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Chapter 6

CONVERTIBLE BONDS: FUNDING STRATEGIES, PRICING, LIQUIDITY AND MARKET OBSERVATIONS

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ABSTRACT

Convertible bonds are securities that can be converted into common stock at the option of the investor. As corporate debt instruments they give the holder the right to forgo future principle and/or coupon payments to convert such payments into a pre-defined quantity of shares in a company’s stock. Convertible bonds give the holder the ability to share in the price appreciation of a company's stock with the safety of a floor price set at the debt level. The presence of downside protection makes convertibles attractive to many private and institutional investors searching for yield-enhancing securities with a degree of defense against adverse volatility movements. As a hybrid security, convertibles are generally priced as a straight bond and a call option on the underlying equity. This chapter will discuss traditional and contemporary valuation techniques aligned to the accounting treatment of convertible bonds. It will also analyze the optimal call and conversion policy of issuers and investors respectively, with reference to recovery rate, hazard rate, coupon payments and dividend yield of the security. Our analysis will then show that the likelihood of convertible debt issues increases when the costs of either straight debt or common stock issues are high, and mirrors the ‘backdoor equity hypothesis’ which predicts that convertible bonds are a substitute for common equity and that this substitution is most likely to occur in firms facing significant information asymmetries and high financial distress costs. Using stock liquidity analysis, we will see that the probability of exercise of convertible bonds issued against a firm’s stock directly affects the liquidity of the stock itself, while controlling for firm size, book to market equity value and firm beta. The effects of conversion probability on stock liquidity are less pronounced for smaller firms, which helps explain time series variations in the liquidity premiums for smaller firms over time.

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INTRODUCTION

Convertible bonds are debt securities that can be converted into common stock at the investor's discretion. The convertible bond holder receives periodic coupon payments from the issuer. The holder retains the right to convert the convertible bonds into common stock prior to maturity. A holder who chooses not to convert prior to maturity will receive the full principle of the bond, in the absence of credit default. Most convertible bonds are a form of subordinated debt. In the event of default other bondholders receive preference over convertible bondholders, who retain seniority over preference and common stockholders. A convertible bond is a hybrid security, part debt and part equity.

The value of a convertible bond can be disaggregated into a common bond that features an embedded option granted to the investor. Convertible securities are a subset of the larger family of exchangeable securities which, in general, grant the holder the right to partially or wholly exchange a fixed income security for a pre-defined number of shares of equity in a firm. Convertible bonds generally come with callable and/or putable features, which often dictates that such securities are relatively complex to price because their value depends not only on how the stock price changes but also on the behavior of interest rates. The callable and putable features of convertibles imply an embedded call or put option whose value depends on interest rate levels and volatility.

Corporations issue convertibles for two main reasons. One is the desire to raise equity capital without giving up more ownership control than necessary. A second reason is that convertibles are a cost-effective method of financing to the issuer. Many smaller enterprises could only issue debt at prohibitively higher rates unless a convertible covenant was attached. Companies with poor credit ratings often issue convertibles in order to lower the yield necessary to sell their debt securities. Corporations with weak credit ratings may also have great potential for growth. Such companies may sell convertible debt issues at a near-normal cost, not because of the quality of the bond but because of the attractiveness of the conversion feature based in the firm's growth potential. The conversion option compensates the investor to accept a lower interest rate than would be the case on a straight debt issue. When first issued, convertible bonds usually offer lower coupon rates than non-convertible or straight bonds. However the realized return on a convertible bond has the potential to exceed its stated yield to maturity due to the convertibility feature.

Convertible bonds give their holders the ability to share in price appreciation of the company's stock. The straight bond value component of the convertible acts as a floor because if the stock price remains depressed during the entire holding period, the bond's value is retained, albeit subject to interest rate risk. A convertible instrument during a depressed stock price phase is referred to as a fixed-income equivalent or busted convertible. If however stock prices rise, the holder participates in the upside through their option to convert the security into stock. In such instances the convertible bond is referred to as a common stock equivalent and the market conversion premium per share will be relatively small. Between these extremes the convertible instrument value behaves as a hybrid which contains the characteristics of both fixed income and common stock securities. The presence of downside protection makes convertibles attractive to private and institutional investors searching for yield enhancement securities with a degree of defense against adverse volatility movements. From the holder's perspective convertible bonds are attractive because they offer the opportunity to earn a potentially large return associated with stocks coupled with the relative safety of a bond.

CHARACTERISTICS AND STRATEGIES OF CONVERTIBLE SECURITIES

Convertible Bond Features

Like most typical bonds, convertible bond issues contain a published issue size, issue date, maturity date, maturity value, face value and coupon amount. The following features are specific to convertible bonds:

- ***Conversion price:*** The nominal price per share at which conversion takes place.
- ***Conversion ratio:*** The number of shares each convertible bond converts into expressed per bond or on a per cent basis.
- ***Parity (Conversion) value:*** Capitalization value (equity price × conversion ratio).
- ***Conversion premium:*** Value difference between the market value of the convertible instrument relative to the parity value of a straight bond.
- ***Call feature:*** The ability of an issuer to call a bond for redemption before maturity, sometimes subject to certain share price performance. This feature motivates investors to convert early in response to the threat of repayment in cash for what may be a lower amount. Almost all convertibles are callable by the issuer.
- ***Put feature:*** The ability of a holder to sell the bond to the issuer before maturity (usually on a specific date or dates) at a premium. If the bond can be sold on multiple dates it will be sold as a rolling premium. This type of bond protects investors if interest rates rise after bond purchase. Investors can sell their bond back to the issuer and lend the proceeds elsewhere at a higher rate. To enable such protection investors accept a lower yield relative to that of a straight bond.
- ***Resettable feature:*** If the strike price is resettable, convertible bond holders can gain additional exposure to the equity component. For instance, if the price of the underlying stock falls, the parity value of the convertible also falls and therefore by resetting the strike price, or raising the conversion ratio, the convertible's parity value increases.

Convertible Bond Types

There are a range of variants to the basic structure of convertibles. Vanilla convertible bonds are simply bonds which may be converted at the option of the holder into the shares of the issuer at a pre-determined rate, and may be redeemable by the issuer prior to the final maturity date, subject to certain share price performance conditions. Exchangeable bonds are securities which may be exchanged into shares other than those of the issuer. Strictly speaking exchangeable bonds are not convertibles however they share certain characteristics which assists with the valuation and redemption strategy of such instruments.

Mandatory convertibles are short duration securities (generally with yields higher than expected on the underlying common shares) that are compulsorily convertible upon maturity into a fixed number of common shares. If the intention is to provide a floor value at maturity, convertibility may be into a sufficient number of shares based on the stock price at maturity to provide a minimum redemption value. Mandatory convertibles are the most equity-like of convertible issues, and the more popular examples for such instruments include Dividend Enhanced Convertible Stock (DECS) and Preferred Equity Redemption Stock (RERCS). The issue is for preferred stock whose conversion into common equity is mandatory, usually several years from issuance. Mandatory convertibles generally offer high dividend yields and a cap or a partial cap to upside equity participation. Similarly mandatory exchangeable convertible bonds are short duration securities and also generally offer higher yields than on the underlying common shares.

These securities are compulsorily exchangeable upon maturity into a fixed number of common shares. Mandatory convertibles trade on the open market, unlike most convertible securities which trade on the over-the-counter (OTC) dealer market for institutional accounts. This makes them more accessible to non-institutional investors.

Contingent convertibles, or CoCos, allow the holder to convert the debt instrument into stock if the price of the stock is a certain percentage above the conversion price known, as the contingent conversion trigger. This type of bond is favored by issuers because the shares of underlying common stock were only required to be included in the diluted earnings-per-share (EPS) calculation if the issuer's stock traded above the contingent conversion price. In contrast vanilla convertible bonds immediately increase the volume of diluted shares outstanding, reducing the reported EPS. However changes to GAAP in 2004 eliminated the favorable treatment of these instruments, including any so-called grandfathering provisions of issued instruments, and as a result their popularity has declined.

Some of the rarer forms of convertibles include the family of so-called reverse convertibles and ‘going-public’ bonds. Reverse convertible securities are short-term coupon-bearing notes that are structured to provide enhanced yield while participating in certain equity-like risks. Their investment value is derived from the underlying equity exposure which is paid at regular intervals in the form of fixed coupons. Depending on the terms of the bond, the higher the coupon payment, the more likely it is that the investor is delivered shares on maturity. Investors generally receive the full principal back at maturity plus accrued interest in cash if a ‘knock-in’ level is not breached at any time over the life of the security. The knock-in level is typically 70-80 per cent of the initial reference price and the underlying stock, index or basket of equities is the reference share, however in most cases, reverse convertibles are linked to a single stock. So-called ‘going-public’ bonds are fixed-interest securities that convert into shares of the company if it lists on an appropriate stock market prior to maturity. These instruments were designed to reduce downside risk to underwriters taking bonds at issue. Some time subsequent to their issue, the bonds become convertible or exchangeable into shares, with the conversion price reflecting the expected share price at the time of conversion. However this price may be fixed at a discount to encourage conversion. One characteristic of ‘going-public’ bonds is that the primary distribution date is de-coupled from the date when the conversion price is fixed. Finally the ambiguously defined ‘hybrid bonds’ are issued as loan capital and the issuer retains the right to convert the bonds into preference shares with similar conversion rights and income. The purpose of these instruments is to allow the bonds to be maintained as a tax offset while simultaneously providing the option to swap the bonds into cumulative or non-cumulative preference capital. The issuer only achieves the best of both worlds if the hybrid bond is structured so that non-payment of interest does not constitute an event of default.

CONVERSION STRATEGIES

Firm Perspectives

Convertible bonds tend to be issued by smaller and more speculative companies because it is costly to assess their business risks, and there are concerns that the company's management may not act in the bondholders' interest, see Stein (1992). Convertible bonds often represent unsecured and generally subordinated debt. Usually, the issuer is in a new line of business that makes it difficult for investors to assign a fair discount rate by assessing the probability of business failure or default. The convertibility feature aligns the interests of the holders of convertible bonds with those of the company's management, allowing the investors to profit when the company's share price rises and to minimize losses when its share price falls. Convertible debt is therefore structured to allow managers to obtain financing immediately through a delayed equity offer.

Corporations use convertible debt as a substitute for common equity because it also provides indirect equity financing that mitigates the adverse selection costs associated with direct equity offerings. Stein (1992) refers to this as the 'backdoor-equity' hypothesis. In addition, Stein shows that the likelihood of convertible debt issues increases when the costs of either straight debt or common stock issues are high. The backdoor equity hypothesis predicts that convertible bonds are a substitute for common equity and that this substitution is most likely to occur in firms facing significant information asymmetries and high financial distress costs. A financially leveraged firm tends to issue convertible debt only if management is relatively optimistic about its future share price performance, see Lewis et al. (1999). Convertible debt issue announcements produce a significant negative stock price reaction that is consistent with the backdoor-equity hypothesis.

Convertibles can be used to increase the total amount of debt a company has on issue. If a company is not expected to increase straight debt beyond certain limits, to avoid negatively impacting its credit rating and the cost of debt, issuing convertibles can provide additional funding when the straight debt 'window' may not be available (Fabozzi, 2009). Subordination of convertible debt is often regarded as an acceptable risk by investors if the conversion rights are attractive by way of compensation. Companies in some jurisdictions are subject to limits on the number of shares that can be offered to non-shareholders non-pre-emptively and therefore convertibles can access funding without the need to lobby for an expensive issue of equity.

Convertibles also can be employed as the currency used for takeovers. The acquirer can theoretically offer higher income on a convertible than the dividend yield on the target's shares without having to raise the dividend yield on all the acquirer's shares. This eases the process for an acquirer with low-yield shares bidding for a company with higher-yielding shares. Perversely, the lower the yield on the acquirer's shares, the easier it is for the acquirer to create a higher conversion premium on the convertible, with the consequent benefits to the likelihood of the takeover. Only anecdotal evidence supports this view and it remains an avenue for further research.

The market for convertibles is regularly pitched towards non-taxpaying investors. The price will substantially reflect the value of the underlying shares, the discounted gross income advantage of the convertible over the underlying shares, plus some value for the embedded optionality of the bond. The tax advantage is greatest with mandatory convertibles. A high tax-paying shareholder can benefit from the company securitizing gross future income on the convertible, income which it can offset against taxable profits.

Three possible rationales exist for the issuance of putable convertibles: the risk-shifting hypothesis, the asymmetric information hypothesis, and the tax savings hypothesis. Using a sample of firms choosing to issue either putable or ordinary convertibles, Chemmanur and Simonyan (2010) found that firms that issue putable convertibles are larger, less risky and have larger cash flows, confront smaller growth opportunities and have lower bankruptcy probabilities compared to those issuing ordinary convertibles. Second, putable convertible issuers have lower pre-issue market valuations, more favorable announcement effects, and better post-issue operating performance compared to ordinary convertible issuers. Third, putable convertible issuers have better post-issue long-run stock return performance compared to ordinary convertible issuers. Fourth, firms issuing putable convertibles with larger conversion premia have lower pre-issue market valuations, more favorable announcement effects, and better post-issue operating performance compared to firms issuing putable convertibles with smaller conversion premia. Finally, putable convertible issuers also have greater tax obligations and better credit ratings on average than ordinary convertible issuers. Their analysis therefore supports the asymmetric information and tax savings hypotheses but provides little support for the risk-shifting hypothesis.

Finally, dilution of the voting rights of existing shareholders only occurs upon conversion of the bond. However convertible preference shares may carry voting rights when preference dividends are in arrears. The biggest voting impact occurs in issues of exchangeable rather than convertible bonds.

Investor Perspectives

As discussed, the conversion price of a convertible is calculated as the product of the share price on the date of issue of the convertible and the designated conversion premium of the bond at issue. If the stock price is depressed far below the conversion price, the fair value of the convertible bond behaves like the value of a straight bond. If the stock price is far above the conversion price, the fair value of the convertible bond behaves like the value of the stock.

It is also possible to value a convertible bond as a combination of an issuer's stock, with a relatively high yield, combined with a European put option and a swap to maturity that provides bond coupons in exchange for equity dividends. Instead of valuing a convertible bond as a fixed income instrument combined with an embedded call option, the convertible feature posits that it is a stock that possesses a yield greater than its dividend and it thus can be likened to a put floor. The stock value is simply the conversion value (stock price multiplied by the conversion ratio) and the put value represents the fixed income value of the convertible (Fabozzi, 2009; Fabozzi, Liu and Switzer, 2009). These complementary views allow convertibles to appeal to both issuers and investors who maintain different risk preferences.

Upon conversion to stock any accrued interest will be lost, and this is referred to as the 'screw clause.' A trading strategy to avoid losing accrued interest is to sell an equivalent amount of stock short against the convertible bond, maintain the short position until the interest payment date, and then convert the bond and deliver the stock against the short position. This approach allows the investor to capture accrued interest upon conversion.

Put options can be used to hedge the credit risk for issues that do not have well defined investment values. Many low grade convertibles have uncertain or indeterminate investment values because of the high correlation between declining stock prices and the corresponding credit spreads (known as negative gamma). Investors may choose to carry this type of position with a stock hedge that is much higher than the theoretical delta implies (bearish hedge) – but this type of a hedge may cause significant upside losses if the stock price moves up sharply. Since the strike price of the embedded convertible is a function of the fixed income value, puts can be purchased with a strike price near the expected fixed income value's determined strike price.

An investor can also construct a synthetic convertible to exploit market inefficiencies, particularly mispricing of options. An investor can purchase a long term call option on a stock and couple it with a coupon paying bond to it to create an undervalued convertible bond. In practice the bond may be from a government issuer or another firm and therefore be uncorrelated to the option, which reduces downside company specific risks. Synthetic convertible notes are created when an investor identifies options that are trading below the long term implied volatility but cannot establish a sufficient position due to low liquidity levels in the options market.

Seeking to arbitrage relative price differentials between a convertible bond and the company's straight debt is a common capital structure trade. By taking a long position in a convertible bond and a short position in a high yield debt instrument from the same company, a synthetic long call option is created which also virtually eliminates credit risk. Also, a long position in a straight bond and a short position in an overvalued convertible bond creates a net short call option position, which can lock in a positive yield spread and lower time to maturity. If equity and debt markets are experiencing different levels of sentiment, which offers differences in company valuation, capital structure hedges look to purchase convertible bonds and sell the underlying stock at a delta of one. Capital structure arbitrage and other strategies aimed at exploiting price differentials are common in the convertible bond markets.

Optimal Call and Conversion Policy

Convertibles may be called before maturity to allow the firm to refinance in a lower interest rate environment. They may also be called because they are deep in the money which forces holders to convert to stock. The call provision generally contains a call notice period (around 30 days) which allows the parity level to move up in the money enough to ensure that under reasonable circumstances the parity will not fall below the call price. The amount of time it takes for the parity level to reach trigger level is a function of volatility. As volatility changes so does the expected life of the convertible and its value. If the parity level falls below the call price the issuer will be forced to pay cash instead of stock to the holders of the convertible.

The question of what is the optimal call policy for convertible bonds has attracted considerable attention built on the research of Brennan and Schwartz (1977) and Ingersoll (1977a). Their findings suggest that the optimal call policy for convertible bonds is to call the bond when the conversion value first exceeds the call price, since forcing conversion eliminates the bondholders' premium or option value. However, empirical studies have claimed that firms consistently deviate from this call policy and delay calls (Ingersoll, 1977b; Constantinides and Grundy, 1987). This claim was first based on Ingersoll's finding that firms wait, on average, until the conversion value exceeds the call price by around 44 per cent, which was later confirmed in Mikkelson (1985).

Asquith and Mullins (1991) found that convertible bonds are called quickly after the conversion value exceeds the conversion premium plus a ‘safety premium’ unless there is a cash flow advantage to not calling. The required safety premium is assumed to be a function of stock price volatility. The large call premium found by Ingersoll is explained by call protection and doesn't indicate a call delay. This is a field that is attracting greater research interest.

Lau and Kwok (2004) investigated how the recovery rate, hazard rate, coupon payments and dividend yield affect the optimal conversion policy and to examine the interaction of both conversion and callable features. In particular, their research explored the impact of the notice period requirement on the critical call price. Using a valuation algorithm for the pricing of one-factor contingent claims of convertible bonds with credit risk, the critical stock price at which the convertible bond should be called by issuer or converted into shares by bondholders depend sensibly on various features in the bond indenture. In particular, they showed that the notice-period requirement and coupon payments have profound impact on the value of the critical stock price. The so-called ‘delayed call phenomena’ is largely attributed to the underestimation of the optimal call price at which the issuer should call the bond. A large portion of the magnitude of the call delay can be eliminated when careful contingent claims pricing calculations are performed using accurate estimates of recovery rate, hazard rate, coupon payments and dividend yield.

VALUING CONVERTIBLE BONDS

To properly value convertible bonds it is necessary to correctly value the conversion premium per share, embedded call and/or put options and to understand how a change in interest rates affects the stock price. A non-callable and non-putable convertible bond is easily disaggregated into two transactions; a long position in a straight bond without any call or put provisions, and a call option on the stock, where the number of shares that can be converted is equal to the conversion ratio. The fair value of the call option depends on the usual factors that determine stock call option prices, such as stock volatility and time to maturity (or convertibility). The theoretical value of a call option can be derived using an appropriate option pricing model.

To approximate the present value of a callable, putable convertible bond, it is a matter of simply aggregating the components that comprise the instrument, such that the convertible bond value will equal the value of a straight bond *plus* the value of the call option on the stock *plus* the value of the put option on the bond *minus* the value of the call option on the bond. The negative value attributed to this last element, the call option on the bond, accounts for the issuer's right to call the security prior to maturity. The value of the issuer's right to call is dependent on expected interest rate volatility and general economic conditions that affect optimal exercise of the call feature.

The intrinsic value of a convertible bond is the greater of either the conversion value or the bond's investment value (value as a corporate bond without the conversion option). To estimate the bond investment value we must determine the required yield on a non-convertible bond with the same credit quality rating and similar investment characteristics. If the convertible bond does not sell for the greater of these two values, arbitrage profits could be realized.

LINKING CONVERTIBLE BOND EXERCISE PROBABILITY AND STOCK LIQUIDITY

We now consider how the liquidity of a firm's stock reacts to the behavior of convertible bonds issued by the firm. Specifically, we expect the liquidity of the underlying stock to change in response to the anticipated exercise of convertible bonds issued by a firm. The probability of conversion of a convertible bond issued against a firm's stock is expected to be directly and positively related to the liquidity of the underlying stock. We also investigate the underlying cause of the expected increase in liquidity conditional on the conversion of bonds into equity. Increased liquidity can be caused by favorable changes in the debt-capital ratio of firms and also by market expectations of higher volumes of stock available for trade upon conversion. The results will show that higher expected volume of stock available for trade is the primary reason for the increased liquidity.

The illiquidity measure employed for this analysis is the daily ratio of absolute stock return to its dollar volume, averaged over some period, as used in Amihud (2002). The illiquidity measure can be interpreted as the daily price response associated with one dollar of trading volume. While order-based measures of illiquidity using bid-offer spreads and the probability of information based trading can provide a more detailed analysis of market microstructure effects, the illiquidity measure used here serves as a more general estimate of the price impact of conversion probabilities over a longer period.

Research evidence strongly suggests that illiquid assets offer greater returns than otherwise similar liquid assets (Grossman and Miller, 1988; Kothari et al. 1995; Datar et al. 1998). While illiquidity is clearly a central component of asset pricing, capturing the essence of what actually defines illiquidity is a more difficult prospect (Eleswarapu and Reinganum, 1993; Amihud, 2002). The effect of convertible instruments on the liquidity of the stock against which they are issued will aid in forming a more comprehensive picture of the true character of asset illiquidity.

Illiquidity Measures

The value for the cumulative probability distribution function $N(d_2)$ expression as defined in Ingersol (1977) is used as a proxy for the probability of exercise. The general specification estimates includes controls for the size of the firm $Size_t^i$, the book-equity ratio BE_t^i and firm beta $Beta_t^i$, and is represented as

$$ILLIQ_t^i = \alpha_0 + \alpha_1 N(d_2^i)_t + \alpha_2 Size_t^i + \alpha_3 BE_t^i + \alpha_4 Beta_t^i + \varepsilon_i, \tag{1}$$

for the *i*-th stock, where

$$d_2^i = \frac{\ln(S_0^i / X^i) + (r - q^i - (\sigma^i)^2 / 2)T}{\sigma^i \sqrt{T}}, \tag{2}$$

and S_0^i is the current value of the stock, X^i is the strike price for conversion, r is the continuously compounded risk free rate, σ^i is the stock price volatility and $N(.)$is the cumulative probability distribution function for a variable that is normally distributed with a mean of zero and a standard deviation of one. The illiquidity variable is estimated using

$$ILLIQ_t^i = \frac{1}{n_t^i} \sum_{d=1}^{n_t^i} \frac{\left| R_{t,d}^i \right|}{V_{t,d}^i}, \tag{3}$$

where $R_{t,d}^i$ and $V_{t,d}^i$ are, respectively, the return and dollar volume (in millions) on day *d* in week *t*, and n_t^i is defined as the number of valid observation days in week *t* for stock *i*. The effect of conversion probability, book to market equity and firm beta on illiquidity is examined for a portfolio of firms over time. A cross-section of each firm at each point in time is also conducted by adding a variable to represent the size of the firm to the regression. Firm size as an independent variable is explicitly excluded from the portfolio regression since sub-portfolios grouped by firm size will be examined separately.

The test procedure for the second set of regressions follows the Fama and MacBeth (1973) method. A cross-sectional model is estimated for each week $t = 1, 2, \ldots$ where weekly values of illiquidity are a function of stock characteristics:

$$ILLIQ_t^i = \alpha_{0,t}^i + \sum_{j=1}^{J} \alpha_{j,t}^i X_{j,t}^i + U_t^i. \tag{4}$$

$ILLIQ_t^i$ is the illiquidity defined in equation (3) on stock *i* in week *t* and $X_{j,t}^i$ is characteristic *j* of stock *i* estimated from data in week *t*. The coefficients $\alpha_{j,t}^i$ measure the effects of stock characteristics on illiquidity and U_t^i are the residuals. The weekly regressions of model (4) over the period produce 104 estimates of each coefficient $\alpha_{j,t}^i$, $j = 1,..,4$. These weekly estimates are averaged and tests of statistical significance are performed.

A Measure of Illiquidity - $ILLIQ_t^i$

In capital markets, investors desire securities to be sufficiently liquid to facilitate the trading of securities. Investors generally demand a risk premium for securities that do not meet their liquidity expectations and may be willing to accept lower returns for more liquid securities. Studies by Easley et al. (1996), Datar et al. (1998) and Amihud (2002) establish this link. A perfectly liquid market exists if any amount of a particular asset can be instantaneously converted into a more liquid form and can then be converted back into an asset at no cost. There is no wealth depletion from transaction costs in a perfectly liquid market. In contrast, a perfectly illiquid asset cannot be traded at any price. A liquid market however, is deemed to exist if such a conversion results in so-called minimal transaction costs (Easley and O'Hara, 1987).

Transaction costs consist of both explicit and implicit costs. The implicit costs associated with a transaction, which include bid-offer spreads and market impact costs, generally arise because of regulatory limits, information dissemination, participation and technological constraints. For instance, minimum tick sizes that are artificially large increase transaction costs and act as a disincentive to investors. Explicit costs generally include the externally imposed costs of executing a transaction such as brokerage commissions and taxes. We will consider only the implicit costs of trading in stocks in this paper.

Liquidity may be divided into two broad categories: trade-based measures and order-based measures (Amihud, 2002). Trade-based measures commonly used include trading volume, trading frequency and turnover ratio. Trade-based measures are simple to calculate using readily available market data and have widespread acceptance particularly among market professionals. Order-based measures include absolute and relative bid-offer spreads and bid and offer volumes at each price step used to measure the so-called depth of the market. While order-based measures are suitable for intraday liquidity studies, such measures provide limited advantages for observing liquidity over longer frequencies. It is doubtful that there is a single measure that captures all aspects of stock price liquidity. The trade-based measure of the response of price to order flow first suggested in Kyle (1985) and employed by Amihud (2002) is used as a measure of illiquidity.

The use of this illiquidity measure is applicable in this study for several reasons. An illiquid stock, that is, one that has a high value of $ILLIQ_t^i$, is one where the stock's price moves a lot in response to little volume. Consistent with this view, Amihud (2002) shows empirically that $ILLIQ_t^i$ is positively related to measures of price impact and fixed trading costs over the time period in which microstructure data was available. This measure follows the concept of illiquidity proposed in Kyle (1985) which detects the response of price to order flow. The $ILLIQ_t^i$ parameter can also be interpreted as a measure of consensus belief among investors about new information. While a number of factors contribute to the liquidity of a firm's stock, we expect that the presence of convertible instruments with a high likelihood of conversion will have a positive influence on the stock's liquidity.

A Measure for the Probability of Conversion - $N(d_2)$

The value of the option component of the bond is estimated using contingent claim valuation techniques from Ingersoll (1977a). The option-like characteristics of convertibles provide a useful measure to use as a proxy for the probability of conversion. More importantly, this measure provides a reasonable estimate for the temporal probability of conversion of each convertible bond because it allows the parameters of the option to change through time.

The most appropriate measure of the probability of exercise of a convertible instrument is to obtain a value for the cumulative probability distribution function $N(d_2)$ expression as defined in Ingersol (1977). The value of a call option under the Black and Scholes framework using risk neutral valuation can be expressed as

$$c = e^{-rT}[S_0 N(d_1)e^{(r-q)T} - XN(d_2)], \tag{5}$$

where S_0 is the current value of the stock, X is the strike price for conversion, r is the continuously compounded risk free rate, σ is the stock price volatility and $N(.)$is the cumulative probability distribution function for a variable that is normally distributed with a mean of zero and a standard deviation of one. In addition,

$$d_1 = d_2 + \sigma\sqrt{T}, \tag{6}$$

where d_2 is defined in equation (2) assuming a continuous dividend yield q. This approach relies on the general assumptions underlying the Black and Scholes (1973) and Merton (1973) models.

The Black and Scholes model is intuitively understood when broken down into the two main parts. The first element of the equation $S_0 e^{-qT} N(d_1)$ derives the expected benefit from acquiring the stock outright. This is equivalent to multiplying the stock price adjusted for the continuous dividend yield $S_0 e^{-(r-q)T}$ by the change in the call premium, with respect to a change in the underlying stock price $N(d_1)$. The $N(d_1)$ term, known as the delta, measures the sensitivity of the convertible bond to its underlying stock value.

The second component of the model $Xe^{-rT}N(d_2)$ is the present value of paying the exercise price on the expiration day. In other words $Xe^{-rT}N(d_2)$ is the present value of the strike price times the probability that the strike price will be paid. While this view is relevant for share options, the underlying principles of the formula can also be applied to compute the probability of conversion of a convertible bond that has a conversion price X.

The value $N(d_2)$ serves as a useful proxy for the probability of exercise since it dynamically incorporates the risk free rate, volatility of the underlying stock, dividend yield, time to maturity of the convertible instrument and the conversion price. Intuitively, under the Black and Scholes model the expression $N(d_2)$ is the probability that the option will be exercised in a risk neutral world. The fair value of a convertible instrument however, is not strictly obtained in a risk neutral world, and is typically priced using a numerical approximation such as a binomial tree using a combination of both risk free and credit adjusted rates. The fair value of a convertible instrument is obtained in practice using a linear combination of the risk free rate and a credit spread as the appropriate discount factor. Therefore, while the expression for $N(d_2)$ cannot strictly be used to assess the true probability of exercise under either the risk neutral or real world measure, it serves as a useful proxy for the overall likelihood of exercise since it incorporates changes in dividends, volatility and time.

The main advantage in using this approach is that the inputs can be synchronised to each point in the data. The Black and Scholes formula rests on the assumptions of constant volatility, dividend yield and risk free rate through time. While this provides only approximate fair values for stock options we will ignore the minor limitations of the Black and Scholes model in this study. In any case, the value obtained for $N(d_2)$ is only an approximate representation of the probability of conversion and does not fully reflect the set of decision variables typically applied by a bondholder.

It is important to include all factors that may affect the probability of conversion using the most recent observations in the market. For instance, investors may perceive that higher dividend yield can provide greater liquidity, ignoring the impact of taxation. This is similar to the findings of Redding (1997) that suggests large investors prefer companies with high liquidity while also preferring to receive dividends. Hence time dependent dividend yields are used in this analysis.

Cross Sectional Control Variables - $Size_t^i$, BE_t^i and $Beta_t^i$

We control for firm size, book to market equity and firm beta. The $Size_t^i$ variable is the market value of stock *i* at time *t*. The market value of the stock is related to liquidity since a larger stock issue has smaller price impact for a given order flow and a smaller bid-offer spread. Stock expected returns are negatively related to size shown in Fama and French (1992) and it can also be viewed as being another proxy for liquidity, see Amihud and Mendelson (1986).

A relationship between expected return and book to market equity BE_t^i has been shown by Fama and French (1992) due to the functional relation between expected return and the market value of equity. We include the BE_t^i variable to ensure the regression captures the effects of changes to the book value of assets and its effect on expected returns. Book to market equity value is the ratio of total assets to firm market value. Book value is calculated as the market value of equity plus total assets minus the book value of equity. The book to market values ranges between 0.31 and 3.73.

The $Beta_t^i$ variable is included as a measure of risk. The effect of beta is expected to be positive. The values for beta are included to ensure that the effects of systematic risk are accounted for. The betas are calculated against the most representative market capitalisation index for each country. The market portfolios used were the US S&P500 growth index for US stocks, the Korean S&P200 growth index for Korean Stocks and the Straits Times Index for Singapore firms. Betas for each of the 107 stocks analysed varies between 0.89 and 2.91.

MARKET AND TRADING ISSUES

The data used in this study is taken from three commercial bank databases consisting of a total of 107 publicly listed US, Korean and Singaporean firms who have issued non-callable convertible bonds. All bonds issued are convertible at the discretion of the holder any time prior to maturity, are non-callable by the issuer and contain provisions for accrued interest between coupon payments upon early conversion. The non-callable feature allows us to neatly de-couple the bond and equity option components of the convertible instrument to measure exercise probabilities. The conversion premiums of the bonds examined in this study lie in the range of 18-125 per cent with a median conversion premium of 36 percent. For a five-year bond the conversion prices for most of the bonds are not unrealistically high. The option component of each convertible bond therefore contains an American-style exercise feature. Each bond is subject to rigid coupon payments ranging from 3 percent to 8 percent. Each bond had a maturity of three years or more from initial issue and was issued between July 1997 and October 2001. In all cases the initial non-conversion period constitutes less than 25 per cent of the entire life of the bond. All convertibles provide the option to be converted into the stock at a specified conversion ratio of the issuing company and not another company indirectly. None of the convertibles used are subject to a ratchet feature or similar characteristic that requires the payable yield of the convertible to be increased should dividends on the common stock increase. Only firms whose credit quality as quoted by Standard and Poors and Moody's remained the same throughout the life of the convertible were used in this study. This removes any bias in the results caused by increased trading activity following credit upgrades or downgrades. Over 55% of the bonds were converted into equity either before or at maturity while the remaining bonds expired out of the money at maturity. No stock splits or rights issues were recorded in the data.

Data Input Definitions

The $ILLIQ_t^i$ data was computed at a weekly frequency for each of the 107 stocks over the life of the convertible bonds in the sample. The $ILLIQ_t^i$ data was transformed into weekly data by computing the arithmetic average of daily data across each week. The range of the $ILLIQ_t^i$ variable in the sample data was very large. It is therefore possible that any estimated relationship between liquidity and the probability of exercise may be driven by a few extreme realizations of $ILLIQ_t^i$. To correct for this possibility, the highest and lowest 2.5 percent of observations of $ILLIQ_t^i$ were discarded from the data. The truncated data set contains weekly $ILLIQ_t^i$ values that range from 0 to 1.09 for all stocks.

The probability of conversion as measured by $N(d_2)$ requires several inputs that change through time. The volatility, risk free rate and dividend yield must be updated at each data point to obtain a weekly updated measure for $N(d_2)$. The risk free rate is maturity-matched to observed government bond yields at each point in the data set. The dividend yield is also updated at each data point to obtain an accurate value for $N(d_2)$. We assume a constant dividend yield measured at each point in the data set for each stock. This is a reasonable assumption given that the dividend yields for 80 per cent of the stocks in our sample are zero while the remaining stocks are relatively stable at 1.8-2.9 per cent over the estimation period. We assume constant volatility of the stock return out to the maturity of the convertible bond measured using an exponentially weighted moving average (EWMA) model to update the volatility for each weekly data point. The EWMA method is more accurate than constant historical volatility measures because it captures changes in volatility translating directly into changes in $N(d_2)$.

The EWMA model has weights α_i assigned to the continuously compounded return u_i that decrease exponentially further back in time, see Engle (1982). The weighting scheme leads to a simple formula for updating volatility estimates,

$$\sigma_n^2 = \lambda\sigma_{n-1}^2 + (1-\lambda)u_{n-1}^2 , \tag{7}$$

where the estimate for the volatility σ_n on week n is calculated from the previous week's estimate of volatility σ_{n-1}on day $n - 1$, and the most recent observation on changes in the return of the stock u_{n-1}. To obtain the starting value of weekly volatility in the EWMA updating scheme, we use

$$\sigma_n^2 = (1-\lambda)\sum_{i=1}^{m}\lambda^{i-1}u_{n-1}^2 , \tag{8}$$

where the number of weekly observations m used for the initial estimation is set to be relatively large $m=100$.

The value for λ in the EWMA model controls how responsive the estimate of the weekly volatility is to the most recent observations of the stock return. We apply a value of $\lambda = 0.97$ to estimate the weekly volatility. Figure 1 shows the EWMA volatility for one of the more volatile stocks used in this study. The jumps in volatility have an important effect on the value of $N(d_2)$ and are updated to obtain the most accurate value to represent changes in the probability of exercise.

The risk free rate, dividend yield and volatility are updated weekly using the most recently observed data. The weekly value of $N(d_2)$is computed for each stock over the life of the data series. The data points corresponding to the highest and lowest 2.5 per cent for $N(d_2)$ were discarded from the sample to prevent bias from outliers. The final data series for $N(d_2)$ is therefore truncated in a similar way to the $ILLIQ_t^i$ variable. This procedure provides an accurate picture of the temporal probability of conversion $N(d_2)$ that takes into account changes in the risk free rate, dividend yield and most importantly, volatility. From these assumptions, the probability of conversion as measured by $N(d_2)$ ranges from 0.0015 to 1.000 for all stocks used in the study.

RESULTS

Liquidity and the Probability of Conversion

The empirical tests use a two-pass regression method on the estimates in equation (9). In the first pass all firms are grouped within in a single portfolio. The $ILLIQ_t^i$ variable was regressed on values of $N(d_2)$, book to market equity BE_t^i and firm beta $Beta_t^i$ over the estimation period

$$ILLIQ_t^i = \alpha_0 + \alpha_1 N(d_2)_t^i + \alpha_2 BE_t^i + \alpha_3 Beta_t^i + \varepsilon_i \,. \quad (9)$$

Table 1 provides the regression results. It is evident that a strong positive relationship exists between liquidity and the probability of conversion, as measured by $N(d_2)$. The results are statistically significant at the 1 percent level. The book to market equity and firm beta has no significant impact at the 1 percent level.

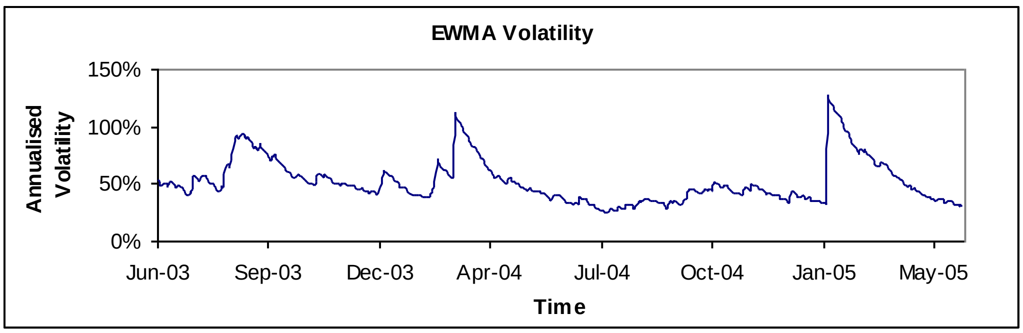

Figure 1. Weekly exponentially weighted moving average (EWMA) volatility for a firm chosen from the sample estimated over a two-year period. The EWMA updating scheme is used as a proxy for implied stock volatility to evaluate the probability of conversion measured using $N(d_2)$ over the estimate period.

In order to isolate the impact of the probability of conversion on liquidity, the differences in liquidity between stocks whose bonds have a high conversion probability compared with those with little chance is examined. We conduct a second pass regression which groups the same set of firms into four portfolios based on the likelihood of exercise of the convertible bonds in the final 12 months of each bond's life. The general regression remains the same however the firms are sorted into four portfolios based on the value of $N(d_2)$ observed over the final 12 months of the life of each bond. The first portfolio consists of firms where the probability of conversion is greater than 75 per cent, $N(d_2) > 0.75$. The second portfolio consists of firms where the probability is between 50-75 per cent, $0.5 < N(d_2) < 0.75$. The third portfolio groups firms whose probability is between 25-50 per cent, $0.25 < N(d_2) < 0.5$. The fourth portfolio groups firms who have issued bonds with little chance of conversion, $N(d_2) < 0.25$. Firms that switched from one portfolio to the other are excluded from the second pass regression. By sorting on conversion probabilities, we are able to maximise the cross sectional variation of $ILLIQ_t^i$ to be explained by $N(d_2)$.

Table 1. Regression of illiquidity on conversion probability and other firm characteristics 2002-05

Constant	**$N(d_2)$**	BE_t^i	$Beta_t^i$	**Adjusted R^2**
0.126	-0.181			0.843
(9.846)	(4.608)			
0.022	-0.075	0.187		0.821
(2.379)	(3.841)	(1.858)		
0.123	-0.106		-0.032	0.792
(4.273)	(5.891)		(-1.171)	
-0.418	-0.164	1.325	0.021	0.779
(1.485)	(3.891)	(1.931)	(0.548)	

Regression of stock illiquidity $ILLIQ_t^i$ on the probability of conversion of convertible bonds issued against the stock $N(d_2)$, the book to market equity value BE_t^i and firm beta $Beta_t^i$. The table presents the means of the coefficients and the t-statistics are in parentheses. The portfolio of all stocks includes the stock characteristics of all 107 firms measured over the period in which the convertible bond is issued prior to maturity or exercise. The illiquidity measure used $ILLIQ_t^i$ is ratio of absolute daily stock return to its dollar volume averaged for each week. The probability of conversion is measured using $N(d_2)$ and is updated using market observed values for the risk free rate, dividend yield and an exponentially weighted moving average (EWMA) updating scheme for stock volatility. Book-to-market equity value is the ratio of total assets to firm market value. Book value is calculated as the market value of equity plus total assets minus the book value of equity. Beta is the firm beta measured as the covariance of the stock and the market portfolio divided by the variance of the market portfolio. The market portfolio is the best representative broad based market capitalisation index for Singapore, Korea and US firms respectively.

Amihud (2002) examined the relationship between returns and liquidity in a time-varying framework and showed a significantly positive relationship between expected market illiquidity and *ex ante* stock excess return, which suggests expected stock excess returns are, in part, a premium for stock illiquidity. The effects of illiquidity on stock excess returns differ across stocks by their size over time and therefore liquidity affects smaller stocks more strongly than larger stocks. We also conduct a second pass regression on the same set of firms grouped into four portfolios by size, quartiles 1 to 4, to detect the impact of conversion probability on stock liquidity for small and large firms. The results are presented in Table 2.

The results suggest that the probability of conversion is statistically significantly related to the liquidity of stocks against which convertibles are issued. The effect is more pronounced for stocks with a high probability of conversion and also for smaller stocks. The insignificant results for firms constituting the $N(d_2) < 0.25$ portfolio indicate that convertibles with a low probability of conversion have no effect on underlying stock illiquidity.

Table 2. Cross sectional regression of illiquidity on conversion probability and other firm characteristics 2002-05

Variable	All stocks	$N(d_2) > 0.75$	$0.75 > N(d_2) > 0.5$	$0.5 > N(d_2) > 0.25$	$N(d_2) > 0.25$	Quartile 1 (largest)	Quartile 2	Quartile 3	Quartile 4 (smallest)
Constant	-0.418	-0.217	-0.434	-0.427	-0.019	-0.484	-0.231	-0.089	-0.410
	(1.485)	(2.762)	(1.116)	(1.287)	(0.547)	(2.767)	(1.987)	(1.340)	(1.672)
$N(d_2)$	-0.164	-0.249	-0.226	-0.148	-0.070	-0.652	-0.298	-0.334	-0.219
	(3.891)	(5.772)	(4.778)	(3.343)	(1.882)	(5.667)	(4.892)	(3.991)	(3.361)
BE	1.325	1.194	0.790	0.981	2.101	0.882	1.017	0.887	0.790
	(1.931)	(2.466)	(2.050)	(1.326)	(3.210)	(1.898)	(0.991)	(0.845)	(0.549)
Beta	0.021	0.011	0.066	0.004	0.101	0.204	0.108	0.038	0.045
	(0.548)	(1.098)	(0.510)	(0.659)	(0.228)	(0.989)	(0.078)	(0.552)	(0.434)
Adjusted R^2	0.722	0.853	0.775	0.666	0.594	0.815	0.827	0.713	0.703

Cross sectional regressions of illiquidity on the probability of conversion of convertible bonds issued against the stock, and the stock characteristics of book to market equity BE_t^i and firm beta $Beta_t^i$. The portfolio of all stocks includes the stock characteristics of all 107 firms measured over the period in which the convertible bond is issued prior to maturity or exercise. The illiquidity measure used $ILLIQ_t^i$ is ratio of absolute daily stock return to its dollar volume averaged for each week. The probability of conversion is measured using $N(d_2)$ and is updated using market observed values for the risk free rate, dividend yield and an exponentially weighted moving average (EWMA) updating scheme for stock volatility. Book-to-market equity value is the ratio of total assets to firm market value. Book value is calculated as the market value of equity plus total assets minus the book value of equity. Beta is the firm beta measured as the covariance of the stock and the market portfolio divided by the variance of the market portfolio. The market portfolio is the best representative broad based market capitalisation index for Singapore, Korea and US firms respectively.

The book to market equity value BE_t^i is significant for the portfolio of all stocks, all portfolios of varying conversion probabilities and the three smaller quartile stock portfolios. This suggests that the expected return as reflected in the BE_t^i variable has a more significant effect on liquidity for smaller stocks and stocks with a higher than average probability of conversion. However the BE_t^i results are very significant for stocks with little chance of conversion, $N(d_2) < 0.25$, suggesting that investors treat all convertibles as straight debt and any illiquid effects are a result of firm size and performance. Perhaps surprisingly beta is insignificant for all portfolios.

Cross Sectional Model

We construct a cross sectional model by regressing stock characteristics against $ILLIQ_t^i$ as in equation (2). The model is estimated for the two years immediately prior to maturity for each bond generating 104 sets of coefficients. I choose the final two years of each bond since greater changes in $N(d_2)$ against $ILLIQ_t^i$ due to the time decay of the option can be observed in this period. The mean and standard error of the 104 estimated coefficients are calculated for each stock characteristic followed by a t-test of the null hypothesis of zero mean. The results, presented in Table 3 strongly support the hypothesis that illiquidity is strongly related to the probability of conversion after controlling for firm size, book to market equity and firm beta.

As shown in Table 3 it is apparent that a strong positive relationship exists between the probability of conversion and stock liquidity. The highly significant values for $N(d_2)$ across each regression confirm that stock illiquidity and conversion probabilities are inversely related, or conversely liquidity and conversion probability are directly related. The BE_t^i and $Beta_t^i$ parameters are statistically insignificant while firm size is statistically significant for each of the regressions. This is because firm size can be viewed as a coarse measure of illiquidity as shown in Amihud and Mendelson (1986) and therefore the inverse relationship between $Size_t^i$ and $ILLIQ_t^i$ is evident. In addition, small illiquid stocks should experience stronger effects of market illiquidity through a greater positive effect of expected illiquidity on *ex ante* return and a more negative effect of unexpected illiquidity on contemporaneous return. For large liquid stocks both effects should be weaker since these stocks become relatively more attractive in times of tighter market liquidity.

From these results we conclude that a strong positive relationship exists between liquidity and the probability of conversion, as measured by $N(d_2)$ along with a direct and positive relationship between liquidity and firm size.

Table 3. Cross sectional regression of stock illiquidity on conversion probability and other firm characteristics 2002-05

Constant	$N(d_2)$	$Size_t^i$	BE_t^i	$Beta_t^i$	**Adjusted R²**
0.226	-0.127				0.813
(7.856)	(3.608)				
0.168	-0.137	-0.042			0.834
(4.702)	(3.984)	(2.891)			
0.022	-0.075		0.187		0.772
(2.379)	(3.841)		(1.858)		
0.123	-0.106			-0.032	0.790
(4.273)	(5.891)			(-1.171)	
0.097	-0.219	-0.056	0.016		0.801
(2.087)	(3.099)	(2.443)	(0.576)		
-0.418	-0.164		1.325	0.021	0.721
(1.485)	(3.891)		(1.931)	(0.548)	
0.202	-0.098	-0.110	0.032	0.120	0.697
(1.219)	(2.882)	(2.088)	(0.242)	(1.656)	

Cross sectional regression of stock illiquidity $ILLIQ_t^i$ on the probability of conversion of convertible bonds issued against the stock $N(d_2)$ and the other stock characteristics of firm size $Size_t^i$, book to market equity BE_t^i and firm beta $Beta_t^i$. The table presents the means of the coefficients and the t-statistics. The cross section of stocks includes the stock characteristics of all 107 firms measured over the period in which the convertible bond is issued prior to maturity or exercise. The illiquidity measure used $ILLIQ_t^i$ is ratio of absolute daily stock return to its dollar volume averaged for each week. The probability of conversion is measured using $N(d_2)$ and is updated using market observed values for the risk free rate, dividend yield and an exponentially weighted moving average (EWMA) updating scheme for stock volatility. Book-to-market equity value is the ratio of total assets to firm market value. Book value is calculated as the market value of equity plus total assets minus the book value of equity. Beta is the firm beta measured as the covariance of the stock and the market portfolio divided by the variance of the market portfolio. The market portfolio is the best representative broad-based market capitalisation index for Singapore, Korea and US firms respectively.

LIQUIDITY, CAPITAL STRUCTURE AND SHARE VOLUME

The exercise of convertibles allows us to isolate the reasons why liquidity may change as the probability of conversion changes. For a bond that is approaching expiry with a high probability of conversion, the liquidity of the stock is expected to increase. Figure 2 shows the traded volume of stock against the share price and the maturity date for the entire portfolio of stocks. A weak relationship can be observed between volume traded and share price changes, although this relation is not consistent over the period. When the volume and stock returns are combined to measure liquidity through the $ILLIQ_t^i$ parameter, the correlation between stock liquidity and $N(d_2)$ is much clearer.

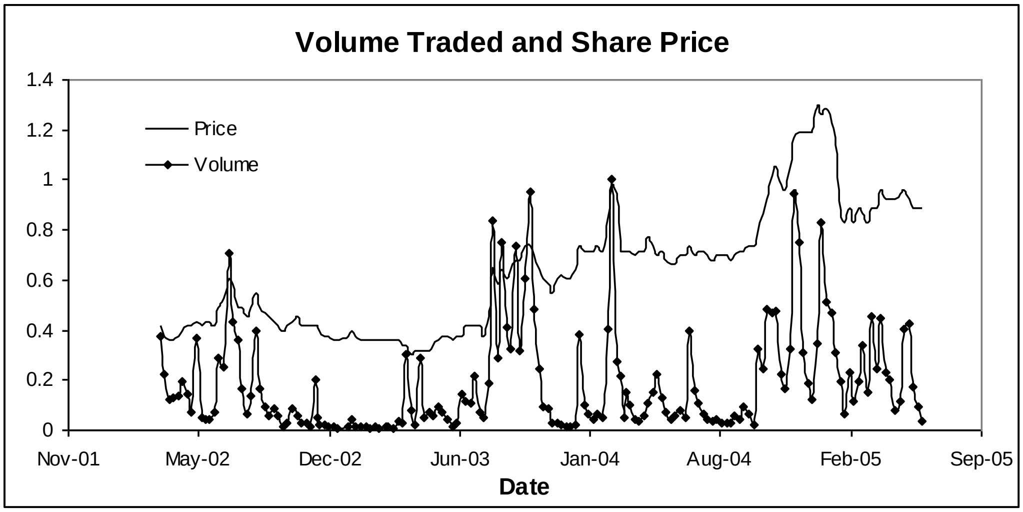

Figure 2. Traded volume of stock against the share price for a portfolio of firms that have issued convertibles against their own stock 2002-05. Both sets of data have been normalised for ease of comparison.

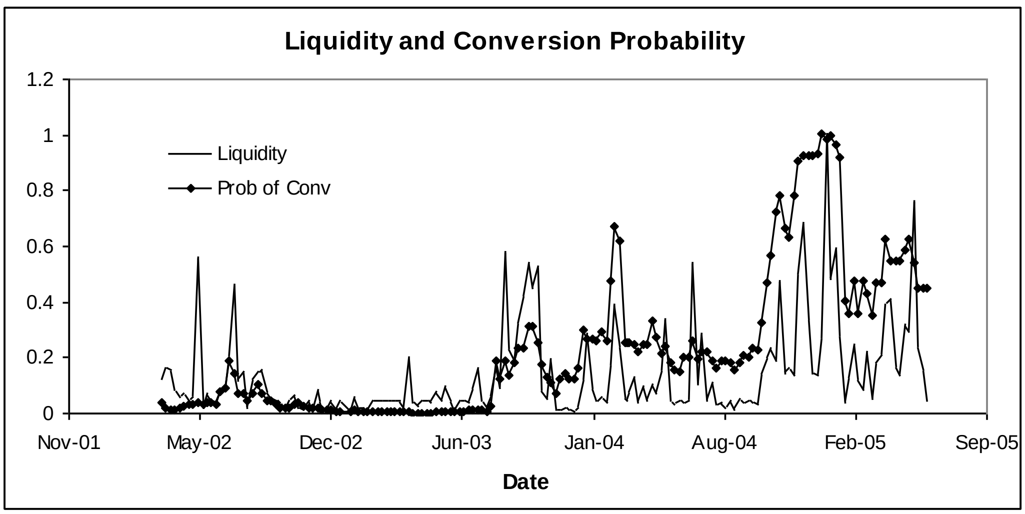

Figure 3. Liquidity against the probability of conversion for a portfolio of firms that have issued convertibles against their own stock. Liquidity is measured as the inverse of $ILLIQ_t^i$ and the conversion probability is measured using $N(d_2)$ 2002-05. Both sets of data have been normalised for ease of comparison.

Figure 3 shows the liquidity against the conversion probability for the entire portfolio of stocks. Increases in the share price clearly translate into increases in the probability of conversion however other factors such as volatility and the time decay of the option component of the convertible have an effect.

Table 4. Cross sectional of regression of illiquidity on the expected change in capital structure and tradeable share volume 2002-05

Variable	All stocks	$N(d_2)$ > 0.75	0.75 >$N(d_2)$ >0.5	0.5 >$N(d_2)$ >0.25	$N(d_2)$ > 0.25	Quartile 1 (largest)	Quartile 2	Quartile 3	Quartile 4 (smallest)
Constant	-0.227	-0.342	-0.229	-0.426	0.067	-0.229	-0.410	-0.623	-0.264
	(1.485)	(1.998)	(1.045)	(1.452)	(0.342)	(1.112)	(0.674)	(1.248)	(1.982)
ECS_t^i	-0.325	-0.547	-0.490	-0.210	0.034	-0.109	-0.323	-0.336	-0.326
	(2.931)	(2.445)	(2.288)	(2.378)	(0.671)	(2.234)	(2.096)	(2.797)	(3.001)
VOL_t^i	-1.164	-1.873	-2.099	-1.089	-0.309	-1.003	-0.562	-1.865	-1.992
	(3.891)	(4.554)	(2.432)	(4.385)	(1.223)	(2.887)	(2.781)	(3.589)	(3.779)
Adjusted R^2	0.912	0.943	0.875	0.686	0.394	0.785	0.792	0.760	0.814

Cross sectional regressions of illiquidity $ILLIQ_t^i$ on the probability of conversion of convertible bonds issued against the stock $N(d_2)$, the expected change in capital structure ECS_t^i and the expected proportion of shares available for trade upon conversion VOL_t^i. The portfolio of all stocks includes the stock characteristics of all 107 firms measured over the period in which the convertible bond is issued prior to maturity or exercise. The illiquidity measure used $ILLIQ_t^i$ is ratio of absolute daily stock return to its dollar volume averaged for each week. The probability of conversion is measured using $N(d_2)$ and is updated using market observed values for the risk free rate, dividend yield and an exponentially weighted moving average (EWMA) updating scheme for stock volatility. The firms are used are from Singapore, Korea and the US.

This change is due to the anticipated trade of a higher volume of shares, should the holder wish to immediately sell the newly converted stock, and is also due to the expected change in the capital structure of the firm (West, 2012). Given that the firm will have a significantly lower debt/equity ratio upon conversion this may heighten demand for the stock resulting in even greater liquidity.

Price reactions to convertible debt security offer announcements are negative and statistically significant (Lewis et al. 1999). A major feature of convertible debt issues is the impact of share dilution upon a likely conversion of the debt to equity. While investors will naturally incorporate the likely impact of additional shares being issued following conversion into the share price, there may be endogenous changes in the liquidity of the stock. This could be the result of a sudden increase in the number of tradable shares available, significant changes in capital structure and dividend payment expectations. It is clear from the research of Lewis et al. (1999) that some form of share dilution upon conversion is expected to have an impact on returns. However the impact of the positive effects from a change in capital structure and increased volume of shares is expected to override the negative effects of an expected large block trade of shares. This expectation manifests itself in the exercise probability of convertibles nearing expiry. For all convertible instruments used in the above analysis the proportion of shares to the pre-conversion float is less than 12 percent. Therefore only small effects from share price dilution are expected in these results. For larger proportions being converted upon expiry distortions in liquidity will probably be observed.

For a bond that is approaching expiry with a low probability of conversion, the expected change in liquidity is perhaps less clear. The expiry of the convertible bond can be refinanced with another convertible or straight bond, resulting in minimal change to the capital structure of the firm. No anticipated change in the volume of shares available in the market following conversion should therefore result in minimal impact on liquidity for a convertible that has a low exercise probability.

The following analysis searches for the reasons why liquidity increases as the conversion probability increases. The basic specification estimates are

$$ILLIQ_t^i = \beta_0 + \beta_1 ECS_t^i + \beta_2 VOL_t^i + \varepsilon_i\,, \tag{10}$$

where

$$ECS_t^i = E_t\left[\frac{D_T^i}{D_T^i + E_T^i}\right] \tag{11}$$

represents the anticipated new capital structure of the firm using the debt D and equity E at conversion date T, and

$$VOL_t^i = E_t\left[\frac{conv_T^i}{total_{\tau<T}^i}\right] \tag{12}$$

represents the ratio of the number of shares converted to the existing total ordinary shares available for trade for the i-th firm. The results from this regression are presented in Table 4.

Table 4 shows that both the expected change in the proportion of shares available for trade and the expected change in the debt equity ratio will result in greater liquidity. However the effect of the expected increase in tradeable volume is greater for most portfolios of stocks. This suggests that stock liquidity increases in anticipation of the expected market capitalisation increase upon conversion for firms with a higher probability of conversion. As fund managers rebalance their portfolios in anticipation of the change in the total equity of firms with a high chance of conversion, so the liquidity appears to increase. The expected changes are also greater for smaller firms as evident from the results. The results for the portfolio of stocks with little chance of conversion, $N(d_2) < 0.25$, are insignificant.

ACCOUNTING FOR CONVERTIBLES

Accounting for convertible debt involves reporting issues at the time of (1) issuance, (2) conversion and (3) retirement. The general method for recording convertible bonds at the date of issue follows the method used to record straight debt issues. Any discount or premium that results from the issuance of convertible bonds is amortized to its maturity date because it is difficult to predict when, if at all, conversion will occur. However, the accounting for convertible debt as a straight debt issue raises concerns.

If bonds are converted into stock, the principal accounting problem is to determine the amount at which to record the securities exchanged. Two possible methods of determining the issue price of the stock could be used: the market price of the stocks or bonds, or the book value of the bonds. From a practical point of view, if the market price of the stock or bonds is not determinable then the book value of the bonds offers the best available measurement of the issue price. The common stock is merely substituted for the bonds and should be recorded at the carrying amount of the converted bonds. Supporters of this view argue that an agreement was established at the date of issuance to pay either a stated amount of cash at maturity or to issue a stated number of shares of equity securities. Therefore, when the debt is converted to equity in accordance with preexisting contract terms, no gain or loss should be recognized upon conversion.

Finally the retirement of convertible debt can be considered as either a debt transaction or an equity transaction. If it is treated as a debt transaction, the difference between the carrying amount of the retired convertible debt and the cash paid should result in a charge or credit to income. If it is an equity transaction, the difference should be attributed to additional paid-in capital. It is important to note that the method for recording the issuance of convertible bonds follows that used in recording straight debt issues. Specifically this means that no portion of the proceeds should be attributable to the conversion feature and credited to 'additional paid-in capital.' Although objections to this approach have been raised, for consistency, a gain or loss on retiring convertible debt should be recognized in the same way as a gain or loss on the retiring of debt that is not convertible. For this reason, differences between the cash acquisition price of debt and its carrying amount should be reported in the income statement as a gain or loss. Material gains or losses on extinguishment of debt are considered extraordinary items. Nevertheless, failure to recognize the equity feature of convertible debt when issued creates problems upon early extinguishment. Assume a firm issues convertible debt at a time when investors attach an expected value to the conversion feature.

Subsequently the price of the firm's stock decreases so sharply that the conversion feature has little or no value. If the firm extinguishes its convertible debt early, a large gain occurs because the book value of the debt will exceed the retirement price. This treatment is considered to be incorrect, because the reduction in value of the convertible debt relates to its equity features, rather than its debt features. Therefore an adjustment to 'additional paid-in capital' should be made. However, present practice requires that an extraordinary gain or loss be recognized at the time of early extinguishment.

Since 2008 the accounting treatment for convertible debt that permits cash settlement on conversion requires the issuer to separately account for the liability and equity components of the debt. This allocation results in a discount on the debt component equal to the difference between the total proceeds received and the value of the debt component. This discount is amortized to earnings as deductible interest expense over the expected life of the convertible.

Convertible debt holders have bankruptcy rights that can be activated upon missed coupon payments. These rights lie ahead of preferred shareholders in the case where they fail to receive a schedule dividend payment. Convertible debt holders also have a legal interest in the company's assets senior to preferred shareholders, and many issues are structured so that they provide seniority over stockholders in specific assets and tangibles.

CONCLUDING REMARKS

Convertible bonds give their holders the ability to share in price appreciation of the company's stock. Convertible bonds give the holder the ability to share in the price appreciation of a company's stock with the safety of a floor price set at the debt level. The presence of downside protection makes convertibles attractive to many private and institutional investors searching for yield-enhancing securities with a degree of defense against adverse volatility movements. As a hybrid security, convertibles are generally priced as a straight bond and a call option on the underlying equity, although there are variants required to account for call and put features. We have shown that there is a positive relationship between the probability of conversion of a convertible bond issued on a company's stock, and the liquidity of the stock itself. As the probability of conversion increases, the liquidity of the stock also tends to increase. This effect is more pronounced for larger firms and firms with a higher than average chance of conversion in the 12 months prior to debt maturity. The exercise probability is thus an increasing function of expected stock liquidity.

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