). There are two time periods demarcated by three date points (date 0, 1, 2). At date 0, the firm faces an investment opportunity, but does not have any free cash flows to finance its new project. The project requires an overall investment of K_A or a minimum initial investment of K_0 at date 0. If the project has not fully operational, in the sense of producing cash flows that are sufficient to guarantee that a positive net present value (NPV) overall is generated at date 1, additional external funds must be raised to support a further investment of K_1. If the project becomes fully operational, the net present value of cash flows generated (X) exceed the amount of capital invested. The project does not generate positive operating cash flows sufficient to guarantee a positive NPV until it becomes fully operational. If it becomes fully operational at date 1, it will generate positive cash flows for date 1 and date 2. The project is large in the sense that its NPV is economically substantial – i.e. its outcome will have a significant impact on the firm's stock price. If the firm has not yet decided to abandon the project, it does not have any other resources to start another new project.

2). Ex-ante at date 0, managers of the firm correctly anticipate the likelihood of whether the project will be successful at date 2. However, there is uncertainty as to when the project can be fully operational, which can be reached at date 1 or date 2 with a probability of P_1 and P_2 respectively, where $P_1 \leqq P_2$.[37] Investors judge the quality of firms and the probability of the success of the project based on firms' track record and all publicly available information to date.[38]

3). The interests of managers are in line with those of shareholders. If the expected discounted cash flows generated by the project are less than the investment outlay, managers will decline the project. That is, we do not consider the agency problem in this model.

4). When a bond is issued to finance the project, it cannot be paid back before the maturity date. For simplicity, the interest cost is assumed to be zero.

With the above assumptions, we can assert that if the firm chooses to finance its new project using a bond, it will choose a relatively long maturity bond. Otherwise, financial distress will show up if the project cannot reach its full potential before the maturity date of the bond. However, extending maturity too long may be hazardous. If the maturity goes much beyond the date when the project is fully operational, the issuer might not have the ability or incentive to issue additional equity to pay back the bond. Financial costs might also be higher than necessary if the maturity is set too long since it is normally the case that the longer the maturity, the higher the interest cost.

Furthermore sequential financing of K_0 and K_1 is not optimal. If the project cannot become fully operational with the passage of time, investors are apt to lower their expectations of the likelihood of the success of the project. Additional financing, if available, would be at much higher financing costs.

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[37] This is reasonable since the possibility of fulfilling a project normally grows larger as time goes on.

[38] P_1 and P_2 could be different for the firms and investors. Please note this differs from the asymmetric information assumption. This assumption just says investors keep updating their belief of the firm, which better portray the reality.

To illustrate, we differentiate amongst three types of firms, and compare three alternative financing plans: 1) equity financing, 2) debt financing with maturity at date 2 followed by equity financing (an AP plan), and 3) CB financing.

The basic idea of this analysis is illustrated in Figure 3-3. Since there are uncertainties about the timing of the new project, at the end of each time period, outside investors would adjust their expectations of the mean and standard deviation of the project's cash flows, if the project has not reached its full production level. Financing conditions could deteriorate because of the higher standard deviation, even if the mean value of the project's payout is higher than its present value. As long as the firm's management has an unbiased projection of the true future performance of the firm, a financing plan with CBs could be suitable because management can downplay its promise on the timing to investors while maintaining the right to adjust the conversion process contingent on the performance of the new project. However, as there is a signal of uncertainty when firms choose to issue CBs, it could be perceived as bad news if strong firms finance the project with CBs.

3.3.3.1. Good firms, which have good historical performance

A firm with a good track record is deemed more trustworthy by investors when it deals with new projects. Such a firm has a good reputational standing in the market. The firm is also interested in upholding this reputation. If managers turn good firms into bad ones, they will suffer an irrevocable reputational loss. The managers of good firms have a higher reputational capital at stake when they invest in risky projects so they tend to be conservative. It is easier for investors to agree with these firms' financing decisions and managers' expectations about new projects.

If the managers of good firms deem that P_2=1, they should choose the AP. In this case, equity can be issued at a much higher price than the current price. Their possible loss is the higher interest cost when the project in fact becomes fully operational at date 1. However, given the reduced dilution costs, AP is optimal for current shareholders. Additionally, as good firms can get higher ratings when issuing bond, their bond financing costs in the AP are low.

If the managers of good firms perceive P_2<1 and $P_2X \geq K_A$, to use CB financing plan could be optimal. CB financing is better than the equity financing because the conversion price is higher than the current stock price. Furthermore, CB financing might be better than the AP. If the project is not operational at date 2, the equity financing portion in the AP could be more expensive because the stock price could be lower than that at date 0, which will result in higher dilution effects. If the project becomes fully operational at date 2, the AP dominates. The AP adds more uncertainties to the project and current shareholders. Since managers of good firms are likely to have strong ex-ante confidence in the prospects of their new project, they may not choose CBs. If a good firm chooses to issue CBs, this could be perceived by investors as negative information. The risk profile of issuers is likely to be higher after the CB issuance because the benefits of CB financing by good firms will be offset by the additional risks brought by CB issuance.

3.3.3.2. Weak firms, which have poor or limited historical performance

Managers of weak firms or firms with a limited track record have greater incentives to seek risky opportunities to improve business operations. If they fail, the market may treat it as just another pratfall. However if they succeed, investors may think that it is due to management manipulation.

If weak firms choose to issue bonds, they will have to pay higher premia, to reflect their lower ratings. Long maturity bonds could also be problematic for these firms. Furthermore, if the project has not been completed at date 2, the financial distress cost is higher for the weak firms. Consequently the AP is not an optimal strategy for weak firms. If they choose to issue equity, the dilution effect will be larger as the current stock price is low, and the market discount factor is high. Hence, CB's could be an appropriate choice for weak firms, provided that their managers deem the projects to be good enough to support the CB cost. Otherwise, equity financing will be optimal. After the CB issuance, the risk profile of issuers is lower in the former scenario because the benefits of using CBs by weak firms more than offset the additional risks brought by CB issuance.

A CB financing plan for a weak firm signals managerial confidence in the project: Hence, investors could deem such a plan as good news if they are convinced that the probability of the project's success is high. Consequently, the news of CB issuance from a weak firm could generate a positive market reaction..

3.3.3.3. Ordinary firms, with non-exceptional historical performance

Ordinary firms normally have some non-exceptional historical performance that would easily captivate the confidence of new investors. Most firms belong to this group. When initiating financing plans for a new project, managers need some binding mechanism to attract new investors.

When the managers of ordinary firms deem P_2=1, they could try to mimic good firms and choose the AP. Alternatively, they can choose to issue CB's, which would allow new investors to share in the benefits of the new project, while saving interest costs of straight bond financing. In this way, ordinary firms could attract new long-term shareholders, without immediately harming (through dilution) existing shareholders.

If managers of ordinary firms perceive $P_2<1$ and $P_2X \geq K_A$, they could determine whether they want to face the financial stress if the new project cannot be fully operational at date 2. The probability of financial stress is larger for ordinary firms than for good firms, so ordinary firms are more apt to choose CB financing plan. CBs help mitigate business operational and financial risk. Investors, use CB issuance as a (noisy) signal of the probability of success of the project. After CB issuance, an ordinary firm's risk profile has a higher probability of improving, relative to that of a weak firm. Consequently, the market reaction to CB issuance by ordinary firms tends to be positive. This is something similar to what Stein (1992) suggests, but is based on risk variation analysis.

The risk analysis in discrete time differs from that under the continuous-time framework because it considers the variation of original risks of firms associated with CB issuance. This analysis implies that the abnormal returns around CB issuance should be positively related to the firm volatility risk, but negatively to issuance risk. The underlying stock returns will depend on the variation of the risk profiles of firms after the CB issuance. Since the overall risks of the firms (the sum of the risks of firms and issuance) are higher, the underlying stock returns should decrease subsequent to CB issuance. With the passage of time, if the project proves to be good, the reduction in firm risks will outweigh that effects of increased CB issuance risk[39], and the firm's underlying stock price should increase. This is a matter that can be empirically tested.

We can extend the analysis, to introduce uncertainty in the size of the cash flow that the project can generate, as well as the accuracy of management's expectation of the success of the project. These uncertainties strengthen the case for CB's as a dominant financing strategy for such firms.

To summarize, even if their judgment about whether a project will be successful is correct, when facing uncertainties about the timing of the project, managers of all types of firms could be apt to choose CBs in their financing plans. However, cost/benefit trade-offs for CB's may be present, and as a consequence, their issuance per se need not always be good news for the market. In fact, it is optimal to issue CBs for firms which do not have strong historical performance but have opportunity sets that include good projects with uncertainties. Furthermore, if managerial reputation is important, we can suspect that for larger firms, whose reputation cost is higher, the upside scenarios are more likely to prevail.

3.4. COMPARISONS OF THE APPROACH WITH PREVIOUS THEORETICAL AND EMPIRICAL WORK

3.4.1. Limitations on Forecasting Prowess

Buchanana, Hodgesb and Theis (2001) confirm that large hedgers are poor forecasters of the direction of the price change. Forecasts of stock prices are also a challenge for experts such as mutual fund managers and financial analysts. Mutual funds with passive investment strategies such as index funds do not necessarily generate worse

[39] The conversion of CBs into underlying stocks also helps this risk deduction process.

returns than those with active investment strategies. Henriksson (1984) finds that mutual fund managers are not good at timing the return of the market portfolio. Following Jensen (1968) pioneering study, other studies have also demonstrated it is not evident that such managers outperform the market – e.g. Fama (1998), Chen, Jegadeesh, and Wermers (2000), Lewellen and Shanken (2002), Elton, Gruber and Blake (2003) etc.

3.4.2. Market Reaction to the Issuance of CBs

Essig (1992) finds that proxies for estimation risks are significant in both the probabilistic model of the decision to use convertibles and the regression model of the proportion of the capital structure including convertible securities. Additionally, as we will demonstrate in Chapter 4, CB issuance-specific and company-related risk can explain the abnormal returns in the two days surrounding the issue date of CBs, and their explanatory power almost vanishes in windows far from the issue date. As a consequence, when trading around the issue date, risks related to CBs and company need to be considered.

Chapter 2 finds that there is a U-shape in the normalized volatility series: volatility declines until 3.05 years after the issue date, and then rises thereafter. This "stylized fact" may be consistent with changing degrees of confidence about the prospectus of the issuer through time.[40]

3.4.3. The Benefits of CB's to Investors

Based on our model, CBs may be associated with risk reduction benefits. In

[40] We can not infer from the volatility series that investors and issuers are expecting the real life of CBs to be too long.

addition the model predicates two potentially profitable trading strategies The first is to hold a naked long position of CBs from the issue date to capture the premium that represents the future upside expectation from the firm's management. The possibility of achieving superior returns under this strategy is larger if the issuer possesses higher reputation cost when poor performance shows up. Chapter 2 confirms that naked long position of CBs[41] can derive an average return of 37.26% at the end of the third year from the issuance. A strategy that is based on investments in issues with ratings of CCC or under can achieve a simulated return of 184.91% three years after the issuance.

The second trading strategy predicated by the model involves hedging CBs with different financial instruments. Chapter 2 investigates the returns and risks of a set of hedging strategies related to CBs. Hedged positions that are based on the characteristics of the convertibles are shown to provide superior absolute and relative returns. The delta neutral portfolio by long buying CBs and short selling underlying stocks produces a return of 3.99%[42] one year after the issuance. A bullish gamma hedging strategy can generate a return of 4.79% of the same period. Volatility convergence hedging and credit spread convergence hedging strategies involving different CBs yield returns of 1.50% and 6.01% respectively at the end of first month. An annualized return of 32.39% can be realized by the hedging between CBs and call options, and year-end return of 16.72% by hedging between CBs and bonds. Overall, some profitable opportunities are identified for investors to utilize the structured nature/structural characteristics of CBs.

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[41] The proceeds amount plus the over-allotment sold in the hosted market of the convertible bonds should be in excess of $100 million.
[42] The returns are calculated as portfolios without self capital investment, except the call option hedging. Returns are not annualized unless otherwise specified.

3.5. CONCLUSION

Empirically, it is found that CB issuers, especially those who are large in size but low in rating, do not issue normal corporate bonds first and then issue equity sometime thereafter, although this alternative financing plan could significantly ameliorate dilution effects. This puzzle cannot be well explained in the existing theoretical literature.

This paper proposes that when making their financing and investment decisions, firms and investors prefer CBs because CBs offer more flexibility to deal with uncertainties. A model is developed to demonstrate that even if managerial judgment about the success of a future project is correct, firms would include CBs in their financing plans when facing with uncertainties about the *timing* of the project. However, cost/benefit trade-offs for CBs may be present, and as a consequence, their issuance per se need not always be good news for the market. In fact, it is optimal for firms who do not have strong historical performance but have opportunity sets that include good projects with uncertainties to issue CBs. Based on previous studies in behavioral finance and efficient markets, the rationale has been examined and justified.

This rationale implies that investors could derive significant benefits from investing in CBs by applying the following two trading strategies. The first is to hold a naked long position of CB's from the issue date because CBs incorporate a premium that represents the future upside expectation from the management. The possibility of achieving superior returns under this strategy is larger if the issuer possesses higher reputation cost when poor performance shows up. The second trading strategy predicated by the rationale involves hedging CBs with different financial instruments. This is because when tailoring CBs according to their requirements under uncertainties, issuers in effect transform CBs into structured financial notes that balance the requirement of issuers and investors. By investing in CBs, investors simultaneously get a combination of different financial instruments, which would otherwise require additional financial costs to replicate, or no chance to replicate at all. So, possible investment opportunities might show up among different financial instruments when the prices fluctuate.

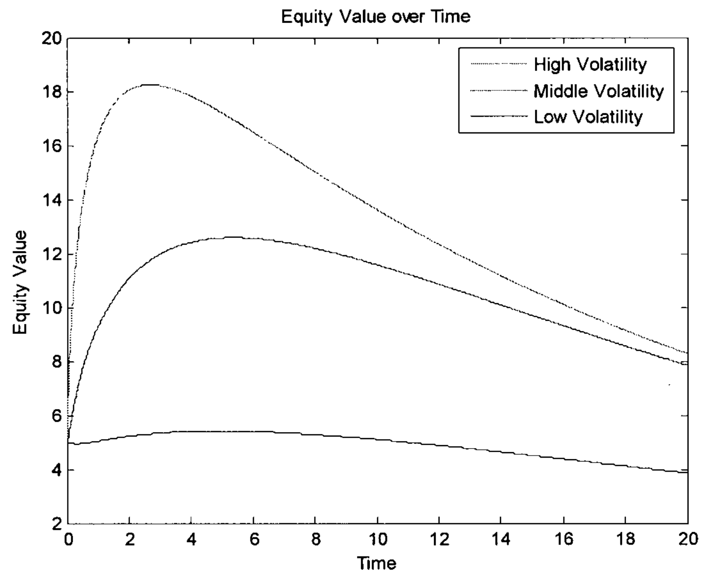
From all the above, CBs can be advantageous for some firms and investors. However, CB issuance would not be deemed as good news for firms with too many risks. Weak firms with credible managers may be well suited to issuing CB's. Otherwise equity financing of their new projects may be more appropriate. While strong firms also have incentives to use of CBs, if they do so, investors' estimation of the new project could be distorted, which might generate an adverse market reaction.

To the best of our knowledge, this study is the first in this area to analyze CBs from the perspective of both firms and investors, and reflects the dynamics of a market place wherein the characteristics both issuers and investors change through time. Future work could lie in the further analysis of the *ex-ante* and *ex-post* expectations of managers before and after the issuance of CBs.

FIGURE 3-1. The Fluctuation of Equity Value over Time

This figure depicts the change of equity value over time. The red, blue and black lines are CB issuers with a volatility of high level, middle level and low level respectively.

Part A. Low dilution factor scenario (γ=10%)



Part B. High dilution factor scenario (γ=50%)

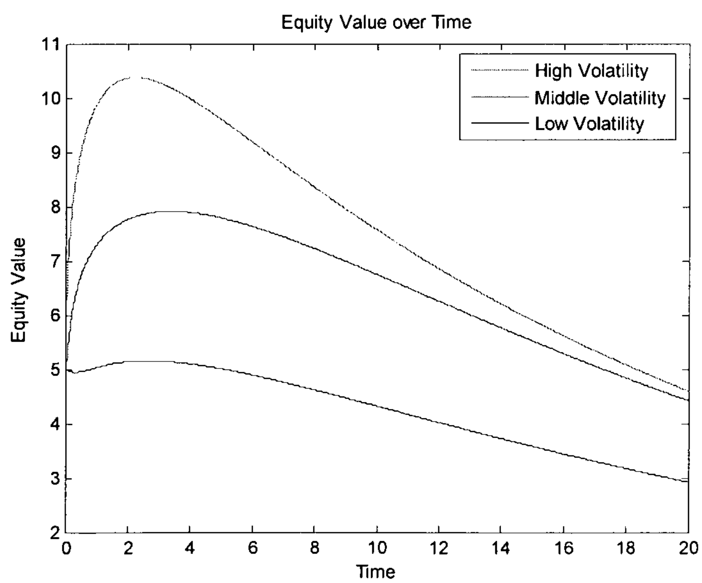
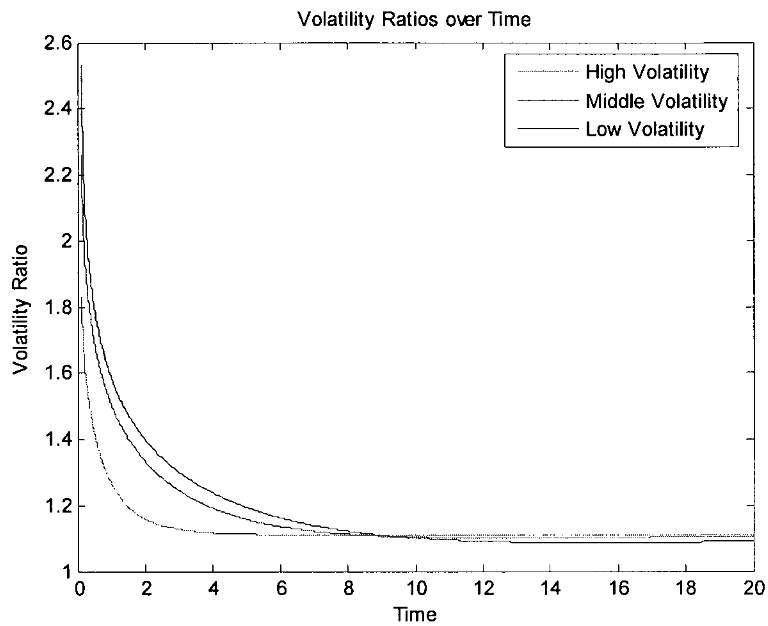


FIGURE 3-2. The Variation of Risk Ratios over Time

This figure illustrates the dynamics of the ratio of total volatility to equity volatility for CB issuers after the CB issuance. The red, blue and black lines are CB issuers with a volatility of high level, middle level and low level respectively.

Panel A. Low dilution factor scenario (γ=10%)



Panel B. High dilution factor scenario (γ=50%)

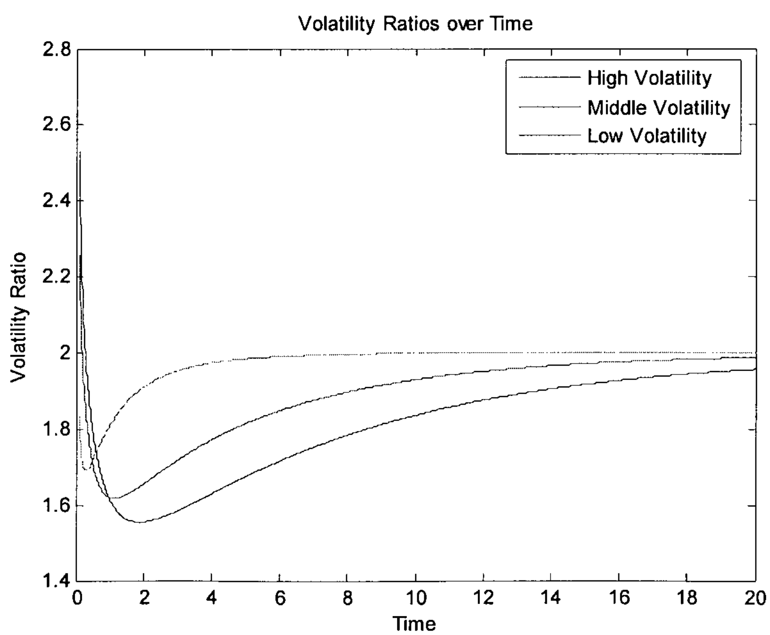
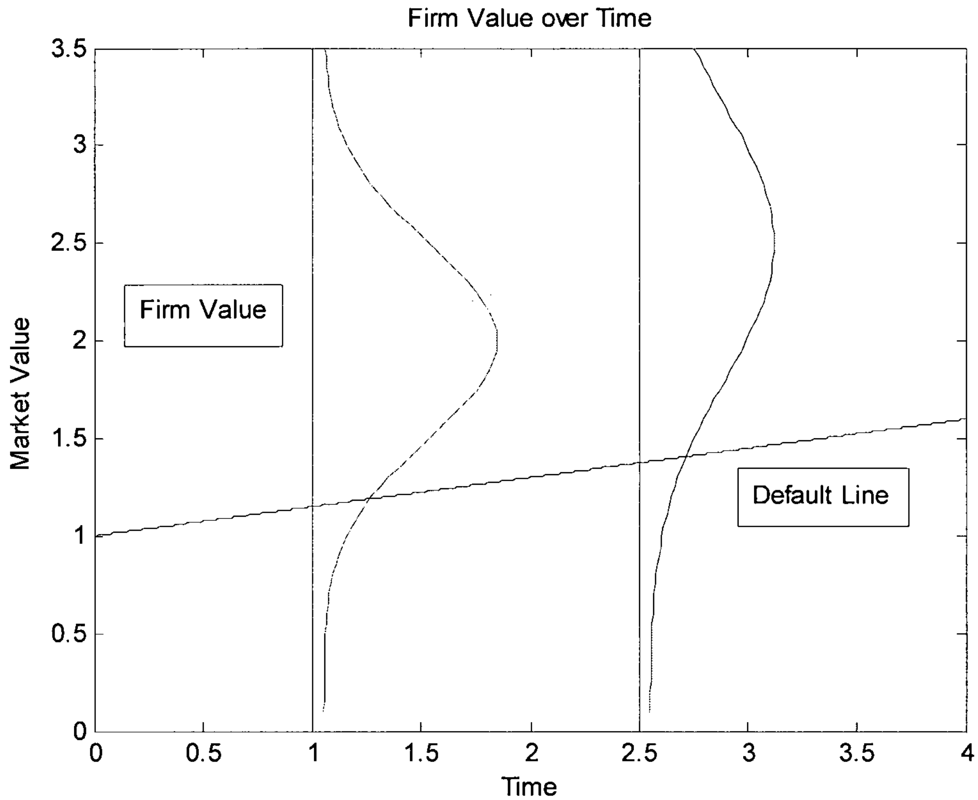


FIGURE 3-3. Firm Value over Time

This figure illustrates the dynamics of the market value of firm over time. The red and blue curves are the firm value density function at t1 and t2 after issuance respectively. The yellow dash line is the firm value. Time 0 is the CB issuance date.



Chapter 4

LIQUIDITY RISK, FIRM RISK, AND ISSUE RISK PREMIUM EFFECTS ON THE ABNORMAL RETURNS TO NEW ISSUES OF CONVERTIBLE BONDS

Abstract

This paper provides new evidence on the effects of the risk profiles of firms on the returns to convertible bond issues. Liquidity risk, firm risk, and issue risk premium factors are examined as determinants of abnormal returns around the convertible bond issue dates. The market responds favorably to the issuance of convertible bonds by issuers with mild levels of firm volatility risk. Liquidity risk (issue size) and issue risk premium factors (convertible Vega) have significantly negative effects on abnormal returns around the issue date. The findings are robust to different grouping criteria and estimation methods.

4.1. INTRODUCTION

Convertible bonds, hereinafter referred as CBs, are financial debentures that can be converted into a preset number of shares at a premium to the stock price at issuance. They are hybrid securities with both debt and equity features, and have served as a major source of financing for firms over the past two decades. According to SDC data, from 1995 to 2006, the total value of CB issues increased in the US by 581.60%. Over this period, the ratio of CB financing to equity financing expanded from 10.15% to 36.75%. The rapid growth of the CB market can be attributed to several factors: 1) CBs reduce cash flow outlays as a consequence of their lower coupon interest costs relative to regular corporate bonds, 2) the dilution effects of CBs are smaller than outright seasoned equity issues, since at issue time, the conversion price is set higher than the current stock price, 3) the timing of the dilution effect is favourable to the firm: i.e. conversion occurs when the firm's improved operations are reflected in its share price, 4) CBs can mitigate agency costs, and 5) CB portfolios provide comparable returns to those of equity portfolios but with much lower levels of volatility.[43]

It remains somewhat of a puzzle that a considerable body of empirical evidence demonstrates that the issuance of new CB's is associated with negative abnormal returns of the underlying shares since: 1) the market normally reacts positively to straight corporate bond issuance; 2) CB's have payoff structures that entail a straight bond component and an equity option component; and 3) in spite of the negative equity market reaction to CB issuance, the market for CB's has grown rapidly over time.[44] One possible resolution of the puzzle that has been adduced is that due to ***dilution effects***,

43 Woodson and Woodson (2002) find that the returns of convertible, equity index, and bond portfolio are 14.28%, 8.69%, and 6.55%, while the standard deviation are 8.62%, 13.25%, and 4.29% respectively.
44 See Smith (1986), and Davidson et al. (1995).

investors perceive CB's as equity from the outset, rather than debt.[45] In this vein, according to the pecking order theory, the market reaction should be negative. However, the evidence that we provide in this paper demonstrates that ***dilution effects are negligible.*** What then explains the abnormal equity performance of firms that issue CBs?

This paper serves to provide new evidence on this score. In particular, we examine the underlying firm characteristics that serve as drivers of the abnormal returns when CB's are issued. The focus is on the relationship between the short-term wealth effect[46] around the issuance of CBs and the characteristics of issuer firms and the features embodied in the issues themselves. In particular, we examine the impact of three factors suggested in Chapter 3: liquidity risk (logarithm of issue size), issue risk (Vega, which measures the sensitivity of CB value to the volatility of underlying stocks), and firm volatility risk (standard deviation of beta[47]) on the abnormal returns to convertible bond issues.

We find that all of these three risk factors serve as significant drivers for the abnormal returns around the CB issue date. The market responds favourably to the issuance of convertible bonds by issuers with mild level of firm volatility risk. However, liquidity risk and issue risk are significantly negatively related to performance. The latter two risk components serve to offset the risk management benefits of convertibles for firms. These findings are robust to different grouping criteria and estimation methods.

This study can be deemed as an empirical test of the hypothesis advanced in Chapter 3 that CBs are beneficial to firms and investors, since they have desirable

45 See Asquith and Mullins (1986).

46 Fabozzi, Liu, and Switzer (2009) demonstrate that a naked long position of CBs from issue date can generate good returns at the end of two or three years after issuance, especially for CBs with low ratings and large issue size.

47 If we deem stock price include the market reactions to all information, the standard deviation of beta could be a very good proxy for the firm's general risk.

properties for firms with uncertain or time-varying investment opportunity sets. The remainder of this paper is organized as follows: Section 2 provides a brief literature review. Section 3 describes the data used in this paper. Section 4 explains the methodology and proxies employed in this study. Results are reported in section 5. An analysis of the effects of CB issuance for different firms is presented in Section 6. The paper concludes with a summary in section 7.

4.2. LITERATURE REVIEW

A considerable body of research over the past half century has looked at

a) the normative question: why firms should use CBs? and

b) the positive question: how does the market reacts to the issuance of CBs?

Modigliani and Miller (1958, 1961, and 1963) propose that financing decision, including the issuance of convertibles, is irrelevant to a firm's valuation. Stiglitz (1969 and 1974) demonstrates the validity of the irrelevance theory under more general conditions. However, Jensen and Meckling (1976) and Green (1984) provide seminal arguments that CBs can be used to alleviate existing shareholders' risk-taking incentives that are at the expense of bondholders by allowing debt holders to share in the upside. Myers and Majluf (1984) and Myers (1984) argue that firms issue CBs to avoid asymmetric information in their pecking order theory. They argue that CBs should dominate equity financing since CBs are less risky. Heinkel and Zechner (1990) show that with new investment opportunities and subsequent informational asymmetry, all-equity financed firms will over-invest. Constantinides and Grundy (1989) and Stein (1992) suggest firms use CBs to inject new equity into the capital structure with lower asymmetric information costs. Lewis, Rogalski, and Seward (2001) explain the use of CBs on the base of equity market rationing, which supports Stein (1992). Baker and Wurgler (2002) extend the asymmetric information approach and demonstrate that firms can use different financial instruments to time the market based on managements' expectations.

Brennan and Kraus (1987) and Brennan and Schwartz (1988) argue that the appeal of CB's relates to their immunity to company risk. Mayers (1998) argues that firms use CBs to reduce financing costs as an alternative to sequential financings that use equity and/or straight debt when facing serially correlated real investment option opportunities.

Several empirical papers have examined the motivation for firms to issue CB's, firm characteristics associated with CB issues, and the market reaction to CB issuance. Billingsley and Smith (1996) conclude that firms use convertibles primarily as an alternative to straight debt as a means to preserve cash flow via lower interest costs. Essig (1992) shows that the ratios of R&D to sales, market value to book value of equity, and long-term debt to equity as well as the volatility of the firm's cash flows, are all positively associated with firms' propensities to employ convertible debt. Lee and Figlewicz (1999) compare different characteristics of firms that issue convertible debt versus convertible preferred stock. The choice of the former is found to be associated with proxies for asymmetric information, financial distress, and taxes.

Dann and Mikkelson (1984) and Eckbo (1986) show significantly negative effects of the CBs offering. Davidson III, Glascock and Schwartz (1995) confirm the negative effects of using CBs and find that low conversion prices send more negative information to the market, which is consistent with the signaling argument proposed by Kim (1990). Arshanapalli, Fabozzi, Switzer, and Gosselin (2005) confirm that during the period from two days before to two days after the issuance of CBs, there is a significantly negative return of –2.19%. Loncarski, Horst and Veld (2006) study the Canadian market, and show evidence of price pressure effects, and an increase in short interest around the issuance date of CBs.

In sum, the existing theoretical and empirical literature has identified and tested several factors affecting the returns to convertible issues. Previous studies have essentially focused on the issuers' perspective alone. Chapter 3 argues that that from an incentive compatibility perspective, one should focus both on issuers and investors. They demonstrate that liquidity risk, firm risk, and issue risk premium factors should be the key determinants of abnormal returns around the convertible bond issue dates, and that the market should not discount firms with firms with low or mild levels of such risks. Our paper serves to provide evidence on the performance of this approach to in explaining abnormal returns of CB issuers vs. alternative models based on the standard efficient markets hypothesis, as well as models that incorporate fundamental issuer characteristics in the estimation.

4.3. DATA DESCRIPTION

The sample consists of all CB offerings from January 1, 1986 to December 31, 2005 for which the underlying shares are traded on the New York Stock Exchange (NYSE), the American Exchange (AMEX), or the over-the-counter (NASDAQ) market from the SDC Platinum database. The basic CB data, including conversion price, coupon rate, expiry date, issue date, ratings, and issue size are obtained from SDC. Missing observations from SDC are replaced with data from the Convertible Bond Database that was provided to us from Morgan Stanley.

The underlying stock prices of the firms in our sample are from CRSP. During the observation period, stock prices are adjusted for stock dividends or splits. The market index returns are also from CRSP. We employ three market proxies in our tests: returns on the value-weighted market portfolio, returns on an equally-weighted market portfolio, and returns on the level of the Standard & Poor's 500 Composite Index.

Company financial data are obtained from the Standard & Poor's Compustat database. Firms are included in the analyses if they have complete data on cash flow, working capital, investment in fixed assets, the real tax rate, growth rates in assets and sales, and various size and risk measures.

Market expectations for CB issuers are proxied by analysts' opinions, as reported in IBES, which includes the estimation of earnings per share, cash flow per share, sales, or operating profit, and the Buy/Hold/Sell recommendations. The divergence of opinion across analysts is proxied by the IBES estimate of standard deviation of the analyst forecasts. Analysts' estimates are updated on the Thursday before the third Friday of every month.

Benchmark interest rates such as Treasury bills/ bonds of different maturities and corporate bonds with different ratings are obtained from Datastream. The four factor data (the returns of market portfolio, size portfolio, book-to-market (BM) portfolio, and momentum portfolio) for Carhart-Fama-French approach are downloaded from Kenneth R. French's Data Library.

The sample for calculating market reactions consists of 732 CBs issuances over the period January 1, 1986 to December 31, 2005. A breakdown of the sample by year of issuance is shown in Table 1. The study period includes both bullish and bearish equity market periods. The average principal amount is highest in 2002, and reaches the second highest level in 2000. The conversion premia are higher after 2001 (including) compared with those in earlier years. In this sense, we infer that since 2001 CBs have become increasingly debt-like.

Figure 1 shows the time series of convertible bond issues over the period studied in this paper.

4.4. METHODOLOGY AND PROXIES

4.4.1. Methodology

In order to analyze the wealth effects and underlying driving factors around the issuance of CBs, we first calculate abnormal returns using standard event study methodologies, as in Brown and Warner (1980, 1985). The computed abnormal returns are then used as grouping variables, as well as dependent variables in regressions that are designed to capture the effects of the various risk factors on firm performance.

4.4.1.1. Abnormal Returns

Abnormal returns are calculated based on filing dates and issue dates. The Issue Date in this paper is defined as the first trading date of the underlying stocks on or after the issue date specified in SDC. The Filing Date is the date when an issuer officially transmits its CBs application or provides notice to the SEC for the issuance of CBs. We study the filing date because: 1) in an efficient market, prices should react to relevant information on the firms when it becomes public, which in many cases occurs on the Filing Date; 2) Information about the issuance of CBs shown in other resources such as newspaper reports or comments from senior officers of a listed company at the time before the filing date may be contaminated with other events, such as disclosure of other financing and investment activities.

Theoretically the information effect of CB financing on the stock price is ambiguous. The issuance of CBs could be good news for shareholders since the firm is issuing more debt with much lower financing cost compared with that of normal bonds, and the issuance of CBs might be a good signal for the future performance of the issuer. However, the issuance may be adverse, if dilution and liquidity effects are considerable.

Abnormal returns are computed using the standard market model approach. We assume that returns of underlying stocks follow the single factor market model:

$$R_{jt} = \alpha_1 + \beta_j R_{mt} + \varepsilon_{jt} \tag{4-1}$$

where R_{jt} is the rate of return of the underlying common stock of the j_{th} firm on day t, R_{mt} is the rate of return of the market portfolio on day t, β_j measures the sensitivity of R_{jt} to the market portfolio, and ε_{jt} is a random error variable.[48] Significance tests are

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[48] he abnormal return of j_{th} firm's stock on day t can be computed as:

$$A_{jt} = R_{jt} - \left(a_j + \beta_j R_{mt}\right)$$

The average abnormal returns are calculated as:

$$AAR_t = \frac{\sum_{j=1}^{N} A_{jt}}{N}$$

where t is defined in days relative to the event date. N is the number of days studied in the period. The cumulative average abnormal return (CAAR) is calculated as:

based on Patel (1976).[49]

$$CAAR_{T1,T2} = \frac{1}{N_1}\sum_{j=1}^{N}\sum_{t=T1}^{T2} A_{jt}$$

where N_1 is the number of stocks included in the analysis. The cumulative abnormal return (CAR) is just the CAAR formula without the average factor of N.

[49] The standardized abnormal returns are: $SAR_{jt} = \frac{A_{jt}}{S_{A_jt}}$

where S_{A_jt} is the variance of A_j at time t, which is estimated as.

$$s^2_{A_{jt}} = s^2_{A_j}\left[1 + \frac{1}{D_j} + \frac{\left(R_{mt} - \overline{R_m}\right)^2}{\sum_{k=T_{Db}}^{T_{De}}\left(R_{mk} - \overline{R_m}\right)^2}\right],$$

$$s^2_{A_j} = \frac{\sum_{k=T_{Db}}^{T_{De}} A^2_{jk}}{D_j - 2}.$$

where R_{mt} is the observed return on the market index on day t, and $\overline{R_m}$ is the average market returns.

The total value of SAR_{jt} across all the observations examined, $TSAR_t$, is supposed to follow a t-distribution with D_j-2 degrees of freedom. The null hypothesis is that the expected value of $TSAR_t$ is zero, with a variance of Q_t.

$$TSAR_t = \sum_{j=1}^{N} SAR_{jt},$$

$$Q_t = \sum_{j=1}^{N}\frac{D_j - 2}{D_j - 4}.$$

where D_j is the number of returns in the estimation period of firm j.

Alternatively, we may use the statistics of Z, which follows the standard normal distribution.

$$Z_{T1,T2} = \frac{1}{\sqrt{N}}\sum_{j=1}^{N}\left(\frac{1}{\sqrt{Q^j_{T_1,T_2}}}\sum_{t=T_1}^{T_2} SAR_{jt}\right),$$

where

$$Q^j_{T_1,T_2} = (T_2 + T_1 + 1)\frac{D_j - 2}{D_j - 4}.$$

Market returns are calculated using an estimation period that has 250 trading days (approximately one calendar year) in length. The estimation period is the same for both the filing date and issue date event studies and ends 40 days before the event. The results we report use the Equally Weighted Index from the CRSP database as the benchmark. This index is relevant for our purpose because the dataset includes firms from different industries listed on NYSE, AMEX or NASDAQ.[50] To test the robustness of the findings in abnormal returns, we use Carhart-Fama-French approach, which states that the abnormal return of securities is explained by the market portfolio and three factors designed to mimic risk variables related to size, book-to-market (BM) and momentum. The four-factor pricing model is the following.

$$E(R_{it}) - R_{ft} = b_{1i} * (E(R_{mt}) - R_{ft}) + b_{2i} * E(SMB_t) + b_{3i} * E(HML_t) + b_{4i} * E(WML_t) \quad (4\text{-}2)$$

where b_i is the factor loadings, SMB is the difference in returns between portfolios of small capitalization firms and big capitalization firms, HML is the difference in returns between portfolios of high book-to-market and small book-to-market firms, and WML is the difference in returns between portfolios of stock price winners and stock price losers. Similarly to Lemma 4-2, we can derive abnormal returns by subtracting expected returns from real returns.

4.4.1.2. Comparison of mean abnormal returns across sub-samples

In order to detect whether firm and issue characteristics are significantly different across sub-samples, we employ the mean comparison method. Sub-samples are divided

[50] We also use the CRSP value-weighted portfolio as well as the S&P 500 as alternative market portfolio proxies to test for robustness. The results, which are available on request, are unaffected by the use of alternative market proxies.

into two groups based on the abnormal returns: observations with positive/negative abnormal returns. We explore several alternative time intervals and classify observations into three groups: positive/negative and almost zero abnormal returns.

The method to compare the mean is based on the general assumption that the sub-sample variances are unknown and possibly unequal. Significance is assessed based on the t-statistic:

$$\frac{\bar{X}-\bar{Y}}{\sqrt{\frac{S_x^2}{n_x}+\frac{S_y^2}{n_y}}} \rightarrow t_{n_x+n_y-2} \tag{4-3}$$

where $\bar{X}$ and $\bar{Y}$ are the mean of sample X and Y respectively; S_x^2 and S_y^2 are the variance of the two samples; n_x and n_y are the number of observations in the two samples. The null hypothesis of this test is that the mean of the two samples should be the same.

4.4.1.3. Regression analysis

To identify the driving factors of these abnormal returns, cross-sectional regressions are performed. What we want to examine is whether risks related to issuers and issues can explain abnormal returns around issuance.[51] The risks selected, as per Chapter 3, include liquidity risk (logarithm of issue size), risks to firms (standard

[51] A similar test conducted around the filing date is not meaningful because at the filing date, 1) the terms of the CB normally have not been determined, which means that the value of the CB cannot be assessed; 2) the actual issue date is still unknown, which means that hedged position of CBs cannot be set up yet; and 3) based on the Bloomberg database, no abnormal variations of the accumulated short interests around the filing date of CBs are observed; however an increase of accumulated short interest is observed around the issue date.

deviation of beta), and risk to CBs (Vega). The basic model estimated is:

$$\text{Return}_{ij} = \alpha 0\ (+\alpha 1\ \text{FCFE/Sales}) + \alpha 2\text{Vega} + \alpha 3\text{Ln (Issue Size)} + \alpha 4\ \text{std(beta)} + \varepsilon_{ij} \qquad (4\text{-}4)$$

where Return_{ij} is the daily abnormal returns (AR) or cumulative abnormal returns (CAR) observed in the event windows (-2, +2) around issue date. FCFE/Sales is the firm's Free Cash Flow to Equity normalized by sales, which relates to the cash flows available to equity holders. As this paper aims to test whether risk proxies can explain the abnormal returns, FCFE/Sales is deemed as a controlling factor only. Vega is the sensitivity of CBs value with respect to the volatility of the underlying stock, which proxies the risk related to CBs. Ln (Issue Size) is the logarithm of the total dollar amount of proceeds, which could proxy for the liquidity risk and dilution effect related to CBs. However, the market liquidity risk should be more prominent in ln (Size) since we are looking at the short term, when the dilution effects from conversion are highly uncertain.[52] The variable std (beta) is the standard deviation of beta estimates, which proxies for the risk of issuers.

To address the problem of heteroskedastic error terms, we employ the White (1980) procedure as developed by MacKinnon and White (1985),[53] as well as Feasible Generalized Least Square (FGLS).[54]

Finally, we employ the Error-components Model with fixed effects assumption to

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[52] Furthermore, as we will show subsequently, dilution effects are not significantly different across positive/negative return groups.

[53] See also Long and Ervin (2000).

[54] FGLS is based on the following regression model:

$y_t = X_t\beta + u_t$, $E(u_t^2) = \exp(Z_t R)$, which is estimated in a three-step process:

i) OLS of $y_t = X_t\beta + u_t$,

ii) Auxiliary linear regression of $\ln(u_t^2) = (Z_t R) + v_t$, and

iii) The feasible weighted least squares with weights equal to $\sqrt{\exp(Z_t \hat{R})}$

compare the CAR regressions. The fixed effects assumption, rather the random effects, is appropriate, since there are a small number of observation periods with a relatively large number of issuers.

4.4.2. Alternative Proxy Variables

For completeness, alternative proxy variables are also used based on Gordon (1962) model:

$$P = \frac{D_1}{K - g} \tag{4-5}$$

where P is the price, D_1 is dividend of next period, K is the constant required rate of return, and g is the growth rate.

The proxies are divided into three groups: a) based on issuer fundamental characteristics; b) characteristics of the issue (size, CB features ; and c) the prevailing interest rate.

4.4.2.1. Proxies related to the issuer

We choose to test a comprehensive set of proxies related to the issuer in cash flows, growth, and risks, as well as other factors that the extant literature has proposed as determinants of the wealth effect.

Cash flow

Cash flow is important for issuers in the sense that it serves as a constraint to the firm's financing and investment activities. Three types of cash flows are examined in this study: 1) Cash Flow from Operations, which measures the returns to the firm's fundamental activities; 2) Free Cash Flow to the Firm (FCFF), calculated as net income plus non-cash charges-minus working capital investment plus the product of interest and one minus tax rate, and minus capital expenditures; this variable captures cash available to both equity holders and debt holders; and 3) Free Cash flow to equity (FCFE), which is the cash available to common shareholders after funding capital requirements, working capital needs, and debt financing requirements. It is calculated as FCFF minus the product of the interest rate and one minus the tax rate, plus net borrowing. By studying FCFF and FCFE simultaneously, we can disentangle the divergent interests of shareholders v.s. bond holders. Aside from looking at absolute values of the cash flow variables, we also examine them as a proportion of total assets or total sales.

Growth and profitability

EPS (Earning per share) growth is a straightforward proxy of the historical growth of an issuer. We compute the growth of both the diluted EPS and basic EPS including extraordinary items in the three years preceding the issuance of CBs. Capital expenditure and R&D expenditures are good proxies for the future growth potential of issuers. Tobin's Q is another proxy for the growth of a firm. As per Chung and Pruitt (1994), Tobin's Q is defined as the sum of the book value of debt, market value of equity and the liquidating value of preferred stock, divided by the book value of total assets. Tobin’s Q is calculated at the fiscal year end preceding the issue date of CBs.

We choose the ratios of operating income over sales and over total assets at the fiscal year end preceding the issue date of CBs as proxies for the profitability of an issuer.

Risk

Risks are measured both from the perspective of firms (performance uncertainty of the business operation) and investors. We differentiate between three categories of risk:

business risk, financial risk, and market risk.

Business risk is the uncertainty associated with the variability of operating income, as a consequence of fluctuating sales and production costs. Three measures of the business risk of the issuer are examined: 1) the coefficient of variation of the firm's EBIT over a five year horizon; 2) the standard deviation of the firm's sales over a five year period; and 3) the firm's operating leverage, computed as the average of the absolute value of the percentage change in the firm's operating income divided by the percentage changes in sales over a five year period. The impact of a change in sales on the firm's operating income will be more pronounced if it has higher fixed costs.

Financial risk is the additional risk a shareholder bears when a firm uses debt financing. Four proxies are used: 1) the firm's long term debt ratio, calculated as the book value of long-term debt to the total capital of the firm; 2) the firm's short term debt maturity structure, calculated as the ratio of short-term debt to the total debt of the firm; 3) the firm's interest coverage, estimated as the ratio of the cash flow from the firm's operations to interest expense before the CB issuance; 4) the long-term debt coverage ratio, estimated as the ratio of the firm's cash flow from operations to long-term debt before the CB issuance.

Market risk is measured using Carhart-Fama-French-type factors including: 1) the firm's beta and unlevered beta, calculated as the beta during the period one year and 40 days before the issue date; 2) the firm's size to proxy for the Fama French size risk factor; 3) a proxy for the Fama French book to market factor: calculated as the absolute value of one minus the ratio of market value and book value of the equity of an issuer; 4) a (Carhart) one year momentum factor, calculated is the total rate of return on the underlying common stock during the fiscal year preceding the issuance of CBs; 5) the standard deviation of the firm's beta calculated in the five years before the CB issuance. We also include the historical volatility of firm's stock returns as well as higher moments of the returns (skewness and kurtosis) to capture non-normalities in the distribution of returns. Finally, Brennan and Schwartz (1988) argue that firms issue convertible debt precisely when uncertainty concerning the underlying risk of a firm's investment projects is greatest. To proxy for the uncertainty with respect to the expectation of issuer's future performance, we use the standard Deviation of the EPS estimation and percentage of down estimates from analysts before the issuance of CBs. These variables are retrieved from IBES. Unlevered betas are derived from the levered beta estimates using:

$$B_U = \frac{B_L}{\left[1+(1-T_c)*\left(\frac{D}{E}\right)\right]} \tag{4-6}$$

where T_c is the firm's tax rate and D/E is the firm's debt to equity ratio.

Other Factors

There are some other factors that could influence the valuation of a firm after the issuance of CBs. The first is the firm's tax-rate, which measures the potential tax shields available to an issuer. The higher the marginal tax rates, the more issuers can take advantage of direct tax benefits of additional interest obligations associated with CBs financing. Issuers with lower profitability will derive fewer direct tax benefits from the CB's. There are different proxies to measure the tax shield a firm can utilize. Similar to the methodology employed by Houston and Houston (1990), we use the average tax rate, which provides a summary measure of the ability of issuers to take advantage of direct tax benefits associated with additional debt financing.

Additionally, we use the firm's depreciation rate, measured as the ratio of the firm's depreciation charges over total PPE (Physical property, plant, and equipment) to measure non-debt tax shield. This ratio can also be deemed as the rate at which the physical plant is written off, which could be related to the guaranty of CBs. This ratio can also be related to the risk of the current fixed assets of a firm. For completeness, we also include the firm's change in working capital as per Essig (1992), the number of industries (4-digit SIC codes an issuer has in SDC database) in which the firm operates to capture potential diversification benefits or real options as per Lee and Figlewicz (1999), and the ratio of net fixed asset (net PPE) to total assets as per Titman and Wessels (1988).

4.4.2.2. Issue Specific Factors

The issue specific factors that we consider are: size, conversion premium and the CBs option risk parameters.

Issue Size

Issue size can influence the price of CBs and underlying stock prices through dilution effects and liquidity effects, both of which are positively correlated with the number of CBs issued. The absolute issue size should be negatively related to the valuation because of liquidity effect. On the other hand however, if we deem CBs can act to reduce the agency costs associated with debt/equity financing, the issuance of CBs, especially for small but rapidly growing firms, can be an effective way to alter the risks of their total assets. So the relative size could be positively related to the valuation.

Similar to Dann and Mikkelson (1984), we employ proxies for both absolute and relative issue size. The logarithm of the total dollar amount of proceeds is chosen to proxy the absolute issue size. The relative change of the liabilities due to CB issuance is measured by the total dollar amount raised divided by the book value of total liabilities of the firm. The potential impact on equity market as a result of the CBs issue is estimated as the total dollar amount raised divided by the market value of common stock. Dilution effects are proxied by the number of shares issued upon conversion divided by the number of shares outstanding.

Debt structure

Since CBs are part of the debt burden of the firm before their conversion, it is worthwhile to study the relative debt structure for the valuation effect. The ratio of long-term debt before the offering divided by the market value of common stock one day before the issuance of CBs is used to measure previous long-term debt utilization[55]. The ratio of total liabilities before the offering divided by market value of common stock one day before the issuance is employed to measure debt financing capacity and total debt utilization. Finally, we use the debt ratio[56] after issuance divided by debt ratio before issuance to study the change of debt ratio that is a consequence of the CB issuance.

Proxies Related to the features of CBs

Lewis, Rogalski, and Seward (2003) find that the market reacts differently to the debt-like vs. equity-like orientation of the CBs issuance. The more equity-like of the CBs, the more negative is the price response of the market, which is consistent with the pecking order theory of Myers (1984). Debt-like CB's differ from equity-like CB's in several interrelated dimensions including: conversion ratios, maturity dates, coupon rates, call periods, and the time to first call. Debt-like CBs have higher conversion premia,

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[55] Several capital-structure related measures here can also be deemed as issuer specific proxies. We list here for convenience.
[56] Total debt divided by total assets.

shorter maturities, and shorter call periods. In this study, we use three proxies to differentiate the debt and equity components. The first is the conversion premium, which is calculated as dividing the conversion price by stock price minus one. From this value, we can study how quickly the management of the issuer wants CBs to be converted into shares after their issuance. The second proxy is the conversion probability specified in the Merton (1973) model, which extend the Black and Scholes (1973) model by incorporating dividend rates. The higher the conversion probability, the more equity-like of the CBs. The formula of the conversion probability is:

$$N(d_2) = N\left(\frac{\log\left(\frac{S}{X}\right) + \left(r - q - \frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}} \right)^{57} \tag{4-7}$$

where S is the price of the underlying stock price, X is the conversion price, q is the continuously compounded dividend yield of the underlying stock, r is the continuously compounded yield of 10-year Treasury bond, σ is the volatility of the logarithm returns of underlying stocks calculated during the period from 240 days to 1 day before the date. T-t is the time till maturity. N (·) is the cumulative distribution function of standard normal distribution.

The third proxy is the sensitivity of the CB value to its underlying stock, which is

[57] If considering the potential dilution effect of CBs, we could incorporate the dilution factor into the formula.

$$N(d_2)1 = N\left(\frac{\log\left(\frac{V}{B}\right) + \left(r - q - \frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}} \right) - \gamma N\left(\frac{\log\left(\frac{\gamma V}{B}\right) + \left(r - q - \frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}} \right)$$

also called the delta. The higher delta, the more equity component CBs have.[58]

$$Delta = e^{-q(T-t)} N\left(\frac{\ln\left(\frac{S}{X}\right) + \left(r - q + \frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{(T-t)}} \right) \tag{4-8}$$

Two other proxies that measure the sensitivity of CBs are used: 1) Gamma, which measures the sensitivity of delta to the price of the underlying stock. Gamma is higher when the conversion price is nearer to the underlying stock price.

$$Gamma = e^{-q(T-t)} \frac{\phi\left(\frac{\ln\left(\frac{S}{X}\right) + \left(r - q + \frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{(T-t)}} \right)}{S\sigma\sqrt{(T-t)}} \tag{4-9}$$

2) Vega, which measures the sensitivity of CBs value to the volatility of underlying stock. Vega is higher when conversion price is nearer to the underlying stock price.

$$Vega = e^{-q(T-t)} S\sqrt{(T-t)}\phi\left(\frac{\ln\left(\frac{S}{X}\right) + \left(r - q + \frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{(T-t)}} \right) \tag{4-10}$$

where $\phi\,(\cdot)$ is the probability distribution function of standard normal distribution.

4.4.2.3. Interest rate, Term structure, and Default Risk Measures

The ten year T-bond yield is used as a proxy for the macroeconomic discounting

[58] The short term Greek measures used here does not consider dilution factor since around issue date, CBs are normally unconvertible, which means the short-term dilution effect could be neglected. Theoretically speaking, it can only be treated as an approximation since we treat call option for underlying stocks as the main term when we consider the Greek measures of CBs.

factor. Term structure risk is calculated as the difference between the return on the 3-month Treasury bill and 6-month Treasury bill. Default/credit risk is measured as the difference between the Moody's Aaa rated corporate bond and the Moody's Baa rated corporate bond.

4.5. RESULTS

In this section, we first look at the abnormal returns around filing/issue dates of CBs for our sample. We then proceed to analyze the underlying drivers of the abnormal returns first using a firm grouping approach and then using a regression models approach that is motivated by the theoretical model.

4.5.1. Abnormal Returns

Table 2 reports the abnormal returns for the event study conducted using the filing date of the CB issuance as the event date. The first column shows the event window. Day 0 is the filing date, while day 1 is one day after the filing date etc. The dates in the windows are trading days. The second and third column show the Cumulative Abnormal returns (CAR) and Cumulative Average Abnormal returns (CAAR) respectively. The market returns used to calculate abnormal returns in this table is the CRSP equal-weighted market return series.[59] The fourth to seventh column show the number of positive abnormal returns, of negative abnormal returns, the ratio of positive to negative returns, and the number of observations in the estimation. Z–statistics are reported in the eighth column, while the significance level is shown in the ninth column.

From Table 2, we find that the abnormal returns in all the different event windows are significantly negative at the 1% level. The significance level is higher when the

[59] Similar results are generated by using value-weighted market returns and S&P 500 index returns.

window is nearer to the SEC filing date. The abnormal return on the filing date is -0.72% with a Z statistic of -7.60; for the (-1, 1) window it is -1.39%, with a z-statistic of -8.10%. Evidently, the filing of CB issuance is not perceived as good news, consistent with previous studies. The number of positive abnormal return observations is smaller than that of negative ones; however, a large portion of observations do have positive abnormal returns: the lowest and highest ratios of the number of positive to negative abnormal returns are 0.57 and 0.72 respectively.

Table 3 reports the abnormal returns for the event study that uses the CB issue date as the event date. Panel A shows the results using a simple market model approach, while Panel B shows the results using the Carhart-Fama-French risk factor approach. The structure of this table is similar to that of Table 2. From Panel A of Table 3, we find that the abnormal returns in all the different trading windows are again significantly negative at a level of 1% using the market model. The results are more significant when the event window is in close proximity to the issue date. The abnormal return on the filing date is -0.81% with a Z statistic of -8.76%; for the (-1, 1) window it is -1.81%, with a z-statistic of -10.24%. The significance level is highest for the trading window of issue date and two days before the issue date, which differs from filing date effects. The number of positive abnormal return observations is smaller than that of negative ones; however, a large portion of observations have positive abnormal returns: the lowest and highest ratios of positive to negative abnormal returns are 0.48 and 0.57 respectively.

From Panel B of Table 3, we find the abnormal returns typically exceed those of Panel A. In addition, most of the abnormal returns are highly significant. In sum, similar to the filing date results, CB issue dates also correspond to significant negative stock price reactions.

4.5.2. Characteristics Difference across Groups

On average, CB filings and issues are deemed as bad news events in the marketplace. However, for many firms, the abnormal returns are positive. What characterizes firms who derive favorable shareholder valuation effects around the issue dates of CBs? A summary of possible differentiating factors is shown in Table 4.

4.5.2.1. Characteristics related to the issuer

We first examine cash flows differences between negative and positive abnormal return portfolios (referred as "matching sub-samples" afterwards). Significant differences are observed. The ratio of average cash flows across matching sub-samples is largest around issue dates. It is interesting to note that the more cash flows issuers generate, the more negatively is the market's reaction to the issuance, which is consistent with Chapter 3. That is, CB financing is more probable to be perceived as good news for medium or weak firms.

The growth and profitability differences across matching sub-samples show different significance levels. The average three-year EPS growth, which can proxy for historical growth is higher in the negative abnormal return portfolio, although the EPS growth difference is not statistically significant between portfolios. However, the average capital expenditure and R&D to sales ratios, which proxy for future growth, are significantly higher for the negative abnormal return portfolio. In sum, it is apparent that the market reaction to the issuance of CBs is more linked to future growth prospects. Tobin's Q is not significantly differently across the matching sub-samples, but the negative reaction portfolios also have higher Tobin's Q values. Additionally, the profitability of the assets does not differ across matching sub-samples.

Firms with higher business risks have more negative market reactions.[60] The ratio of standard deviation of sales to mean value of sales and the operating leverage are significantly different across groups. Leverage variables also differ. However, bankruptcy risk, as proxied by interest coverage does not appear to differ across the matching samples. Higher moments of stock returns show significantly different valuation effects. The stock return before issuance and the divergence of market to book value do not show any significant valuation effects. The beta, standard deviation of beta and standard deviation of unlevered beta all show significant differences across matching sub-samples. The larger the beta-related proxies, the lower are the abnormal returns. In sum, risks do have valuation effects around the issuance of CBs, and the market prefers firms with low or mild level of risk to issue CBs, which coheres with Chapter 3.

Neither the estimated EPS (from analysts) nor the differences between the absolute and relative difference between the estimated and actual EPS are significantly different across matching sub-samples; however, the volatility of the analysts' opinion as to future EPS is significantly different between matching samples. The higher the volatility of analysts' opinions, the more negative the market reaction, consistent with Doukas, Kim and Pantzalis (2006). Analysts' estimates for the upward/downward future stock price performance are in line with the ex post market reaction. The sign of the estimation error of EPS is positive in all event windows, which shows the upward bias of analysts' estimation for CB issuing firms.

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[60] We also group firms into three categories according to their abnormal returns, and find that those in the strongly positive abnormal return group are associated with mild levels of risk. These results are available on request.

Tax rates are significantly different across the matching sub-samples. The higher the tax rate, the higher the tax shields, however the lower are the returns of the portfolio around CB issuance. This phenomenon may be due to a number of factors including: 1) the limited actual amount of tax shield for these firms, since both the coupon of CBs and the earnings of CB issuers are low; 2) the market treats CB more like equity, consequently the higher tax rate, the lower percentage of earnings could be shared by shareholders. The ratio of net fixed asset over total assets and the ratio of depreciation over PPE are also significantly different across matching sub-samples with negative valuation effects. Neither the number of industries nor the change in working capital is significantly different across matching sub-samples for any of the event windows examined.

4.5.2.2. Interest rate, term premium and credit risk premium effects

We find that the level of interest rates, interest term-structure risk and credit risk are all significantly different across matching sub-samples in the entire event windows examined. The higher the level of interest rates, term premium and credit risk premium, the more favorable the effect of the CB issuances. These results are intuitively appealing since: 1) with higher interest rates, the interest cost savings are higher; 2) in riskier economic environments, the expectations of both equity/debt investors and issuers can be more easily aligned with the use of CBs.

4.5.2.3. Proxies related to the issue

The total issue size of CBs is significantly different in all the event windows examined. Larger issue sizes are associated with more negative abnormal returns on the underlying stocks. However the relative issue sizes (defined as the nominal value of the issue divided by the market value of common stock) are almost equal between the matching groups. The differential effects of the absolute and relative size imply that liquidity risk is more prominent than the dilution effect for CB issuances.

Of the three proxies for the equity vs. debt "orientation" of CBs, only the probability of converting CBs into shares is significantly different between matching groups. There is no significant difference for the conversion premium and the delta value between matching sub-samples. This contrasts with Lewis, Rogalski and Seward (2003).

Both Gamma and Vega are significantly different between matching sub-samples. CB's with higher values of Gamma and Vega are associated with more negative market reactions, as they are perceived to be riskier.

4.5.3. The Drivers of Abnormal Returns

Table 5 reports the determinants of abnormal returns (AR) around the issue dates of CBs. The columns of this exhibit represent different event windows. On the upper-left (upper right) superscript shows the significance level calculated from the White method by assuming $diag\left(\hat{u}_t^2/(1-h_t)^2\right)$ (OLS method) as the covariance matrix. For each window, two models are employed. Model I include three regressors: liquidity risk (logarithm of issue size), issue risk (Vega), and firm volatility risk. Model II uses these three regressors as well as free cash flows (FCFE) to equity divided by sales as a robustness test.

On the whole, the models are significant, based on the computed F-statistics.

From Table 5, we find that the influence of issue size on abnormal returns is significantly negative for the 2 trading days before the issue date, but not significant thereafter. The market impact is negatively correlated with issue size on or before the issue date. This may due to the fact that some investors short sell the underlying stocks to set up a hedging portfolio.[61] Vega has a significantly negative effect. Firm risks have positive effects on abnormal returns, but are significant in only a few cases. FCFE/Sale is only significant before the issue date. [62]

Table 6 shows the determinants of the cumulative abnormal returns (CAR) for sample firms. The results are largely similar to those of Table 5, with the exception of the FCFE/Sale variable. Although not reported in the table, the R-square of Model I and Model II in both abnormal returns and cumulative abnormal returns decreases quite quickly in windows farer away from the issue date.

From the above, we may say the key drivers of abnormal returns around the issue date are: market liquidity impact (issue size), risks to CBs' prices (Vega), and risks to the firm (std(Beta)). The first two of these drivers are particularly noteworthy. We find CBs can help firm to deal with firm's risk, but the additional risks brought by the CB issuance induce negative valuation effects around issuance. These risks can explain abnormal returns near the issuance event. After CB issuance, the negative returns should maintain until the decrease in the firm's risk overweight the increase of additional risks brought by CB issuance when CB issuer demonstrate themselves about the prospect of the new projects financed by CBs.

[61] Short interest positions for CB issuing companies rise around the issuance: the mean and median ratio of short interest after CB issuance to that before issuance are 228.08% and 46.29% respectively.
[62] We also include other proxies as independent variable. The model of 4-4 works best.

4.5.4. Robustness Tests

In order to test the robustness of the results, we separate the observations into different groups and run the regressions with alternative specifications.

First, market returns using value-weighted portfolio containing all issues in the CRSP database and S&P 500 Index are examined. The results are similar to what we obtain when we use the CRSP equal weighted portfolio benchmark for returns.

Second, we put the observations into three groups instead of two to compare the mean values. These three groups are significantly-negative abnormal-return group, the almost zero abnormal-return group, and the significantly-positive abnormal-return group. The results are similar to what we report in previous sub-sections. However, for risk proxies, market tends to favor firms with mild levels of risk to issue CBs.

Third, we also perform truncated regressions including only with observations with extreme absolute abnormal returns. The results are quite similar to those reported here. Fourth, we choose the real returns, not the abnormal returns, around the issue date to run the regressions. The determinants of real returns are reported in Table 7. The direction and significance and direction of the impact are similar to those reported in Table 5.

Fourth, we run the regression of CAR by employing both FGLS and Error-components Model with fixed effects, the later of which is reported in Table 8. Again, the results are similar to what we report in the previous sub-sections. The issue size and Vega remain the most significant drivers of abnormal returns.

Fifth, we run the regression of CAR calculated by Carhart-Fama-French approach. The results, which are reported in Table 9, are similar to those by simple market model.

Sixth, if considering the potential dilution effect of CBs, we could incorporate the dilution factor into the formula of Vega.

$$Vega1 = e^{-q(T-t)} V\sqrt{(T-t)} \left(\phi\left(\frac{\ln\left(\frac{V}{B}\right) + \left(r - q + \frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{(T-t)}} \right) - \gamma\phi\left(\frac{\ln\left(\frac{V\gamma}{B}\right) + \left(r - q + \frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{(T-t)}} \right) \right) \quad (4\text{-}11)$$

where

$\gamma = \frac{m}{m+n}$ [63], m is the number of shares converted from CBs, and n is the initial number of shares before the CB issuance. V is the firm value, which is proxied by the sum of market value of equity, book value of normal corporate bond and the proceeds of issuing CBs. B is the proceeds of CBs.

Then we can use Vega1 in Lemma 4-11 as a proxy of CB volatility risk to run regressions on cumulative abnormal returns (CAR). The results are similar to those reported in Table 5.

Finally, the rating of CB issuance firms could be another proxy for the firm volatility risk, since it incorporates comprehensive information about the performance of a firm. Due to lack of data, we use ratings of CB issuance instead. What we found is that the firm volatility risk is still positively related to the abnormal returns of CBs, although the influence of the CB issuance ratings is not significant anymore.[64]

Consequently, we may say that the findings are quite robust with respect to

[63] Although theoretically Lemma 4-11 is better than Lemma 4-10, it is not easy to implement it in empirical studies since: 1) CB normally bears a lock-up period, in which CB cannot be converted into underlying stocks. For the event windows near the issue date studied here, the CB normally cannot be converted; 2) the real conversion process of CBs is quite different from what theoretical models forecast; and 3) there is not a reliable estimate of firm value because of data constraints, which means there is no proper empirical variable inputs for the expressions.

[64] This is not surprising since the ratings of the CB's themselves may differ from those of the underlying firms.

different estimating methodologies and grouping methods.

4.6. AN ANALYSIS OF THE CB ISSUANCE EFFECT

The market responds favourably to the issuance of convertible bonds by issuers characterized as "mild risk" firms. However, issues that enhance Vega or compromise liquidity (i.e. have high "issue risk") are associated with negative returns.

A natural question that arises is why all types of firms issue CBs' independent of the differential issue risk. The answer is illustrated in Figure 2, which shows the wealth effects of CB issuance for different types of firms.

CB issuance influences investors' expectations about both returns and risks of issuers. Ex ante, expected future returns for CB issuers should be higher than existing returns to the extent that CB's are used to projects with a high risk adjusted NPV. Otherwise the option to convert into common stock would be worthless for CB issuers. Chapter 2 provides empirical confirmation that a naked position of CBs or underlying stock from the issue date can derive superior returns over long horizons. Improved earnings expectations are also shared by analysts, although their recommendation seems to be over-optimistic.[65] On the other hand, total risks of issuers could be higher or lower depending on the firm's type after the issuance. If the project is successful (i.e. the firm is of higher quality) the firm's risk will decline, as the convertible bonds are converted into common stock, ceteris paribus. However, when the issue risk is high, the return enhancement benefits for high quality firms may be offset in the short run. The change of total risk before and after CB issuance depends on these two offsetting factors.

For firms with a low quality portfolio of investment projects, the negative firm

[65] The bias of the estimation error of earnings for the analysts for these issues is always positive.

"type" effects may reinforce the negative issuance effects. The effects of CB issuance for weak firms are plotted in Table 9, in which the probability distribution is flatter with fatter tails, but the expected returns could grow larger due to the issuance. Managers may have asymmetric information about the new project financed by CB issuance, and the firm's prospects. Consequently, in the long-run, CB financing could be beneficial if the managers eventually move the firm value distribution further away from the default value. However, for firms initially characterized as high risk type firms, CBs may not be appropriate.

For firms with medium levels of risk, the market reacts more favorably because the market has more confidence that project financed by the CB will succeed. The perceived total risks of the firm will decrease, while the expected firm value will increase. CB issuance is warranted for such firms.

For firms of high quality, the market is more likely to react negatively because the risks decreased by the use of CB are likely not large enough to offset the additional risks brought by CB issuance. The perceived future return will be deemed positive but not substantial, because otherwise the good firms should issue a normal corporate bond instead. Consequently our empirical findings are consistent with the theory in Chapter 3 that CB's are beneficial for firms with medium levels of risk. They are also consistent with the fact that CBs are normally treated as junk bonds in the US, even for many firms that are recognized as "blue chip."[66]

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[66] For example, when issuing CBs, UPS, United Technologies, Automatic Data Processing, and CIBER have a Moody's rating of not lower than Aa.

4.7. CONCLUSION

This essay examines the empirical relation between the characteristics of issuers/issue and the abnormal returns of firms that issue CB's. We confirm that there are significant negative abnormal returns around the filing date of the notice or application to SEC and the issue date at a significance level of 1%. The abnormal return on the filing date and issue date is -0.72% and -0.81% respectively. The significance statistics is higher when the window is nearer to event date, and the significance statistics is larger for issuance date effects, which supports the view that selling pressures exist around the issuance date of CBs.

Consistent with Chapter 3, the market responds favorably to the issuance of convertible bonds by issuers with mild levels of firm volatility risk. Liquidity risk (issue size) and issue risk premium factors (convertible Vega) have significantly negative effects on abnormal returns around the issue date. The findings are robust to different grouping criteria and estimation methods.

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APPENDIX A. Proof of Lemma 1

By substituting Lemma 1 into the partial differential equation of equity, which is Equation 3-4, we can test whether the formula for the value of equity is correct.

$$
\begin{aligned}
& rV\Phi(d_1) - \gamma rV\Phi(d_1^{'}) + 0.5\sigma V\frac{\phi(d_1)}{\sqrt{T}} - 0.5\gamma\sigma V\frac{\phi(d_1^{'})}{\sqrt{T}} - 0.5\sigma V\frac{\phi(d_1)}{\sqrt{T}} - rBe^{-rT}\Phi(d_2) + \cdots \\
& + 0.5\gamma\sigma V\frac{\phi(d_1^{'})}{\sqrt{T}} + \gamma rBe^{-rT}\Phi(d_2^{'}) \\
& = \left(rV\Phi(d_1) - rBe^{-rT}\Phi(d_2)\right) - \left(\gamma rV\Phi(d_1^{'}) - \gamma rBe^{-rT}\Phi(d_2^{1})\right) \\
& = rF2
\end{aligned}
\tag{A.1}
$$

where

$$d_1 = \frac{\ln\left(\frac{V}{B}\right) + \left(r + \frac{\sigma^2}{2}\right)\tau}{\sigma\sqrt{\tau}}$$

$$d_2 = d_1 - \sigma\sqrt{\tau}$$

$$d_1^{'} = \frac{\ln\left(\frac{V\gamma}{B}\right) + \left(r + \frac{\sigma^2}{2}\right)\tau}{\sigma\sqrt{\tau}}$$

$$d_2^{'} = d_1^{'} - \sigma\sqrt{\tau}$$

$\Phi(\bullet)$ is the cumulative distribution function of the standard normal distribution.

$\phi(\bullet)$ is the probability distribution function of the standard normal distribution.

APPENDIX B. Proof of Lemma 2

We further assume that the equity of the firm follows stochastic differential equation as

$$\frac{dF2}{F2} = \mu_1 dt + \sigma_2 dW_1 \tag{A.2}$$

By Ito's Lemma, we can write

$$\begin{aligned} dF2 &= F2_V dV + \frac{1}{2} F2_{VV} (dV)^2 + F2_t dt \\ dF2 &= \left[\frac{1}{2} \sigma^2 V^2 F2_{VV} + \mu_1 F2_V + F2_t \right] dt + \sigma V F2_V dW_2 \end{aligned} \tag{A.3}$$

By comparing the terms in Lemma (A.1) and Lemma (A.3), we have

$$\frac{\sigma}{\sigma_2} = \frac{\sigma V}{\sigma V F2_V} \tag{A.4}$$

So, we have

$$\frac{\sigma}{\sigma_2} = \frac{1}{\left(\Phi(d_1) - \gamma \Phi(d_1^{'}) \right)} \tag{A.5}$$

APPENDIX C. CB Pricing with Normal Corporate Bond in Firm's Capital Structure

Similar to the process of deriving Lemma 1, we can derive CB pricing formulae when the firm's capital structure includes normal corporate bond. Now the firm value is equal to

$$V = F1(V, \tau) + F2(V, \tau) + F3(V, \tau) \tag{A.6}$$

$F3(V, \tau)$ is the value of normal corporate bond. We assume the face value and maturity t are (B_1, T_1) and (B_2, T_2) for convertible bond F1 and normal corporate bond F3 respectively. Without loss of generality, we further require that $T_2 < T_1$. Then we can evaluate CB at time T_2.

$$F3 = V - C(V, B_2, T_2)$$

$$F1 = \begin{cases} 0, V_{T2} \le B_2 \\ V_{T2} - C(V_{T2}, B_1, T_1 - T_2) + \gamma C(V_{T2}, \dfrac{B_1}{\gamma}, T_1 - T_2), V_{T2} > B_2 \end{cases}$$

$$F2 = V - F1 - F3$$

Figure 4-1. The Issuance of Convertible Bond

This figure depicts issuance of convertible bond studied in this paper.

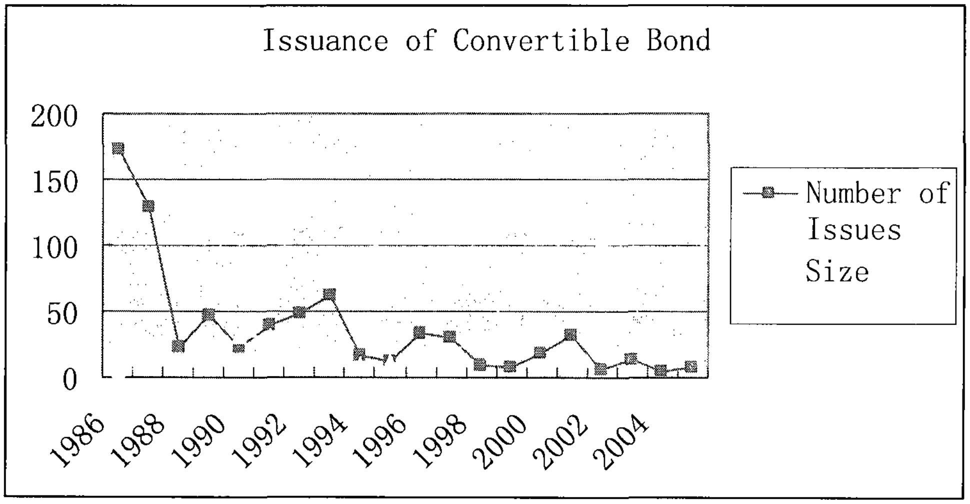

Figure 4-2. The Effects of CB Issuance for Different Firms

This figure illustrates the effects for CB issuance for weak firm, medium firm and strong firm. The red line is the value before CB issuance, while the blue line is the value after CB issuance perceived by investors. The black vertical line is the value for default.

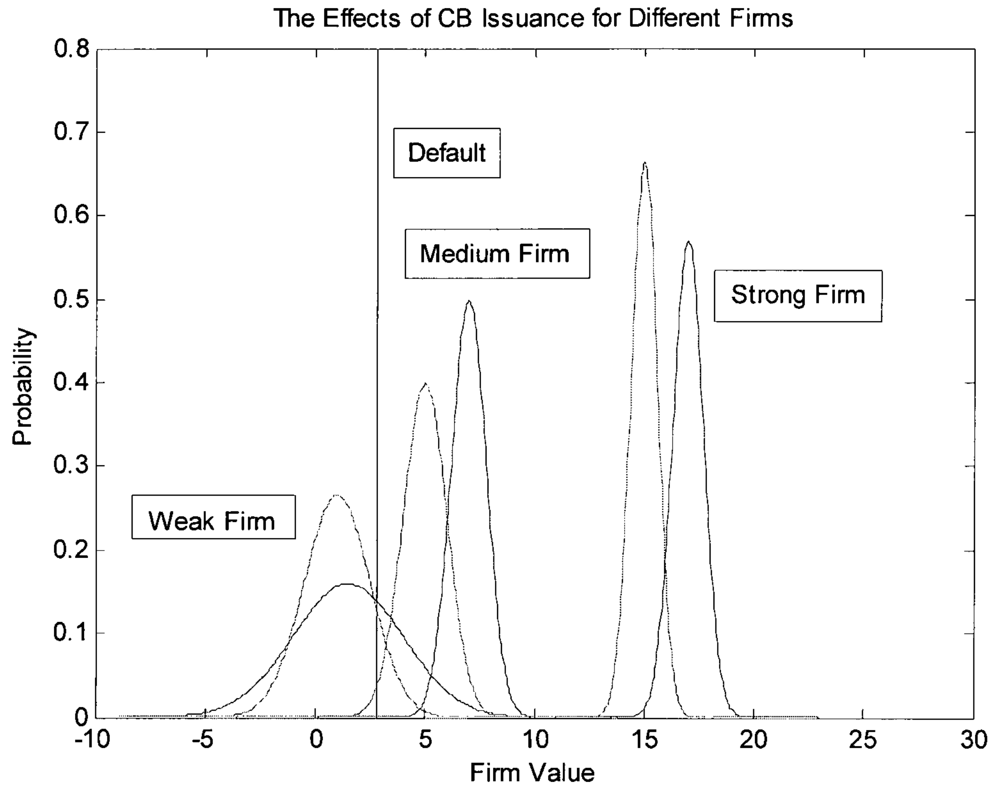

TABLE 4-1. Distribution of the Convertible Bonds Issuance by the Year

This table reports the yearly characteristics of convertible bonds issues used in the study. The time period is from 1986 to 2005. There are total 732 observations in the sample.

Year	Number of Issues	Coupon (%)		Principal Amount (Million USD)		Conversion Premium (%)	
		Mean	Median	Mean	Median	Mean	Median
1986	172	7.39	7.25	52.67	35.00	22.66	23.16
1987	129	7.01	7.00	70.15	45.00	22.79	23.94
1988	22	5.92	7.00	101.80	75.00	23.56	22.03
1989	47	N/A	N/A	161.89	60.00	21.11	21.97
1990	23	N/A	N/A	297.48	100.00	17.83	18.03
1991	40	N/A	N/A	322.85	130.00	18.48	18.19
1992	48	6.28	6.50	123.25	82.50	21.35	21.72
1993	62	5.30	5.75	146.75	65.00	21.60	22.28
1994	17	6.14	6.63	106.06	75.00	20.22	20.49
1995	12	6.40	6.69	124.21	101.75	22.31	21.01
1996	34	5.85	6.00	150.66	100.00	22.51	23.14
1997	30	6.10	6.25	171.93	115.00	30.46	23.51
1998	9	4.38	4.50	349.99	343.50	24.84	23.29
1999	7	3.07	1.50	627.51	260.00	18.42	20.01
2000	18	3.65	3.88	702.45	300.00	26.50	25.00
2001	32	2.28	1.75	598.35	502.50	29.10	28.40
2002	6	5.50	5.50	1025.80	705.00	26.47	32.25
2003	13	3.90	3.31	571.25	200.00	42.76	38.00
2004	4	4.84	5.13	146.25	150.00	39.25	37.50
2005	7	4.05	3.25	395.71	150.00	25.32	25.00
Total	732						

Note: The coupon rates in 1989, 1990, and 1991 in this sample are floating interest rate.

Table 4-2. Abnormal Returns around the Filing Dates of CBs

This table reports the abnormal returns for the event study conducted using the filing date of the CB issuance as the event date. The first column shows the event window. Day 0 is the filing date, while day 1 is one day after the filing date etc. The dates in the windows are trading days. The second and third column show the Cumulative Abnormal returns (CAR) and Cumulative Average Abnormal returns (CAAR) respectively. The market returns used to calculate abnormal returns in this table is the CRSP equal-weighted market return series. The fourth to seventh column show the number of positive abnormal returns, of negative abnormal returns, the ratio of positive to negative returns, and the number of observations in the estimation. Z–statistics are reported in the eighth column, while the significance level is shown in the ninth column.

Windows	CAR	CAAR	Number of Returns		Ratio Posi/nega	Total number	Z-Values	Significance level
			Positive	negative				
(-10,0)	-1.46%	-0.13%	305	425	0.72	730	-4.63	c
(-10,1)	-1.92%	-0.16%	294	436	0.67	730	-5.88	c
(-10,2)	-1.97%	-0.15%	302	428	0.71	730	-5.77	c
(-10,5)	-2.16%	-0.14%	295	435	0.68	730	-5.63	c
(-5,0)	-1.50%	-0.25%	279	451	0.62	730	-6.05	c
(-5,1)	-1.96%	-0.28%	275	455	0.60	730	-7.49	c
(-5,2)	-2.01%	-0.25%	269	461	0.58	730	-7.16	c
(-5,5)	-2.20%	-0.20%	283	447	0.63	730	-6.63	c
(-2,0)	-1.13%	-0.38%	287	443	0.65	730	-6.22	c
(-2,1)	-1.59%	-0.40%	278	452	0.62	730	-7.89	c
(-2,2)	-1.64%	-0.33%	272	458	0.59	730	-7.25	c
(-1,0)	-0.93%	-0.47%	295	435	0.68	730	-6.39	c
(0,1)	-1.18%	-0.59%	264	466	0.57	730	-8.91	c
(-1,1)	-1.39%	-0.46%	277	453	0.61	730	-8.10	c
0	-0.72%	-0.72%	284	446	0.64	730	-7.60	c

Note: This table uses the Market Pricing Model. The abnormal returns using Carhart-Fama-French approach are similar.

In the last column, a, b, and c denote statistical significance at the 10%, 5% and 1% levels of a two-tails test respectively.

Table 4-3. Abnormal Returns around the Issue Dates of CBs

Panel A. Abnormal Returns using simple market model

This table reports for the event study conducted using the issue date of the CB issuance as the event date. The abnormal returns are estimated by the simple market model. The first column shows the event window. Day 0 is the issue date, while day 1 is one day after the issue date etc. The dates in the windows are trading days. The second and third column show the Cumulative Abnormal returns (CAR) and Cumulative Average Abnormal returns (CAAR) respectively. The market returns used to calculate abnormal returns in this table is the CRSP equal-weighted market return series. The fourth to seventh column show the number of positive abnormal returns, of negative abnormal returns, the ratio of positive to negative returns, and the number of observations in the estimation. Z–statistics are reported in the eighth column, while the significance level is shown in the ninth column.

Windows	CAR	CAAR	Number of Returns		Ratio Posi/nega	Total number	Z-Values	Significance level
			Positive	negative				
(-10,0)	-3.04%	-0.28%	256	476	0.54	732	-9.30	c
(-10,1)	-3.35%	-0.28%	252	480	0.53	732	-9.70	c
(-10,2)	-3.35%	-0.26%	257	475	0.54	732	-9.26	c
(-10,5)	-3.31%	-0.21%	265	467	0.57	732	-8.34	c
(-5,0)	-2.43%	-0.40%	243	489	0.50	732	-10.09	c
(-5,1)	-2.74%	-0.39%	240	492	0.49	732	-10.37	c
(-5,2)	-2.74%	-0.34%	248	484	0.51	732	-9.62	c
(-5,5)	-2.70%	-0.25%	264	468	0.56	732	-8.21	c
(-2,0)	-1.75%	-0.58%	253	479	0.53	732	-10.25	c
(-2,1)	-2.07%	-0.52%	248	484	0.51	732	-10.25	c
(-2,2)	-2.06%	-0.41%	254	478	0.53	732	-9.06	c
(-1,0)	-1.49%	-0.75%	240	492	0.49	732	-10.60	c
(0,1)	-1.12%	-0.56%	236	496	0.48	732	-8.13	c
(-1,1)	-1.81%	-0.60%	236	496	0.48	732	-10.24	c
0	-0.81%	-0.81%	236	496	0.48	732	-8.76	c

In the last column, a, b, and c denote statistical significance at the 10%, 5% and 1% levels of a two-tails test respectively.

Panel B. Abnormal Returns using Carhart-Fama-French model

This table reports for the event study conducted using the issue date of the CB issuance as the event date. The abnormal returns are estimated by the Carhart-Fama-French model. The first column shows the event window. Day 0 is the issue date, while day 1 is one day after the issue date etc. The dates in the windows are trading days. The second and third column show the Cumulative Abnormal returns (CAR) and Cumulative Average Abnormal returns (CAAR) respectively. The market returns used to calculate abnormal returns in this table is the CRSP equal-weighted market return series. The fourth to seventh column show the number of positive abnormal returns, of negative abnormal returns, the ratio of positive to negative returns, and the number of observations in the estimation. Z–statistics are reported in the eighth column, while the significance level is shown in the ninth column.

Windows	CAR	CAAR	Number of Returns		Ratio Posi/nega	Total number	t-Values	Significance level
			Positive	negative				
(-10,0)	-3.35%	-0.30%	244	488	0.50	732	-4.76	c
(-10,1)	-3.71%	-0.31%	239	493	0.48	732	-5.37	c
(-10,2)	-3.76%	-0.29%	249	483	0.52	732	-5.66	c
(-10,5)	-3.76%	-0.23%	251	481	0.52	732	-6.49	c
(-5,0)	-2.68%	-0.45%	238	494	0.48	732	-3.02	c
(-5,1)	-3.04%	-0.43%	229	503	0.46	732	-3.57	c
(-5,2)	-3.09%	-0.39%	231	501	0.46	732	-3.85	c
(-5,5)	-3.09%	-0.28%	256	476	0.54	732	-4.60	c
(-2,0)	-1.90%	-0.63%	238	494	0.48	732	-2.67	c
(-2,1)	-2.26%	-0.57%	247	485	0.51	732	-2.74	c
(-2,2)	-2.31%	-0.46%	247	485	0.51	732	-2.90	c
(-1,0)	-1.61%	-0.80%	247	485	0.51	732	-1.70	
(0,1)	-1.21%	-0.61%	239	493	0.48	732	-1.45	
(-1,1)	-1.97%	-0.66%	234	498	0.47	732	-2.23	c
0	-0.85%	-0.85%	245	487	0.50	732	-0.93	

In the last column, a, b, and c denote statistical significance at the 10%, 5% and 1% levels of a two-tails test respectively.

Table 4-4. Characteristics Comparison between Different CAAR Groups

This table reports the average value of the characteristics of two groups of CBs observations, those with negative and positive CAAR calculated by Carhart-Fama-French approach. The rows are different characteristics; while the columns are different event windows examined in the sample. For each characteristic in every window, the left top is the average values for negative CAAR, the left bottom is that for positive CAAR, and the right one is the significance level. 1, 2, and 3 denote statistical significance at the 10%, 5% and 1% levels of a two-tails test respectively.

Items	(-10,1)		(-5,1)		(-2,1)		(-1,1)	
	Mean	Sgnf	Mean	Sgnf	Mean	Sgnf	Mean	Sgnf
COF/Sales	0.25	2	0.29	3	0.25	2	0.25	3
	0.10		0.09		0.09		0.07	
FCFF/sales	0.69	3	0.79	3	0.70	3	0.65	3
	0.20		0.14		0.19		0.14	
FCFE/Sales	0.35	2	0.37	3	0.35	3	0.33	3
	0.17		0.14		0.14		0.11	
Cap Expenditure	0.10	2	0.10	3	0.10	3	0.10	3
	0.07		0.07		0.06		0.06	
R&D/Sales	0.15	3	0.32	2	0.12	3	0.27	1
	0.01		0.03		0.02		0.03	
Tobin's Q	3.01	0	3.07	0	2.98	0	3.13	0
	2.26		1.94		1.81		2.26	
EPS Growth	0.97	0	0.79	0	0.87	0	0.89	0
	0.54		1.37		1.44		0.33	
Operating Income/Sales	0.11	0	0.03	0	0.12	0	0.05	0
	0.05		0.07		0.06		0.07	
Net PPE/ASSETS	0.35	3	0.33	3	0.33	3	0.33	3
	0.23		0.20		0.20		0.20	
Depreciation/Total PPE	0.35	3	0.35	3	0.35	3	0.34	3
	0.23		0.19		0.18		0.18	
Std(Sales)/Mean Sales	0.31	3	0.31	3	0.31	3	0.31	3
	0.15		0.16		0.13		0.15	
Δ Operating Earnings/Δ Sales	3.18	3	3.19	3	8.87	2	3.49	3
	1.03		0.86		1.21		0.94	
Long-term Debt/Total Capital	0.49	2	0.52	3	0.51	2	0.49	3
	0.28		0.21		0.29		0.21	
Short-term Debt/Total Debt	0.57	3	0.58	3	0.57	3	0.58	3
	0.38		0.35		0.31		0.35	
COF/Interest Expense	-7.39	0	12.16	0	12.19	0	12.07	0
	4.20		6.46		5.71		6.42	
divergence market from book	4.66	0	4.69	0	4.64	0	4.79	0
	4.99		4.76		4.69		5.35	
Stock Return	0.26	0	0.25	0	0.27	0	0.27	0
	0.24		0.23		0.27		0.25	
std(Return)	0.45	2	0.45	2	0.46	1	0.46	1
	0.41		0.41		0.42		0.42	
Std(std(R))	0.01	2	0.01	3	0.01	1	0.01	2
	0.01		0.01		0.01		0.01	
Skewness(std(R))	1.18	0	1.18	3	1.21	0	1.22	2
	1.12		0.91		1.11		0.97	

Table 4-4. Characteristics Comparison between Different CAAR Groups (Continued)

Items	(-10,1)		(-5,1)		(-2,1)		(-1,1)	
	Mean	Sgnf	Mean	Sgnf	Mean	Sgnf	Mean	Sgnf
Kurtosis(std(R))	5.78	0	5.84	3	5.92	0	6.05	2
	5.55		4.67		5.50		4.85	
Down Estimate of Analysts	0.34	3	0.33	3	0.35	3	0.34	3
	0.1		0.04		0.09		0.08	
Std(EPS Estimation)	0.13	2	0.13	2	0.13	1	0.15	2
	0.09		0.09		0.09		0.09	
beta	0.88	3	0.89	3	0.91	3	0.91	3
	0.72		0.75		0.76		0.76	
Std(beta)	0.30	3	0.31	3	0.31	3	0.31	3
	0.24		0.25		0.25		0.25	
Std(beta_Unlevered)	0.43	3	0.44	3	0.44	3	0.45	3
	0.28		0.28		0.29		0.28	
Interest rate	0.07	3	0.07	3	0.07	3	0.07	3
	0.08		0.08		0.08		0.08	
Interest risk	0.17	2	0.17	3	0.17	3	0.17	3
	0.20		0.21		0.21		0.22	
Credit risk	0.98	3	0.98	3	0.99	3	1.00	3
	1.20		1.25		1.23		1.26	
Number of Industries	3.96	0	4.07	0	4.07	0	4.02	0
	4.28		3.87		3.90		3.77	
Issue Size	5.05	3	5.21	3	5.21	3	5.22	3
	4.32		4.16		4.26		4.16	
Issue Size/Equity	1.23	1	1.23	0	1.23	0	1.22	0
	1.21		1.21		1.22		1.22	
Firm Size	7.12	3	7.20	3	7.21	3	7.22	3
	6.14		5.45		5.67		5.40	
Total debt	7.69	3	8.55	3	8.58	3	8.83	3
	6.26		5.69		5.96		6.38	
Tax rate	0.34	3	0.32	2	0.33	3	0.34	3
	0.23		0.23		0.23		0.22	
Conversion Premium	0.21	0	0.20	0	0.19	0	0.19	0
	0.19		0.19		0.18		0.17	
Delta	0.79	0	0.80	0	0.80	0	0.80	0
	0.80		0.80		0.80		0.81	
N(d2)	0.38	3	0.38	3	0.38	3	0.38	3
	0.45		0.44		0.43		0.43	
Gamma	0.66	3	0.64	3	0.63	3	0.62	3
	0.39		0.38		0.38		0.38	
Vega	14.25	3	14.68	3	14.86	3	14.82	3
	7.84		7.20		7.93		7.49	

Table 4-5. Abnormal Returns Determinants around Issue Dates of CBs

This table reports the determinants of abnormal returns (AR) around the issue dates of CBs. AR is calculated with equal weight market returns. FCFE is the free cash flows to equity holders divided by sales, Vega is calculated by Black-Scholes-Merton model, Ln (Size) is the logarithm of issue size, std (Beta) is standard deviation of beta. The columns of this exhibit represent different event windows. 0 is the issue date, and 1 is one trading day after the issue date etc. On the upper-left (upper right) superscript shows the significance level calculated from the White method by assuming $diag\left(\hat{u}_t^2/(1-h_t)^2\right)$ (OLS method) as the covariance matrix.

Items	-2		-1		0		1		2	
	I	II	I	II	I	II	I	II	I	II
Intercept	$^{c}0.0190^{c}$	$^{b}0.0167^{c}$	0.0116^{b}	0.0114^{b}	0.0080	0.0064	-0.0010	-0.0047	0.0034	0.0035
FCFE	--	$^{c}-0.0045^{b}$	--	$^{b}0.0037^{a}$	--	-0.0029	--	0.0011	--	-0.0010
Vega	$^{b}-0.0208^{c}$	-0.0002	$^{b}-0.0191^{b}$	$^{c}-0.0316^{c}$	0.0010	$^{b}-0.0262^{c}$	$^{c}-0.0224^{c}$	-0.0226^{c}	-0.0075	-0.0044
Ln(Size)	$^{c}-0.0040^{c}$	$^{c}-0.0043^{c}$	$^{a}-0.0025^{b}$	-0.0020^{a}	$^{c}-0.0041^{c}$	-0.0020^{a}	0.0011	0.0015	0.0004	0.0002
std(Beta)	0.0145^{b}	0.0007	0.0010	0.0087	0.0005	0.0172^{b}	0.0117^{a}	0.0154^{b}	-0.0027	-0.0047
R^2	4.93%	4.27%	2.33%	5.12%	2.54%	3.69%	2.10%	3.07%	0.53%	0.46%
F-test	7.60^{c}	5.06^{c}	3.50^{b}	6.13^{c}	3.83^{c}	4.35^{c}	3.15^{b}	3.60^{c}	0.78	0.53

a, b, and c denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 4-6. CAR Determinants around Issue Dates of CBs (Market Model)

This table reports the determinants of cumulative abnormal returns (CAR) around the issue dates of CBs. AR is calculated with equal weight market returns. FCFE is the free cash flows to equity holders divided by sales, Vega is calculated by Black-Scholes-Merton model, Ln (Size) is the logarithm of issue size, std (Beta) is standard deviation of beta. The columns of this exhibit represent different event windows. 0 is the issue date, and 1 is one trading day after the issue date etc. On the upper-left (upper right) superscript shows the significance level calculated from the White method by assuming $diag\left(\hat{u}_t^2/(1-h_t)^2\right)$ (OLS method) as the covariance matrix.

Items	(-2, 0)		(-2, 1)		(-2, 2)		(-1, 0)		(-1, 1)	
	I	II	I	II	I	II	I	II	I	II
Intercept	[c] 0.0386 [c]	[c] 0.0345 [c]	[c] 0.0376 [c]	[b] 0.0298 [c]	[c] 0.0410 [c]	[b] 0.0333 [c]	[a] 0.0196 [b]	[a] 0.0178 [b]	0.0186 [b]	0.0131
FCFE	--	-0.0037	--	-0.0025	--	-0.0035	--	0.0008	--	0.0019
Vega	[b] -0.0390 [c]	[b] -0.0580 [c]	[c] -0.0614 [c]	[c] -0.0805 [c]	[c] -0.0690 [c]	[c] -0.0849 [c]	-0.0181 [b]	[a] -0.0578 [c]	[b] -0.0406 [c]	[c] -0.0803 [c]
Ln(Size)	[c] -0.0106 [c]	[c] -0.0083 [c]	[c] -0.0095 [c]	[b] -0.0067 [c]	[c] -0.0091 [c]	[b] -0.0065 [c]	[c] -0.0066 [c]	-0.0040 [b]	[b] -0.0055 [c]	-0.0024
std(Beta)	0.0160	0.0266 [b]	0.0277 [b]	0.0420 [c]	0.0250 [a]	0.0373 [b]	0.0015	0.0259 [b]	0.0132	[a] 0.0413 [c]
R^2	7.84%	8.64%	7.16%	[b] 9.07%	7.05%	8.97%	4.12%	7.27%	3.77%	8.56%
F-test	12.48 [c]	10.73 [c]	11.31 [c]	11.32 [c]	11.12 [c]	11.18 [c]	6.31 [c]	8.89 [c]	5.74 [c]	10.62 [c]

a, b, and c denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 4-7. Real Returns Determinants around Issue Dates of CBs

This table reports the determinants of real returns around the issue dates of CBs. FCFE is the free cash flows to equity holders divided by sales, Vega is calculated by Black-Scholes-Merton model, Ln (Size) is the logarithm of issue size, std (Beta) is standard deviation of beta. The columns of this exhibit represent different event windows. On the upper-left (upper right) superscript shows the significance level calculated from OLS.

Items	-2		-1		0		1		2	
	I	II	I	II	I	II	I	II	I	II
Intercept	0.0141 [b]	0.0131 [b]	0.0083	0.0078	0.0090 [a]	0.0059	-0.0002	-0.0027	0.0030	0.0030
FCFE	--	-0.0027	--	0.0046 [b]	--	-0.0013	--	0.0022	--	-0.0007
Vega	-0.0148 [b]	0.0023	-0.0247 [c]	-0.0344 [c]	-0.0036	-0.0263 [c]	-0.0225 [c]	-0.0247 [c]	-0.0062	-0.0034
Ln(Size)	-0.0032 [c]	-0.0036 [c]	-0.0014	-0.0009	-0.0036 [c]	-0.0015	0.0010	0.0013	0.0005	0.0005
std(Beta)	0.0144 [b]	0.0012	0.0097	0.0150 [b]	0.0049	0.0184 [b]	0.0150 [b]	0.0188 [b]	-0.0011	-0.0038
R^2	2.81%	2.36%	2.28%	5.74%	2.12%	3.28%	1.98%	3.46%	0.31%	0.28%
F-test	4.24 [c]	2.74 [b]	3.43 [b]	6.92 [c]	3.18 [b]	3.85 [c]	2.97 [b]	4.07 [c]	0.45 [b]	0.32

a, b, and c denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 4-8. CAR Determinants around Issue Dates of CBs (Fixed-effects Model)

This table reports the determinants of cumulative abnormal returns (CAR) around the issue dates of CBs estimated by Error-components Model with fixed effects. AR is calculated with equal weight market returns. FCFE is the free cash flows to equity holders divided by sales, Vega is calculated by Black-Scholes-Merton model, Ln (Size) is the logarithm of issue size, std (Beta) is standard deviation of beta. The columns of this exhibit represent different event windows. On the upper right superscript shows the significance level calculated from OLS.

Items	(-2, 0)		(-2, 1)		(-2, 2)		(-1, 0)		(-1, 1)	
	I	II	I	II	I	II	I	II	I	II
Intercept	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FCFE	--	-0.0012	--	-0.0006	--	-0.0007	--	0.0006	--	0.0002
Vega	-0.0130^{c}	-0.0193^{c}	-0.0154^{c}	-0.0201^{c}	-0.0138^{c}	-0.0170^{c}	-0.0135^{c}	-0.0268^{c}	-0.0120^{c}	-0.0212^{c}
Ln(Size)	-0.0035^{c}	-0.0028^{c}	-0.0024^{c}	-0.0017^{c}	-0.0018^{c}	-0.0013^{c}	-0.0018^{c}	-0.0008	-0.0013^{b}	-0.0005
std(Beta)	0.0053	0.0089^{b}	0.0069^{b}	0.0105^{c}	0.0050^{a}	0.0075^{b}	0.0044	0.0138^{c}	0.0026	0.0091^{b}
R^2	2.63%	2.77%	1.82%	2.26%	1.36%	1.69%	1.21%	3.21%	0.89%	2.19%
F-test	11.94^{c}	9.79^{c}	10.95^{c}	10.59^{c}	10.20^{c}	9.84^{c}	5.41^{c}	11.38^{c}	5.31^{c}	10.25^{c}

a, b, and c denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 4-9. CAR Determinants around Issue Dates of CBs (Four-factor Model)

This table reports the determinants of cumulative abnormal returns (CAR) calculated by Carhart-Fama-French approach. FCFE is the free cash flows to equity holders divided by sales, Vega is calculated by Black-Scholes-Merton model, Ln (Size) is the logarithm of issue size, std (Beta) is standard deviation of beta. The columns of this exhibit represent different event windows. On the upper right superscript shows the significance level calculated from OLS.

Items	(-2, 0)		(-2, 1)		(-2, 2)		(-1, 0)		(-1, 1)	
	I	II	I	II	I	II	I	II	I	II
Intercept	0.0357^{c}	0.0311^{c}	0.0335^{c}	0.0270^{b}	0.0352^{c}	0.0294^{b}	0.0191^{b}	0.0172^{b}	0.0169^{a}	0.0131
FCFE	--	0.0026	--	0.0037	--	0.0039	--	0.0031	--	0.0043
Vega	-0.0381^{c}	-0.0611^{c}	-0.0643^{c}	-0.0950^{c}	-0.0727^{c}	-0.1014^{c}	-0.0203^{b}	-0.0662^{c}	-0.0465^{c}	-0.1000^{c}
Ln(Size)	-0.0098^{c}	-0.0076^{c}	-0.0083^{c}	-0.0056^{b}	-0.0077^{c}	-0.0052^{b}	-0.0060^{c}	-0.0033^{b}	-0.0045^{b}	-0.0013
std(Beta)	0.0207	0.0233^{b}	0.0389^{a}	0.0429^{c}	0.0188^{a}	0.0368^{c}	-0.0048	0.0219^{b}	0.0064	0.0401^{c}
R^2	7.09%	8.04%	6.80%	10.66%	6.91%	10.95%	3.99%	8.27%	4.10%	11.76%
F-test	11.19^{c}	9.92^{c}	10.70^{c}	13.55^{c}	10.88^{c}	13.95^{c}	6.10^{c}	10.23^{c}	6.28^{c}	15.13^{c}

a, b, and c denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 4-10. CAR Determinants around Issue Dates of CBs (Structural Model)

This table reports the determinants of cumulative abnormal returns (CAR). AR is calculated with equal weight market returns. FCFE is the free cash flows to equity holders divided by sales, Vega1 is calculated by Lemma 4-22, which incorporate dilution factor, Ln (Size) is the logarithm of issue size, std (Beta) is standard deviation of beta. The columns of this exhibit represent different event windows. On the upper right superscript shows the significance level calculated from OLS.

Items	(-2, 0)		(-2, 1)		(-2, 2)		(-1, 0)		(-1, 1)	
	I	II	I	II	I	II	I	II	I	II
Intercept	0.0124	0.0116	0.0182	0.0176	0.0323^{b}	0.0309^{a}	0.0066	0.0051	0.0124	0.0111
FCFE		-0.0034		-0.0040		-0.0052		0.0012		0.0005
Vega1	0.0000	0.0000	-0.0001^{b}	-0.0001^{b}	-0.0001^{c}	-0.0001	0.0000	0.0000	-0.0001^{b}	-0.0001
Ln(Size)	-0.0068^{b}	-0.0067^{b}	-0.0088^{c}	-0.0086^{c}	-0.0114^{c}	-0.0111^{c}	-0.0052^{b}	-0.0052	-0.0072^{b}	-0.0072^{b}
std(Beta)	-0.0224^{a}	-0.0193	-0.0249^{a}	-0.0219	-0.0285^{a}	-0.0234^{c}	-0.0072	-0.0046^{b}	-0.0096	-0.0072^{b}
R^2	2.96%	3.04%	4.30%	4.46%	5.76%	5.86%	1.68%	1.59%	2.89%	2.76%
F-test	2.29^{a}	1.77	3.37b	2.64^{b}	4.58^{c}	3.51^{c}	1.28	0.91	2.23^{a}	1.60

a, b, and c denote statistical significance at the 10%, 5% and 1% levels respectively.